Africa's mining potential: Current landscape, opportunities, and challenges

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Africa: An embarrassment of mineral riches

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The subject of mining often gives rise to fanciful claims and various forms of criticism, particularly in relation to funders and traditional international cooperation. All extractive activities are unsustainable by definition, since they consist of selling a product, whether in raw or processed form, taken from a finite source.

But our planet is going through a period in which achieving climate sustainability, *i.e.*, putting a stop to global warming, requires a huge increase in production of the minerals considered to be critical to a successful transition to renewable energies. Sustainability must therefore necessarily be built on the back of unsustainability, and renewable energies on finite mineral resources.

This is not the paradox it initially appears to be. Once we acknowledge that no energy source is fully green or clean, we can then focus on designing and structuring energy industries that produce as little carbon as possible, while controlling the negative effects—whether social or environmental—of the entire supply chain.

This urgent climate context is compounded by growing geopolitical tensions, driven by fierce competition between the great economic powers to secure their mineral supplies in the medium term.

Africa thus finds itself courted for both economic and strategic reasons. By way of example, between 2018 and 2022, 14% of global foreign direct investment (FDI) in the critical minerals sector was located in Africa. The book that AFD is proud to set forth before you today explores the mining potential of Africa, with a focus on the conditions for successful mining development in Africa, rather than on mapping out the continent's existing resources.

This would be a moot point if Africa had no mineral resources, but, as the book explains, the metals used in the manufacturing of electric vehicles (cobalt, copper, lithium, and graphite), fuel cells (platinum), and wind and solar power technologies (copper, lithium, cobalt, and nickel) are already being extracted and exported from the continent. Copper is also a major resource in Zambia and in the Democratic Republic of the Congo, and deposits of lithium and rare earth elements are present in smaller proportions on the continent.

But this book does not focus solely on the transition minerals, for mining in Africa is a much broader topic. Mining output began to increase markedly in the 2000s, mainly as a result of the liberalization of the mining sector (in both Africa and elsewhere), but also due to high gold prices and the development of new mines around the world, mainly by investors from the Anglosphere (including from Canada, Australia, and the United Kingdom).

This phenomenon accelerated in the second half of the 2010s, due to the increase in international investment (from China, the United Arab Emirates, India, Russia, the United States, Canada, Japan, and Morocco) in gold, but also in other resources (copper, cobalt, diamonds, manganese, bauxite, iron, titanium, and tin) and, from 2020, in new metals (such as graphite, platinum, rare earth elements, and lithium).

If the continent is to truly benefit from its mineral resources, mining sector jobs and tax revenue will need to grow. At present, both remain too low. Since mining resources are not renewable, the profits made from their extraction must be reinvested in education, human capital, and infrastructure, in order to prevent the present mining boom from being a mere flash in the pan.

The number of jobs directly linked to the mining sector is thought to be around 2 million across the continent—a modest figure given the size of Africa and its population. We can therefore immediately dismiss the idea that social development in Africa can be based solely on the mining sector, for this would be impossible even if the number of jobs were to double or triple. In all conceivable scenarios, with the exception of a limited number of countries or perhaps even regions, the contribution of mining will necessarily be supplementary to that of other sectors. The ability to develop mineral processing activities on the continent will therefore be crucial to achieving greater social impact.

In terms of tax revenues, the book explains how the mining boom of the 2000s, caused by rising metal prices, led to a flood of investment for which African governments were not adequately prepared. This has resulted in corporate tax rates in the mining sector being generally lower than those for general taxation.

Finally, since the benefits of mining are still typically concentrated in a small geographical area, it is vitally important to give greater consideration to environmental, energy, and social issues in and around mines. While mining is often profitable, this profit can be a source of land use conflicts and environmental degradation, with the potential for conflict between the populations who lived in the area before mining and those who have since moved to production sites.

This report seeks to take a clear-sighted approach to this topic: first, by refusing to ignore the problems associated with the supply of the minerals that are critical to the success of the energy transition, and second, by avoiding a naive or idealistic view, given that the extractive sector carries greater risks than other economic activities.

We hope this book successfully avoids these pitfalls.

1. Mining in Africa today: What, who, and where?

Mining output began to increase significantly in the 2000s in both Africa and around the world more broadly, mainly as a result of the liberalization of the mining sector, high gold prices, and the opening of new mines across the globe, primarily by investors from the Anglosphere (from places such as Canada, Australia, and the United Kingdom).

In the second half of the 2010s, this growth was further accelerated by the increase in international investment (notably from China, the United Arab Emirates, India, Russia, the United States, Canada, Japan, and Morocco) in gold, but also in other elements (copper, cobalt, diamonds, manganese, bauxite, iron, titanium, and tin) and, from 2020, in new metals (such as graphite, platinum, rare earth elements, and lithium).

Africa has played an important role in this global mining boom, albeit still with a relatively modest share of investment: Between 2018 and 2022, less than 14% of global foreign direct investment (FDI) in the critical minerals sector was located in Africa.

What minerals, and where?

Across Africa, mining production is essentially focused on 15 minerals. Precious metals represent 46% of the value of the continent's metal exports, a long way ahead of ferrous metals (23%), non-ferrous metals (19%), and industrial minerals (12%).

The term "energy transition metals" is used to refer to those used in the manufacturing of electric vehicles (such as cobalt, copper, lithium, and graphite), fuel cells (platinum group metals), and wind and solar power technologies (copper, lithium, cobalt, and nickel). These represent nearly 29% of exports.

Precious metals: Gold and platinum group metals (PGMs)

The current dynamism of the African mining sector is largely driven by gold production. South Africa's gold reserves are the largest on the continent, and the third largest worldwide.

West Africa is, however, becoming a major player in gold mining, particularly in Ghana, Burkina Faso, and Mali, which have sizable reserves that appear to be as-yet relatively untouched. The platinum group metals (PGMs) needed to manufacture fuel cells are primarily produced in South Africa, which is the world's biggest producer of palladium and platinum. South African gold mining production has, however, seen a big drop, due to the immense depth of several major historic extraction sites, which have reached their limits of exploitation.

Ferrous metals: Cobalt, manganese, coltan, chrome, nickel, and iron

Africa is by far the global leader in cobalt production. The continent has over 50% of global reserves of this non-ferrous metal, 48% of which are located in the Democratic Republic of the Congo (DRC).

In 2022, over 58% of known global manganese reserves were concentrated in Africa, and it was the global leader in manganese production. Africa is also the biggest producer of coltan (72% of global production) and chrome (50% of global production).

The continent remains a modest producer of nickel and iron, however, accounting for 4% and 3% of global production respectively, primarily in South Africa. Although many other African countries have sizable reserves, they remain largely untapped. This is particularly true for West Africa, where some of the world's largest deposits of these minerals are found.

Non-ferrous metals: Bauxite, copper, zinc, and lithium

Africa is a major player in bauxite production, essentially due to the vast resources located in Guinea. In 2022, this country had the world's largest reserves of bauxite, accounting for 23.8% of the global total.

Africa also has large quantities of copper that remain as-yet untapped. The continent's main exploited reserves are shared between the DRC and Zambia, in an area known as the "Copperbelt." These two countries have the seventh and eleventh largest global reserves of this metal respectively.

In zinc production, however, Africa is a minor player in global terms, accounting for just 4% of output. South Africa has recently become its leading producer, accounting for 30% of total production on the continent.

Numerous extraction projects are being pursued for rare earth elements—in Burundi, Tanzania, Angola, Madagascar, and South Africa—and for lithium—in the DRC, Mali, and Zimbabwe—but Africa remains a small player in production of these minerals.

Industrial minerals: Diamonds, phosphate, and graphite

Africa is particularly well endowed with diamonds, accounting for around 43% of global reserves in 2022, chiefly divided between South Africa, Namibia, Botswana, the DRC, and Angola.

The continent also has vast phosphate reserves (around 80% of the global total), although in practice, African phosphate production is massively dominated by Morocco. This country alone accounts for around 70% of global reserves, but it is still only the world's second largest producer, after China.

Finally, in relation to graphite, Africa accounts for 20% of global production and has 20% of global reserves. Mozambique is the leading producer in Africa, followed by Madagascar and Tanzania.

Trends in mineral exploitation

A dual trend can be seen in the attribution of exploration budgets for mining resources in Africa. Although countries with an established history of mining still attract larger exploration budgets, they are losing momentum in mining production in favor of new emerging countries.

The majority of African production of a few key metals has long been concentrated in a small number of historic mining countries. The most significant of these is South Africa, along with the DRC, Ghana, Burkina Faso, and Zambia, which are the leading destinations for exploration budgets in Africa and had the largest number of open mines in their territories over the period 2000–2021.

Since 2012, however—and despite a small rebound in 2018—exploration budgets targeting these countries appear to have stagnated, or even declined, revealing the relatively weak attraction of the African mining sector. While this very relative loss of momentum is essentially due to the fall in metal prices, it is important to note that exploration spending in these countries has not yet picked up, even though the mining sector is growing again at the global level. The main reasons for this, in spite of the high quality of the continent's resources, are the inadequacy or fragility of some of its infrastructure (energy, rail, and airports), security concerns, and a negative perception of the political and economic risks (the energy costs attributable to the sector).

Overall, there is renewed interest in the mining sector among African countries, in particular in Senegal, Côte d'Ivoire, and Mali. In parallel with this, several countries that have not historically had substantial mining operations on their territory are trying to gain a foothold in the market by developing their mineral mapping and by introducing policies to attract exploration and potential investment. Cameroon, the Republic of the Congo, Uganda, Chad, Togo, Benin, Djibouti, and the Central African Republic (CAR) are thus developing several mining projects, even though they do not currently have any major industrial mines.

The emergence of new actors

The liberalization of the sector, driven by the reforms promoted by the World Bank in the 1980s, was accompanied by the long-term establishment of Canadian, Australian, and, to a lesser extent, Swiss and American actors in the African mining sector.

Even now, an analysis of the share of total African mining production by company reveals that Western mining companies massively dominate the sector, accounting for 80% of mining investment in Africa. Anglo American (United Kingdom, formerly a South African company), Glencore (Switzerland), and First Quantum Minerals (Canada) are the leading players in African mining production, with these three companies alone accounting for nearly a quarter of total production on the continent in 2018. These Western actors continue to be very active in financing exploration projects and expanding existing mines.

The mining boom of 2009-2013 also saw the arrival of new "emerging" actors, most notably China, which has dramatically increased its position on the continent. Since then, in line with its "Going Out" policy,[1] and in response to its growing demand for minerals, China has thus established a strong

1. The "Going Out" policy is the Chinese government's strategy for promoting Chinese investment abroad.

presence in the African mining sector. In 2018, Chinese companies accounted for 41% of African cobalt production and 28% of African copper production.

Russia, the other giant in the mining sector, also took advantage of the opening up of the sector to gain a foothold in Africa, primarily in diamonds and platinum in southern Africa, and gold in West Africa. It has noticeably increased its presence on the continent since the first international sanctions were imposed following its annexation of Crimea in 2014, and it continues to maintain close relations with countries such as Mali, Zimbabwe, South Africa, and the CAR.

Although its role is less closely scrutinized than that of China, India is also a major player in the African mining sector, primarily in southern Africa. India's main objective is to secure its supply of coal, of which it is a major consumer (this fuel accounts for 70% of its energy mix). It is also positioning itself in African iron to supply its steel industry, but also in zinc, lead, copper, gold, and precious metals, via the Indian mining giant Vedanta.

The Gulf states (the United Arab Emirates, Saudi Arabia, and Qatar) have long been partners for the African gold trade, and they are now gradually establishing themselves in the diamond sector and in industrial metals such as cobalt and aluminum.

South Africa has always been an outlier on the continent. It has long been a leader in African mining production, and it now has a large number of companies that operate in its own territory, in southern Africa (its immediate environment), and in the rest of the continent, which are comparable in size to the biggest international investors active on African soil. South Africa has developed its own global players in the mining industry, including AngloGold Ashanti, Anglo American Platinum, Impala Platinum, and Gold Fields, which rank among the world's top fifty mining companies in terms of market capitalization.

Morocco has also developed a pan-African strategy through major actors such as Managem and the state-owned Office Chérifien des Phosphates (OCP). OCP has a monopoly on the extraction, processing, and sale of phosphate in Morocco, and it is the world's largest phosphate company (with a market share of 31%). The OCP Group is pursuing an expansion strategy across twelve African countries. Managem, meanwhile, is the leader in the Moroccan metal mining sector, operating 15 mines across eight African countries, including Guinea, Gabon, the DRC, and Sudan.

African countries have therefore developed ambitious policies to benefit from the mining boom in critical minerals for the energy transition, but also in other valuable minerals such as gold. These countries now need to devise new policies to encourage the processing of these minerals on the continent, which would increase their tax revenues and enable them to reap greater economic benefit from their resources, while ensuring they are able to manage the resulting environmental and social impacts.

2. The actual economic contribution

While mining is presented as a major lever for development by most of the countries concerned, numerous regional and international financial institutions are urging consideration of the **macroeconomic consequences** of this rapid development on **exports, growth, employment**, and of course **tax revenues**. How can the sector be supported in a way that enables it to best serve sustainable growth for the benefit of all?

The role of the mining sector in these economies

Remarkably, exports of mining products as a share of gross domestic product (GDP) fell only slightly during the fall in mineral prices in 2015, and have then risen sharply since 2016. The share of mining exports in the value of total exports has also continued to grow: The average for the continent was 25% over the period 2013-2021, compared with 14% over the period 2005-2012.

Mining exports account for a very significant share of total exports in many African countries, representing over 50% in Zambia, the DRC, Mauritania, Guinea, Mali, and Burkina Faso. The sector has bounced back particularly strongly in Burkina Faso, Ghana, and Mali for gold, and also in Sierra Leone and Guinea. Over the past ten years, mining exports have largely consisted of gold and diamonds (which together accounted for 12% of the continent's total exports), metals (7.5%), and minerals (6%).

Even so, the contribution to GDP remains low, whether based on mining product exports as a share of GDP, mining rents as a share of GDP, or mining resources as a share of total wealth. On average, the figure is 10%. In comparison, for oil-producing countries, oil resources generally represent 30%

of GDP. It therefore seems unlikely that mining-dependent African countries have been major victims of a "resource curse" in recent years, since their dependence on natural resources is lower than that of the energy resource-dependent countries typically subject to this curse, and given that such economies have become less dependent on these mining resources over the last ten years (though another boom is expected to occur in the near future).

Overall, the mining sector typically generates few jobs across the African continent as a whole: barely 2 million in the 38 countries for which the International Labour Office (ILO) collects data, or 1% of the continent's workforce, and there was little change in this figure over the 2010s. However, this figure must also be considered in light of the jobs created around mines and in comparison with other extractive industries. Employment in mining-related services remains low—estimated by the ILO at 4% of the workforce—but the "indirect jobs" effect may be bigger than *via* services to the mining sector alone, if effects linked to local supply are taken into account. The World Bank study (2017)[2] on local employment in the mining sector in South Africa, Mali, and Ghana, as defined broadly, found multipliers of between 1.5 and 1.8. In the view of these authors, this reflects a limited effect, due to the capital-intensive nature of the sector and the lack of local supply opportunities.

The reality of the "resource curse"

In relation to "Dutch disease,"[3] there is ample evidence in the literature to support the first part of the argument that natural resource windfalls lead to under-industrialization in major mining countries as a result of the sectoral reallocation predicted by Dutch disease models, i.e., a reduction in the manufacturing sector and an increase in imports. This is shown by our longitudinal analysis for the period 2005-2020, with exchange rate appreciation in the short term concomitant with lower industrialization in the medium term, though there is a more marked effect on energy resource-dependent countries than on mining-dependent countries. However,

2. Chuhan Pole P., A.L. Dabalen & B.C. Land (2017). "Mining in Africa: Are local communities better off?," Africa Development Forum, World Bank Group, Washington, DC. (http://documents.worldbank.org/curated/en/517391487795570281/Mining in Africa are local communities better off).
3. "Dutch disease" is the phenomenon that occurs when weak development of the manufacturing sector is driven by increased export revenues causing currency appreciation. Manufacturing exports thus become less favorable than imports.

studies fail to demonstrate the second part of the argument: the idea that real exchange rate appreciation and deindustrialization reduce growth or income in mining countries. Our longitudinal analysis by country type for the period 2005-2020 shows no relationship in the data, with no difference in growth rates over this period.

Dependence on natural resources is often seen as an obstacle to diversification, particularly of exports: an argument linked to that concerning under-industrialization. While the share of African exports represented by natural resources has grown together with extractive activity, our longitudinal analysis shows that the number of products exported by mining-dependent countries has increased, and their export concentration has therefore fallen slightly. Since 2016, however, this trend has slightly reversed with the rise in the price of mining products. It will therefore be crucial for mining countries to process some of their resources in order to diversify the products they export—as set out in the roadmap of the Africa Mining Vision (AMV).

A third argument to support the idea that abundant resources have a negative impact on growth is based on the observance of trends toward greater volatility in terms of trade, leading to reduced investment in physical capital and boom-bust cycles that can make it more difficult to implement prudent fiscal policies. While debt stock does appear to have slightly increased since 2010 in mining-dependent countries, the decline in private investment since 2014 does not appear to be any more marked in these countries than in other African countries.

It is important to highlight the role played by "good" or "bad" governance in these findings. This is because an abundance of resources creates rents that can easily be appropriated in countries where institutions are weak. In the absence of strong institutions, resource rents can encourage rent-seeking behavior, increase corruption, undermine the quality of institutions, and, in extreme cases, even lead to violent conflict. In highly energy resource-dependent countries, but also in mining-dependent countries, an increase in corruption—already very high—has indeed been observed over the last fifteen years. The longitudinal analysis also shows a higher level of political violence index values in countries that are highly dependent on energy and mining resources.

Although there is little evidence of a negative effect on income and growth, non-monetary indicators of well-being are significantly lower in energy resource-rich countries such as Angola, Gabon, and Nigeria. This is often explained as the result of the volatility and uncertainty associated with revenue from natural resources, which leads to lower investment in human capital. But our longitudinal analysis for the period 2005-2020 shows that investment in human capital has grown more in mining-dependent countries than in other countries on the continent; while the Human Development Index (HDI) is lower in these countries, its trend over the period is similar to that of countries not dependent on non-renewable resources. Similarly, the recent article by Masi *et al.* (2020)[4] shows that the presence of a strong natural resources sector does not necessarily translate into a lower human development score.

In conclusion, mining countries in Africa do not appear to have fallen victim to the kind of resource curse observed in oil-producing countries: The exploitation of mining resources does not appear to be bad for economic growth in itself, though it can contribute to a deterioration in governance and in political institutions. Under-industrialization and the volatility of mineral prices may also play a significant role, though not as much as initially expected. It should be noted, however, that since the fall in mining product prices over the period 2011–2016, the mining sector has never been large enough to disrupt macroeconomic aggregates in the manner of oil, gas, or coal. The very real macroeconomic disruption that is observed in countries dependent on these energy resources in Africa suggests that if mineral prices were to rise sharply, similar imbalances might be observed in the future.

Mining taxation is a subject that merits in-depth discussion. The mobilization of public resources is a priority in most African countries, and the mining sector is an important source of income for countries that are highly dependent on the extractive industries. Mining taxation is a strategic issue, since the goal is to provide governments with more revenue, while at the same time ensuring that mining rents are shared more fairly in periods of higher prices and growth, and encouraging companies to invest in order to sustain and continue to develop this activity.

4. Masi T., A. Savoia & K. Sen (2020). "Is there a fiscal resource curse? Resource rents, fiscal capacity, and political institutions in developing economies," WIDER Working Paper 2020-10, World Institute for Development Economics Research (UNU-WIDER). (https://doi.org/10.35188/UNU-WIDER/2020/767-5).

A pivotal moment

The energy transition brings with it increased demand for mining resources, or critical minerals. Alongside this, the mining boom gathered pace in the second half of the 2010s due to the growth in international investment in gold, along with other resources (copper, cobalt, diamonds, manganese, bauxite, iron, titanium, and tin).

Africa possesses vast natural resources, including minerals. This is therefore an opportune moment for African countries to review their current tax regimes in order to encourage more effective mobilization of the revenue that will be needed to support their own energy transitions.

Unlike the oil sector, in which countries and companies have largely adopted production (or revenue) sharing agreements, the mining sector is dominated by the concession model. States thus need to optimize their tax systems with a view to recovering part of the revenue generated by mining, and to do so with a view to rebalancing. The debate about how to optimize fiscal policy in order to enable African governments to capture a "fair" share of rents is therefore resurfacing on the back of rising prices for some of the key strategic minerals used in the energy transition.

It is crucial to avoid reproducing the cycle of the 2000s, when the wave of privatizations from the 1990s combined with the rise in metal prices in 2000 to produce a flood of investment, but African governments were not adequately prepared to negotiate with mining multinationals, and their mining codes were not adapted enough to allow them to generate decent revenue from the mining operations carried out by major corporations in the sector. Tax incentives were also included too systematically in the early mining agreements that were negotiated, few of which have enabled governments to collect the revenue they were expecting. A famous example of this asymmetric relationship is the "Chinese contracts" signed between Beijing and Kinshasa between 2007 and 2008, worth several billion US dollars (USD).

Since 2010, a rebalancing of interests

Since 2010, countries producing minerals—both critical and otherwise—have been drafting new mining codes to rebalance the interests of all stakeholders.

Mining royalties—which are typically paid to local authorities rather than to central government—are rising, and their rates are increasingly variable or progressive based on the price of raw materials. On average, corporate tax (CT) rates for the mining sector are generally lower than those for general taxation, but there is less use of exemptions under mining agreements (indeed, a lower rate that is actually applied and complied with is preferable to a higher one that is not).

States are now more likely to be given shares free of charge, which enables them not only to receive dividends but also to gather information on the operation of the mine that can be useful in determining the true profitability of the project and therefore the appropriate level of taxation.

Finally, there has been a resurgence of rent taxes, which can be used to compensate losses arising from underestimates (intentional or otherwise) of potential mineral prices by companies.

While taxes have increased overall, an increase in the tax rate does not guarantee that the revenue will actually be collected.

Taxation over the past decade (2010–2020)

Despite the progress made, revenues from Africa's mining sector remain below their potential. The 2013 Africa Progress Report[5] drew the attention of the international community to this costly paradox for mobilization of domestic resources in Africa. Moore and Lundstøl (2016)[6] observe that while turnover in the sector grew by a factor of 4.6 during the most recent boom from 2000 to 2010, tax revenues only increased by a factor of 1.15.

Things were little better over the 2010s, with tax revenues still significantly lower—by a factor of 2 to 5—than mining rents from extraction over this period.

The challenges of mining taxation

Revision of mining codes is therefore not enough in itself and can even prove counterproductive, as frequent changes in levels of taxation can make things difficult for investors and lead them to abandon their projects.

For while the decline in mining revenues is partly due to the fall in mineral prices through to 2019, it is also the result of the recurrent challenges African countries face when it comes

5. Africa Progress Report 2013 – Equity in extractives: Stewarding Africa's natural resources for all," Africa Progress Panel.
6. Moore M. & O. Lundstøl (2016). "What have we learned about mining taxation in Africa?," Summary Brief Number 1, International Centre for Tax & Development (ICTD).

to mining taxation: the limited capacity of their tax and mining authorities; the race to the bottom still being waged by the continent's economies; the non-taxation of the artisanal sector, which is a major producer of transition minerals; and the stabilization clauses included in historic agreements, which freeze tax provisions over periods of ten to thirty years and make it effectively impossible to apply new tax rules.

The problem of tax noncompliance

The biggest challenge remains aggressive tax optimization by multinational companies, under which they reduce profits declared in high-tax countries in order to transfer them to countries with more favorable tax rates.

A number of studies have found a relationship between tax rates and mining company profits. For example, Beer & Devlin (2021)[7] show that a 1% increase in the corporate tax rate leads to a 3.5% reduction in the corporate tax base. In 2021, the International Monetary Fund (IMF) estimated that 15 African countries were losing between 450 and 730 million USD a year in corporate tax revenue due to profit transfers by multinational companies.

The strategy most often used in the mining sector to erode the tax base and transfer profits is abuse of transfer pricing rules. Companies that sell minerals to their foreign subsidiaries for processing may thus do so below the actual price in order to reduce the profit, and therefore the tax levy, in the country where the mineral is originally extracted. Other similar techniques are also used, such as overvaluation of investment costs, high levels of debt to affiliates, treaty shopping (Kinda & Tagem 2023),[8] and indirect transfers of interests in mining companies (Albertin et al. 2021).[9]

7. Beer S. & D. Devlin (2021). "Is there money on the table? Evidence on the magnitude of profit shifting in the extractive industries," IMF Working Paper No. 2021/009.
8. Kinda H. & A.M.E. Tagem (2023). "Double taxation treaties and resource revenue mobilization in developing countries: A neural network approach," WIDER Working Paper 2023/125. Helsinki: UNU-WIDER (https://doi.org/10.35188/UNU-WIDER/2023/433-5).
9. Albertin G., B. Yontcheva, D. Devlin, H. Devine, M. Gérard, S. Beer, I. Jankulov Suljagic & V.V. Thakoor (2021). "Tax avoidance in sub Saharan Africa's mining sector," IMF Departmental Paper No. 2021/022.

The implementation of transfer pricing standards and price floors

Steps have been taken by the international community to tackle this problem, notably through actions to combat tax base erosion and profit shifting (the OECD BEPS project), and through transfer pricing standards. For example, to determine the sale price of copper between related parties, Zambia has adopted a rule known as the "sixth method," which uses publicly quoted prices, adjusted to the specific terms of the sale, to calculate the proceeds of the sale for taxing profits. In 2020, the Zambia Revenue Authority (ZRA) won a legal case against a Glencore subsidiary, Mopani Mining Copper PLC, that was abusing copper transfer prices to avoid taxation.

3. Environmental and social issues

Against the backdrop of competition between the major global economies, there is a danger that some of the negative socioeconomic and environmental impacts specific to the mining industry will be deliberately ignored in a bid to rapidly secure resources. But failure to consider these issues could compromise efforts to mitigate climate change and protect biodiversity, and would repeat past mistakes by systematically exploiting developing countries and treating them merely as a source of basic raw materials. Chapter 3 thus sets out to place African mining in its local context, with a critical exploration of the mechanisms by which the sector can have serious social and environmental impacts on mining areas.

The influence of mining codes on governance of African mines

The governance of the mining sector plays a central role in determining its social and environmental impacts. It is primarily guided by mining codes, which define the "rules of the game" for mining companies, including in relation to allocation of mining titles, regulation of mining operations, and involvement of local communities. African mining codes have also been influenced by the international financial institutions (IFIs), which since the 1990s have supported a shift in regulation in favor of the private sector. But mining governance goes beyond the mining code of a single country; it also includes an extensive set of non-binding standards that serve as a benchmark for the development of international mining projects, in particular for assessing their social and environmental impacts. These standards, integrated into what are known as "fourth generation" mining codes, include alternative royalty mechanisms that have been introduced by states, the international community, and civil society to plug the gaps in mining codes. They are influenced by various international standards, such as the Equator Principles, World Bank standards, OECD due diligence guidance, and the Sustainable Forestry Initiative (SFI) standards.

Mining projects and the limitations of mining companies' corporate social responsibility policies

The initiation phase of a mining project is a crucial stage encompassing exploration, impact assessment, and negotiation with local communities. This stage is characterized by complex interactions between the various teams within mining companies, which need to ensure the operation will be profitable enough to absorb the costs, while accounting for negative externalities. The process of obtaining exploitation permits is often subject to impact assessments conducted by consulting firms that are nominally independent but whose impartiality may be called into question given their economic dependence on mining companies. These studies are essential for assessing the social and environmental costs and for obtaining the permits needed for the physical construction of mining sites. Finally, this first section of the chapter discusses the complexities of financial compensation for communities impacted by mining, and in particular the difficulties encountered by these communities in negotiating or rejecting the terms of compensation. Analysis of this stage reveals the power dynamics and potential conflicts that can arise during these negotiations.

Mining sites, which are often located in remote rural areas, generally have a distinct lack of public infrastructure, such as health centers, schools, and water and electricity networks. Although the establishment of an industrial mining site leads to the creation of essential infrastructure such as roads and water and electricity plants, the construction of other vital infrastructure such as health centers and schools is often delegated to corporate social responsibility (CSR) policies. However, this approach often creates an imbalance between the public services provided by international mining companies and those provided by the state. Infrastructure is also often built in the immediate vicinity of extraction sites, rather than to suit demographic realities and local needs. This often results in longer travel times for local communities, without new roads always being built to remedy the situation.

The development of mining sites may also result in the forced displacement of the populations living in the areas directly affected, but not all inhabitants of neighboring areas necessarily benefit from displacement and relocation programs, meaning that some communities suffer from the effects of mining without receiving adequate compensation.

The territorial impact of mining in Africa

In Africa, as elsewhere, mining has a profound effect on the surrounding territory. Analysis of the territorial impact of mining reveals spatial transformation and its repercussions on local communities. It indicates the pressure exerted on land and water resources by the expansion of mining activities, leading to a reduction in agricultural land and pastureland. These changes intensify conflicts of use and exacerbate soil erosion, accentuating existing environmental problems. The transition from collective to private ownership models, often under the influence of mining development and national legislation, often stokes social tensions and a feeling of dispossession among local populations.

The various stages of mineral extraction are also a major source of pollution for the territory, with serious environmental and health repercussions. They include water, soil, and air contamination, with a harmful impact on both biodiversity and the health of local communities. Management of mining waste and the use of toxic chemicals such as cyanide and mercury are major problems. The effects of this pollution can endure long after mines have closed, requiring major work to rehabilitate sites and restore ecosystems. Mining companies have a role to play in mitigating these impacts, in particular by complying with environmental standards to limit collateral damage.

Territorial reconfiguration linked to the impact of mining, and transformation of the socioeconomic fabric

The opening of a mine tends to alter the representations and perceptions that local communities hold of their territory. It has an impact not only on the consumption of resources such as land and water, but also by redefining geographical space, with a profound effect on areas of activity and the lives of local communities. Mines create physical barriers that disrupt the movement of people and livestock, increase journey times, and in some cases overload existing infrastructure such as roads, exacerbating safety and environmental problems.

These changes have a significant impact on local communities, which are often left without adequate compensation or the ability to seek legal recourse. It is therefore crucial to take these impacts into account as part of sustainable development policies and territorial planning.

An in-depth analysis of the impact of mining on local communities in Africa highlights the profound changes caused by the opening of mines, particularly in rural areas. This transformation is accompanied by a metamorphosis of the landscape and of traditional ways of life, leading to a shift in economic activities and increased pressure on local resources. Although mines are often presented as a source of employment, the reality is more complex: A good number of jobs remain out of reach for many people, and unemployment is emerging. At the same time, the opening of a mine intensifies economic and social inequalities, exacerbating inflation in property and consumer goods and impacting the lives of indigenous communities. In short, mining has a significant effect on the socioeconomic structure of mining territories, with both positive and negative repercussions for local populations.

Conflicts of use and the case of African mining towns

Conflicts of use reflect the socioeconomic consequences of mining on local communities. Later in this book, we highlight the transformation of traditional economic activities, such as pastoralism, along with the immense damage done to them by land encroachment by mining companies. This situation often forces local populations to change their way of life, exposing them to unemployment and job losses, and therefore loss of income. Local inflation caused by higher wages and population growth also affects the price of land, housing, and consumer goods. Finally, in some cases the environmental compensation programs that are supposed to protect the environment paradoxically worsen the socioeconomic situation of communities by restricting their access to natural resources.

The socioeconomic challenges faced by mining towns in Africa reflect rapid demographic growth and the associated problems, such as inflation, inequality, and economic dependence on mining activities. Social tensions emerge between indigenous and non-indigenous populations, with an impact on housing and services. The sustainability of urban planning can also be an issue, as shown by the example of Kolwezi in the DRC, where mining on the outskirts of the city is creating health and environmental hazards.

Artisanal mining: Current status and future trends

The considerable growth in artisanal mining in Africa, particularly in artisanal gold mining, has made this form of exploitation a crucial economic activity in some West African countries, and a significant contributor to global gold production. Despite its important economic role, artisanal gold mining is often informal, and it can cause social, environmental, and security problems. Local communities are affected by displacement, loss of livelihoods, and health problems caused by the use of toxic chemicals. Local conflicts and security are also major issues, with artisanal gold mining areas becoming targets for ambushes and the funding of terrorist activities. The environmental impact includes land degradation, water pollution, and soil erosion, posing challenges for site restoration after the extraction phase.

4. The opportunities in mineral processing

In recent years, the acceleration of the energy and digital transition has increased global demand for critical minerals exponentially: Between 2017 and 2022, demand for lithium jumped by 200%, cobalt by 70%, and nickel by 40%. By 2030, the demand for critical essential minerals is expected to increase by a factor of 3.5.

Africa, which has vast resources and deposits of these minerals, hopes to take advantage of this to pursue industrialization based on increased local processing of minerals, thereby strengthening its role in global value chains.

Such ambitions must, however, be analyzed in the light of the geological, political, and environmental realities of each country, as well as the international context. Over time, they may notably be affected by the rise of “green protectionism” among the great economic powers and the numerous partnerships proposed to African countries.

Africa’s dominant position

The term “critical minerals” encompasses a range of resources essential to the construction of the infrastructure required for the energy and digital transition (including solar panels, wind turbines, electric vehicles, touch screens, data storage, and system connectivity).

Various lists of these minerals have been drawn up by critical mineral-consuming countries, each based on assumptions about future demand, future use, and availability, and thus reflecting the strategic nature of the target mineral for the country.

Africa has a dominant position in the production of four minerals that are considered critical according to several lists: cobalt, manganese, chrome, and platinum. The continent is also a major producer of five other minerals: bauxite, graphite, copper, nickel, and zinc.

An opportunity for the continent?

The prominence of Africa in this area has prompted the governments of countries on the continent to suggest to investors that they process minerals locally, in order to create more added value and thus generate local and regional economic benefits.

These states intend to capitalize on the new movement toward free trade and regional integrity (with the establishment of the African Continental Free Trade Area, or AfCFTA) by developing competitive regional value chains (RVCs). This new policy is central to the agenda of the African Minerals Development Centre (AMDC), established by the African Union (AU).

With time and support from good incentive policies, most of these projects could be realized and made sustainable. Some countries less well endowed with minerals may need to adopt more modest targets, notably the development of networks of suppliers of products and services to mining companies, from vans and spare parts manufacturing to catering, surveying, and human resources services, incorporating local content requirements to lower the barriers to entry for local companies.

While such services will not have the status or economic potential of refining, they will help to strengthen local upstream supply chains and will add useful value to the exploitation of minerals in Africa.

Mineral processing

To maximize profit from their mineral resources, African countries could therefore develop a local mineral processing industry. Across the sector value chain, the extraction of minerals is much less profitable than the downstream stages of producing goods from minerals. This would also contribute to the continent's long-awaited industrialization. The example of copper provides a useful illustration of the challenges that will need to be overcome: In Zambia and the DRC, while mining production increased in the 2010s, there was a fall in semi-finished goods as a share of exports.

Battery production

The ambitions of some African countries extend to the production of batteries for electric vehicles, which will also depend on the existence of a market for vehicles powered by locally produced batteries. Due to a lack of affordability and charging infrastructure, the African market for four-wheeled electric vehicles is likely to remain limited for the foreseeable future. The value chain for batteries made from nickel, lithium, and manganese could thus be restricted to the production of battery precursor materials.

There is, however, greater potential in the African market for two- and three-wheeled electric vehicles, which use lithium iron phosphate batteries, which are also valuable for stationary energy storage. Industries based on battery chemistry are thus more likely to be viable. This will require investment in cell manufacturing plants: This should be encouraged by support for domestic manufacturers of two- and three-wheeled electric vehicles, by more lithium discoveries, and by regional coordination on lithium refining.

The strategy of export restrictions

Some African countries have adopted a strategy of trying to force the hand of mining companies by restricting exports of non-processed raw materials, with the aim of favoring local downstream industries. If we combine the various types of measure (bans, export quotas, licenses, and export taxes) with the 70 minerals and metals present on the African continent, almost 2,500 such export restrictions were in place in 2021 (compared with 1,000 in 2009). However, the use of export restrictions in Africa does not appear to have been effective in stimulating local mineral processing. There has been no improvement in the revealed comparative advantage of processed goods, and in some cases these decisions have even undermined the overall performance of the industries.

Promoting special economic zones (SEZs)

One of the major challenges for local processing is financing, since states need to attract investors that are prepared to provide the funds needed to build industrial plants. Direct revenues might however be maximized if several countries joined forces to develop processing complexes and major industries. It is in this context that projects for special economic zones (SEZs) around mineral processing are emerging.

Over the past decade, dozens of new SEZs have sprung up to meet the needs of the mining industry. They include the Platinum Valley,[10] which is designed to revolutionize African production of hydrogen fuel cells. The United Nations Economic Commission for Africa (UNECA) and African Export-Import Bank (Afreximbank) recently signed a framework agreement to create an SEZ for battery and electric vehicle manufacturing in the DRC and Zambia.

Developing the local market

Another obstacle to the emergence of a processing industry is the lack of a sufficiently large local market to justify the creation of local processing facilities and to enable the development of RVCs. Since no single African country possesses all the minerals needed to produce batteries, countries will need to pool their mineral supplies to achieve the scale required.

Numerous trade barriers remain in place on the continent: The higher up the mining value chain the product is, the higher the tariffs between African countries. This is a major obstacle to developing value chains. In addition, each product is covered by an average of 2 to 4 technical standards, and, on average, the trade costs associated with these non-tariff measures (NTMs) reduce trade in mining products by 4.9 percentage points (compared with an average of 2.6% for consumer goods). The AfCFTA project, which aims to reduce these tariff and non-tariff barriers, could provide a valuable framework for the necessary changes.

10. The SEZ is part of the platinum corridor, with a focus on the section linking Maputo (Mozambique) to Walvis Bay (Namibia), via Nelspruit, Pretoria, Rustenburg (South Africa), Lobatse (Botswana), and Windhoek (Namibia). The SEZ is designed to develop enrichment of PGMs, mining equipment and machinery, renewable energy products and components, and logistics.

Major infrastructure challenges

In addition to the need to develop a local market, energy challenges and the transport systems currently available will make it very difficult to go beyond simple mineral processing and create Africa-wide integrated value chains.

Processing plants have huge energy requirements, and access to electricity remains a major problem for many African countries. While industrial extraction consumes relatively little energy, processing minerals into refined products is usually very energy-intensive. The world's major mineral refineries are often located in places where energy is cheap and readily available. The other obstacle is the lack of land transport. Africa's transport networks need to be regenerated or developed to support current traffic levels and absorb these massive mineral flows.

In short, Africa has the potential to create value, but to realize this potential it will need to strengthen its position in the mineral commodities market, leverage its comparative advantages, and improve its infrastructure, energy systems, and general investment conditions. Alliances therefore need to be built at both the African and international levels. The opportunity presented by processing is not, however, limited to energy transition minerals. The continent needs to develop its processing capacities not only for the minerals it already produces in large quantities (platinum and gold), but also for construction materials (iron and steel). This is especially important given that the demand for strategic minerals is so great that the energy transition industries may shift toward using other components and thus away from lithium, for example.

Overview of the African mining sector

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and Emilie Normand

Chapter 1

Contents

Chapter 1

Overview of the African mining sector

1. Africa's mineral resources: A general outline

Africa's mineral resources are both well known and little known. An array of mines, deposits, and artisanal operations are dotted across the continent, where more than 30 different types of minerals are exploited. The number of sites in operation is likely to exceed one thousand. Each country has its own mining history and traditions, some of which are very old. This chapter aims to provide a broad yet modest outline of the mining and geological landscape of the continent as it approaches a new stage in its development.

1.1. Africa, a vast continent representing 20% of Earth's land area

At 30 million km², Africa covers 20% of our planet's land area, an area big enough to accommodate several large countries or even other continents, including the United States, Australia, India, Japan, China, France, and Europe.

The African continent stretches 8,000 km from 37° latitude north to 34° latitude south, straddling the two hemispheres. Its territory includes diverse climatic zones determined by latitude, bordering oceans, and altitude, including Mediterranean, Saharan, intertropical, equatorial, and southern climates. The continent has experienced intense erosion over long periods of time. Its land is generally very flat, aside from a few mountain ranges and some recent volcanic episodes.

Mount Kilimanjaro in Tanzania stands at 5,895 m, while the Ethiopian highlands rise to 4,500 m. The Congo Basin, known as the "lungs of Africa," lies at an altitude of between 300 and 400 m. The Sahara Desert occupies 30% of Africa's land area, and Africa is also home to the planet's oldest desert, the Namib Desert. The continent is drained by a dozen or so very long rivers, including the Nile (6,671 km in length), the Congo (4,700 km), the Niger (4,200 km), the Zambezi (2,574 km), Orange River (2,432 km), the Senegal (1,800 km), and the Limpopo (1,750 km), which trace a sometimes sinuous route from their upstream river basins to the sea. East Africa is marked by the East African Rift, a long fault zone running from north to south which has shaped the landscape of the region through volcanic activity and uplift and which provided a favorable environment for the development of the first humans.

Map 1. ***Physical map of Africa***

Source: Mapswire, CC BY-SA 4.0 <https://creativecommons.org/licenses/by-sa/4.0>, via Wikimedia Commons.

1.2. Africa, a long geological history dating to the Precambrian

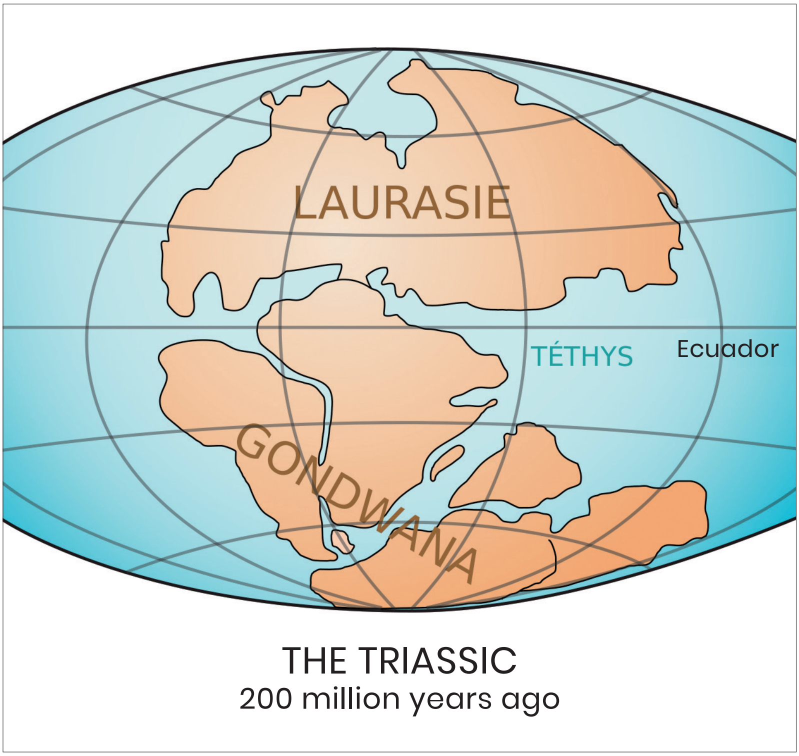
Geologically speaking, Africa is a very old continent, spanning at least 3.8 billion years of Earth's history. It is largely composed of Precambrian bedrock, dating to between 3.8 Ga (billion years ago) and 541 Ma (million years ago). This bedrock hosts most of the continent's mineral deposits, while Phanerozoic-eon cover (from 541 Ma to today) is limited to a few small areas.

The continent is formed of ancient rocks produced as a result of cratonization and multiple very old orogeneses (mountain-building processes) occurring outside the more recent northern rim. It was originally part of a supercontinent known as Gondwana, a much larger landmass encompassing present-day Africa, Arabia, Madagascar, India, Australia, South America, and Antarctica. These countries and continents thus share a geological history predating the opening of the oceans and seas that separated them some 120 Ma, which explains the many geological and mineral (carbon, iron, manganese, gold, diamonds, etc.) similarities between these now distant lands.

Map 2. ***Cratonization***

Source: Voudloper, CC BY-SA 3.0 via Wikimedia Commons.

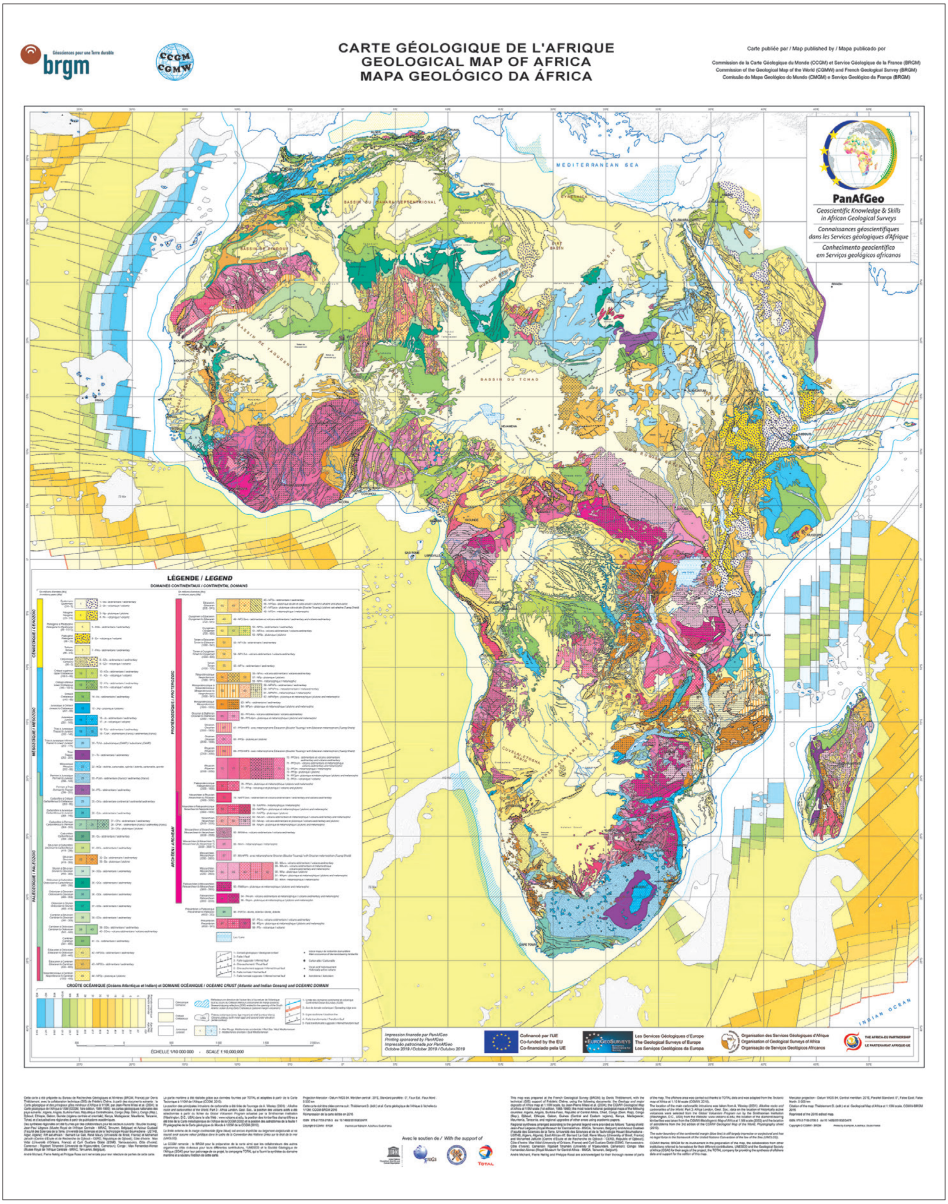
Map 3. ***Gondwana***



Source: Benoît Rochon, CC BY 3.0 via Wikimedia Commons.

Since the end of the Precambrian (541 Ma), there has been little change around the continent's major basins, which survive to this day. Knowledge about African geology is growing steadily as a result of various institutional geological and mining infrastructure projects and scientific research, but much remains to be explored at the local and regional levels. This includes the sustained, in-depth study of ore-rich provinces and their potential through the continuous compilation of exploration and exploitation data produced by mining companies active in Africa. The compilation and synthesis of this data is an area of work that must be developed if geological and mining knowledge of the continent is to be improved. With this in mind, an updated 1:10,000,000 geological map of Africa was published in 2016, on the occasion of the 35th International Geological Congress held in Cape Town, South Africa (Map 4).

Map 4. *Geological map of Africa*



Source: Bureau de recherches géologiques et minières (BRGM)
(French Bureau of Geological and Mining Research)

1.3. Mining in Africa: A not-so-ancient activity

The history of mining in Africa is closely linked to the colonization of the continent in the nineteenth century and industrial development in European countries such as the United Kingdom, Germany, Spain, France, Italy, and Portugal in the twentieth century. The exploitation of mines is not that old: The oldest formal African mines date back just 150 years. In South Africa, Zimbabwe (formerly Southern Rhodesia), Morocco, and Tunisia, the mining sector has provided a basis for the development of local industries.

Box 1. Some milestones

South Africa: the Witwatersrand (Transvaal) Gold Rush dates to 1886, some twenty years after the discovery of diamond deposits in Kimberley.

Central Africa: in 1906, during Belgian colonization, the first copper mines were opened in the Democratic Republic of the Congo (DRC), operated by the Union minière du Haut-Katanga (UMHK).

North Africa: the operation of phosphate mines in Tunisia and Morocco dates to the 1930s, with both countries under French protectorate from 1881 and 1912 respectively.

West Africa: the operation of bauxite mines in Guinea dates to the 1950s. The Fria plant—the first alumina production plant in Africa, established by the French industrial group Péchiney—was built in 1957.

Madagascar: the first chromium mines date to 1955 (Ugine-Péchiney).

Sahel: uranium mining in Niger began in 1968 in Arlit, under the direction of the Commissariat à l'énergie atomique et aux énergies alternatives (CEA) (French Alternative Energies and Atomic Energy Commission).

East Africa: Tanzania's gold mines (Geita and Banyahulu) are recent (early 2000s). They opened following the publication in the 1990s of the results of prospecting works dating to German colonization.

That said, the exploitation of metals in Africa is actually much older. The first gold mines in Egypt date back 4,000 years: the oldest in the world. The gold trade in Ghana (Asante Empire), thrived in the fifteenth century with Portuguese maritime exploration. In the thirteenth century, the emperor of Mali, Mansa Musa, made a pilgrimage to Egypt covered in gold. In the Democratic Republic of the Congo (DRC), copper was used as a currency of exchange (known as *la croisette* due to its cruciform shape) in the eighteenth century. The iron industry is even older. Iron metallurgy was mastered in numerous places in the period between 500 and 1,000 BCE. Still today, ancient slag can be found in the Dogon country (Mali), located south of the Sahara.

Decolonization in the 1960s led to the nationalization of mines or the creation of semi-public companies (SPCs). In the early 1990s, African countries started to open up to foreign corporations. The first foreign investment was in the gold sector (Mali, Ghana, Zimbabwe), using the latest techniques for the recovery of gold from low-grade minerals (heap leaching, carbon in pulp), which have since become widespread. Many other countries—including Mauritania, Guinea, Tanzania, Burkina Faso, Côte d'Ivoire, and Senegal—followed suit, each at their own time and pace.

The last two decades have seen a proliferation of new gold mines in Africa, including some very large ones, such as Tasiast in Mauritania (2010) and Kibali in the DRC (2011). This was later followed by the mining of other minerals/elements, including copper, bauxite, and diamonds. New investors from China, Canada, Australia, South Africa, the United States, Kazakhstan, Russia, the United Arab Emirates, Morocco, and India have arrived on the continent. Slowly but surely, these investments are helping to turn the page on the mining history of the countries concerned and channel them in new directions with new partners. African countries remain very attached to their mining past and to the activity itself. Together with agriculture and Africa's young population, the mining sector represents one of the three pillars upon which the continent's development depends.

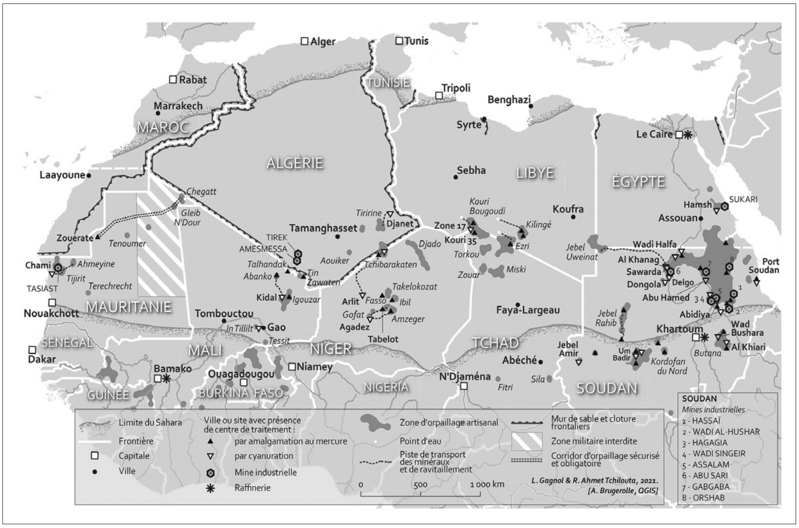
1.4. Africa's minerals: Resources that remain largely untapped

Much is known about some of Africa's mineral resources, while little or nothing is known about others.

In South Africa, the Witwatersrand gold deposits have been mined for more than 100 years, in some cases at depths of more than 3,000 m. Overall, these resources, including any exploitable reserves, are well studied.

Between 2009 and 2016, the countries of the Sahel and the Sahara experienced a gold rush on an astonishing scale across a vast territory stretching from Sudan to Mauritania. The geological foundations of these deposits are still poorly understood, but it is conceivable that major regional structures exist with possibilities of mineralization deep underground.

Map 5. ***Gold mining in the Sahel since 2009***



Source: Gagnol and Tchilouta (2020).

In the 2010s in the DRC, American geologists uncovered new copper deposits in the Congolese section of the Copperbelt (Lualaba Province), 25 km west of Kolwezi. These giant deposits, which are exceptionally rich in copper (with a copper content >5%), raise the expectation of finding entirely new, colossal reserves of world-class quality. The Kamoa-Kakula mine (40% owned by the Canadian mining company Ivanhoe, 40% by the Chinese group Zijin, and 20% by the Congolese state) opened in 2021, producing 393,000 tonnes of copper as early as 2022, with a production target of 600,000 tonnes per year for the next forty years, starting in 2025. Kamoa-Kakula is the largest copper discovery in Africa and the world's fourth-largest copper mine.

Since 2015, gemstones of exceptional quality have been unearthed in Lucapa Diamond Company's new Lulo diamond mine in Angola's Cuango basin. These include a 404-carat diamond discovered in 2016 and a 170-carat pink diamond, the largest gemstone of its kind to be found in 300 years.

These examples aim to show that a large part of the continent's mineral wealth is yet to be revealed. Much remains undiscovered or untapped. New metals needed for the energy and digital transitions (lithium, nickel, cobalt, rare earth elements, coltan [or columbite-tantalite], platinum, graphite) present new opportunities for Africa. In Malawi, the Australian company Sovereign Metals Ltd. has just identified resources including 18 megatonnes (Mt) of rutile and 24 Mt of graphite in the central part of the country. In Zimbabwe, mining residues in deposits initially mined for tin and tantalum are now being mined for their lithium resources, which were of no economic interest several years ago. Many countries, particularly oil-rich ones such as Nigeria, Angola, Algeria, Libya, Cameroon, and the Congo, have not invested much in mining to date, but may seek to follow the example of Saudi Arabia by diversifying their economies in preparation for a "post-oil" scenario and in order to develop renewable energies, such as solar, wind, and green hydrogen.

The history of mining in Europe spans more than 1,500 years, that of Africa less than 150. In just 20 years, China has become the leading mining and metal-producing country in the world. This bodes well for Africa, whose mining resources are still relatively untapped. In recent years, new countries (Indonesia, Kazakhstan, and countries in Latin America, among others) have come to the fore in different sectors. The mining of all these resources has prompted the reclassification of reserves and of producer countries. South Africa, which in the 1970s was the leading global producer of many substances, has seen its position in international rankings fall, though it remains high.

Despite the dynamic developments now underway and which are sure to continue, Africa's main mining resources can be classified based on current production and knowledge, as outlined below.

Table 1. ***Substance and metal reserves in Africa***

SUBSTANCES AND METALS	COUNTRIES	RESERVES
1 – Industrial minerals		
Phosphates	**Morocco** (2nd largest producerand leading exporter in the world), Egypt, Tunisia, Algeria, Senegal, Togo, South Africa. Africa accounts for 82% of global reserves and 56% of global production.	**Morocco** holds the world's largest reserves (50 Gt or 22%), Egypt (2.8 Gt), Tunisia (2.5 Gt), Algeria (2.2 Gt), South Africa (1.6 Gt), Senegal (50 Mt), Togo (30 Mt).
Soda Ash (sodium carbonate)	**Bostwana, Kenya, Ethiopia** Africa accounts for 3% of global production.	**Botswana** (400 M t), **Ethiopia** (400 M t) – each representing 1% of global reserves, Kenya (7 Mt).
Fluorine	**South Africa** (4th largest global producer with 5% of global production) Kenya, Morocco, Namibia.	**South Africa** (41 Mt) holds the third-largest share of global reserves (17%). Other countries: n.a.
Baryte	**Morocco** (3rd largest global producer with 16% of global production), Algeria.	n.a.
Kyanite, Sillimanite, andalusite	**South Africa** (leading global producer with 34% of global production).	n.a.
Vermiculite	**South Africa** (leading global producer with 34% of global production), Zimbabwe, Uganda.	n.a.
Garnet	**South Africa** (3rd largest global producer with 15% of global production).	n.a.
Beryllium	**Mozambique, Uganda,** Madagascar, Nigeria, Rwanda.	n.a.
Arsenic	**Morocco** (2nd largest global producer with 11% of global production).	n.a.
Mercury	**Morocco**	n.a.

Source: Authors based on USGS.

SUBSTANCES AND METALS	COUNTRIES	RESERVES
2 – Ferrous and non-ferrous minerals		
Iron	**South Africa** (12th largest global producer with 76 Mt, or 3% of global production), Mauritania (12 Mt), Guinea, Liberia, Gabon. Large mining projects underway: Simandou (Guinea), Belinga (Gabon).	High-grade reserves **South Africa**: 1 Gt (0.6% of global reserves), other countries: n.a.
Bauxite / alumina / aluminum	**Guinea** (leading global producer with 86 Mt, or 22% of global production), Ghana, Cameroon, South Africa, Mozambique. Few alumina plants (<1% of global production). Some aluminum producers.	**Guinea** holds the largest share of global reserves of high-grade bauxite (7.4 Gt), representing 23% of global reserves.
Manganese	**South Africa** (leading global producer with 7 Mt, or 36% of global production), Gabon (2nd largest global producer with 4.6 Mt, or 23% of global production), Ghana, Côte d'Ivoire, Burkina Faso.	**South Africa**: holds the largest share of global reserves (640 Mt or 37%), Gabon: 6th in the world with 61 Mt (>3%).
Chromium	**South Africa** (Bushveld) (leading global producer with 18 Mt, or 43% of global production), Zimbabwe (Great Dyke).	**South Africa**: 2nd largest reserves in the world (200 Mt or 35%), Zimbabwe: n.a.
Ilmenite	**Mozambique** (2nd largest global producer), South Africa, Madagascar, Senegal, Kenya. Africa holds 82% of global reserves and accounts for 56% of global production.	**South Africa** ranks 7th in the world with 30 Mt, Mozambique 8th with 26 Mt, and Madagascar 9th with 22 Mt.
Rutile	**Sierra Leone** (2nd largest global producer with 22% of global production), South Africa (3rd largest producer with16% of global production), Kenya, Madagascar, Malawi, Mozambique. Africa accounts for 53% of global production.	**Africa** holds 17% of global reserves. South Africa ranks 3rd in the world with 6 Mt (13% of global reserves), Mozambique ranks 5th, Sierra Leone ranks 7th.
Vanadium	**South Africa** (3rd largest global producer with 9% of global production).	**South Africa**: ranks 4th in the world with 3.5 Mt (13% of global reserves).

Source: Authors based on USGS.

SUBSTANCES AND METALS	COUNTRIES	RESERVES
3 – Base metals		
Copper	**DRC** (7th largest global producer with 1.8 Mt, or about 8% of global production), Zambia (11th in the world), South Africa.	**DRC**: ranks 7th in the world with 31 Mt (3.4 % of global reserves), Zambia: ranks 11th with 19 Mt.
Cobalt	**DRC** (leading global producer with 68% of global production), Zambia (n.a.), Madagascar and Morocco (1.5%).	**DRC**: ranks 1st in the world with 4 Mt (48% of global reserves), Madagascar: 0.1 Mt (1.5 % of global reserves), Zambia and Morocco: n.a.
Lead, zinc	Morocco, Tunisia, Algeria, DRC, South Africa. New production in South Africa (Gamsberg) and DRC (Kipushi).	n.a.
Nickel	Madagascar, Botswana, Zimbabwe, South Africa, Tanzania, Burundi. Modest production at present.	Tanzania (Kabanga): 15% of global reserves, Burundi (Musongati mine): n.a., South Africa (Bushveld Complex): n.a., Madagascar (Ambatovy mine): n.a.
Tin	**DRC** (5th largest global producer of cassiterite with 20 kt, or 6% of global production), Nigeria, Rwanda, Burundi, Ethiopia, Mozambique, Uganda.	**DRC**: ranks 8th in the world with 130 kt (3% of global reserves), other countries: n.a.
Coltan (tantalum)	**DRC** (leading global producer with 860 t, or 43% of global production), Rwanda (17% of global production), Nigeria, Uganda, Burundi, Mozambique. Africa accounts for 72% of global production.	n.a.

Source: Authors based on USGS.

SUBSTANCES AND METALS	COUNTRIES	RESERVES
4 – Precious metals		
Gold	**South Africa** (7th largest global producer with 110 t, or 3.5% of global production), Ghana (11th largest global producer with 90 t), Sudan, DRC, Zimbabwe, Mali, Burkina Faso, Guinea, Senegal, Tanzania, Côte d'Ivoire. Africa accounts for 13% of global production.	**South Africa**: ranks 3rd in the world with 5,000 t (10% of global reserves), other countries: n.a.
Platinum group metals (PGM)	**South Africa** (South Africa (leading global producer of palladium and platinum, accounting for 43% and 73% of global production respectively), Zimbabwe.	**South Africa**: with 63 Mt, holds the largest share of global reserves (90%), Zimbabwe: with 1 Mt, holds the 3rd largest share of global reserves (1.4%).
Diamonds (gemstones)	**Botswana** (2nd largest global producer with 23% of global production), Angola (4th largest global producer with 13% of global production), South Africa (5% of global production), DRC (3% of global production), Namibia, Sierra Leone, Zimbabwe, Lesotho, Central African Republic (CAR), Ghana. Africa accounts for 50% of global production.	n.a.
Precious stones (emerald, sapphire, ruby, tanzanite, aquamarine, others)	**South Africa, Mozambique, Zambia** (leading global producer of emeralds), Zimbabwe, Namibia, Madagascar, Tanzania, Kenya.	Numerous varieties Reserves: n.a.

Source: Authors based on USGS.

SUBSTANCES AND METALS	COUNTRIES	RESERVES
5 – Transition minerals		
Lithium	Zimbabwe, DRC, Mali, Namibia, Ghana. Mining projects in Mali, DRC, and Zimbabwe.	n.a.
Rare earth elements	Burundi, Malawi, Angola, Tanzania, South Africa, Madagascar. **Burundi** entered the market for rare earth elements in 2018, becoming the leading African producer.	n.a.
Graphite	**Mozambique** (leading producer in Africa), Madagascar (2nd largest producer in Africa), Tanzania. Africa accounts for 20% of global production. Production being developed.	**Africa** holds 20% of global reserves. Madagascar ranks 4th in the world (7%), Mozambique ranks 5th (7%), Tanzania ranks 6th (5%).

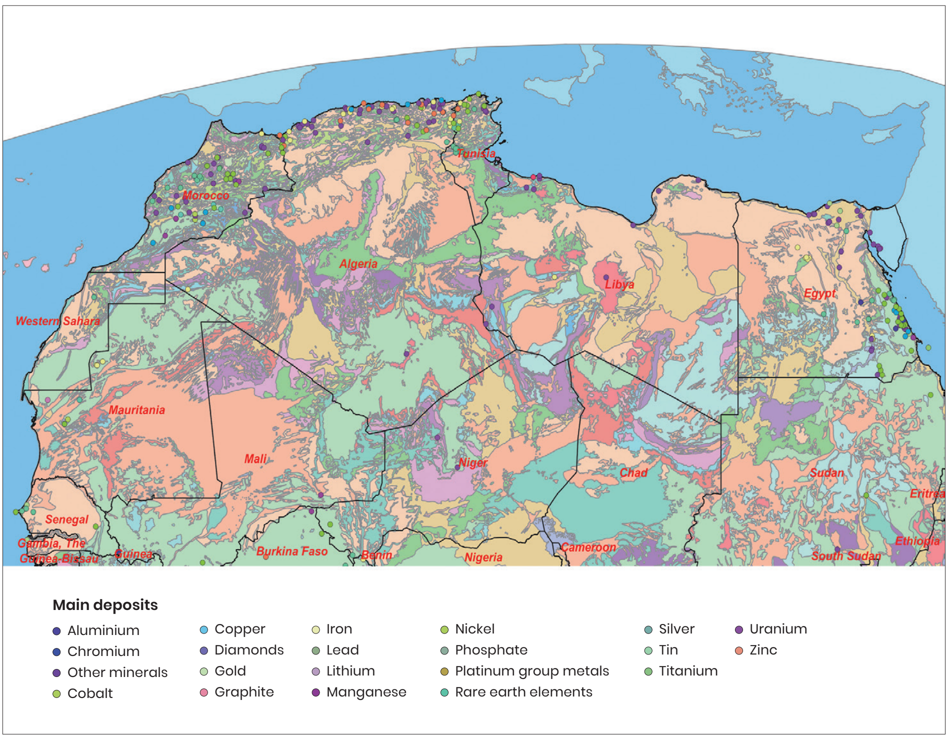
SUBSTANCES AND METALS	COUNTRIES	RESERVES
6 – Energy minerals		
Carbon	**South Africa** (7th largest global producer with 243 Mt, or 4.2% of global production), Mozambique, Zimbabwe, Botswana, Zambia, Tanzania.	**South Africa**: 9.8 Gt (0.9% of global reserves).
Uranium	**Namibia** (3rd largest global producer with 5, 753 t, or 12% of global production), Niger (6th largest global producer with 2,248 t, or 5% of global production), South Africa, Botswana, Tanzania, Malawi.	**Africa** holds 20% of global reserves. Namibia ranks 4th in the world (6%), South Africa ranks 5th (5%), Niger ranks 6th (5%).

Source: Authors based on USGS.

These mineral resources are distributed among several hubs and regions across the African continent, like pieces of a vast puzzle with some parts missing, particularly in oil-producing countries low in mineral resources (Algeria, Nigeria, Libya, and others).

Map 6. ***Geology of North Africa***

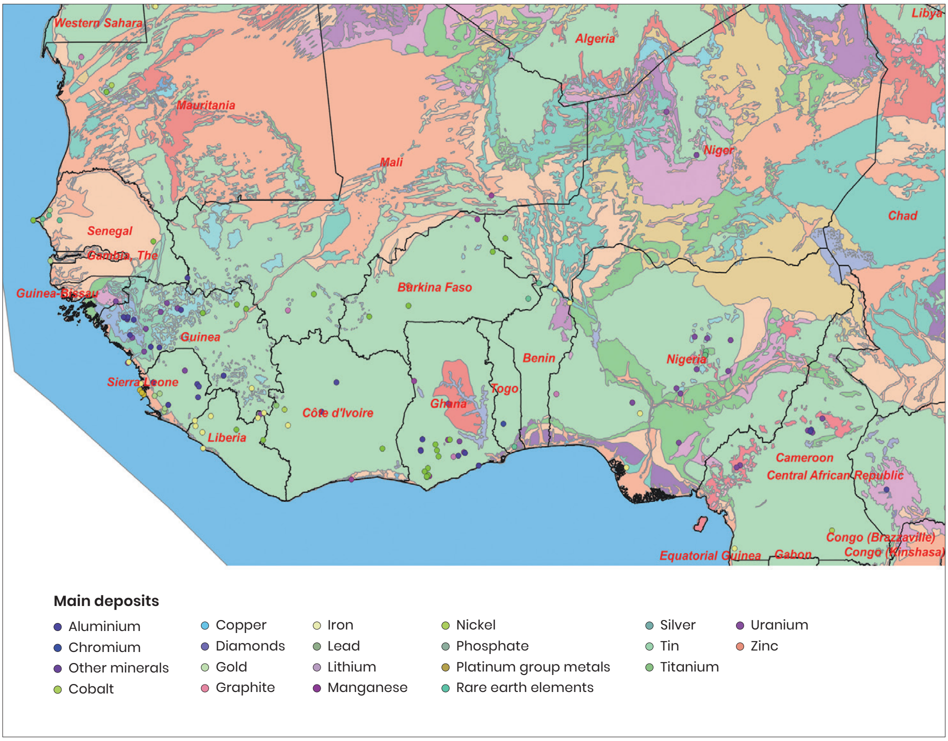
1 - North Africa is a region rich in phosphate and industrial minerals (baryte, fluorine, and others). Morocco has developed an entire industrial and chemical development hub around its phosphate and metal (copper, lead, zinc, cobalt) mineral resources.



Source: Authors based on USGS.

Map 7. ***Geology of West Africa***

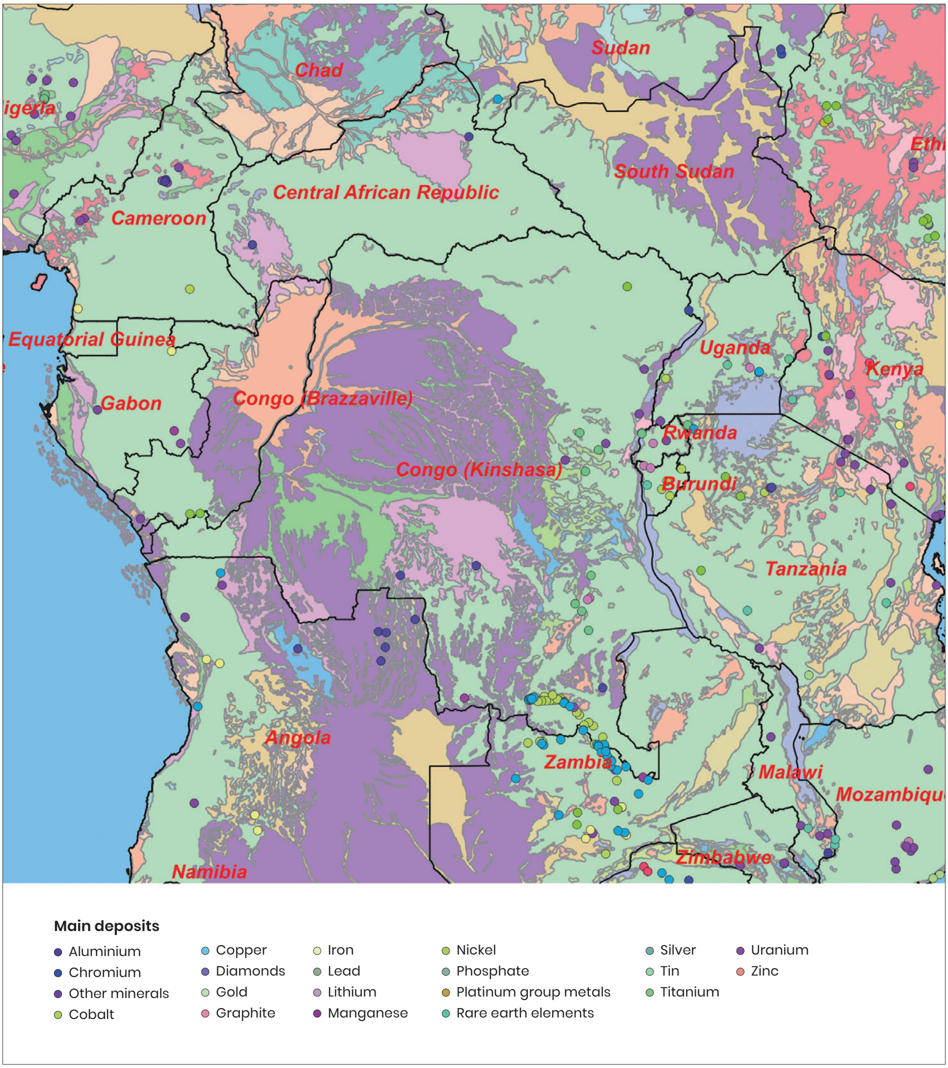
2 - West Africa and the Gulf of Guinea harbors multiple gold deposits, which are exploited using both industrial and artisanal means. Production is growing fast, and Ghana has become the leading producer of gold in Africa, ahead of South Africa, the continent's historic champion. A mining hub is emerging in Guinea based on world-class bauxite and iron resources, which are still underexploited.



Source: Authors based on USGS.

Map 8. ***Geology of Central Africa***

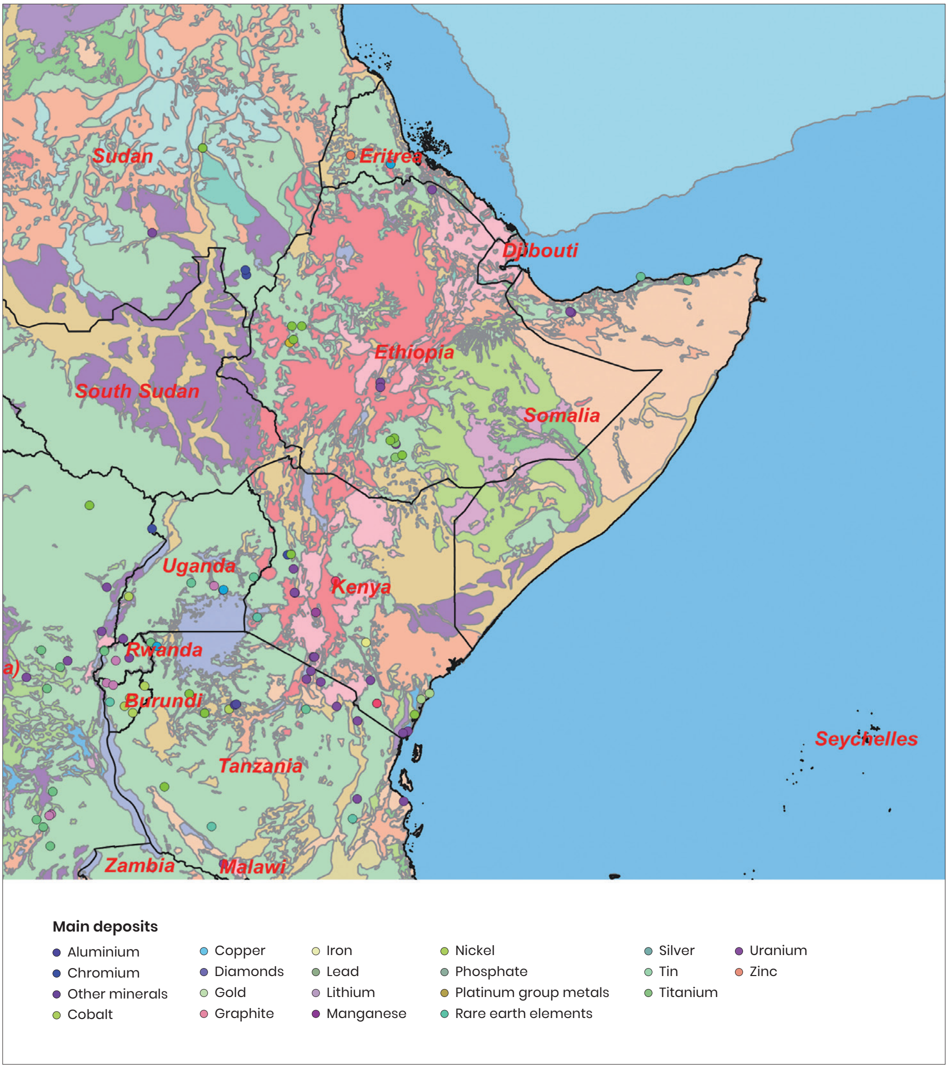
3 - Central Africa is experiencing unprecedented growth in copper and cobalt mining (DRC and Zambia). The region's exceptional wealth of energy transition metals (lithium, copper, cobalt, nickel, coltan) make it a global strategic hub. The diamond industry is developing rapidly as a result of the recent opening of Angolan mines and multiple discoveries over the last ten years.



Source: Authors based on USGS.

Map 9. ***Geology of East Africa***

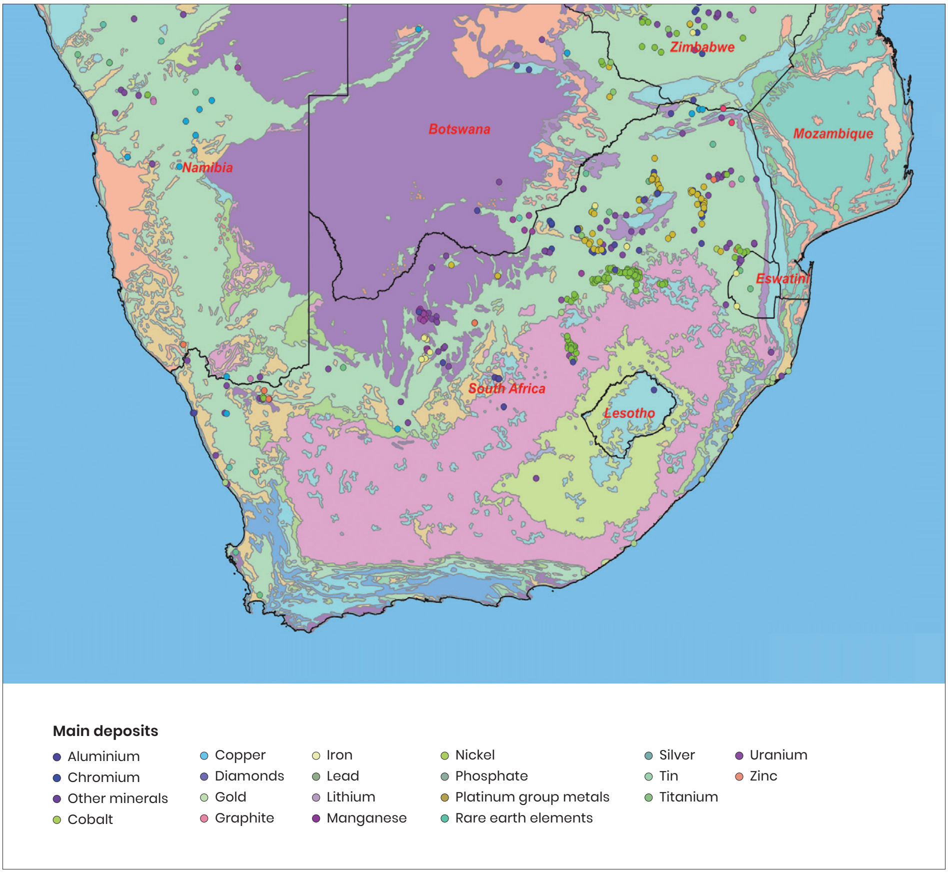
4 - East Africa and Madagascar's mineral resources are still relatively untapped. Both Madagascar and Tanzania hold large reserves of gold and precious stones, but also of nickel. Other East African countries (Ethiopia, Sudan, South Sudan, Uganda) should see their mining sectors develop rapidly given the richness of their subsoil.



Source: Authors based on USGS.

Map 10. ***Geology of Southern Africa***

5 - Southern Africa is the oldest and most developed mining region in Africa. South Africa and Zimbabwe harbor significant quantities of diverse resources, including gold, diamonds, platinum, chromium, titanium, iron, manganese, and graphite. Namibia and Botswana are rich in diamonds, uranium, lithium, and rare earth elements. Zambia is one of the world's leading copper producers.



Source: Authors based on USGS.

The exploitation and discovery of new deposits requires considerable effort and investment on an ongoing, long-term basis.

2. Mining production

The first part of this chapter focused on Africa's geological riches and its mining history. However, given the many recent developments in the sector, the continent's mining production also requires analysis if current trends are to be understood. We have therefore produced a quantitative and qualitative overview of the African mining sector in order to gauge the continent's position in terms of global production of each mineral. In this section, we will explain our methodology and provide a summary of our main conclusions. The full overview can be found in the appendices.

Why an overview of the African mining sector is necessary

In any analysis of the African mining sector, it quickly becomes clear that reliable, up-to-date data is limited. Existing sources are few and far between, and most are produced by Western institutions that naturally tend to prioritize their own geographical region. For example, in the data supplied by the United States Geological Survey (USGS) and used by the vast majority of media outlets and researchers, small producers—many of which are located in Africa—are invisible (see Box 2). Further, with the exception of a few states such as South Africa and Morocco that produce reliable mining statistics, most of the data provided by African countries is too limited and not updated often enough, making any assessment of a country's actual production and recent developments impossible. However, it is important to acknowledge other, less utilized sources—proposed by the British Geological Survey (BGS) and World Mining Data in particular—which provide details of mineral production by country and therefore cover all African countries.

This paucity of statistics on mining in Africa is nothing new. In 2009, the document setting out the Africa Mining Vision referred to African countries' difficulty producing and maintaining high-quality mining statistics. Since the amount of easily accessible information about the African mining sector is limited, it is not surprising that there is a tendency to minimize the continent's current and future place in global mining production.

The value of mining data in Africa

This statistical opacity of the African mining sector is in stark contrast with its growing media coverage. The opening of new mines in Africa regularly makes the headlines in both the specialist press and the general media. Moreover, recent partnerships signed between various Western countries (the United States, the EU [European Union], France, etc.) and African nations (the DRC, Namibia, etc.) have helped shine a light on the continent's subsoil, reflecting its increasing importance in supplying minerals to the global economy. The growing influence of South Africa's Investing in African Mining Indaba conference, an event that truly has its finger on the pulse in terms of mining activity in Africa, is particularly illustrative of Africa's new position as a mineral extraction stronghold.

Factual information about African mining production is essential given what is at stake for the continent. The opportunities for economic development presented by the mining sector are highly anticipated by African countries, particularly given the difficulties they have faced in achieving the Agenda 2030 goals. However, it is difficult to develop public policies capable of capitalizing on the continent's dynamic mining sector when the actual and future scale of mining production is not known.

The dynamism of Africa's mining sector also needs to be properly evaluated because of the continent's position in green energy value chains. Thanks to its geological riches, Africa finds itself in a privileged position in order to meet the energy transition's colossal need for minerals. The overview of African mining production presented in the following two sections also sheds light on the new geostrategic importance of African countries as a result of greater exploitation of their mineral resources.

Constructing a quantified overview of the key minerals

In this chapter, we will analyze the African mining sector through the lens of the main minerals exploited on the continent. This sectoral perspective should allow us to reveal any continent-wide dynamics and to predict future developments. Our analysis centers on 14 datasheets focusing on a selection of minerals chosen on the basis of the criteria set out in Box 2. These datasheets provide a brief summary of the continent's position based on a statistical compilation of the available data[1] and sector-based intelligence taken from a number of national and international reports and academic articles, as well as a variety of other sources from specialized media outlets. The mineral datasheets are divided into three sections:

- the first section gives an overview providing a concise quantitative summary of production in Africa, a ranking of producer countries, the principal mines, and the continent's share of global production;
- the second section sets out the developments and dynamics that helped form the African mining sector as it is today. This section places a greater focus on the main mineral producing countries and seeks to highlight the mining companies operating within the sector;
- finally, the third section is naturally more forward-looking in that it considers likely developments within the sector on the basis of the main mining projects that have been announced—and particularly those we believe to be the most likely to make the African countries concerned major producers of certain minerals.

1. See Box 3 for a discussion of the main sources used.

Box 2. Typologies of the minerals studied in this chapter

This chapter focuses on the most important minerals extracted from Africa's subsoil. A mineral's importance can be assessed from different perspectives in accordance with the value attributed to them.

Critical and strategic minerals

Minerals can be classified in a number of ways (using chemical and economic typologies in particular). However, successive crises related to the COVID-19 pandemic and the war in Ukraine have brought to the fore new typologies emphasizing the dependence of globalized economies on the supply of certain minerals. The notions of critical and strategic minerals are usually defined by highly industrialized countries and are therefore particularly useful for understanding the new geostrategic position of the African mining sector. In this chapter, we will use the following definitions:

- critical metals: metals where supply risks have the potential to damage a country's entire economy;
- strategic metals: metals where supply risks have the potential to damage one or several industrial sectors in a given country.

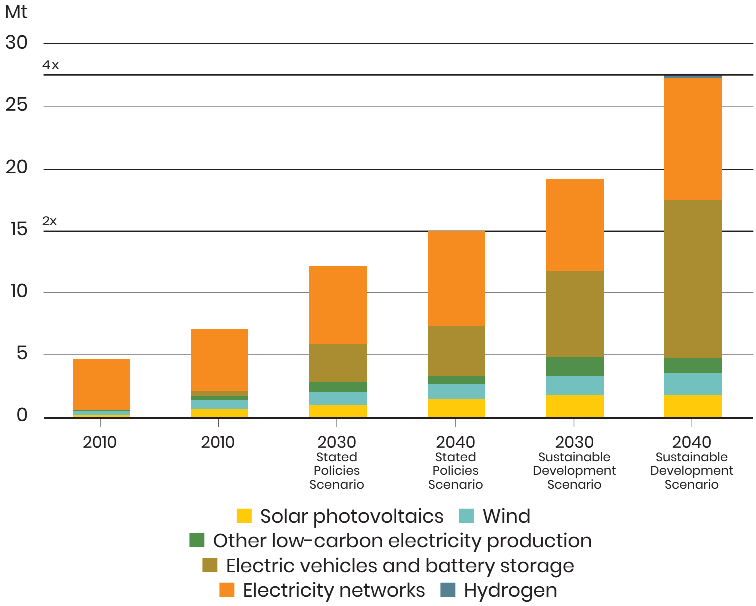
A number of different risks might affect a country's metal supply. According to the International Energy Agency (IEA), these risks can be classified as geological, geopolitical, economic, or socio-environmental.

The notions of critical and strategic metals (as well as lists thereof) vary depending on the country. In this chapter, we use the lists drawn up by the world's largest economies—those that are therefore most likely to import African minerals and to invest in the continent's mining sector: the EU, the United States, and China.

Energy transition minerals

International institutions, including the World Bank and the IEA, have identified a group of minerals that will be crucial for implementing the energy transition. Sometimes referred to as "transition minerals," this typology encompasses minerals whose production must be increased in order to decarbonize global energy mixes and comply with commitments to limit global warming.

According to the IEA's Sustainable Development Scenario (SDS), global demand for energy transition metals could increase fourfold, but there is great uncertainty about the global economy's capacity to produce such metals in sufficient quantities. The ability of African countries to produce these minerals has therefore come under particular scrutiny.



Source: IEA 2021.

Other minerals of interest

Finally, it should be noted that the typologies set out here have been developed from the point of view of the needs of countries outside of Africa. They should not obscure the importance for African countries of certain metals that are neither critical nor strategic for most industrialized nations, such as gold and diamonds (mainly used for non-industrial purposes). Their significance within the economies of some African countries makes them supremely important in the eyes of African governments, as the development of those sectors provides them with important tax revenue (Chapter 2).

2.1. Summary of the sectoral overview

This summary of the African mining sector sheds new light on the continent's place in the global mining ecosystem. It demonstrates that Africa is taking an increasingly central position in the global production of the minerals explored in this section. We will see that mining production began to surge in the 2000s but took an entirely new turn in the second half of the 2010s when a number of large mines were opened. It is therefore important to note that Africa has not been excluded from the global mining boom; on the contrary, the continent is heavily involved (as discussed in the third section of this chapter).

Our research highlights a number of champions of African mining production, but it also provides a glimpse of future upheavals. South Africa remains Africa's largest player in the mining sector by far, positioning itself as the undisputed leader in the production of certain minerals (coal, iron, manganese). However, new players are increasingly challenging for the established leader's share of production. By way of example, Ghana became the continent's leading gold producer in 2018 as South Africa's gold production went into a slow decline. The trend was reversed again in 2021, but this was more due to the problems encountered by Ghana's artisanal and small-scale gold mining sector than a boom in South African gold production, which was, in fact, in the process of being overtaken by Burkina Faso. The DRC has also been positioning itself as a serious challenger to South Africa, particularly in energy transition minerals. The DRC is already by far the continent's leading cobalt and copper producer, and it should also soon be moving into the highly strategic lithium sector.

Finally, the sectoral datasheets seek to demonstrate the continent's mining potential. As well as the DRC's vast potential in energy transition minerals, a whole series of other continental (and even global) projects are taking shape across Africa. Consider for example the Darwendale platinum project and the Chivhu chromium project, both located within the Great Dyke deposit in Zimbabwe, the copper/cobalt project in Mutoshi in the DRC, the Simandou iron project in Guinea, or the Phalaborwa rare earth elements project in South Africa.

Box 3. Methodology

The information, statistics, and figures relating to the African mining industry used in Chapter 1 are mainly taken from four databases.

Firstly, three aggregated databases developed by government institutions:

- USGS is America's earth science government agency. It publishes annual Mineral Commodity Summaries cataloging the reserves and production of the main producer countries for more than 90 minerals. USGS is the benchmark in terms of data on mineral reserves. However, it should be used with a certain amount of caution, as it focuses on the ten mining countries that produce the most or hold the most reserves, which means that it does not provide details about most African countries, preferring to aggregate their reserves and production;
- World Mining Data is a database managed by Austria's Federal Ministry of Agriculture, Regions, and Tourism (BMLRT[2]). Every year, it catalogues the mining production of a wide range of countries;
- The British Geological Survey (BGS) publishes an annual survey of each country's mining production in World Mineral Production.

Finally, a fourth, more granular database is provided by S&P Global:

- Capital IQ Pro is managed by S&P Global Ratings. This database differs from those listed above because it provides disaggregated data on individual mines and mining companies. In particular, it includes financial data on public and private mining companies, their shareholding structure, their main transactions and investments made, as well as data on titles and any property they own. Further, it provides access to specific data on development stages, the dates operations begin and end, locations, owners and operator history, production, profitability, and reserves and resources. However, S&P Global depends on companies providing and updating any such data.

In fact, researching the African mining industry represents somewhat of a challenge in terms of gathering data. Many African countries do not publish statistical data or do not update them. Incidentally, it is significant that the main databases

2. *Bundesministerium für Landwirtschaft, Regionen und Tourismus.*

identified and used for our research are exclusively Western, not African. In some countries, up-to-date information is lacking because human and economic resources are insufficient to provide exhaustive and regular compilation, particularly if the mining sector is not a key part of the national economy.

As far as possible, data from our four databases has been cross-referenced with national statistics (produced by mining ministries, national statistics offices, central banks, mining professional bodies, and mining chambers, depending on the country). Finally, the reports published by the Extractive Industries Transparency Initiative (EITI), supported by 28 African countries, have been a particularly important source.

Some data on production, consumption, and trade comes from global trade statistics, based on the import and export customs declarations provided by each country and centralized in the UN's Comtrade database [3] (via the TradeMap and UNCTADstat [4] tools in our research). However, this data must also be handled with caution as there are some inconsistencies between import and export data. Customs classification errors and late or even absent reporting are also found. The existence of a black market that is by definition not included in the statistics should also be taken into account, especially as it likely represents a share of mining production, particularly in the gold sector.

Estimated production values are calculated on the basis of prices of varying precision and reliability. The specialist stock markets only provide daily prices for base metals (aluminum, copper, nickel, lead, tin, zinc, cobalt, molybdenum) and precious metals (gold, silver, platinum, palladium, rhodium).[5] Some metals are traded within the framework of forward contracts and prices are not made public.

We have used World Mining Data's nomenclature to classify the various metals and minerals:

***(i)* iron and ferro-alloy metals:** iron, chromium, cobalt, manganese, molybdenum, nickel, niobium, tantalum, titanium, tungsten, vanadium;

***(ii)* non-ferrous metals:** aluminum, antimony, arsenic, bauxite, beryllium, bismuth, cadmium, copper, tin, gallium, germanium, indium, lithium, mercury, lead, rhenium, selenium, tellurium, rare earth elements, and zinc;

3. UN Comtrade (United Nations Commodity Trade Statistics Database).
4. UNCTAD (United Nations Conference on Trade and Development).
5. Mainly the London Metal Exchange (LME).

***(iii)* precious metals:** gold, silver, and PGMs (platinum group metals), which include platinum, palladium, ruthenium, rhodium, osmium, iridium, and rhenium;

***(iv)* industrial minerals:** asbestos, baryte, bentonite, diamonds (gem/industrial), diatomite, feldspar, fluorspar, graphite, gypsum, kaolin, magnesite, perlite, phosphate, potash, salt, sulfur, talc, vermiculite, and zircon;

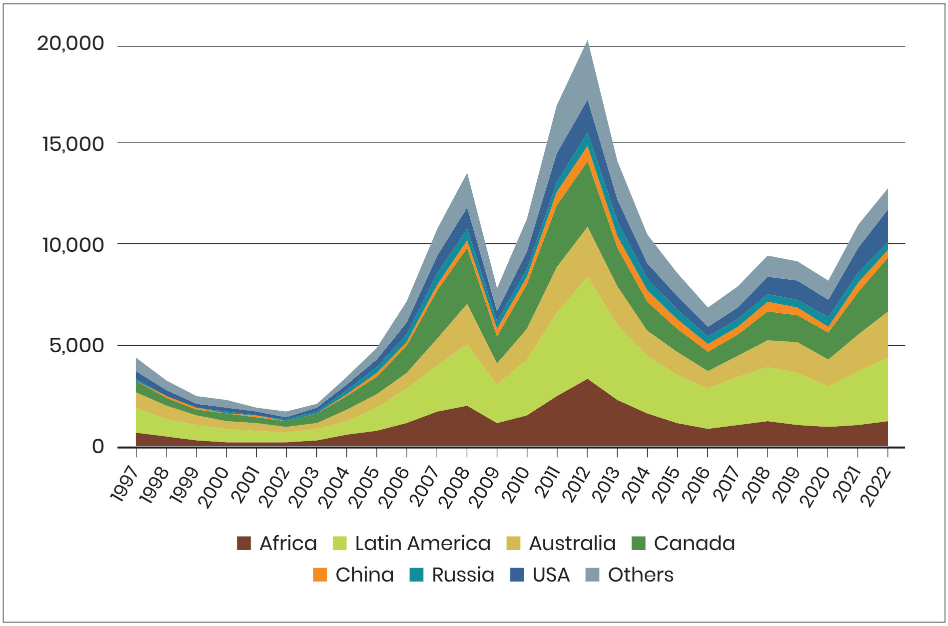
***(v)* mineral fuels:** steam coal, coking coal, uranium. It should be noted that natural gas and oil have been excluded from this research and that industrial minerals are considered a separate group, with the exception of diamonds, graphite, and phosphate. In our research, we have chosen not to present the "transition" metals as a distinct group, but they are subject to a targeted analysis.

3. Africa: Home to a major mining boom

Africa's mining operations have evolved considerably in recent years, as evidenced by a rise in investments and exploration spending and mine openings across the continent. This mining boom came about because of a favorable international context, the revelation of Africa's geological potential, and stabilization within African nations. However, it was also the consequence of diversification within Africa in three areas: *(i)* of mining countries themselves, with many countries beginning to develop their previously fledgling mining sectors; *(ii)* of the minerals sought and exploited beyond the gold, copper, and diamonds traditionally mined in Africa; and *(iii)* of the nationalities of proprietors investing in Africa.

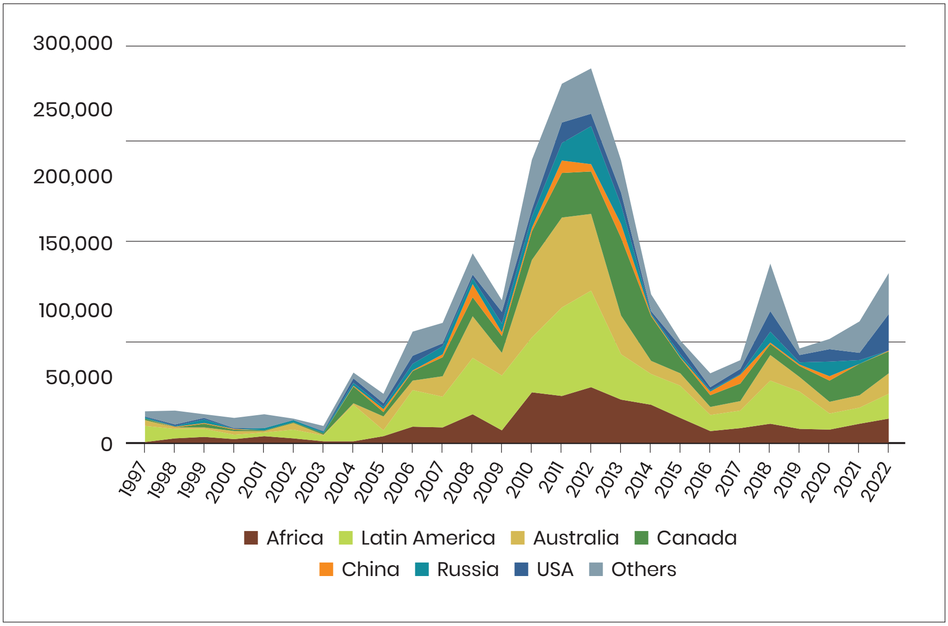
Investment in the African mining sector has increased significantly over the last 30 years for several reasons.

Graph 1. ***Change in mining exploration budgets by region (USD millions)***



Source: Authors based on S&P Capital IQ Pro data.

Graph 2. ***Change in greenfield and brownfield investments by region (USD millions)***



Source: Authors based on S&P Capital IQ Pro data.

Factor 1: The emergence of a very favorable global context for the development of the mining sector, with a dramatic rise in raw materials prices between 2003 and 2012.

The 2000s marked the beginning of a new phase of globalization, characterized by a gradual shift within the international hierarchy and a financialization of the raw materials markets. This resulted in a spectacular rise in raw materials prices, including minerals (Couharde et al. 2012). Driven by growth and urbanization within developing countries, particularly China, mineral demand skyrocketed in the early 2000s, causing an increase in prices that boosted mining investment. Investments targeting mining exploration therefore surged on a global scale (graphs 1 and 2). Africa was no exception: The exploration budget[6] in Africa increased almost eightfold, from USD 270 million in 2000 to USD 2,019.9 million in 2008. Meanwhile, investment increased sevenfold, from USD 3,236.1 million to USD 21,531.6 million.

La crise financière internationale de 2008-2009 provoque une chute des cours et un recul important des investissements miniers. L'augmentation des cours des métaux reprend cependant dès 2010 et avec elle les dépenses d'exploration et les investissements qui atteignent un pic sans précédent en 2012 (respectivement 20 397,4 M USD et 41 834,3 M USD au niveau international), les compagnies minières ayant été peu affectées par la crise. L'Afrique est alors la deuxième destination des dépenses d'exploration (3 365 M USD, soit 16,5 % des dépenses mondiales), derrière l'Amérique latine (25,4 %) et devant le Canada (15,9 %) et l'Australie (12,3 %). Entre 2012 et 2016, le volume mondial d'investissements dédiés à l'exploration suit la tendance baissière des cours des métaux avant de redécoller lorsque ceux-ci atteignent des niveaux similaires à ceux du supercycle minier de 2003-2008.

Levels of investment in mining exploration in Africa have broadly followed the same trends as elsewhere and have remained highly dependent on fluctuations in metal prices, as has been the case in other mining exploration destinations. However, it should be noted that the correlation between price fluctuations and fluctuations in the African exploration budget was higher at the beginning than at the end of the period studied. During the first mining supercycle

6. "Exploration budget" is a term used by S&P Capital IQ in particular. It refers to all investments focusing on mining exploration in a particular country. It includes investments made by private mining companies (majors, intermediates, and juniors) and states and is used to indicate a country's attractiveness in relation to mining.

(2003–2008), Africa witnessed a dramatic increase in its exploration budget, not only in terms of value (from USD 270 million in 2000 to USD 3,365 million in 2012) but also in terms of its share of the global exploration budget (from 11.7% in 2000 to 15.7% on average between 2003 and 2012). Africa was not simply following the rising global investment trend; it was acting as one of its engines because it was capturing a larger share of investment. Investment fell between 2012 and 2015, but Africa remained the world's second-biggest destination for exploration investment, behind Latin America.

However, the most recent increase in mining investment—which began in the mid-2010s, driven in particular by the return of global growth, the digital transition, and a continued rise in gold prices—has been less advantageous to Africa than in the past. The upturn in investment has been more moderate in Africa, while exploration spending for Africa's subsoil stabilized at approximately USD 1,113.4 million annually between 2016 and 2022. This mining boom has been more beneficial to Latin America (25% of the global exploration budget in 2022), Canada (20.7%), Australia (17.9%), and the United States (12.3%) than Africa, which has seen its relative share of global exploration spending fall since 2017, down to 9.7% of global spending in 2022, the lowest it has ever been in the entire period studied here. Greenfield and brownfield investments made in Africa fluctuate to a greater degree, but overall they represent a larger share of global investment, averaging 14.8% between 2016 and 2022.

Surges in international interest in the mining sector—initially between 2003 and 2008 with the growth of emerging nations and then from the mid-2010s with the definition of energy transition policies and supply securitization policies among the main purchasers—have therefore clearly benefited Africa, as it has seen an overall rise in investment over the period. Investment (exploration budget and greenfield and brownfield investments combined) amounted to USD 14,423.6 million on average between 2017 and 2022, compared to USD 3,796.2 million between 2000 and 2005.

Box 4. Mining exploration

Mining companies use exploration programs to identify any exploitable mineral resources on the tracts of land allocated to them by mining states via exploration licenses. The scale of these activities is reflected in the amounts that both private mining companies (majors, intermediates, and juniors) and states spend on exploration as part of their exploration budgets. Mining exploration takes place during the early stages of a mining project: Once a feasibility study has been completed (Box 5), investment is no longer considered as being used for exploration.

There are two types of mining exploration: *(i)* identification of extensions of deposits that have already been discovered. Considered low-risk, this activity is often undertaken on the basis of the depletion of reserves in already-known deposits and is often carried out by risk-adverse majors; and *(ii)* identification of deposits in areas where none have yet been found. Considered high-risk, this activity is often performed by juniors. Juniors have therefore played a crucial role in developing the African mining sector by enabling new deposits to be exploited or opening up exploitation of deposits in countries where the majors do not want to risk investment due to significant reputational risks (Zimbabwe, Sudan, Eritrea, etc.) (Brook 2011).

Mining exploration is cyclical in the sense that investment in exploration is highly dependent on external events, particularly price fluctuations, newly available information or technology, investment changes as a result of a country's economic climate, and changes to public policy. Mining exploration spending is a good indicator of the situation within the mining sector: Unlike the opening of a mine, something that requires about a decade to prepare, exploration is a variable that mining companies find relatively easy to adjust. Logically, juniors are therefore more able to access venture capital at the height of the mining cycle. Further, in principle, analysis of mining exploration spending can provide a rough indication of future production or, at the very least, of the sectors that will prove attractive to mining companies.

Factor 2: Africa's substantial and largely untapped and unexplored mineral potential

At the start of the millennium, it was believed that Africa had considerable potential for growth (Taylor et al. 2009), as it was home to 30% of the world's mineral resources, with nearly 60 minerals identified, including strategic metals (Maréchal 2013). However, it only represented 5% of the world's mining production on average and 15% of global mining exploration budgets—i.e., equivalent to or less than Australia, Canada, and South America, whose surface areas (8, 10, and 18 million km^2 respectively) are far smaller than Africa's (30 million km^2). The emergence of a highly favorable international context for mining investment was therefore a "window of opportunity" (Maréchal 2013) for Africa to develop its vast resources against a background of increased global demand.

Taylor et al. (2009) underlined the strong probability of the existence of major undiscovered mineral resources in Africa due to its favorable geology. Africa's known deposits are among the largest and richest in the world and, for example, enabled South Africa to become the world's leading producer of platinum at the beginning of the twentieth century and Botswana to be the world's leading diamond producer. Consequently, the existence of similar deposits, as yet undiscovered because of a lack of a more comprehensive cartography, is a distinct possibility given the continent's geology. With some of the most inhospitable terrain in the world, recurrent geopolitical tensions, and a lack of infrastructure that still complicates access to the terrain, Africa therefore still possesses vast regions that have not been subject to any geological cartography or systematic, modern mineral exploration—unlike countries such as Canada and Australia that had implemented intensive exploration programs for their subsoil throughout the twentieth century. Hence the perception of Africa as an "El Dorado"[7] full of promise if its exploration could be financed.

7. Viard E. (2011), "Le secteur minier, un levier de croissance pour l'Afrique?," Editorial, Secteur Privé & Développement - La revue de Proparco, Vol. 8 (https://issuu.com/objectif-developpement/docs/revuespd8_secteurminier_fr; consulted on February 1, 2023).

Factor 3: Internal developments within African countries making them more attractive to investors

The nationalizations of the 1960s and 1970s were largely reversed in the 1980s due to a combination of market liberalization and poor performances by Africa's public mining companies. State control had discouraged exploration and the development of new projects, and investments in the sector were rare, as the majority of the profits were reinjected into the country's tax revenues (McMahon 2011). The reforms implemented in the 1980s and 1990s (mainly at the instigation of the World Bank) therefore sought to revive the sector. Although they may be criticized for reducing institutional capacity and lowering social and environmental norms and standards (Campbell 2006), these reforms did result in harmonization and greater stability within the African mining sector and, consequently, the creation of a more investor-friendly environment (Maréchal 2013).

The early 2000s were marked by greater peace on the continent, the establishment of new governance and environmental regulatory mechanisms (transparent revenue management, rights of indigenous populations, environmental management, etc.), and the introduction of national and international initiatives (EITI in 2003, the ECOWAS[8] mining initiative in 2009, etc.) (Anani 2020). As a result, investments in African countries were increasingly viewed as sound and therefore became more attractive.

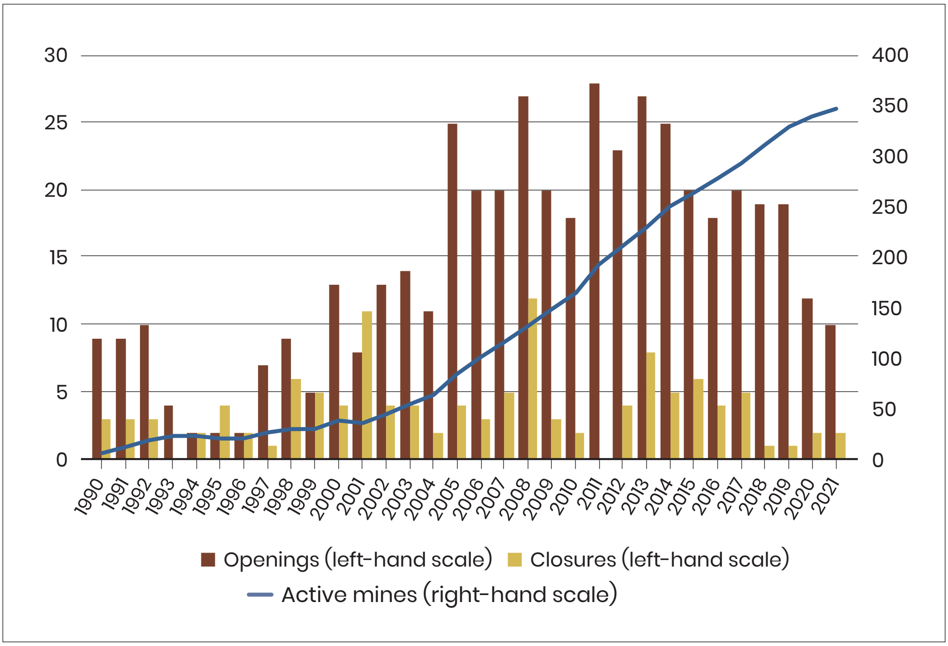
Greater investment in the African mining sector led to a dramatic increase in the number of active mines on the continent. Over the last 30 years, the number of mines opened in Africa has increased on an unprecedented scale (Graph 3).

Obtaining reliable and exhaustive figures on the change in the number of mines in Africa is difficult, particularly because of the complex nature of mining projects (Box 5), the opacity of the African mining sector, and the scarcity of African mining statistics (Box 3). Graph 3 is based on the available data in the S&P Capital IQ Pro database on the number of mines opened and closed in respect of 930 mining projects that had reached the production stage. There are limitations to this approach, as only 354 projects (39% of the projects identified) include a production start date. However, as the figures reflect the major trends described in the literature, it is our view that an interpretation of this data is useful, despite its piecemeal

8. Economic Community of West African States.

nature. Further, 805 projects do not include an end-of-operations year, principally because mining projects, by their very nature, are often halted, suspended for maintenance, or inactive without being declared closed, and another mining company will often resume operations a few years later, for example following a takeover or a change in raw materials prices.

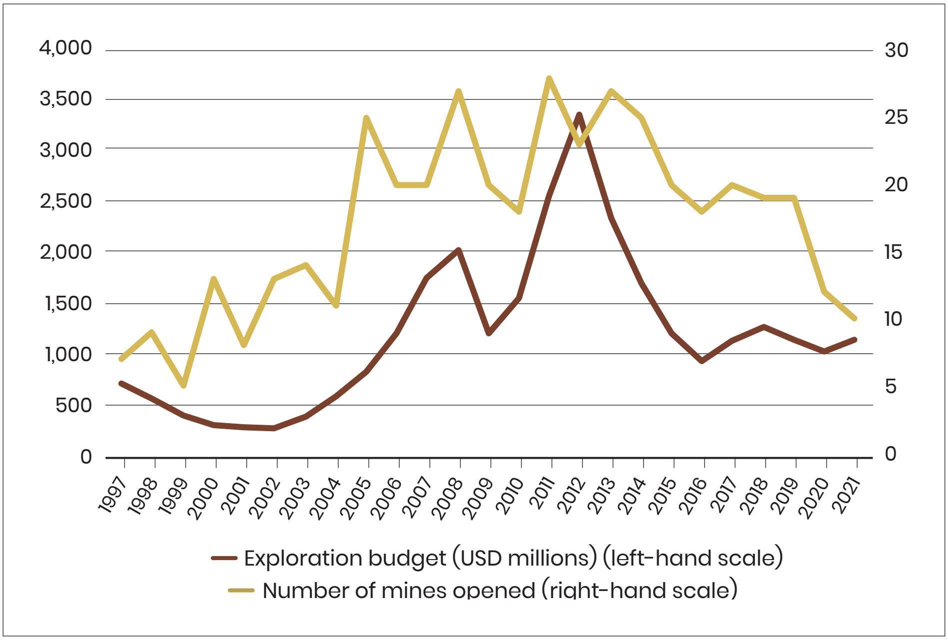
Graph 3. ***The number of mines opened and closed in Africa per year***



Source: Authors based on S&P Capital IQ Pro data.

Graph 3 indicates a clear upward trend in the number of active mines in Africa during this period. However, a few variations can be detected that broadly follow the same trends as those observed during the analysis of investments: Stagnation between 1990 and 2000 (during restructuring of the sector); a surge in the number of mines between 2000 and 2012, with an isolated jump in closures in 2008 as a result of the financial crisis; followed by stagnation and indeed a decline in the number of mine openings from the mid-2010s. It should be noted that the most recent data (from 2020 and 2021) should be viewed with some caution because of the length of the data compilation process.

Graph 4. ***Change in the number of mines opened and the annual exploration budget in Africa***



Source: Authors based on S&P Capital IQ Pro data.

However, changes in the annual exploration budget are clearly more closely correlated to changes in global raw materials prices than the number of mines opened each year. Indeed, while it is relatively easy to adjust the amount invested in exploration depending on the global situation, bringing forward or delaying the opening of a mine prepared over a number of years is extremely complicated (Box 5). The only adjustment variables in terms of operation are closure—see the peak of closures in 2008 for example—or suspension of activities.

Of course, not all exploration programs financed result in the opening of a mine. Many do not locate sufficient reserves or reveal that profitability would be too low to invest in operations that would require considerable human resources over a long period of time. Of the nearly 4,000 mining projects identified in Africa, less than a quarter actually reached the production stage. In fact, many projects cease all activity before reaching that stage. It is therefore valuable to consider the indicators relating to exploration budget (revealing the preoccupations of mining actors in a given period) alongside those concerning the opening of mines (demonstrating how operations evolve in practice after years of development).

Focusing on mines opened in Africa automatically excludes mining projects that are in the initial or advanced development stages. As these projects can reveal much about potential future investment dynamics in the African mining sector, they will therefore also form part of our analysis.

Box 5. Characteristics of industrial mining projects

Developing a mining project from initial discovery to production takes 16.5 years on average, although this varies depending on the minerals extracted, the location of the site, and the type of mine constructed: Development of an Australian lithium mine takes 4 years on average, compared to 7 years for a South American lithium mine, while a copper mine will take 17 years on average, and a nickel mine between 13 and 20 years (IEA 2021). Before making any reference to mines, projects are therefore discussed in terms of five development stages: *(i)* the initial exploration phase for projects where an initial exploration to estimate resources is underway; *(ii)* the advanced exploration phase for projects where an initial estimate of resources has been completed and exploration now seeks to calculate potential reserves[9] and refine estimates with additional drilling; *(iii)* the feasibility phase, during which a feasibility study examines in more detail the extraction procedures for the substances of interest, economic profitability, environmental impact, any indigenous titles and community agreements, legal requirements, and permits; *(iv)* the pre-production phase for projects where a decision has been taken to continue development of the project to enable production and where construction is planned or has begun; and *(v)* the production phase, which encompasses working mines (those with mineral production), satellite mines (being developed within a large mine complex), mines undergoing expansion, mines with limited or residual production (because commercial exploitation is only just beginning or is in decline), and closed mines.[10] However,

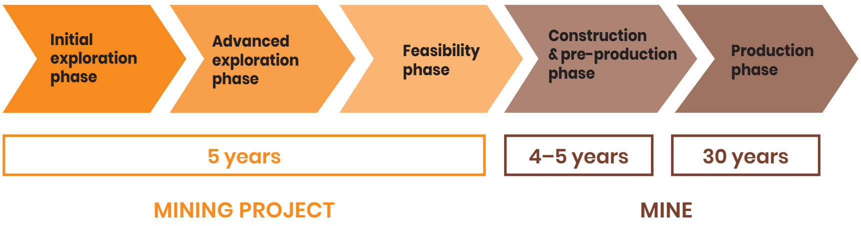
9. The mining sector distinguishes between mining resources, which refer to a deposit's maximum potential calculated purely on the basis of the quantity of minerals and metals contained therein, and mining reserves, which refer to the part of a deposit that can actually be exploited, and which therefore incorporates economic, technical, legal, environmental, and social criteria.
10. Mining companies sometimes add two more distinct phases: closure and post-closure. See for example the case of Newmont.

just because a mine is closed, that does not necessarily mean that all activity will cease on that site. Many former African mines are targeted by artisanal miners who continue to exploit mining residues. The DRC's uranium[11] and copper[12] mines are just two examples of this. On average, the exploration and feasibility phases last approximately 12 years, while the mine construction phase takes 4 to 5 years: 1.8 years on average for construction planning, and 2.6 years for construction itself (IEA 2021).

As well as the development stage, attention must be paid to developments within the mining project itself. Due to the long life cycle of most mining projects (approximately 30 years, but this varies greatly depending on the size of the deposit exploited), frequent changes of owner, and sometimes complex and costly maintenance procedures, mining projects that reach the production stage have not necessarily been continuously active from the beginning. Mining work can also be temporarily suspended for legal reasons, because of a lack of funds, a fall in the price of the mineral exploited causing the mine's profitability to fall, or for a number of technical, political, environmental, or social reasons.

It should be noted that these development phases and activity statuses concern industrial mining projects. Industrial mining is distinct from artisanal and small-scale mining (ASM). Much has been written about ASM, and each mining country has adopted its own legislation on the subject. Here, we define ASM as all mining operations (artisanal, semi-mechanized, or semi-industrial) that do not require any heavy equipment, significant investment, or cutting-edge technology.[13] Generally speaking, ASM is not included in mining statistics and mining investments, and it is difficult to obtain precise figures on this subject.

11. *Trafic d'uranium*, a documentary by Patrick Forestier (2009).
12. Ross A., "Send in the troops: Congo raises the stakes on illegal mining," Reuters, July 17, 2019 (https://www.reuters.com/article/us-congo-mining-insight-idUSKCN1UC0BS; consulted on February 3, 2023).
12. Keita S. (2001), "Étude sur les mines artisanales et les exploitations minières à petite échelle au Mali," *International Institute for Environment and Development* (IIED), No. 80 (https://www.iied.org/sites/default/files/pdfs/migrate/G00727.pdf; consulted on January 30, 2023).



An increase in mining exploration investment has therefore resulted in an increase in the number of active mines in Africa. This dual rise has led to diversification in three areas: *(i)* diversification of the African countries where mining companies are established; *(ii)* diversification of the minerals exploited; and *(iii)* diversification of investors themselves, which are of increasingly varied nationalities and sizes.

4. An increase in the number of mining countries in Africa

A growing number of African countries have been developing their national mining sectors, resulting in a gradual diversification of destinations for mining investment and mines themselves across Africa. While the increase in investment and mine openings discussed above initially strengthened the main established mining destinations (South Africa, Tanzania, Ghana, DRC, Zambia, Burkina Faso, Mali), there has also been a gradual rise in other countries developing their own mining ecosystems.

4.1. Greater diversity in investments and mine openings

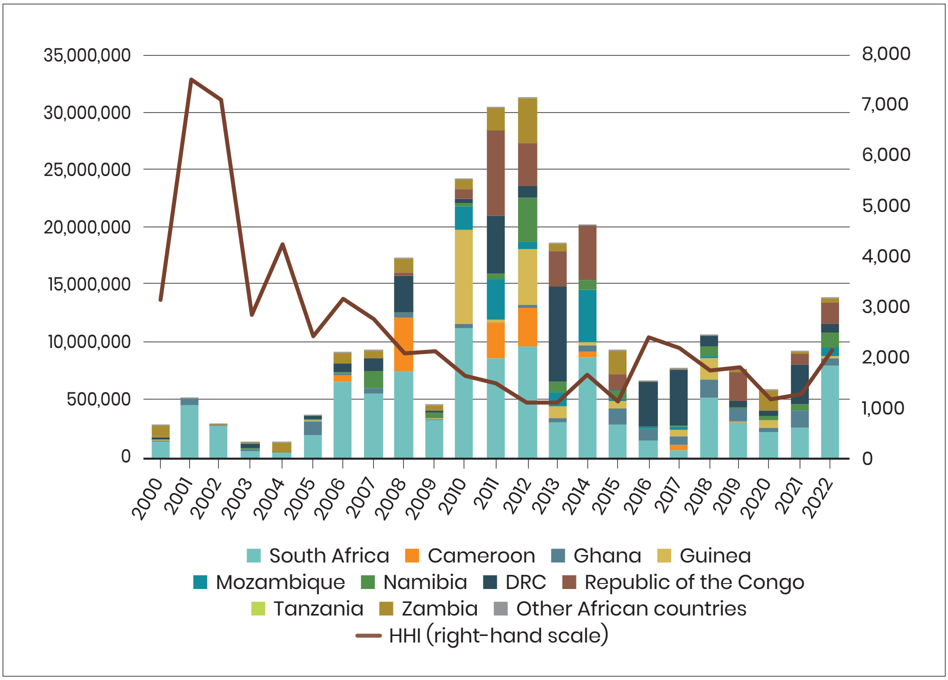
Mining investments slowly began to rise at the beginning of the twenty-first century. They mainly targeted well-established mining countries with stable mining sectors (South Africa, Tanzania, Botswana, Ghana, and Namibia) that could attract investors. Meanwhile, many other mining countries such as the DRC were striving to restructure their newly liberalized sectors. An analysis of exploration spending provides a particularly clear indication of the tendency to concentrate investment in particular countries: Between 2000 and 2004, those five countries alone represented 63.3% of exploration spending (compared to 28.3% between 2018 and 2022). Concentration of greenfield and brownfield investments was even more marked: South Africa received the vast majority of investment until 2010.

The mining boom that began in 2003 both strengthened established mining destinations (as shown by the rise in the absolute value of exploration investment in South Africa, Tanzania, Botswana, and Ghana up to 2012) and led to diversification in investment destinations and mine openings. Exploration investment therefore became markedly more diverse from 2003 onward. This shift was visible in both the Herfindahl-Hirschman Index (HHI)[14] of the exploration budget (Graph 5a) and the number of mine openings (Graph 3). Significantly, the five countries on which most exploration investment was focused in 2022 only represented 49% of Africa's total exploration budget. The fact that Mali, the DRC, and Côte d'Ivoire were among the top five in 2022 (in 1st, 2nd, and 4th position respectively) is an indication of the changing dynamics observed during this period.

Within the main destinations for exploration investment, therefore, there appear to be two parallel trends: *(i)* large, established mining countries that were still attracting more investment but were declining in relative terms; and *(ii)* new countries that were becoming more favorable to investment.

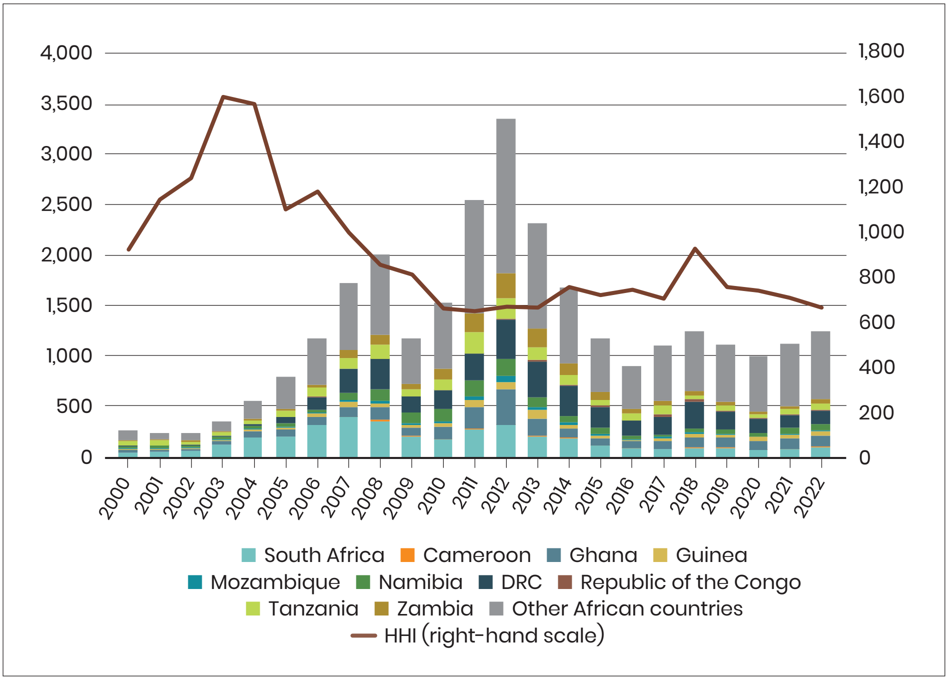
14. The Herfindahl-Hirschman Index (HHI) measures market concentration. It is calculated by totaling the squared market share of each company operating in a market. The higher the index, the greater the market concentration.

Graph 5a. ***Change in exploration budgets (USD thousands)***



Source: Authors based on S&P Capital IQ Pro data.

Graph 5b. ***Change in greenfield and brownfield mining investments (USD millions) in Africa***



Source: Authors based on S&P Capital IQ Pro data.

***Table 2.** Countries' share of mining investment in Africa between 1990 and 2022 (USD millions)*

COUNTRY	1990-2022			
	Investment	Exploration budget	Total FDI	Share (%)
South Africa	111,366.1	3,951.5	**115,317.6**	28.4
DRC	38,335.7	3,807.9	**42,143.6**	10.4
Rep. Congo	26,586.1	,153.5	**26,739.6**	6.6
Guinea	18,838.7	755.4	**19,594.1**	4.8
Zambia	17,912.2	1,533.0	**19,445.2**	4.8
Ghana,	14,020.7	2,313.1	16,333.8	4.0
Namibia	12,950.2	1,447.2	14,397.4	3.5
Mozambique	13,666.8	370.5	14,037.3	3.5
Cameroon	12,772.9	64.2	12,837.1	3.2
Tanzania	10,566.7	1,851.8	12,418.5	3.1
Zimbabwe	11,418.5	341.1	11,759.6	2.9
Botswana	9,509.4	1,214.7	10,724.1	2.6
Liberia	10,150.3	221.9	10,372.2	2.6
Mauritania	9,628.5	564.3	10,192.8	2.5
Burkina Faso	7,890	2,254.0	10,144.0	2.5
Mali	6,822.9	1,736.7	8,559.6	2.1
Madagascar	7,258.9	258.5	7,517.4	1.9
Sierra Leone	6,255.7	345.6	6,601.3	1.6
Ethiopia	5,155.0	332.7	5,487.7	1.4
Senegal	4,211.9	803.6	5,015.5	1.2
Côte,d'Ivoire,	3,720.9	1,140.1	4,861.0	1.2
Eritrea	2,666.6	300.6	2,967.2	0.7
Niger	2,558.5	302.4	2,860.9	0.7
Angola	1,464.1	1,246.0	2,710.1	0.7
Malawi	2,179.1	98.2	2,277.3	0.6
Morocco	1,619.3	373.7	1,993.0	0.5
Egypt	1,385.0	298.1	1,683.1	0.4

COUNTRY	1990-2022			
	Investment	Exploration budget	Total FDI	Share (%)
Gabon	974.8	260.4	1 235.2	0.3
Lesotho	869.4	75.5	944.9	0.2
Tunisia	907.0	35.8	942.8	0.2
Sudan	627.6	122.1	749.7	0.2
Nigeria	584.7	31.4	616.1	0.2
Uganda	516.4	51.1	567.5	0.1
Burundi	522.3	40.7	563.0	0.1
Algeria	431.4	60.5	491.9	0.1
Central African Republic	316.5	106.6	423.1	0.1
Kenya	194.8	165.9	360.7	0.1
Guinea-Bissau	165.8	22.9	188.7	0
Togo	14.5	0	14.5	0
Chad	0	9.9	9.9	0
Djibouti	0	7.7	7.7	0
Rwanda	0	6.9	6.9	0
Eswatini (*)	0	5.7	5.7	0
Gambia	0	3.1	3.1	0
Somalia	0	1.5	1.5	0
Benin	0	0.2	0.2	0
TOTAL	**377,035.8**	**29,088.2**	**406,124.0**	**100**

Source: Authors based on S&P Capital IQ Pro data.
The top five countries for each period are in bold and highlighted.
(*) formerly Swaziland.

COUNTRY	2000-2004			
	Investment	Exploration budget	Total FDI	Share (%)
South Africa	10,219.5	500.4	**10,719.9**	63.7
DRC	617.3	47.8	**665.1**	4.0
Rep. Congo	0	0	**0**	0
Guinea	115.0	53.6	168.6	1.0
Zambia	1,947.0	60.3	**2,007.3**	11.9
Ghana,	815.9	167.1	**983.0**	5.8
Namibia	152.7	115.1	267.8	1.6
Mozambique	0	40.5	40.5	0.2
Cameroon	0	0	0	0
Tanzania	265.4	186.8	**452.2**	2.7
Zimbabwe	104.6	45.2	149.8	0.9
Botswana,	156.4	99.2	255.6	1.5
Liberia,	0	6.7	6.7	0
Mauritania	137.0	17.3	154.3	0.9
Burkina Faso	56.5	40.2	96.7	0.6
Mali	64.1	94.1	158.2	0.9
Madagascar,	0	4.3	4.3	0
Sierra Leone	9.4	4.8	14.2	0.1
Ethiopia	0	0.3	0.3	0
Senegal,	0	11.9	11.9	0.1
Côte d'Ivoire	2.6	27.0	29.6	0.2
Eritrea	0	17.0	17.0	0.1
Niger	0	4.9	4.9	0
Angola,	15.0	64.1	79.1	0.5
Malawi	0	0.6	0.6	0
Morocco	397.4	10.9	408.3	2.4
Egypt	0	10.3	10.3	0.1

COUNTRY	2000-2004			
	Investment	Exploration budget	Total FDI	Share (%)
Gabon	31.0	16.1	47.1	0.3
Lesotho	18.0	4.5	22.5	0.1
Tunisia	0	7.0	7.0	0
Sudan	0	8.2	8.2	0
Nigeria	0	0	0	0
Uganda	0	0.6	0.6	0
Burundi	0	0.7	0.7	0
Algeria	9.0	1.8	10.8	0.1
Central African Republic	0	8.1	8.1	0
Kenya	0	6.4	6.4	0
Guinea-Bissau	0	1.6	1.6	0
Togo	0	0	0	0
Chad	0	0	0	0
Djibouti	0	0	0	0
Rwanda	0	0	0	0
Eswatini (*)	0	0.2	0.2	0
Gambia	0	1.8	1.8	0
Somalia	0	0	0	0
Benin	0	0	0	0
TOTAL	**15,133.8**	**1,687.4**	**16,821.2**	**99.7**

Source: Authors based on S&P Capital IQ Pro data.
The top five countries for each period are in bold and highlighted.
(*) formerly Swaziland.

COUNTRY	2008-2012			
	Investment	Exploration budget	Total FDI	Share (%)
South Africa	40,726.0	1,353.7	**42,079.7**	25.0
DRC	9,843.6	1,302.8	**11,146.4**	6.6
Rep. Congo	12,143.8	1,319.1	**13,462.9**	8.0
Guinea	13,330.2	1,135.1	**14,465.3**	8.6
Zambia	8,222.8	716.4	8,939.2	5.3
Ghana	1,091.5	898.1	1,989.6	1.2
Namibia	4,989.4	842.3	5,831.7	3.5
Mozambique	6,348.8	481.1	6,829.9	4.1
Cameroon	11,086.0	68.5	**11,154.5**	6.6
Tanzania	4,105.9	752.4	4,858.3	2.9
Zimbabwe	4,614.2	778.8	5,393.0	3.2
Botswana	1,870.1	421.6	2,291.7	1.4
Liberia	6,300	150.3	6,450.3	3.8
Mauritania,	3,172.4	382.6	3,555.0	2.1
Burkina Faso	2,586.5	1,257.1	3,843.6	2.3
Mali	1,495.6	552.1	2,047.7	1.2
Madagascar	5,500	196.9	5,696.9	3.4
Sierra Leone	2,444.0	442.8	2,886.8	1.7
Ethiopia	257.8	142.3	400.1	0.2
Senegal	1,002.0	312.5	1,314.5	0.8
Côte d'Ivoire	195.3	336.8	532.1	0.3
Eritrea	174.1	225.6	399.7	0.2
Niger	1,961.5	834.8	2,796.3	1.7
Angola	192.2	524.8	717.0	0.4
Malawi	232.5	129.4	361.9	0.2
Morocco	121.3	591.2	712.5	0.4
Egypt	346.6	81.4	428.0	0.3

COUNTRY	2000-2004			
	Investment	Exploration budget	Total FDI	Share (%)
Gabon	0	211.1	211.1	0.1
Lesotho	465.4	88.6	554.0	0.3
Tunisia	730.5	9.5	740	0.4
Sudan	505.0	33.7	538.7	0.3
Nigeria	0	172.8	172.8	0.1
Uganda	0	19.3	19.3	0
Burundi	0	869.8	869.8	0.5
Algeria	356.0	1400.6	1 756.6	1.0
Central African Republic	206.5	69.4	275.9	0.2
Kenya	15.7	39.6	55.3	0
Guinea-Bissau	165.8	238.8	404.6	0.2
Togo	0	1.1	1.1	0
Chad	0	720.7	720.7	0.4
Djibouti	0	302.8	302.8	0.2
Rwanda	0	30.5	30.5	0
Eswatini (*)	0	148.5	148.5	0.1
Gambia	0	72.1	72.1	0
Somalia	0	136.8	136.8	0.1
Benin	0	478.1	478.1	0.3
TOTAL	**146,799.0**	**21,274.3**	**168,073.3**	**99.6**

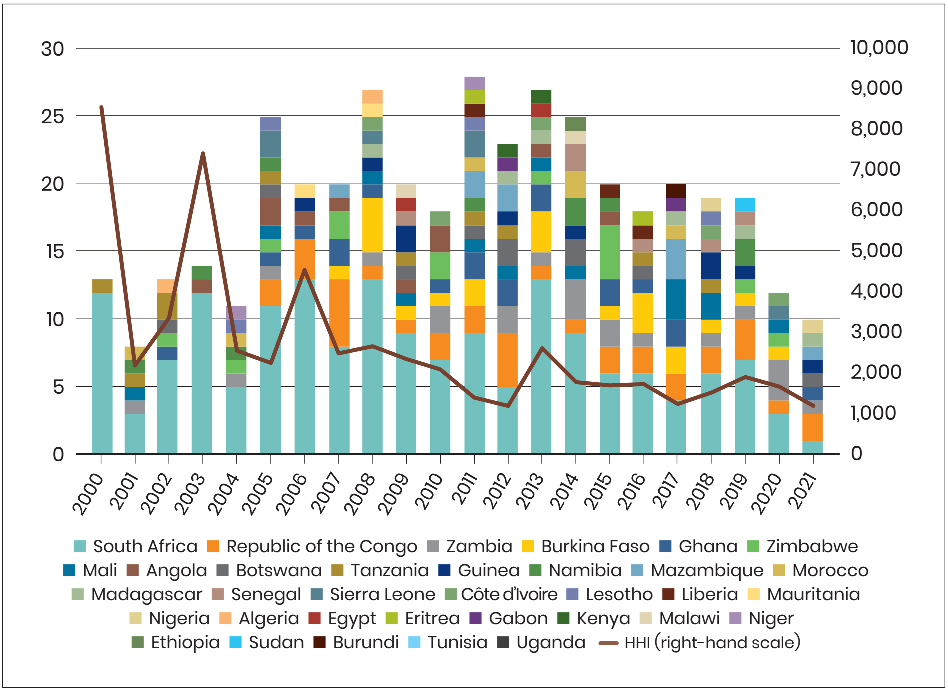
Source: Authors based on S&P Capital IQ Pro data.
The top five countries for each period are in bold and highlighted.
(*) formerly Swaziland.

COUNTRY	2018-2022			
	Investment	Exploration budget	Total FDI	Share (%)
South Africa	21,644.5	462.6	**22,107.1**	29.8
DRC	6,130.8	847.1	**6,977.9**	9.4
Rep. Congo	5,340.4	52.3	**5,392.7**	7.3
Guinea	2,622.4	179.9	2,802.3	3.8
Zambia	2,472.0	177.1	2,649.1	3.6
Ghana	5,102.1	512.3	**5,614.4**	7.6
Namibia	3,117.2	244.5	**3,361.7**	4.5
Mozambique	1,004.5	33.1	1,037.6	1.4
Cameroon	77.7	12.1	89.8	0.1
Tanzania	1,906.8	245.7	2,152.5	2.9
Zimbabwe	1,005.7	125.0	1,130.7	1.5
Botswana	2,101.4	168.7	2,270.1	3.1
Liberia	35.9	32.1	68.0	0.1
Mauritania	202.9	59.3	262.2	0.4
Burkina Faso	2,134.5	590.2	2,724.7	3.7
Mali	2,216.3	576.8	2,793.1	3.8
Madagascar	1,330.7	99.9	1,430.6	1.9
Sierra Leone	637.0	20.2	657.2	0.9
Ethiopia	105.4	51.7	157.1	0.2
Senegal	1,488.6	175.0	1,663.6	2.2
Côte d'Ivoire	2,629.6	487.4	3,117.0	4.2
Eritrea	26.1	11.7	37.8	0.1
Niger	557.7	35.9	593.6	0.8
Angola	560.9	138.9	699.8	0.9
Malawi	1,268.9	32.9	1,301.8	1.8
Morocco	641.6	119.7	761.3	1.0
Egypt	466.2	116.4	582.6	0.8

COUNTRY	2018-2022			
	Investment	Exploration budget	Total FDI	Share (%)
Gabon	887.8	26.8	914.6	1.2
Lesotho	6.0	1.0	7.0	0
Tunisia	169.5	0.1	169.6	0.2
Sudan	0	33.3	33.3	0
Nigeria	16.2	16.6	32.8	0
Uganda	381.0	18.7	399.7	0.5
Burundi	0	3.8	3.8	0
Algeria	0	2.4	2.4	0
Central African Republic	0	0	0	0
Kenya	161.0	43.5	204.5	0.3
Guinea-Bissau	0	3.5	3.5	0
Togo	0	0	0	0
Chad	0	5.8	5.8	0
Djibouti	0	2.3	2.3	0
Rwanda	0	0.7	0.7	0
Eswatini (*)	0	0	0	0
Gambia	0	0	0	0
Somalia	0	0	0	0
Benin	0	0	0	0
TOTAL	**68,449.1**	**5,767.0**	**74,216.1**	**100**

Source: Authors based on S&P Capital IQ Pro data.
The top five countries for each period are in bold and highlighted.
(*) formerly Swaziland.

Graph 6. ***Change in the number of mines opened in Africa***



Source: Authors based on S&P Capital IQ Pro data.

4.2. A relative fall in the attractiveness of "established" mining countries?

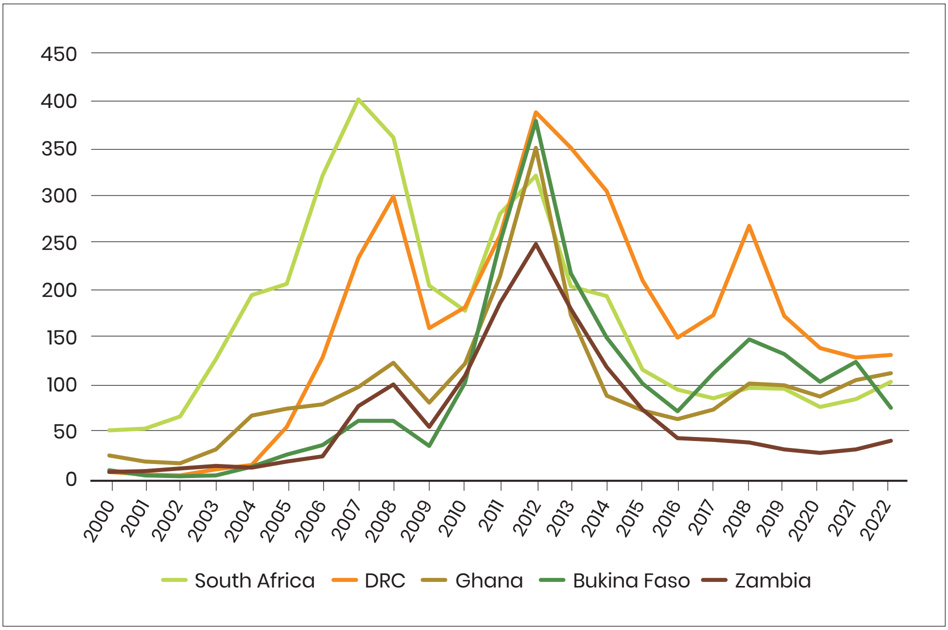
The graphs indicating exploration spending and investments made by mining companies in African countries (graphs 5a and 5b) and the number of mines opened by African country (Graph 6) demonstrate that the share of a few "established" mining countries (with long-standing mining operations and home to most African production in a few of the key metals) was very high.

Between 2000 and 2021, South Africa, the DRC, Ghana, Burkina Faso, and Zambia were the leading destinations for exploration investment in Africa and were home to the largest number of mine openings. They were all among the top global producers and all contributed substantially to Africa's mining boom. However, the exploration budget directed at these countries appears to have stagnated or even declined from 2012 (despite rebounding slightly in 2018), suggesting a fall in the attractiveness of the traditional engines of the African mining sector (Graph 5a). This relative fall is also perceptible in the attractiveness index developed by the Fraser Institute (Yunis and Aliakbari 2022), which listed South Africa in 75th place (out of 84 countries) in 2021 compared to 48th (out of 91 countries) in 2017, the DRC 82nd in 2021 compared to 51st in 2017, and Ghana 43rd in 2021 compared to 22nd in 2017.[15] Only Burkina Faso saw an improvement in its position, moving from 68th place in 2017 to 58th in 2021. However, the continuation of that trend is in doubt given the country's security crisis. It should also be noted that although Ghana's attractiveness has declined according to the Fraser Institute, it remains the second highest-ranked African country (behind Morocco in 8th place in 2021).

The explanation for this relative loss of momentum lies principally in falling prices. However, it is important to note that exploration investment in these countries has not risen again or even stabilized (with the notable exception of Ghana), even though the global mining sector is booming once more and other African countries (particularly Mali, Côte d'Ivoire, and Guinea) are witnessing an increase in their exploration investment.

15. Zambia is not included in the Fraser Institute rankings.

Graph 7. ***Change in exploration budgets in South Africa, the DRC, Ghana, Burkina Faso, and Zambia (USD millions)***



Source: Authors based on S&P Capital IQ Pro data.

South Africa is clearly a giant in the African mining sector, despite a relative loss of momentum. According to figures from S&P Global, 125 new mines[16] were opened on its territory between 1990 and 2021, i.e., nearly a third (30.6%) of all new mines established in Africa over that period. It was also the focus of the largest share of total exploration investment over the period (13.6%). According to the USGS, it has the largest manganese and platinum group metals (PGM) reserves in the world, the second-largest chromium, zircon, and vermiculite reserves, the third-largest fluorspar reserves, and the fourth-largest gold and vanadium reserves. South Africa's overall mining potential is therefore considerable, and it is an intensive mineral exploiter. It produces 36 of the 49 minerals that World Mining Data identified as being produced by at least one African country in 2020. It is Africa's leading produ-

16. I.e., not including those already open during that period or those possibly not correctly identified in the S&P Capital IQ Pro database.

cer of 18 of them and the world's leading producer of five of them (chromium, manganese, platinum, rhodium, and vermiculite). According to the Minerals Council South Africa,[17] the mining sector represented 8.7% of South Africa's gross domestic product (GDP) in 2021, with production amounting to approximately USD 70 billion (ZAR[18] 1,188.5 billion) and sales amounting to USD 50 billion. Moreover, the sector represented 50% of South African exports in 2021 according to UNCTAD, and the formal mining industry employed 458,954 people in 2021. Historically, the mining sector has been one of the country's drivers of development thanks to the establishment of global mining companies (AngloGold Ashanti, De Beers, African Rainbow Minerals, Anglo American, Glencore, Ivanhoe, etc.). The country's production peaked between 2000 and 2006, but production and export levels have been falling ever since. South Africa's mining sector has been losing momentum in the face of logistical and energy-related challenges, as well as increasing production costs. However, this relative loss of momentum, resulting in a decrease in the concentration of exploration investment since 2006, should not mask the fact that South Africa's mining sector is considerably more advanced than its neighbors' and remains attractive for investors. The country enjoys political stability and a level of development that is unparalleled on the African continent, helping to explain why South Africa is still the number one location for new mine openings.

The **Democratic Republic of the Congo (DRC)** is Africa's second-largest country behind Algeria, and its subsoil is one of the richest in the world—hence its classification as a "geological scandal."[19] It is home to around 50 of the minerals identified, including the largest cobalt reserves in the world (60% of the total identified) and the world's seventh-largest copper reserves (principally in the Copperbelt in the south of the country). Its economic specialization in the mining sector dates back to the Belgian colonial era. The mining sector represented 47% of the DRC's GDP in 2020 and 76.6% of its exports in 2021 (USD 17.7 billion), mainly from copper and cobalt and mostly destined for China. It is the world's leading

17. The Minerals Council South Africa is a professional body for mining companies established in South Africa (representing 90% of South African mineral production). It seeks to promote the South African mining sector and publishes an annual report summarizing sector trends from the previous year.
18 South African Rand (the national currency).
19. Attributed to the Belgian geologist Jules Cornet in his 1892 description of the impressive diversity and abundant quantity of the territory's mineral resources (Bouscarle 2021).

producer of cobalt and tantalum, and Africa's leading producer of copper and niobium. Overall, the DRC's mining sector has been growing impressively since 2005. The DRC had been the world's main producer of cobalt and an important producer of copper since the mid-twentieth century, but its production fell dramatically because of the two Congo Wars in 1996–1997 and 1998-2003. When tensions began to ease, the copper-cobalt-bearing (copper, cobalt, and zinc) and tin-bearing (cassiterite, coltan, and wolframite, also commonly known as the 3Ts) sectors rapidly recovered. The gold sector began to grow later, with the opening of Kibali, Africa's largest industrial gold mine, in 2009. Meanwhile, the diamond sector, which was the only sector not to have suffered too extensively from the conflicts, has been experiencing a slow decline since 2005. The DRC's copper, cobalt, 3Ts, and lithium reserves have been attracting significant interest in the context of the energy transition (CMOC Group Limited, Zijin, China Nonferrous Metal Mining Group, China Railway [China]; Glencore [Switzerland]; Ivanhoe Mines [Canada]; Eurasian Resources Group [Luxembourg]; Shalina Resources [United Arab Emirates], etc.). However, the country is still vulnerable to sporadic violence, which has a particular impact on mining regions: Gold and the 3Ts are considered "blood minerals" helping to fund the armed groups destabilizing the Kivu region in the east of the country in particular. Mines are also the cause of growing societal issues (smuggling, child labor, the sector's significant levels of informality, etc.) and environmental challenges.

Ghana, formerly known as the Gold Coast, is a long-standing producer of gold, which continues to dominate its mineral production: According to the Ghana Chamber of Mines, 97% of the gross revenue generated by mining in 2021 came from gold.[20] After a period of general economic decline in the 1970s and 1980s, Ghana's mining industry returned to strength thanks to the market-based adjustment policies recommended by the International Monetary Fund (IMF) and the World Bank. These reforms diluted the state's dominance in the mining sector, making it more attractive to overseas investors (Newmont [United States]; Gold Fields and AngloGold Ashanti [South Africa]; Asanko Gold Mines, Kinross, and Golden Star [Canada]; Perseus Mining [Australia]; and Blue International Group [United Kingdom]). Ghana was Africa's leading gold producer between 2018 and 2020, before dropping to fifth position in 2021 after a 30% fall in the sector, mainly

20. 2021 Mining Industry Statistics and Data (2022), The Ghana Chamber of Mines (https://ghanachamberofmines.org/wp-content/uploads/2022/11/Facts-and-Figures-2021.pdf).

due to the collapse of small-scale gold production—the introduction of a 3% withholding tax on production, however, was likely responsible more for fostering illegal gold trafficking than halting production in the sector. Nevertheless, gold still represents the country's leading export, is an essential source of tax revenue, and plays an important role in the country's development. Ghana's mineral resources should develop further in the medium term, particularly thanks to the development of its iron reserves (Ghana Integrated Iron and Steel Development Corporation) and lithium reserves (Atlantic Lithium, an Australian company that owns the Ewoyaa deposit), and development of its existing mining sectors: manganese (Ghana Manganese Company, controlled by the Chinese group Ningxia Tianyuan Manganese Industry Co., Ltd.), bauxite (Ghana Bauxite Company, controlled by the Ghanaian group Ofori Poku Company Limited), and diamonds (artisanal operation having been in free fall—2021 was the first year to record growth [114%] since 2014). The country intends to develop its infrastructure (particularly rail) and its processing chain (aluminum industry).

Burkina Faso's mining sector represented 16.1% of GDP and 83.9% of the country's exports in 2020. It is mainly driven by gold production (it was Africa's fifth-largest gold producer in 2020). Gold has been the country's leading export product since 2008, representing almost all the industrial mines in operation in Burkina Faso and receiving the majority of investment in the mining sector. The gold sector experienced unbridled growth up until the outbreak of the security crisis in 2022 and its direct threat to the gold industry, resulting in the forced closure of four mines. Meanwhile, zinc production—from just one mine: Perkoa (Trevali Mining, Canada)—ended in 2022, and the development of manganese and nickel is still a remote prospect. Burkina Faso's mining sector is therefore going through a reconfiguration period. Negotiations are underway between the Burkinabé government and companies principally from Canada, the United Kingdom, and Russia, as well as France and China, with regard to logistical issues.

The mining sector is at the heart of **Zambia's economy**: In 2020, it represented 11.1% of its GDP, 79.5% of its exports, and 31.4% of government revenue. Zambia is not so much dependent on the mining sector in general as on copper specifically (it has one of the most one-dimensional economies in the world). It is Africa's second-largest producer of copper (behind the DRC) thanks to steadily rising production ever since the liberalization of the mining sector in the 2000s. Half of the country's copper production comes from just two mines, Sentinel and Kansanshi, operated by the Canadian company First Quantum Minerals, the leading industrial producer of copper, gold, and soon nickel in Zambia. Zambia also produces precious stones (emerald and amethyst), manganese, and coal. The state intends to attract investors in order to diversify operations and make the country a key player in transition minerals (copper, nickel). In particular, Zambia's president, Hakainde Hichilema, intends to strengthen the country's copper industry so as to achieve 3 million tonnes by 2030, i.e., a threefold increase of current production. He aims to do this by attracting investors with a reduced corporate tax rate, reintroduction of the deductibility of royalties, temporary suspension of the issuance of permits to clean up the system, and digitalization of the land registry department to combat corruption, among other things. Broadly speaking, the sector is attracting interest from a number of different places, with Canadian, British, Chinese, Indian, and Swiss companies positioning themselves in the country.

Overall, the five countries discussed above remain Africa's mining giants. Even though the exploration spending they attract has been falling, they are still comfortably ahead of their potential competitors thanks to their well-established mining history, which has enabled them to acquire significant know-how and to forge long-standing ties with investors. They therefore still have more operational mines on their territories than anywhere else in Africa and are among the ten African countries with the most active projects. However, their downward trajectory is in stark contrast with the dynamism shown by countries with more recently developed mining sectors.

Other former mining countries (such as Botswana, Tanzania, Namibia, and Mauritania) have experienced a more marked fall in investment over this period. At the beginning of the 2000s, they were among the main destinations for exploration spending, but their share of the African exploration budget has gradually reduced (Graph 5a, Table 2). However, they are displaying greater dynamism than South Africa, the DRC, Zambia, Burkina Faso, and Ghana in terms of projects. Their mining projects/active mines ratio is good, and they are among the African countries developing the most projects in absolute terms.

4.3. The rise of new mining countries

Generally speaking, African countries are showing renewed interest in their mining sectors. **Several countries that traditionally did not have a significant mining sector are attempting to position themselves within the market** by developing their mining cartography and implementing attractive policies for investors. Cameroon, the Republic of the Congo, Uganda, Chad, Togo, Djibouti, and the Central African Republic (CAR) are developing a number of mining projects even though they do not currently have any industrial mines in the production stage (Graph 6). For example, the CAR has significant mineral resources (diamonds, gold, precious stones, iron, copper, cobalt, chromium, nickel, graphite, uranium, etc.) that have thus far been little exploited. The mining sector, largely informal, consists of artisanal mining of gold and diamonds and remains a significant source of conflict.[21] Nevertheless, the **CAR** intends to develop its mining sector: Preparation of a reform to the Mining Code launched in 2009 was completed in August 2022 and proposes in particular the creation of a new public company, GEMINCA (Gemmes et minéraux de Centrafrique), the creation of a mining fund, and an adjustment to mining tax rules to benefit investors.[22] Moreover, the country rejoined the EITI in 2021 (having been suspended in 2013) and has defined three priorities: *(i)* increased mining investment, *(ii)* formalization, production, and improvement of working conditions in the artisanal sector, and *(iii)* improved governance of the sector.[23] The CAR hopes that development of its mining sec-tor will benefit its population, which is one of the poorest in the world. Meanwhile, a number of overseas investors are already seeing the potential of investing in the country. Russia is particularly well-established: The paramilitary group Wagner has been operating in the CAR's diamond sector

21. Salih Z.M. & J. Burke (2023), "Wagner mercenaries sustain losses in fight for Central £African Republic gold," The Guardian, February 2, 2023 (https://www.theguardian.com/world/2023/feb/02/wagner-mercenaries-sustain-losses-in-fight-for-central-afrcan-republic-gold; consulted on February 2, 2023).
22 Rapport Initiative pour la transparence dans les industries extractives (ITIE) en République centrafricaine 2020 (2022) (https://eiti.org/sites/default/files/2023-02/CAR%202020%20EITI%20Report.pdf).
23. Website of the Central African Ministry of Mines and Geology (https://mines.gouv.cf/sites/default/files/2018-12/FICHE%20THEMATIQUE%20INDUSTRIE%20EXTRACTIVE%20-%20RCA.pdf,consulted on February 21, 2023).

since 2018 and hopes to strengthen its hold over the country's mining resources.[24] The Central African government is also targeting India as a preferred partner, particularly via the company Vedanta Resources.[25]

24. *Africa Defense Forum*, "Le groupe Wagner pille les diamants de la RCA," January 17, 2023 (https://adf-magazine.com/fr/2023/01/le-groupe-wagner-pille-les-diamants-de-la-rca/; consulted on February 21, 2023).
25. India has an invite to mine natural resources from oil-to-gold in Central African Republic, *The Economic Times*, November 8, 2022 (https://economictimes.indiatimes.com/industry/indl-goods/svs/metals-mining/india-has-an-invite-to-mine-natural-resources-from-oil-to-gold-in-central-african-republic/articleshow/95379083.cms?from=mdr ; consulté le 15 février 2023).

Table 3. ***Mining projects/active mines ratio in African countries***

COUNTRY	ACTIVE MINES[26]	ACTIVE MINING PROJECTS	PROJECTS/MINES RATIO
Cameroon	0	13	–
Rep. Congo	0	9	–
Uganda	0	8	–
Chad	0	4	–
CAR	0	3	–
Togo	0	2	–
Djibouti	0	1	–
Kenya	1	7	7
Côte d'Ivoire	7	43	6.1
Ethiopia	2	12	6
Gabon	3	17	5.7
Tanzania	9	48	5.3
Nigeria	2	10	5
Malawi	2	9	4.5
Botswana	12	53	4.4
Mozambique	6	25	4,2
Madagascar	7	26	3.7
Namibia	18	57	3.2
Mali	15	46	3.1
Eritrea	2	6	3
Somalia	1	3	3

26. All mines not categorized as inactive by S&P Global (active, undergoing maintenance, activity temporarily suspended, status unreported) are included here.

COUNTRY	ACTIVE MINES	ACTIVE MINING PROJECTS	PROJECTS/MINES RATIO
Niger	2	5	2.5
Burkina Faso	18	41	2.3
Guinea	11	25	2.3
Liberia	4	9	2.35
Mauritania	7	11	1.6
Zimbabwe	18	28	1.6
Senegal	9	14	1.6
Zambia	31	43	1.4
Sudan	3	4	1.3
DRC	39	49	1.3
Sierra Leone	6	7	1.2
Ghana	29	32	1.1
Algeria	4	4	1
Eswatini (*)	1	1	1
Morocco	17	13	**0.8**
Tunisia	4	3	**0.8**
South Africa	231	159	**0.7**
Lesotho	3	2	**0.7**
Egypt	5	3	**0.6**
Angola	14	8	**0.6**
Rwanda	2	1	**0.5**

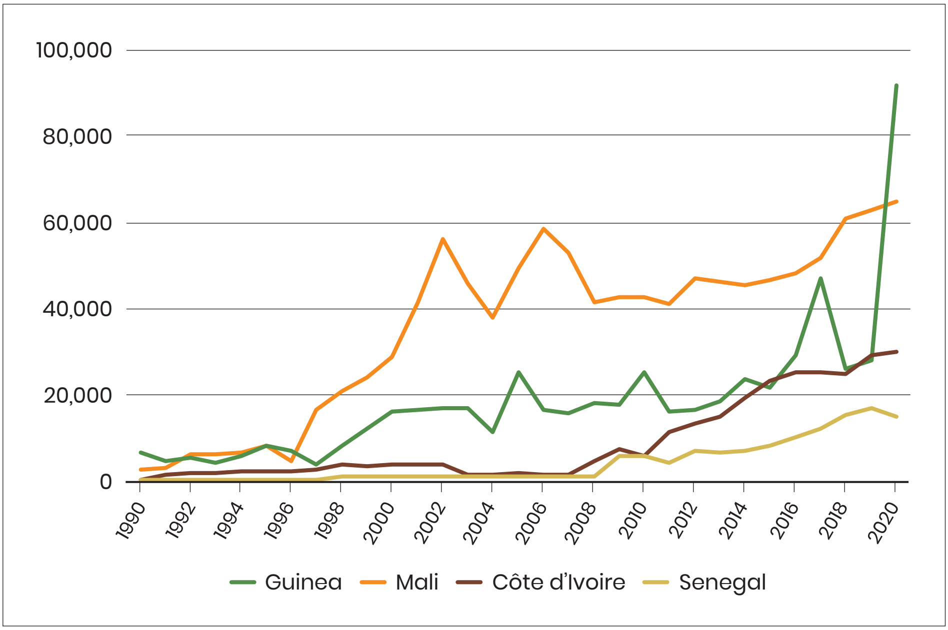
Source: Authors based on S&P Capital IQ Pro data.
(*) formerly Swaziland.

Overall, there is evidence of African states attempting to seize the opportunity to develop an important part of their economies. **Countries such as Malawi, Eritrea, Liberia, Burundi, and Sudan that have some, albeit limited, mining experience have good mining projects/active mines ratios.**L The case of l'**Ethiopia** provides a particularly good illustration of this new dynamism. According to the EITI,[27] it possesses 200 tonnes of gold, 360 million tonnes of coal, and 69 million tonnes of iron. Since Prime Minister Abiy Ahmed came to power in 2018, the country has been gradually opening up to private investors as it looks to develop its mining sector. Currently, the Ethiopian mining sector is principally focused on gold, which represented 93% of the value created by the mining sector in 2019—the remainder coming from the extraction of construction minerals (limestone, salt, marble, gypsum, etc.). Ethiopian gold production centered on the Lega Dembi and Sakaro mines until the operating license of Midrocgold Mines (the Ethiopian owner) was suspended after protests criticizing the mines' serious environmental impact in 2018.[28] Since then, gold production has therefore relied on artisanal mining (3.2 tonnes in 2019). However, Ethiopia would like to attract overseas firms to explore its gold resources, as well as potash and tantalum. In particular, the Ethiopian government is offering tax incentives in an attempt to increase the mining industry's contribution to GDP from 3% during the pre-COVID period to 10% by 2030.[29] In an example of the country's new dynamism, the Swedish exploration company Akobo Minerals began production at the Segele gold deposit in the space of a few months (initially planned for the end of 2022, it had to be delayed until the beginning of 2023). The Segele deposit appears to be very promising.[30] It should be noted that no new deposits had been exploited in Ethiopia since 1994.

27. Ethiopian Extractive Industries Transparency Initiative (EEITI) (2021), Final Report for year ended 7 July 2019, EITI, Addis Ababa (https://eiti.org/sites/default/files/attachments/2019_eeiti_report_final.pdf).
28. "Ethiopian mine Lega Dembi's environmental impact," *BORGEN Magazine*, November 1, 2020(https://www.borgenmagazine.com/ethiopian-mine-lega-dembis-environmental-impact-explained/; consulted on February 21, 2023).
29. Whitehouse D. et al., "Mines: Projets, transactions, technologies… Qu'attendre de 2023?," *Jeune Afrique*, January 25, 2023 (https://www.jeuneafrique.com/1408817/economie/mines-projets-transactions-technologies-quattendre-de-2023/; consulted on January 31, 2023).
30. "Éthiopie: Le potentiel aurifère du gisement Segele revu à la hausse grâce à une nouvelle campagne de forage," *Agence Ecofin*, April 25, 2022 (https://www.agenceecofin.com/or/2504-96956-ethiopie-le-potentiel-aurifere-du-gisement-segele-revu-a-la-hausse-grace-a-une-nouvelle-campagne-de-forage; consulted on February 21, 2023).

However, and most significantly, we have seen the spectacular emergence of new mining powers, such as Mali and Côte d'Ivoire, as well as (to a lesser extent) Guinea and Senegal. Mali and Côte d'Ivoire were respectively the first and fourth leading destinations for exploration investment in 2022 and respectively had three and six times more projects in development than active mines. They are performing better than any other country in terms of growth in the value of their mining industries and have therefore succeeded in becoming two of Africa's largest producers. In 2020, Mali became Africa's fourth-largest gold producer and 14th in the world; meanwhile, Côte d'Ivoire was Africa's seventh-largest gold producer and 21st in the world. Gold production has increased in spectacular, and seemingly limitless, fashion (Graph 8), resulting in increased investment in both countries.

Graph 8. ***Change in gold production in Côte d'Ivoire, Guinea, Mali, and Senegal (kg)***

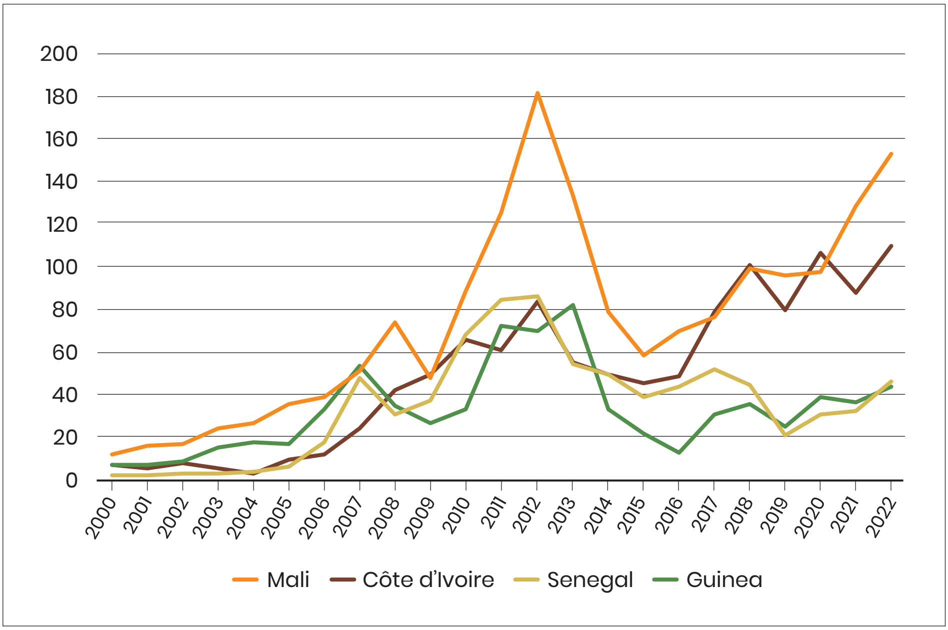


Source: BGS.

Mali's extractive sector is a significant part of the country's economy, representing nearly 80% of its exports in 2021 and 18% of government revenue in 2018. It has witnessed a spectacular appetite for its gold sector and therefore benefited from the largest exploration budget in Africa in 2022 (USD 153.9 million). Of that sum, 93% was allocated to gold, and 53% of that amount involved projects in the advanced exploration stage or with a feasibility study underway. The gold sector consists of more than 350 artisanal mines and employs nearly 2 million people (around 10% of Mali's population). A number of mining giants have therefore established themselves in the country's gold sector, particularly the Canadian firms Barrick Gold (at the Loulo Gounkoto complex on the Mali-Senegal border) and B2Gold (at the Fekola mine), as well as smaller actors that have taken over major projects: Boto Gold purchased by the Moroccan firm Managem from IAMGOLD in December 2022;[31] Sadiola purchased by a subsidiary of the Emirati company Allied Gold Corporation from AngloGold Ashanti and IAMGOLD in 2020; and the Tabakoto and Segala projects purchased from Endeavour Mining by Algom Resources, a subsidiary of the Ghanaian group BCM Investments domiciled in Sierra Leone. Exploration is booming, be it in the gold sector with the Kobada (Toubani Resources, Canada), Sanankoro (Cora Gold, British Virgin Islands), and Niaouleni (Sylla Gold, Canada) projects,[32] or the lithium sector—Mali hopes to become a lithium producer in 2024 via the Goulamina and Bougouni mines.[33] However, the picture is more nuanced than it might initially appear: Mali's security crisis is having a serious impact on its attractiveness, and in 2021 the Fraser Institute placed Mali in 81st position (out of 84 countries) in terms of investment attractiveness. The crisis has not yet affected exploration investments, but there is a very real risk of the country following a similar trajectory to Burkina Faso.

31. IAMGOLD, press release: "*IAMGOLD annonce des réserves prouvées et probables de 13,9 millions d'onces et des ressources mesurées et indiquées attribuables de 23,9 millions d'onces en 2020,*" February 17, 2021 (https://s2.q4cdn.com/610165863/files/doc_ news_ fr/2021/02/NR-04-21_R-R_2020_Update_FR_FINAL.pdf; consulted on January 9, 2023)..
32. "Golden opportunity for mining in Southern Mali," Investing News Network (INN), December 28, 2022 (https://investingnews.com/gold-mining-southern-mali/; consulted on January 31, 2023).
33. "Mali: Le chinois Fosun International financera la construction de la mine de lithium Bougouni," *Agence Ecofin*, January 19, 2023 (https://www.agenceecofin.com/investisse- ment/1901-104646-mali-le-chinois-fosun-international-financera-la-construction-de- la-mine-de-lithium-bougouni; consulted on January 27, 2023).

Graph 9. ***Change in exploration budgets invested in Mali, Côte d'Ivoire, Senegal, and Guinea (USD millions)***



Source: Authors based on S&P Capital IQ Pro data.

Côte d'Ivoire is home to nearly 35% of West Africa's Birimian greenstone belt, with its wealth of gold, iron, manganese, bauxite, diamond, and columbite-tantalite resources. Traditionally a gold producer, until recently Côte d'Ivoire's mining sector relied almost exclusively on artisanal production. The coup d'état in 1999 and two civil wars between 2002 and 2011 hampered the development of industrial production while artisanal operations prospered, driven by an increase in prices.[34] However, when Alassane Ouattara became president in 2011, Côte d'Ivoire began to establish an attractive mining policy, developing its geological potential. It joined the EITI in 2008, as well as the Kimberley Process Certification Scheme (KPCS), and developed an investor-friendly legal framework by reforming its Mining Code in 2014. In addition to

34. Sauerwein T. (2020), "Gold mining and development in Côte d'Ivoire: Trajectories, opportunities and oversights," Land Use Policy, Vol. 91, 104323, Elsevier (https://doi.org/10.1016/j.landusepol.2019.104323).

its legal framework, Côte d'Ivoire also developed its logistical and energy infrastructure, exporting its electricity to its neighbors. The strategy was immediately successful, as the country began to be targeted for investment.[35] In 2016, the Fraser Institute had Côte d'Ivoire as the highest-ranked African country in its investment attractiveness index (17th out of 104 countries), and Ivorian gold production surged, increasing by 457% between 2010 and 2020. Barrick Gold (Tongon), Endeavour Mining (Ity), and Perseus Mining (Yaouré, Sissingué) set up in the country, and the number of projects multiplied. In 2022, the country had six times more projects in development than active mines. Exploration has therefore been intensive, particularly in the gold sector (USD 103.2 million, or 93% of its exploration budget in 2022). Côte d'Ivoire's mining sector currently remains dominated by gold, but it also includes manganese, nickel, and bauxite following the opening of the Bénéné mine in 2020.[36]

The situation in Guinea and Senegal has been less dynamic than in Mali and Côte d'Ivoire (Graph 9), but large-scale projects are underway in those two countries. These projects include the development of the phosphate sector, the revival of the Falémé integrated iron project (Senegal), accelerated exploitation of the gold sector in the Kédougou region (Senegal), supervision and promotion of artisanal mines, accelerated exploitation of zircon deposits, and the development of a regional mining hub in Senegal.[37] Meanwhile, Guinea's bauxite sector is booming: It is the world's second-largest bauxite producer, and the sector has been attracting the interest of Chinese, British, Emirati, Indian, and Australian firms as the government seeks to encourage the development of a Guinean processing industry.[38] Guinea's gold sector is also performing strongly thanks to the establishment of

35. Vuuren R.J. van, "Mining in West Africa: Mali and Côte d'Ivoire to experience unprecedented growth rates," *Mining Review Africa*, April 21, 2017 (https://www.miningreview.com/west-africa/mining-in-west-africa-mali-and-cote-divoire-to-experience-unprecedented-growth-rates/; consulted on February 21, 2023).
36. *Rapport Initiative pour la transparence dans les industries extractives (ITIE) en Côte d'Ivoire 2020 (2022)* (https://eiti.org/sites/default/files/2023-01/Rapport-ITIE-CI-2020-Version- finale-V-30-12-2022%20%281%29.pdf).
37. R*apport Initiative pour la transparence dans les industries extractives (ITIE) au Sénégal Semestre 1 2022 (2022)* (https://eiti.org/sites/default/files/2023-01/Rapport-Semestre-1- 2022-22122022_0.pdf).
38. "Guinée: Les compagnies minières sommées de transformer la bauxite sur place," *Jeune Afrique*, April 10, 2022 (https://www.jeuneafrique.com/1337652/economie/guinee- les-compagnies-minieres-sommees-de-transformer-la-bauxite-sur-place/; consulted on January 4, 2023).

new players such as Morocco[39] and Canada, and artisanal gold mining is booming. Finally, the Simandou iron ore project, long coveted by investors, seems to be progressing with the formation of Chinese-French-Singaporean and Chinese-British consortiums in 2022.[40]

5. A mining sector largely dominated by gold, copper, and diamonds but attracting new interest in transition minerals

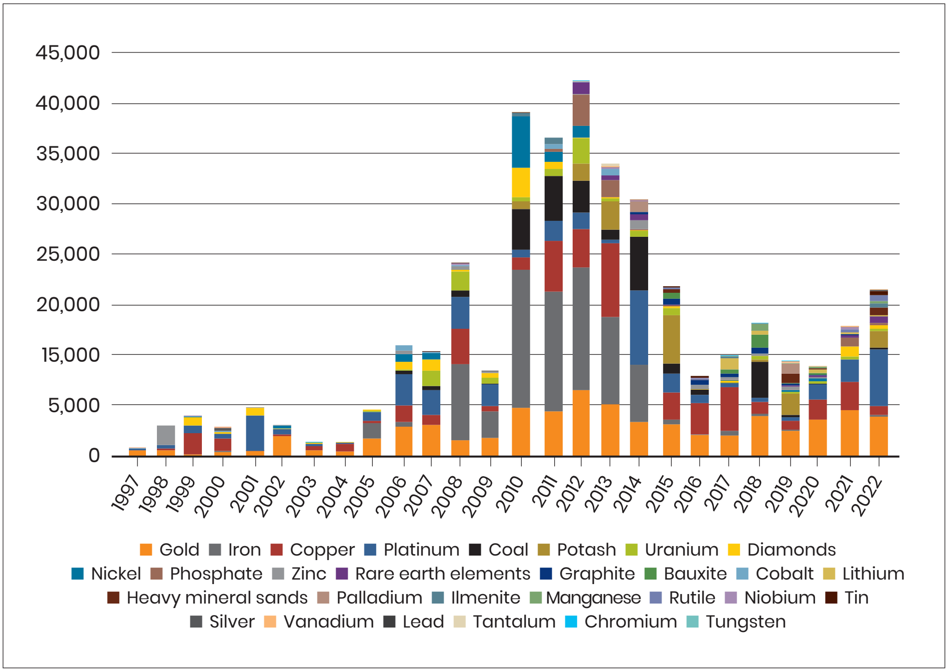
This section seeks to analyze the mining boom on the basis of the minerals concerned. By breaking down greenfield and brownfield investments (Graph 10), exploration budgets (Graph 11), mine openings (Graph 12), and drilling operations (Graph 13) by mineral type, we have identified two trends of differing significance:

- increased gold, copper, and diamond exploration and mine openings. These three minerals alone represent nearly 80% of the exploration budget and 60% of mines opened between 2000 and 2022;
- real diversification in terms of the number of minerals sought and exploited, although they remain dwarfed by gold, copper, and diamond production.

39 Mousjid B., "Mines: Sénégal, Mali, Guinée… Le marocain Managem reprend les actifs d'Iamgold," *Jeune Afrique*, December 21, 2022 (https://www.jeuneafrique.com/ 1402767/ economie/mines-senegal-mali-guinee-le-marocain-managem-reprend -les-actifs-diamgold/; consulted on January 4, 2023).

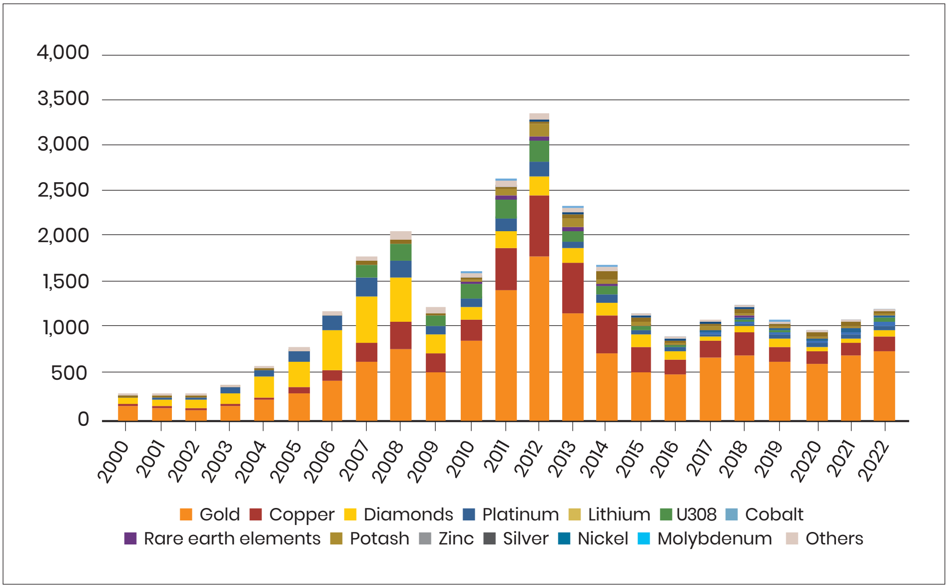
40. "Chinese, foreign consortiums reach deals with Guinean government on Simandou iron ore project's infrastructure buildup," *Global Times*, December 25, 2022 (https://www.globaltimes.cn/page/202212/1282558.shtml; consulted on January 4, 2023).

Graph 10. ***Change in greenfield and brownfield investments by mineral type (USD millions)***



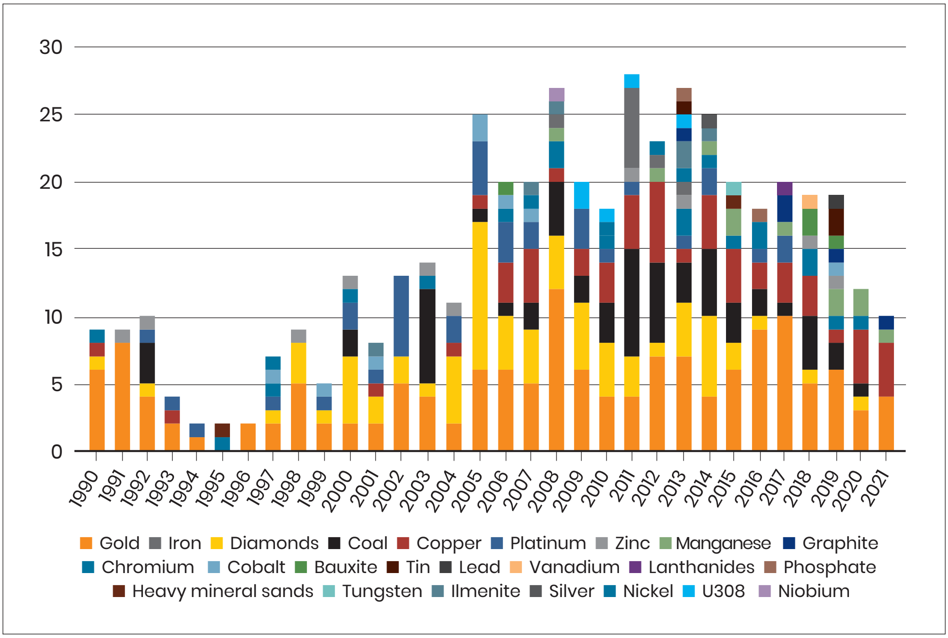
Source: Authors based on S&P Capital IQ Pro data.

Graph 11. ***Change in the African exploration budget by mineral type (USD millions)***



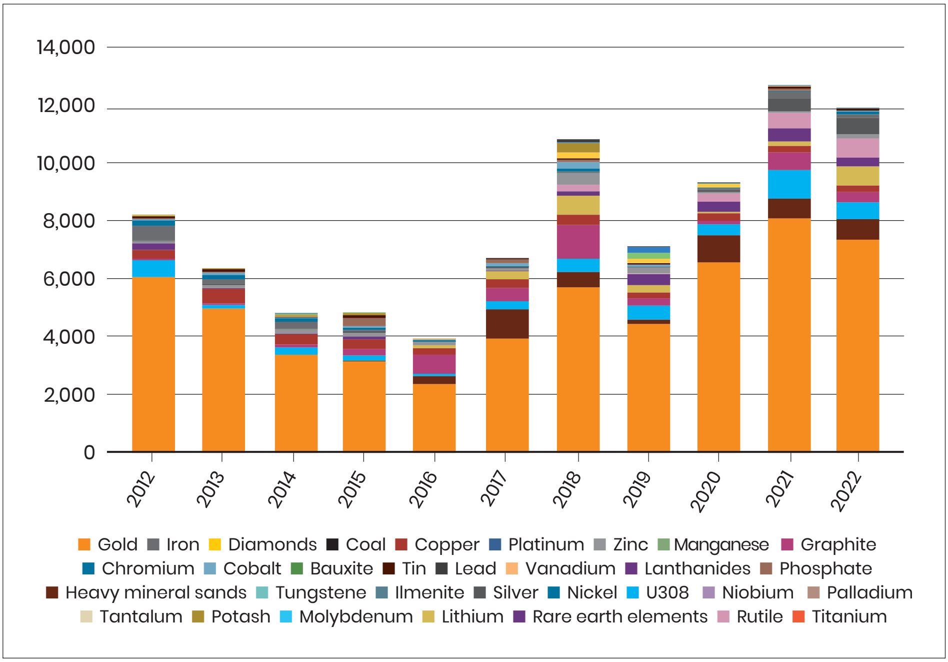
Source: Authors based on S&P Capital IQ Pro data.

Graph 12. ***Change in the number of mines opened in Africa by mineral type***



Source: Authors based on S&P Capital IQ Pro data.

Graph 13. ***Change in the number of drilling operations in Africa by mineral type***

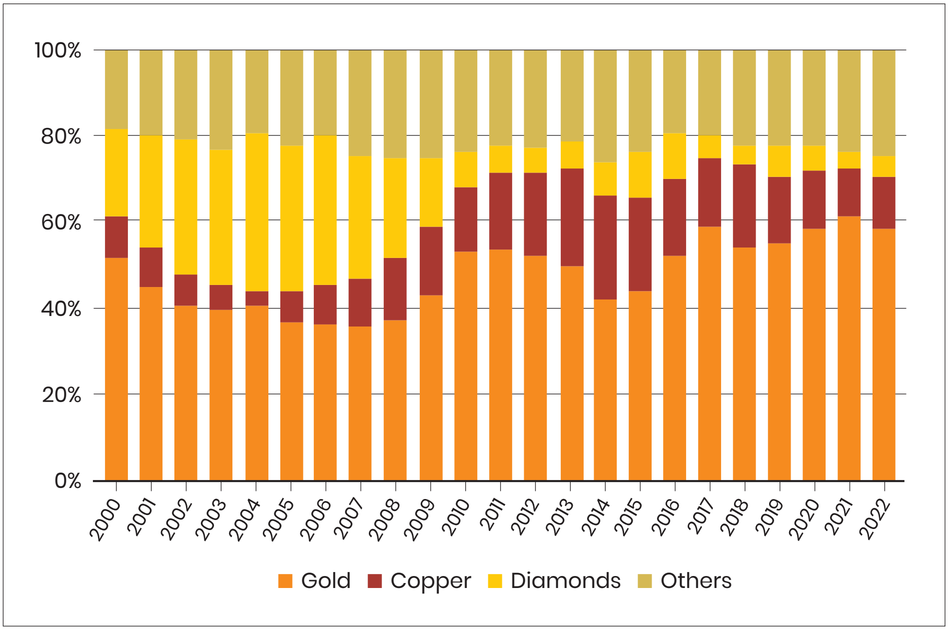


Source: Authors based on S&P Capital IQ Pro data.

5.1. Gold, copper, and diamonds: The three minerals that continue to attract the most investment and mine openings

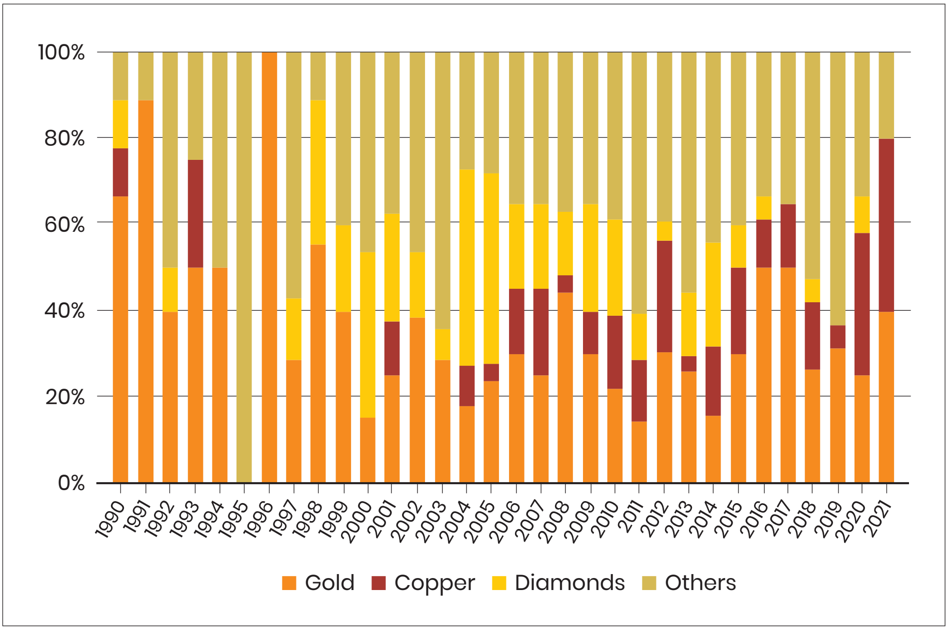
Gold, diamonds, and copper have been the three main minerals sought and exploited since the beginning of the twenty-first century. These three minerals have been exploited in Africa for centuries. The "gold rush" and, to a lesser extent, the "diamond rush" were significant moments in Africa's history: Precious metals were a considerable attraction for firms from the colonizer nations. The Copperbelt between Zambia and the DRC was also highly coveted, and following its discovery, copper rapidly rose to become one of Africa's most exported mineral materials. In recent years, these three minerals have consolidated their position. Far from seeing their relative share fall in favor of "green" minerals, as one might have imagined, gold, copper, and diamonds continue to occupy a disproportionate place in Africa's mining landscape.

Graph 14a. ***Change in the share of gold, copper, and diamonds in Africa's total exploration budget***



Source: Authors based on S&P Capital IQ Pro data.

Graph 14b. ***Change in the respective share of gold, copper, and diamonds in the number of mine openings***



Source: Authors based on S&P Capital IQ Pro data.

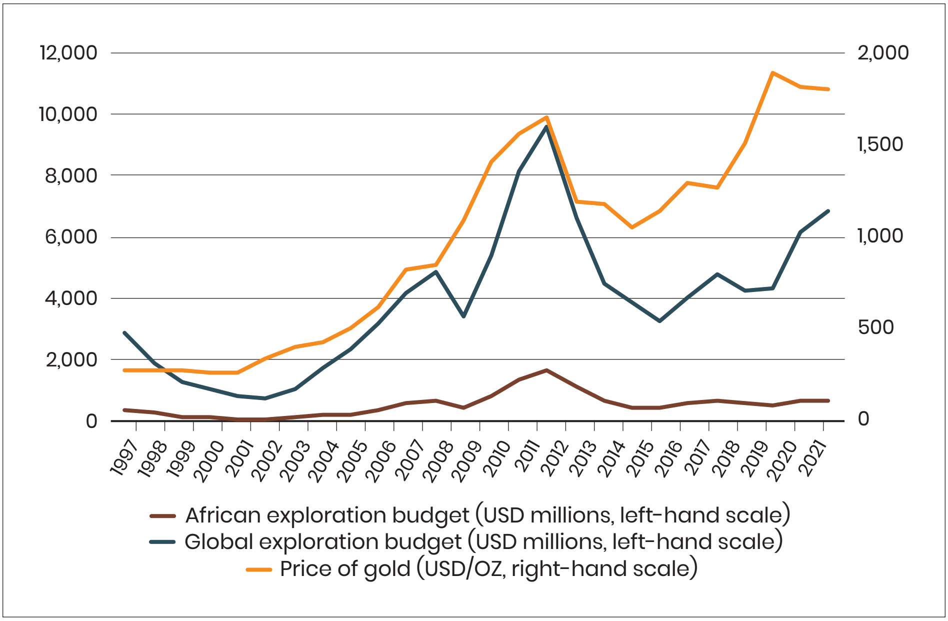
Gold, copper, and diamonds are Africa's most attractive minerals. They were the largest exploration spending items over this period, representing 77% of Africa's total exploration budget on average (Graph 14a), with gold and copper[41] alone amounting on average to 70% of drilling operations carried out between 2010 and 2022.

Exploration is particularly dynamic for these three minerals: Exploration budgets in Africa focusing on these three minerals broadly track mineral prices and global exploration budget trends. However, they peaked noticeably during the mining boom. These three minerals drove the dramatic rise in Africa's total exploration budget during the mining boom—diamonds during its initial phase (2003-2008) and gold and copper during its second phase (2009–2012). Global exploration budgets for gold and copper increased by 186% and 197% respectively between 2009 and 2012, while the African exploration budget for those two minerals increased by 207% and

41. Unfortunately, we do not have data on drilling operations in the diamond sector.

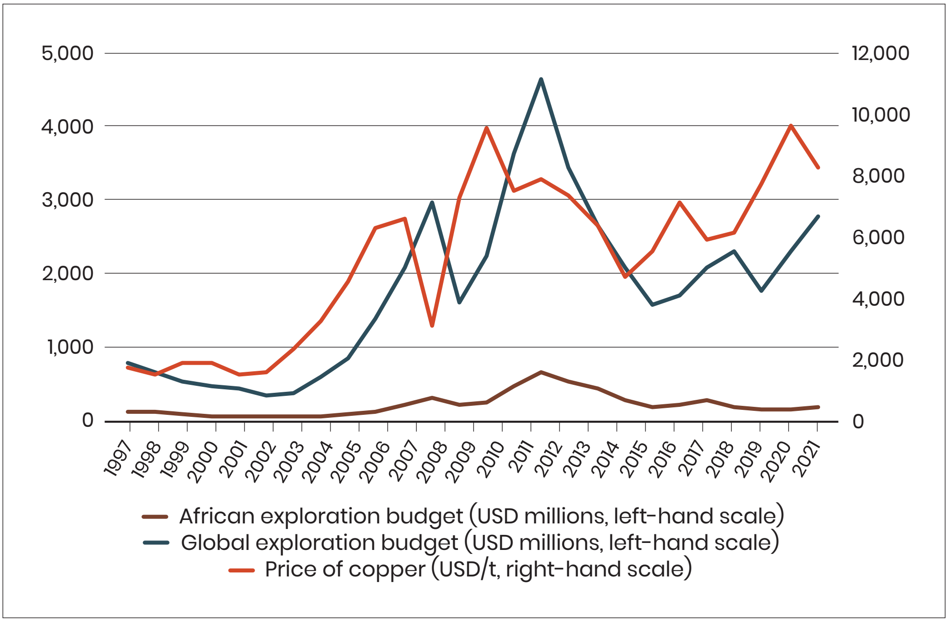
270% respectively (graphs 15a and 15b). The difference was even more striking during the diamond peak between 2003 and 2007: The global diamond exploration budget increased by 229%, while the corresponding African budget increased by 402% (Graph 15c).

Graph 15a. ***Comparative change in the African gold exploration budget and the global gold exploration budget***



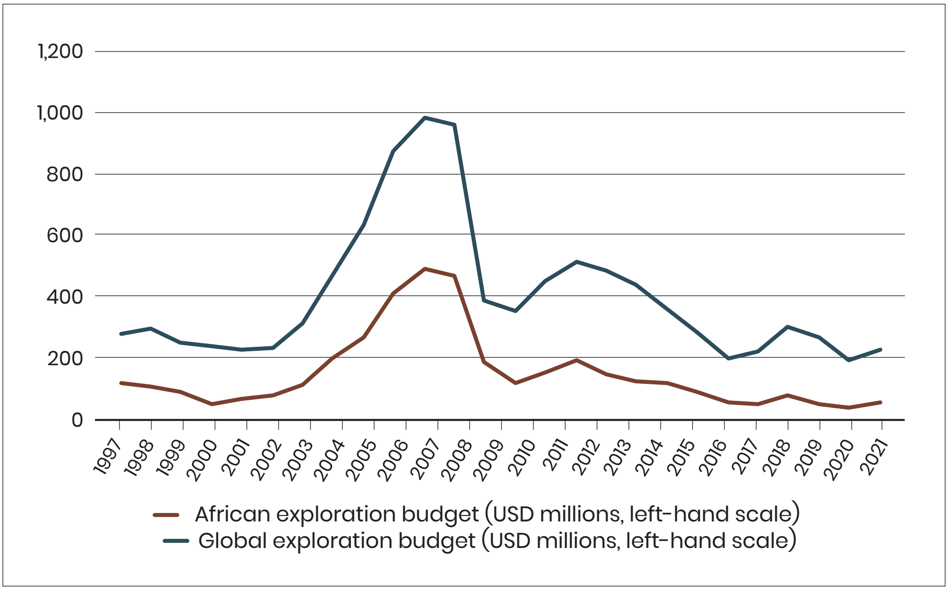
Source: Authors based on S&P Capital IQ Pro data.

Graph 15b. ***Comparative change in the African copper exploration budget and the global copper exploration budget***



Source: Authors based on S&P Capital IQ Pro data.

Graph 15c. ***Comparative change in the African diamond exploration budget and the global diamond exploration budget***



Source: Authors based on S&P Capital IQ Pro data.

These three minerals are particularly attractive because gold and copper are two of the world's most traded—and therefore most sought after—raw materials. In 2020, gold and copper were ranked first and third in global mineral production value (USD 182,779 million for gold and USD 128,360 million for copper), with iron sandwiched between them with a value of USD 164,589 million.[42]

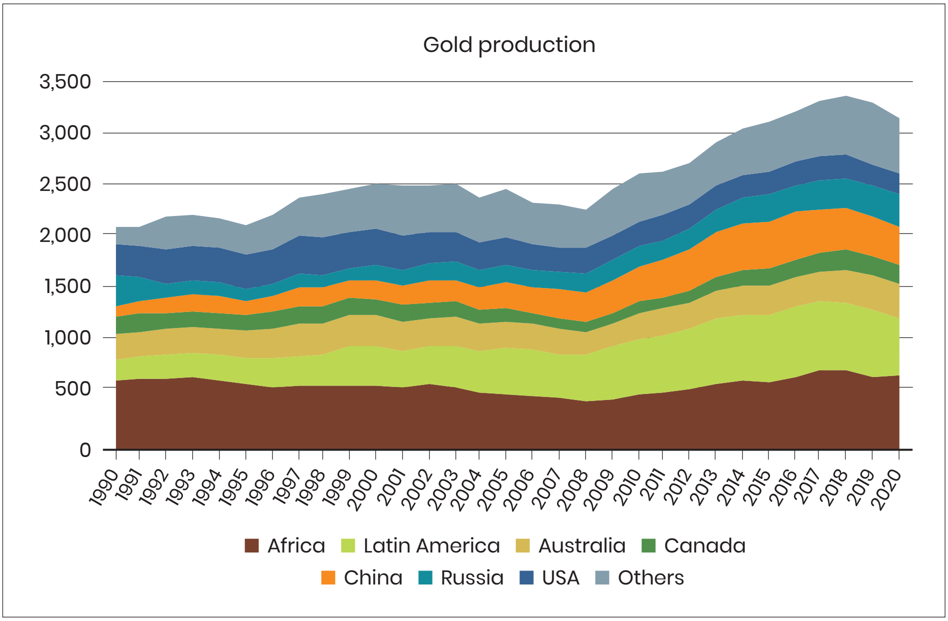
Gold is a safe-haven asset during crises, and copper, omnipresent in industry, can be considered "a backbone of the most advanced industrial and technological sectors, while its consumption curves also continue to serve as an economic barometer in the digital era" (Chalmin 2011). Global production of gold and copper has increased since 2008 (graphs 16a and 16b), and this trend should continue to be favorable for both minerals. Gold is one of the safest investments, so it should benefit from the after-effects of the COVID-19 pandemic and the war in Ukraine. Meanwhile, demand for copper should boom. According to the TIAM-IFPEN model,[43] its consumption should increase from 27 million tonnes in 2015 to 86-102 million tonnes (range) by 2050 on the basis of scenarios predicting an explosion in the power networks, consumer goods, and transport sectors (Hache, Barnet, and Seck 2020). The IEA has identified copper as a critical metal for the energy transition, and its demand, as well as its production, should continue to increase.

Investors are therefore keen to target those two minerals, and Africa, as an established gold and copper producer with vast reserves, is in their sights. In 2020, Africa's gold and copper production represented the most commercially valuable elements of the continent's mining sector, amounting respectively to USD 40,339 million and USD 16,815 million—far ahead of palladium (USD 5,580 million) and iron (USD 5,254 million).[44] These two minerals are attracting growing levels of exploration investment, their production is increasing, and they are extracted in increasingly large mines and in a growing number of countries. However, despite such dynamism in Africa, the continent's share of the international gold and copper markets has increased less quickly than African

42. Calculated on the basis of total production of the mineral recorded in 2020 (World Mining Data) and the average price of the aforementioned mineral in 2020 (IMF).
43. Times Integrated Assessment Model-IFPEN.
44. It should be noted that some minerals (such as diamonds and graphite) are not traded on global markets. It is therefore difficult to estimate an average trade price and to calculate a representative commercial value for these minerals.

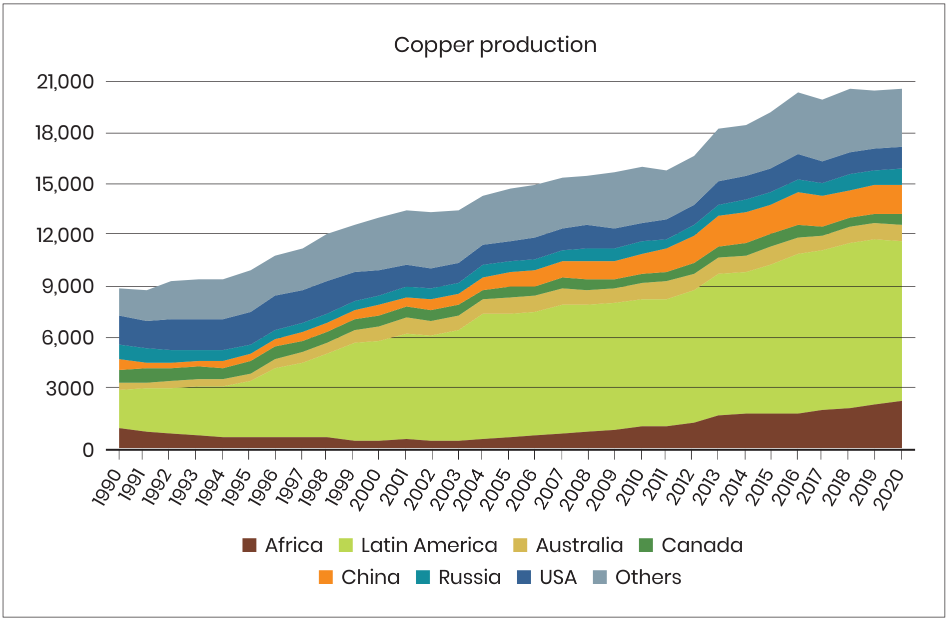
production. Between 2010 and 2020, African gold production increased by 35%, while the share of African production in global production only grew by 12.5% (from 20.2% to 22.7%). Meanwhile, African copper production increased by 109%, while its share of global production grew by only 63% (from 8.3% to 13.3%). These variations suggest that international competition is continuing to grow in the face of sustained global demand. The market is therefore far from being saturated, and gold and copper investments in Africa still have a bright future in front of them—consider the large number of mining projects in the gold and copper sectors (respectively 1,066 and 255 projects in development).

Graph 16a. ***Change in global gold production (tonnes)***



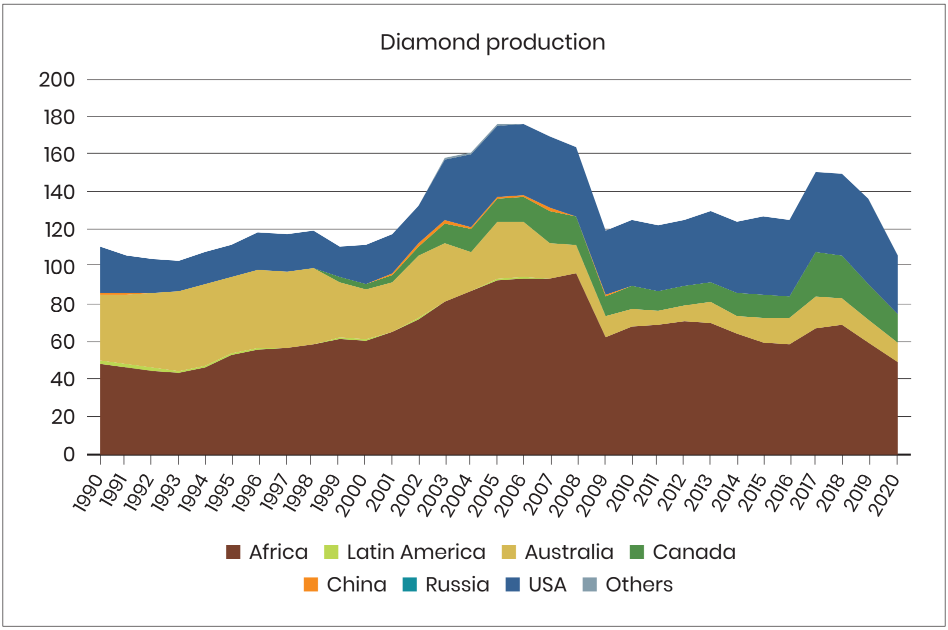
Source: Authors based on BGS data.

Graph 16b. ***Change in global copper production (thousands of tonnes)***



Source: Authors based on BGS data.

Graph 16c. ***Change in global diamond production (millions of carats)***



Source: Authors based on BGS data.

Africa's diamond sector is particularly attractive because of the continent's large share of the global diamond market. The size of the diamond market is far smaller than those of the other two minerals discussed above, and it has not experienced the same upturn in the period studied, being neither a safe-haven asset nor a transition mineral. Demand for African diamonds surged significantly in the early 2000s, as demonstrated by the attraction of exploration investment (third-largest exploration budget in the period studied and second-largest budget between 2000 and 2008), the opening of mines (14% of newly opened mines were exploiting diamonds as their main product), and increased production. Africa's diamond sector is of great importance on the global scale: The continent has attracted more exploration investment in the diamond sector than anywhere else since 1990, and it remains the world's largest producer. However, the sector has been in relative decline since 2009 (Graph 16c).

These three minerals (gold, copper, and diamonds) have had a significant impact on the evolution of the African mining sector over the last few decades, but all three face distinct challenges. The gold sector has continued to be attractive in terms of exploration and the number of mines opened, but copper and diamonds each followed very different trajectories between 2000-2008 and 2009-2022. Diamonds had been the focus of the second-largest exploration budget, and more diamond mines were opened between 2000 and 2008 than any other mineral but one. However, diamonds were relegated to third place in exploration budgets and fourth position in terms of the number of mines opened (i.e., behind copper and coal) between 2009 and 2021. Copper's fortunes, meanwhile, moved in the opposite direction, particularly in the DRC, where copper investments became attractive once more, while the diamond sector became relatively less so.

Box 6. Gold, the undeniable champion of the African mining sector, across all categories

Gold is the behemoth of Africa's mining landscape. It was the focus of nearly half the African exploration budget over the study period, and it is Africa's most valuable mining product (more than twice the commercial value of copper in second place). More than a third of the mines opened over the course of the last 30 years exploit gold as their main product (36.3%), and nearly two-thirds of drilling operations involved gold (64%). No other mineral comes close to the size of Africa's gold sector. And while it has always held this dominant position, it should be noted that the trend continues to favor the African gold sector, which has consolidated its influence over the continent. In the most recent period (2020-2022), the number of drilling operations was higher than ever, and the gold exploration budget continued to increase, along with production at the continental level.

The continuing attractiveness of gold must be seen against the backdrop of the massive extension of gold exploitation (both industrial and artisanal) around the world as a result of both technological deepening and geographical widening (Verbrugge and Geenen 2019). The last few decades have seen the emergence of major technological changes in the gold sector that have enabled a shift from underground mining operations to open-pit operations and have led to more efficient processing technologies. These cheaper techniques, combined with digitalization and increased use of subcontracting (Kenny and Bezuidenhout 1999), have brought about a generalized fall in costs. It should also be noted that a gold mine is much less dependent on transportation infrastructure than most basic minerals (Abugre and Akabzaa 1998): Hence, expenditure is lower and production can begin more quickly than in other types of mine. As a result, gold was particularly targeted by international investments from the 1990s onward. International firms diversified their investment destinations, and the gold industry therefore underwent a geographical expansion.

Therefore, despite declining reserves in established gold mining countries (Australia, Canada, United States, Russia) and the problems encountered by South Africa (which represented nearly three-quarters of global gold production in the 1970s), production actually grew, driven by the increase in the number of gold-producing countries, particularly from the beginning of the 2010s. New giants therefore appeared in the form of Peru, Ghana, and Indonesia. Also worthy of note was the emergence of a number of medium-scale African gold producers. A third of the world's 30 largest gold-producing countries were African (Table 4). In comparison, the BGS identified only 23 African gold-producing countries in 1990 (five of which were among the world's top 30 producers) and 27 in 2000 (six of which were among the world's top 30 producers).

Table 4. ***Production of the 30 largest gold-producing countries in 2020***

RANK	COUNTRY	PRODUCTION (kg)	SHARE (%)	CUMULATIVE SHARE (%)
1	China	365,340	11.37	11.37
2	Australia	327,889	10.21	21.58
3	Russia	308,560	9.60	31.18
4	United States	193,400	6.02	37.20
5	Canada	182,352	5.68	42.88
6	Mexico	142,787	4.44	47.32
7	**Ghana**	**125,114**	**3.89**	**51.22**
8	Kazakhstan	116,964	3.64	54.86
9	Uzbekistan	104,600	3.26	58.11
10	Brazil	98,922	3.08	61.19
11	**South Africa**	**95,887**	**2.98**	**64.17**
12	**Guinea**	**91,798**	**2.86**	**67.03**
13	Peru	88,054	2.74	69.77
14	**Mali**	**71,200**	**2.22**	**71.99**
15	Indonesia	66,190	2.06	74.05
16	**Burkina Faso**	**62,138**	**1.93**	**75.98**
17	**Tanzania**	**55,805**	**1.74**	**77.72**
18	Papua New Guinea	52,510	1.63	79.35

RANK	COUNTRY	PRODUCTION (kg)	SHARE (%)	CUMULATIVE SHARE (%)
19	Colombia	48,561	1.51	80.87
20	Turkey	42,100	1.31	82.18
21	**Côte d'Ivoire**	**38,523**	**1.20**	**83.38**
22	**Sudan**	**35,700**	**1.11**	**84.49**
23	Argentina	34,936	1.09	85.57
24	Chile	33,895	1.05	86.63
25	**Democratic Republic of the Congo**	**29,597**	**0.92**	**87.55**
26	Dominican Republic	28,154	0.88	88.43
27	Kyrgyzstan	24,150	0.75	89.18
28	Bolivia	23,207	0.72	89.90
29	Suriname	21,214	0.66	90.56
30	**Zimbabwe**	**20,873**	**0.65**	**91.21**

Source: Authors based on World Mining Data figures.

Gold is therefore perceived to be a safe-haven asset in many African countries.[45] For example, it is striking to observe that Mali and Burkina Faso, although suffering the effects of major security crises, remain important gold exploration destinations; national gold production has even increased. Investment in gold exploration in Burkina Faso did fall slightly in 2022, and its trajectory for increasing production is currently impacted by the closure of industrial gold mines vulnerable to the advancing conflicts. However, Mali continues to be an attractive destination; mining companies spent more on exploration in that country than anywhere else in Africa in 2022. Moreover, their exploration programs concluded with promising discoveries that bode well for sustained development of gold production in Mali, currently Africa's fourth-largest producer.

45. "Afrique économie - L'or, bouée de sauvetage des gouvernements africains," *RFI*, May 11, 2022 (https://www.rfi.fr/fr/podcasts/afrique-%C3%A9conomie/20220511-l-or-bou%C3%A9e- de-sauvetage-des-gouvernements-africains).

5.2. Relative diversification in energy transition metals

Global interest in minerals has surged over the last few decades. Driven by a new wave of technological developments (information and communication technologies [ICTs], artificial intelligence [AI], etc.) and the need to decarbonize energy mixes—two very mineral- and metal-intensive fields—we are witnessing a race to secure critical minerals (Paillard 2011; Kalantzakos 2019). This notion of criticality encompasses "all the risks linked to the production, use, and end-of-life management of a raw material: geopolitical, economic, production, and environmental or social risks" (Hache, Barnet, and Seck 2020). The list of materials considered critical varies according to the political and economic interests of the actors concerned, but they broadly overlap with the list of transition minerals developed by the IEA. The IEA has identified five priority minerals: cobalt, copper, lithium, nickel, and rare earth elements (REEs[46]). It has also identified 27 other metals that merit special attention: silver, arsenic, boron, cadmium, chromium, tin, gallium, germanium, graphite, hafnium, indium, iridium, lead, magnesium, manganese, molybdenum, niobium, platinum, selenium, silicon, tantalum, tellurium, titanium, tungsten, vanadium, zinc, and zircon.

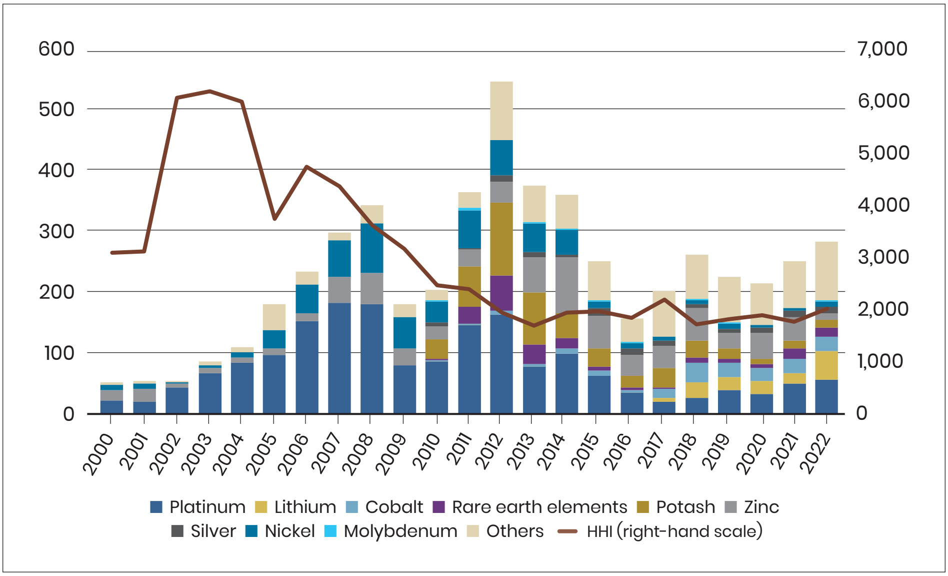
Nearly half of African countries possess one or several of the critical minerals required for the energy transition, and the renewed interest in these metals has caught the attention of African states. A number of the continent's governments are therefore endeavoring to play a larger role in mining projects, either directly (through public companies or vehicles) or indirectly (partnerships between local actors and overseas investors). The African Union (AU) is currently working with the African Development Bank (AfDB) to develop a pan-African strategy for the management of green metals. ECOWAS is also working with the AfDB to develop regional green metal partnerships. These strategies encompass not only exploitation of the minerals themselves, but also the development of a processing sector for those minerals (see Chapter 4).

46. Rare earth elements encompass 17 chemical elements (scandium, yttrium, and the 15 lanthanides). Known as the "vitamins of modern society," they have gradually become an essential element for numerous cutting-edge industries (particularly the military sector) and play an important role in the development of "green" energies (magnets for wind turbines). They have remarkable properties (high thermal stability, high electrical conductivity, strong magnetism) that have led to significant performance improvements for technologies while reducing the quantity of materials consumed. However, their extraction presents some environmental, geopolitical, and social problems. The IEA is mainly focusing on neodymium, dysprosium, praseodymium, and terbium.

But to what extent has this state-led diversification of Africa's mining sectors through the development of transition mineral exploration and exploitation been successful? Broadly speaking, it is difficult to say that the position of these minerals has been strengthened, given that gold, copper, and diamonds continue to be the focus of the majority of the exploration budget and most mine openings. However, when gold, copper, and diamonds are excluded from the analysis (as well as combustible minerals, which will be discussed separately), the trend toward diversification is relatively clear.

A larger proportion of exploration investment has been focused on an increasing number of metals (from USD 52 million in 2000 to USD 283.8 million in 2021, with investment peaking at USD 550.5 million in 2012). The Herfindahl-Hirschman Index (HHI) recorded a sharp fall between 2003 and 2022, suggesting a significant drop in the concentration of the exploration budget (Graph 17). The increase in the amounts focusing on exploration of other minerals indicates both the attraction of mining companies to these minerals (most of which are essential for the transition) and the desire of African states to diversify their production, since exploration can only be carried out by companies with exploration licenses granted by states, which decide which metals and minerals can actually be explored.

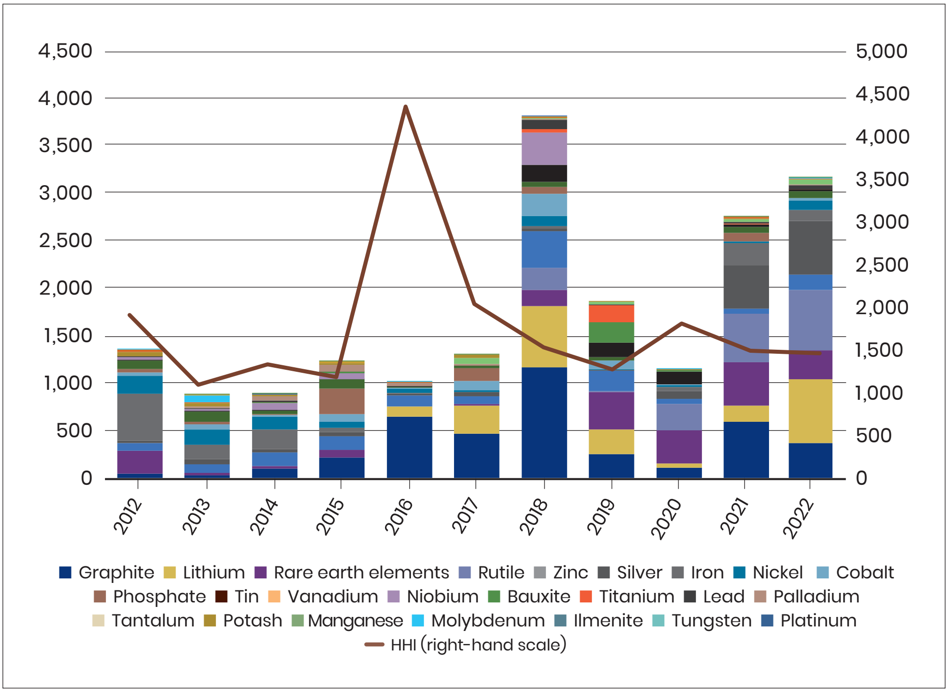
Graph 17. ***Change in the African exploration budget for minerals excluding gold, copper, diamonds, and combustible minerals (USD millions)***



Source: Authors based on S&P Capital IQ Pro data.[47]

47. The platinum budget encompasses the PGMs more broadly, i.e., the zinc/lead budget and the potash/phosphate budget. The "Others" category aggregates the budgets for chromium, tin, niobium, tantalum, heavy mineral sands, and other industrial minerals, as well as the budgets for silver, cobalt, lithium, molybdenum, phosphate, potash, and rare earth elements between 1997 and 2009.

Graph 18. ***Change in the number of exploratory drilling operations carried out for minerals excluding gold, copper, diamonds, and combustible minerals (number of drilling operations)***



Source: Authors based on S&P Capital IQ Pro data.

There is therefore real momentum in the increasingly sought-after transition minerals sector. As a logical consequence, the number of active mines and, above all, the number of mining projects in development focusing on these minerals have increased. Significantly, the mining projects/active mines ratio for most of the transition minerals is greater than the ratios for gold, copper, and diamonds (Table 5).

Table 5. ***Mining projects/active mines ratio by mineral type***

MINERAL	MINES IN THE PRODUCTION STAGE[48]	MINING PROJECTS	PROJECTS/MINES RATIO
Molybdenum	0	3	-
Palladium	0	1	-
Potash	0	18	-
Titanium	0	1	-
Zircon	0	2	-
Lanthanides	1	34	34
Lithium	1	27	27
U3O8	7	150	21.4
Nickel	7	68	9.7
Iron ore	27	164	6.1
Graphite	7	42	6
Lead	3	18	6
Rutile	1	6	6
Gold	*198*	*1,066*	*5.4*
Tantalum	3	14	4.7
Ilmenite	7	28	4
Niobium	1	4	4
Heavy mineral sands	2	7	3.5
Copper	*74*	*255*	*3.4*
Diamonds	*104*	*356*	*3.4*
Bauxite	8	26	3.3
Tin	6	19	3.2
Zinc	9	27	3
Vanadium	3	8	2.7

MINERAL	MINES IN THE PRODUCTION STAGE[48]	MINING PROJECTS	PROJECTS/MINES RATIO
Platinum	41	88	2.1
Coal	130	221	1.7
Cobalt	9	14	1.6
Phosphate	23	30	1.3
Manganese	24	25	1
Chromite	35	20	0.6
Silver	2	1	0.5
Tungsten	4	2	0.5
Chromium	1	0	0
TOTAL	**738**	**2,745**	**3,7**

Source: Authors based on S&P Capital IQ Pro data.

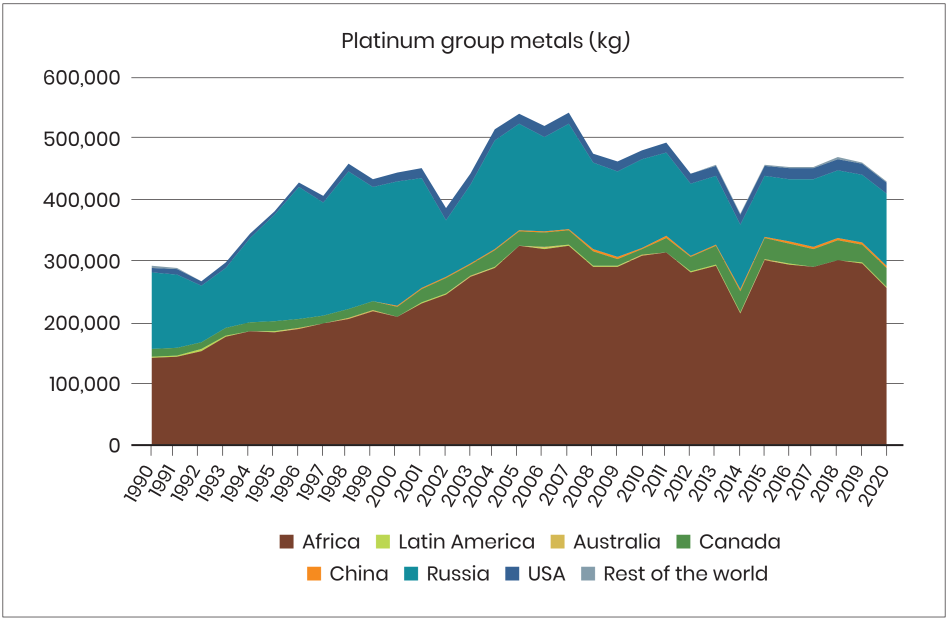
Africa has long been a leading global producer of platinum, chromium, manganese, and cobalt. It possesses a large number of mines where the main materials extracted are platinum group metals (41 mines in the production stage), chromium (35 mines), manganese (24 mines), and cobalt (9 mines)—It is important to note that a significant number of its copper mines also exploit cobalt as a by-product. The continent therefore plays a major role in the global production of these minerals (graphs 19a, 19b, 19c, and 19d). Production of these four minerals increased around the world during the research period, a trend that should continue due to increased demand. Although the attractiveness of African platinum and cobalt declined for a time (between 2013 and 2018 and between 2016 and 2019 respectively), to the benefit of other countries such as Canada and Australia, there is now renewed interest in both materials (graphs 20a and 20b). This attractiveness resulted in a greater number of drilling operations in the platinum, cobalt, and manganese sectors in 2021 and 2022,

48. The mines included for each mineral are only those where the mineral is extracted as the main material.

and above all a number of mining projects in development greater than the number of active mines. Only chromium has a smaller number of mining projects in development than active mines.

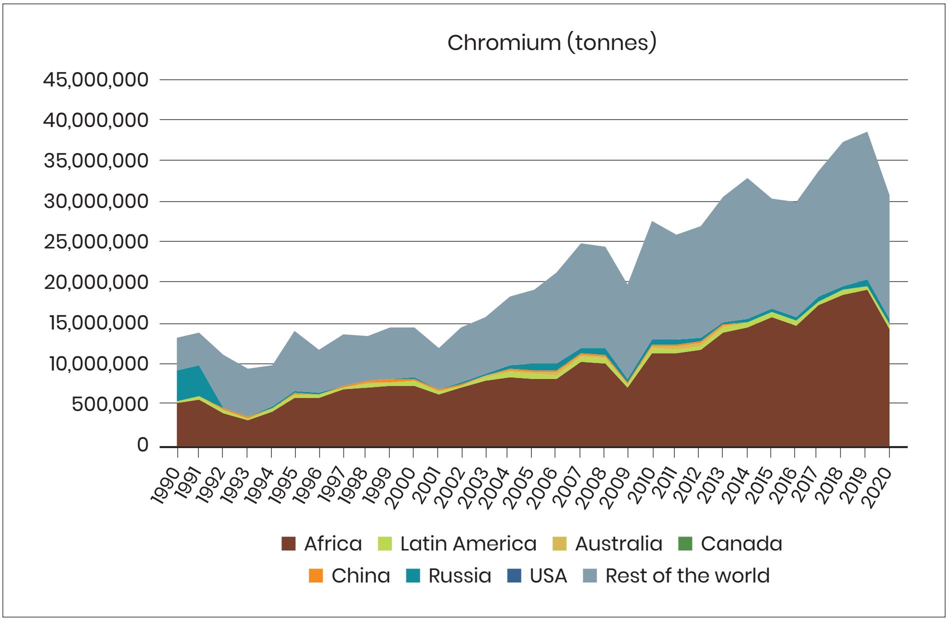
The continent has therefore asserted its strong position in platinum, chromium, manganese, and cobalt exploitation and should continue to develop these four transition minerals in view of their growing demand.

Graph 19a. ***Global platinum production***



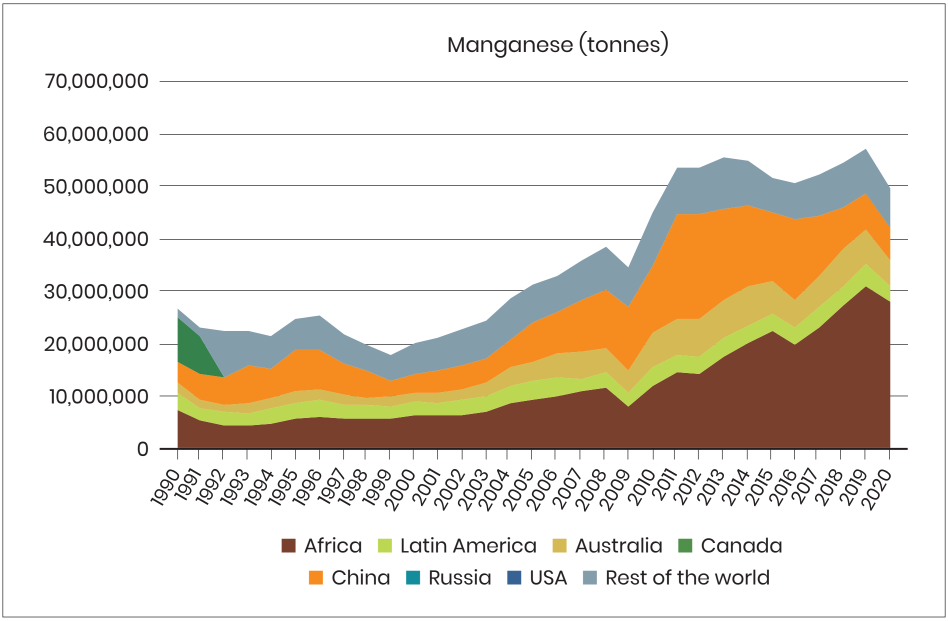
Source: Authors based on BGS data.

Graph 19b. ***Global chromium productionGraph 19b: Global chromium production***



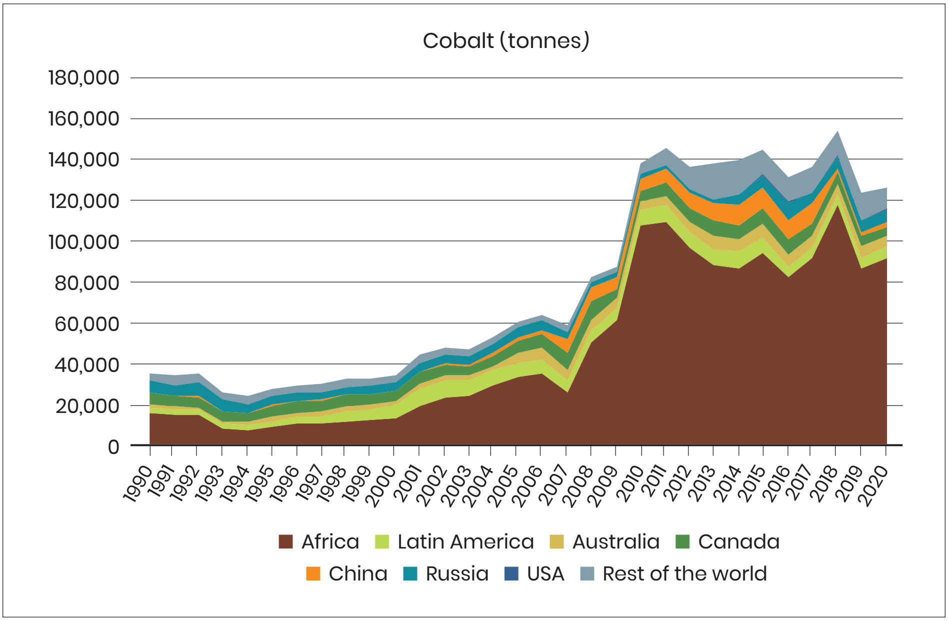
Source : auteurs à partir des données de BGS.

Graph 19c. ***Global manganese production***



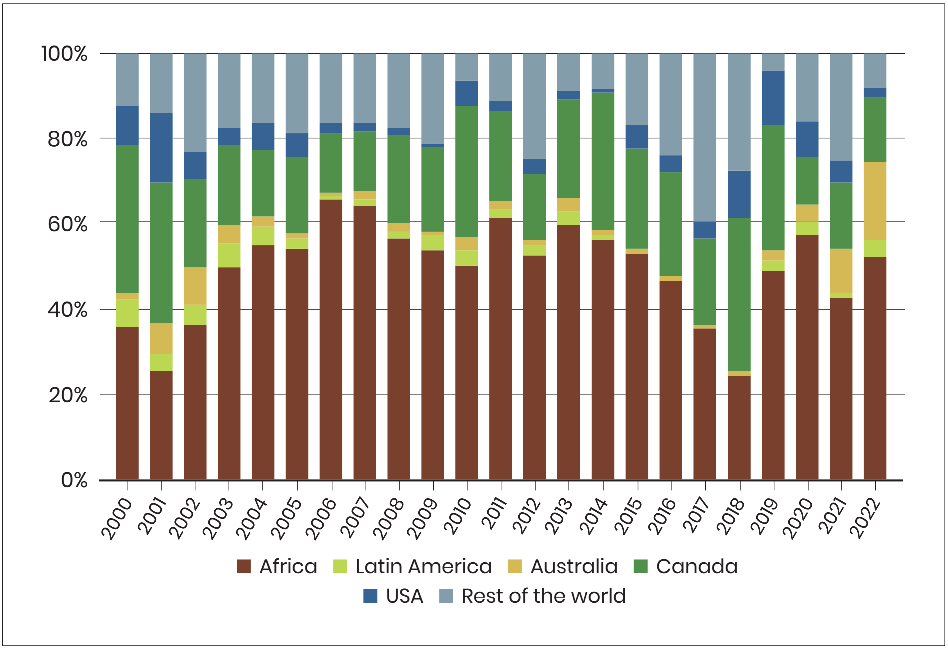
Source: Authors based on BGS data.

Graph 19d. *Global cobalt production*



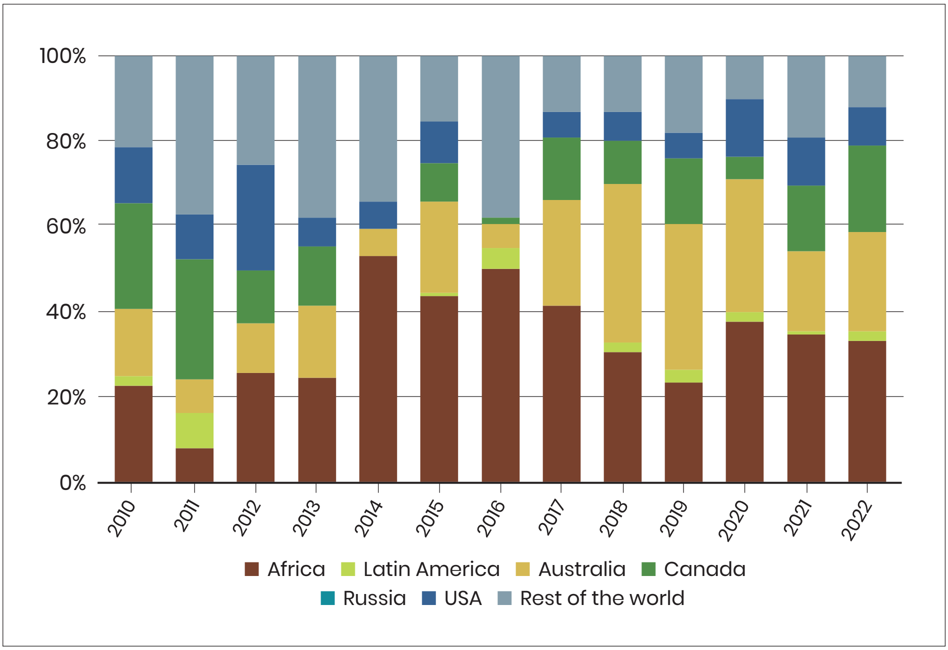
Source: Authors based on BGS data.

Graph 20a. *Global platinum exploration budget destinations*



Source: Authors based on S&P Capital IQ Pro data.

Graph 20b. ***Global cobalt exploration budget destinations***

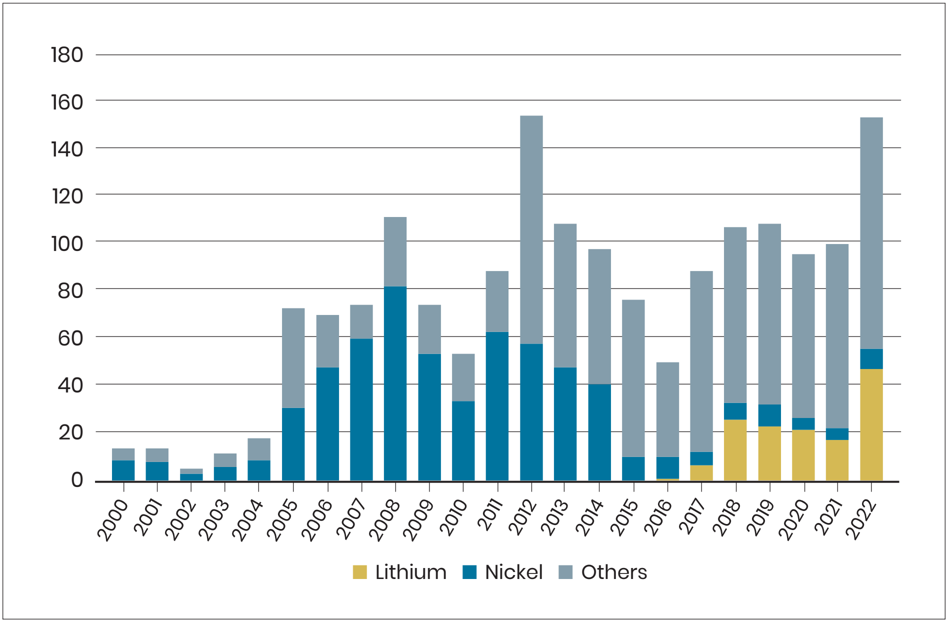


Source: Authors based on S&P Capital IQ Pro data.

Interest in rare earth elements, lithium, nickel, and graphite is more recent and has resulted in a proliferation of projects in development rather than increased African production. Although very recent, this interest is certainly real. For example, in the DRC, the provinces of Tanganyika and Haut-Lomami are rich in lithium, but until 1982 only tin was extracted there. The DRC did not display an interest in lithium until the 2010s, when it granted mining companies the first blocks containing signs of that metal. In the same political vein, the DRC's new Mining Code identified four "strategic metals" in 2018 (cobalt, coltan, germanium, and lithium) for which the royalty rate would rise from 2% to 10%.[49]

49. Devey Malu-Malu M., "Le lithium, une niche stratégique pour la RDC," *Jeune Afrique*, June 18, 2021 (https://www.jeuneafrique.com/1163411/economie/le-lithium-une-niche-strategique-pour-la-rdc/; consulted on January 31, 2023).

Graph 21. ***African exploration budget for lithium, nickel, and "other" minerals (USD millions)***



Source: Authors based on S&P Capital IQ Pro data.

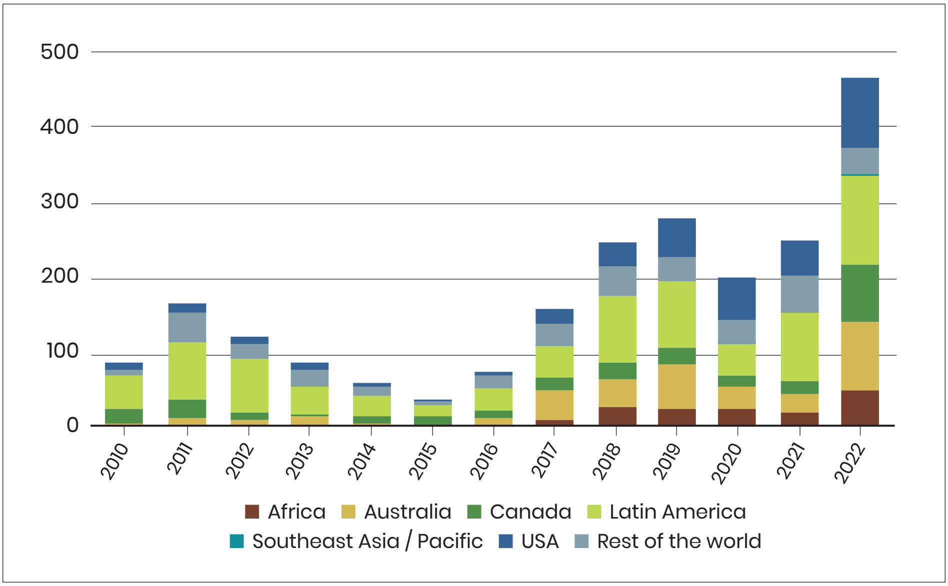
The number of active mines is still very small (one rare earth elements mine and one lithium mine; seven nickel mines and seven graphite mines), but there has been a boom in the number of projects: 27 projects to extract lithium, 34 rare earth elements projects, 42 graphite projects, and 68 nickel projects (Graph 21). More than just a case of recent diversification, this is likely to be the trend in forthcoming years. Consider the increase in lithium exploration investment since 2018 and the explosion of "other" minerals, a category that encompasses a number of critical minerals. The number of projects targeting these minerals should increase further. Nickel exploration investment appears to have peaked, which explains why there are so many nickel projects in development: Deposits have been identified, and projects are now in the development phase. Meanwhile, lithium is still broadly in the exploratory phase.

In reality, Africa is only just beginning to attract investor attention in terms of these new minerals. The continent still only represents a small share of global lithium and nickel exploration budgets, which have been rising around the world since 2018 (graphs 22a and 22b). It remains to be seen whether African countries will be able to attract a greater share of investments in these minerals.

However, it should be underlined that while Africa is still only attracting a minority of exploration investments in these sectors, mine takeovers and investments in green mineral mining development projects already represent substantial sums for African economies. For example, in January 2022 the Chinese company Sinomine acquired the Bikita lithium mine (in Zimbabwe) for USD 180 million. In December 2022, the Chinese company Huayou purchased the Arcadia lithium mine, also located in Zimbabwe, for USD 422 million, making it one of the country's largest investments.[50]

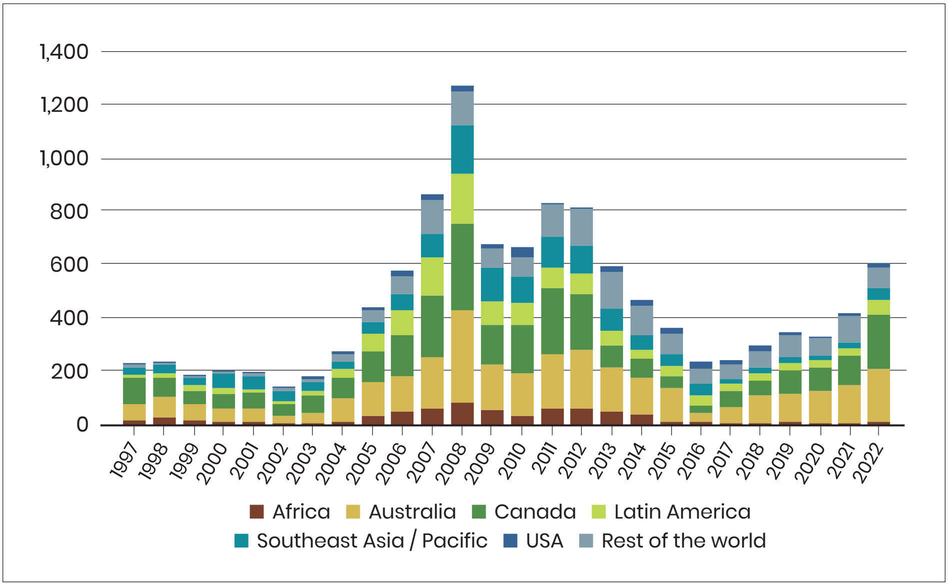
50. Holmey O., "Les minerais 'verts', une aubaine sous condition pour l'Afrique," *Jeune Afrique*, November 2, 2022 (https://www.jeuneafrique.com/1384635/economie/les-minerais-verts-une-aubaine-sous-condition-pour-lafrique/; consulted on November 7, 2022).

Graph 22a. ***Africa's share of the global lithium exploration budget (USD millions)***



Source: Authors based on S&P Capital IQ Pro data.

Graph 22b. ***Africa's share of the global nickel exploration budget (USD millions)***



Source: Authors based on S&P Capital IQ Pro data.

5.3. The complex role of "development minerals"

"Industrial" minerals have also played a part in Africa's mining growth. This category encompasses all the non-metallic minerals and materials (baryte, phosphate, feldspar, gypsum, kaolin, salt, sulfur, etc.[51]) extracted, treated, processed, and used in sectors such as construction, industry, infrastructure, and agriculture. These minerals (also known as "base metals and minerals" by economists) are predisposed to be used near their extraction sites because of their very low price on raw materials markets and high transportation costs. However, data on these minerals is very patchy, firstly because the informal nature of part of the sector makes data collection quite complicated, and secondly because most of the literature on the mining sector (including on the informal sector) focuses on the "high value" metals and minerals that can attract investment and be taxed.

However, recent developments suggest that more attention should be paid to these minerals and that their role in development should be reconsidered, on the basis of three observations: *(i)* the extraction of metals, energy minerals, and precious gemstones only represents a minority of global extraction operations (industrial minerals and construction materials represent 84.2% of global mining production); *(ii)* most mineral materials are not exported (most industrial minerals and construction materials remain in the country where they were extracted); and *(iii)* large multinationals only represent a majority of the national economy in a minority of countries.

Franks (2020) underlined that, while being of "low value" on global markets, these minerals are nonetheless important vectors of development, and he therefore suggested that they be known as "development minerals"52 (Franks et al. 2016). Unlike the metals, energy materials, and precious gemstones exploited for export, which have significant tax potential, attract FDI, generate exports and significant public revenue, but have little local impact in terms of jobs and local benefits, the economic value of these minerals resides in their local and domestic use. Development minerals are extracted and used nationally; they have little tax potential but strong consumption and production potential.

51. Diamonds and graphite also fall into this category due to their industrial use, but, having discussed them above, these minerals will not be analyzed here.
52. This name should not imply that exported mining products do not support national or local development. It simply helps underline the more immediate development impact of the extraction of these minerals.

Extraction of these minerals creates a large number of (relatively unskilled) jobs and makes a significant contribution to the national economy. As they do not generate the same amount of tax revenue, these minerals are not associated with the same macroeconomic and political challenges (inflation, rentier effect, etc.). Industrial minerals do not cause conflicts, do not represent an important source of illegal trafficking, and are not associated with the negative impacts of rapid immigration as a result of illegal gold mining, for example.

The environmental impact of their extraction also differs from that of non-industrial metals and minerals, more closely resembling other forms of land development (dust, noise, deforestation, etc.) than purely mine-related consequences, such as toxic waste (tailings) or mercury contamination of soils and rivers—although it should be recalled that extracting sand from riverbeds also presents very real problems. However, the social problems brought about by this largely informal activity resemble other informal sectors (gold, copper, cobalt, etc.): health risks, child labor, community relations, environmental impact, organizational and productivity challenges, etc.

Development minerals are gradually being recognized as a critical issue for Africa. For example, they play a significant role in the economies of the North African countries, which produce large amounts of industrial minerals. They all produce salt (53.8% of African production), and most produce phosphate (89.4% of African production and 18.8% of global production), gypsum (69% of African production), baryte (99.9% of African production), bentonite (44.6% of African production), feldspar (89.1% of African production), and sulfur (12.1% of African production). Morocco is particularly striking because of the dominance of phosphate within its mining sector and its economy overall: It is the world's second-largest phosphate producer and the leading global exporter, producing 37 million tonnes of phosphate in 2020 according to the Office chérifien des phosphates (OCP), compared to 3.2 million tonnes in Tunisia, 2.1 million tonnes in Egypt, and 1.3 million tonnes in Algeria. The OCP is a public company with a monopoly over the extraction, processing, and sale of phosphate, and is therefore the world's largest phosphate company, posting turnover of USD 7.7 billion in 2021.

An ACP[53]-EU Development Minerals Programme, in partnership with the United Nations Development Programme (UNDP), was launched in 2013. It focused on six target countries, including three in Africa: Uganda, Zambia, and Cameroon. In Uganda, 390,000 direct jobs (44% of which are held by women) are connected to artisanal and small-scale mining of development minerals, and this production is 7.5 times the value of officially reported production of all mineral commodities and 4.2 times the value of informal gold production. In Zambia, nearly 6,815 direct jobs are involved, and in Cameroon it is 8,869. An increasing number of organizations are demanding that this issue receive more attention. For example, the AU, the World Bank, and the ACP-EU Development Minerals Programme have indicated their desire to develop legislation on overseeing and formalizing the extraction of development minerals.

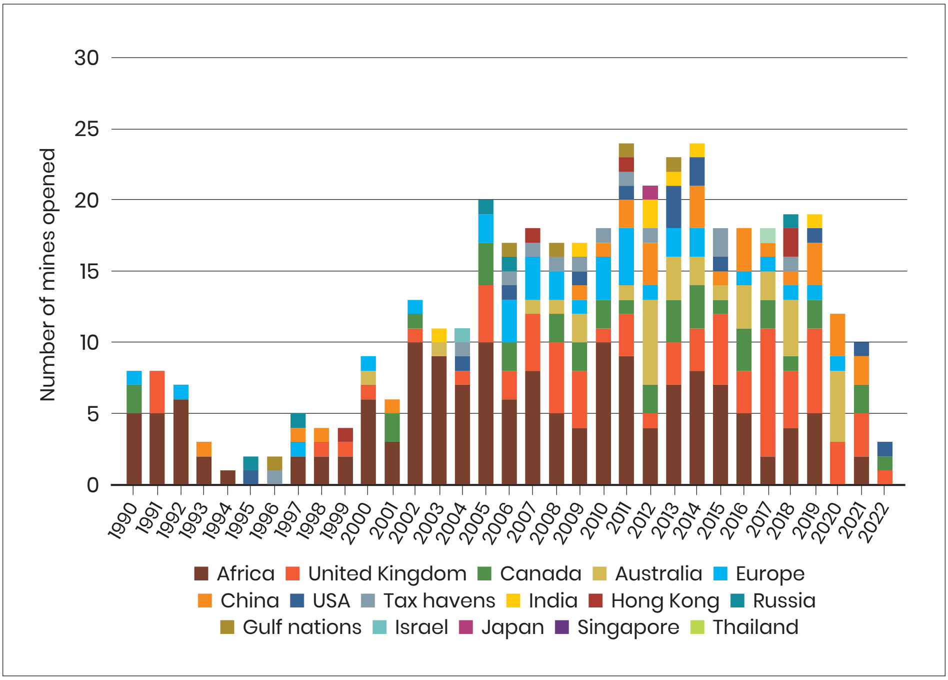
In conclusion, Africa's mining boom has largely strengthened the gold, copper, and diamond sectors. However, it has also enabled diversification to begin, particularly in terms of transition minerals. African states appear ready to gamble on diversification and its great potential for industrialization. However, it remains to be seen whether Africa will be successful in seizing the momentum surrounding transition minerals or whether it will continue to specialize in exporting minerals such as gold and diamonds that are less likely to drive industrialization. Development minerals represent another increasingly key issue. Little studied due to the opacity of the sector and a lack of interest from international investors, they nonetheless possess significant national development potential if oversight of their extraction can be improved.

53. Africa, Caribbean, Pacific.

6. Different investment phases: From largely Western domination to the arrival of actors of diverse nationalities engaging in a new "Scramble for Africa"

Mining operations in Africa have long been conducted by Western companies—with the notable exception of South African firms. The United Kingdom, Canada, and Australia remain the uncontested champions of the African mining sector, but they face increasingly stiff competition. New actors began to position themselves during the mining boom between 2003 and 2008: China, along with India, Russia, and the United Arab Emirates, developed strategies to increase their influence. Meanwhile, dynamic African actors are seeking to establish themselves across the continent.

Graph 23. ***Nationalities of the main owners of mines opened between 1990 and 2022***



Source: Authors based on S&P Capital IQ Pro data.

6.1. The enduring dominance of Western actors

Mining operations in Africa were long conducted almost exclusively by Western companies. The former colonial powers had a stranglehold over exploitation of their colonies' subsoils up until independence. The impact of Belgian companies such as the Union minière du Haut-Katanga (the largest company in the DRC until 1966 [CRISP[54] 1967]), French companies such as the Compagnie des phosphates de Gafsa (CPG) (Tunisia's largest company and France's fifteenth-largest company in 1949 [Clozier 1950]), and British firms such as Anglo American was considerable.

The decolonization of Africa marked a relative decline in the role of the former colonial powers in the mining sector. **However, the United Kingdom has managed to retain its position, particularly in the South African and Tanzanian mining sectors, which remain key players in the global mining industry.** The London Metal Exchange (LME) is one of the world's largest metal markets and has remained the uncontested benchmark market for prices of the six major nonferrous metals (copper, tin, lead, zinc, aluminum, and nickel), as well as steel since 2008 and cobalt and molybdenum since 2010.[55] Further, several major players in the global mining industry are British and have their headquarters in London. The United Kingdom also has smaller players that have managed to establish national or regional dominance. For example, Endeavour Mining is a British company present in Burkina Faso, Côte d'Ivoire, Mali, and Senegal. It is the largest gold producer in West Africa.

France, Belgium, Portugal, Italy, and Germany have not retained the same level of influence within the mining sectors of their former colonies. A gradual loss of their mining know-how has made them less attractive as partners than well-established mining powers. The Belgian group Forrest International, established in the DRC in 1922, has gradually abandoned copper and cobalt extraction to focus on construction materials. The Portuguese group Escom Mining exploits diamonds in Tchegi in Angola. Meanwhile, France's Orano (formerly Areva) continues to exploit uranium in Niger, Eramet is active in ilmenite in Senegal and has one of the world's largest

54. Centre de recherche et d'information socio-politiques (Sociopolitical Research and Information Center) (Brussels).
55. LME was bought out by Hong Kong Exchanges and Clearing in 2012.

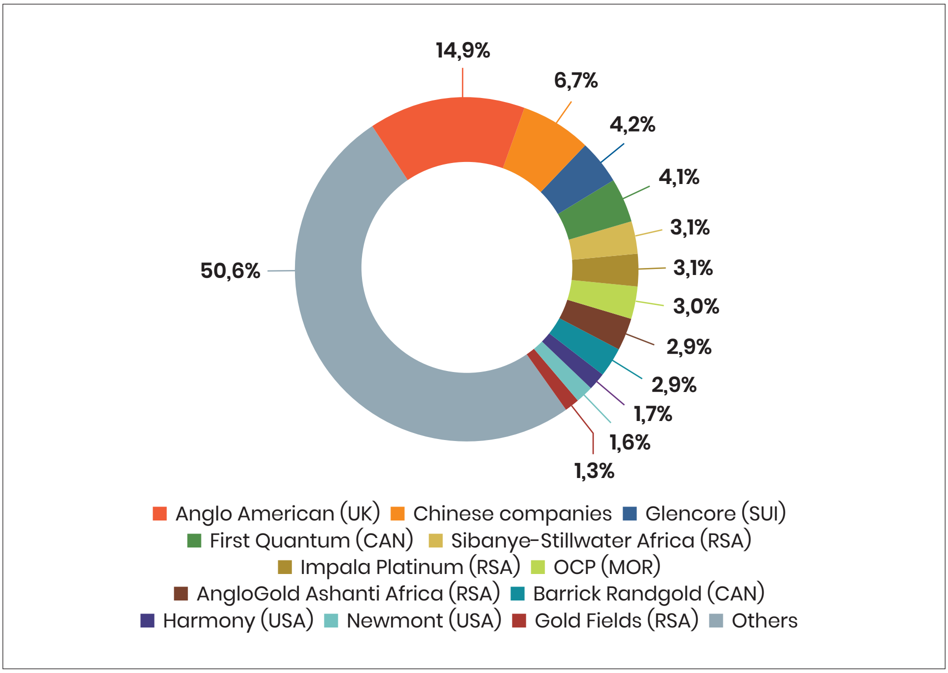
manganese mines in Gabon (Moanda),[56] Auplata Mining Group exploits lead in Morocco, Batla Minerals exploits diamonds in South Africa and Lesotho, and Dune is carrying out gold exploration in Côte d'Ivoire.

The contribution of the former colonial powers to Africa's mining production is therefore very marginal. There are several reasons for this. First, colonization's difficult legacy has been an obstacle to bilateral relations. Second, the mining expertise of these countries has been eroded as they have closed mines in their own countries. Further, the EU's growing role in representing the interests of member states and influencing the direction of European powers in Africa (Hugon 2010) has not yet included the mining sector, and it has not committed itself to defining a common mining investment policy. Finally, European funding for the mining sector declined and even came to a halt from the late 2000s due to decreasing social acceptance and the rise of environmental issues.

The liberalization of the mining sector in the 1980s following reforms promoted by the World Bank resulted in **the enduring establishment of Canadian, Australian, and (to a lesser extent) Swiss and American actors in the African mining sector.** Currently, these companies' share of Africa's total mining production[57] is proof that Western companies overwhelmingly lead the pack. **Anglo American (United Kingdom), Glencore (Switzerland), and First Quantum Minerals (Canada) are therefore the champions of African mining production.** These three companies alone were responsible for nearly a quarter of production in 2018 (Graph 24[58]).

56. COMILOG (Compagnie minière de l'Ogooué, a subsidiary of Eramet), the world's leading producer of high-grade manganese ore (https://www.eramet.com/fr/groupe/filiales/comilog; consulted on February 22, 2023).
57. The approximate mining production is calculated by totaling the production value for each mineral in USD. The controlling share is determined on the basis of the shares actually held by companies in mining properties.
58. Taken from work by Ericsson, Löf, and Löf (2020), this graph is based on the aggregation of all mining production converted into USD.

Graph 24. ***Companies' share of total African mining production in 2018***



Source: Authors based on the work of Ericsson, Löf, and Löf (2020).

Western actors occupy an important position in the national economies of African countries and continue to be very dynamic by financing exploration projects and the expansion of existing mines. For example, **First Quantum Minerals owns the two largest copper mines in Zambia (Sentinel and Kansanshi) and alone is responsible for half of all copper production in Zambia.** The Sentinel mine was the largest investment in Zambian infrastructure since the construction of the Kariba dam in 1959 (USD 2.1 billion for its construction between 2012 and 2016). Further, the firm has signaled its intention to strengthen its position in the sector with a new investment of USD 1.35 billion over 20 years in its Kansanshi mine. Meanwhile, **the Swiss giant Glencore holds 75% of the Kamoto Copper Company (KCC), the world's largest cobalt producer** and a leading global copper producer thanks to its exploitation of the Kamoto mine, the largest working mine in the DRC and the world's largest cobalt mine.

Beyond these major global groups, **a number of juniors from Western countries are also very actively involved in exploration and initial project development.** For example, Australian juniors are very active in lithium exploration: AVZ Minerals is currently conducting a feasibility study on the Manono-Kitolo project located in the south of the DRC, which could represent one of the richest lithium deposits in the world; and Atlantic Lithium is accelerating its work in Ewoyaa to ensure it becomes Ghana's leading lithium mine by 2024.

6.2. The rise of "emerging" players

The mining boom of 2003–2008 saw established industrial powers confirm their hold on Africa territory, but it was also marked by the appearance of "emerging" players. Africa had successfully forged relations with Moscow, Beijing, Brasilia, and New Delhi in the context of decolonization and the birth of the non-aligned movement during the Cold War. However, these ties had been stretched to their limit during the 1980s, the decade of "Afropessimism" (fall in raw materials prices, debt crisis, inflationary spiral, resurgence of armed conflict, etc.). The BRICS nations [59] were also facing their own problems: The USSR was attempting to halt its decline, China to build a socialist market economy, India to escape the economic crisis it was experiencing at that time (trade deficit, weak growth, low foreign currency reserves), Brazil to escape its debt crisis and reabsorb hyperinflation, and South Africa to end its international isolation (South Africa will be considered separately from the other emerging players in "6.3. The emergence of African countries?"). In concrete terms, the emerging nations' lack of interest in Africa led to a dwindling of diplomatic relations and a fall in trade (Santander 2014).

The emerging players successfully returned to the international stage in the early 2000s, following the sustained acceleration of development of the Chinese, Indian, and Brazilian economies resulting in high growth rates (between 5% and 10%). Thanks to urbanization and growth in the emerging nations, the rise in mining demand responsible for the mining boom resulted in a **larger role for the emerging nations in the global mining sector**. Anxious to secure their supplies of raw materials to fuel industrialization, Africa became their target. Since 2002 (and more particularly since 2005), mining companies from the emerging nations have become serious

59. Brazil, Russia, India, China, and South Africa.

competitors to the well-established Western companies (Maréchal 2013). **The BRICS nations shared a desire to possess a large domestic mining industry and national champions that could influence the international mining sector.** In 2022, the Brazilian company Vale was the world's fourth-largest mining company in terms of market capitalization, the Russian companies Norilsk Nickel and Polyus were respectively 13th and 29th, the Indian companies Coal India and Vedanta were respectively 27th and 31st, and no fewer than 10 Chinese firms were among the 50 largest mining companies. The emerging nations thus possess mining know-how that makes them real competitors, not only in terms of exploration (carried out by a multitude of small independent operators) but above all in respect of major exploitation. The emerging nations are generally more accommodating about loan conditions than international backers and have therefore been able to invest in countries where Western nations dare not, such as Zimbabwe (Brook 2011).

Of the emerging nations, China has made the most dazzling progress in Africa. In line with its "Going Out" policy and in response to its growing mineral demand, China began to establish itself in the African mining sector in the late 2010s. For example, in 2018, Chinese companies were responsible for 41% of Africa's cobalt production and 28% of its copper production. Russia is another mining giant that used the mining boom to put down roots in Africa, mainly in diamonds in Southern Africa and gold in West Africa. In particular, it increased its influence over the continent following the imposition of the first international sanctions as a result of Russia's annexation of Crimea in 2014, and it continues to have close ties with countries such as Mali and the CAR, despite being isolated on the international stage due to its invasion of Ukraine in February 2022.

India has not been the focus of as much research as China or Russia, but it holds significant sway within the African mining sector, mainly in Southern Africa. As a major consumer of coal (70% of its energy mix), India's principal goal is to secure its supply of this material. It has also established itself within Africa's iron sector to support its steel industry, as well as within the zinc, lead, and copper sectors via its mining giant, Vedanta.

Brazil's investments in the African mining sector have been much smaller than those of the other emerging nations. Traditionally, it focused its investment on Angola and Mozambique, with which it enjoys cultural proximity as fellow Portuguese-speaking nations, but Brazil has gradually been erased from the African mining landscape in the wake of corruption scandals and the consequences of ecological disasters caused by the failure of the Bento Rodrigues and Brumadinho dams (in 2015 and 2019 respectively).

The mining boom has enabled the emerging powers to put down their markers in the African mining sector. They are responsible for a significant share of Africa's mining production, are dynamic investors, and enjoy good relations with African nations. **Investments made by emerging economies in the mining sector often form part of broader financial and cooperation agreements between states** (Maréchal 2013). The emerging economies therefore play a significant role in infrastructure financing, which is essential in the mining sector (such as China in Guinea). Mining licenses can be granted in exchange for the construction of infrastructure (such as the "contract of the century" concluded between China and the DRC) or other types of service (such as those rendered by the Russian paramilitary group Wagner to Sudan and the CAR).

6.3. The emergence of African countries?

South Africa has always been something of an outlier on the continent. A driver of Africa's mining production, it boasts a large number of companies that are very active across the continent and are comparable in size to the biggest investors on African soil. **South Africa has developed its own global mining companies (particularly AngloGold Ashanti, Anglo American Platinum, Impala Platinum, and Gold Fields)** that rank among the world's 50 largest mining firms. These large companies (as well as a plethora of smaller actors) have enabled South Africa to become very well-established in the mining sector, not only within its own territory but also across the continent, and it has opened far more mines than any other African nation in recent decades (Graph 6). It sought to expand beyond its borders from an early stage, initially into Southern Africa before targeting the entire African continent and eventually the rest of the world.

Morocco has also been developing an African strategy through actors such as Managem and the Office chérifien des phosphates (OCP). The Boucraâ phosphate mine in Western Sahara, operated by OCP's subsidiary Phosboucraa (owned outright by OCP since 2002), has given OCP a monopoly over the extraction, processing, and sale of phosphate in Morocco. It is the world's largest phosphate company, with 31% of the market. The OCP group, which includes 15 subsidiaries and international joint ventures (IJVs), has developed a strategy to expand into Africa. OCP Africa operates in twelve countries across the continent (Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Nigeria, Rwanda, Senegal, Tanzania, and Zambia). It aims to work in the "food security" sector with small farmers and governments. Managem, meanwhile, is the leader of Morocco's mining sector. It initiated what it refers to as its "African ambitions" by taking a stake in SEMAFO, a Canadian mining exploration company, in 1997. Currently, Managem is exploiting 15 mines producing copper, zinc, lead, gold, silver, cobalt, and fluorine in eight African countries (Managem is also established in Switzerland and the United Arab Emirates). In an illustration of its steadfast dynamism, it acquired assets from the Canadian company IAMGOLD in Senegal, Mali, and Guinea in December 2022.[60]

While other African nations have not been able to develop mining giants on this scale, the mining boom has enabled a **group of African actors** to flourish at the national level. The liberalization movement and the state's subsequent massive withdrawal from the sector liberated the growth potential of national companies long condemned to slow growth and strictly local development due to complicated access to capital and skills. Many national companies have therefore been able to achieve ambitious commercial objectives by capitalizing on their assets: privileged access to local mineral resources, good knowledge of the terrain, and easy access to international markets thanks to bank loans and bond issues as a result of soaring prices between 2003 and 2008.

More generally, many countries were keen to breathe new life into the old, nationalized companies (such as Gécamines or the Société minière de Kilo-Moto [SOMIKO] in the DRC) or to establish new firms. For example, the Mauritanian authorities created Maaden Mauritanie in 2020 to manage artisanal and semi-industrial gold production. There has been a strong desire across the continent to take back control of national mining industries by creating new companies and reviewing existing mining contracts. For example, Burundi suspended all mining operations by overseas groups in July 2021 until new contracts could be negotiated.[61] Further, cooperation (some-

60. Mousjid B., "Mines: Sénégal, Mali, Guinée… Le marocain Managem reprend les actifs d'Iamgold," *Jeune Afrique*, December 21, 2022 (https://www.jeuneafrique.com/1402767/economie/mines-senegal-mali-guinee-le-marocain-managem-reprend- les-actifs-diamgold/; consulted on January 4, 2023).
61. Habarugira B., "Suspension des activités des sociétés minières: 'L'État n'en tirait pas profit'," *Burundi Eco*, July 30, 2021 (https://burundi-eco.com/suspension-activites-societes-minieres-etat-nen-tirait-pas-profit/; consulted on December 5, 2022).

times enforced) between international companies and local firms as joint owners of mining projects also enables mining expertise to be transferred, which is beneficial for the development of African mining companies.En outre, la coopération, parfois forcée, entre les entreprises interna-tionales et les entreprises locales, copropriétaires des projets miniers, permet également un transfert de l'expertise minière bénéfique au développement des entreprises minières africaines.

6.4. A new "Scramble for Africa"?

Africa is witnessing a race for resources that is attracting players from around the world. Recent enthusiasm for minerals (particularly energy transition minerals) has led to a number of new players attempting to position themselves within this landscape. **Africa's traditional gold trading partners in the Gulf (the United Arab Emirates, Saudi Arabia, and Qatar) are therefore now also seeking to establish themselves in the mining sector** (see Chapter 4).

Other players attempting to take advantage of this momentum include Turkey and Iran, countries from Southeast Asia such as Thailand and Singapore, and other developed countries such as Sweden, Japan, and South Korea, which are gradually increasing their influence by investing in specific projects.

Generally speaking, the number of potential actors is growing, but they are also increasingly interconnected. Mining projects represent a substantial investment (and revenue), so a number of different companies will frequently share the capital of one asset. **As the size of the projects in development increases, so too does the size of the consortiums, which involve a variety of international actors.** For example, the Kamoa-Kakula mine (DRC) contains the highest concentration of copper and the world's fourth-largest copper reserves. It is managed through a joint venture comprising Zijin (China, 39.6%), Ivanhoe Mines (Canada, 36.9%), the state of the DRC (20%), and Crystal River Global Limited (Hong Kong, 0.8%). The Simandou project in Guinea is shared between several consortiums: *(i)* the North blocks (1 and 2) are held by the SMB-Winning consortium comprising the Singaporean company Winning Shipping, the French transport and logistics firm UMS, and Shandong Weiqiao, a large Chinese aluminum company. Another consortium led by the Chinese company China Baowu Steel Group Corp. plans to invest in the SMB-Winning consortium by acquiring 49% of two SMB subsidiaries (WCS InfraCo and WCS MineCo), subject to joint approval from the Guinean and Chinese governments; *(ii)* the South blocks (3 and 4) belong to Simfer, a joint venture in which the Rio Tinto group holds 53%. The remaining shares are held by the Chinese companies Chinalco and Baowu. The state of Guinea currently holds 49% of the Compagnie des bauxites de Guinée (CBG), and 51% is held by Halco Mining Inc., a consortium involving three large global bauxite firms: America's **Alcoa** (the world's second-largest bauxite producer), Rio Tinto Alcan, a subsidiary of the world's leading bauxite producer Rio Tinto (United Kingdom), and **Dadco Investments** (twenty-fifth largest global bauxite producer).

Conclusion

Global mining production is currently booming thanks to the digital and energy transitions. In this new mining paradigm, African countries aspire to play an increasingly dominant role and to take full advantage of growing demand for mineral resources to promote the development of their own mining sectors.

The rise of the African mining sector is not new. It dates back to the early 2000s, a period marked by the liberalization of the sector, high gold prices, and a rapid influx of overseas investors. This trend has accelerated since 2015, but with some significant variations. On the one hand, the type of investor has changed. Established mining countries have gradually lost their influence as new players have emerged. Western companies (mainly from the Anglosphere) have continued to lead the way in terms of mining investment in Africa, but they have lost part of their influence to emerging players such as the BRICS nations—China, Russia, and India in particular. The type of mineral targeted by such investments has also changed, with growing interest in critical minerals, although precious minerals such as gold remain very popular.

The rapid development of African mining sectors places the continent at the heart of a new geostrategic dynamic, the implications of which are still difficult to fully grasp. However, it is undeniable that in the midst of a period of fragmentation and reconfiguration of alliances, Africa's mineral resources are increasingly coveted. The main challenge facing African countries will be to navigate between overseas investors seeking to secure their own supplies and the capacity of their national mining sectors to support their own development.

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The actual economic contribution

Julien Gourdon, Harouna Kinda
and Thomas Lassourd

Chapter 2

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The actual economic contribution

Introduction

The Agence française de développement (AFD) (French Development Agency) operates in all 55 countries in Africa. Their development trajectories may vary, but **mining is a critical sector for most African countries.** The mining sector is currently experiencing **unprecedented growth** due to *(i)* the development of resources that were known about but had remained relatively untapped, *(ii)* increasing global demand for base metals, and *(iii)* the rise of new digital technologies, renewable energies, and electric vehicles.

Most African countries have **committed to developing their mining sectors, and over the past 20 years they have been the focus of intensive exploration projects.** Many mines have been opened and others are in the launch or exploration phases.

In the future, natural resource extraction will therefore become an important economic activity across Africa (Devarajan and Fengler 2013). But what macroeconomic consequences will it have? How will it impact the Human Development Index (HDI) and the United Nations' Sustainable Development Goals (SDGs)? And how should it be supported to ensure sustainable growth for the benefit of all?

More broadly, although most of the countries concerned view expansion of the mining sector as a very powerful lever for development, a number of regional and international financial institutions are calling for greater consideration of the **macroeconomic consequences** of the sector's rapid development on **growth, public finances, and employment.**

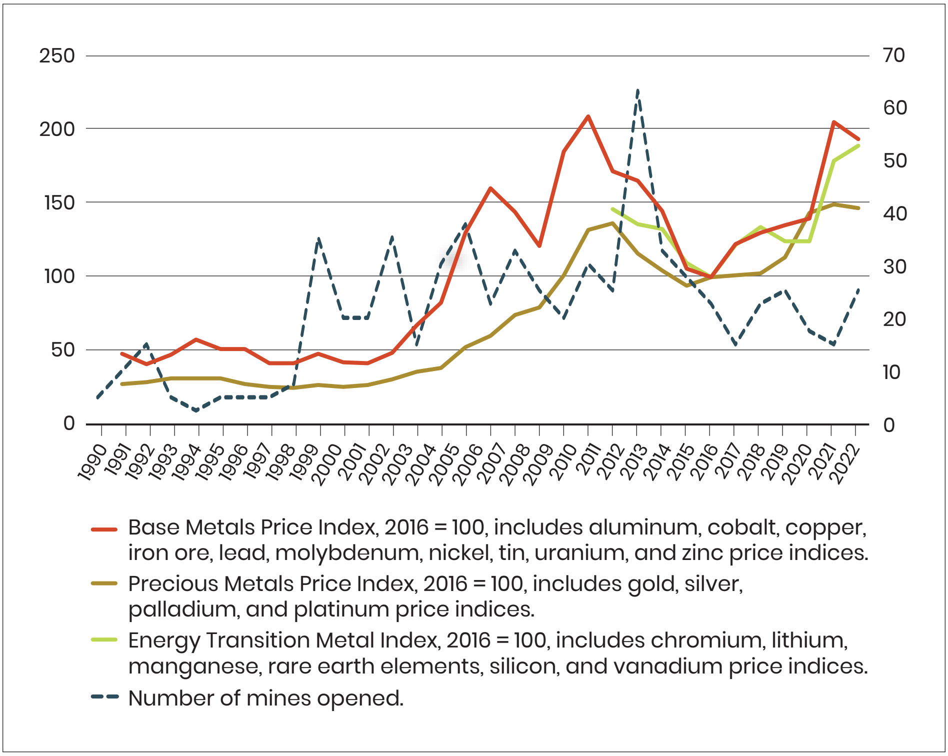
Mining taxation is a particularly important component in this respect. Public resource mobilization is a priority in most African countries, and the mining sector represents an important source of revenue for countries that are highly dependent on the extractive industries. Mining taxation is a strategic area because it both enables states to increase government revenue and can ensure a fairer distribution of mineral rents during periods of growth, while still encouraging companies to invest in order to maintain and further develop this activity. In this chapter, we will explore the mechanisms and implications of current fiscal regimes, as well as how the configuration of a rentier economy can influence the development and management of public policies.

1. Macroeconomic effects: Growth, employment, and investment

The marked increase in raw materials prices at the beginning of the twenty-first century boosted production of extractive materials and increased investor interest in Africa's abundant natural resources, including its minerals (gold, diamonds, copper, and iron ore). Resource exploration intensified in the 2000s when a number of new deposits were discovered and new mines were rapidly opened. Graph 1 illustrates the three major booms on the international markets (two of which were closely associated with the technological and, subsequently, energy transitions): the coltan boom in the late 1990s (1998, 1999), the increase in the price of gold (from 2005), and the increase in the price of copper (since 2018), the latter rise related to increased demand for electronic products.

The price of raw materials increased three or fourfold between 2000 and 2011, and the number of mines opened in Africa surged from 5 to 30 per year on average, peaking at 60 in 2012, illustrating, incidentally, the time lag between investment and raw materials prices. However, mineral and metal prices then fell until 2016, resulting in a marked (lagged) fall in the number of mines being opened until 2017. Prices began to recover in 2017, and from 2018 the number of mines being opened also started to increase. Following a pause during the COVID-19 pandemic, momentum returned in 2021 with nearly 30 new mines opened per year.

Graph 1. ***Change in the number of mines opened (right-hand scale) and in mineral and metal prices since 1990 (left-hand scale)***



Sources: Authors based on the IMF Commodity Metals Price Index and S&P for the number of mines opened

In order to anticipate the potential impacts of the continent's most recent mining boom, starting in 2019, it is worth studying the macroeconomic effects of the African mining boom of the 2000s, and in particular its impact on growth, employment, and investment.

1.1. The resource curse

This section will begin by examining the literature on the economic impact of natural resources within developing countries (DCs), analyzing four particular factors that emerge. The literature on the economic impact of natural resources within DCs has been overwhelmingly dominated by the notion of the "resource curse," whereby resource-rich economies tend to perform more poorly in economic terms than countries with fewer such resources. There are four possible explanations for this: *(i)* under-industrialization as a result of currency appreciation; *(ii)* obstacles to economic diversification; *(iii)* exposure to significant price variations; and *(iv)* institutional risk.

Our analysis has compared the changes since 2005 in a number of aggregates for mineral-resource-intensive, non-mineral extractive-resource-intensive, and non-natural-resource-intensive countries. Tables 1a and 1b and Map 1 present the results for two groups created on the basis of the share of mineral exports in GDP (gross domestic product—A), the share of mineral rents in GDP (B), and the share of mineral resources in total wealth (C). As a result, mining countries can be divided into two groups: Those moderately dependent on mineral resources (MDMR) and those highly dependent on mineral resources (HDMR) over the period 2005–2020.

Table 1a. ***Groups of countries dependent on mineral products (%)***

MDMR	(A)	(B)	(C)	HDMR	(A)	(B)	(C)
Botswana	2.6	0.5	4.3	**South Africa**	6	1.4	5.5
Côte d'Ivoire	0.1	0.5	1.0	**Burkina Faso**	0.6	4.0	5.8
Ghana	0.5	3.0	3.5	**DRC**	18.6	6.2	8.3
Madagascar	4.2	0.1	0.5	**Guinea**	7.4	5.3	13.7
Mozambique	10.0	0.1	0.1	**Liberia**	–	3.3	11.4
Niger	4.3	0.2	0.2	**Mali**	0.1	5.6	7.0
Rwanda	2.9	0.3	1.3	**Morocco**	1.8	3.5	10.9
Senegal	0.9	1.2	3.2	**Mauritania**	13.5	8.6	32.2
Sierra Leone	6.2	1.1	2.6	**Namibia**	11.0	1.3	6.4
Sudan	0.0	2.2	1.7	**Togo**	3.6	5.6	11.7
Tanzania	1.2	1.6	2.4	**Zambia**	26.4	6.6	12.1
Tunisia	0.6	0.5	3.2	**Zimbabwe**	7.8	2.1	2.9

Note:
(A) Share of mineral exports in GDP – WITS, World Bank;
(B) Share of mineral rents in GDP – WDI, World Bank;
(C) Share of mineral resources in total wealth.
Source: Authors

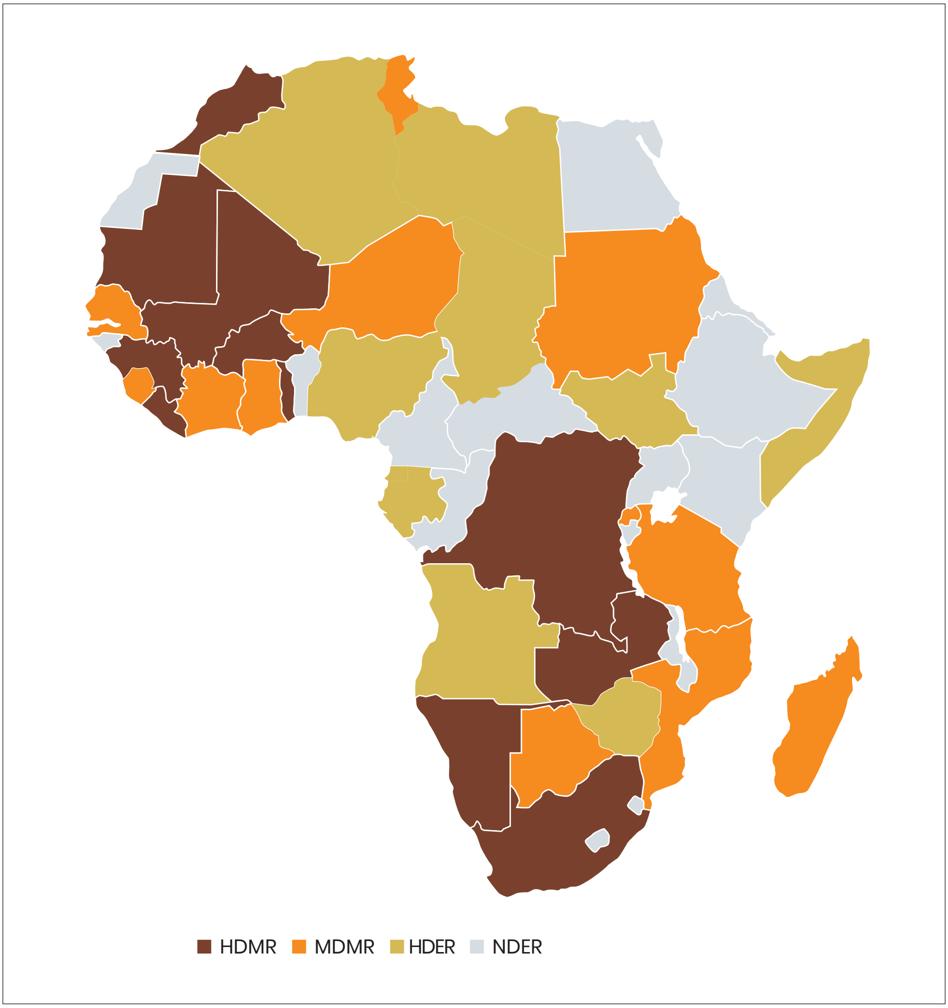
There are also two distinct groups of countries that are not dependent on mineral resources: those not dependent on energy resources (NDER), i.e., oil, gas, and coal, and those highly dependent on energy resources (HDER). The second group includes the countries generally identified in the literature as being affected by the resource curse.

Table 1b. ***Groups of countries not dependent on mineral products (%)***

NDER	(A)	(B)	(C)	HDER	(A)	(B)	(C)
Benin	0.3	0.0	0.0	Algeria	0.1	0.1	0.3
Cameroon	0.5	0.0	0.1	Angola	1.3	0.0	0.0
Congo	0.4	0.0	0.0	Burundi	0.3	0.2	0.6
Egypt	0.4	0.2	1.6	Chad	–	0.0	0.0
Ethiopia	0.0	0.2	0.5	Equatorial Guinea	0.0	0.0	–
Gambia	0.2	0.0	0.0	Gabon	–	0.0	0.1
Guinea-Bissau	0.0	0.0	–	Libya	0.2	0.0	0.0
Kenya	0.3	0.0	0.1	Nigeria	0.9	0.0	0.0
Lesotho	2.8	0.0	0.0	Somalia	–	0.0	0.0
CAR	2.0	0.0	0.0	South Sudan	0.0	0.0	
Malawi	0.8	0.0	0.0				
Uganda	0.1	0.0	0.1				

Note:
(A) Share of mineral exports in GDP – WITS, World Bank;
(B) Share of mineral rents in GDP – WDI, World Bank;
(C) Share of mineral resources in total wealth.
Only countries with a population over 1.5 million are included in this table.
Source: Authors.

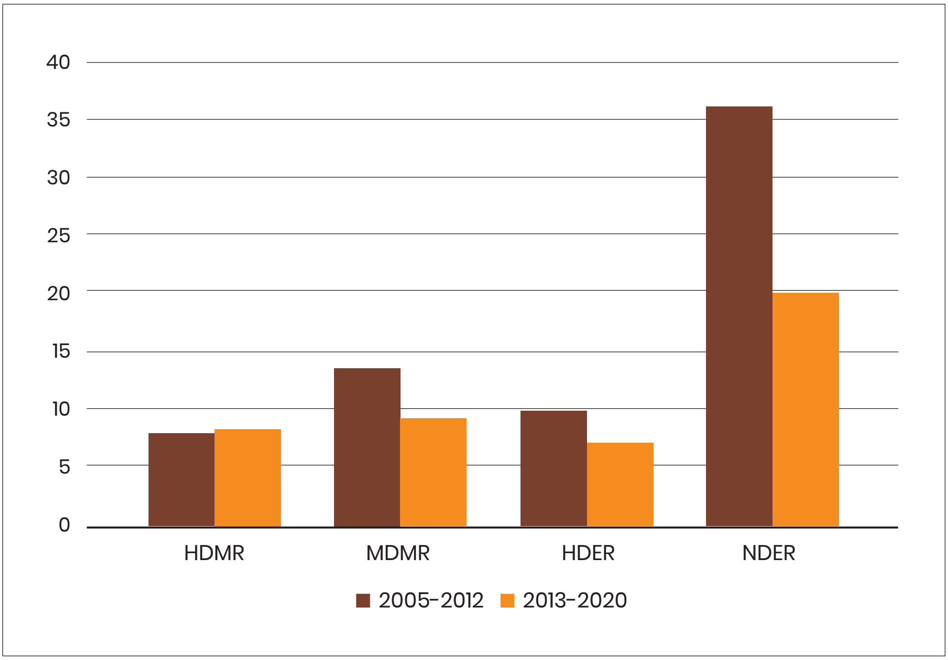
Map 1. ***Countries dependent on mineral resources (2015–2020)***



Source: Authors based on the mineral rents (% of GDP) series in the WDI, World Bank

First and foremost, Graph 2 illustrates how the place of natural resources in African economies has shrunk since 2012 as a consequence of the fall in raw materials prices. This shift has been felt most particularly in HDER (oil, gas, and coal) countries, where natural resources represented up to 35% of GDP between 2005 and 2012, as well as in HDMR countries.

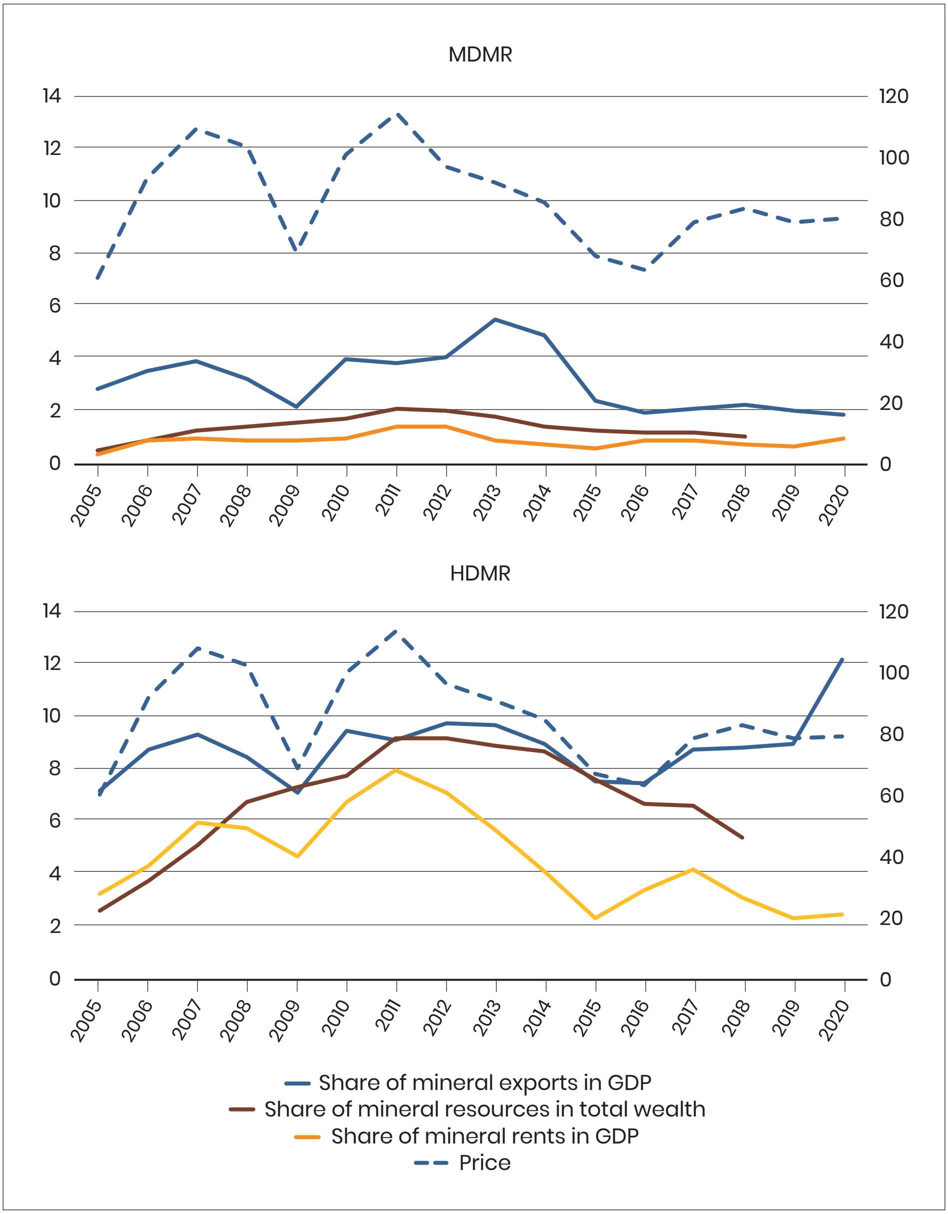
Graph 2. ***Contribution of natural resources to GDP (%)***



Source: Authors based on the WDI, World Bank

The longitudinal analysis set out in graphs 3a and 3b clearly demonstrates this fall in the importance of the mining sector in these economies from 2012. However, a recovery can be seen from 2020, with early indications of the most recent mining boom, mainly in relation to energy transition minerals. It is therefore probable that the more recent effects of the resource curse are difficult to discern in African countries dependent on mineral resources, because *(i)* their dependence on natural resources is less marked than that of the countries dependent on energy resources generally affected by this curse, and *(ii)* the dependence of economies on mineral resources has fallen over the last 10 years (until the anticipated future boom).

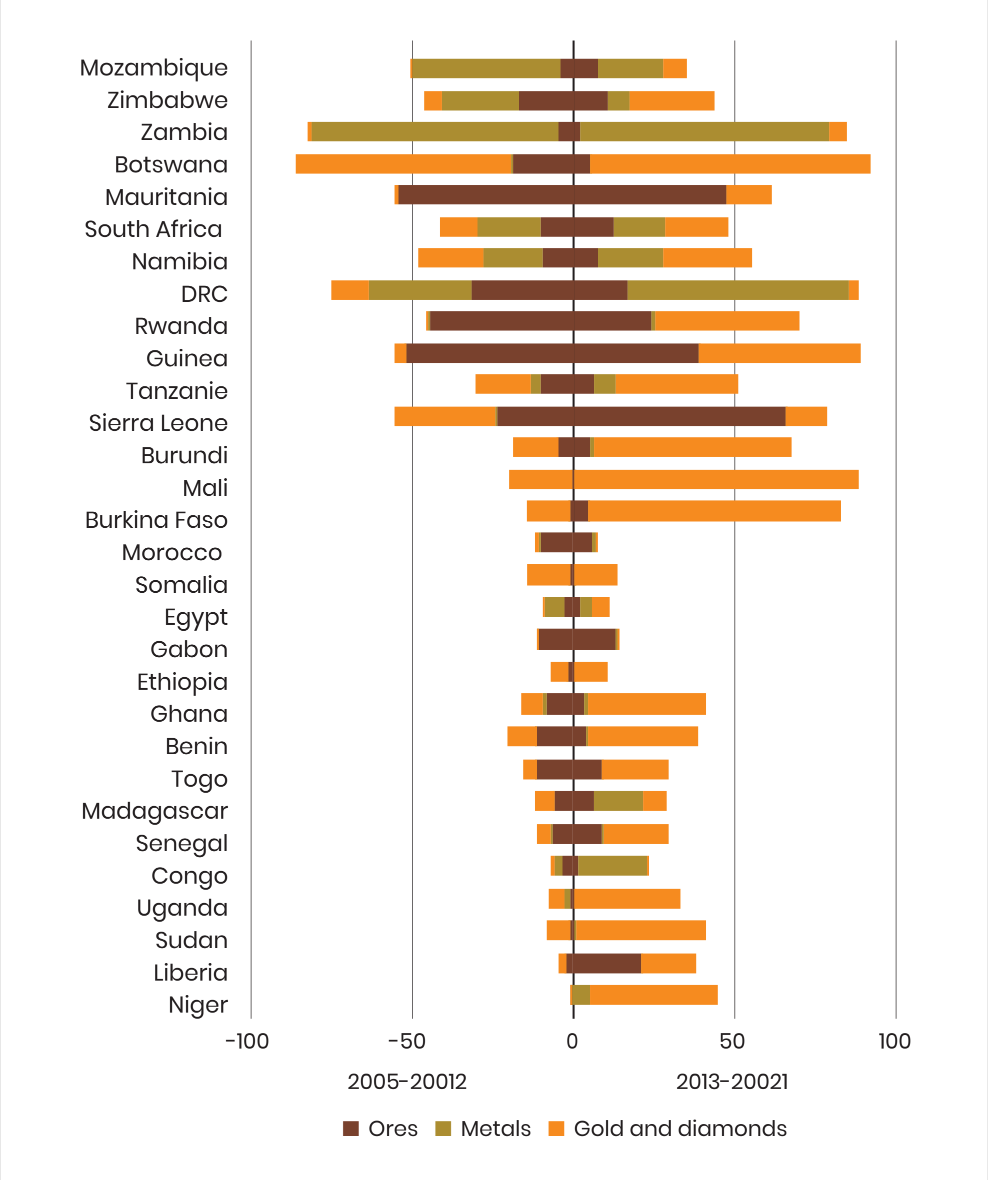
Graph 3a and 3b. ***Contribution of mineral resources to the economies of mining countries (%, left-hand scale) and price changes (index, right-hand scale)***



Sources: Authors based on the WITS, World Bank; WDI, World Bank

However, it is significant that the share of mineral exports in GDP only slowed slightly during the fall in mineral product prices and has surged since 2016. Further, the share of mineral exports in total exports has not slowed: The continental average was 25% between 2013 and 2021, compared to 14% between 2005 and 2012. The share of mineral exports in total exports (Graph 4) is very high in many African countries: Above 50% in Zambia, the DRC, Mauritania, Guinea, Mali, and Burkina Faso. The upturn has been particularly strong in Burkina Faso, Ghana, and Mali in terms of gold, as well as in Sierra Leone and Guinea. Gold and diamond products (representing 12% of total exports from Africa), metals (7.5%), and ores (6%) represented a large proportion of mineral exports over the past 10 years.

Graph 4. ***Share of mineral exports in total exports (%)***



Note
Ores (SITC 27 & 28): crude and metalliferous ores
Metals (SITC 68): ferrous and non-ferrous metals
Source: Authors based on the WITS, World Bank

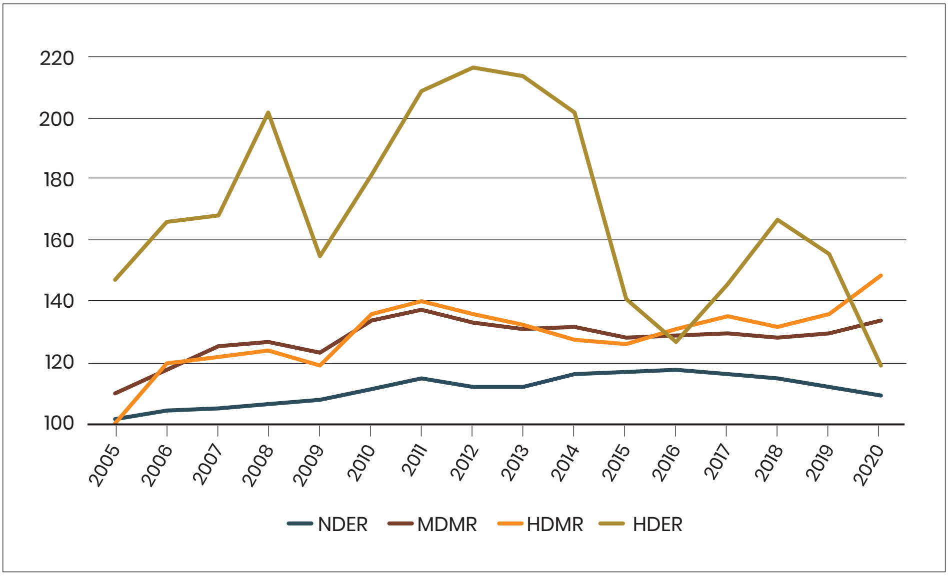
1.1.1. Dutch disease

One of the most well-known explanations for the link between an abundance of resources and economic slowdown is Dutch disease (Corden 1984; Corden and Neary 1982). According to this model, a boom in natural resources exports generates exceptional income that in the short term increases global demand and, consequently, the price of non-tradable goods (services) compared to tradable goods (the manufacturing sector). This amounts to an appreciation of the real exchange rate and leads to increased production within the non-tradable goods sector, while the tradable goods sector shrinks. Factors of production such as labor and capital are reallocated from the tradable goods sector to the non-tradable goods sector, creating medium-term under-industrialization. This kind of market response to a natural resources boom does not in itself represent a long-term fall in growth.

However, if the tradable goods sector is better able to drive economic growth than the extractive sector, the natural resources boom will act as an obstacle to such growth. The manufacturing sector generally posts increasing returns to scale through learning-by-doing, and positive externalities (particularly in relation to human capital) affect this sector to a greater extent than the extractive sector (Sachs and Warner 2001; Torvik 2001). Further, a tax windfall as a result of resource exploitation can lead entrepreneurial talents to move away from productive activities to focus on rent-seeking activities that are more profitable in the short term but inefficient in terms of economic and social development (Mehlum et al. 2006; Torvik 2001).

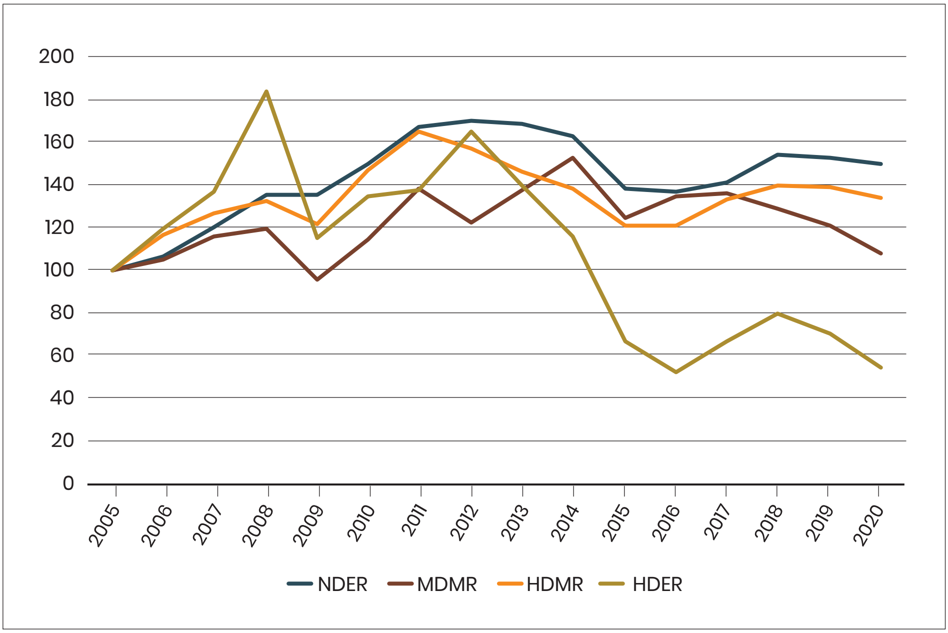
The literature supports the first part of this argument, concurring that resource windfalls result in under-industrialization in the major mining countries because of the sectoral reallocation predicted in Dutch disease models, i.e., a smaller manufacturing sector and increased imports (Harding and Venables 2016; Ismail 2010). The longitudinal analysis from 2005 to 2020 effectively demonstrates short-term exchange rate appreciation (Graph 5), alongside less medium-term industrialization (Graph 6), but more so in countries dependent on energy resources than in those dependent on mineral resources.

Graph 5. ***Terms of trade (index)***



Source: Authors based on the WDI, World Bank

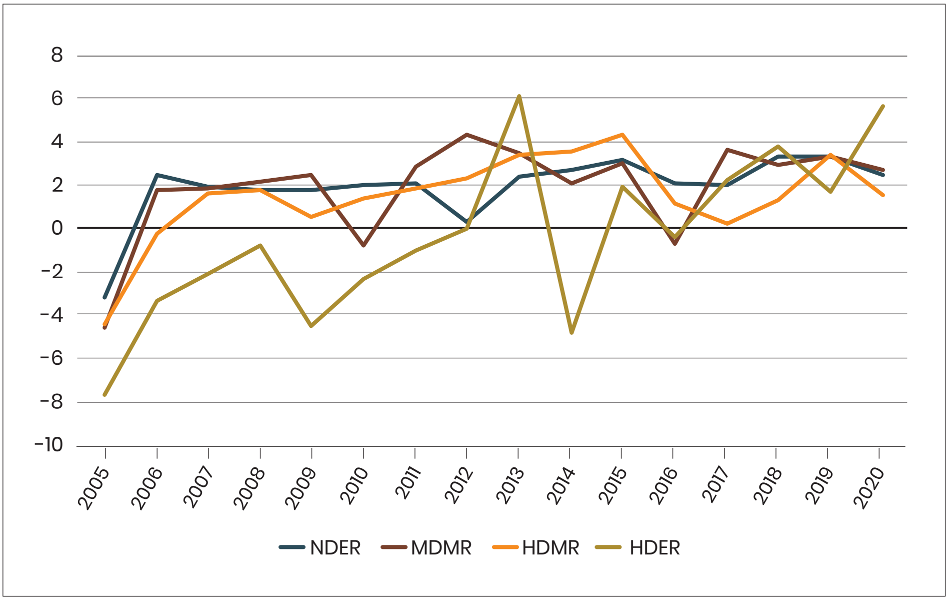
Graph 6. ***Value added (VA) in industry by worker (index)***



Source: Authors based on the WDI, World Bank

However, research has been unable to confirm the second part of the argument whereby real appreciation and deindustrialization reduce the growth or income of mining countries. For example, Sala-i-Martin and Subramanian (2003) did not find a significant relationship between overvaluation of the exchange rate and economic growth. The longitudinal analysis from 2005 to 2020 by group confirms the lack of such a relationship in the data, as changes in growth rates during the period under consideration are not different.

Graph 7. ***Growth in GDP per capita (%)***

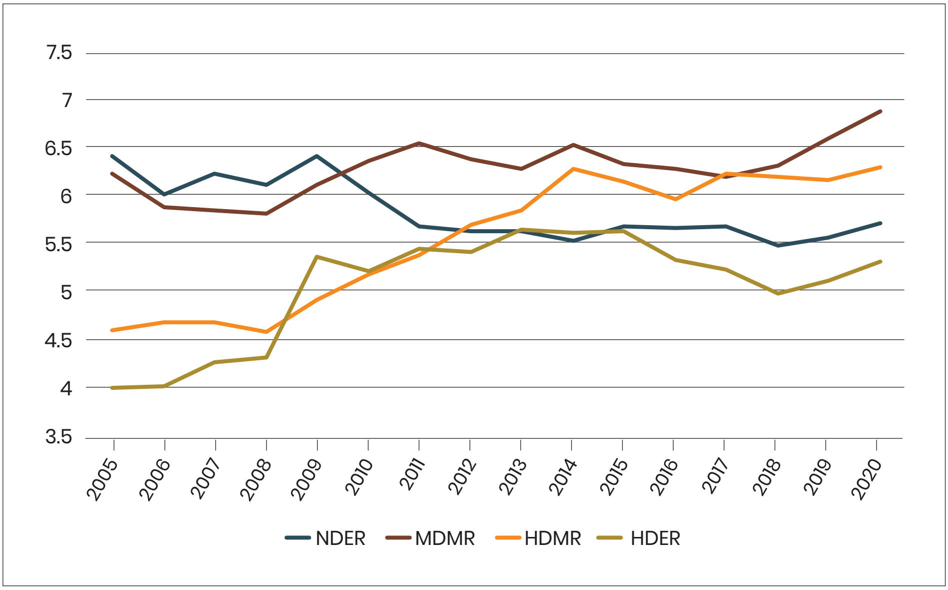


Source: Authors based on the WDI, World Bank

However, although proof of a negative effect on income and growth is lacking, there remains concern regarding the consequent delay to industrialization, as the continent desperately needs such a process for its development. After adjusting for the effect of per capita income, non-monetary well-being indicators are significantly lower in countries with abundant energy resources such as Angola, Gabon, and Nigeria. The explanation often provided is that the volatility and uncertainty of revenue derived from natural resources results in less investment in human capital. This is confirmed in the sample for countries dependent on energy resources. However, the longitudinal analysis from 2005 to 2020 indicates that countries dependent on mining revenue have made greater efforts to invest in human capital than other countries in Africa (Graph 8). Moreover, while the HDI is lower in those countries, its evolution over the period is similar to that of countries not dependent on non-renewable resources (Graph 9).

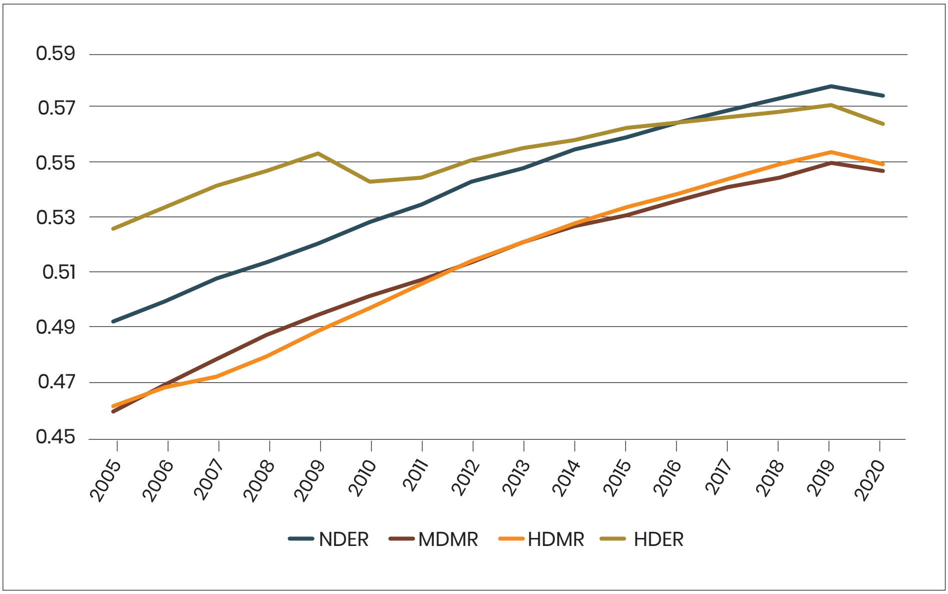
Similarly, a recent article by Masi et al. (2020) demonstrates that the presence of a strong natural resources sector does not in itself necessarily lead to poorer human development results. The impact of natural resources varies widely, and countries with similar levels of resource rents may achieve very different results in terms of poverty, inequality, health, and education. One of the main drivers of the effects of the natural resources sector on development is the type of states and political institutions developed by resource-rich economies.

Graph 8. ***Health and education spending (% GDP)***



Source: Authors based on the WDI, World Bank

Graph 9. ***Human Development Index (HDI)***

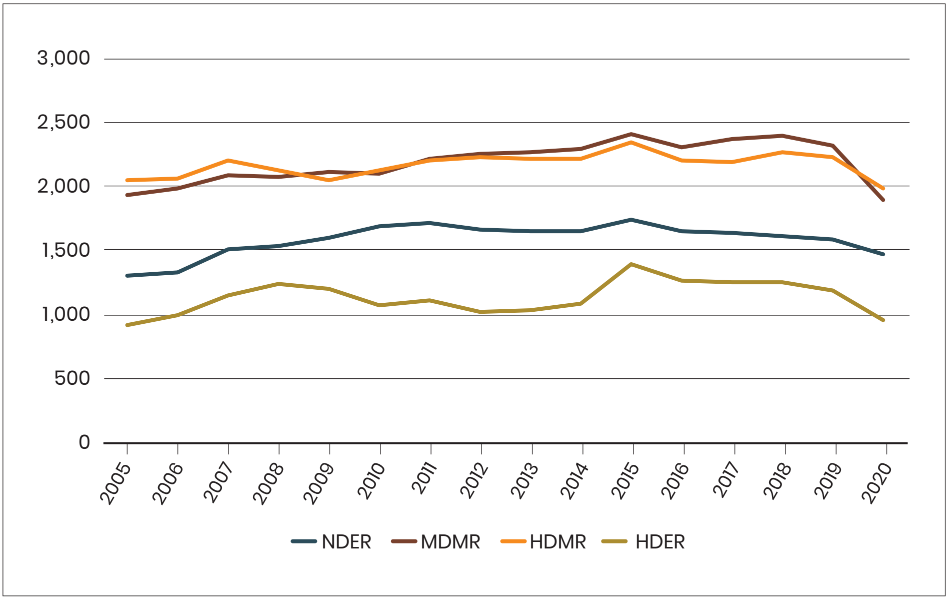


Source: Authors based on UNDP data

1.1.2. An obstacle to economic diversification

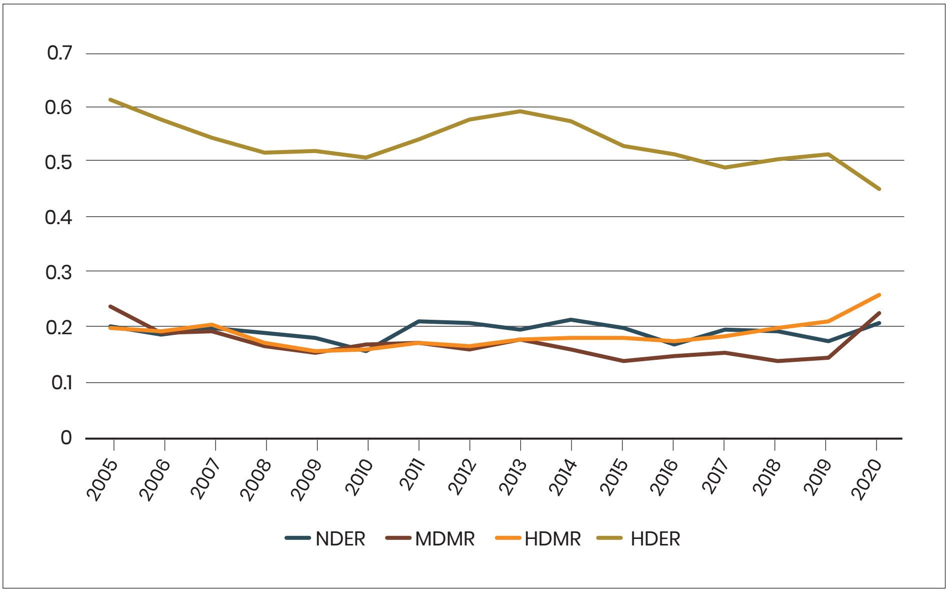
Dependence on natural resources is often described as an obstacle to diversification, particularly in terms of exports. This argument is related to that of under-industrialization. The share of natural resources in exports from Africa has increased in line with extraction operations. Between 2005 and 2020, mining extractive industries accounted for nearly a quarter of total exports from African countries (oil and gas alone representing nearly half the continent's total exports). However, the longitudinal analysis reveals that the number of products exported by countries dependent on mineral resources has increased (Graph 10), and exports from those countries have therefore become slightly less concentrated (Graph 11). In this context, it will be essential for mining countries to process some of their natural resources in order to diversify the products they export—indeed, that is the suggested roadmap in the Africa Mining Vision (AMV) (African Union 2009).

Graph 10. ***Number of products exported***



Source: Authors based on the WITS, World Bank

Graph 11. ***Export concentration (HHI – Herfindahl-Hirschman Index)***



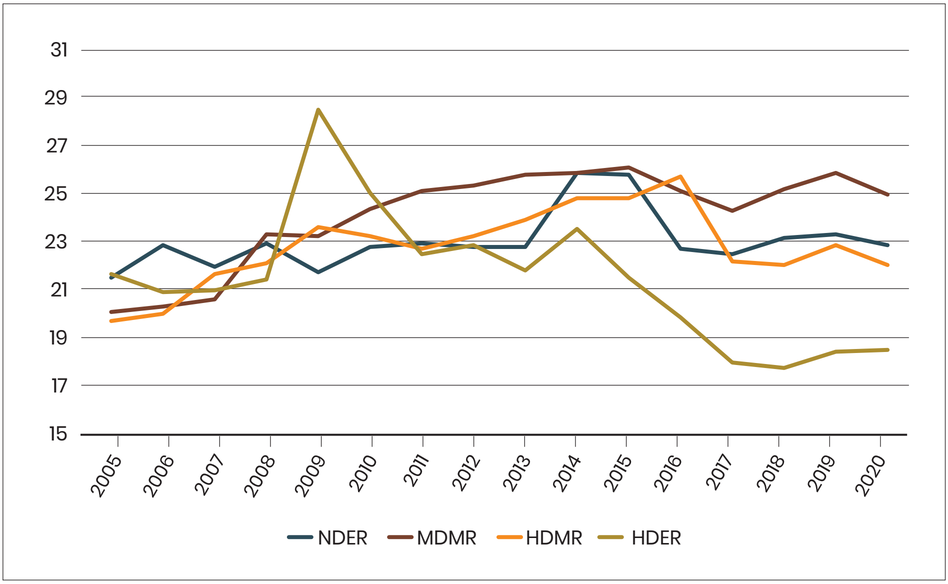
Source: Authors based on the WITS, World Bank

1.1.3. Exposure to price variations

A third argument supporting the idea that resource abundance has a negative effect on growth is based on an observation of greater volatility and, until the beginning of the 2000s, a steady decline in raw materials prices. Natural resources exporters are therefore more exposed to greater volatility in terms of trade, leading to reduced investment in physical capital, which can hamper economic growth. Moreover, in countries exporting resources, tax revenue is often highly dependent on revenue from natural resources. Price volatility and expansion-recession cycles can make it more difficult to establish prudent tax policies. For example, a resource boom can encourage a government to increase its spending and its borrowing by using future revenue from resources as a guarantee. However, if the government does not anticipate a fall in raw materials prices, it can subsequently find itself with a large level of debt and a weak flow of foreign resources to repay it. A natural resources boom can therefore lead to over-indebtedness (Manzano and Rigobon 2001). Stabilization mechanisms exist for some agricultural products (cotton, etc.) in Africa, but not for mineral products.

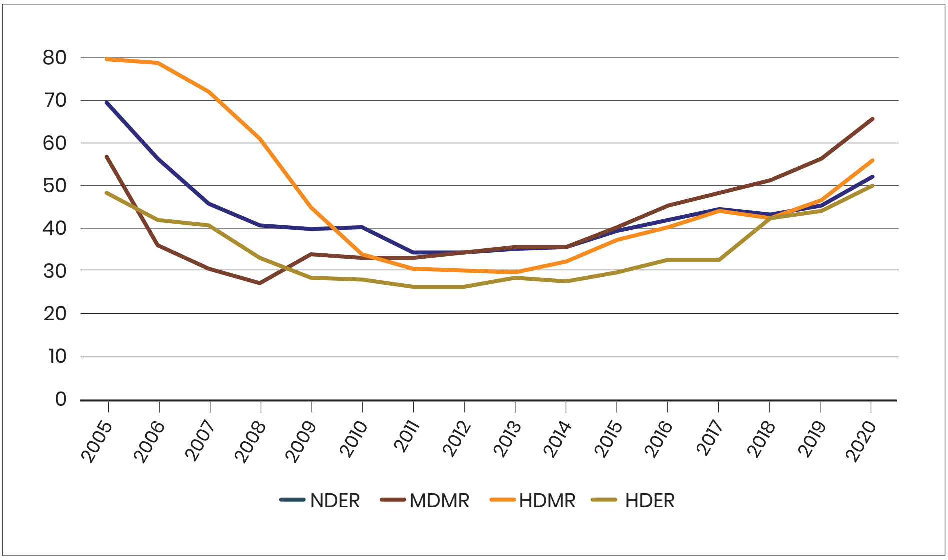
While it appears certain that the stock of debt in countries dependent on mineral resources has increased slightly since 2010 (Graph 13), the fall in private investment since 2014 does not seem more marked in those countries than in other countries in Africa (Graph 12). It should be noted at this point that the literature on the resource curse suggests that a fall in private investment can also be a consequence of states pursuing rent-seeking policies that exacerbate public appropriation via taxes, reducing incentives to invest (Lane and Tornell 1996; Tornell and Lane 1999). This argument is related to institutional risk and will be discussed below.

Graph 12. ***Investment (GFCF as % GDP)***



Source: Authors based on the WDI, World Bank
GFCF: gross fixed capital formation

Graph 13. ***Debt (stock as % GNI)***



Source: Authors based on the WDI, World Bank

1.1.4. Institutional risk

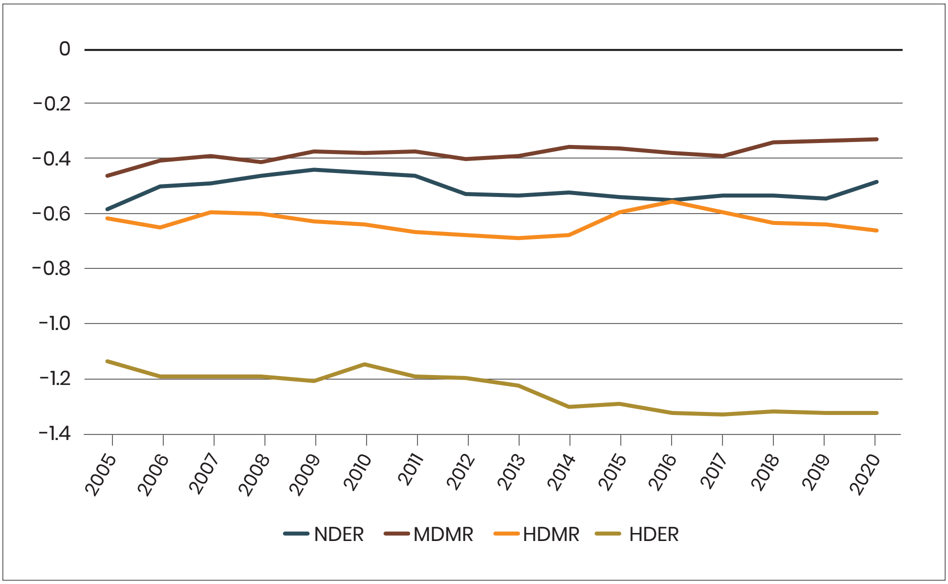
However, not all resource-rich countries, or even those with a rentier economy, are exposed to weaker economic performance (Canada, United States, China, the Gulf states, etc.). It is therefore important to emphasize the role of "good" or "bad" governance in these results, as well as the state of national socioeconomic structures and their integration within international economic structures.

More attention has been paid to political economy channels in order to explain the poor development results of resource-rich countries. Those resources create rents that can be easily appropriated when institutions are weak. Without strong institutions, resource rents can encourage rent-seeking behavior, increase corruption, undermine the quality of institutions, and, in extreme cases, even lead to violent conflict. Aragón et al. (2015) have identified some political economy channels through which resource abundance can hinder economic growth and the well-being of populations.

First, greater opportunities for rent appropriation can lead to an increase in political corruption (Brollo et al. 2013) and therefore compromise the development of democratic institutions (Ross 2004). With the additional revenue at their disposal, political leaders can appropriate rents while spending more to appease voters. Greater opportunities for appropriating rents can then attract other corrupt figures to the political scene, ultimately damaging the quality of political leaders. In a situation where governments are more dependent on revenue from natural resources than taxes from citizens, they are less inclined to construct (or strengthen) institutions to guarantee state accountability. From a rational, individual perspective, this can encourage leaders to develop a rentier economy (to increase the possibility of appropriating rents), to the detriment of diversifying public investment and development strategies. Indeed, levels of corruption in countries that are highly dependent on energy resources and mineral resources have increased significantly over the last 15 years (Graph 14).

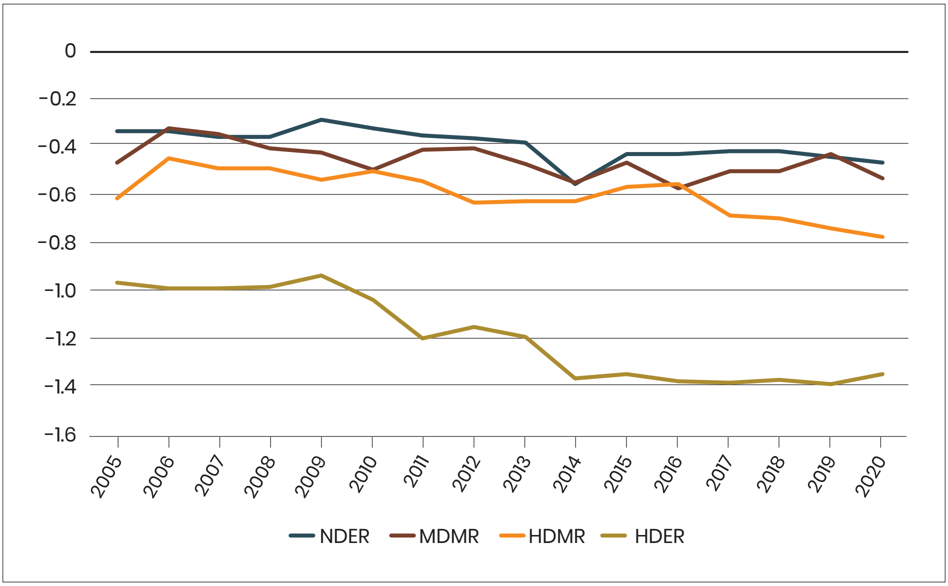
Finally, resource booms can increase predatory behavior and encourage greed. This can lead to a climate of violence and potential conflict (Collier and Hoeffler 2005; Grossman 1999). A conflictual context can have adverse consequences on capital stock and investment flows, running the risk of wiping out any progress made in terms of development and weakening state capacities. In this context, the longitudinal analysis also shows higher political violence index values in countries that are highly dependent on energy resources and mineral resources (Graph 15).

Graph 14. ***Corruption (index)***



Source: Authors based on the WDI, World Bank

Graph 15. ***Political violence (index)***



Source: Authors based on the WGI, World Bank

In conclusion, mineral resources exploitation in and of itself does not appear to be detrimental to economic growth. However, it can play a part in damaging governance and political institutions. Finally, deindustrialization and price volatility can also have an impact, but not as much as initially anticipated. However, it should be noted that prices fell between 2011 and 2016; the mining sector was therefore never large enough to disrupt macroeconomic aggregates, unlike oil, gas, or coal. The very real macroeconomic disruption observed in African countries dependent on those energy resources might suggest that, were mineral prices to surge, similar imbalances might well occur in the future. This reflects the results of the research conducted by Cust and Zeufack (2023), who analyzed the resource curse in sub-Saharan Africa between 2004 and 2018 and found that the phenomenon was only observed in oil resource-rich countries, not mineral resource-rich countries (with the exception of some criteria in Zambia, the DRC, and Guinea).

1.2. Employment

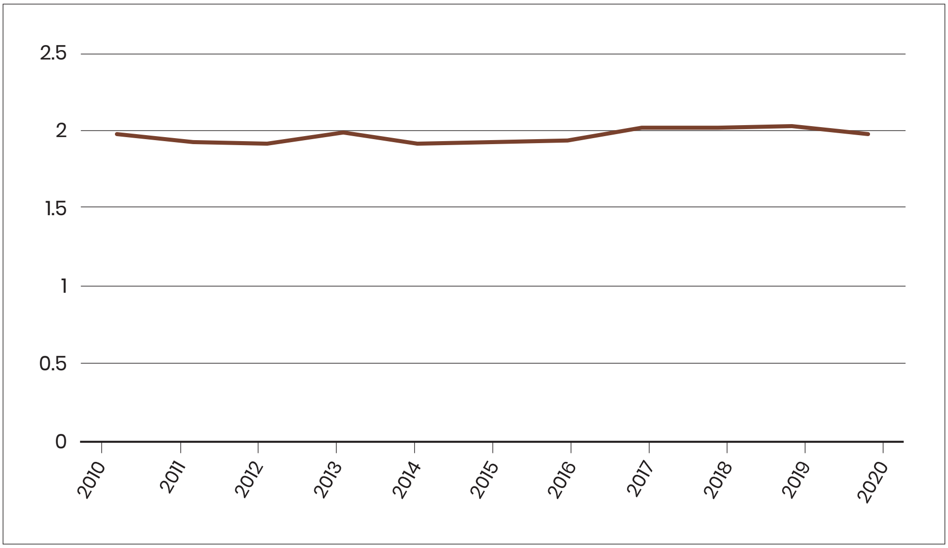
Dans l'idéal, un boom minier devrait provoquer l'augmentation des salaires nominaux et des autres revenus, étendre les opportunités d'emploi non minier et, de façon générale, améliorer le bien-être des populations locales et réduire la pauvreté. Cependant, il existe des conséquences négatives ; ainsi, une ouverture de mine attire souvent des travailleurs venant d'autres régions : l'augmentation des salaires s'en trouve alors comprimée, les services locaux de santé et d'éducation surchargés, les prix des biens et services non échangeables, notamment des loyers, s'envolent, ce qui peut donc avoir pour résultat de diminuer les revenus réels des riverains. Ces aspects sont développés dans le chapitre 3. La présente section se concentrera sur l'aspect création d'emplois.

1.2.1. Formal employment

It has become imperative for countries to translate their abundant resources into inclusive socioeconomic development, through employment in particular. The public often has a negative view of the impact of mining on local communities, because while mines make a substantial contribution to export revenue and, in many cases, GDP, the sector typically generates few jobs on the national scale. For example, in Mali, large-scale mining represented approximately 7% of GDP in 2013. However, less than 1% of the population was employed in the sector (Sanoh and Coulibaly 2015).

Overall, the mining sector generates few jobs across the continent—barely 2 million in the 38 countries where the International Labour Organization (ILO) collects data, i.e., 1% of the continent's workforce. This number barely changed between 2010 and 2020 (Graph 16).

Graph 16. ***Mining jobs (millions)***



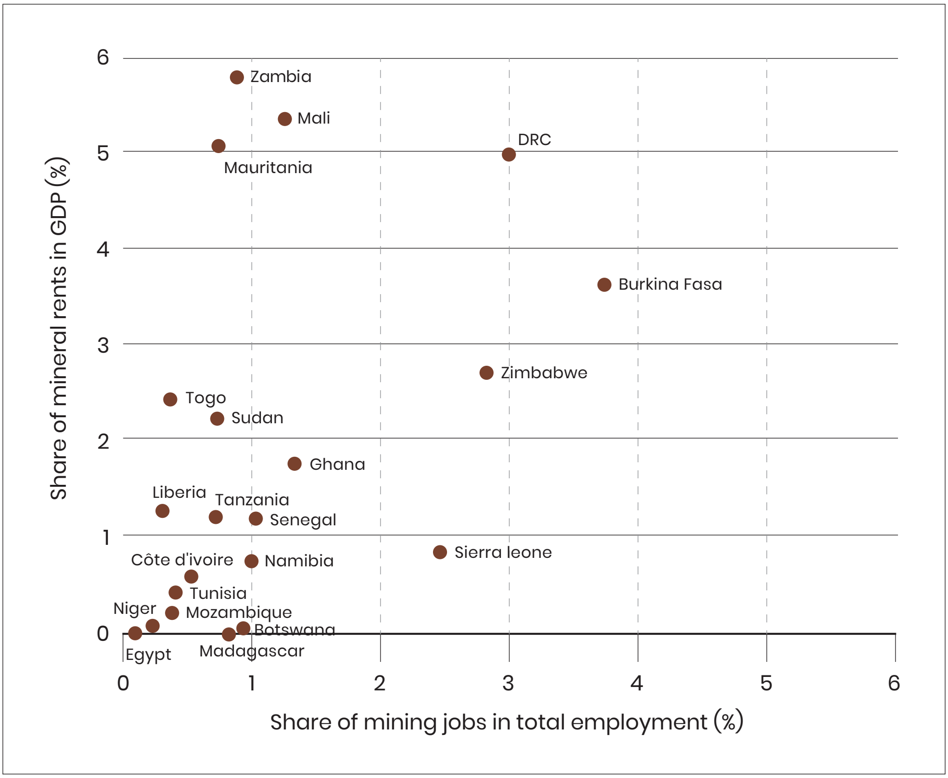
Source: Authors based on ILO data

There is a certain amount of disparity between the continent's economies in terms of the creation of formal mining jobs (Graph 17). Mining operations in Mali, Zambia, and Mauritania (Box 1) do not appear to create many jobs (barely 1% of total employment) compared to the value of their mineral rents (more than 5% of GDP). Meanwhile, Burkina Faso and Zimbabwe's mining sectors seem to create more jobs.

Box 1. Mining jobs in Mauritania

According to estimates in the EITI Annual Report on Mauritania, the mining sector employed **64,936 people** in 2019, i.e., **7.4% of the active population**. Mining companies employed 12,936 people, i.e., 1.5% of the active population. It should be noted that the Société nationale industrielle et minière (SNIM) is Mauritania's largest employer after the public sector. However, mining companies do not supply most of the jobs within the sector: Approximately 52,000 gold panners work on a smaller scale.

Graph 17. ***Mining employment vs. mineral rents***



Sources: Authors based on ILO and World Bank data

1. Faujas A. (2021), "Mauritanie: La SNIM peut-elle s'éviter un sort 'à la SONATRACH'?," < *Jeune Afrique*, January 8 (https://www.jeuneafrique.com/1101599/economie/mauritanie-la-snim-peut-elle-seviter-un-sort-a-la-sonatrach/; consulted on December 12, 2022).

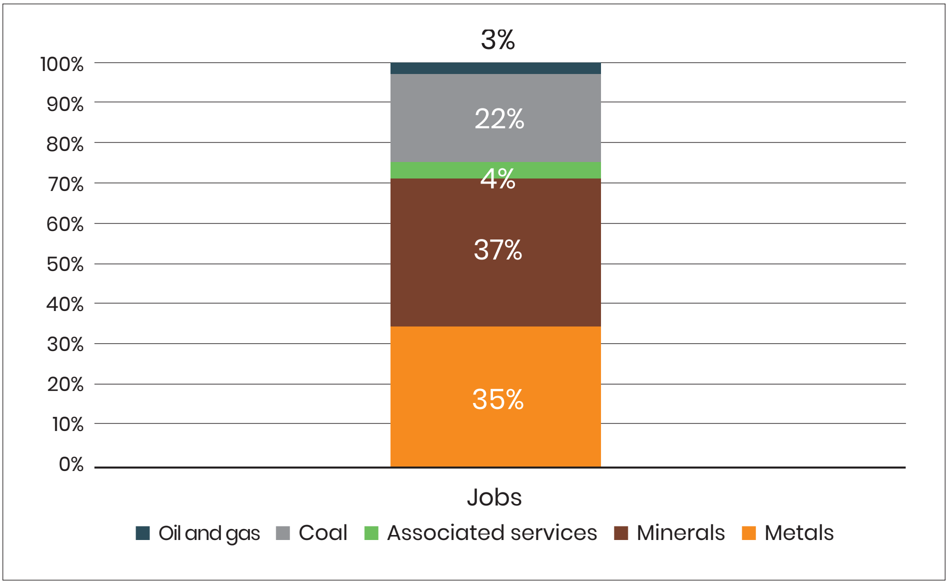
These results concerning employment in the mining sector must also be considered in terms of the jobs created around mines and in comparison with other extractive industries (Graph 18). Of the nearly 3 million jobs within extraction firms in Africa, 70% are connected to the mining sector, excluding energy resources. The coal sub-sector is responsible for 25% of jobs in the extractive industries across the continent but lies far behind mineral extraction (37%) and metal extraction (35%).

Jobs in services supporting the mining sector remain scant, at approximately 4% according to the ILO. However, the effect of "indirect jobs" encompasses more than simply mining services alone when local procurement is also taken into account. World Bank research (2017) into local employment in the broad sense in the mining sector in South Africa, Mali, and Ghana found multipliers ranging from 1.5 to 1.8. In other words, for every job in the mining sector, 1.5 other jobs are created elsewhere because of backward linkages and mining company expenditure. In the authors' view, these multiplier effects are limited due to the sector's capital intensity and the lack of local procurement opportunities. Efforts are being made (in Tanzania for example) to improve the potential for local procurement in catering services, vehicle repair, metal processing, electrical work, plumbing, and mechanics.

Improving local supply chains within the mining sector is one of the main principles of the AMV (African Union 2009) for macroeconomic strategies aiming to make the extractive sector a lever for development in national socioeconomic contexts. Esteves (2011) explains that in the early 2000s some international institutions, such as the International Finance Corporation (IFC) and the United Nations Industrial Development Organization (UNIDO), were already encouraging the creation of economic opportunities through the development of small and medium-sized enterprises (SMEs) that could be integrated into the supply chains of larger companies. However, Esteves also notes that local supply chains are usually unable to connect up with new markets because of the prerequisites, standards, norms, and supply and production capacities specific to supplying large companies. Those markets also tend to reproduce gender-based inequalities of access to employment (Esteves 2011). However, Esteves emphasizes that local supply chains could be better integrated if greater consideration were given to local content, the connections to be made and strengthened with the local socioeconomic fabric, and support for the sustainable development of local companies, as well as earlier identification of gender issues and the needs of women in terms of access to employment and entrepreneurship (Esteves 2011).

In that respect, the potential of mining to bring about structural change as a result of agglomeration effects and productivity gains could have an even wider impact on employment. Transferring the workforce from the relatively unproductive traditional agricultural sector to the mining sector could have positive impacts and provide non-agricultural employment opportunities for women in particular. The traditional agricultural sector could also be strengthened by feeding into the supply chains of industrial mining sites. This could encourage public-private partnerships (PPPs) between mining community policies and local development strategies led by states or international development agencies.

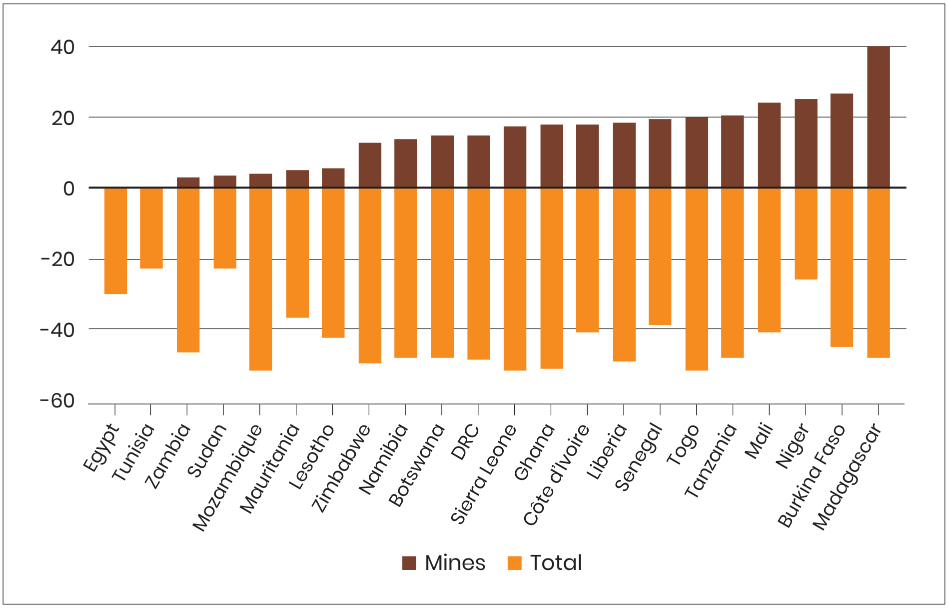
Graph 18. ***Mining jobs in Africa***



Source: Authors based on ILO data

The proportion of women working in formal mining jobs is markedly lower than in other sectors in Africa, and, ultimately, that figure barely changed over the course of the research period (Graph 19). However, it amounts to around 20%, and even exceeds that threshold in 10 countries. It remains significantly below the proportion of female workers in industry in general (between 40% and 50% on average). In total, it is believed that 490,000 women were employed in the formal mining sector in Africa in 2020. However, 99% of women working in mines were operating in the artisanal sector, where they represented half of all workers.

Graph 19. ***Proportion of women in the mining industry (%)***



Source: Authors based on ILO data

1.2.2. Employment in artisanal mines

In Africa, artisanal mining (defined as exploitation by individuals or small groups using rudimentary technology and equipment) is responsible for a significant proportion of the continent's production. More significantly, it is a crucial source of income for millions of people. Indeed, when properly regulated and structured, the artisanal mining sector presents an opportunity for economic development, particularly in rural areas that have been affected by a fall in agricultural productivity and which lack other means of subsistence, as has been observed in Zimbabwe (Box 2).

Box 2. Artisanal and small-scale mining in Zimbabwe

With approximately **1,207,338 workers** (207,338 in the industrial sector according to the ILO and approximately 1 million in the artisanal sector), Zimbabwe's mining sector employs **8% of the population**. The majority of production comes from **artisanal and small-scale mining (ASM)**, which is responsible for **63%** of Zimbabwe's gold production. A report by PACT[2] estimated that in 2016, gold ASM represented **1.2% of GDP** (total gold production amounting to 2.6% of GDP), generating **USD 3.8 million** in royalties (out of a total of USD 15.6 million for total gold production) and employed **7% of the population** (7.1% for the entire gold sector), creating approximately **1 million direct and indirect jobs**. It was the country's **third-largest mining activity in terms of its contribution to GDP (21%)**, behind platinum production (32%) and industrial gold production (26%).

Workers in the artisanal mining sector extract and process more than 35 different minerals and make a significant contribution to global production of essential mineral products. The most important raw materials extracted using artisanal methods in terms of value are gold and diamonds: There are 15 million people involved in artisanal gold mining alone in Africa. This type of business is very well established in Burkina Faso (Box 3). The artisanal sector produces approximately 10% to 15% of all the gold extracted around the world, between 15% and 20% of diamonds extracted (AMDC 2015), between 20% and 25% of tin and tantalum, and approximately 80% of precious and semi-precious stones (colored stones) (Lucas 2011; Villegas et al. 2012). According to the AMV, 18% of Africa's gold and nearly all its precious stones (with the exception of diamonds and certain rubies) are produced by the artisanal sector, which could make an important contribution to Africa's national and local economies (African Union 2009).

2. "The contribution of artisanal and small-scale gold mining to Zimbabwe's economic growth and development," PACT and the Institute for Sustainability Africa (INSAF), Washington, D.C. (2017).

Box 3. Artisanal gold mining in Burkina Faso

Artisanal gold mining is **well established** in Burkina Faso. According to the archaeologist Jean-Baptiste Kiéthéga, it dates back to at least the fifteenth century. However, over the last two decades it has changed out of all proportion.[3] The Enquête nationale sur le secteur de l'orpaillage (ENSO) (National Artisanal Gold Mining Survey)[4] estimated that there were 448 artisanal gold production sites in 2016 and **140,196 people** working in the country's artisanal gold mining sector. The UNDP, meanwhile, believes that the sector employs nearly **1.3 million people**. Artisanal production is mainly concentrated in the south-west (4.7 tonnes, representing 50% of production, employing 33% of the labor force at 61 production sites) and the north (2.4 tonnes, representing 25% of production, employing 24% of the labor force at 61 production sites). However, no fewer than 12 of Burkina Faso's 13 regions were involved in artisanal gold mining operations in 2016 according to the ENSO.

In 2020, artisanal mineral trading counters declared gold production of **0.3 tonnes**, with a value of USD 12.9 million. However, that only reflects a tiny proportion of total artisanal production, as much of it travels through **informal channels**. The ENSO therefore estimated that total artisanal gold production in 2016 amounted to 9.5 tonnes, with a value of FCFA 232 billion.[5] Bohbot[6] has underlined this discrepancy between declared production and actual production, which often proves to be significantly greater. For example, he highlights the fact that Togo exports several tonnes of gold despite not having any industrial gold mines. Public Eye, a Swiss nongovernmental organization (NGO), was able to trace that gold back to artisanal mining sites located in northern and western Burkina Faso. Artisanal gold is produced by *(i)* pit managers (the most frequent form of artisanal gold production encountered), *(ii)* gold miners using raking, scraping, or scooping techniques, *(iii)* small-pit gold miners using digging techniques, and (iv) gold miners who reprocess rejects. Artisanal gold mining also represents a significant investment; the ENSO estimates that in 2016 the total investment made by pit managers

3. Bohbot J. (2017), "L'orpaillage au Burkina Faso: Une aubaine économique pour les populations, aux conséquences sociales et environnementales mal maîtrisées," *ÉchoGéo* 42 (https://doi.org/10.4000/echogeo.15150; consulted on January 10, 2023).
4. Zouré F. et al. (2017), "Enquête nationale sur le secteur de l'orpaillage (ENSO)," Institut national de la statistique et de la démographie (INSD), Burkina Faso.
5. CFA franc. The eight member states of the West African Economic and Monetary Union (WAEMU) use the West African CFA franc (XOF) as their currency. In parallel, the six member states of the Central African Economic and Monetary Community (CEMAC) use the Central African CFA franc (or XAF) as their currency.
6. Bohbot, "L'orpaillage au Burkina Faso."

and other operators amounted to **FCFA 6.8 billion** (USD 10.9 million), mainly in the south-west (FCFA 3,016 million, or USD 4.8 million) and the north (FCFA 1,253 billion, or USD 2 million).

The Extractive Industries Transparency Initiative (EITI) report examined employment in the 16 companies that account for the majority of the industrial mining sector and claimed to employ **10,105 people** in 2020. It should be noted that 93.4% were Burkinabè nationals and that women represented 8.2% of the workforce.

The EITI added artisanal employment to this figure to obtain a total of **51,631 jobs provided** by the mining sector in 2020, representing **0.7%** of the active population. This figure may initially appear relatively low, but it does not take into account the informal sector.

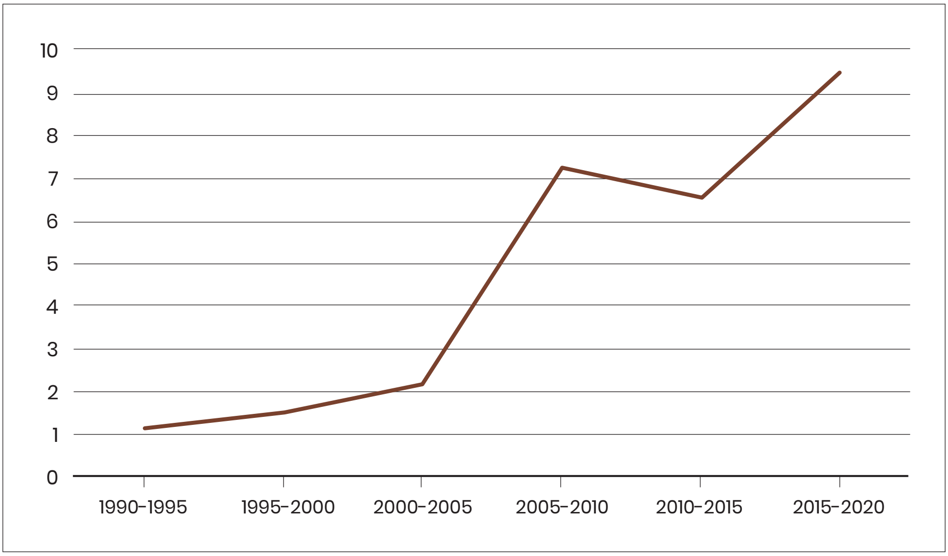
In reality, most of the jobs created by the mining sector are to be found in **artisanal mining**. The ENSO-2017 survey[7] carried out by the Institut national de la statistique et de la démographie (INSD) (National Institute of Statistics and Demography) found that in 2016, **140,196 workers** were employed in an occupation connected to artisanal gold exploitation at 448 functional artisanal gold production sites across the country. More specifically, 114,879 individuals were working in gold exploitation, 22,037 were providing services (crushing, grinding, washing, water provision, motorized pumps, electricity, etc.), and 3,280 were working in gold purchasing.

The EITI report drew on other sources that estimated that the sector employed **between 1 and 1.2 million people**, including approximately 300,000 diggers (10% of the active population). The World Bank DELVE survey estimated that the sector employed 1.26 million people in 2016. In conclusion, it is difficult to be sure of the true impact of informal artisanal gold mining in terms of jobs, particularly as it is a seasonal activity for many miners. However, it certainly accounts for the majority of jobs in the mining sector.

Africa does indeed have more artisanal and small-scale miners than almost anywhere else in the world. According to the DELVE program (Graph 20), nearly 40 million people are involved in the artisanal sector in 80 countries around the world, including 10 to 12 million (26% to 30%) in Africa. Artisanal mining therefore represents 15% to 20% of mining production in Africa, but more than 80% of the sector's jobs (not including workers in related sectors—see Box 4 on the artisanal sector in Burundi).

7. Zouré F. et al. (2017), "Enquête nationale sur le secteur de l'orpaillage (ENSO)."

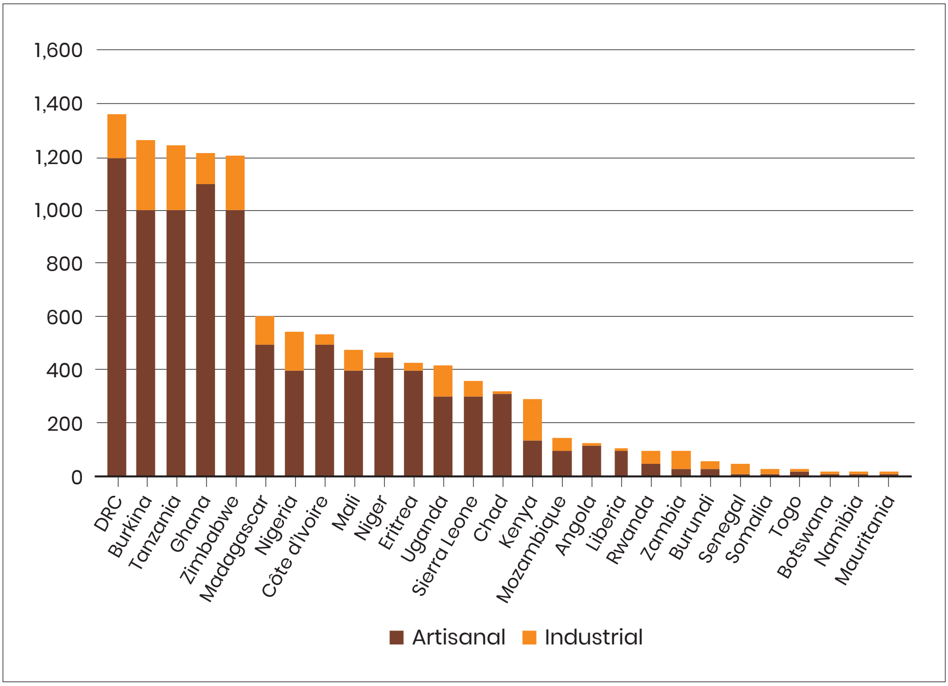
Graph 20. ***Employment in artisanal mines (millions)***



Source: Authors based on DELVE, World Bank

According to figures from the World Bank's DELVE program, the five African countries with the largest number of people working in artisanal mining are the DRC, Burkina Faso, Tanzania, Ghana, and Zimbabwe, with more than 1 million individuals in each country. For many countries in Africa, artisanal exploitation of mineral resources is a major source of employment. However, in most cases industrial extraction sites are established in areas previously exploited by the artisanal mining sector.

Graph 21. ***Industrial vs. artisanal employment between 2015 and 2020 (thousands)***



Source: Authors based on DELVE, World Bank

The mining industry must therefore compete with the economic activity of artisanal and small-scale mines. While, to some extent, the development of an industrial mining site can compensate for the loss of jobs among local communities, it cannot compensate for the loss of jobs at artisanal mines, which often involve immigrants who have come to the area because of artisanal sites or have invested in their exploitation. Such competition between artisanal and industrial mines is therefore the root cause of numerous conflicts and tensions in all of Africa's mining countries (Engels 2017; Capitant 2017; Sovacool 2019; Katz-Lavigne 2020; Okoh 2014; Zvarivadza and Nhleko 2018; Pedersen et al. 2019).

Box 4. The artisanal sector in Burundi

Almost all of Burundi's mineral extraction comes from **artisanal and small-scale mining (ASM)**, although the scale of the Burundian ASM sector is markedly smaller than in neighboring DRC and Rwanda. ASM produces all of Burundi's gold, amounting to 3 tonnes. It employs nearly **34,000 workers**, mainly in rural areas, and provides the Treasury with **significant foreign exchange revenue**. Small operations, when formalized, operate in compliance with the **2013 Mining Code** within the framework of cooperatives and associations. However, very high levels of **informality** remain. Further, analysis of Burundi's artisanal gold mining sector by the International Peace Information Service (IPIS) in 2015[8] underlined its preponderant role and the **need to incorporate it into certification procedures**: Burundi plays a significant role in the **illegal ASM gold trade** in the eastern DRC.

Artisanal mining is concentrated in the **northern provinces** of Burundi: Kayanza, Cibitoke, Kirundo, and Muyinga. Gold mainly comes from the Cibitoke and Muyinga provinces, while the 3 tonnes referred to above come from Kayanza, Kirundo, and Muyinga. According to estimates, ASM employs nearly **34,000 people** in Burundi. Artisanal exploitation of the 3 tonnes is performed by **6,000 to 7,000 workers**, three-quarters of whom are effectively mine workers—the remaining quarter wash minerals and carry out related logistical tasks. The gold sector employs between **14,000 and 27,000 people**. Assuming that each worker has five dependents, that means between **85,000 and 160,000 individuals** are dependent on ASM. It is common for people to have **multiple jobs**, and many rural households take up seasonal mining to earn extra income. Diggers are mainly men; women and children often wash minerals, transport water, supply the site, etc. According to the Mining Code, workers are supposed to belong to a cooperative in an attempt to formalize the sector. However, in reality this is often not the case, and **fictitious cooperatives** abound. In 2016, a World Bank study identified 82 artisanal sites mining for gold, wolframite, coltan, and cassiterite. Only 37 of them had mining licenses.

8 Matthysen K. (2015), "Review of the Burundian Artisanal Gold Mining Sector," *IPIS*, April 22 (https://ipisresearch.be/publication/review-of-the-burundian-ar-tisanal-gold-mining-sector/; consulted on December 5, 2022).

It is important to emphasize that the artisanal mining sector, while often associated with the informal sector, is particularly well structured and organized. It operates in a number of different spheres and areas of specialization using a variety of organizational and decision-making structures, and it remains closely connected to international markets (Katz-Lavigne 2020; Sovacool 2019). Many businessmen and women invest significant sums of money in artisanal mining sites in their own or neighboring countries. Those sites will operate in accordance with national legislation under the supervision of trade union organizations, local entrepreneurs, or members of armed groups (even national armed forces in the case of some illegal operations). They are managed via a hierarchical system, from the "pit" manager to the digger and the women and children who carry out sieving and extract the mineral. Artisanal sites sell their product via traders and trading counters that often invest in artisanal sites themselves before selling production on to national purchasing offices that in turn sell it on the international market.

Whether they mine gold, coltan, cobalt, tin, or copper, artisanal sectors operate under a variety of legislative systems. They can be criminalized, partially authorized, or perceived as sectors qualifying for priority investment to strengthen local supply chains and generate economic benefits for rural regions. However, even when individuals have the correct exploitation permits, national authorities tend to restrict their access to artisanal and small-scale mining sites—particularly when these are located near industrial gold sites—as artisanal exploitation causes too much environmental damage (see Box 5 on the situation in Ghana). This was the situation near several gold mining sites run by the mining company Banro in the DRC in the late 2000s and early 2010s. The police removed artisanal gold miners, including those legally paying taxes to obtain the artisanal mining permits issued by the Congolese authorities (Radio Okapi, 2011, 2012 ; LDGL[9], 2009).

9. League for Human Rights in the Great Lakes Region.

Box 5. Artisanal gold mining in Ghana

Artisanal gold mining is **an important part of Ghana's gold sector**. Until 2020, it was responsible for just under a third of Ghana's gold production and employed almost a million people. However, the sector (and "galamsey"[10] in particular) is almost too attractive, which presents something of a challenge. Many Ghanaians leave their jobs to work in artisanal gold mining because it offers higher salaries—GHS[11] 300 to 500 a day. For example, many students drop out of school to become miners, as do their teachers and headteachers.

On November 29, 2022, George Mireku Duker (deputy minister for lands and natural resources) responded to **vociferous demands that artisanal gold mining be banned**.[12] Given that artisanal gold mining was responsible for "nearly 40% of Ghana's total gold production"[13] and employed nearly a million people, he considered it had an important role to play in Ghana's economy and should therefore not be prohibited. However, he recognized the need to strengthen regulations within the sector—although he emphasized that Ghana's artisanal sector is held up as an example in Africa.

As Okoh (2014), Zvarivadza and Nhleko (2018), and Pedersen et al. (2019) have noted, the legislative framework for Africa's artisanal mining sector and the commitment to improve its professionalization and its development capacities are poorly reflected on the ground. Nonetheless, a number of projects are seeking to formalize and regulate the artisanal sector and encourage synergies between the various operational levels, creating what is referred to as a multiscale mining sector that can act as a bridge between the extractive industries and local populations involved in the artisanal sector. An initial pilot project to guarantee the coexistence of the artisanal sector alongside an industrial gold

10. "Galamsey" is derived from the expression "gather them and sell." It refers to an illegal small-scale gold mining operation in Ghana.
11. Ghanaian cedi (Ghana's national currency).
12. "No ban on small-scale mining – Mireku Duker," *GhanaWeb*, December 1, 2022 (https://www.ghanaweb.com/GhanaHomePage/NewsArchive/No-ban-on-small-scale-mining-Mireku-Duker-1672682; consulted on December 19, 2022).
13. This figure is hard to assess, but it was generally estimated to amount to approximately 30% until 2020. According to the Ghana Chamber of Mines, artisanal production registered by export companies fell considerably in 2021.

site was conducted in Ghana (Sovacool 2019; Okoh 2014). In Tanzania, the 2017 Sovereignty Act confirmed the completion of a gradual evolution of national legislation to better protect the artisanal sector against the extractive industries and to encourage the coexistence of these two modes of exploitation. In 2013, the Tanzanian government supported a joint initiative with the World Bank and two mining companies (Barrick Gold and AngloGold Ashanti) to implement two pilot projects around the Geita and North Mara gold mines to ensure greater formalization and professionalization of the artisanal sector and better regulation of the processing of the minerals extracted (Pedersen et al. 2019, 342–343).

A number of initiatives have also been introduced in the DRC: *(i)* authorization for the artisanal sector to operate on the periphery of industrial gold sites and to exploit mine tailings, as long as the ore extracted is sold back to the industrial mine at a fixed rate; and *(ii)* formalization of the artisanal cobalt sector and reinforcement of its ties with the international market. The latter initiative came about following a pilot project conducted between 2018 and 2020 at the Mutoshi site in Lualaba province involving the Congolese authorities, a mining company, an artisanal mining cooperative, and a raw materials trader. As a result of this initiative, revenue from informal mining has increased and exploitation standards have been strengthened, particularly by providing the equipment required to turn the artisanal site into a semi-mechanized operation.[14] However, the pilot project had to be halted because of the COVID-19 pandemic. This led to a significant fall in income for artisanal operators and severed the process for reselling their product at transparent and fair prices.

In some cases, mining companies can also choose to adopt a more conciliatory position with local communities (Box 6) and authorize exploitation of mine tailings or even satellite sites that would not be profitable for an industrial mine (Hubert 2021). However, these practices never become formal agreements guaranteeing exploitation by local communities, and, as such, they remain dependent on the goodwill and discretion of mining companies. Pilot projects advocating incorporation of artisanal exploitation into industrial sites, cooperation between the two modes of exploitation, or capa-

14. Agence Ecofin (2023), “En RDC, l'exploitation minière artisanale et à petite échelle contribue de 15 à 30 % de la production de cobalt (Rapport),” February 28 (https://www.agenceecofin.com/mines/2802-105950-en-rdc-lexploitation-miniere-artisanale-et-a-petite-echelle-contribue-de-15-a-30-de-la-production-de-cobalt-rapport).

city strengthening and professionalization for the informal sector are valuable approaches. However, the fact remains that these projects are usually promoted by international institutions and in mining company community policies. They are short-term solutions that have little concrete or positive impact on the artisanal sector (Okoh 2014; Pedersen et al. 2019).

Box 6. Artisanal gold mining in Guinea

Guinea is experiencing a boom in **artisanal gold mining**. Prohibited in much of the country, it is well established in Upper Guinea, where it is perfectly legal—the cultural legacy of centuries of gold mining to supplement income from agricultural activities. The gold rush began 30 years ago, probably because of higher water levels, access to new production technologies, and impoverishment among the population. Today, artisanal gold mining is particularly well established in Upper Guinea in the prefectures of Dinguiraye, Kankan, Kouroussa, Mandiana, and Siguiri.

This boom has had a number of consequences: *(i)* gold mining has become **permanent** rather than seasonal; *(ii)* the number of **artisanal gold mining sites** (nearly 200 in Guinea) has surged, causing more accidents and greater environmental damage; *(iii)* the number of artisanal gold miners has risen markedly, increasing fivefold in 30 years, with the EITI suggesting that there were **221,923 artisanal gold miners** in 2016; and *(iv)*artisanal gold miners have been **moving** between the various sites, leading to an increase in temporary camps and the development and urbanization of neighboring villages. In 2016, traditionally extracted gold exports amounted to more than half that of industrial gold exports: 18 tonnes (USD 612 million) from industrial sources compared to 11.8 tonnes (USD 395 million) from artisanal gold mining.[15]

For example, artisanal gold mining is developing near the **Lefa mine** owned by the Société minière de Dinguiraye (SMD). The mine's profitability has sparked the interest of artisanal gold miners who have been arriving in their thousands from across the country, from Burkina Faso, and even from Mali. Once a vein has been exhausted, they leave behind them damaged land and water courses polluted by mercury. According to a 2015 study by

15. "L'or en partage. La participation des orpailleurs au développement local," PROJEG, 2018.

the Centre du commerce international pour le développement (CECIDE) (International Trade Center for Development), a Guinean NGO, mining areas are therefore those that witness the greatest number of **violent social conflicts**.

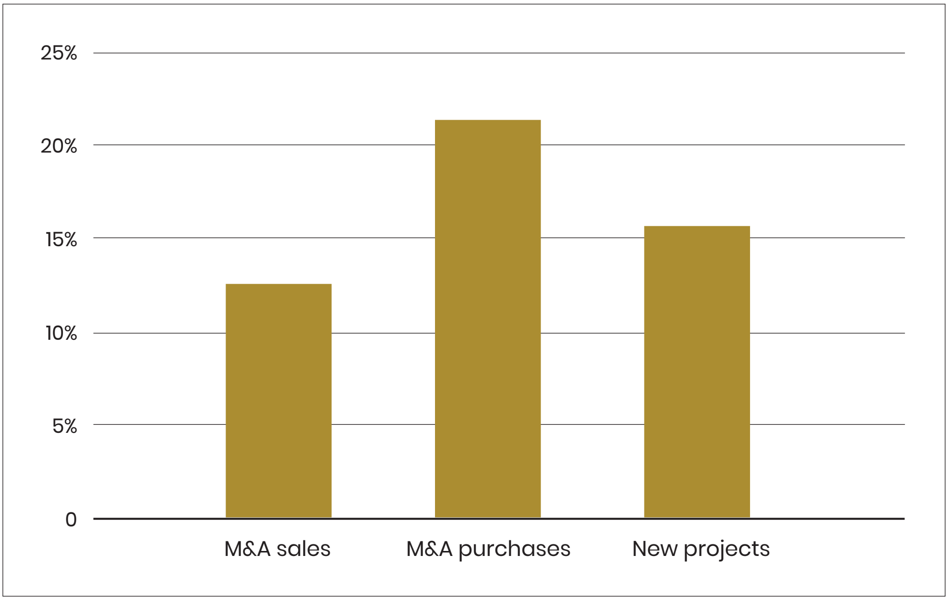
1.3. Investment

The mining boom that began in the early 2000s clearly indicates that opportunities exist, but how this potential can be maximized and the extent to which the legal situation affects foreign direct investment (FDI) remain to be determined. First, it is important to consider how investment has evolved over the last 15 years, be it through mergers and acquisitions (M&A) or greenfield and brownfield investment depending on the country, the mineral type, and the investor's country of origin. Subsequently, the regulatory framework available to investors will be analyzed and any recent changes presented.

1.3.1. Changes in investment

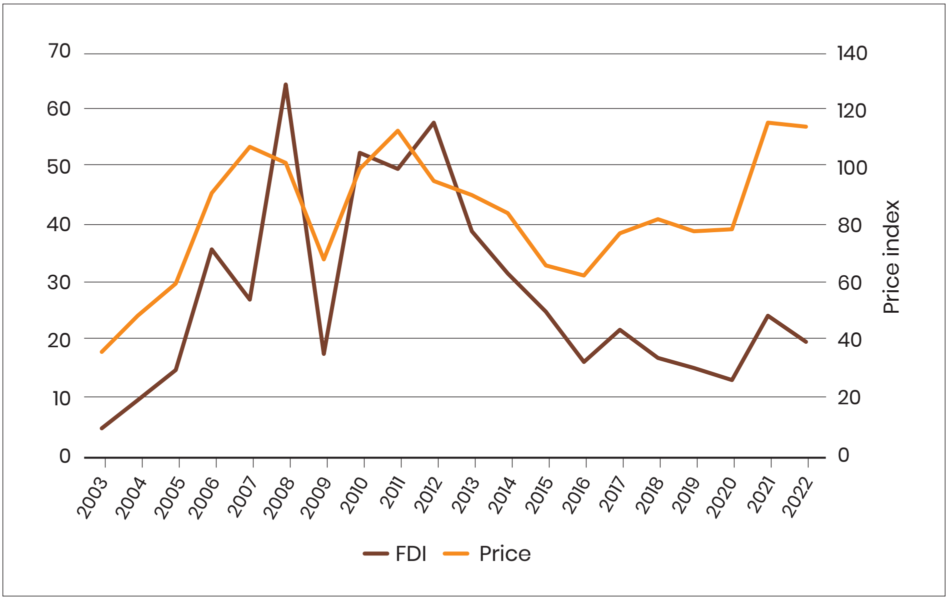
UN Trade and Development (UNCTAD) figures from reports on global investment between 2010 and 2020 indicate that investment in the mining sector averaged between 15% and 20% of total investment during this period (Graph 22). As was the case for the mining sector's economic contribution, investment in the sector fell from 2012, having risen sharply at the beginning of the 2000s. However, the figures show that investment picked up again in 2018 with the launch of initiatives involving energy transition metals. Investment has therefore been increasing since 2018 (Graph 23). In this respect, FDI in the African mining sector amounted to USD 16.7 billion in 2020 and represented 30% of total FDI in Africa. These trends are a clear reflection of changes in mineral and metal prices.

Graph 22. ***Share of total investment in Africa between 2010 and 2020 (%)***



Source: Authors based on UNCTAD data

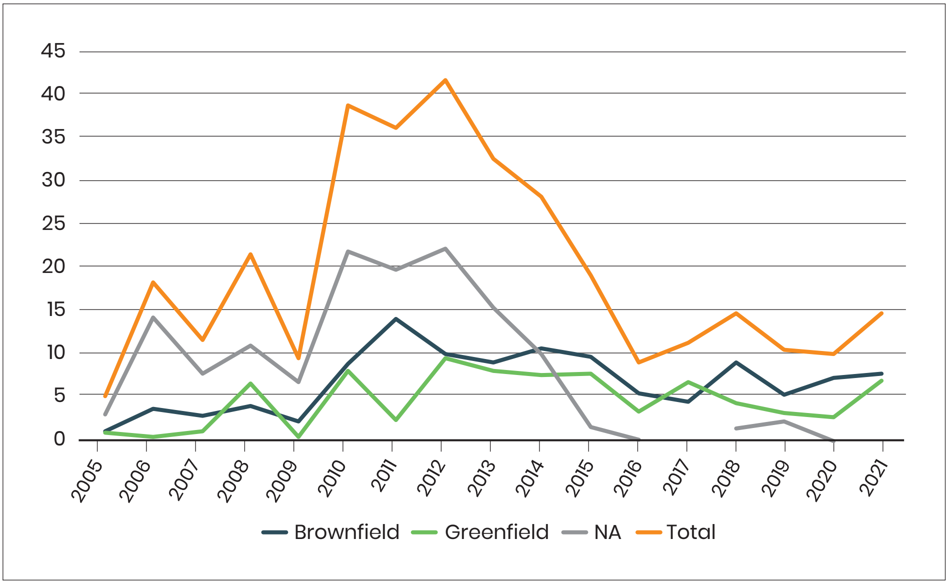
Graph 23. ***Amounts of mining investment (USD billions)***



Source: Authors based on S&P data

Investment takes different forms: *(i)* the purchase of existing companies with a view to making significant changes, known as "brownfield" investment; and *(ii)* investment through the development of new companies, known as "greenfield" investment (Graph 24). Such investments are widely promoted by host countries because they create jobs and are also a source of technology and skills transfer. However, another form of investment, M&A (Graph 25), involves acquiring existing companies to control them without introducing any major changes, and this generally does not have a significant impact on operations or employment. The other form of investment considered here is exploration budgets (Graph 26) allocated for locating new deposits.[16] Whatever the form, there was a very noticeable increase in investment in the African mining sector between 2005 and 2012, followed by a sharp deceleration before the upturn observed in 2019.

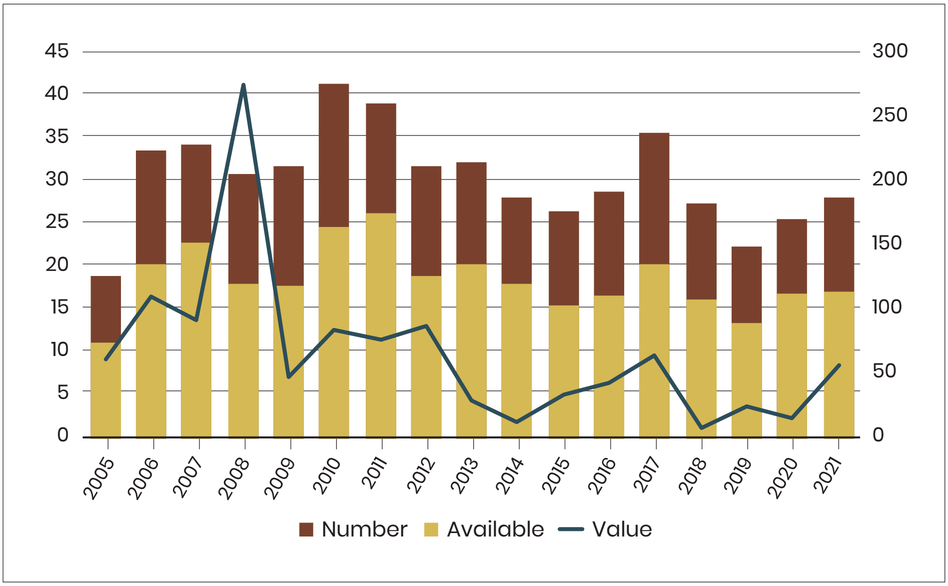
Graph 24. ***FDI (USD billions)***



Source: Authors based on S&P data

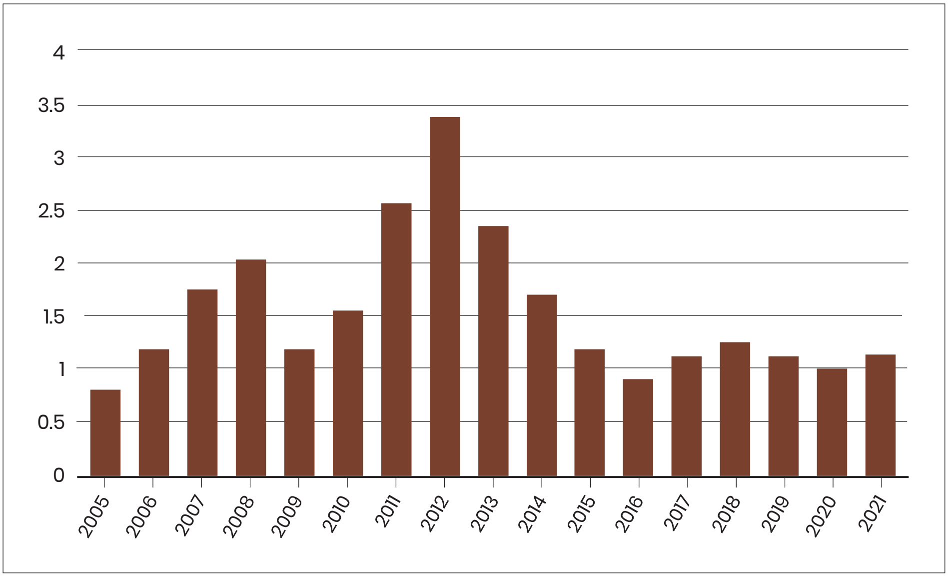
16. Greenfield investment is a form of FDI where a transnational company establishes itself in a DC to build new factories and/or new stores. Brownfield investment is another form of FDI where a transnational company purchases an existing company on industrial land with a view to making significant changes. M&A is also a form of FDI, consisting of the acquisition of existing companies to control them without implementing any major changes. Finally, exploration budgets are another form of FDI aiming to locate new deposits.

Graph 25. ***M&A transactions (USD billions and number)***



Source: Authors based on S&P data

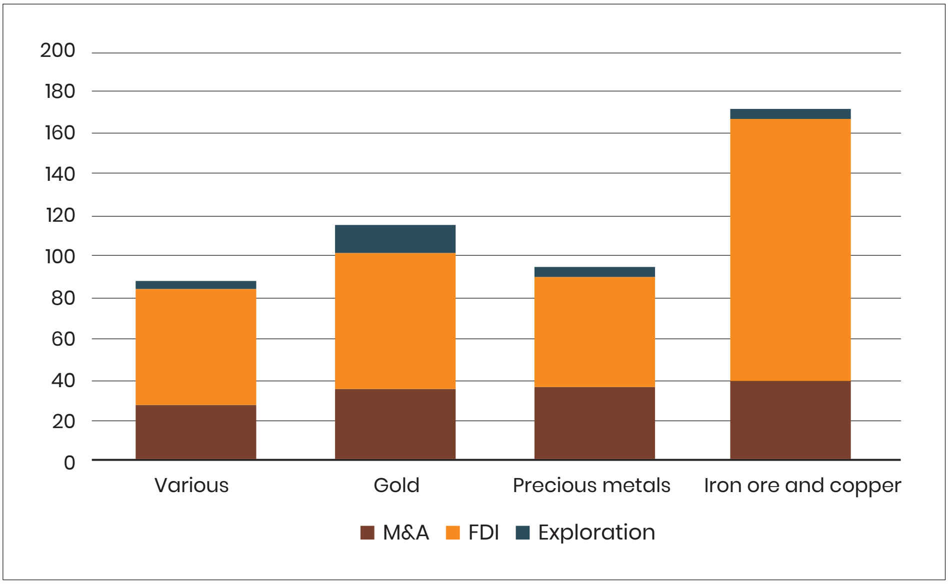
Graph 26. ***Exploration budget (USD billions)***



Source: Authors based on S&P data

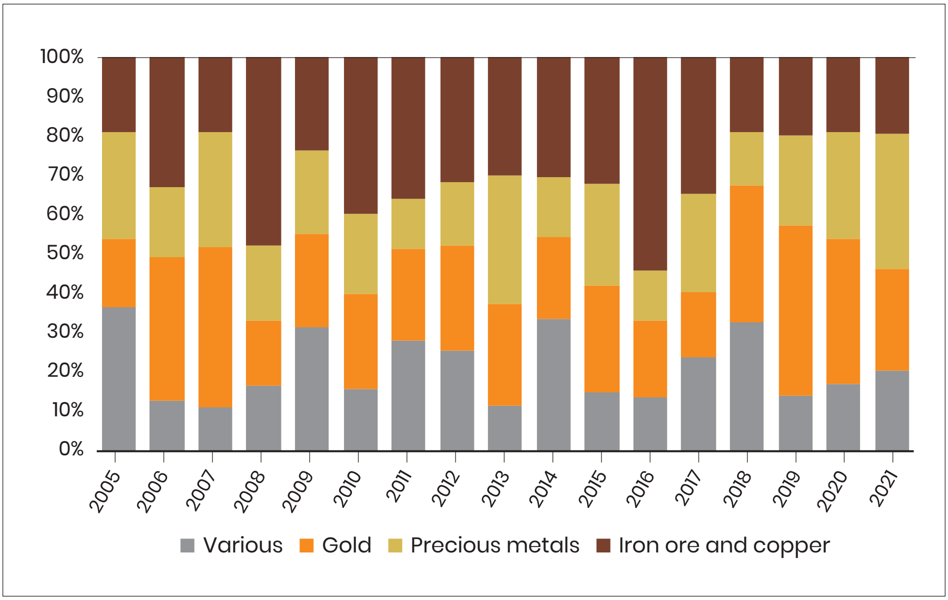
Beginning in 2005, mining investment in Africa initially focused on iron ore and copper (cumulatively worth USD 170 billion), followed by gold (USD 115 billion) and precious metals (USD 90 billion) (Graph 27). While the investment boom between 2005 and 2012 was also driven by investment in iron ore and copper and various other minerals, the upturn in investment since 2019 is actually the result of investment in precious metals and gold. The investment recovery therefore reflects a change in which areas of the mining sector are generating interest (Graph 28).

Graph 27. Type of investment by mineral/metal between 2005 and 2020 (USD billions)



Source: Authors based on S&P data

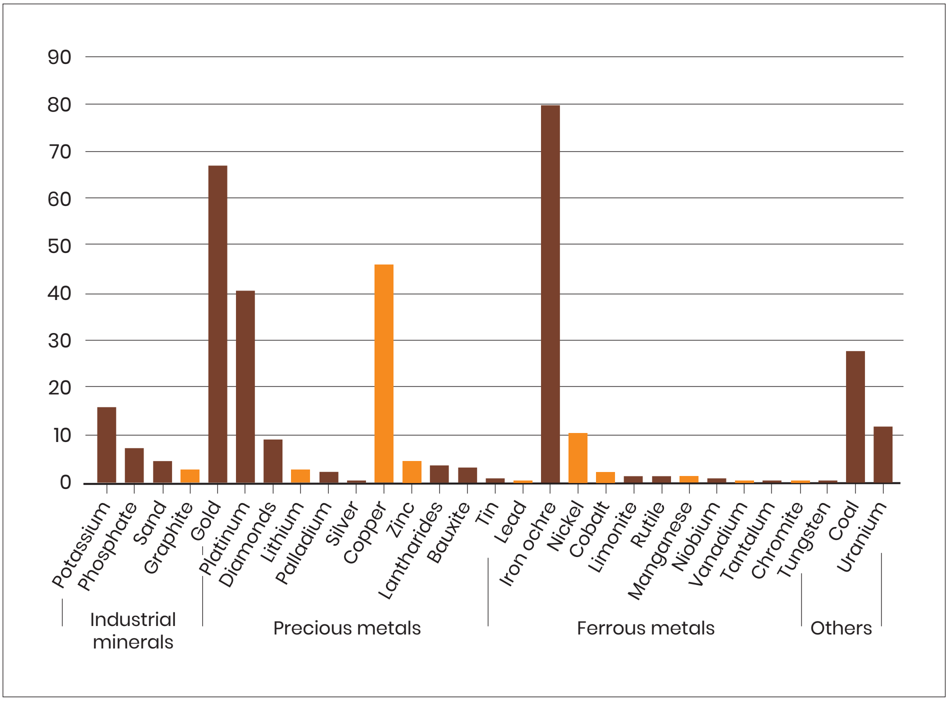
Graph 28. ***Total investment by mineral***



Source: Authors based on S&P data

S&P is able to provide valuable granular information about FDI excluding M&A (Graph 29). Finally, the eight main metals and minerals can be broken down as follows: three precious metals (gold, platinum, and diamonds), two ferrous metals (nickel and iron), two industrial minerals (potassium and phosphorous), and one non-ferrous metal (copper). Energy transition metals (in red) are not yet the focus of substantial levels of investment (excluding copper), but this should change in the near future.

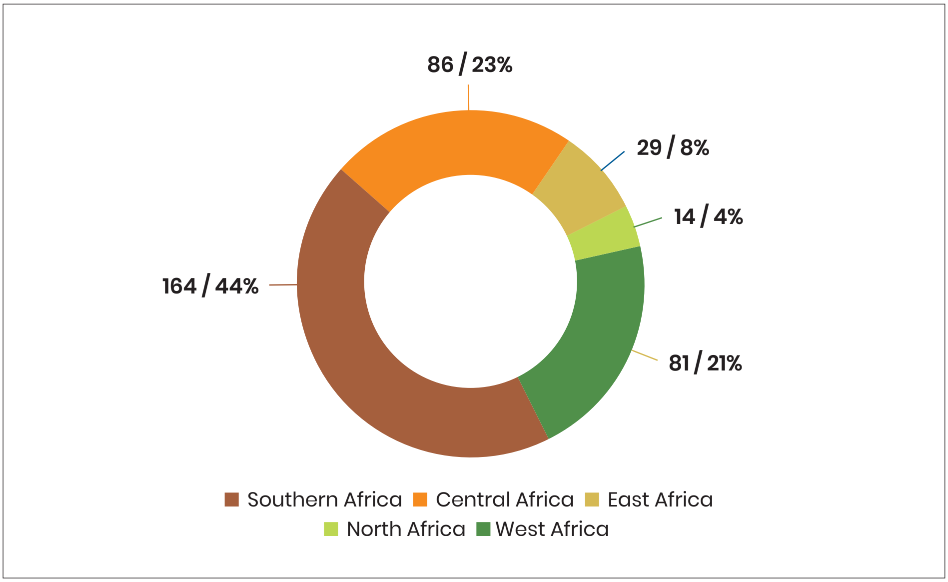
Graph 29. ***FDI (greenfield and brownfield) (USD billions)***



Key: Energy transition metals are shown in orange.
Source: Authors based on S&P data

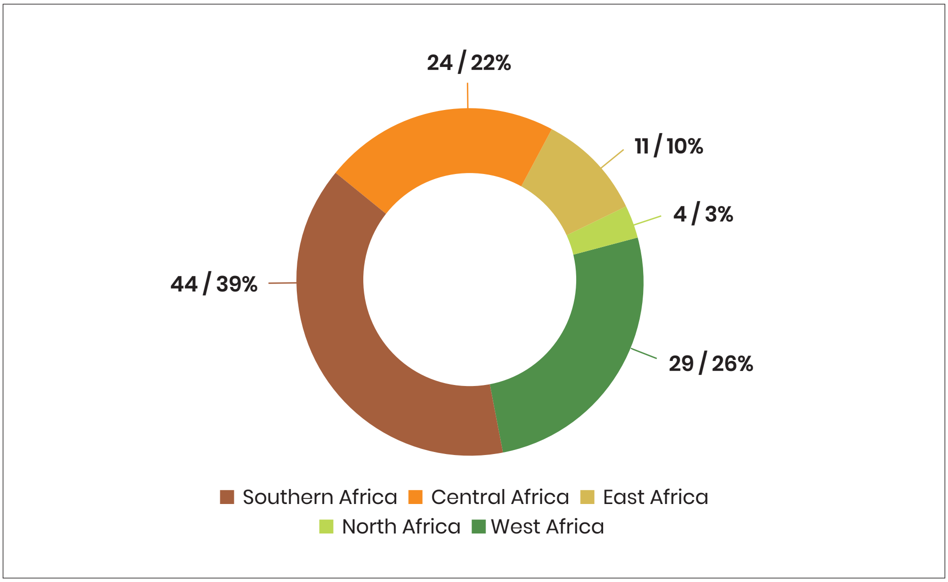
South Africa profited significantly from the mining boom of the early 2000s, as did Southern Africa as a whole, receiving nearly half of investment flows between 2005 and 2020, amounting to USD 164 billion (Graph 30). Below them came West and Central Africa with almost equal shares. It should be noted that it is countries in West Africa, and Central Africa more recently, that have benefited from the sharp increase in investment since 2015.

Graph 30. ***FDI by region 2005–2020 (USD billions, %)***



Source: Authors based on S&P data

Graph 31. ***FDI by region 2015–2020 (USD billions, %)***



Source: Authors based on S&P data

1.3.2. The regulatory framework available to investors

Changes in investment flows are clearly dependent on raw materials prices, which determine whether an investment is profitable or not. However, the regulatory framework available to investors is also a determining factor in deciding whether or not to invest and how revenue from projected extractive operations is distributed.

The nature and timing of investments mean that FDI in extractive industries is vulnerable to public appropriation because of the "dynamic inconsistency" problem. Mining codes and associated contracts therefore contain provisions guaranteeing legal protections for investors.

In this context, state agreements or contracts provide companies with a specific guarantee (a lien), i.e., an assurance that the state will not be able to change a principle further down the line and will only be able to lodge an appeal against the investor before the competent international courts, where international law alone shall prevail. These contracts therefore become a means of neutralizing the state's normative power in respect of the companies operating on its territory (boxes 7 and 8).

However, both parties can be vulnerable. In some cases, very large multinationals with a dominant role in the basic commodities sector can hold sovereign countries "hostage." Credible threats to "withdraw" and close FDI operations therefore form a significant part of these firms' negotiation strategies.

Box 7. Comprehensive review of contractual relations in Burundi

In July 2021, **Ibrahim Uwizeye** (minister of hydraulics, energy, and mines) **suspended the activities of mining companies** operating in Burundi. The ban affected Rainbow Mining Burundi (exploiting a rare earth elements mine in Gakara), Tanganyika Mining (a gold mine in Cimba), African Mining Limited (a gold mine in Muhwazi), and Ntega Mining Burundi (a coltan mine in Runyankenzi) in particular. He asserted that his decision was justified because the **lack of balance in the contracts** signed "risked resulting in major losses for the country" (statement by Minister Uwizeye on July 24, 2021).[17] Burundi's current Mining Code provides

17. Habarugira B. (2021), "Suspension des activités des sociétés minières: 'L'État n'en tirait pas profit,'" *Burundi Eco*, July 30 (https://burundi-eco.com/suspension-activites-societes-minieres-etat-nen-tirait-pas-profit/; consulted on December 5, 2022).

for long-term mining licenses (running for 25 years), the creation of joint ventures between the state and mining companies, compulsory free carried interest of at least 10%, at least 30% of votes on joint venture boards of directors, and key positions on these boards (such as the post of vice-chair). Yet, the Burundian government considers that 10% is not enough.

However, the suspension did not mean that mining licenses were withdrawn, simply that operations were to be halted until the companies and the Burundian state reached a **new agreement**. Only the company **Comptoir minier des exploitations du Burundi (COMEBU)** was authorized to continue mining minerals in the country for the contractually agreed period.

Mining cooperatives were recently authorized to **resume operations on gold sites** after nearly a year-long suspension, provided they adhered to the new regulations in force. In particular, Article 8 of the **decree of June 22, 2022**, sets out that all mining cooperatives must sell **30% of their production** to the state before any commercial transactions. Moreover, as far as is possible, they must **inform** the Office burundais des mines et carrières (OBM) (Burundi Office for Mines and Quarries), the local authorities, and the security and intelligence services of their gold production to guarantee that all such production is taken from the exploitation site to the Banque de la République du Burundi (BRB), the only gold trading counter. However, although artisanal gold mining will be able to resume, new contracts are apparently still being negotiated for the resumption of industrial operations.

It should be noted that the suspension of mining operations has not been without **consequences for Burundi's economy**. Revenue from gold exports (the country's leading export product in 2020) dropped from USD 45.9 million in 2020 to USD 0.01 million in 2021. In order to make up for the shortfall and to facilitate the resumption of mining, cooperatives will initially not pay the fixed duties and annual surface fee royalties. However, they will not be exempt from payment of VAT, taxes, and other charges.[18]

According to Minister Uwizeye, Burundi's **mining policy** is currently being revised. A technical team is also updating the **guide for investors** in the mining sector and quarries.

18. Kuriyo B. (2022), "Reprise de l'exploitation artisanale de l'or," *Burundi Eco*, September 23 (https://burundi-eco.com/reprise-de-lexploitation-artisanale-de-lor/; consulted on December 5, 2022).

Box 8. Zimbabwe's fragile legislative framework

Aware of the limitations of Zimbabwe's mining legislation, the national authorities have announced, alongside a plan to quadruple mining revenue, a **review of some of the mining sector's operating rules**. They have identified the following areas as requiring particular focus: *(i)* revision of the Mining Code in force since 1961; *(ii)* membership of the EITI; *(iii)* reducing corruption in the mining sector; and *(iv)* **computerizing the mining cadastre** to avoid disputes caused by multiple allocations of licenses.

Zimbabwe's legislation is characterized by a **permissive approach to granting licenses**, enabling foreign companies to **hold 100% of a mining license in perpetuity for any basic commodity**, with the exception of platinum and diamonds. As a result, many companies held **multiple licenses acquired at a low price without any pressure to transform them into productive mines**, reducing Zimbabwe's potential production and depriving other companies of the possibility of developing those projects. In 2020, the minister of mines, Winston Chitando, announced that the government **would henceforth require companies to develop such assets—in essence, "use it or lose it**." Initiatives of this kind seek to guarantee that minerals will be extracted to the benefit of the state and society. However, Warren Beech, head of mining and infrastructure at the law firm Eversheds Sutherland, believes that the **Zimbabwean state-owned mining company could be the biggest loser** when this principle is applied, because it has not yet begun operations.

Zimbabwe has previously sought to encourage local companies to acquire shareholding interests via the **Indigenization and Economic Empowerment Act** of 2007, whereby at least 51% of the equity of all commercial enterprises in Zimbabwe had to be owned by Zimbabweans. This law was **repealed in 2018**.

The **OECD**[19] **(2021)** has drawn up a set of Guiding Principles for Durable Extractive Contracts to assist host governments and extractive resource investors. They contain a number of interesting points in this respect. These OECD guidelines (Box 9) are not the same as the **OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas (2016).**

19. Organisation for Economic Co-operation and Development.

The Guiding Principles for Durable Extractive Contracts offer a way of explaining the content of contracts to the public, thereby helping to manage tensions between stakeholders. They include eight principles that host governments, investors, and technical assistance (TA) providers can use as a shared benchmark for future negotiation of durable and mutually beneficial contracts. We will examine all aspects of the principles in this section, with the exception of those relating specifically to taxation, which will be studied in the following section.

Box 9. OECD Guiding Principles

1/ Coordination between the extractive sector and broader sustainable development objectives.
Extractive contracts must form part of an overall vision, based on a long-term strategy defined by the host government on how the extractive sector can fit into and contribute to broader sustainable development objectives.

2/ The contract must be founded on a transparent relationship where goals and expectations are shared throughout the lifecycle of the project.
This principle means that a durable contract is based on a qualitative information sharing relationship and an operational partnership between the host government, the investor, and the community throughout the lifecycle of the project. Transparency is crucial in this respect.

3/ Management of each party's legitimate interests in accordance with applicable international and national law.
A durable contract balances the legitimate interests of the host government and the investor, as well as the specific concerns of local populations, in accordance with international and national law. This is important because there have been cases of contractual provisions violating international or national law.

4/ Safety, prudence, and management and remediation of a project's adverse impacts.
A durable contract must not only seek economic and social development; it must also take into consideration any consequences stemming from the activity in terms of the environment or the health and safety of populations by clearly establishing the responsibilities of the host government and the investor in terms of preventing, mitigating, and determining any impacts, in consultation with the affected populations.

5/ Sharing technical and financial data.
A durable extractive contract is founded on a negotiation based on the sharing of technical and financial data in order to establish a common understanding of performance and a project's main risks and opportunities throughout its lifecycle. In principle, mining contracts should not contain any confidentiality clauses, although many do. Similarly, it is prohibited for any information to be withheld—particularly in cases of unequal scientific and technical know-ledge, which are common in mining.
6/ Respect for the rule of law.
A durable contract is concluded in a business climate where the rule of law prevails, i.e., as part of a fair, clear, and transparent legal framework. From this point of view, any disputes that might occur would be handled ***in an appropriate and fair legal manner.***
7/ Review: The possibility of review is itself an OECD principle.
A durable contract must respect the laws of the host country while providing for the possibility of new laws, regulations, or even policies being adopted, as long as they are not arbitrary, they comply with the international standards and best practice generally accepted within the industry, and they take into consideration the possibility of under-performance in any project.
8/ A fair fiscal system.
A durable contract is accompanied by a fair fiscal system operating between the host government and the investor. This system should take into account possible risks and benefits, acknowledge that each party may seek to renegotiate any incentives, and authorize tax revenue to be collected as soon as production sales begin.

These principles are noble, but it is difficult to monitor their application, particularly in Africa. In this context, the **EITI**, launched in 2004, seeks to shed light on the hydrocarbon, mineral, and wood industries. Initially, its main aim was to publish the extractive revenues and taxes collected by companies and the authorities (EITI 2005).[21] Its system has been adopted by 26 African nations (out of 53 member states around the world). They publish annual reports on their extractive revenue and submit them for the approval of the EITI's international board. The EITI now also focuses on the condi-

20. This approach is supported by some of the sector's largest multinationals, such as Shell, Total, Trafigura, Anglo American, and Rio Tinto (all of which are members of the EITI's international and multi-stakeholder board), because it is a national process initiated at the request of governments.

tions surrounding the obtention and resale of mining licenses before they become operational, because that issue has been at the root of many instances of corruption in the African extractive sector (EITI 2019). Transparency is not a miracle solution for combating corruption, but it has an important deterrence effect (Box 10). By publishing extractive contracts, states are discouraged from signing contracts that might go against or be poorly aligned with national interests.

Box 10. A favorable investment climate in Mauritania

The **Ministry of Petroleum, Mines, and Energy** is responsible for the development and regulation of the mining sector. The General Directorate of Mines is responsible for applying any mining policies agreed. Until 2020, two other public bodies, the **Société mauritanienne des hydrocarbures et de patrimoine minier (SMHPM)** and the **Office mauritanien de recherches géologiques (OMRG)**, also formed part of the institutional mining framework. Mauritania has created a favorable climate for mining investment thanks to: *(i)* a legal framework that is favorable for investment, *(ii)* simplified procedures for accessing mining titles, *(iii)* a simplified tax regime that includes a three-year tax exemption for new investors, *(iv)* a VAT exemption for mining products (including imported products), *(v)* variable mining royalty rates, and *(vi)* a tax exemption for reinvested dividends. Mauritania also has a wide range of tools for cataloging and mapping the mining sector.

Exploration licenses are granted on a "**first come, first served**" basis and are valid for three years with the possibility of extending them twice. Mining exploitation licenses are granted for 30 years, can be extended for 10 years, and cover an area measuring 500 km² for all minerals except diamonds, for which the license can be extended to cover 5,000 km².

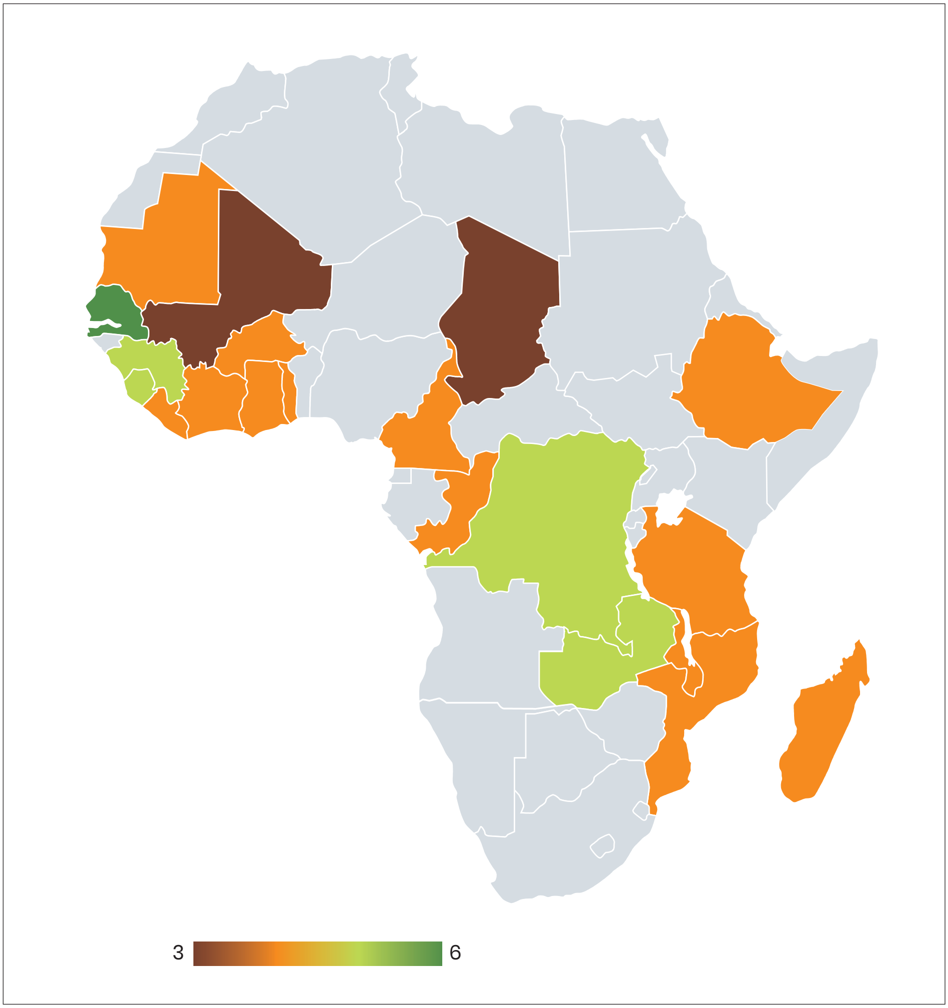
The main piece of legislation governing the sector is the 2008 **Mining Code**, amended in 2009, 2012, and 2014. In addition to the Code and its application decrees, a **standard mining contract** was drawn up in 2012 to serve as a reference for governing relations between the state and operators. In particular, it includes consideration of requirements in terms of transparent management of mineral resources and the environmental impact as provided for in **Framework Law 2000-045**. Other pieces of legislation apply to the entire industrial sector, such as the General Tax Code (GTC), the Customs Code, the Trade Code, the Water Code, and the Investment Code.

Mauritania has signed the main mining sector agreements and adopted the principal international mining initiatives, in particular the **AMV** and the **Minamata Convention on Mercury**. Following its request for membership in 2005, Mauritania was confirmed as an EITI candidate in 2007, before being designated "compliant" in 2012. In 2018, the country was assessed on the basis of EITI Standard 2016, and in 2019 the EITI board recognized Mauritania's "meaningful progress." Since 2018, the Mauritanian EITI office has set itself the goal of ensuring that extractive industry data is systematically disclosed via the Data Warehouse portal and through "awareness campaigns" about EITI reports.[21]

In total, 28 African countries have committed to improving the transparency and accountability of management of their extractive sectors by implementing the EITI Standard. They are assessed, as part of a validation process, on their progress in terms of compliance with the EITI criteria. five countries are still awaiting validation (Gabon, Uganda, CAR, Angola, and Niger). In terms of the other 22 countries that have already been assessed, since 2010 it appears that 2 have had fairly poor results and are therefore inadequate (Mali and Chad), 15 are recording moderate but meaningful progress, and 4 have scored highly and are making entirely satisfactory progress, (DRC, Guinea [Box 11], Sierra Leone, and Zambia [Box 12]). Meanwhile, Senegal has been posting a very high performance.

21. MREITI – Initiative pour la transparence des industries extractives en Mauritanie (2021), *Rapport annuel d'avancement 2020.*

Map 2. ***African members of the EITI***



Key:
Brown: countries posting fairly poor results, i.e., inadequate;
Orange: countries recording moderate but meaningful progress;
Light green: countries scoring highly and making satisfactory progress;
Dark green: countries performing very highly.

Source: Authors based on EITI data

Box 11. Reform of Guinea's legislative framework

Guinea has significantly reformed its system of mining governance. The mining sector is now governed by a new **Mining Code** adopted in 2011 and amended in 2013. It seeks to clarify (particularly in relation to the 1995 Mining Code) the framework for mining operations, firstly through management of mining titles, the conditions governing state shareholding in the mining sector, improved transparency rules, protection of the environment, community development, and management of mining revenue and the sector's economic spin-offs. The new Mining Code is supplemented by a set of decrees, including the Decree of 2014 on adoption of a "standard" mining contract.

In its 2019 assessment of mining governance, the **Natural Resource Governance Institute (NRGI)** found that the process for granting mining titles and governance of the *Société guinéenne du patrimoine minier* (SOGUIPAMI) (see below) were the most important areas for reform. Transparency within the sector also remained problematic.

Guinea implemented a new **cadastre procedure** in 2016, published its mining cadastre and mining contracts online in 2017, and created a single point of contact for requesting titles through the Centre de promotion et de développement miniers (CPDM). The improved conditions surrounding revenue management and monitoring in this area have resulted in an increase in the state's mining revenue. Government revenue from the mining sector amounted to GNF[22] 2,294.1 billion in 2020, or 13.2% of total government revenue.

In terms of transparency within the sector, Guinea joined the **EITI**[23] in 2005. It was declared a candidate country in 2007 and compliant in 2014, before being validated for the EITI Standard 2016 in 2018. The EITI board has recognized Guinea's "meaningful progress."

Improvement in the investment framework has resulted in the **signing of agreements and contracts** combining mineral extraction projects and infrastructure and refinery construction projects.

22. Guinean franc (national currency).
23. The EITI is an international nonprofit organization governed by Norwegian law. It seeks to strengthen governmental systems by increasing transparency within the extractive industry. It develops an "EITI Standard" against which member countries are assessed. In each EITI country, a multi-stakeholder group comprising representatives from government, business, and civil society supports implementation of the EITI Standard in the country concerned.

The 2019-2020 EITI report summarized the main results achieved over the course of those two years. It found that 2019 saw a direct agreement for funding for the Guinea Alumina Corporation (GAC), an agreement on Konta port between the Republic of Guinea and the Indian mining company Ashapura, the start of operations by Ashapura in Forécariah, reallocation of blocks 1 and 2 of the Simandou mining deposit to the Société minière de Boké (SMB), a basic convention with the company Henan Chine, a rail contract with SMB, and, finally, a contract for the construction and operation of the SMB-Winning consortium's alumina refinery. Further, in 2020 the following documents were also signed: a basic convention between the Republic of Guinea and the company Winning Consortium Simandou for exploitation of iron ore from blocks 1 and 2 of the Simandou mine, and a contract between the Guinean state and the Chinese mining company Chalco (Aluminum Corporation of China Limited) for the construction of a factory in the prefecture of Boffa.

The first AU Conference of Ministers Responsible for Natural Resources Development (Addis Ababa, October 2008) resulted in the Africa Mining Vision (AMV) and established the principle of prudent, transparent, and efficient management and development of natural resources, as well as the principle of rapid and sustainable socioeconomic development (African Union 2009). This first common initiative between AU member state governments focused on access to and management of natural resources. It proposed developing industrialization via the mining sector and beginning to process raw materials—Africa's abundant minerals, metals, and other materials.

The AMV did not become a dead letter, because an Action Plan was adopted in 2011, while some countries and Regional Economic Communities (RECs) have since reformed their mining codes. This "new generation" of African mining codes includes not only declarative provisions on these issues but also concrete provisions, particularly relating to conflicts of interest and compliance with the applicable regulations in terms of the environment, health, and artisanal mines. They represent a modest attempt, by Africa and for Africa, to adopt true social and environmental responsibility (SER). The second part of this chapter will consider these recent developments through the lens of taxation.

Box 12. Zambia's clear legislative framework

In terms of legislation, the mining sector is governed by the 2015 **Mines and Minerals Development Act** (MMD Act), as amended in 2016 and 2018. The mining industry is placed under the governance of the **Ministry of Mines and Minerals Development** (MMMD), which is responsible for granting mining licenses, large-scale mining operations, precious stones exploitation, mine-related environmental, health, and security issues, geological analyses, and royalty payment monitoring.

Zambia's mining system is structured around licenses that dictate the main duties and obligations inherent to possession of such a license. The fiscal regime applied to the mining industry is mainly determined by the 2015 MMD Act, the 2016 MMD Regulations, and general law (Income Tax Act, Customs and Excise Act, etc.). The applicable rates are 5% for industrial and energy minerals, as well as base metals, between 5.5% and 10% for copper, 6% for precious metals and precious stones, and 8% for cobalt. Companies are then taxed at 30% on earnings from mining operations and 35% on earnings from mineral processing. There are also a number of other taxes, including VAT and export taxes. In addition, Zambia has implemented a set of tax incentives, in particular the absence of a withholding tax on dividends (typically between 15% and 20% for other types of companies), has authorized deferred payment of royalties under certain conditions (as well as the preparation of accounts in dollars [USD] rather than the national currency [the Zambian kwacha, ZMV]), and has recognized the principles of capital costs deduction for active mines and a capital cost allowance.[24]

According to the mining cadastre, 1,118 new licenses have been granted to 950 entities, bringing the number of active licenses in 2020 to 3,570 (compared to 3,329 in 2019).

24. ZEITI – Zambia Extractive Industries Transparency Initiative (2021), 13th Zambia EITI report.

2. Taxation in the mining sector

The increase in natural resources exports has made a substantial contribution to public finances, providing African countries with the funding they so desperately need to strengthen their human capital and management capacities, and to invest in infrastructure. Among the main raw materials exporters, fiscal dependence on raw materials revenue is in excess of 50%. However, most governments of mineral resource-rich DCs struggle to mobilize the substantial revenue from the extractive sector due to a range of challenges that require appropriate responses if these countries are to achieve their goals and make the most of their resources.

Out of 54 African countries, 20 could be said to be resource-rich according to the IMF's criteria. Collectively, they generate more than 80% of the continent's GDP, a quarter of which stems from the mining sector (Africa Progress Report 2013). According to the EITI, the mining sector is responsible for a large share of government revenue in many African countries. Natural resources exploitation can provide jobs and other outputs, but its main advantage is the creation of government revenue to support development and the well-being of citizens. Generating such revenue requires a well-designed fiscal regime that takes into consideration the nature of extractive resources, the considerable uncertainties inherent in their exploration, and government capacities (NRGI Natural Resource Charter).

Debate about the optimal fiscal policy for African governments to harness a "fair" share of rents has been rekindled following the increase in international raw materials prices over the last 20 years (Laporte and Rota-Graziosi 2015). Mining fiscal regimes must both attract investors and ensure sufficient revenue for states. Such revenue also has an additional economic justification beyond mere income creation.

Taxing mineral resources can be perceived as compensating for the natural capital depleted by mining and the negative externalities it generates. Firstly, and fundamentally, mineral resources are by their very nature finite and non-renewable, in the sense that their extraction permanently depletes a country's stock of resources (natural capital). Mining taxation therefore plays an essential role in compensating for decapitalization. This involves taking a fair share of the revenue earned from mining and using it to ensure the well-being of current generations and to enable future generations to benefit from the economic spin-offs through productive expenditure, sovereign funds, and economic diversification.

A second, underlying reason is that mining operations (both industrial and artisanal) and mineral processing generate different types of negative externalities. Broadly speaking, mining operations cause environmental damage such as forest and soil degradation, heavy metal pollution, cyanide release in natural areas, mercury release from artisanal mines, and atmospheric pollution. This has serious impacts on human health and will be discussed in more detail in Chapter 3.

Similarly, mineral extraction contributes to overloading and/or expanding public services due to settlements in mining locations; artisanal mines create a "gold rush" effect. In both industrial and artisanal mining, towns close to mining sites naturally experience inflation, particularly in terms of land and many other essential products and necessities. It is therefore important to note the related pressure on other limited natural resources such as water sources and disruption to the social tissue. This can have repercussions on well-being within the local community.

Most African states have reformed their mining codes to capture a larger share of the rent generated by mining companies. This trend continues today: Mining royalty rates are rising, rent taxes are reappearing, and states are increasingly taking a stake in the capital of mining companies. In the first part of this section, we will assess the main fiscal regimes in Africa. In the second part, we will examine (actual) effectiveness in revenue collection. The third section will consider the various challenges that remain, and the fourth section will explore potential solutions.

2.1. Africa's current fiscal regimes

A mining fiscal regime encompasses all the instruments and tools that determine how revenue from mining projects is shared between the state and companies. Mineral resources benefit countries, principally via taxes paid by mining companies. However, mining companies and the mining industry as a whole are evolving rapidly, both in time and space, suggesting that new expectations might be generated. Consequently, there is certainly a need for appropriate fiscal regimes that recognize the speed of change and that what worked 10 or 20 years ago will not necessarily work in 20 years' time. In view of these trends, it is essential that fiscal regimes play their part in the debate on how mining should benefit both the host countries and investors in the long term. The key characteristics of a good fiscal regime in the future should include simplicity, dependability, and progressiveness.

This section will first examine the fiscal tools currently being used, followed by recent changes to mining codes, before finally considering the disparity between mining codes and mining contracts.

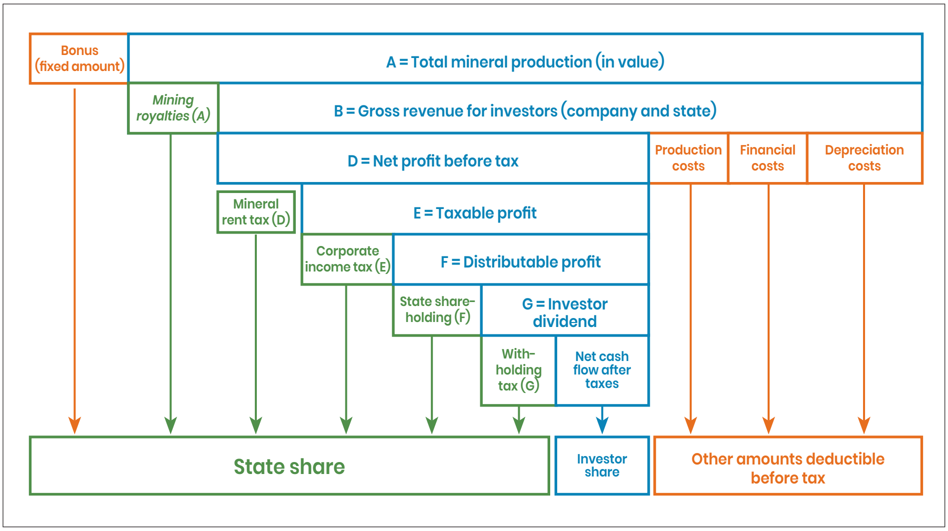
2.1.1. Presentation of fiscal tools

Since the pioneering research by Hotelling (1931) and Brown (1948), an extensive literature on resource taxation has focused on fiscal instruments capable of capturing a portion of the rent specific to the mining industry. A number of fiscal tools can be used to create a fiscal regime for mining projects, particularly royalties, taxes, production sharing, and bonuses. Signing bonuses represent revenue at the beginning of an extraction project, known as "front-end loaded," while taxes based on profits tend to be "back-loaded."

Diagram 1 illustrates typical revenue flows in a tax and royalty system for a production sharing contract between a state and a company. We will consider a simplified cash flow model influenced by a presentation made by the Foundation for Studies and Research on International Development (FERDI) and the Intergovernmental Forum on Mining, Minerals, Metals, and Sustainable Development (IGF) on the FARI model (Fiscal Analysis of Resource Industries)—the most well-known model for sharing mineral rents in African countries, developed by the IMF—which only includes the main variables. The figures provided are illustrative and therefore provide an indication of the tax base and the level of taxation based on a few instruments.

Occasionally, a company may pay a country a "signing bonus" before production begins. As regards the sharing of mineral rents, total production (A) in value is first taxed via a royalty at a rate of 0.5% to 15% depending on the country's mining legislation. The remainder represents gross revenue (B) for investors, from which production costs, financial costs, and depreciation costs are deducted. The resulting figure represents net profit before tax (D), which in some instances is liable for payment of a mineral resource rent tax (MRRT). For example, in Chad, the MRRT tax base is the difference between turnover and operating costs (including royalties) plus an additional 50%. MRRT is only payable when that difference is greater than zero (0). Without prejudice to corporate tax (CT) provisions, MRRT cannot be deducted from corporate tax calculation bases. In Côte d'Ivoire, additional profits taxes are payable by holders of mining licenses: The rate is set at 7% of turnover, minus transport and refining costs. The CT rate ranges from 15% to 35% depending on the country. Further, net profit can be allocated to a company's reserves or be distributed to shareholders in the form of dividends. In the latter case, the state's non-contributory shareholding (amounting to approximately 10% in Africa) is deducted. The remainder constitutes investor remuneration. If a foreign investor wishes to repatriate its gains to the country where it is tax resident, a "withholding" tax is applied to dividends, interest, and other forms of remuneration. The rate varies from country to country depending on the fiscal provisions of its GTC and the tax treaty between the two countries concerned.

Diagram 1. ***Typical revenue flow in a mineral rent sharing cash flow system***

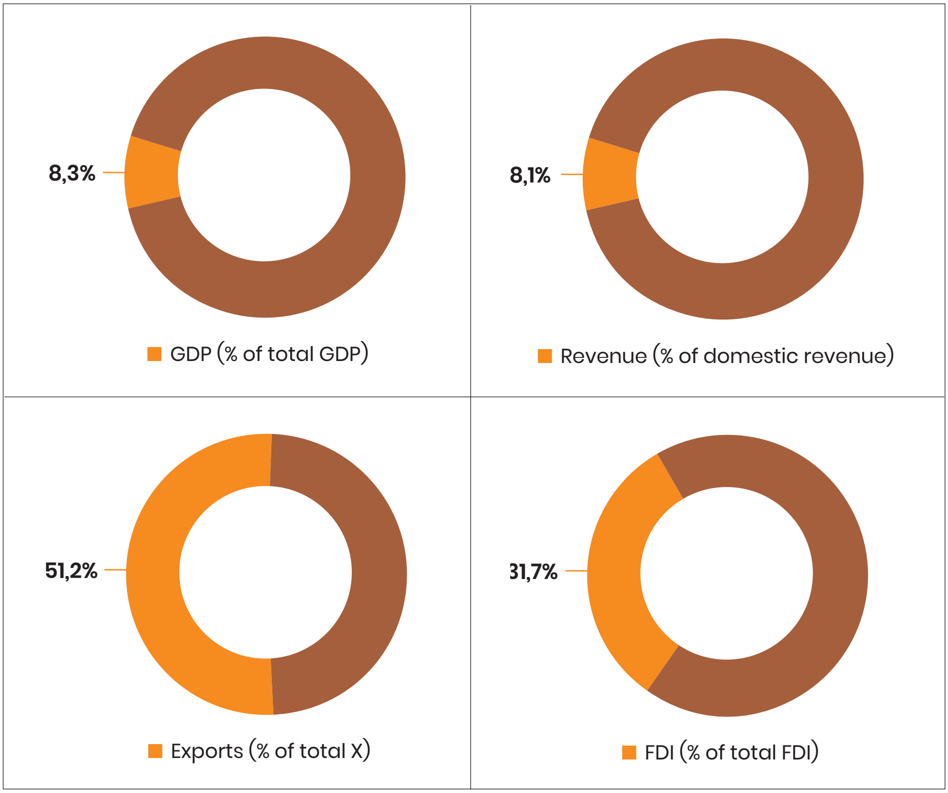


Source: Created by the authors based on an NRGI design

2.1.2. Recent changes to mining codes

Africa's mining boom began at the start of the millennium as a result of an increase in international raw materials prices. Investment in Africa's mining sector by multinationals is growing, and the volume of mineral product exports has surged. The contrast between the scale of mining projects and the inadequacy of tax revenues from mining is an issue that should concern all stakeholders (Graph 32), and this paradox lies at the heart of Africa's latest mining reforms. In the wake of the bull market cycle in the 2000s, new mining codes have been drawn up and/or existing mining contracts revised to rebalance the interests of all parties.

Graph 32. Contrast between mining operations and mining revenue in Africa (2009–2019)



Source: Authors based on IMF, "Countering tax avoidance in sub-Saharan Africa's mining sector" (imf.org).

While the priority for African states in the 2000s was to attract mining investment, often by offering significant tax benefits, today that trend has been reversed. Since the 2010s, most African states have reformed their mining codes in an attempt to capture a larger share of mineral rents (Table 2).

Tunisia was a pioneer in this respect, being the first country to renegotiate its contracts in 2002. Numerous other countries followed its lead, including Guinea, Tanzania, and Mozambique. New mining laws fostering an increase in state revenue have now been adopted by 22 countries, and this fiscal trend continues today.

Table 2. ***Dates of the most recent revision of mining codes by African states***

COUNTRY	YEAR	COUNTRY	YEAR
Tunisia	2003	**Algéria**	2014
Liberia	2005	**Burkina Faso**	2015
Madagascar	2006	**Morocco**	2015
Niger	2022	**Chad**	2016
Mauritania	2008	**Ghana**	2016
Zimbabwe	2010	**Sierra Leone**	2016
Mozambique	2012	**Tanzania**	2016
Afrique du Sud	2012	**Zambie**	2016
Burundi	2013	**RDC**	2018
Guinea	2013	**Côte d'Ivoire**	2019
Senegal	2016	**Mali**	2020

Source: Authors based on FERDI data

This widespread revision of mining regulations by African states has resulted in a fourth generation of African mining codes, caused by "an increased awareness that previous reforms to mining legislation and the conditions relating to their implementation were unable to respond to the development challenges facing many African countries" (Box 13). The "refiscalization" of the mining sector therefore lies at the heart of the new mining laws and contracts (Box 14), which must ensure the implementation of just and fair taxation for all stakeholders.

Box 13. Reform of the DRC's Mining Code

In 2018, the DRC enacted a law to reform the country's Mining Code to **rebalance mining revenue in the state's favor**. The new Mining Code reduced the length of mining licenses from 30 to 25 years, with only one extension possible. **The state's stake** in company capital increased from 5% to 10%, with an additional increase of 5% upon each extension. The 2018 Mining Code also included an **increase in royalties** *(i)* from 0.5% to 1% for iron and ferrous metals, *(ii)* from 2% to 3.5% for non-ferrous metals and base metals, and *(iii)* from 2.5% to 3.5% for precious metals. It also introduced two new elements: **a royalty of 10% for strategic minerals, and a special 50% tax on excess profits**, defined as profits generated when the price of a commodity exceeds the price used in the feasibility study by 25%.

Large overseas companies (CMOC Group Limited, Glencore, AngloGold Ashanti, Barrick) sought to **oppose some of the provisions in the new code**, particularly removal of the "stabilization clause" that provided for maintaining taxes at their initial rate for 10 years.

The **mining sector's contribution has gradually increased** since the new Mining Code was introduced, with the **tax rate increasing from 12% to 15%**. Mining royalties increased from CDF[25] 75 billion (USD 36.6 million) in 2017 to CDF 1,065 billion (USD 519.8 million) in 2021, representing **8% of the Congolese state's total revenue at the end of 2021**. The **special tax on mining operators' excess profits** should increase revenue from the mining sector threefold by 2026. However, CT noncompliance remains high according to the authorities.

According to FERDI's mining taxation database (Bouterige et al. 2019), a number of significant trends are impacting mining tax legislation in African countries:

- on average, the CT rate has fallen over the last three decades. This drop is evident between 1990 and 2010, but since 2010 some countries have begun to raise their rates again;
- mining royalty rates are rising and, moreover, are increasingly variable or progressive in line with the price of raw materials and differentiated by mineral. Most countries divide minerals into a number of different groups;

25. Congolese franc (the DRC's national currency).

- mineral resource rent tax and taxes on additional profits are reappearing. Since 2018 in particular, taxes on additional profits have made a comeback in the DRC, Sierra Leone, and Chad. Of the African countries rich in mineral resources, Zimbabwe was one of only a few to retain its tax on additional profits in its CT legislation in 2017;
- states are increasingly taking a (non-contributory) stake in mining company capital, with a slight increase in rates. State shareholding was traditionally provided for in mining codes free of charge, and generally at 10%. As well as a non-contributory stake in the capital, additional shareholding is often specified as a possibility, but this must take place in accordance with normal shareholder conditions.

Box 14. Improvement in Guinea

Improved revenue generation conditions have led to an increase in the Guinean state's mining revenue. Government revenue from the mining sector amounted to GNF 2,294.1 billion in 2020, representing 13.2% of total government revenue.

All extractive revenue is placed in the **Treasury's** single account. Mining revenue is therefore allocated as part of the overall budgetary process with a few exceptions:

- revenue allocated for the **Mining Investment Fund (MIF)**, amounting to 5% of the taxes paid by the holders of mining titles and funding mining research, training, and promotion of the mining sector;
- revenue collected by local communities via the **surface fee** companies pay directly to mining villages;
- contributions to the **Fonds de développement économique local (FODEL) (Local Economic Development Fund)** for the funding of community projects. This contribution is deducted from company turnover (0.5% for iron and bauxite, 1% for other substances). The FODEL is allocated locally in line with the impact of the mining sector on the villages concerned (35% for communities with operational mines within the area covered by the mining title, calculated on a pro rata basis of the surface area occupied, compared to 20% for communities impacted on the basis of an environmental and social impact study within the area covered by the mining title, calculated on a pro rata basis of the population);

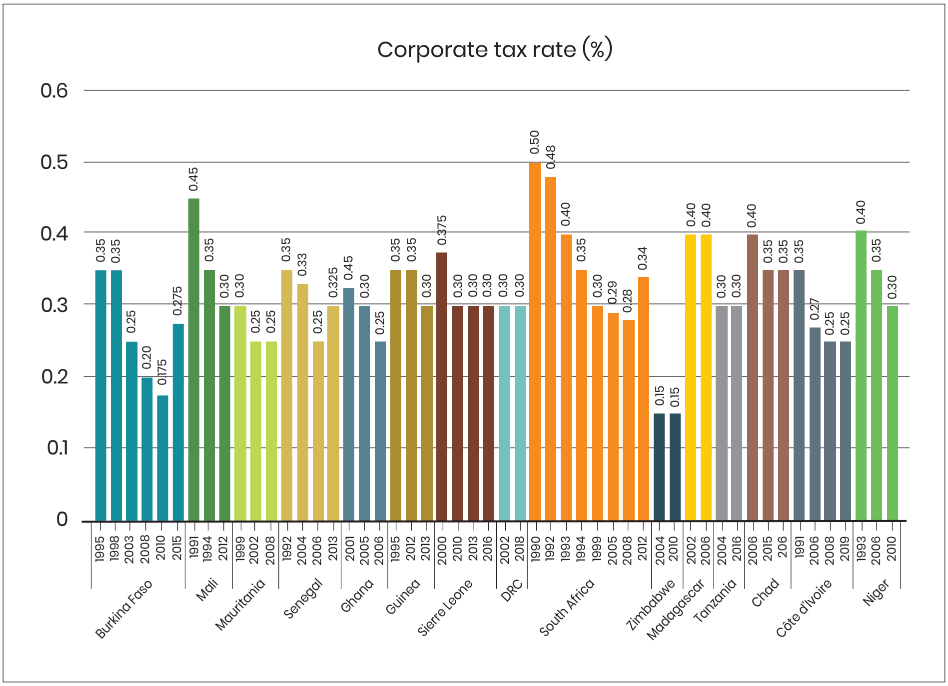
- contributions to the **Fonds national de développement local (FNDL) (National Fund for Local Development)**, whereby 15% of a set of six taxes on mining substances are transferred to villages for local community development. It should be noted that the FNDL became operational in 2019.

Analysis of tax rates on mining companies

Graph 33 illustrates the evolution of CT rates by country according to the year they adopted a new mining fiscal regime. On average, CT rates have fallen over the last three decades. Between 2000 and 2010, the trend was indeed downward; however, since 2010 some countries have increased their rates. Most countries have removed systematic tax exemptions in order to capture a larger share of mineral rents. Taking into account the most recent mining codes currently in force, we can see that mining fiscal regimes in the majority of African countries have set a CT rate of between 25% and 35%. Nigeria's new Mining Code does not specify a CT rate, which means that the normal GTC rate applies (30% currently).

Some African countries include variable tax rates in their legislation. For example, South Africa imposes a tax on profits based on a progressive rate of between 0% and 34% depending on the profitability of the mine. Madagascar uses three rates (25%, 35%, and 40%) that increase in line with the internal rate of return (IRR) of industrial gold mines only. Finally, Zimbabwe proposed a reduced rate of 15% for owners of mining titles in exchange for a tax on additional profits.

Graph 33. ***CT rate based on the year a new mining fiscal regime was adopted***



Source: Authors based on FERDI data

Analysis of mining royalty rates by metal type

Mining royalties are an ad valorem tax on the value of a mineral when it is sold or exported. Mining royalty rates have been rising. Moreover, an increasing number of rates are variable or progressive in line with raw materials prices and are differentiated by mineral in most countries, where minerals are divided into various groups.

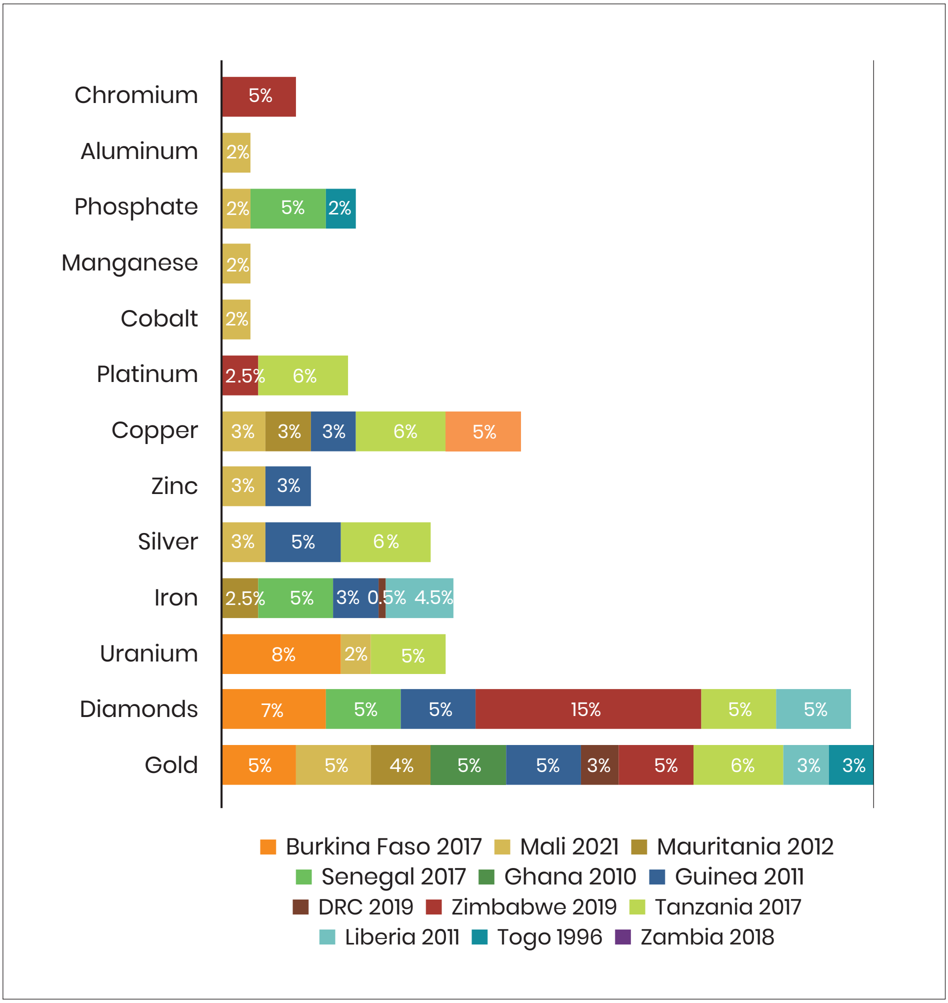
In many mining countries, variable royalties represent a potential improvement compared to inflexible fixed-rate royalties. Variable royalties could be a key fiscal instrument for countries that already depend on royalties for the collection of mining revenue. They provide more flexible revenue than fixed-rate royalties and are easier to implement than taxes based on profits or cash flow. More complex variants of variable royalties even use operating profits as the tax base, rather than gross revenue, and therefore have more in common with a corporate income tax than ad valorem royalties. Compared to a fixed-rate royalty, variable royalties are more suitable for volatile mineral and metal prices: They generate more revenue when prices are high and less revenue when prices are low. However, variable royalties do require consideration of the economic aspects of mining during the design phase. A number of the variable royalty regimes studied were poorly calibrated in relation to the price cycle of the metals market or gave too little attention to changes in costs.[26]

Graph 34 presents ad valorem mining royalty rates by country and by type (or category) of metal. Most countries have opted for a fixed royalty rate for gold: 5% for Ghana, Guinea, and Sierra Leone; and 6% for Tanzania. South Africa applies a progressive rate in line with the operating profits of the mining project, ranging from 0.5% to 5% for unrefined mineral resources and 0.5% to 7% for refined minerals. In the DRC, the 2018 Mining Code provided for rates on minerals to be increased from 2.5% to 3.5% for gold and up to 10% for strategic minerals such as cobalt.

In Zimbabwe, mining royalty rates correspond to a percentage of the gross market value of the minerals produced and sold, as follows: diamonds (15%), platinum (10%), other precious stones (10%), gold (5%), precious metals (3.5%), base metals (2%), industrial minerals (2%), methane gas from coal deposits (2%), and coal (1%). In 2011, Burkina Faso adopted a variable mining royalty rate in line with the price of gold (ranging from 3% to 6%), as did Mauritania in 2012 (between 4% and 6.5%), Senegal (between 5% and 7% surtax), and Mali (between 3% and 8%).

26 For more details, see the policy paper "Variable royalties: An answer to volatile mineral prices," written by Anna Fleming and David Manley (NRGI), and Thomas Lassourd (IGF), with input from National Treasury, South Africa and support from IGF and ATAF (https:// www.igfmining.org/wp-content/uploads/2022/11/variable-royalties-an-answer-to-volatile-mineral-prices.pdf).

Graph 34. ***Ad valorem mining royalty rates by country and type (or category) of metal***



Source : auteurs sur la base de la FERDI.

Tax benefits have therefore been reduced and tax rates increased. However, discrepancies between legislative provisions and contractual arrangements are possible, as mining contracts can include special tax provisions.

Encadré 15. Burundi's tax problem

Burundi's mining sector is governed by the **2013 Mining Code**, as amended in 2016, and the **2015 Mining Regulations**. The Mining Code regulates both small- and large-scale operations, although the overwhelming majority of its mining production (and all of its gold and 3Ts [tungsten, tin, and tantalum] production) is artisanal or small-scale.

Burundi's mining royalty rates are set out in its 2015 Mining Regulations. The rates for ASM are 3% for base metals, 2% for precious metals and precious stones, and 1.5% for other substances, including gold and the 3Ts. Royalties must be paid to the Office burundais des recettes (OBR) export office. However, in 2019 it was decided that all gold exports should be processed by the country's central bank, the Banque de la République du Burundi (BRB). There is thus uncertainty surrounding the collection of mining royalties.

Other costs are also applicable: *(i)* license fees (USD 600 per hectare for a two-year period that can be extended), *(ii)* surface fees (USD 5,000 for gold, USD 1,500 for coltan, and USD 1,000 for cassiterite and wolframite), *(iii)* license fees for trading houses, and two taxes not included in the Mining Code, namely *(iv)* an export tax (0.2% for gold, 1% for cassiterite and wolframite, and 2% for coltan) and *(v)* a currency repatriation tax of 1% of the value of each transfer. Further, production of gold and the 3Ts is subject to a **fixed local ta**x payable to the local authorities where the mining occurs of BIF [27] 500 per month (USD 0.25) for coltan, BIF 200 (USD 0.10) per month for cassiterite and wolframite, and BIF 200,000 (USD 100) per year for mining cooperatives. Actors in the mineral supply chain are also subject to an **environmental tax** paid annually by trading houses (BIF 2 million, or USD 1,019), mining cooperatives (BIF 1 million, or USD 509), and transporters of mineral products (BIF 0.5 million, or USD 255) to the Office burundais pour la protection de l'environnement (OBPE).[28]

We have been unable to access the details of Burundi's mining revenue. In this respect, Burundi lacks **transparency** (in 2021, Burundi was 169th out of 180 countries/ territories on Transparency International's Corruption Perceptions Index [CPI]). Broadly speaking, tax compliance is poor in Burundi, and it is likely that this holds true to an even greater extent in the informal ASM sector.

27. Burundian franc (national currency).
28. Lyster O. & A. Smith-Roberts (2021). *Madini Project: Comparative analysis of the fiscal regimes & implications for mineral trade of ASM 3TGs in Rwanda, Uganda, Burundi and the DRC*, Levin Sources Limited.

One of the most significant elements of Burundi's mining fiscal regime is its system of **high fixed costs**, particularly in terms of gold mining. Given that gold and the 3Ts are produced entirely by small operators, these costs seem exorbitant—particularly as Burundi has the world's lowest GDP per capita—and do not encourage **formalization of the economy**. The unclear legal status of the export and currency repatriation taxes further reinforces actors' disinclination. Finally (although this is not strictly speaking a tax issue), Burundi's **2019 ban on gold exports by private entities** has certainly played a role in encouraging or discouraging formalization of the gold trade. The existing gold trade might be pushed underground, and trafficking networks could take gold out of Burundi, either straight to international gold trading centers (the United Arab Emirates, for example, which is in the process of becoming one of the world's leading gold trading hubs) or across the country's borders into neighboring Rwanda and Uganda. In the long term, this situation will not have a positive impact on Burundi's government revenue and will only sap more confidence and stability from this sector.[29]

2.1.3. Disparities between mining codes and mining contracts

It is important to analyze the extent of both compliance and disparity between the specific codes governing taxation and the framework agreements concluded between African states and mining companies.[30] Technically, mining agreements are a special legal tool providing investors with a clear and precise legal framework adapted to the specificities of a particular mining project. They include guarantees (such as stabilization clauses) and provide the necessary facilities for mobilizing financial resources with a view to conducting mining operations.

However, they are also frequently used as an opportunity to revise the fiscal regime that will be applied to the company and can therefore reduce tax revenue. Mining taxation therefore appears to be a form of "contractual taxation" or taxation negotiated between public authorities and mining companies. The fact that the public authorities offer investors (particularly in the mining sector) a more favorable fiscal and

29. *Ibid.*
30 These contracts are known variously as framework agreements, mining agreements, basic conventions, and mining concessions. They are generally ratified by the national assembly/parliament of the country concerned and therefore possess the force of law.

customs regime than is available under ordinary law has long been presented as an essential element of a country's attractiveness. However, a contradiction often exists between this type of contractual tax exemption and the increased mining revenue targeted by reforms to mining codes over the last 20 years.

In addition to the primacy of agreements over mining codes, the principles of independence and exclusivity in contractual taxation also serve to give such agreements a powerful normative value. Some agreements are substantially (even completely) separate from national legislative frameworks. One such example is the revised and consolidated basic convention between the Republic of Guinea and Chevaning Mining Company Limited and AngloGold Ashanti de Guinée SA, signed on June 28, 2016. This amended contract retained several of the advantages granted through mining reforms enacted prior to the new 2011 Mining Code; it expressly provides for a stand-alone fiscal and customs regime. And yet, the 2011 Mining Code is supplemented by a set of decrees that include the decree of 2014 on adoption of a "standard" mining contract, which was not used in the agreement of June 2016.

This conflict between mining codes and the provisions of particular agreements manifests itself in a number of ways: contractual abandonment of fiscal tools provided for in positive mining law; manipulation of certain tax bases; lower tax rates; and changes to collection deadlines for taxes, duties, and mining royalties. All these mechanisms reduce the effective tax burden faced by mining companies.

Diallo and Laporte (2022) analyzed the extent of compliance and disparity between codes governing gold taxation and agreements in Burkina Faso (5 companies), Mali (9 companies), Guinea (3 companies), Ghana (7 companies), and Sierra Leone (1 company). Such disparities are mainly to be found in Sahelian countries (Table 3).

Table 3. ***Disparity between mining codes and mining agreements in five African countries***

	BURKINA FASO	MALI	GUINEA	GHANA	SIERRA LEONE
Abandonment of fiscal tools	x	x	x		
Tax base manipulation					
Lowering of tax rate			x		
Changes in collection deadlines		x	x		

Source: Authors based on Diallo and Laporte (2022)

Disparities therefore persist between legislative prescriptions (mining codes) and contractual arrangements (mining contracts). However, the new legal frameworks show a clear trend toward the harmonization of mining codes and mining agreements (Diallo and Laporte 2022). With the previously accepted virtues of tax benefits now being challenged, the most recent reforms to the general investment framework (particularly mining investment) are moving in the direction of regulating contractual derogations via legislative provisions. Mining legislation produced as a result of the most recent mining reforms in Burkina Faso, Mali, Guinea, Ghana, and Sierra Leone therefore includes a number of legal tools to ensure that contracts comply with mining laws.

One area of progress shared by all the most recent reforms to mining taxation in Africa is the principle that mining companies are subject to the ordinary law fiscal regime. Indeed, one of the consequences of the exclusivity and independence of some mining agreements was the fact that those contracts became removed from the legal and fiscal framework of ordinary law. They were only concerned with the taxes, duties, and mining royalties expressly provided for in the mining contracts. Previous mining codes took a restrictive approach to the fiscal tools applicable to mining projects. The new approach makes the mining sector bound by the ordinary law fiscal regime.

However, mining contracts that have already been signed are still usually governed by a stabilization clause that guarantees maintenance of the fiscal regime in force when the mining license was granted or upon signature of the mining agreement. A revised mining code can therefore only be applied to new mining projects. Those in the operational phase continue on the basis of the mining contracts signed with the state. However, countries do sometimes renegotiate their mining agreements to bring them into line with the new mining code in force. For example, the process for reforming mining legislation began in 2006 in Niger with the reform of the Mining Law, and Guinea revised its mining code in 2011. The renegotiation of mining contracts requires upstream consideration of the feasibility of integrating economic, social, and environmental sustainability criteria consistent with the fourth-generation mining legislation launched in Africa at the beginning of the 2000s.[31]

2.2. Effectiveness in revenue collection

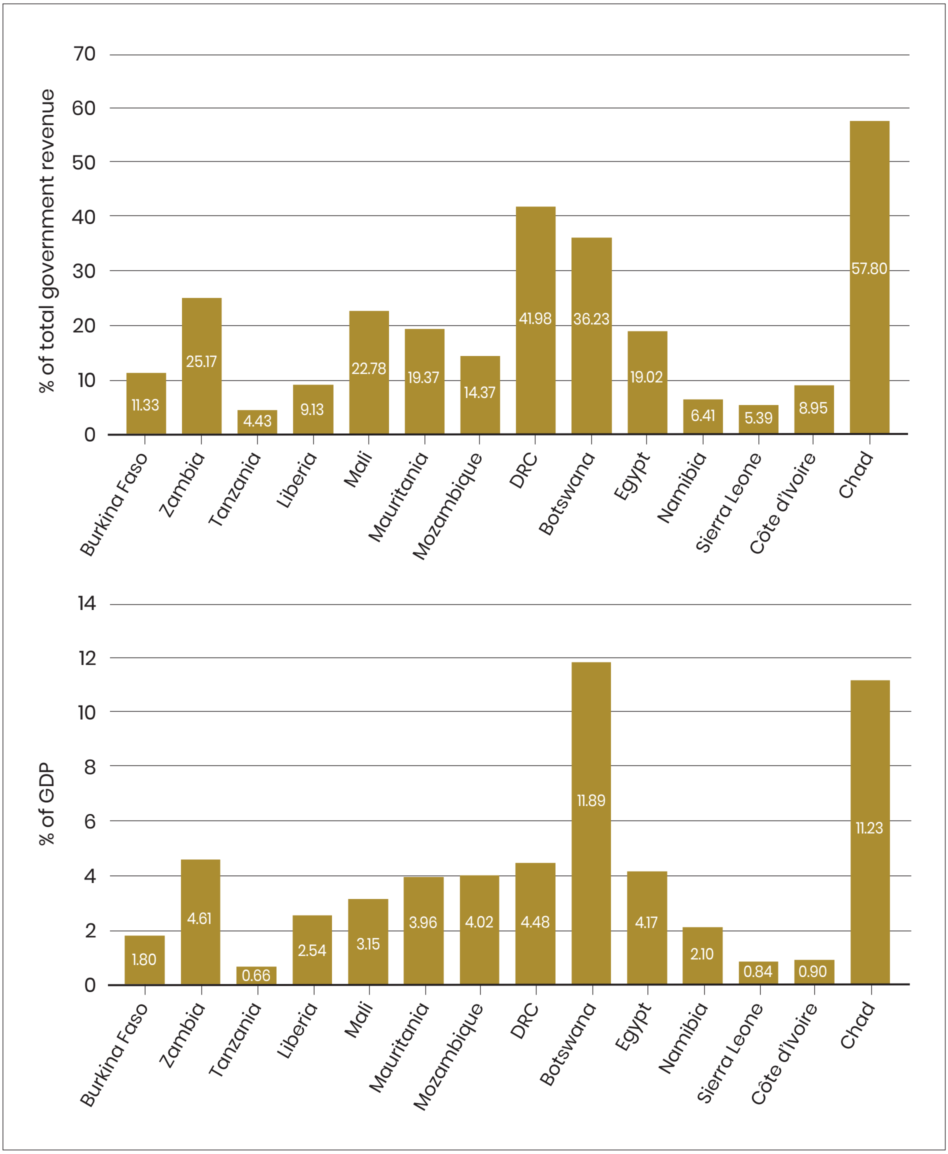
This section will analyze the mining sector's contribution to GDP and total government revenue. Much of the data on the mining tax revenue of 14 African countries is taken from the EITI website. Data on total government revenue, current GDP, and official exchange rates (LCU[32] compared to USD, average of the period) comes from the IMF. Finally, this section will present an analysis of the effectiveness (average effective tax rate or AETR) of the gold fiscal regime in 10 African countries.

2.2.1. Contribution to economies

According to our calculations (Graph 34), between 2010 and 2019, government revenue from extractive resources represented approximately 4% of GDP and 20% of total government revenue on average in the 14 African countries concerned. The amount of government revenue collected from extractive companies is substantial in many African countries, as some of them are highly dependent on this revenue (Graph 35). Such dependence is particularly noticeable in some countries: Revenue from extractive resources averaged 42% of total government revenue in the DRC, 36% in Botswana, and 58% in Chad between 2010 and 2019. The share of government revenue from extractive resources (or the share of mineral rents paid to the government) in GDP also varies depending on the country. The share of government revenue from extractive resources in GDP amounted to approximately 11% for Chad and 12% for Botswana.

31. Lado H., C. Vadot & I. Amani (2017), "La renégociation des contrats miniers en Afrique – Cas du Niger et de la Guinée" (https://ucac-icy.net/demo/wp-content/uploads/2017/11/Etude-Lado-La-Ren%C3%A9gociation-des-contrats-miniers-en-Afrique-cas-Niger-et-Guin%C3%A9e-vF-min.pdf).
32. Local currency unit.

Graph 35. ***Average contribution of government revenue from extractive resources 2010–2019***

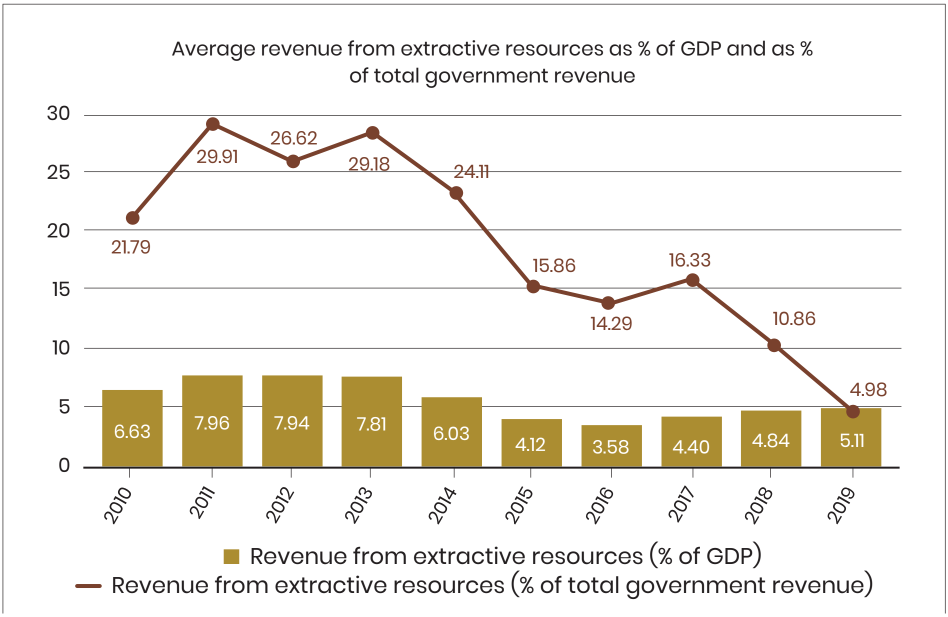


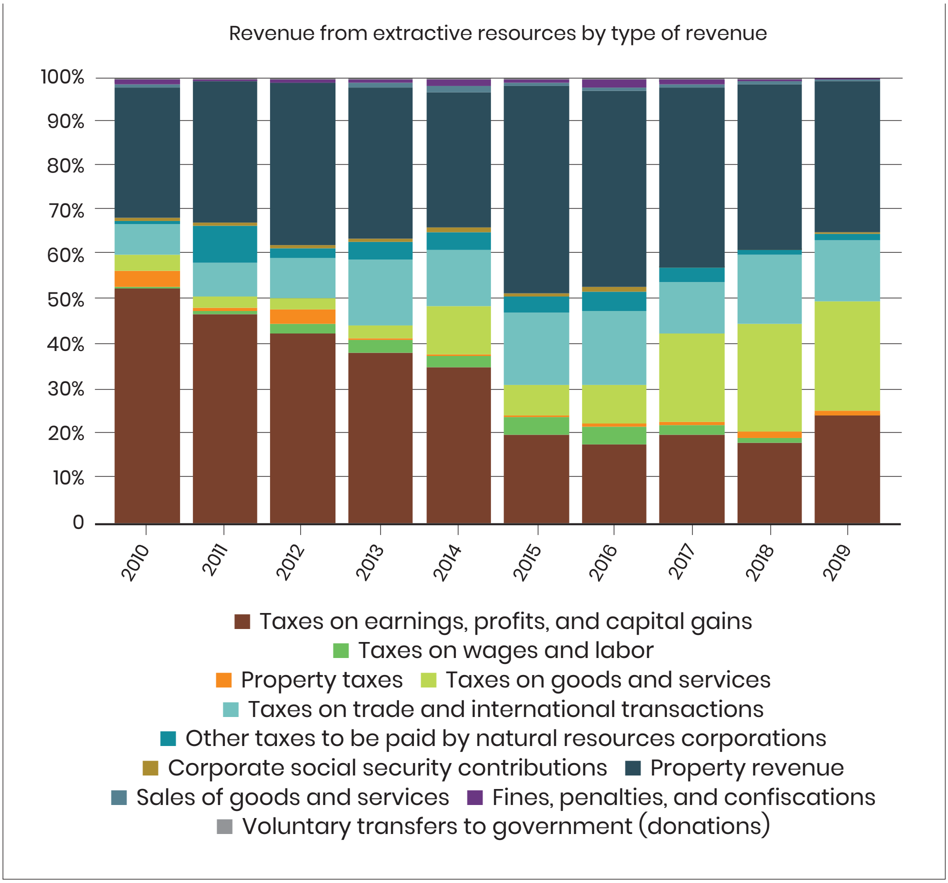
Source: Authors based on EITI data

We have analyzed how government revenue from extractive resources as a percentage of GDP and as a percentage of total government revenue has changed, as well as how government revenue by type of revenue has changed (graphs 36a and 36b). On average, government revenue from extractive resources has fallen in the 14 African countries studied during the period in question, both as a percentage of GDP and as a percentage of total government revenue. This can be partly explained by the fall in prices since 2012. However, it is also a result of the trend to reduce CT rates. Interestingly, the share of property revenue (dividends and rents), taxes on goods and services, and taxes on trade and international transactions appears to have increased to compensate for a decline in income taxes, which fell from approximately 52% in 2010 to less than 25% in 2019.

The share of cumulative revenue from *(i)* property revenue, *(ii)* taxes on goods and services, and *(iii)* taxes on trade and international transactions amounted to more than 75% in 2019, compared to approximately 42% in 2010. The most obvious increase involves duties and taxes on goods and services (VAT, sales tax, tax on turnover and excise duties), which are collected more efficiently than taxes on trade and international transactions or taxes on wages and labor.

Graph 36a and 36b. ***Changes to the contribution of revenue from extractive resources by type of revenue***

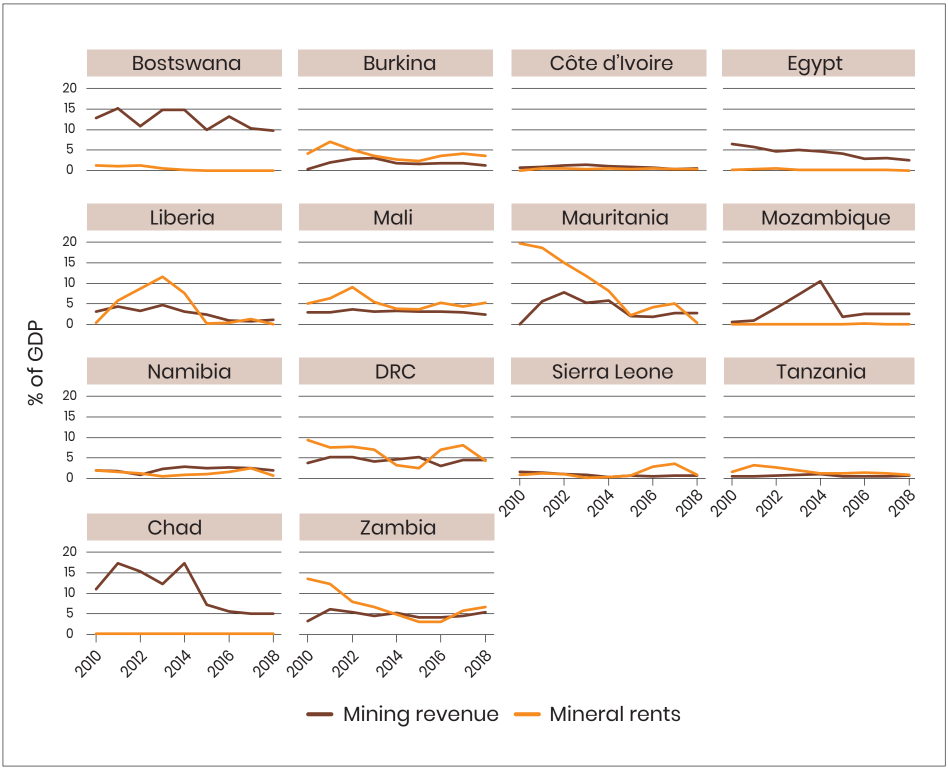




Source: Authors based on EITI and IMF data

Graph 37 provides a detailed but concise presentation of changes by country. There is a clear fall in the share of government revenue from the extractive industries in GDP for a group of six countries in our sample (Botswana, Egypt, Liberia, Mauritania, Mozambique, and Chad). However, there was no such sharp decline in the other countries, even though mineral product prices began to fall in 2012. This suggests that mining revenue was collected more efficiently within those countries, partly due to their revised mining codes and partly because their economies are so dependent on the mining sector that GDP fell as government revenue from extractive resources declined.

Graph 37. ***Changes to the contribution of government revenue from extractive resources by country***



Source: Authors based on FERDI data

2.2.2. Comparative analysis of fiscal regimes: The case of the AETR for gold

However, it is difficult to compare fiscal regimes purely on the basis of the different tax rates implemented for a range of mining projects in a range of countries. Tax revenue is dependent on the amount of investment and profit, and major disparities between the various fiscal instruments used by countries initially appear to make comparisons extremely difficult. A summary indicator for mineral rent sharing throughout the lifecycle of a mining project therefore needs to be calculated. Fiscal tools are described as neutral, progressive, or regressive depending on their impact on the state's share of profits when the profit margin or the profitability of the mining project rises:

- neutral: the state retains the same share of profits as profitability increases or decreases;
- progressive: the state's share of profits increases as the profitability of the mining project increases;
- regressive: the state's share of profits falls as the profitability of the mining project increases.

The best option will depend on what a particular state wishes to achieve. Regressive fiscal tools such as mining royalties are often based on simple tax bases such as turnover. They can prompt governments with poor audit capacities to increase collection. However, they can also discourage investment, particularly for projects with a low profit margin, because they require companies to transfer income to the state even when extraction costs are greater than profits. Progressive tax tools, such as mineral resource rent taxes, protect corporate interests during periods of low profitability and give governments the option of receiving a significant share of exceptional profits when profits are high. However, this approach is often more difficult to apply efficiently because it requires an ability to verify costs and calculate profits.

A number of institutions have developed mineral rent sharing models that determine an average (sometimes marginal) effective tax rate (AETR). This approach, based on the valuation techniques used in corporate finance, consists of assessing the gross and net cash flows associated with a mine's operations throughout its lifecycle and applying the various taxes, duties, and other compulsory payments. This generates a single indicator representing a country's entire fiscal regime and its impact on a mine's lifecycle, which can sometimes exceed 30 years. This approach is valuable for international comparisons and fiscal policy reform simulations. The IMF has developed the FARI model. The FERDI foundation also proposes a model for the sharing of gold mine rents covering a sufficiently long time period to assess the evolution of mining legislation in Africa. Other organizations have used this model with a varying degree of specificity depending on their objectives: the NRGI Fiscal Regime Design (NRGI 2016), the IGF financial model (IISD—International Institute for Sustainable Development 2008), and the Benchmarking Gold Mining Fiscal Regimes (CCSI—Columbia Center on Sustainable Investment 2021).[33]

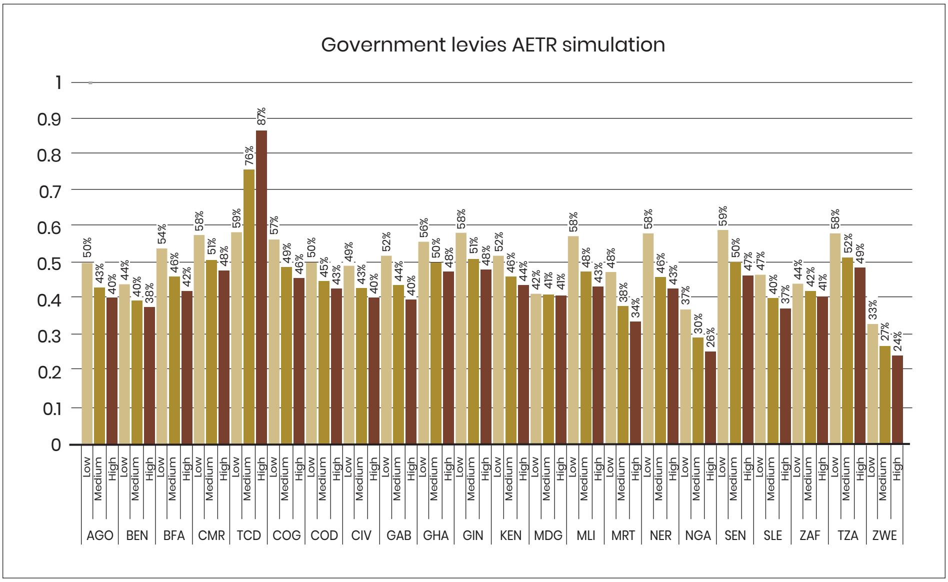
33. CCSI (2021), "Benchmarking model: Comparing fiscal regimes across gold producing jurisdictions."

The average effective tax rate (AETR) represents the share of mineral rents received by the state throughout the lifecycle of a mining project. This indicator provides a summary of a mining corporation's tax burden by applying each country's mining fiscal legislation to a representative mine in order to compare the fiscal regimes of the various countries.

FERDI's calculation of the AETR includes fixed duties, surface fees, mining royalties, CT, the minimum tax rate, withholding taxes on interests and dividends, and dividends paid to the state (via a free shareholding). The sharing of mineral rents does not only depend on the fiscal regime; it also depends on the profitability of the mining project, and this in turn depends on a number of criteria such as the quantity produced, the grade of the deposit, the price of raw materials, and production costs.

In 2019, the results gave AETRs ranging from 33% to 59% for a low-grade mine, 27% to 76% for a medium-grade mine, and 24% to 87% for a high-grade mine (Graph 38). An AETR above 100% would mean that the tax burden was excessive and that investors would lose income by exploiting the mine. According to convention, if AETRs do not exceed 59% for a given mine, the regime is viable. Hence, in all countries (with the exception of Chad—TCD), low-grade, open-pit mine projects (1.8 g/t), medium-grade open-pit mine projects (3 g/t), and high-grade open-pit mine projects (4 g/t), as well as underground mine projects (5.5 g/t), are economically profitable.

Graph 38. ***Average effective tax rates (AETRs) by country and by type of mine in 2019***



Note: AETR for metal
(gold: for a discount rate of 10% and a gold price of 1,100 USD/oz).
Source: Authors based on FERDI data

African countries have therefore sought to revise their mining codes and harmonize contracts and codes, while still opting for a fairly efficient system so as not to damage the profitability of mining projects. However, there are other elements of taxation that pose serious challenges which must be overcome if remuneration is to keep pace with mineral rents.

2.3. The challenges surrounding mining taxation

Revenue from Africa's mining sector remains below its potential. The Africa Progress Panel report (2013) drew the international community's attention to this paradox which has proven so costly in terms of mobilizing domestic resources within Africa. Moore and Lundstøl (2016) have contrasted how turnover within the sector multiplied by 4.6 during the last mining boom (from 2000 to 2010), while tax revenue only increased by a factor of 1.15. The numerous challenges facing African countries in terms of maximizing their mining revenue can be divided into three main categories: *(i)* structural and governance challenges, *(ii)* fiscal policy challenges, and *(iii)* challenges related to the administration and implementation of fiscal regimes.

2.3.1. Structural and governance challenges

Mining taxation in Africa is part of a complicated global, regional, and national economic and political context that is the root cause of many structural problems and poor governance.

First, the mining sector faces a paradox. While the investment required to develop viable extractive projects requires stable economic parameters, **mineral prices are highly volatile**. They are largely determined in the short term by the global balance between supply and demand. Increases or decreases in mineral prices in turn impact the share prices of publicly traded mining multinationals, the cost of labor, energy, and other industrial inputs, as well as the level of investment. The sector therefore tends to overinvest when mineral prices are high and underinvest when they are low, leading to chronic underinvestment (seen today in the demand for energy transition minerals), which in turn triggers a repetition of the cycle of raw material prices. This paradox is found in states that are often keen to offer numerous licenses and tax exemptions when prices are low and investment is rare, but then increase their requirements when prices rise—to the extent that investors accuse them of having a "resource nationalism" policy (White and Case 2021) and some investment opportunities are lost.

Second, **the mining sector itself is complex**, and there is often significant information asymmetry between states and mining operators. Mining multinationals have access to the most "cutting-edge" information in geology, mining engineering, law, and economics. During the development phase of mining projects, multinationals often have a much more advanced understanding of the projects themselves and the international market in which they operate. This complicates the task of the host authorities responsible for negotiating the fiscal terms and other economic provisions of mining contracts, as well as their supervision and implementation. This asymmetry is even greater within civil society and among the local communities of mining sites, limiting their participation and their oversight role.

Third, African states have to be aware of the effects of regional and international tax competition leading to downward pressure on duties and taxes. Such tax competition, which is often more perceived than real, is encouraged by investors in their negotiation strategies. However, since 2020 this trend has been reversed thanks to the agreement of an inclusive BEPS[34] framework for a global minimum tax rate, requiring multinationals to pay an effective tax rate of at least 15% in every country in which they operate.[35] Over and beyond tax competition per se, states often also feel under pressure to harmonize their fiscal instruments and to comply with industry best practice, despite this sometimes being in conflict with national legal frameworks or attempts to reform the sector (Campbell 2009).

Fourth, **the political economy often complicates management of the sector** at the national level. The state of relations between mining industry actors (companies and subcontractors) and political leaders can determine whether or not there is political will to maximize revenue from the sector and support the tax and mining authorities with revenue collection. For example, DRC's reform of its Mining Code in 2017/2018 fell victim to politicization of the sector and the economic interests of the political party in power.[36] Further research on the role of political economy in the mobilization of domestic mineral resources is ongoing.[37]

2.3.2. Fiscal policy challenges

Fiscal policy is a key tool for enabling producer countries to maximize their revenue. The principles of good fiscal policy have been extensively debated internationally, and a general consensus has been reached. According to the Natural Resource Charter, the aim of an extractive industries fiscal regime is as follows: "Tax regimes and contractual terms should enable the government to realize the full value of its resources consistent with attracting necessary investment, and should be robust to changing circumstances."[38] However, it can be difficult to put such fiscal policy principles into

34. The Base Erosion and Profit Shifting (BEPS) measures are a set of recommendations proposed by the OECD within the framework of the OECD/G20 project working toward a coordinated international approach to combating tax noncompliance by multinational companies seeking to exploit weaknesses and differences in fiscal rules by transferring profits to countries or territories where a company's operations are minimal (a tax optimization strategy). The inclusive BEPS framework involves 140 countries and jurisdictions working in collaboration to implement the recommended BEPS measures and thus combat BEPS.
35. https://www.oecd.org/fr/topics/policy-issues/base-erosion-and-profit-shifting-beps.html
36. https://resourcegovernance.org/articles/democratic-republic-congos-new-mining-fiscal-regime-task
37. https://resourcenationalism.ca/research/fiscal-linkages-and-mineral-taxation/
38. https://resourcegovernance.org/publications/natural-resource-charter-2nd-ed

practice. The main challenges concern the quality of the fiscal regime, the systematic use of tax incentives, negotiation of mining contracts, and updating of provisions to combat tax noncompliance.

First, many countries do not choose a **fiscal regime that reflects their geological attractiveness**, their mining policy goals, or their monitoring and implementation capability. For example, a country that does not have a mining tradition, has little available geological information, and which is seeking to develop an industrial mining sector should choose a simple fiscal regime, aligned with ordinary law and without excessive state intervention. Conversely, a country with abundant mineral deposits, a long tradition of mining legislation, and partnerships with foreign investors is in a position to develop a more complex fiscal regime that maximizes its revenue. Contradictory mining policy goals can also make fiscal regimes complex and ambiguous. For example, some require free carried interest (FCI) in the capital of major mining companies to increase the state's presence in the sector, while also imposing high royalty rates to maximize short-term financial profits. These instruments can be compatible but can also penalize investment or prove impossible to implement if they are used excessively.

Second, the use of tax incentives by African countries is too systematic. They are sometimes offered following difficulties encountered with their fiscal regimes, as discussed above.[39] For example, a country using a fiscal regime that is overly reliant on mining royalties and free carried interest may also offer significant tax exemptions. This results in a fiscal regime that is increasingly difficult for both investors and states to understand. Tax incentives granted within the mining sector are typically unnecessary or overly generous, as they are rarely a determining factor in terms of investment.[40] Mining operators tend to set up in countries with good geological potential and relatively stable operating conditions. Beyond a minimum threshold of financial profitability, the level of taxation is not a determining factor. However, investors will never turn down the tax exemptions available to them and will be the first to demand them if this is standard practice in the country or region. Meeting these demands can be difficult if state officials are insufficiently prepared or acting at the mercy of political interventions.

39. The IGF Mining Tax Incentives Database indicates that tax incentives are offered more fre-quently in Africa than on other continents: https://www.igfmining.org/fr/resource/igf-mining-tax-incentives-database/

40. https://www.igfmining.org/fr/financial-benefits/global-mining-tax-initiative/tax-incentives/

Third, as discussed earlier, **the negotiation of ad hoc mining contracts** represents a risk in terms of defining a fiscal regime. This type of negotiation is practiced more in Africa than elsewhere[41] and often leads to the creation of specific fiscal regimes for each mining project. This tends to reinforce the negotiating power of mining investors, which can propose all kinds of provisions enabling them to reduce their effective tax rate, such as the introduction of tax incentives or a parallel VAT system. IMF analysis indicates that of the 15 resource-intensive countries in sub-Saharan Africa, 9 offered a reduced corporate income tax rate in at least one mining contract.[42] The stabilization clauses often negotiated in these fiscal agreements further complicate the situation by freezing the fiscal (and sometimes non-fiscal) provisions of mining contracts valid for 10, 20, or 30 years—or even longer.

Fourth, the legal and regulatory framework of the African mining sector is not always up to date with the most recent attempts to **combat tax noncompliance**. The international community has made some progress in this area, in particular the OECD's BEPS project (e.g., combating excessive interest deductions and treaty shopping[43]), standards on transfer pricing, information sharing, capital gains tax on indirect mining title transfers, and other good practices highlighted by the Platform for Collaboration on Tax,[44] a joint initiative of the IMF, the World Bank, the OECD, and the United Nations (UN). At the regional level, the African Tax Administration Forum (ATAF) also proposes common approaches to be adopted by African countries.[45] When these advances are not reflected in African legislation, mining companies can maintain the unfair tax arrangements they have been forced to abandon for their operations in other jurisdictions.

2.3.3. Challenges related to the administration and implementation of fiscal regimes

Problems relating to governance or fiscal policy within the mining sector are often encountered at the level of the implementation of fiscal regimes. Faced with the sophisticated tax planning strategies of multinational mining companies, Africa's tax and mining authorities are often underequipped

41. See the mining contracts published on www.resourcecontracts.org
42 https://www.imf.org/en/Blogs/Articles/2021/11/05/blog-countering-tax-avoidance-sub-saharan-africa-mining-sector
43. The systematic search for international tax agreements that offer the best possibilities for reducing the overall tax burden.
44. https://www.tax-platform.org/publications
45. https://www.ataftax.org/

in terms of staff, equipment, and budgetary resources. They do not coordinate either their approaches or their sources of information.

The **mining revenue** collected by states is often below that **predicted in the financial models used ex ante**. One of the main explanations is **aggressive tax optimization** by multinational companies, enabling them to reduce the profits they declare in countries with a high tax rate and transfer them to countries with preferential tax rates. A number of studies have shown the relationship between tax rates and the level of profit of mining companies.[46] In particular, Beer and Devlin (2021) demonstrated that a 1% increase in the corporate tax rate leads to a 3.5% reduction in the tax base for that tax. Among the techniques used to erode the tax base and transfer profits, those most frequently used in the mining sector are abuse of transfer pricing rules, overvaluation of capital costs, over-indebtedness with affiliated companies, treaty shopping, and indirect transfers of mining titles (Albertin et al. 2021).[47]

In Africa, poor implementation and monitoring of laws in general, and tax laws in particular, further encourage aggressive tax planning among mining multinationals. The Resource Governance Index (RGI) published by the NRGI indicates that there is a substantial difference between what is stipulated in law and what actually occurs in practice with regard to natural resources governance.[48] This state of affairs is not surprising: African administrations are often underequipped in terms of staff, equipment, and budgetary resources, particularly in mining regions that are often located in remote areas.

In terms of the **tax authorities, the main challenge is understanding the mining sector value chain and the extent of integration of mining multinationals**. To identify any risks surrounding transfer pricing manipulation and to perform tax audits successfully, a detailed understanding of the assets, risks, and functions specific to each multinational subsidiary, as well as the risks specific to each phase of the value chain, is essential.[49] Many tax authorities in Africa do not have specific teams for the mining and extractive sectors and do not

46. https://www.sciencedirect.com/science/article/abs/pii/S0301420722002720
47. https://www.igfmining.org/beps/current-topics/
48 https://resourcegovernance.org/publications/resource-governance-index-legal-reform-implementation-sub-saharan-africa
49. https://documents.banquemondiale.org/en/publication/documents-reports/documentdetail/469501517336564583/transfer-pricing-in-mining-with-a-focus-on-africa-a-reference-guide-for-practitioners

have the necessary skills or tools to carry out complex audits of transfer prices.[50]

Other problems persist in terms of administration. In particular, Calder (2014) refers to the following: diverse and complex fiscal regimes, mining sector royalties and taxes, weak procedures, poor IT and information management systems, lack of fiscal centralization within the sector, an inability to manage late payment risks, and poor management of tax rebates. In many cases, the situation is made worse by the cumbersome nature of paper systems that put additional pressure on limited administrative resources.

Further, there is very little **taxation of artisanal mines because of the sector's lack of a proper structure**. Artisanal miners generally need the consent of landowners to access land and use it for mining purposes. However, large illegal artisanal mining operations persist. In some cases, miners operate without a license but with the consent of the customary authorities and/or the legal or effective landowners. Industrial operations are very capital-intensive and highly mechanized. They are located in rural areas in the midst of fertile agricultural land and have little interaction with local economies: They hire few local workers and purchase few local products, their profits are not distributed to local residents, and only a small fraction of tax revenue is allocated to local authorities (Aryeetey et al. 2007).

2.4. Solutions

The challenges surrounding mining taxation in Africa are significant but not insurmountable. The advantage of the mining sector in terms of regulation is the physical presence of minerals in the host countries. Mining operations are visible, verifiable, often concentrated in particular regions, and dominated by a limited number of operators. Even in a fragile context, national tax authorities can focus their limited means on this key sector for mobilizing domestic resources. Numerous studies and analyses carried out by academics and international organizations in recent years have identified possible responses to the challenges surrounding structure and governance, fiscal policy, and administration and implementation of fiscal regimes identified above.

50. https://resourcegovernance.org/fr/publications/preventing-tax-base-erosion-africa-regional-study-transfer-pricing-challenges-mining

2.4.1. Solutions to structural and governance challenges

To respond to the structural and governance challenges surrounding mining taxation, states must make strong commitments in a number of areas.

First, **collection of mining revenue must be placed at the heart of mining policy, and commitment must be obtained at the highest level of the state**. Developing and monitoring a fiscal regime specific to the mining sector goes beyond the typical work performed by mining and tax authorities: It needs interministerial consideration. African states can make use of a number of regional and international instruments to develop the fiscal component of their mining policies: the AMV (African Union 2009), NRGI's Natural Resource Charter (NRGI 2014), and the IGF's Mining Policy Framework (IGF 2013).

Second, states can **respond to information asymmetry by investing more in research and knowledge on the mining sector**. Mining schools, national and regional research laboratories focusing on this theme within the sector, and cutting-edge geological studies represent important progress. In particular, better knowledge of the subsoil can give states more options in terms of granting mining titles and sharing revenue. For example, licenses could be granted on the basis of tendering, national companies could be involved, and production sharing contracts could be drawn up.

Third, **states can coordinate at a regional level** to move forward with a common approach to foreign investment in this sector and **avoid the vicious circle of tax competition**. This would work particularly well in geological zones that cross borders (such as the Sahelian gold zone or the famous Copperbelt in the DRC and Zambia) and share many geological and economic features. Neighboring states can facilitate the sharing and publication of geological data to further strengthen the general attractiveness of the area, develop regional infrastructure and hubs to reduce transport and energy costs, and harmonize their respective fiscal regimes to avoid competition. The development of a WAEMU Mining Code and an ECOWAS Common Investment Code [51] are good examples of regional coordination.

Fourth, **improved governance** can play a role in a state's response to the issue of corruption within the sector. African states can use tools such as the EITI to improve transparent management within the sector and the Resource Governance Index (RGI) to identify areas for reform and measure any progress made, or focus more specifically on the risks of corruption using diagnostics relating to the extractive sector.

51. *Mining Policy Framework* (MPF).

2.4.2. Solutions aux défis de politique fiscale

Over the last 20 years, understanding of mining sector fiscal policies has evolved on the basis of the diverse and varied experiences of mining countries at different stages in their economic development.[52] The main lessons that can inspire African states are presented here.

Within the framework of development or reform of a mining code, it is essential that the fiscal regime be assessed on the basis of cutting-edge economic research and good knowledge of the potential of the country's mining sector (IMF—International Monetary Fund 2012). It is not enough simply to compare one's fiscal regime with those of neighboring countries. Comparison supposes a similar economic outlook. For example, comparing the fiscal regime for Mali's gold sector with that in force in Burkina Faso might be justified due to the geological similarities of the region. However, analysis of the fiscal regime applicable to bauxite in Guinea—which holds a third of global reserves of this mineral needed to make aluminum—requires consideration of the entire value chain and an understanding of the role of other large producers in the market, such as Brazil, Australia, and Indonesia. An essential tool for evaluating fiscal regimes is the rent sharing economic model (AfDB – African Development Bank 2017) implemented by the IMF,[53] the IGF,[54] and FERDI[55] in particular.

It is important to ensure that stakeholders are widely consulted during the development or modification of a mining sector fiscal regime. An internal consultation procedure within the tax authority is essential. However, this must be supplemented by an external consultation involving mining operators in particular (ideally via a professional body such as the chamber of mines or the chamber of commerce), civil society, and other representatives of citizens and local communities. This kind of consultation can take time, but it is important in order to ensure the legitimacy of the process and guarantee that the fiscal regime responds to the concerns of all stakeholders. It therefore provides the implicit guarantees of stability that are important for long-term investment in the sector.

52. https://investmentpolicy.unctad.org/international-investment-agreements/treaty-files/6441/download
53. https://resourcegovernance.org/sites/default/files/nrgi_Fiscal-Regime-Design.pdf
54. https://www.imf.org/en/Topics/fiscal-policies/fiscal-analysis-of-resource-industries
55. https://www.igfmining.org/beps/resources/igf-financial-model/

It is recommended that a specific mining regime, or at least a mining sector fiscal regime, be established and that it apply to all owners of mining titles, rather than the various elements of the fiscal regime being determined through the negotiation of individual mining contracts. This could be achieved via the mining code, the GTC, or a standard mining contract. The negotiation of mining contracts in the context of information asymmetry mentioned above systematically favors investors, who can resort to various arguments justifying tax exceptions and benefits. The first risk is granting fiscal conditions that are overly favorable to investors; the second is creating multiple, sometimes divergent, fiscal regimes that complicate the work of the tax authorities.

African states can also take inspiration from fiscal policy innovations introduced in other countries that could be adapted to their own context. While the traditional and still dominant model for sharing mineral rents involves adding ad valorem mining royalties to the ordinary law fiscal regime (Otto et al. 2006), many countries have experimented with various alternatives (IISD – International Institute for Sustainable Development 2020), such as different versions of the mineral resource rent tax, a variety of models for sharing production or sharing profits, various structures for national companies, as well as various administrative options for simplifying the collection of mining revenue. Some of these innovations have been compiled and analyzed by the IGF within the framework of its "Future of Resource Taxation" project.[56]

It is also time to rethink the excessive use of tax incentives. Many actors within the sector recommend limiting the tax incentives granted to mining operators, which are often inefficient and overly favorable to the latter given the evident profitability of mining projects. Where they are necessary, it is recommended that incentive-related tax expenditure be analyzed upstream and that the cost/benefit ratio for the host country be calculated precisely using economic models (Readhead 2018a). The Global Minimum Tax (GMT), which will be implemented from 2024 in some countries where mining multinationals are tax resident, should also be taken into account. The GMT should enable those countries to collect taxes on profits not taxed at the source (in African mining countries).

56. https://www.igfmining.org/tax-base-erosion-and-profit-shifting/the-future-of-resource-taxation/

Finally, it might be necessary for some African countries to review their network of fiscal agreements with a view to resolving the issue of clauses that are harmful to them and that allow taxes to be avoided in their country. Examples include the definition of a permanent establishment, withholding taxes on dividends, interest, royalties, and other payments to nonresidents, as well as the application of capital gains tax to the direct or indirect transfer of interests in a mining title.[57] Such a review might require the renegotiation or termination of some fiscal agreements (as Senegal has done with Mauritius[58]) or signature of the multilateral instrument proposed by the OECD as a multilateral solution to replace some obsolete provisions in fiscal agreements.[59]

2.4.3. Solutions to challenges related to the administration and implementation of fiscal regimes

Better governance of the mining sector and informed fiscal policies suited to a country's capabilities can facilitate the collection of mining royalties, duties, and taxes. However, it is also important to improve administrative capabilities and expertise if African states are to collect the revenue they expect from the mining sector.

On the one hand, mining authorities' capabilities in respect of economic, fiscal, and revenue issues must be strengthened. Mining ministries or departments play a key role in defining the fiscal regime applicable to the mining sector, as well as its implementation. They are sometimes directly responsible for collecting and monitoring mining royalties and export duties, managing state holdings in the capital of mining companies, and overseeing national companies that themselves generate state holdings. They are often responsible for monitoring imports, construction and investment costs, production, and exports. However, these ministries and departments do not always have the necessary skills and lack qualified staff, particularly in terms of economic issues (AfDB 2017), mining and fiscal legislation, statistics, accounting, and audit. Better monitoring of the quantity, quality, and value of mining exports is particularly important.

57. https://www.igfmining.org/tax-base-erosion-and-profit-shifting/the-future-of-resource-taxation/
58. https://www.igfmining.org/beps/resources/protecting-right-to-tax-mining-income-tax-treaty-practice-mining-countries/
59. https://www.icij.org/investigations/mauritius-leaks/senegal-nixes-unbalanced-tax-treaty-with-mauritius/

Meanwhile, mining expertise must be strengthened within tax authorities and finance and budget ministries. The frameworks developed by finance and budget ministries often play a key role in drawing up sector-based fiscal policy, mining contract negotiations, and the introduction of legislation and implementing texts that are crucial for reducing the risk of tax base erosion and profit shifting. Responses to the challenges of aggressive tax planning in the mining sector often require detailed knowledge of the industry's specificities. Similarly, sector-based expertise reduces the risk of information asymmetry between companies and tax authorities during tax audits (Bourgain and Zanaj 2020). In particular, recent advances in fiscal legislation in Africa on transfer pricing require significant sector-based expertise if tax audits are to succeed (Readhead 2016). Such expertise can contribute to better analysis of the risks of transfer pricing manipulation specific to the mining sector (Redhead 2017a). Knowledge of the value chains of the different mineral products is particularly important for auditing mineral sale transfer pricing.[62]

As well as skills specific to tax/mining authorities, enhanced dialogue between states and investors is valuable to encourage compliance with legislation and limit potential disputes. African legislation and regulations are not always clear, particularly for foreign investors, and it would be useful for authorities to clarify fiscal legislation and liabilities and discuss problems in terms of their application. Some countries, such as South Africa[64] and Zambia,[65] have long published straightforward and clear information about taxpayer liabilities online.

Finally, transparency at all stages of the mining sector value chain, and in respect of mining revenue in particular, can only encourage better oversight by government agencies, civil society organizations (CSOs), and the legislative authorities. Implementation of the EITI standard[65] includes transparency of the fiscal regime applicable to mining operators, publication of production and sales statistics, disclosure of mining

60. https://www.oecd.org/en/topics/beps-multilateral-instrument.html
61. https://www.igfmining.org/beps/current-topics/
62. https://documents1.worldbank.org/curated/en/649861485263000566/pdf/112220-REVISED-PUBLIC-EN-Comparables-toolkit-published-Edited.pdf
63. https://www.sars.gov.za/wp-content/uploads/Ops/Guides/LAPD-Gen-G01-Taxation-in-South-Africa.pdf
64. https://www.zra.org.zm/tax-information/
65. https://eiti.org/fr/exigences-itie

titles, their effective owners, and mining contracts,[66] and publication of corporate tax liabilities broken down by mining title and type of payment. This information can be valuable for the authorities themselves, and it can also contribute to raising awareness among the population and political decision-makers of the importance of monitoring mining operations and the associated revenue.[67/68/69]

Conclusion

Previously a modest industry, natural resources extraction will undoubtedly become an important economic activity in many African countries in the future. It is therefore important to consider the macroeconomic consequences of the mining sector's recent development in terms of growth, exports, investment, and employment, as well as tax revenue.

The share of mining exports in total exports in value has increased significantly, from +14% on average between 2002 and 2012 to +25% between 2013 and 2021. However, the share of these exports in GDP, while increasing, generally remains modest (less than 10%), and, similarly, the share of mineral rents in GDP does not exceed 8%. The effects of the resource curse on African countries have therefore barely been perceptible in recent years. However, this curse can play a part in damaging governance and political institutions. Overall, the mining sector typically creates few jobs across the continent (barely 2 million), and this number did not change significantly over the course of the 2010s. Even when taking into account potential indirect jobs, this is far from a job-creating mining boom. The often-informal artisanal sector is where the jobs are really generated. It employs 10 million people and is responsible for a significant proportion of the continent's mineral production. On average, investment in the mining sector represented between 15% and 20% of total investment between 2010 and 2020 and has been increasing since 2018: Half of productive investments have been for new sites or extensions of existing sites (the rest being M&A operations).

66. https://www.icmm.com/en-gb/our-work/governance-and-transparency/mineral-resource-governance/contract-transparency
67. https://www.pwyp.ca/putting-transparency-to-work
68 https://www.pwyp.ca/resources/many-ways-to-lose-a-billion
69 https://globalwitness.org/en/campaigns/oil-gas-and-mining/finding-the-missing-millions/

Mobilizing public resources is a priority in most African countries, and the mining sector is an important source for countries that are highly dependent on the extractive industries.

Mining taxation is a strategic issue because it can provide states with more revenue, but it can also ensure a fairer distribution of mineral rents in periods of growth, while encouraging companies to invest to ensure the sustainability of this activity and continue its development. Mining codes began to be revised in 2010 to rebalance interests, but it should be noted that tax revenues are still significantly lower than mineral rents from extraction. This presents a number of recurrent challenges in terms of mining taxation: *(i)* the low capacity of tax and mining authorities in some countries; *(ii)* the fiscal "race to the bottom" that is still underway in the continent's economies; *(iii)* non-taxation of the artisanal sector; and *(iv)* stabilization clauses in past contracts freezing fiscal provisions for 10 to 30 years and therefore making new fiscal provisions impossible. However, the greatest challenge to be overcome remains the aggressive tax optimization of multinational companies seeking to reduce the profits they declare in countries with high tax rates to transfer them to countries with more favorable tax rates. Provisions to combat this already exist (such as the "sixth method"[70]) and are beginning to be applied in Africa.

70. Within the framework of the "sixth method" for evaluating sales revenue, states use the reference price (London Metal Exchange [LME] or Platts, for example) to calculate sales revenue for the purposes of a corporate income tax. The risk of under-evaluation is reduced if sales are calculated on the basis of a posted public price and not a declared sales price, as used in the other five methods (https://www.iisd.org/system/files/2023-11/determining-the-price-of-minerals-framework.pdf). Zambia in particular uses the "sixth method"(https://resourcegovernance.org/sites/default/files/documents/special-rules-for-commodity-sales-zambia-sixth-method.pdf).

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Appendix

Summary of mining royalty rates by country and type of mineral

COUNTRY	MINING ROYALTIES
Burkina Faso	2017 (Mining Code): Tax base: Turnover Rate: – Uranium: 8% – Diamonds and precious stones: 7% – Gold: * Price strictly less than USD 1,000 per ounce: 3% * Price between USD 1,000 and USD 1,300 per ounce: 4% * Price strictly greater than USD 1,300 per ounce: 5% – Other precious metals: 4% – Base metals and other mineral substances: 3%
Burundi	2015 Mining Regulations: 3% for base metals 2% for precious metals and precious stones 1.5% for other substances, including the “3Ts” (tin, tungsten, and tantalum)
DRC	2019 (Mining Code): – **Construction materials** in common usage: 0% – **Iron and ferrous metals**: 0.5% – **Industrial minerals** (gypsum, kaolin, dolomite, l imestone cement, glass sands, fluorine, diatomite, montmorillonite, baryte, talc, limestone): 1% – **Solid hydrocarbons and other uncited substances:** 1% – **Non-ferrous and/or base metals:** 2% – **Precious metals:** 2.5% – **Precious stones and colored stones:** 6% – **Strategic substances:** 10%
Ghana	2010 (Modified Mining Code): All minerals: 5%

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COUNTRY	MINING ROYALTIES
Guinea	2013 (Modified Mining Code and Amended Mining Code: Standard-grade **iron**: 3% (iron ore price measured by Platts China Iron Fines CFR 62%) minus transport costs (measured by the Baltic Exchange Capesize Index Route C3: Tubarao/Qingdao) **Bauxite:** 0.075% (LME[71] 3-month bid price per tonne of primary aluminum for bauxite 40% Al2O3) **Other non-ferrous substances:** – Base metals (copper, tin, nickel, zinc): * Concentrate: 3% (FOB[72] price) * Metal: 3% (FOB price) – Minor metals (cobalt, titanium, molybdenum): 3% (FOB price) **Rough diamonds:** – Industrial production: 5% (BNE[73] estimate) – Semi-industrial production: 3.5% (BNE estimate) – Stone with a unit value equal to or greater than USD 500,000: 5% (BNE estimate) **Other precious stones (emerald, ruby, sapphire) and other gemstones:** – Industrial production: 2% (BNE estimate) – Semi-industrial production: 1.5% (BNE estimate) – Stone with a unit value equal to or greater than USD 500,000: 5% (BNE estimate) **Precious metals (silver, gold, platinoids, palladium, rhodium):** 5% (London fixing)
Liberia	Tax base: 2011 (amended GTC): – General: "Fair market value FOB Liberia" – Listed minerals: "International price index" – Gold: "London afternoon gold price fixing" – Rates: 2011 (amended GTC): – Iron: 4.5% – Gold and other base metals: 3% – Trade diamonds: 5%

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71. London Metal Exchange
72. Free On Board
73. *Bureau national d'expertise* (Guinean government agency that oversees diamond and precious stone exports).

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COUNTRY	MINING ROYALTIES
Mali	Mineral substances are divided into the following groups: Group 1: Diamond, emerald, sapphire, ruby, beryl, jade, opal, garnet, alexandrite, andalusite, chalcedony, quartz, tourmaline, corundum Group 2: Gold, silver, lead, zinc, copper, molybdenum, platinoids Group 3: Chromium, nickel, cobalt, vanadium, platinum, iridium, osmium, palladium, rhodium, titanium, tin, niobium, tantalum, tungsten, lithium, zircon, rare earth elements Group 4: Iron, manganese, aluminum, phosphate, gypsum, fluorine, rock salt, alkali salts, baryte, potassium Group 5: Uranium, thorium, peat, lignite, coal, charcoal, oil shale 2021 (Implementation Mining Code): Tax base: Effective quantity (quantities of market mineral products sold) X [Average price (weighted average of prices obtained for sales of market mineral products) – Provisional price (provisional sales price for market mineral products)] Rates: **Groups 1 and 2:** – Price increase of between 10% and 20%: 3% – Price increase of between 20% and 30%: 4% – Price increase of between 30% and 40%: 5% – Price increase of between 40% and 50%: 6% – Price increase above 50%: 8% **Groups 3, 4, and 5:** – Price increase of between 10% and 20%: 2% – Price increase of between 20% and 30%: 3% – Price increase of between 30% and 40%: 4% – Price increase of between 40% and 50%: 5% – Price increase above 50%: 6%

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COUNTRY	MINING ROYALTIES
Mauritania	2012 (Modified Mining Code): – Group 1: Iron, manganese, titanium (in rock), chromium, vanadium – Group 2: Copper, lead, zinc, cadmium, germanium, indium, selenium, tellurium, molybdenum, tin, tungsten, nickel, cobalt, platinoids, gold, silver, magnesium, antimony, barium, boron, fluorine, sulfur, arsenic, bismuth, strontium, mercury, titanium, and zirconium (in sand), rare earth elements – Group 3: Coal and other fossil fuels – Group 4: Uranium and other radioactive elements – Group 5: Phosphate, bauxite, sodium and potassium salts, alum, sulfates other than alkaline earth sulfates, any other metallic mineral substance exploited for industrial use, any industrial or ornamental rock excluding quarry mineral substances exploited for industrial use such as asbestos, talc, mica, graphite, kaolin, pyrophyllite, onyx, chalcedony, and opal – Group 6: Ruby, sapphire, emerald, garnet, beryl, topaz, and any other precious stones – Group 7: Diamonds Mining royalties 2012 (Modified Mining Code): **Group 1:** 2%, except for iron: *Iron converted into steel in Mauritania:* 2.5% *Exported iron:* variable rate depending on the iron price (The Steel Index): – Price strictly less than USD 100 per tonne: 2.5% – Price between USD 100 and USD 105 per tonne: 3% – Price between USD 105 and USD 200 per tonne: 3.5% – Price strictly above USD 200 per tonne: 4% – **Group 2**: 3%, except for gold, copper, platinum group metals (PGMs), and rare earth elements: *Gold:* variable rate depending on the gold price (London afternoon gold price fixing): – Price strictly below USD 1,000 per ounce: 4% – Price between USD 1,000 and USD 1,200 per ounce: 4.5% – Price between USD 1,200 and USD 1,400 per ounce: 5% – Price between USD 1,400 and USD 1,600 per ounce: 5.5% – Price between USD 1,600 and USD 1,800 per ounce: 6% – Price strictly above USD 1,800 per ounce: 6.5% *Copper:* variable rate depending on the copper price (LME 3-month average): – Price strictly below USD 6,000 per tonne: 3% – Price between USD 6,000 and USD 7,000 per tonne: 3.5% – Price between USD 7,000 and USD 8,000 per tonne: 4% – Price between USD 8,000 and USD 9,000 per tonne: 4.5% – Price strictly above USD 9,000 USD per tonne: 5% *PGMs and rare earth elements:* 4% **Group 3:** 1.5% **Group 4:** 3.5% **Group 5:** 2.5% **Group 6:** 5% **Group 7:** 6% **Groupe 7 :** 6 %

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COUNTRY	MINING ROYALTIES
Mozambique	Tax base: 2015 (Mining Code): “value of the mineral product extracted, after processing,” i.e., “price of the most recent sale” or, by default, “international market reference price.” Transport costs from the mine to the export point are deductible. Rates: Diamonds: 8% Precious metals, precious and semi-precious stones, heavy mineral sands: 6% Base metals, coal, ornamental rocks, and other minerals: 3% Sand and stone: 1.5%
Senegal	2017 (Mining Code): – Calcium aluminate phosphate: 5% – Lime phosphate: 5% – Phosphoric acid: 1.5% – Cement: 1% – Iron: * Ore concentrate: 5% * Ore to be converted into steel locally: 2% – Base metals, radioactive substances: * Ore concentrate: 3.5% * Ore to be converted into a refined product locally: 1.5% – Gold: * Raw: 5% * Refined overseas: 5% * Refined in Senegal: 3.5% – Zircon, ilmenite, and other heavy minerals: 5% – Diamonds and other gems: * Rough: 5% * Cut: 3% – Alkali salts and other licensed substances: 3%
Tanzania	2017 (various modifications) and 2018 (Amended Mining Code): – Uranium: 5% – Precious stones and diamonds: 6% – Metal ores (copper, gold, silver, platinum, etc.): 6% – Gems: 1% – Other minerals (including construction materials and salt): 3%

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COUNTRY	MINING ROYALTIES
Togo	1996 (Mining Code): Large-scale mining license: – Construction materials: FCFA 100 per m^3 – Industrial materials other than phosphates: 1% of market value – Ferrous and non-ferrous non-precious metals: 2% of market value – Precious metals: 3% of market value – Precious and semi-precious stones: 5% of market value – Strategic mineral substances, hydrocarbons, mineral waters, and geothermal deposits: – Other mineral substances: 2% of market value – Phosphates: 2% of pit-head price
Zambia	2018 (Modified Mining Code): Copper: 5% if "standardized price" < 4,500 USD/tonne 6% if USD 4,500/tonne ≤ "standardized price" < USD 6,000/tonne 7.5% if USD 6,000/tonne ≤ "standardized price" < USD 7,500/tonne 8.5% if USD 7,500/tonne ≤ "standardized price" < USD 9,000/tonne 10% if "standardized price" ≥ USD 9,000/tonne
Zimbabwe	2016 (Modified Mining Code): Tax base: "gross fair market value" Rates: 2019 (Finance Law): - Diamonds (but no royalty is payable for diamonds sold to local diamond dealers with a reduction equivalent to the value of the royalty that would otherwise be payable): 15% - Other precious stones: 10% - Gold produced by small-scale gold miners: 2% - Gold produced by other miners: * 3% (if the gold they produce is sold when its price is less than USD 1,200 per ounce) * 5% (if the gold they produce is sold when its price is greater than USD 1,200 per ounce) - Platinum: 2.5% - Other precious metals: 4% - Base metals excluding chromium: 2% - Chromium: 5% - Industrial metals: 2% - Coalbed methane: 2% - Coal: 1%

Source: FERDI legislative and tax database

Governance and social and environmental impacts of the mining sector

Patrice Ebah, Nicolas Hubert and Hugo Lapeyronie

Chapter 3

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Governance and social and environmental impacts of the mining sector

Introduction

Decisions relating to governance of the mining sector determine the well-being of the people living in the local communities affected by mining development. In countries that are rich in natural resources, the governance of the mining sector also determines how extractive activities are regulated, and whether the state is able to redistribute mining revenues and implement poverty reduction and sustainable development programs. Where policies and practices ensure informed, inclusive, and accountable decision-making, natural resources may help equitable, prosperous, and sustainable societies to emerge. At the same time, the often severe and long-lasting environmental consequences of mining mean that these activities must be carefully balanced with the management of other natural resources, and that the rights of local people and communities must be protected.

1. Governance of the mining sector

In this section we will examine the model of governance and internal composition of mining sites, since this largely determines the social and environmental issues created by extractive activity, and the way mining firms perceive them. This section will therefore consider governance of the procedure for granting mining titles, the position of state-owned firms, and the management of national budgeting processes and subnational revenue-sharing.

1.1. How do mining codes determine how a mine is governed?

To understand how mining codes determine how a mine is governed, it is first necessary to appreciate their scope. These codes set out the rules governing the entire lifespan of a mine, from exploration to closure. As well as determining the main elements of mining taxation, as discussed in Chapter 2, mining codes typically cover a wide range of areas, including:

- lthe allocation of mining titles: mining codes establish the criteria for the allocation of mining titles such as exploration permits and mining licenses. They also set out the conditions for the renewal and termination of titles;
- the regulation of exploration and exploitation: mining codes regulate mining activities, including exploitation, mineral processing, environmental protection, occupational health and safety, waste management, and the use of water resources;
- the involvement of local communities: mining codes may also specify the measures that mining companies must take to involve local communities in mining activities and ensure they benefit economically, and may also set out the measures that should be taken in relation to compensation, reparations, and the relocation of local communities.

Mining codes are therefore a vital tool for governments, since they set out the "rules of the game" for mining companies that want to exploit a country's mineral resources. Mining companies must follow the standards and procedures laid down by the mining codes in order to obtain the licenses needed to operate the mines. Mining codes can vary from country to country, and even from region to region, depending on a country's mining history and social and cultural norms. Mining companies therefore need to work closely with regulatory bodies to ensure that their plan for establishing a mine complies with all the requirements of the mining code currently in force.

The image that is sometimes conveyed of mining in African countries resembling a "Wild West" is a long way from the truth, since the codes in these countries are in fact both operational and enforced. Recent changes to the codes have largely been focused on the private sector, however. As highlighted in the work of Campbell (2010), Ferguson (2005), and Porter and Watts (2017), programs promoted by international financial institutions (IFIs) (African Union 2013) to liberalize and open up Africa's extractive industries to the global market have helped shape African mining codes to make them more competitive and more attractive to foreign direct investment (FDI). One of the main consequences of these inducements has been the adjustment and reduction of the burden of fiscal, social, and environmental legislation on mining investors, in order to fully facilitate their integration into the socioeconomic fabric of the nations concerned.

Mining companies may legally derogate from the requirements imposed by mining codes in certain instances. However, such derogations are often subject to strict conditions, and express provision is frequently made for them in mining codes. Temporary or permanent exemptions from environmental or social obligations may, for example, be granted if a company can demonstrate that compliance is impossible or impracticable due to exceptional circumstances (such as natural disasters).

In practice, exceptions to mining codes often fall outside the scope of the codes. They are determined by mining agreements (contractual frameworks)—which are not necessarily made public—negotiated between a government and a mining company. In such cases, the mining code is used to establish the standards and regulations used as the basis for the agreements, thus enabling specific arrangements between the state and the mining company to be introduced.

Corruption, which is rife in Africa's extractive sectors, is obviously another way of circumventing the requirements imposed by national mining codes.[1] However, broadly speaking, what really calls into question the true effectiveness of mining codes in fully carrying out their role of regulating the industry is the difficulty, if not inability, of governments to control the actions of powerful international mining companies. As Ferguson (2005) argues, extractive territories in Africa tend to be "off the grid" areas that are not subject to the norms and rules of the host country, but to those of the mining companies, which gradually replace the state.

A country's mining governance is not solely determined by its mining code, however. There is also a large body of standards that are not binding at either the legal or regulatory level, but that constitute a genuine framework of best practice and principles to implement when developing international projects for the exploitation of natural resources, particularly when assessing the social and environmental impacts. Central to this "fourth generation" of mining governance (Besada and Martin 2015) are the alternative accountability mechanisms introduced by states, the international community, and civil society to make up for the shortcomings of mining codes. These mechanisms are based on two central pillars: *(i)* greater transparency and accountability on the part of the mining industries, i.e., increasing the visibility and

1. See in particular *2021 Resource Governance Index*, foreword Suneeta Kaimal (Natural Resource Governance Institute), accessed November 14, 2024, https://resourcegovernance.org/publications/2021-resource-governance-index.

responsibility of mining activities by disclosing more information about their operations and making mining companies accountable for their social and environmental impacts; and *(ii)* greater social and environmental responsibility on the part of mining companies, which are required to be more proactive and committed about taking the social and environmental aspects of their activities into account.

These alternative accountability mechanisms are supported by a whole range of international standards. These include the socioenvironmental standards from the Equator Principles,[2] World Bank standards, the *Due Diligence Guidance for Responsible Business Conduct* issued by the Organisation for Economic Co-operation and Development (OECD), and the Sustainable Forestry Initiative (SFI). Compliance with these standards involves a duty to carry out social, economic, and environmental assessments prior to project development in order to document any expected impacts and the strategies put in place to mitigate and offset them.

For international economic actors, compliance with these standards and associated specifications is paramount, since it helps determine the financing capacities and interest rates for the loans required to develop extractive projects. In Africa, the African Mining Vision (AMV), supported by the African Union (AU) and the World Bank (AU 2013), has marked a major turning point, becoming the normative reference for the extractive sector from the late 2000s onward. Its aim is to maximize the economic, social, and environmental benefits of Africa's mining sector, reduce poverty, and stimulate economic growth, while ensuring sustainable management of mineral resources and promoting peace and stability on the continent. The AMV calls for the development and implementation of a cohesive, integrated mining policy framework for Africa. This framework encourages collaboration both between African countries and with international partners to support the sustainable development of the mining sector in Africa. The framework was adopted in 2009 but, despite still being promoted by African institutions, has resulted in little concrete action (Hilson 2020).

Since the mid-2010s, several African countries have used the AMV and World Bank recommendations to initiate reform of their mining codes, particularly with a view to strengthe-

2. The Equator Principles are a financial industry benchmark that have been adopted by financial institutions on a voluntary basis. Their purpose is to ensure that social and environmental risks are taken into account in the financing of projects. The principles are based on responsible financing and comply with the standards set out by the World Bank.

ning local supply chains, increasing public revenues from mining taxation, and improving the redistribution of mining revenues in order to use them as a lever for development. These reforms also form part of the political agendas of the actors responsible for them. In Burkina Faso, for example, the mining code was reformed following the overthrow of President Blaise Compaoré. However, it was not greatly different from the previous code drawn up in 2004, since it continued to attach great importance to the advantages granted to international firms, gave prominence to the industrial sector at the expense of the artisanal sector, and focused less on national and local development opportunities (Hubert 2018).

In Madagascar, reform of the mining code has been a source of both hope and concern, and for similar reasons, among both civil society and international investors. The first draft law, adopted in November 2019, is still being debated, and forty-one articles were amended when it was submitted to the Malagasy Parliament in May 2023, following which a dedicated parliamentary committee was created.[3] In the Democratic Republic of the Congo (DRC), reform of the mining code, which was adopted in 2018, was also part of a specific political approach. The objective of the reform, which was led by President Joseph Kabila as he sought to circumvent the constitution in order to run for a third presidential term, was to substantially increase tax revenues from the mining sector. It met with strong opposition from mining companies and international investors.[4]

The Belgian think tank Justice et Paix has highlighted how this reform could strengthen the Congolese state's control of the extractive sector in a meaningful way, particularly in terms of tax revenues and their more equitable redistribution to decentralized state institutions, and could also reinforce social and environmental standards. Justice et Paix nevertheless draws attention to the fact that this reform still gives prece-

3. For further information, see the announcement on the website of the Madagascan National Assembly at https://assemblee-nationale.mg/projet-de-loi-portant-refonte-du-code-minier-adopte-en-seance-pleniere/, and articles published on newspaper websites, including *Le Monde* (https://www.lemonde.fr/afrique/article/2020/01/14/a-madagascar-semaine-decisive-pour-le-nouveau-code-minier_6025829_3212.html), *La Tribune Afrique* (https://afrique.latribune.fr/finances/commodities/2022-09-01/madagascar-vers-un-nouveau-code-minier-pour-securiser-l-or-malagasy-929011.html), and *Africa Intelligence* (https://www.africaintelligence.fr/afrique-australe-et-iles/2022/12/21/le-code-minier-rate-le-coche-parlementaire,109874891-bre).
4. For further information, see the articles published on the websites of the newspaper *La Croix* (https://www.la-croix.com/Monde/Afrique/Nouveau-code-minier-RD- Congo-2018-03-12-1200920098) and TV5 Monde (https://information.tv5monde.com/afrique/rdc-desaccord-autour-du-nouveau-code-minier-28633).

dence to mining in the industrial sector, and notes the ongoing lack of clarity regarding the state's actual ability to apply controls and enforce the new standards, and the enduring opportunities for derogation from the mining code via the opaque bilateral negotiations for drawing up mining agreements.[5] Tanzania has conducted a similar reform of its mining code, with the same aim of strengthening oversight of the extractive sector, limiting the social and environmental impacts, and increasing tax revenues, but with more convincing results. In 2020, for example, *La Tribune Afrique* reported a 52.6% year-on-year increase in the country's mining revenues.[6]

1.2. Implementation of mining development projects (from exploration and impact assessment to negotiations with communities)

The extractive sector is thus particularly closely supervised and regulated by several layers of national and international legislation and standards. As a result, international mining companies incorporate these standards into their processes in order to meet the requirements and expectations of international markets, which partly finance extractive projects and help determine the price of mining shares based on the company's image and reputation. These social and environmental accountability standards and requirements apply at different stages of a mining project. To explore how this works in practice, and the associated issues, in this subsection we will look at the stages involved in implementing a mining project, and how this process pits different teams within mining companies against one another.

This is because, while these teams are part of the same mining project or the same mining company, they compete in terms of the costs and profitability of the phases in which they are involved, causing them to defer negative externalities to the later stages of mining development. There are typically four main stages associated with the development of a mining site: *(i)* preparation, *(ii)* impact studies and construction, *(iii)* exploitation and, ultimately, site closure, and *(iv)* site rehabilitation.

5. See the analysis by Justice et Paix: https://www.justicepaix.be/en/mining-code-in-dr-congo-the-challenges-of-reform/.
6. For further information, see the *La Tribune Afrique* website: https://afrique.latribune.fr/finances/2020-08-17/mines-grace-aux-reformes-la-tanzanie-recolte-des-revenus-en-hausse-de-52-6-en-un-an-855031.html#:~:text=Mines%20%3A%20gr%C3%A2ce%20aux%20r%C3%A9formes%2C%20la,par%20le%20pr%C3%A9sident%20John%20Magufuli.

The teams involved in preparing a mining project (exploration and prefeasibility and feasibility studies) tend, for example, to emphasize the geological potential of a site, and the geographical ease of building infrastructure and extracting and exporting mineral ores. This stage is essential, since it makes it possible to assess the potential profitability of a mining site. It therefore largely determines the project's feasibility study, which is the main basis for applying to banks, investment funds, and private investors for the financing required to develop the project, i.e., for the key stages of the impact study, construction, and mining.

It is important to note that the exploration stage is not managed exclusively by in-house teams at international mining companies—also known as "majors." This stage is often carried out by smaller companies—also known as "juniors"—that specialize in the acquisition of mining exploration titles, the geological improvement of sites, and resale to industry majors. In Africa, the exploration stage is also increasingly based on early identification of high-potential artisanal mining sites. As promising deposits are identified, exploration plots at these sites are rapidly acquired for further geological research. Where the identification of such sites leads to the establishment of industrial mining sites this can often lead to serious local conflicts with artisanal miners who have invested substantial capital in small- and medium-scale mining at the site. Since these miners mainly operate without either a license or a legal mining title, and do not come from the local communities, they are not eligible for financial compensation and therefore lose the capital they have invested.

Once the feasibility study has been approved and funding for the project secured, the impact and implementation studies are carried out. The purpose of this stage is to confirm the financial viability of the mining site, by affirming its geological potential and assessing the social and environmental costs associated with exploiting it. In compliance with national mining codes, it is these impact studies that determine whether or not exploitation permits, and thus authorization to begin the physical construction of the site, are obtained. Depending on the specifics and requirements of national mining codes, these impact studies often have to be carried out by firms that are independent of the mining companies, in order to ensure an objective examination of the costs borne by local communities and the benefits they might derive from mining operations. However, these consultancy firms often have a clientelist relationship with the mining companies, since the latter directly appoint the agencies that carry out the social and environmental assessments. The impact studies are therefore deliverables paid for by the mining companies, and the companies are the agencies' main clients. In most cases, these impact studies and the associated permits are publicly accessible and therefore generally available on request. In practice, however, it is often necessary to apply to the appropriate national office to consult physical copies of the documents, a process that involves not only visiting the office in person but also dealing with a number of administrative hurdles, such as identifying and interacting with the appropriate department/person, obtaining permission to consult the documents in question, settling on a time to consult them, and someone being there in person to provide access to them.

The studies focus on three impact areas (direct, indirect, and health) based on their proximity to the center of the mining site: the pits where the minerals are extracted, the areas where the minerals are processed (mechanical and chemical extraction), and the areas where mining waste is stored. It is these three impact areas that determine whether local people receive compensation for the presence of the mining operation, and if so, how much. This stage also creates competition within local communities, as divisions appear between those who receive compensation and those who do not. People who do not receive compensation may feel aggrieved by financial compensation policies since they also suffer social and environmental impacts that affect their daily lives and standard of living. This frustration is also shared by people from indirect impact areas, who receive less compensation. This competition within communities near mining sites is also increased by the refusal of a significant percentage of the people affected to participate in the relocation programs provided for in mining codes, often deeming the land and housing provided by mining firms, and their locations, to be unsuitable for their activities. These people often prefer to receive direct financial compensation so that they can buy new land from people who have not been affected.

Compensation amounts and terms are initially determined by national mining codes. In Burkina Faso, for example, compensation for expropriated agricultural land is assessed on the basis of the annual yield per hectare set out in the mining code, and determined over a period of three to five years. As a consequence, people whose land has been expropriated receive a one-off payment rather than a recurring income. Use of the term "negotiation" for the compensation process is therefore not strictly accurate. First, the lump sums are determined in advance by the mining codes, and second, by the time discussions begin on compensation for local communities, the mining project will already have obtained exploitation permits: the project will already have secured funding, will be embedded in the territory in question, and will have been approved by the national authorities. If the project were to be canceled, the mining agreement between the state and the international mining companies would thus become null and void, and the relevant costs and compensation would have to be paid. In practice, the people affected are not really in a position to refuse or even negotiate compensation terms, or to receive any real support from the national authorities.

It is only once a mining agreement has been drawn up between the state and the mining company that consultations with local people actually begin. The relevant national and local authorities, typically consisting of representatives of the relevant environmental and ministerial departments, and representatives of the local authorities concerned, hold meetings with the local communities that will be included in the various impact areas. Although these meetings officially begin the negotiation phase, they are more of an information and awareness-raising exercise for the local communities. In this situation, the relevant environmental and ministerial departments, and the local authority representatives, act more as intermediaries for the central government and mining companies than as genuine actors and stakeholders in the mining process. In most cases, local communities seem to feel they are being summoned by the mining firms and government officials rather than being consulted. The ability of local people and communities to intervene with their own representatives and national authorities to assert their rights is therefore minimal.

On the whole, in communities local to mining sites, one constant that can be observed is the hope raised by the opening of a mine, and the subsequent disappointment regarding the amount of compensation received, alongside frustration with the reality of industrial mining. However, the greatest source of frustration with these financial compensation processes lies in the duplicity involved in the "negotiation" process. Negotiations are initially conducted orally with local communities in accordance with their endogenous norms, which are based on customary law. The negotiations are then transcribed into official documents using the modern wording of the mining and land codes, which sometimes conflict with customary law and differ from the agreements reached orally with the local communities. These documents are also drawn up in the languages of the national governments, inherited from the former colonial powers, whereas the overwhelming majority of these local communities live in deprived rural areas, and tend either not to be proficient in the language of the former colonial occupiers, or to be illiterate. This makes it difficult for them to understand the final wording of the written agreements.

For example, in Burkina Faso, Senegal, Guinea, and Côte d'Ivoire, the amount and nature of compensation are calculated according to the annual yields of the plots of land cultivated by the local communities, thereby conforming with the norm of customary law establishing a system of ownership that is neither private nor individual but semicollective, with individuals having exploitation rights (Diallo 2017; Fent 2020; Knierzinger 2016; Hubert 2018; République de Côte d'Ivoire 1995). The perception of local people is that financial compensation is recompense for a temporary relinquishment of their land use rights, rather than bare ownership of the land. It is only when the mining project takes physical shape that the people who have received compensation realize that their plots of land will never be returned to them. However, in accordance with the written documents they have signed without actually being in a position to understand their content, they have no legal recourse available to assert their rights. There have also been instances in which the figures of customary or political authority representing the local communities during the negotiation stage have appropriated the ownership or exploitation rights to the land in order to obtain and collect the benefits that may be associated with the mining income, further harming the people whose land has been expropriated, and creating significant conflict within the local communities. These aspects are not of course universal, but depend on both endogenous political and social structures and the associated land tenure systems.

However, it is important to emphasize that this divergence in understanding between the concept of individual private property and the endogenous notion of ownership of exploitation rights is the result of the various reforms of the land and mining codes, reflecting the inclusion of African resources in the international economy and financial system. Indeed, as Burkina Faso's mining code illustrates perfectly, all of the land and subsoil remain the property of the state, and are therefore open to potential exploitation by international economic actors. The same mining code determines the terms of access to natural resources and the resultant compensation when they are exploited.

It is also important to note that social and environmental impact studies, the demarcation of impact areas, and compensation policies are part of the mine construction stage and therefore included in its costs. These costs will therefore also be assessed in the light of the financial viability of the mining project as a whole, and therefore its prospects for successful completion. While social and environmental impact studies have to comply with international standards and the norms of national mining codes, it should not be forgotten that, in Africa, most mining legislation has been amended over the last two decades to make the sector more competitive (Campbell 2010). The various teams involved in this stage of mine development thus handle the economic and legislative realities of the extractive project so as to optimize potential returns and defer social and environmental costs to the next stage, that of exploitation. It is therefore the production teams that manage the main social and environmental costs, using community policies and rehabilitation funds, even though, paradoxically, they are the most vulnerable to the need to ensure that the project provides an economic return.

As such, even if the teams responsible for the mining firm's community policies and social and environmental responsibility may have significant regard for the communities affected and may work on innovative sustainable development projects, they are constrained by the economic realities of the extractive project, the burden of borrowed financing, and the expectations of the shareholders of international mining companies for a return on their investment. The whole process of assessment, compensation, and community relations therefore involves constant bargaining and negotiation between social and environmental responsibility and the project's profit targets. This relationship is inextricably bound up in a clash between global financial market norms and the reality of the endogenous sociopolitical norms and structures of the local communities.

1.3. Development of the mine: Construction, management during the operating period (CSR), and post-mining rehabilitation

In his 2005 article "Seeing Like an Oil Company: Space, Security, and Global Capital in Neoliberal Africa," James Ferguson presents extractive sites as enclaves of development located within countries in the "Global South." These territorial enclaves are located in outlying, generally rural territories with high levels of poverty and a lack of public infrastructure such as health centers, schools, and vocational training centers, supply networks for electricity and running water, and even roads. The development of industrial extractive sites enables a significant amount of infrastructure to be built to fill this gap, particularly road, electricity, and water infrastructure to help the mining site become operational. The construction of other infrastructure that is lacking, such as the provision of drinking water, health centers, and schools, is generally linked to firms' community relations or corporate social responsibility policies.

Nevertheless, as pointed out by Ferguson (2005) and the majority of studies of the extractive sector (inter alia: Drechsel et al. 2018; Geenen 2014 and 2019; Tegera 2010; Vlassenroot and Raeymaekers 2004; Watts 2010), more often than not construction of this infrastructure creates two different standards, one for public assets provided by the international mining company and the other for those provided by the state. Similarly, as a result of the mining codes' transfer of authority to the international mining companies, the companies provide not only public assets, but also security in the territories where they operate, sometimes positioning themselves as having the same degree of power as the state and thereby helping to undermine the state's legitimacy and its ability to assert its authority over its own territory. While mines make an undeniable contribution to public infrastructure, the main concern is that the purpose of this infrastructure is to ensure the site becomes operational and to comply with corporate social responsibility (CSR) policies. The mining firms therefore manage the upkeep and maintenance of this infrastructure, but there is a risk that it will deteriorate over time if its preservation is not incorporated into post-mining rehabilitation programs.

The processes of building this infrastructure and making it operational also raise questions in relation to the reality of mineral extraction. The infrastructure is always built in the direct vicinity of extraction sites, to support their operations and community policies. However, these sites are built exclusively in response to geology and the presence of mined ores. As a result, they take less account of the needs, population distribution, and accessibility of the territories concerned. Furthermore, it is important to question the contribution of this infrastructure in relation to the social, health, and environmental impacts of mining.

The growing literature on the extractive sector encompassing Africa and other parts of the globe, in both the Global South and North, makes it possible to determine a general outline of the various environmental impacts of extractive activity. For technical and profitability reasons, mining is mainly carried out in open pits. In addition to ore extraction sites, an industrial mining site includes storage areas for the chemicals needed for leaching and separating the ore from the rock. In the case of precious ores such as gold, these consist of toxic chemicals such as cyanide and mercury. Every industrial mining site also includes industrial infrastructure areas for processing ores, site administration areas, areas designated for living quarters for expatriate, international, and regional workers, and a site security area. Lastly, there are also the various mining impact areas, which are classified according to the degree of contamination and direct impact experienced by the local communities.

This description of the process of physically establishing extractive industries is critical for understanding that the primary impact of mining is spatial, a point to which we will return several times in the sections that follow. Mining does not just monopolize land and water resources, but also monopolizes space, resulting in a profound reconfiguration of the geography of its areas of activity, and therefore of the living and economic environment of the local communities. Indeed, mining sites often physically separate towns and villages, restricting access to water resources and agricultural or pastoral activities. The demarcation of direct impact areas and mining, storage, and processing areas creates physical barriers (such as fences, pits, and buildings) that prevent the movement of people and livestock.

This situation often results in increased travel times for local communities, and is generally not solved by building new roads. Conversely, preexisting road infrastructure is overused by the vehicles used to operate or supply the mining site. The result of this overuse of transport infrastructure is its rapid deterioration, a growth in traffic leading to a rise in the number of road accidents, and an increase in the amounts of rainwater runoff and dust produced by the road used by the companies' large mining trucks, in addition to the dust produced by digging the pits. While rainwater runoff and increases in airborne dust may appear insignificant at first glance, they are in fact the primary environmental and health impacts noticed by local residents. These phenomena contribute significantly to the pollution of water resources and fields, and have a major negative impact, both quantitatively and qualitatively, on crop yields. The high levels of airborne dust also contribute significantly to mining-related lung diseases.

In most cases, the development of extractive sites also entails the displacement—often seen as forced—of the people located in the mining sites' direct impact areas. This displacement and relocation process is initiated ahead of the construction of the site and is an integral part of the "negotiation" process with local communities, but is also accounted for in community programs and CSR policies. Relocation programs are usually accompanied by the "modernization" of housing and the creation of residential neighborhoods based on exogenous architecture and materials. As such, they do not meet people's needs, and are not suited to the environmental and climatic conditions of the regions in which the mining sites are located.

These house rebuilding and modernization processes are thus usually rejected by the people for whom they are carried out, either because the relocation site is incompatible with their day-to-day activities (often due to lack of access to water or the distance from service infrastructure, businesses, and agricultural and grazing areas), or because the new buildings are poorly designed (such as a lack of ventilation and thermal insulation, and cracks in cement walls presenting a risk of collapse). Examples include the Inata and Essakane mining sites in Burkina Faso, and the Banro sites in the DRC. However, some mining companies and social and environmental assessment firms have learned from earlier mistakes and have started to change their practices. Endeavour Mining, for example, has rebuilt the village displaced by its Karma mining site in Burkina Faso exactly as it was before.

Not all local residents are involved in the relocation and resettlement programs, however. People residing in indirect impact areas continue to live in their homes, sometimes just a few dozen meters from the fences designating the perimeter of a mine, and therefore endure the impacts of mining on a daily basis. These people are the most adversely affected by mining, either because of the dust generated, the pollution of drinking water sources, or the noise and vibrations from the use of explosives to mine the pits. Due to the intensity of the explosions and the proximity of the remaining houses in the indirect impact areas, these vibrations can often damage the structure of buildings (with cracks appearing in the walls, eventually causing houses to collapse). At the Falagountou site in Burkina Faso, the Canadian company IAMGOLD has attempted to alleviate this situation by delivering raw materials, including bags of cement, to the people affected in this way. The latter have not been entirely satisfied with this solution, and are demanding financial compensation.

The dividing line between community policies, CSR, and redress for the health, social, and environmental impacts of mining blurs even further when it comes to water resource management and the local development programs implemented during the mine's active life. As far as water resource management is concerned, it is important to bear in mind that the development of mining generates direct competition with domestic, agricultural, and pastoral uses of water. In Burkina Faso, for example, the mining code gives mining firms priority access to water resources. In situations of severe water stress, as in the Sahel, mining operations not only divert watercourses and build dams to build up the water reserves needed to extract the ore, but also draw directly from groundwater. To remedy this situation, mining companies usually highlight the construction of boreholes and water treatment plants as part of their CSR policies. Although these activities are presented as improvements and sustainable development policies, they cannot compensate for the losses mining causes to local people, or provide them with the same access to drinking water they had before the mine was built.

While we will return to the environmental pollution caused by industrial mining operations in more detail in the sections below, it is important to emphasize here the rationale behind community and CSR policies. These policies are deployed during the site exploitation stage to mitigate the negative impacts caused by mineral extraction, rather than to run a local development project alongside the economic project. A number of studies and reports, including those by social and environmental research firms paid for by the mi-ning companies, show that the drinking water of the communities living near the mining sites at Kalska, Essakane, and Inata in Burkina Faso is contaminated by cyanide, mercury, and arsenic (Hubert 2021; Ouédraogo and Amyot 2013; ORCADE 2006, 2013; Porgo and Gokyay 2017). The construction of a dam at the Inata site for the exclusive use of Avocet resulted in access to water being cut off for local people. Since the remaining boreholes had become unfit for use, the mining company has undertaken to supply the community with water by tanker truck, a situation that is set to continue beyond the exploitation phase, and raises numerous questions in relation to the post-mining stage.

It is important to note that this situation is similar for geographical regions that are not facing water stress. Eastern DRC, for example, is regarded as a water-abundant region, but due to pollution and a lack of treatment facilities, access to drinking water remains particularly limited,[7] and the spread of mining sites is contributing to restricting access by communities, despite the mining companies' CSR policies. On May 8, 2009, the Canadian mining company Banro, which was the main operator of gold mining sites in eastern DRC until the mid-2010s, held an official ceremony in the Luhwindja chiefdom to celebrate the installation of a drinking water distribution system designed to serve 18,000 people in four villages. The system in fact consisted of a well supplying the entire population of the local community from a single faucet, installed after the mining firm had caused drinking water sources to dry up due to industrial exploitation of the Twangiza mining site (Ligue des droits de la personne dans la région des Grands Lacs [LDGL] 2009).

The assessment of IAMGOLD's developments at its Essakane mining site is even more damaging. IAMGOLD has won several international awards for its social responsibility and local and community development projects, including a Towards Sustainable Mining (TSM) Environmental Excellence Award from the Mining Association of Canada (MAC). It is also a stakeholder in a public–private partnership (PPP) implementing the "Water and Sustainable Economic Growth in the Sahel (ECED–Sahel)" project. The purpose of this project, which is partly financed by Global Affairs Canada (GAC) and Burkina Faso's Ministry of the Environment to build dozens of boreholes and water towers, is to support herders' and farmers' groups in order to boost local development that protects food security, to improve access to drinking water, to build a water treatment plant, and to galvanize inclusive and egalitarian local development that promotes women's empowerment. The project aims to provide access to drinking water for over 13,200 households, or more than 60,000 people, in the towns of Dori, Essakane, and Markoye, right in the heart of the area where IAMGOLD operates the Essakane site.[8] The company has thus received public funding, and recognition as an environmentally responsible firm, for compensating for the loss of access to water directly caused by its own activities. In contrast to the situation at the Banro sites in the DRC, building water distribution and treatment infrastructure might at least have a lasting impact into the post-mining stage.

7. For further information, see the UNICEF website: https://www.unicef.org/drcongo/ce-que-nous-faisons/eau-hygi%C3%A8ne-et-assainissement#:~:text=En%20RDC%20comme%20partout%20dans,%C3%A0%20promouvoir%20des%20pratiques%20hygi%C3%A9niques.
8. For further information, see the website dedicated to IAMGOLD's CSR programs: https://hss.iamgold.com/English/home/default.aspx.

As far as investment to boost local economic development is concerned, the impact of mining company programs has to be assessed with regard to the impoverishment caused in local communities by the introduction of extractive sites, a dynamic to which we will return in the sections below. While this position is still debated among economists, there is almost universal agreement among scholars in development studies, geography, and the social sciences, supported by both qualitative and quantitative studies (Drechsel et al. 2018; Gamu et al. 2015; Mazalto 2010; Ouoba 2018; Thune 2011; Watts 2010; Zabsonré et al. 2018), that mining development is generally a factor in the impoverishment of communities at both the local and national level. Most studies carried out in situ, including at the Sabodala and Taïba sites in Senegal (Diallo 2009), the sites operated by Barrick Gold Corporation and AngloGold Ashanti in Tanzania (Lauwo et al. 2016), the Luhwindja site operated by Banro in the DRC (Geenen and Claessens 2013), the Ityen site in Côte d'Ivoire (Allouche and Mohammed 2017), and the sites operated by Rio Tinto in Madagascar (Gerety 2019), tend to show that programs to support agriculture, market gardening, and livestock and poultry farming do not in fact compensate for the losses caused by the expropriation of land, the monopolization of water resources, and reduced yields caused by air pollution (dust).

If we take the example of the Essakane site in Burkina Faso, where IAMGOLD has received recognition for its sustainable development practices, several local officials have explained that, in reality, the new areas provided for farming are much less fertile than the land taken for mining development, and are not suitable for growing local cereals such as pearl millet, which was central to the diet and culture of the local people.

Box 1. Questions raised by rehabilitation of the Kalsaka mining site

If we take the example of the Kalsaka mining site in Burkina Faso, the investigations and research carried out by Thune (2011), Hubert (2021), and Zongo (2019) highlight both the problems national authorities face in accessing post-mining rehabilitation funds, and the difficulty of actively implementing a post-mining rehabilitation program against a backdrop of less stringent extractive sector regulatory norms and the reduced ability of states and institutions to enforce them. In the case of the Kalsaka site, the British company Amara Mining (formerly Cluff Gold) contributed to the post-mining rehabilitation fund throughout the operating period, in compliance with Burkina Faso's 2003 mining code. Nevertheless, still in compliance with Burkina Faso's mining code, the site was managed by the Burkinabé company Kalsaka Mining S.A. which was 78%-owned by the British mining company and operated as a subsidiary of the international company. When the site was declared no longer economically viable in 2012, the Burkinabé subsidiary was placed in compulsory liquidation, and the communities living near the mining site lost their main point of contact for implementation of the site rehabilitation plan.

The fund that, in theory, was set aside for the rehabilitation of the Kalsaka site and received contributions throughout the mine's operating period, remained untouched by the international mining company. Although the fund's resources were deposited in an international bank account, the Burkina Faso authorities were only able to access them in 2017, following the intervention of an international court of arbitration. Once access to the fund—worth 42,624 billion CFAF[9]—had been secured, an internal conflict broke out within the public authorities in Burkina Faso about access to and management of the fund, with three ministries (Economy, Finance, and Environment) and the municipality of Kalsaka all claiming the right to manage it. In 2021, after the fund had been transferred to the Ministry of the Environment and two inter-ministerial committees had been set up, the rehabilitation programs had still not been implemented and, in the meantime, a new actor, the Indian mining company Balaji Group, had purchased mining rights with a view to reopening the Kalsaka site, rendering the anticipated rehabilitation meaningless. The reopening of the mining site raises several major questions regarding rehabilitation. First, it is important to identify the impact studies that led to the new mining permit being issued and that will guide the ultimate rehabilitation. Will Balaji Group be required to return the site to the condition it was in when it began mining, or to its original condition, before any mining began? Second, it is important to determine what actions need to be taken in light of the availability of the rehabilitation fund. Is action needed now, while the site is still operating, or should this wait until the site is permanently closed, and run the risk that the money available will be used to make up for the Burkina Faso government's cash flow problems?

9. Along with seven other West African states that are also members of the Union économique et monétaire ouest africaine (UEMOA) (West African Economic and Monetary Union), Burkina Faso's currency is the West African CFA Franc (XOF).

To conclude this section, we need to bear in mind that each major stage in mine development is divided into substages involving dedicated teams from the same mining company, all in competition with each other. With this in mind, it is also important to note that the teams dedicated to each stage of the mining process seek to minimize the costs associated with their involvement, and therefore to maximize their productivity and other pay-related bonuses. This results in the social and environmental costs gradually being moved back toward the final stage of the mining project, the post-mining rehabilitation stage, at which point these accumulated costs have to be reconciled with the budget initially allocated to the project, in accordance with the specific details in each national mining code, and in the rare cases where this final stage is implemented in any meaningful manner.

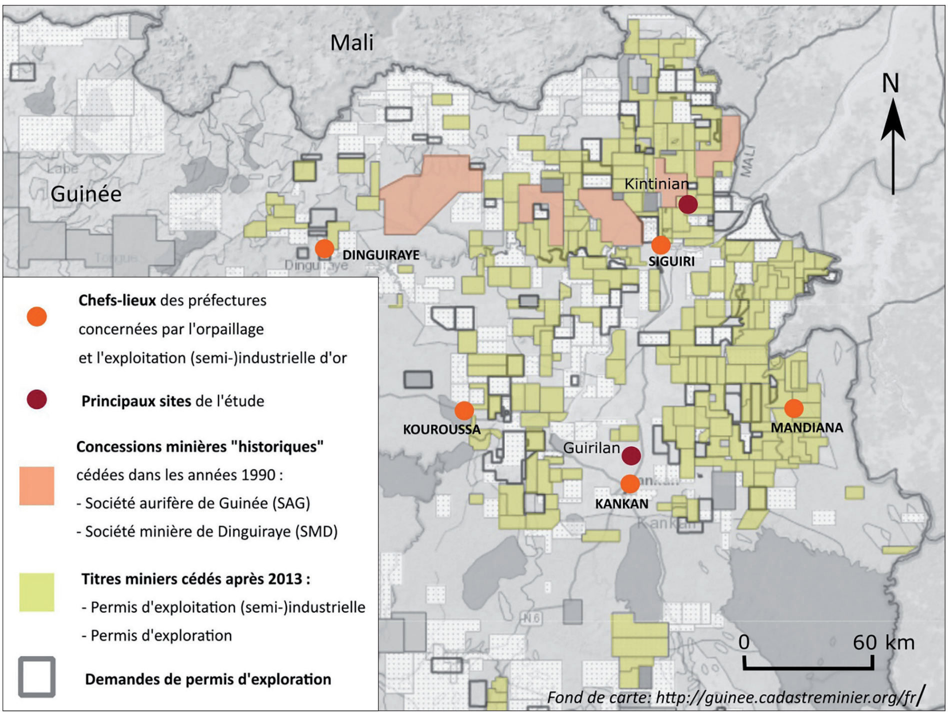
2. The environmental impact and social repercussions of mineral extraction

In this second section we will discuss the environmental impacts of extractive activities in more detail. We will examine the environmental footprint of mining activities and the various externalities that need to be taken into account, as well as how air and water pollution affect local communities, ecosystems, and biodiversity. This section will also address the issues associated with competition for access to natural resources such as water, and the dust generated by mining. We will begin by describing the territorial impact of extractive activities, and the pressure on land and water resources. We will then discuss the pollution generated by industrial mines, before turning to the way in which these environmental impacts can affect the sociopolitical structures of local communities and their relationship with the environment.

2.1. The territorial impact of mines

As noted in subsection 1.3 of this chapter (see above), establishing an industrial extractive project has a major territorial impact that is not restricted solely to the mining site's direct operating areas, or even to the indirect impact areas or health impact areas demarcated during the construction stages. It is also important to consider these territorial impacts in the light of issues specific to the different African nations. As noted by Brink et al. (2014), Jayne et al. (2014), and Abay et al. (2021), African societies are exposed to significant demographic and land pressures. These two phenomena are obviously interrelated, but land pressure is also driven by the strong appeal that African resources hold for the international market, in the logging, agribusiness, and extractive sectors. As studies by Serdeczny et al. (2017), Kolusu et al. (2021), and Zinyengere et al. (2017) also note, these same African societies are simultaneously more exposed to the impacts of global climate change, which means that in the most fragile ecosystems, the economic capacity and food security of rural populations are already being affected by lower agricultural and livestock yields, soil depletion, and various levels of water stress.

Map 1. ***Perritorial pressure exerted by mining titles and concessions in northern Guinea***



Source: Dessertine (2019).

By increasing pressure on water resources, contributing to soil depletion through various forms of pollution, and expropriating a significant proportion of the land on their sites, extractive projects act as catalysts for the impacts of climate change, and may create chain reactions in the social, economic, political, and environmental systems of local communities. As discussed in the previous section, some of the people whose land is expropriated as a result of the development of a mining site will seek to buy new land with the compensation they receive, thereby further reinforcing the land pressure that already exists in the region hosting the mining site, and extending the issues raised by construction of the site into a much wider area than the impact areas identified at the beginning of the process.

The increase in the number of extractive sites generated by the recent African mining boom that began in the early 2010s has inevitably led to a reduction in the geographical space given over to agricultural and pastoral activities (fields and grazing lands), to the overexploitation of the remaining spaces, and therefore to the depletion of soil and grazing areas. In the most fragile ecosystems, such as in the Sahel, this phenomenon, combined with the additional pressure on water resources, has contributed greatly to desertification in the Sahelian and Sahelo–Sudanian climate zones. Similarly, mining projects located in semitropical Sudanian and tropical Guinean climate zones are major causes of deforestation in ecosystems that are no less fragile and subject to strong anthropogenic and climate pressures.

When viewed through the lens of the unfairness of the negotiation and compensation processes associated with the establishment of mining projects, this phenomenon further increases local people's perception of the impacts they have suffered, and their rejection of both the mining process and the central governments that help to introduce them. This is particularly true given that greater land pressure tends to drastically reduce the areas that remain for livestock farming or agriculture, thereby accentuating both soil erosion and preexisting conflicts of use and environmental competition.

2.2. Impacts of mining pollution

In order to understand the issues associated with pollution from mining activities in Africa, we first need to look at the mechanisms that lead to this pollution, the characteristics of which set the mining sector apart from other industries. One of the sector’s main characteristics is that the choice of location for extraction sites mainly depends on the geology of the subsoil. The mining company therefore has to adapt to the environment where the deposit is located. In addition to the territorial impact discussed above, the extraction of mineral resources contributes to the release of a series of more difficult-to-identify pollutants at certain key stages in the extractive process:

- the physical extraction phase, when the ore is extracted from the rock;
- the ore separation process, either mechanical (crushing) or chemical (leaching);
- ore transport by truck, train, or conveyor belt;
- the management of mining waste and the formation of tailings (heaps of accumulated mining by-products).

These stages and their impacts vary according to the nature of the deposit and the methods used to mine it. For example, underground mines generally have a lower impact in terms of air pollution due to lower dust emissions during rock extraction. Mining pollution is therefore unique to each mine, although it is possible to observe some frequently occurring features, based on the type of ore and the associated mining method. Pollution may thus be an integral part of the industrial process, and have specific provision made for it, or may result from industrial accidents such as leaks or mining dam failures.

When discussing mining pollution, and environmental impacts more broadly, several factors need to be taken into account in African mining operations. First of all, the continent's immense mineral wealth and the use of a wide variety of extraction methods to mine its countless deposits—methods that sometimes depart significantly from international standards in the sector—help make mining pollution in Africa a complex reality to grasp. This reality is made even more complex by the wide variety of environments in which minerals are mined in Africa. The continent has unique biodiversity and ecosystems, many of which are still untouched by human activity (Map 3). Lastly, while the proximity of mining sites to residential areas is not a feature that is unique to Africa, it is particularly prominent in certain countries, mainly in southern Africa, exposing large numbers of people to mining pollution.

The combination of these factors contributes to determining the severity of the impact of pollution on the various components of the mining environment. Although mining pollution varies according to the context of each mining site, a number of major trends across Africa can be identified.

These trends must take into account the spatial and temporal dimensions of the mine, since mining pollution is not restricted to the boundaries of the mining site but can extend over tens or even hundreds of kilometers, particularly when it is close to a watercourse (Sonter et al. 2018). It should also be noted that mining pollution does not occur exclusively during the mining site's production stage. The initial risks of pollution and environmental disturbance begin with the initial exploration work and continue for many years after mining has ceased, due to the gradual erosion of mine waste and tailings.

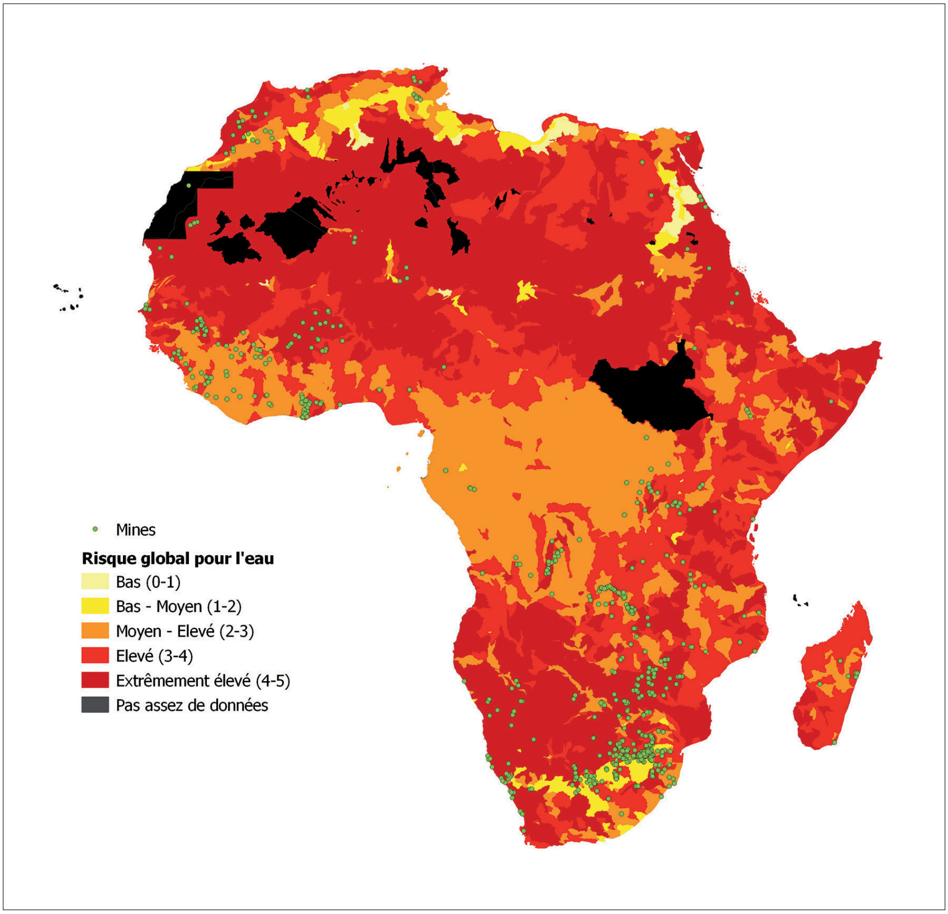
To make it easier to understand these complex phenomena and grasp the wider risks for Africa, particularly with regard to achieving the Sustainable Development Goals (SDGs), we have grouped the types of mining pollution to which the continent is particularly exposed into four categories: *(i)* water pollution, *(ii)* air pollution, *(iii)* pollution of the soil and land-based flora and fauna, and (iv) greenhouse gas (GHG) emissions.

Water pollution and consumption

Water is central to the mining process. It is used at various stages in ore extraction, making water consumption in the mining industry particularly high. This intensive use of water and the contamination inevitably associated with it can pose major problems when it is to the detriment of local communities and/or the ecosystems that depend on them.

In order to support their operations, mining companies have to draw on the resources at their disposal, such as groundwater, lakes, and rivers, which they often share with local communities. In such circumstances, local communities may be exposed to various forms of pollution. In many parts of Africa, water quality is a particularly critical issue, given the difficulties people often face in gaining access to good quality water. In addition, it should be noted that a high percentage of African mines are located in water-stressed areas (Map 2). The mines located in these regions exert considerable pressure on water resources that are already under strain.

Map 2. ***Location of industrial mines and overall risk to water***



Sources: Authors based on data from S&P Capital IQ Pro and Hofste et al. (2019).

The water used in the mining process is thus exposed to various pollution risks. Several sources of pollution can be identified:

- effluent discharge during the various stages of the mining process: this is particularly common with heap leaching, a special leaching technique where chemicals are poured over the ore to extract the metal;
- mine waste leakage: mines generate a great deal of waste, consisting of "noneconomic" residues from mining production. When stored in a solid state, these residues accumulate to form a tailings heap from which rainwater

will inevitably trickle, resulting in polluted water runoff. When stored in liquid form, usually in retention basins, the dams holding back the polluted water can crack or even break, with the sometimes very heavy rainfall in some regions accelerating the overflows;

- water table penetration: in some cases, extraction operations reach sufficient depths to contaminate groundwater. The pollution can then cover a very large area.

Water pollution has a variety of consequences. Proximity to bodies of water (such as rivers, lakes, and marshes) tends to increase the impacts. In these environments, the release of particles laden with heavy metals or other elements can lead to an increase in ecotoxicity and a loss of associated ecosystem services (Ouma et al. 2022). Of particular note is the development in some cases of acid mine drainage, a phenomenon where the oxidation of sulfides creates an acidic solution that contributes to the long-term acidification of watercourses, to the detriment of the species that live in them.

Air pollution

The various stages of mining for ores contribute to the pollution of the air surrounding extraction sites to differing extents. Mechanical extraction of ores using industrial machinery, explosives, or other methods can generate and expel large quantities of dust. This dust is not confined to the extraction site, but can also be dispersed over great distances when the ore is transported, usually by trucks, from which the dust falls. This is noted by Banza Lubaba Nkulu et al. (2018) in their case study of artisanal cobalt mining in the DRC, where the emergence of artisanal mines in the city of Kolwezi led to an accumulation of cobalt-contaminated dust on roofs, yards, and unpaved paths or streets, but also indoors on dirt floors, furniture, kitchenware, food items, clothes, toys, and other objects. This dust was produced by the handling of ore: bags hoisted from the pits, ore stockpiling on the premises and inside houses, and the crushing and handpicking of ore fragments.

The smelters and other infrastructure required to process and refine the ores emit fine particles laden with heavy metals and other pollutants, such as sulfur dioxide (SO_2). This pollution is particularly characteristic of the Zambian copper industry, which has major copper processing facilities located in the north of the country, where the "roasting" of ores contributes to the emission of fumes laden with these particles (Mwaanga et al. 2019).

Together, smoke and dust expose the surrounding population to respiratory diseases and even more serious conditions. For example, Ekosse et al. (2005) conducted a study in the vicinity of the Selebi Phikwe nickel–copper mine in Botswana, and found the mine and smelter to be responsible for the high incidence of chest pain among people living nearby. In Burkina Faso, people living near the Kalsaka and Essakane gold mines quickly established a link between air pollution and the emergence of various diseases that can result in hospitalization (Hubert 2021). In Zambia, these air pollutants are also thought to have caused silicosis, tuberculosis, and other lung diseases. They also contaminate the food chain, exposing people to a variety of heavy metals, including lead and cadmium, that present significant health risks (Mwaanga et al. 2019).

Pollution of the soil and land-based flora and fauna

Mining has a lasting impact on the environment of the host area, not only from pollution but also by changing the habitat of native species. All these upheavals have lasting repercussions on land-based flora and fauna, the extent of which is still not currently well understood, particularly in Africa (Sonter et al. 2018).

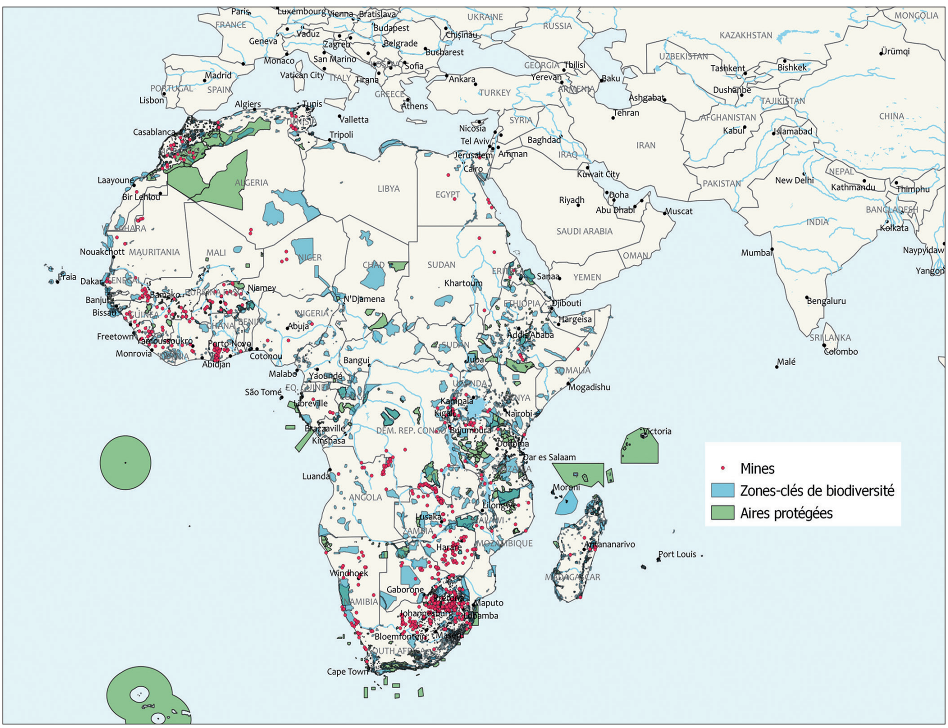
Soil pollution is one of the main vehicles for the environmental changes caused by mining. Geochemical studies analyzing the presence of trace metal elements help reveal the extent of soil contamination by heavy metals released during the various stages of the extractive process mentioned above. In Africa, however, the lack of baseline surveys conducted before a mine becomes operational presents significant problems for quantifying the extent of mining pollution (Kříbek et al. 2014).

The exposure of soil to mining pollution has repercussions for land-based flora and fauna locally. The metals introduced by the various pollutants affect the chemical balance of the soil, in particular its potential of hydrogen (pH). The flora—including species that tolerate these changes in balance to different extents —are also affected. Plants that are more resistant to this stress thrive, while others tend to disappear, leading to a restructuring of part of the local ecosystem. David et al. (2021) note that the diversity of the flora around two tantalum mines in Nigeria has been considerably reduced, with the native species at one of the study sites having almost completely disappeared in favor of nonnative and invasive plants.

As highlighted by ecological studies, and more specifically by those that use the complex systems approach, local ecosystems must be understood in terms of their insertion into, and interdependent relationship with, other regional ecosystems. Different types of pollution concentrated in a particular location can create a lot of pollution and chain reactions affecting all ecosystems and biodiversity, either through pollution of water networks and catchment areas, air pollution, or negative impacts on flora and fauna populations.

As such, the geographical proximity of mining sites to ecologically significant areas is particularly concerning. Map 3 provides an overview of these risks by showing the locations of all the industrial mines in Africa included in S&P's Metals and Mining database in relation to protected areas and key biodiversity areas. It can be seen that a significant proportion of industrial mines are located in the immediate vicinity of, or within, these ecologically valuable areas.

Map 3. ***Locations of industrial mines, protected areas, and key biodiversity areas in Africa***



Sources: Authors based on data and other information (key biodiversity areas, protected areas) from S&P's Metals and Mining database, BirdLife International (2023), and UNEP–WCMC and IUCN (2023).

Greenhouse gas (GHG) emissions

Mining is a major emitter of greenhouse gases (GHG), with the industry estimated to be responsible for approximately 8% of total global GHG emissions (Ritchie et al. 2020). Most of these emissions are generated by the power plants needed to operate all the mining infrastructure, and by the engines of the fleet of vehicles used to extract and transport the ore. A significant percentage of these emissions also comes from smelters and refineries, which require a great deal of energy to process the ores.

Table 1. ***Example of a GHG scope classification for a mine***

SCOPE 1	SCOPE 2	SCOPE 3
Direct GHG emissions	Indirect emissions associated with electricity	Other indirect emissions
GHG emissions from sources owned or controlled by the mining company, such as: • emissions from combustion in boilers, furnaces, or vehicles owned by the company; • emissions from chemical processes in equipment owned or controlled by the company; • emissions from land owned or controlled by the company.	GHG emissions from power plants producing the electricity purchased by the mining company.	GHG emissions resulting from the mining company's activities, from sources that it does not own or control, such as: • emissions from transport by third parties of purchased ores or finished products; • emissions related to the use of products sold.

Source: World Gold Council.

In Africa, fossil energy sources—coal- or diesel-fired power plants—make up the overwhelming majority of mining energy mixes (Banerjee et al. 2014). Alternatively, depending on the context, African mines may use captive power plants (which solely supply the mine) and/or the national electricity grid, sometimes obtaining a significant percentage of the power from the grid. In this latter scenario, indirect GHG emissions (scope 1 and scope 2—see Table 1) from mines depend on the national energy mix. In this respect, most African countries remain largely dependent on fossil fuels, contributing to the high GHG emissions observed in the African mining industry. This is particularly true in the gold sector, in which African mines are ranked among the biggest emitters in the world, with the African gold sector holding the all-time record in this field, with 2,754 kg CO_2-e/oz of gold extracted. By comparison, records show that the Canadian gold sector emits only around 250 kg CO_2-e/oz extracted (Ulrich et al. 2022).

The energy mix of some of the continent's mining countries does, however, also include a significant percentage of green electricity. Thanks to its large hydroelectric production capacity, the DRC's mining sector is able to secure part of its energy supply from decarbonized electricity. This will be the case, for example, for the Kamoa–Kakula copper mine project, developed by Ivanhoe Mines and Zijin Mining Group, for which some of the electricity will come directly from the Mwadingusha hydroelectric power plant, located approximately 200 km away. In relation to the gold sector, access to this hydroelectric power also explains why the DRC is also the African country with the lowest GHG emissions, at less than 500 kg CO_2-e/oz of gold extracted (Ulrich et al. 2022).

2.3. Impact of mining on perceptions of the environment and territorial reconfiguration

As discussed above, establishing an industrial mining site in rural areas of Africa profoundly affects the socioeconomic practices of the communities near the mine, either because of land expropriation, the resultant land pressure, competition for access to water resources, or the pollution generated by the extractive activity. These environmental impacts are significant, as most of the activities involved—agriculture, market gardening, livestock breeding, hunting, fishing, arboriculture, and forestry—are linked to the exploitation of natural resources. The reduction in the scale of these activities and the yields from them inevitably has an impact on the standard of living and food security of the local population, two aspects of their lives that have worsened as a result of the inflation in the cost of living caused by the mining site (an issue that we will address in the next section). However, in addition to the purely economic factors, the reduction in these activities also has a significant impact on the resilience of local ecosystems, and the political structures of local communities.

Furthermore, as highlighted above, the reconfiguration of geographical space, physical and legal restrictions on people's ability to move around, and noise and environmental pollution all contribute to changes in people's habits and lifestyles. They alter perceptions and connections to a "sense of place," defined by cultural approaches to environmental systems (Chan et al. 2011; Fish et al. 2016; Masterson et al. 2017). Local people modify their habits in relation to the environment, thereby reducing the practices involved in maintaining the environmental services that supported socioeconomic activities and helped ensure the sustainability of ecosystems. For example, in some types of arid or semiarid environment, the decline in traditional agricultural and pastoral activities is contributing to a reduction in the practices of retaining water reservoirs, irrigating certain plots of land, and maintaining copses and areas of forest. This change in social and environmental practices and adaptations contributes further to a process of desertification that is already greatly exacerbated by the considerable pressure exerted on water resources by extractive activity.

The reduction in these socioeconomic activities is leading to a gradual loss of local knowledge associated with conservation of the environment and the appreciation of environmental services. For example, at the Inata mining site in the Sahel region of Burkina Faso, the presence of substantial tree cover contributed to the formation of large water reservoirs during the rainy season, which local people maintained by building dikes and irrigation canals to enable crops to be watered in the dry season, thereby helping keep the soil supplied with water. However, this forest area was destroyed by the construction of the mine, further reducing community practices for maintaining water systems. Conversely, in regions that are more exposed to water stress, the mining companies' monopolization of water resources and their practice of diverting watercourses to create retention basins are contributing to watercourses drying and silting up, as seen at the Essakane and Inata sites in Burkina Faso (Hubert 2021), the Frontier copper mine sites in the Haut-Katanga province in the DRC,10 and the Forécariah site in Guinea.[11]

10. See the news brief and report on the Voice of America website: https://www.voaafrique.com/a/tarissement-de-la-riviere-lubembe-dans-la-cite-de-sakania-en-rdc/4374628.html.
11. See the interview with the prefectoral director of mines and quarries for the area that includes the Forécariah site on the website of the NGO Actions Mines Guinée (AMINES): https://www.actionminesguinee.org/2018/04/07/forecariah-directeur-prefectoral-mines-carrieres-letat-lieux-secteur-extractif/.

In a similar vein, the communities neighboring the Essakane and Kalsaka sites in Burkina Faso have also abandoned the traditional reforestation practices that helped combat desertification. At the same time, as part of their community policies, the mining companies have undertaken their own reforestation activities to counterbalance areas that have experienced deforestation. However, these programs have not really succeeded in replacing previous local practices, and do little to include local communities and their local knowledge. The species used are nonnative and sometimes unsuited to the ecosystems where they are introduced; in addition, the species and reforestation areas chosen are often not compatible with either the practices of the local communities or the reality of ecosystems (Hubert 2021).

In addition to the loss of local knowledge and the pronounced deterioration of ecosystems, the decline in the "sense of place," i.e., the practices and habits of local communities, is causing profound changes in their social, cultural, and political structures. In many African societies, including in North Africa, the syncretism between "pagan" beliefs and the "Religions of the Book," i.e., Christianity and Islam, has led to the persistence of many religious constructs associated with the environment, the presence of which may be more marked in animist Christian and Muslim societies. In many cases, the establishment of mining sites, both industrial and artisanal, also leads to the physical destruction of places of worship, or of environmental features that have religious significance and are important to local communities (such as sacred hills, copses, and marshes), either in terms of their collective identity or their political structure.

In some instances, as with the Karma site in Burkina Faso, mining companies take these issues into consideration and incorporate them into their community policies, working with political and religious authorities in the local communities to relocate sacred sites. In other cases, such as at the Kalsaka and Inata sites in Burkina Faso, the mining companies pay little heed to these issues, and destroy places of worship. This destruction reinforces the local communities' distrust of the mining project and the authorities who helped to implement it. Such actions also prevent local communities from carrying out their customary rituals, and interfere with environmental services (regular rainfall, quality of harvests, absence of disease, etc.). While it is difficult to establish an empirical link between the destruction of religious sites and the deterioration of environmental services, this nevertheless reinforces negative perceptions among local people, who associate these events with outbreaks of disease and the occurrence of accidents in their communities, and to a decline in the environmental services they maintained before the opening of the mine.

The negative impact on religious practices associated with the environment inevitably affects the associated political structures, helping to undermine them. This process is, however, exacerbated more significantly by the changing norms governing land tenure. In many sub-Saharan African societies, land ownership is in effect semicollective: the land belongs to the community, under the control of political and/or religious authorities, while individuals have the right to exploit it. However, the expropriations and compensation prompted by the construction of a mining site effectively introduce a new set of regulations governing access to land, based on private, individual ownership and the monetary value of land. This further undermines "traditional" endogenous political structures, while at the same time institutions and political representatives linked to central government are held partly responsible for the social and environmental impacts of the mining project.

The environmental destruction and pollution generated by industrial mining thus result in a spatial reconfiguration of living environments, habitat decline, pressure on natural resources, and the gradual destruction of ecosystems. In addition, these phenomena overlap with and amplify the processes of land pressure and expropriation of land, and contribute to undermining the endogenous sociopolitical structures that were previously the guarantors of the norms for accessing and regulating the environment, resulting in the gradual abandonment of local practices and knowledge that ensure the sustainability and resilience of ecosystems.

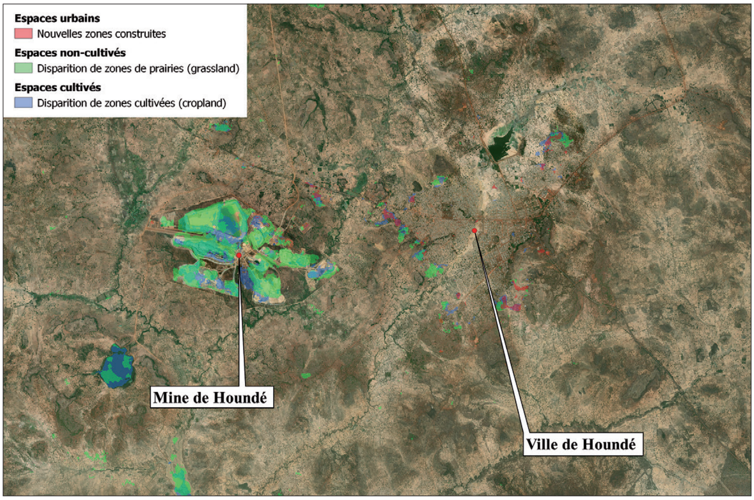
Box 2. The territorial impact of the Houndé gold mine in Burkina Faso

The territorial changes arising from the construction of a mining site can be difficult to comprehend in their entirety, as they cover such a large area and can extend over a long period of time. In recent years, the increasing availability of satellite data has offered a new perspective on the territorial footprint of mining sites.

The image below shows changes in land use following the opening in 2017 of the Houndé gold mine, located in the Hauts-Bassins province, around 260 km west of the capital Ouagadougou.[12] This graphic was produced using Dynamic World land use data with a resolution of 10 m (Brown et al. 2022). The analysis covers the years 2016 to 2023. It should be noted that this does not imply direct causality between construction of the mine and changes in land use.

The open-pit gold mine is on the left of the image, with the town of Houndé on the right. Areas marked in red show the emergence of new urban environments (such as houses and warehouses) in 2023 compared to the situation in 2016. Green areas indicate the disappearance of grassland that could be used for pasture, and blue areas denote the disappearance of previously cultivated land.

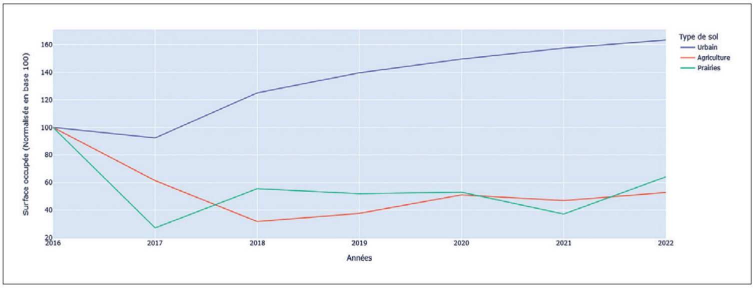
Aerial view of Houndé mine (Burkina Faso)



Sources: Google Earth and authors' calculations based on Dynamic World data (Brown et al. 2022).

12. See https://www.endeavourmining.com/our-portfolio/hounde-mine/.

The graph below shows the change in each of these different land use categories within a 10 km radius of the Houndé mine between 2016 and 2022. As can be seen, the proportion of built-up areas increased by a factor of 1.5 over the study period, while agricultural land/cropland and grassland decreased substantially over the same period.



3. Social impacts

In this third section we will focus more closely on the social and economic impacts and structural changes brought about by the introduction of industrial mining sites. This section will therefore address the questions of employment, changes to socioeconomic activities, conflicts of use, the livelihoods of local communities, changes in consumer and property prices (inflation), and the changes to the urban fabric brought about by industrial mining sites. In this respect, it is important to note that the social and environmental impacts of the extractive sector, which were mentioned in the previous section, are a major driver of structural change in host communities, and present a challenge to their social cohesion. The NGO ORCADE[13] (2006, 2013, 2018) has been monitoring these issues across Burkina Faso for over two decades, and has highlighted the build-up of grievances and frustrations caused by the mining sector, and in particular the perception among local communities that mining development has left them poorer.

13. Organisation pour le renforcement des capacités de développement (Organization for Development Capacity-Building).

3.1. Changes to the socioeconomic fabric of mining territories

The opening of a mine usually represents a profound upheaval for local communities, both in terms of their organization and their income sources. This is particularly the case for communities located in rural areas that were previously untouched by industrial activity. As mentioned above (2.3 Impact of mining on perceptions of the environment and territorial reconfiguration), above all else, the construction of a mine will physically alter the organization of the territory, reducing the area available for other uses and forcing local people to make changes to their ways of life.

The huge investment involved makes the introduction of a mine a major economic shock for the territory, since it has to surrender a very large area to the mining company for its extractive and other associated activities. The creation of new jobs directly or indirectly linked to the mining company's activities (mine employees, service providers, etc.) is one of the positive markers often associated with changes to mining territories in Africa. For example, according to a literature review published by the International Finance Corporation (IFC) in 2013, each direct job created by the Ghanaian mining industry creates an average of twenty-eight indirect or related jobs (IFC 2013).[14] As well as creating jobs, the mining company may also boost the local economy by using local suppliers, where these exist, either to supply food for the mine's employees or to provide specialist services to the mining industry (equipment rental, consultancy firms, etc.).

However, the very positive job creation aspect of the mining industry, which is frequently emphasized, tends to hide an often far more complex reality. The status of a mine as an economic enclave—i.e., its ability, or lack thereof, to involve the local economic structure—is an important topic of debate among economists (Radley 2019). Below, we summarize some of the main points of this debate as it concerns Africa, supplementing some of the points mentioned in previous sections with a social perspective.

14. See: https://documents1.worldbank.org/curated/en/157191468326714061/pdf/835080WP0IFC0J00Box382079B00PUBLIC0.pdf.

A decline in traditional activities associated with spatial reconfiguration, and the emergence of unemployment

As discussed above, the territorial footprint of a mine changes the way communities acquire and can own land. Outside the extraction area, a whole range of elements ancillary to mining of the mineral deposit, such as infrastructure (roads, housing, etc.) or storage areas for mining waste, instill in local communities a sense that they have been dispossessed of their land. This feeling of dispossession comes from restricted access to certain areas, and the degradation of areas that local communities are no longer able to use.

Land use analyses, which can be carried out using satellite data, can help provide a full picture of ongoing reconfigurations, and shed light on the ways in which these affect local communities' ways of life (Lapeyronie and Espagne 2023). Forest and agricultural areas, which are essential to the livelihoods of people in rural areas, are particularly affected by the territorial footprint of mining operations. This type of environmental degradation has been observed in the West Wassa District region of Ghana, which is home to numerous gold mines. In this region, the gold mining industry caused the loss of 58% of forest areas and 45% of farmland, following the granting of mining concessions (Schueler et al. 2011). In this particular case, deforestation was the result of the enforced relocation of farmland.

Through the loss of these key areas for local communities, the construction of a mine makes it more and more difficult, if not impossible, to continue certain traditional economic activities. In Africa, pastoralism is typically one of the activities that is most affected. Occupation of the land by the mining company can hinder or prevent part of the population from using the land, forcing them to abandon their traditional pastoral activities and move into a globalized capitalist society. The socioeconomic impact of these conflicts of use will be developed in greater detail in the next subsection.

For these people, whose traditional way of life is no longer viable, access to the jobs created by the mining company is far from guaranteed, since these jobs are often highly specialized. They are thus faced with a phenomenon that is frequently without precedent in these areas: the emergence of unemployment among those individuals who are unable to take advantage of the economic benefits brought by the mine. With the decline in traditional activities, a whole way of life is forced to evolve, and is likely to disappear, given the central cultural role played by certain practices. In this way, the sustainability of people's way of life is almost invariably compromised by the arrival of mining activities (Andrews 2018).

Rising inequality and inflation

People who are unable to take up the jobs offered by the mining company rub shoulders in the same area with nonindigenous new arrivals, including mine employees. Mineworkers benefit from higher wages, sometimes free housing and, in some cases, some form of welfare. Other migrant populations, attracted by the region's new economic opportunities, may also enter into competition with indigenous populations, and are often better prepared for changes in the mining sector's labor market. Increasing inequality in mining regions is a common feature in Africa, particularly when employment and economic opportunities emerge at the same time.

These inequalities in mining areas are also gendered. According to Kotsadam and Tolonen (2016), most of the jobs created directly and indirectly by mining are taken by men. Women, on the other hand, have more limited employment opportunities linked to mining. The situation of women may be even more greatly impacted since they no longer have as much space to enable them to produce sufficient food under subsistence farming conditions in the role reserved for them in some communities (Andrews 2018).

Lastly, as a result of both the higher wages offered by mining companies, and population growth, the opening of a mine is generally followed by localized inflation. This tends to affect two areas: *(i)* a rise in land and housing prices, which we will explore in more detail in subsection 3.3; and *(ii)* rising prices for food and other everyday consumer goods caused by the emergence of a high-income section of the population. This phenomenon is further reinforced by the geographical distancing from pastoral activities as a consequence of the arrival of mining activities.

Box 3. How environmental offset programs can contribute to deterioration of the socioeconomic fabric

Mining companies are under pressure from their investors and customers to reduce the environmental footprint of their activities. But in some cases, the programs they implement to protect the environment can have negative impacts on local communities, in particular by excluding them from the area, reinforcing the impacts previously created by implementation of the mining project itself. Two recent examples from Madagascar illustrate the potential negative effects of environmental offset policies.

The Japanese–Korean mining company that operates the Ambatovy nickel–cobalt mine, located in the heart of a tropical forest area in the Alaotra-Mangoro region (central-eastern Grande Île), sought to reduce the amount of deforestation, with the aim of achieving net-zero deforestation. To achieve this goal, the company bought up the surrounding farmland and used it to plant new forest areas. The local communities that were dependent on this land for their livelihoods saw their access restricted (Devenish et al. 2022).

QIT Madagascar Minerals (QMM), a subsidiary of the mining giant Rio Tinto—which operates the Tolagnaro titanium mine near Fort-Dauphin in southeast Madagascar—has also sought to limit its impact on local biodiversity by creating an offset area close to the mine. The company has pledged not to carry out any work in this area, and to fund programs to safeguard its flora and fauna. In this instance too, local communities' access to the area has been significantly restricted, despite its importance for subsistence activities (such as hunting and gathering).

Given the exceptional richness of Africa's natural environments, these offset programs are likely to become more widespread across the continent in the coming years. However, it is important to recognize that these initiatives can sometimes conflict with the goals of protecting the environment (SDG 15[15]) and reducing poverty (SDG 1[16]).

3.2. Conflicts of use

In the sections above, we highlighted how land grabbing, expropriation and offset processes linked to mining development, and the social and environmental impacts of extractivism are affecting local communities and bringing about changes in their relationships with land and the sociopolitical structures that used to govern both land and the norms around access to natural resources. This phenomenon has led to a shift from the semicollective system of ownership associated with "traditional" structures to a system of private and individual ownership based on the monetary value of the land, linked to changes in national legislation and the arrangements for managing natural resources imposed by mining development.

15. SDG15: "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss."
16. SDG1: "End poverty in all its forms everywhere."

The main conflict of use observed relates to the terms of negotiations that local communities understand as resulting in the relinquishment of exploitation rights for a defined period. However, these terms are transferred into written form in accordance with the procedures and standards promoted by national authorities and mining companies, resulting in the relinquishment of ownership of the land itself. The confusion resulting from the various overlapping norms, and the instrumentalization of this confusion by the proponents of mining development, encourages the people whose land has been expropriated to live initially on their payoffs and other compensation while waiting to reclaim their land, before realizing that the realities of industrial mining mean that they will never get it back. Situations of this kind often cause major social conflicts and create grievances against representatives of the national authorities, as was the case at the Essakane, Kalsaka, and Karma sites in Burkina Faso (Capitant 2016; Drechsel et al. 2018; Engels 2021; Hubert 2022; ORCADE 2018), and also at various extractive sites in South Africa (Rubin and Harrison 2015), the DRC (Ilunga Kiwende 2022; Mudinga et al. 2022), Guinea (Dessertine 2019), and Cameroon (Nguiffo and Mbianda 2013).

For the people on the receiving end of these land pressures from the mining companies, regardless of whether they are affected by expropriation, these changes redefine their relationship not only to land and money, but also to the practices and norms associated with work and economic activities. The introduction of a monetary value for land is one of the more obvious aspects of these changes, since, in traditional endogenous structures, the right to exploit certain lands or establish herds of livestock was strongly linked to an individual's social status, and also because the monetary value of land does not include the environmental services that used to be provided by the environmental resources that have been monopolized by the mine.

In many cases, as at the Essakane, Inata, Karma, and Kalsaka sites in Burkina Faso, people whose land has been expropriated and who have lost access to land and grazing areas have also lost their main economic activities, and some of the activities that had previously kept them embedded in their own communities. As noted above, increasing land pressure means that, if these people decide to reinvest the money received as compensation without waiting for the theoretical return of their land, they face the problem of finding land to farm outside the region where they live. The compensation paid to them is calculated on the basis of annual yields from their fields, but is not enough for them to live on in their own community or to diversify their activities. They are exposed to high inflation in the prices of everyday consumer goods and real estate as a result of the mining development, so the relative value of their compensation payments is reduced.

In addition, people who have lost access to land and can therefore no longer carry out their farming activities, and others located in indirect and health impact areas, find themselves in competition for access to water and unable to make their remaining agricultural and pastoral activities pay. As mentioned above, mining creates intense competition for water resources and is partly responsible for tree cover and rivers drying up, even in a tropical zone like Guinea. In water-stressed countries such as those in the Sahel, both artisanal and industrial mining activities have a major impact on ground-water and water systems, which either dry up or are contaminated. It is also not uncommon for local people to be forced to obtain running water from areas previously used for livestock. Local communities point out that once compensation payments have been exhausted, people are left with no means of subsistence, having no land on which to grow crops or feed livestock, no water resources to irrigate their crops or water their animals, and no areas where artisanal mining of mineral resources can be carried out as an ancillary subsistence activity.

In addition to conflicts of use and competition over access to resources, the establishment of an industrial mining site also produces profound changes in terms of economic activities and work. Having previously depended mainly on the primary sector, local communities turn more toward service and commercial activities, if they are able to carry these activities out as sole proprietors, or toward the salaried employment opened up by the creation of mining-related jobs. It is nevertheless important to stress that, although the proponents of mining development present job creation as a positive impact, it only benefits local communities to a limited extent.

This is because, in order to meet the firms' standards, the vast majority of jobs offered by mining sites require specialized training and/or a high school diploma—skills and qualifications that local people rarely possess, and that are not part of the training provided by the mining firms. As a result, the companies recruit their employees from the recruitment pools in the administrative regions where they are located, and then nationally and internationally. While some people from local communities do manage to find stable jobs at the mining sites, most are employed on daily contracts—sometimes consecutive, sometimes not—and hence are recruited on a day-to-day basis. These daily contracts are therefore neither regular nor stable over time, and in no way compensate for the loss of economic activity caused by the arrival of the mine. These jobs, whether in the form of salaried employment or daily contracts, also introduce a form of dependence on the mining companies, which become the main job providers and constitute the core economic activities in the regions where they are located.

Lastly, it is also important to consider the impact of the large influx of money generated by mining development. Due to the lack of banking infrastructure and the prevalence of cash in the rural areas where mines are located, most of the compensation awarded to individuals is paid in cash. However, local communities are not used to managing large sums of money, and therefore to spreading their budgets over a number of years, do not have access to banking infrastructure that would enable them to deposit large sums of money over the long term, or access to agricultural or pastoral areas in which they could invest their capital, and have no other, alternative economic activities. They are thus exposed to the theft of their compensation, to racketeering, and to predation by other actors. Scenarios such as these exacerbate the precarious situation in which they have been placed by mining development.

3.3. African mining towns

In this final subsection, we will focus on the specific case of mining towns, since some of their characteristics are important for a full understanding of the impacts of mining in Africa.

Mining towns with rapid population growth can be seen as examples of “boomtown urbanization,” a concept that refers to sudden and rapid spatial, demographic, and economic growth of rural regions driven by changing economic regimes and people’s search for livelihood opportunities (Udelsmann Rodrigues et al. 2021).

As mentioned above, the opening of a mine attracts significant numbers of people, and any towns lying close to an extraction site will usually experience a sharp increase in population. If there are no such towns, a new urban entity may be formed—either by the mining company or otherwise—to accommodate the new arrivals. It is important at this juncture to distinguish between towns founded and managed by the mining company, and towns administered in a more traditional manner. In the former case, the mining company effectively acts as an alternative government, providing jobs, housing, and most of the infrastructure. In the latter situation, the mining company's role is much more limited, with the local government holding the real decision-making power. Since the 1990s, Africa has undergone a significant process of normalization of mining towns, resulting in a reduction in the influence of mining companies, and more democratic control (Marais et al. 2022).

Greater social vulnerability

Mining towns are places where indigenous and nonindigenous people live side by side. The primary impact of the increasing demographic pressure caused by the arrival of nonindigenous people is high inflation, the most egregious consequence of which is greater pressure on land and real estate. This creates a divide with respect to access to housing and land between two groups of people: *(i)* those employed by the mining company, and *(ii)* a disparate group of temporary workers, migrants, and indigenous people. These subcommunities have different standards of living as a result of significant income disparities, with the former enjoying higher incomes.

These two groups may also not have access to the same services. The services in question are generally provided by firms external to the communities, both with regard to the mine site's supply chains (fuel, mining equipment, food, and various supplies) and the daily lives of the nonindigenous people (food, bars, prostitution, leisure activities, etc.). The same applies to access to health care. Tarras-Wahlberg et al. (2017) report significant discrepancies at the Kumba mine in South Africa, where only mining company employees and their families can access the health center provided by the firm.

Demographic pressure is also at the root of social problems, which are indirectly associated with the emergence of unemployment and inflation. These towns tend to have rising crime rates, and to experience the emergence of new phenomena such as prostitution and greater consumption of alcohol, tobacco, and drugs (Mazalto 2010). This produces an increase in disease: primarily of communicable diseases such as AIDS—a higher prevalence of which has been noted by numerous authors—but also noncommunicable diseases caused by lifestyle changes (obesity and alcoholism).

Economic dependence

Mining towns are also characterized by their economic dependence on the nearby mining activities, which has a significant impact on how they are governed. The municipal finances of mining towns are largely dependent on the revenues generated by the mining company and any potential subcontractors, and hence on the taxes on these revenues set and levied by the towns. The amounts vary with the mine's financial position, and therefore indirectly with the value of mining output, which fluctuates in line with changes in international ore prices. This has been noted by Marais et al. (2021) in relation to the town of Kathu in South Africa, which, because of volatile international prices, is unable to set a stable budget and therefore cannot finance ambitious projects that might benefit local people.

The people living in mining towns thus often remain dependent on the services offered by the mining company to those people who can access them. The economic dependence of mining town inhabitants is reinforced by the fact that the services that develop are designed to meet the needs of the nonindigenous people attracted by the mining operation, rather than those of local people. This economic dependence also raises the question of what will happen when the mine ceases operations. Combating climate change means closing a lot of coal mines. South Africa, for example, has embarked on a comprehensive plan to close both its coal-fired power plants and its mines (Marais et al. 2022). This situation raises questions about the future of the people who are economically dependent on mines, and vindicates the ambitious support plans that form part of the Just Energy Transition Partnership (JETP).[17]

Urban sustainability: The example of Kolwezi (DRC)

Lastly, it should also be noted that the proximity of homes to mining sites poses significant problems in terms of urban sustainability. The presence of industrial and artisanal mines on the immediate outskirts or even in the heart of towns (see the example of the town of Kolwezi below) can significantly damage the quality of urban housing. The Kumba iron ore mine in South Africa, which is located just a few dozen meters from the nearest houses in the town of Kathu, provides a particularly

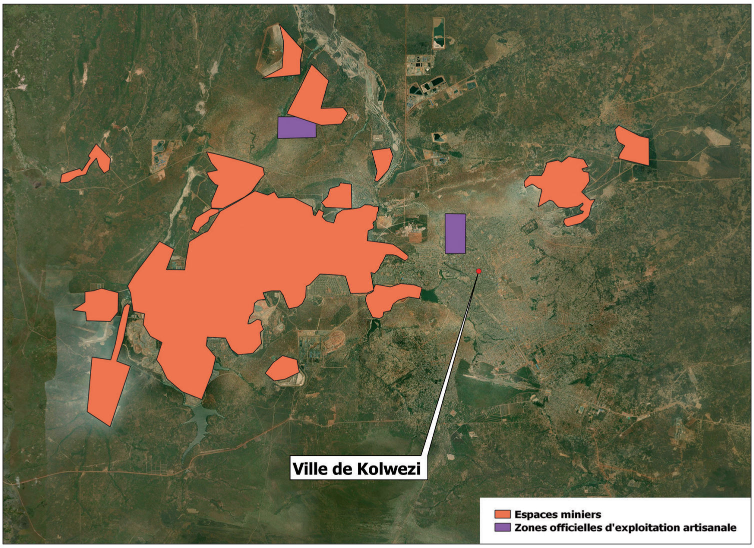
17. See https://www.afd.fr/en/actualites/eu300-million-just-energy-transition-south-africa.

concerning example. Regular blasting operations to break up the rock affect the fabric of the houses, which develop cracks as a result of the explosions (Tarras-Wahlberg et al. 2017), and those living in the most exposed areas are continually covered by dust, making living conditions particularly hazardous from a health point of view.

Box 4. Aerial view of the town of Kolwezi

If we look at the aerial image of the town of Kolwezi below, we can see how the mining areas (in orange) overlap with the rest of the town. The online mining cadastre map[18] shows that the town is in fact closely embedded in an immense mining complex that is likely to grow as new deposits are discovered and exploited. This image also shows two active artisanal mining areas (in purple) in the town itself. The discovery of cobalt deposits underneath homes triggered a full-blown gold rush in the town, disrupting the lives of the other inhabitants and weakening the structure of the houses (Geenen 2021).

Aerial view of the town of Kolwezi



Sources: Maus et al. (2022), DRC mining cadastre, authors' design.

18. Accessible online at: https://cami.cd/mes-cartes/.

The town of Kolwezi in the DRC is a particularly representative example of an African mining town, with a population that has grown from just 60,000 in 1960 to over 500,000 inhabitants today. In the 1970s, the opening of several mines close to the town, which is located in the Copperbelt, created a rapid influx of people that led to uncontrolled urbanization. In the 2010s, cobalt mining in the area around Kolwezi led to a new population boom.

Based on her extensive fieldwork in the DRC, particularly in Kolwezi, Kristien Geenen (2021) has documented how the town is literally being "gnawed away" by mining activities. This is because Kolwezi is surrounded by mines, with work taking place only a few meters from the closest residential areas. The town is also located on a major cobalt deposit, which has created an artisanal mining rush in the town itself. This activity has consequences not only in terms of pollution for the people who live close by, but also for the structure of houses, whose foundations are being weakened and are collapsing as a result of mine shafts and other underground tunnels.

4. The artisanal sector

In this final section we will focus on the artisanal and small-scale mining (ASM) sector, and present the main issues affecting it. We will adopt a geographical perspective, looking at gold panning in West Africa before turning to the key African countries in the ASM sector.

4.1. The impacts of gold panning in West Africa

Mining activities play a crucial role in the global economy, and occupy a vital position in the resource supply chain (International Council on Mining and Metals [ICMM] 2016). In West Africa, gold panning has grown exponentially over the past decade, supplying half of global gold production. In this region, gold panning is the primary source of income for millions of people. Although gold panning is regulated, it is often informal or even illegal, and so presents a number of social, environmental, and security problems.

Establishing gold panning sites has an unquestionable impact on the surrounding communities. The social impacts of these sites are complex, and vary from one area to another (Franks 2012; Kilian 2008). Generally speaking, establishing gold panning sites can encourage the development of the local economy through the creation of short- and medium-term jobs. However, this activity often leads to the displacement of local people, loss of livelihoods, and health problems caused by the use of toxic chemicals such as mercury and cyanide in mineral processing (Wilson et al. 2015). In most areas, the primary social issue arising from establishing gold panning sites relates to security, in the form of local conflicts between indigenous and nonindigenous people that can, in some instances, be extremely violent.[19] These areas are also notorious as prime locations for ambushes and looting, jeopardizing the safety of locals and travelers alike. In extreme cases, such as in the "three borders" area (shared by Burkina Faso, Mali, and Niger), funds from illegal gold panning may be used as a source of financing for terrorist activities.

Alongside these social impacts, environmental impacts are a crucial element of gold panning sites. Studies have shown that gold panning has a number of impacts on the environment, including land degradation, the destruction of tree cover, soil erosion, and degradation of water quality. Excavation of the soil disturbs the surrounding ecosystem (Raghavendra and Deka 2015). The emission of small particles dispersed by the wind creates atmospheric emissions that impair air quality. Gold panning has a direct impact on environmental biota by removing tree and soil cover (Kusimi 2008; Awotwi et al. 2018), displacing wildlife, spreading pollutants, and so on.

19. This is the case with the dispute between two brothers over the Djekoulouma gold mine in Upper Guinea, which has been going on since 2009. The land originally belonged to the brothers' parents. Each of their five sons then founded a village. The youngest brother found gold in his village, Bala, in 2008. Traditionally, this would belong to the oldest brother, who had founded the village of Wassaye. When the gold was discovered, the younger brother, the founder of Bala, broke the news to the oldest brother, and the two agreed to mine the deposit together for a year (artisanal mining in mines currently "abandoned" by the Société aurifère de Guinée [SAG]). But then conflict broke out, as each of the two brothers wanted to take control of the deposit. They both claimed ownership of the land, the younger brother as the first to arrive on the site (the person who discovered the "treasure"), and the oldest brother as the family elder, in line with tradition. There then followed a dispute to determine the true owner of the land. In 2009, clashes resulted in two people dead and sixteen injured, according to the Search for Common Ground report, "Analyse des conflits miniers en Haute-Guinée" (October 2016, pp. 20—21, https://documents.sfcg.org/wp-content/uploads/2017/09/SFCG-Guinee_Analyse-conflits-Ha-ute-Guine%CC%81e-VF-1.12.2016-1.pdf).

Photograph 1. ***Excavation of land at Saman (Kouroussa, Guinea)***

Source: Djamilatou Dabré, RAMR2D doctoral student (ACE Partner).

Photograph 2. ***Loss of tree cover and destruction of soil caused by mining in Côte d'Ivoire***

Source: Tiemoko Paul Tonga, RAMR2D doctoral student (ACE Partner).

Gold panning can therefore contaminate the soil over vast areas. Ako et al. (2014) have shown that the soil disturbed on gold panning sites contains elements such as lead, cadmium, and arsenic, which accumulate in plants and animals, and are transmitted to humans through the food chain. These elements can find their way into surface water and groundwater, making the water unfit for human consumption and directly impacting farming activities.

The impact on water quality and on the availability of surface water and groundwater resources are therefore an important aspect of the effects of gold panning, both during mining operations and in the long term. Ore extraction and processing have a quantitative impact on water resources, with conflicts of use arising from the general domestic use of the surrounding population. The impact on quality is also very noticeable. Gold panning activities have a negative impact on water quality in various ways. The products commonly used in processing are mercury and cyanide, chemicals used to separate gold from the ore by amalgamation or leaching. During both processes, some of these products can seep into surface water and groundwater. In most cases, the solid waste generated also contains significant concentrations of mercury and/or cyanide. This waste is washed away by rainwater, creating highly acidic and/or polluting effluent that may also be dispersed into surface water and groundwater (Akabzaa et al. 2007). Gold panning is a proven source of particulate water pollution; at Ity (western Côte d'Ivoire), the increase in suspended particles in the Cavally River caused by gold panners has increased its turbidity, affecting water quality and impacting the river's flora and fauna (Hué et al. 2020).

Photograph 3. ***Stagnant water near the Memer mine (Burkina Faso)***

Source: Djamilatou Dabré, RAMR2D doctoral student (ACE Partner).

Photograph 4. ***Gold washing station in a river in Côte d'Ivoire***

Source: Tiemoko Paul Tonga, RAMR2D doctoral student (ACE Partner).

One of the biggest challenges for gold panning is that of restoring sites after the ores have been extracted. Some industrial-scale mining projects have begun to restore damaged sites following mine closures, thereby complying with increasingly stringent regulations. Unfortunately, mining areas exploited for illegal or informal gold panning are completely abandoned. On top of this, neither solid nor liquid mine tailings are properly managed, but instead carelessly stockpiled out on the open ground.

Photograph 5. ***Tailings piled up at Saman (Kouroussa, Guinea)***

Source: Khalil Doumbouya, RAMR2D doctoral student (ACE Partner).

Recommendations

The extent and attraction of informal and illegal gold panning in West Africa requires all of the actors involved in mining (private operators, communities, political decision-makers and public bodies, and researchers and teachers) to be highly aware of the true positive and negative externalities described and quantified at the local level. Humanity must, as an absolute necessity, move toward a more strictly controlled and more virtuous and responsible development path at all levels, and throughout mining project and post-mining cycles. These are the challenges that face the countries of West Africa, which still have substantial untapped mining resources.

The legal and policy frameworks at the subregional organization and national levels that either have been or should be put in place must constantly adjust to the reality on the ground and in mining projects.

Greater efforts need to be made to create organizations to monitor and supervise gold panners, and to fund research and training by African Centers of Excellence on mining to ensure that it is incorporated into more sustainable and inclusive development models, since global changes and their ramifications are set to have a significant impact on Africa in the near future.

The ACE Partner 20 program, via its Activité minière responsable et développement durable (RAMR2D) (Responsible Mining and Sustainable Development) network of twenty-three African Centers of Excellence, is addressing this concern through research and the development of frameworks for dialogue.[20] The network provides funding for doctoral research, and ensures that the Niamey Declaration of June 11, 2021 for responsible mining and sustainable development is being implemented. The declaration was drawn up at the end of the Niamey "boot camp" on multilevel approaches to the impacts of artisanal and industrial gold mining in West Africa, and research topics, methodologies, and opportunities reflect this growing awareness. Additional research is currently being published on the various issues addressed, in a spirit of multidisciplinary and transdisciplinary research, using pilot study sites, and in conjunction with the relevant local, regional, and international research and training institutions. These efforts by an entire community of actors are to be welcomed and encouraged.

Harmonizing the legislation of the various countries involved in selling gold would constitute progress regarding capital flight, and would help curb the illicit mining that, because of the lack of control over this resource, poses a threat to the environment and to the security of countries from terrorism.

4.2. Key artisanal mining countries in Africa

Burundi

Almost all mining in Burundi is carried out on an ASM basis, although Burundi's ASM sector is significantly smaller in scale than that of its neighbors, the DRC and Rwanda. ASM encompasses all of Burundi's gold production, amounting to three tonnes annually. This sector employs almost 34,000 workers, in mainly rural areas, and brings in substantial foreign currency earnings to the Burundi treasury. Small-scale mining operations, if formal, belong to cooperatives or associations, in accordance with the 2013 mining code, but there are high

20. The ACE Partner program is designed to support the organization of research by creating a network of African Centers of Excellence specializing in a range of areas (water, mines, health, and digital). The program is financed by the Agence française de développement (AFD) (French Development Agency) with technical support from the Institut de recherche pour le développement (IRD) (French National Research Institute for Sustainable Development): see https://ace-partner.org/ramr2d/en/centres/; https://ace-partner.org/en/news/.

levels of informal mining. A review of Burundi's artisanal gold mining sector carried out by the International Peace Information Service (IPIS) in 2015 also highlighted the importance of this sector and the need to include it in efforts to improve certification, since Burundi plays a key role in the illegal trade involving gold from ASM in eastern DRC.

The end of the civil war and the installation of a new regime in 2005 enabled Burundi to open up to mineral exploration, and several investors ventured into the country, attracted by the favorable trend in the prices of the ores found in its subsoil, and the reform of its mining code (2013). Samancor, a South African company, obtained an exploration permit for nickel in Musongati in 2007, the Canada-based Flemish Gold Corporation obtained an exploration permit in 2010, and the Russian–Lebanese company Tanganyika Mining Burundi was granted one in 2013. Several companies—including Morgan Mining, Ntega Holding Burundi, and Rainbow Mining Burundi—even signed agreements in 2015, despite the political and security crisis that shook the country that year. Some companies have even recently successfully reached the production phase of their mining projects.

But this incipient industrialization is taking place on the background of what remain difficult conditions: the opacity of the artisanal sector and the failure to regularize it, high levels of gold smuggling, a lack of coordination between the financial and technical authorities, a lack of infrastructure, a budget crisis, and corruption. The reform of mining governance initiated prior to the 2015 political crisis has been abandoned, with the authorities focusing primarily on collecting the profits from the artisanal and industrial mining sectors. The initial mining investments in Burundi are therefore already being criticized by civil society, and represent a considerable political and financial risk (Vircoulon 2019). Local communities are particularly critical of the eviction of artisanal miners, and the low level of compensation offered by the mining companies.

Ghana

Artisanal gold panning plays a major role in Ghana's gold mining sector, producing almost a third of the country's gold output up to 2020, and employing almost a million people.

The sector is nevertheless a focal point for tensions, not least because of the extensive pollution caused by the gold panners' use of mercury. The public outcry generated by the trial of Chinese national Aisha Huang, dubbed the "Galamsey Queen" by the press, is a case in point. Huang, who was accused of illegal gold mining, was arrested in 2017 but managed to flee the country under mysterious circumstances, before finally appearing as a defendant on this charge in September 2022.[21]

The environmental impact of artisanal gold panning in Ghana is huge. Barenblitt[22] et al. (2021) estimate that, on average, artisanal gold panning accounts for 30% of Ghana's gold production, but over the period 2007–2017 caused seven times more deforestation than the industrial gold sector. They also found that, between 2005 and 2019, Ghana lost 160,000 hectares of its tree cover, 28% of which was attributable to industrial and artisanal gold mining. Of this 28%, artisanal mines accounted for 85.7% of the loss, and industrial mines for 14.3% over the period in question.

Furthermore, unlike industrial mining companies that can use heavy machinery to dig deep holes in a concentrated area that they are subsequently required to refill, artisanal miners tend to dig a large number of shallow holes over a wide area that they typically do not refill. They also use mercury to extract gold from sediments, leading to serious health problems and long-term contamination of water and soil. Henry Ofosu Addo, a researcher in environmental health at the University of Ghana, has warned of the danger that Ghana may have to import water if the contamination of its rivers by "galamseyers" continues.[23]

Another challenge posed by artisanal gold panning, particularly as practiced by galamseyers, is that it is extremely attractive: many Ghanaians leave their jobs to take up artisa-

21. Marine Jeannin, "Au Ghana, la délicate affaire Aisha Huang, 'reine' chinoise de l'orpaillage clandestin," *Le Monde Afrique,* October 6, 2022, accessed November 14, 2024, https://www.lemonde.fr/afrique/article/2022/10/06/au-ghana-la-delicate-affaire-aisha-huang-reine-chinoise-de-l-orpaillage-clandestin_6144747_3212.html.
22. Researcher at NASA's Goddard Space Flight Center.
23. "Ghana May Import Water if Galamsey is not Banned by Law—Researcher Predicts," *GhanaWeb*, December 10, 2022, accessed November 14, 2024, https://www.ghanaweb.com/GhanaHomePage/NewsArchive/Ghana-may-import-water-if-galamsey-is-not-banned-by-law-Researcher-predicts-1677899.

nal gold panning, which offers higher wages, ranging from 300 to 500 GHS per day.[24] Many students have thus dropped out of their studies to become miners, and have been joined by teachers and school directors.

There have been a number of calls for a ban on artisanal gold panning, to which George Mireku Duker, the Deputy Minister of Lands and Natural Resources, responded on November 29, 2022.[25] Since artisanal gold panning contributed "about 40 per cent of the country's total gold production"[26] and employed over a million people, he argued that it had a huge role to play in the Ghanaian economy and should therefore not be banned. He nevertheless recognized the need to enforce regulations in the industry, and noted that Ghana's artisanal sector was considered one of the best in Africa.

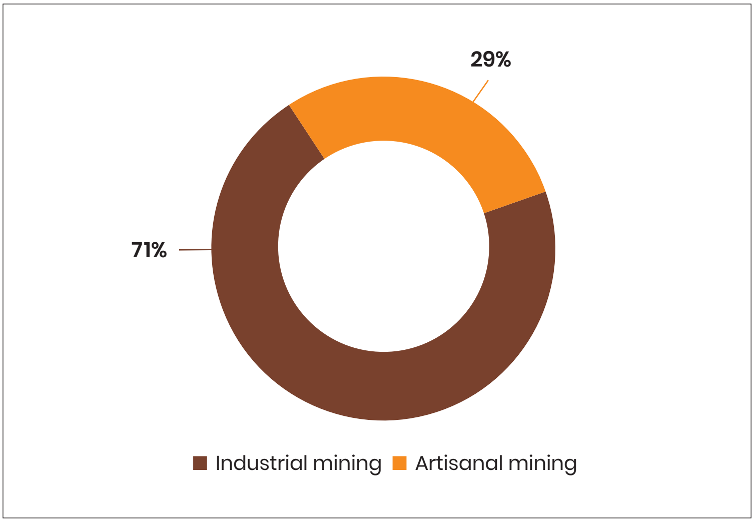
Democratic Republic of the Congo (DRC)

Coltan mining in North and South Kivu is on the radar of NGOs and other organizations because of the working conditions of an estimated 50,000–200,000 miners in this industry. These miners work outside any legal framework: without employment contracts, a social safety net, fixed working hours, insurance, or medical care, and are paid based on the quantity of ore they produce. Trafficking flourishes around the mines, particularly in relation to prostitution. The long-term health effects of coltan dust, which is slightly radioactive, also remain unknown.[27]

A large proportion of those employed in artisanal mining are children and young people (nearly 40,000, according to the Institute for Security Studies [ISS]).[28] The child miners, whose job it is to dig in the mines (often with their bare hands or rudimentary tools) and wash the ore, are exposed on a daily basis to the low levels of radon contained in coltan. They also fall prey to human trafficking networks, and to the many armed groups operating in the region that seek to recruit them as child soldiers.

24. Ghanaian cedi (Ghana's national currency).
25. "No Ban on Small-Scale Mining—Mireku Duker," *GhanaWeb*, December 1, 2022, accessed November 14, 2024, https://www.ghanaweb.com/GhanaHomePage/NewsArchive/No-ban-on-small-scale-mining-Mireku-Duker-1672682.
26. The figure itself is hard to pin down: estimates generally hover around 30% up to 2020. According to the Ghana Chamber of Mines, however, artisanal production recorded by export companies declined significantly in 2021.
27. Sophie Langlois, "Du sang dans nos cellulaires," CBC/Radio-Canada, May 12, 2019, accessed November 14, 2024, https://ici.radio-canada.ca/info/2019/05/coltan-republique-democratique-congo-mines-enfants/.
28. The primary focus of the research undertaken by the Institute for Security Studies (ISS) is the main threats to human security in Africa.

Graph 1. ***Most diamond production comes from artisanal mining (measured in carats)***



Source: Authors based on information from the DRC's Ministry of Mines (2021).

The amount of coltan derived from child labor is difficult to track, since it is extracted illegally and introduced into the global supply chain via smuggling, counterfeiting, and collusion. The DRC government has adopted a number of measures to put an end to child labor in the mining industry: *(i)* the 2018 mining code penalizes the use of child labor and the sale of ores extracted by children; and *(ii)* the Centre d'expertise, d'évaluation et de certification des substances minérales précieuses et semi-précieuses (CEEC) (Center for Expertise, Evaluation, and Certification of Precious and Semiprecious Minerals)—a technical public service of the Ministry of Mines that was created in 2009—is responsible, among other things, for establishing a tracking and certification system for coltan. The DRC has also joined *(i)* the Regional Certification Mechanism (RCM) of the International Conference on the Great Lakes Region (ICGLR) as part of the Regional Initiative against the Illegal Exploitation of Natural Resources (RINR),[29] and *(ii)* the Kimberley Process Certification Scheme (KPCS).[30] The DRC was

29. The RCM is one of six RINR tools used by the ICGLR member states.
30. The KPCS, which was launched in January 2003, provides certainty with regard to shipments of rough diamonds by certifying that they are not conflict diamonds (defined as rough diamonds used by rebels to finance wars against governments around the world).

also involved in the process for drawing up the "OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas" (the Lusaka Declaration, adopted on December 15, 2010). Lastly, the DRC was indirectly affected by application of Section 1502 of the Dodd–Frank Act (US legislation passed in July 2010) concerning due diligence with regard to specific conflict minerals.[31] The country's involvement in these various processes has not yet led, however, to a complete end to the economic exploitation of children.

Coltan, cassiterite, and wolframite, and by extension tantalum, tin, and tungsten respectively are sometimes also called "blood minerals" (Boltanski 2014), because they contribute to armed conflict. In eastern DRC, mineral exports increase the risk of war since they help finance rebel groups (who regularly perpetrate extortion), exacerbate government corruption, stir up secessionist sentiment, and undermine the indigenous population. Although initiatives such as the one launched by the European Union (EU) (2017)[32] aim to improve transparency, the situation is still far from perfect.

Guinea

Guinea is experiencing a boom in artisanal gold panning. Artisanal gold panning is not usually authorized, although it is particularly widespread in Upper Guinea since it is legal there—the cultural legacy of centuries of gold mining to supplement income from agricultural work. Over the past thirty years or so, there has been a veritable gold rush, probably caused by rising gold prices, access to new production technologies, and increasing poverty among the local people. Today in Upper Guinea, gold panning is particularly prevalent around the Dinguiraye, Kankan, Kouroussa, Mandiana, and Siguiri prefectures.

This boom has had a number of consequences: *(i)* gold mining has become permanent rather than seasonal; *(ii)* the number of gold panning sites (nearly 200 recorded in Guinea) has increased rapidly, leading to more accidents and environmental degradation; *(iii)* a massive influx of gold panners—

31. The four "conflict minerals" that are particularly targeted are widely used in the high-tech industries: tantalum (from coltan deposits), tin (extracted from cassiterite), tungsten (extracted from wolframite), and gold.
32. "Regulation (EU) 2017/821 of the European Parliament and of the Council of 17 May 2017 laying down supply chain due diligence obligations for Union importers of tin, tantalum and tungsten, their ores, and gold originating from conflict-affected and high-risk areas."

their numbers are reported to have increased fivefold in the space of thirty years: in 2016, the Extractive Industries Transparency Initiative (EITI) put the figure at 221,923 gold panners; and *(iv)* gold panners moving between the various sites, leading to an increase in the number of temporary camps and the growth and urbanization of local villages. In 2016, the volume of gold exports from traditional mining (gold panning) was more than half of that from industrial gold mining: 11.8 tonnes (USD 395 million) compared to 18 tonnes (USD 612 million) (Arnould 2019).

Gold panning is growing in the vicinity of the Lefa mine owned by the Société minière de Dinguiraye (SMD) (Dinguiraye Mining Company), for example: the mine's profitability attracts the gold panners, who come in their thousands from all over the country, as well as from Burkina Faso and Mali, into the areas adjacent to the mine, leaving behind them devastated land and mercury-polluted rivers once veins have been exhausted.[33] According to a 2015 study by the Centre du Commerce International pour le Développement (CECIDE) (Center for International Trade for Development), a Guinean NGO, mining areas have the highest concentration of violent social conflicts.

Artisanal gold panning is outside the control of the mining authorities, but the state recognizes the practice and is seeking to formalize it. As a result, gold panning is governed by the country's mining code, environmental code, and water and forestry code, and is authorized solely for Guinean nationals who belong to employers' organizations such as the Coordination nationale des diamantaires et orpailleurs de Guinée (CONADOG) and the Association des groupes des orpailleurs de Guinée (AGOG). The state has also launched consultations, set up a technical department to supervise gold panning, identified specially reserved "gold panning corridors," and launched the Mining Sector Governance Support Project (PAGSEM). In 2017, gold panners, local elected officials, the authorities, elders, and civil society actors reached a historic agreement on a 20% tax levy to fund local development. Nevertheless, the situation remains difficult, particularly for migrant workers,[34] while the obvious fact that artisanal gold prospecting exists alongside industrial activity is sometimes a source of tension.

33. Christophe Châtelot, "En Guinée, la mine d'or de Nordgold empoisonne la vie des habitants," *Le Monde*, October 13, 2018, accessed November 14, 2024, https://www.lemonde.fr/long-format/article/2018/10/13/en-guinee-la-mine-d-or-de-nordgold-empoisonne-la-vie-des-habitants_5368992_5345421.html.
34. International Organization for Migration, Displacement Tracking Matrix, "Conditions des migrants orpailleurs étrangers en Guinée: Siguiri, Rapport #1, octobre 2020," accessed November14,2024,https://dtm.iom.int/reports/guin%C3%A9e-%E2%80%94-rapport-sur-les-conditions-des-orpailleurs-%C3%A9trangers-en-guin%C3%A9e-pr%C3%A9fecture-de.

Burkina Faso

Gold panning is a very old activity in Burkina Faso: according to Burkinabé archaeologist Jean-Baptiste Kiéthiéga, it has been practiced in the country since at least the fifteenth century. Over the last two decades, however, it has reached an unprecedented scale (Bohbot 2017). The National Survey on the Gold Panning Sector (ENSO) (Zouré et al. 2017), conducted by the National Institute of Statistics and Demography (INSD) in 2016, estimated that there were 448 artisanal gold production sites and 140,196 people engaged in this work in the country. The United Nations Development Programme (UNDP) estimates that the sector employs nearly 1.3 million people. While artisanal production is mainly concentrated in the regions located in the southwest (4.7 tonnes, or 50% of total production; 33% of the workforce; 61 production sites) and the north (2.4 tonnes, or 25% of total production; 24% of the workforce; 61 production sites), in 2016 gold panning nevertheless took place in 12 of Burkina Faso's 13 regions, according to the ENSO.

Gold production declared by artisanal agencies amounted to 0.3 tonnes, which was worth USD 12.9 million in 2020. This actually represents only a tiny fraction of artisanal production, a large part of which remains outside official channels. According to the ENSO, production was estimated at 9.5 tonnes in 2016, which was worth 232 billion CFAF. Bohbot (2017) highlights the discrepancy between declared and actual production, with the latter being much higher than the former. He shows that Togo, a country with no industrial gold mines on its territory, exports several tonnes of gold; the Swiss NGO Public Eye has traced its provenance to artisanal gold panning sites located in northern and western Burkina Faso. Artisanal gold production includes production carried out by *(i)* pit managers (the most common method), *(ii)* gold miners who sweep, scrape, and collect gold, *(iii)* gold miners who dig small pits, and (iv) gold miners who reprocess discards. Gold panning requires substantial investment: the ENSO estimates that the total amount of investment made by pit managers and other operators came to 6.8 billion CFAF (USD 10.9 million) in 2016, mainly concentrated in the regions located in the southwest (3.016 billion CFAF, equivalent to USD 4.8 million) and the north of the country (1.253 billion CFAF, equivalent to USD 2 million).

Agriculture is the main source of employment (accounting for 80% of the population), but climate conditions—two-thirds of Burkina Faso's territory is located in a semiarid area (Sahelian and Sudano–Sahelian zones)—and economic conditions—global market prices for raw materials, particularly cotton, are subject to fluctuation—are forcing people to seek additional sources of income. As a consequence, gold panning is a popular activity since it requires little initial investment and occupies part of the available workforce created by the significant increase in the population since the 1980s. Gold panning has a major impact on the local economy: mining sites are often located a long way from towns, and so produce “boom towns” that grow in an uncontrolled manner close to artisanal mining sites, and contain mining-related businesses.

Gold panning causes significant environmental degradation, including deforestation, destruction of arable land, and water and soil pollution. Lankouande and Maradan’s 2013 report, *Coût de l’inaction de la gestion des produits chimiques dans le secteur minier et agricole* (The Cost of Inaction in the Management of Chemicals in the Mining and Agricultural Sectors) estimated the damage caused at USD 24 million in 2011. No doubt this figure has since risen sharply with the boom in gold panning.

As a result of the extremely poor health and safety conditions associated with gold panning (landslides, flooding of galleries, exposure to mercury, etc.), this activity also causes numerous health problems, including cardiovascular disease, respiratory disease, infertility, and allergies. The growth of prostitution and drug use at mining sites further increases the unsafe practices and diseases to which gold panners are exposed. In addition, violence occurs frequently at these sites: the discovery of a new vein triggers an influx of people from all over Burkina Faso and neighboring countries, which can create tensions with local populations or between the gold panners themselves as they seek to claim the resources at any cost (Bohbot 2017). The presence of children on mining sites should also be noted [35] : the NGO Terre des Hommes Suisse estimates that children make up 30% of the workforce (the NGO counted 2,000 at the four sites where it was active in 2017).

Zimbabwe

ASM provides a living for people from a wide range of backgrounds, from school students who finance their education by working in the mines, to farmers who work in them

35. “Les enfants mineurs, victimes de la ruée vers l’or au Burkina Faso,” Jeune Afrique, March 22, 2014, accessed November 7, 2024, https://www.jeuneafrique.com/148268/archives-thematique/les-enfants-mineurs-victimes-de-la-ru-e-vers-l-or-au-burkina-faso/.

during the dry season. There are different levels of organization in the ASM sector, ranging from individual miners to cooperatives that belong to the Zimbabwe Miners Federation (ZMF) and pay money to mining license holders. Most miners belong to syndicates that typically comprise between five and twenty miners. Some syndicates operate illegally in disused industrial mines. Gold mines are a source of violence between rival gangs. In 2020, for example, the police arrested 56,764 people as part of two operations, "Chikorokoza Ngachipere" and "No to machete gangs." While some miners did actually belong to the "machete gangs" and had committed violent acts, the only thing many of them did wrong was not to have a mining license.

Une importante partie de la production d'or, provenant principalement de l'EMAPE, continue d'être vendue clandestinement hors du pays, notamment dans des circuits dont les destinations finales sont les Émirats arabes unis (EAU) et, dans une moindre mesure, l'Inde (Martin, 2019). Le ministère des Finances et du Développement économique estime qu'en 2019, le Zimbabwé n'a pu empêcher un flux de contrebande d'or estimé entre 30 et 34 tonnes vers l'Afrique du Sud. Le ministère évalue la contrebande dans le secteur aurifère à un montant de 1,2 Md USD par an environ, soit plus du quart des recettes annuelles espérées.

A significant percentage of gold production, mainly from ASM, continues to be sold illegally outside the country, particularly via routes ending in the United Arab Emirates (UAE) and, to a lesser extent, India (Martin 2019). The Ministry of Finance and Economic Development estimates that, in 2019, Zimbabwe failed to prevent an estimated thirty to thirty-four tonnes of gold being smuggled to South Africa. The ministry estimates smuggling in the gold sector to be worth approximately USD 1.2 billion a year, or more than a quarter of expected annual revenues.

Losses of gold can be attributed to organized crime in the gold ASM sector. They are facilitated by a system that takes advantage of the legal vacuum governing the sector, and the influence of the political actors involved. According to the Zimbabwe Environmental Law Association (ZELA),[36] the unofficial nature of the gold sector has a connection with political interests. The high-profile arrest of Henrietta Rushwaya offers a prime example of the suspected links between smugg-

36. "Illicit Gold Trade and Smuggling: Vulnerabilities Exposed by Rushwaya Case," Zimbabwe Environmental Law Association (ZELA), November 13, 2020, accessed November 14, 2024, https://zela.org/illicit-gold-trade-and-smuggling-vulnerabilities-exposed-by-rushwaya-case/.

ling syndicates and political elites: Rushwaya, the niece of the Zimbabwean president (Emmerson Mnangagwa), and herself president of the ZMF, was arrested in December 2020 at Harare international airport with almost 6 kg of gold (with an estimated value of nearly USD 366,000) in her luggage, as she prepared to board a flight to Dubai (UAE). Although she was eventually acquitted in 2022, investigations and reports by NGOs such as ZELA and the Centre for Research and Development (CRD) revealed that the high level of corruption in security at Zimbabwe's international airports facilitated illegal gold smuggling.

Artisanal miners are linked to the clientelist machine. In his book *Architects of Poverty: Why African Capitalism Needs Changing*, Moeletsi Mbeki (2009) describes a "Minerals–Energy Complex" controlled by oligarchs—who wield substantial influence over key aspects of Zimbabwean economic and political policy—and explains how these high-level illicit networks have become a central feature of the Zimbabwean economy. As described in the International Crisis Group (ICG) report, politicians may derive income from artisanal gold mining by extorting money from artisanal miners or protecting them from possible arrest, while others may own mineral processing plants or "sponsor" artisanal miners by covering their operating costs in exchange for a share of the proceeds from the sale of their output. Several politicians have been accused of encouraging artisanal miners to take over industrial mines. In 2019, for example, a court found former ZANU–PF[37] parliamentarian Vongai Mupereri guilty of encouraging artisanal miners to work illegally in the Gaika gold mine. Politicians also use artisanal miners for electoral purposes.

Diamond mining is controversial, not only because its operations, ownership, and governance are opaque, but also because of the human rights abuses it produces. The discovery of one of the world's richest diamond deposits in Marange in 2006, and the subsequent arrival of 30,000 artisanal miners in the region over the following two years, marked the beginning of a decline in living conditions for local communities. The diamond rush created a water, sanitation, and housing crisis, as well as an increase in black market smuggling and violence. The situation worsened when the government of former president Robert Mugabe, who ruled the country for thirty years, decided to abolish artisanal mining and invite in

37. The Zimbabwe African National Union–Patriotic Front (ZANU–PF) is the party of current president Emmerson Mnangagwa.

the big mining companies: in 2008, almost 200 miners were killed in Operation Hakudzokwi ("No Return") and, in 2009, nearly 5,000 people were displaced from Chiadzwa to Arda Transau. The relocated villagers were supposed to receive arable and grazing land, USD 5,000 compensation, and infrastructure from the mining companies: in reality, the schools and houses that were built are of poor quality, the displaced people have received at best only a fraction of the compensation, some basic infrastructure such as electricity has never been installed, and schools and clinics are a long way from any housing. The surrounding area is also covered with checkpoints—venturing into the Marange Diamond Fields can lead to severe beatings.[38]

Protests are emerging in Marange, with local people insisting that the profits from the diamond industry should benefit the region. In 2021, the Zimbabwe Consolidated Diamond Company (ZCDC) reportedly exceeded its production targets and made a net profit of USD 60 million, but this money is unlikely to be used for local development or to increase miners' wages. Villagers point to loopholes in the legal framework, which does not require some of the wealth from diamonds to benefit local communities. The Zimbabwe National Diamond Policy, which was adopted in 2018, requires the state to allocate 5% of profits from diamonds to a community share trust, but this provision is rarely followed. In addition, the sector remains opaque and has a history of widespread corruption: international groups estimate that Mugabe personally extracted around USD 2 billion from Zimbabwe's diamond industry. In 2021, the Zimbabwe Revenue Authority (ZIMRA) was approached by a whistleblower claiming to have proof that diamond mining firms in Chiadzwa were involved in tax evasion.[39]

38. Farai Shawn Matiashe, "Zimbabwe's diamonds bring wealth for a few, despair for many," *African Arguments*, March 2, 2022, accessed November 14, 2024, https://africanarguments.org/2022/03/zimbabwe-diamonds-bring-wealth-a-few-despair-for-many/.
39. "Explosive dossier exposes Chiadzwa gems tax sleaze," *Mining Zimbabwe*, September 24, 2021, accessed November 14, 2024, https://miningzimbabwe.com/explosive-dossier-exposes-chiadzwa-gems-tax-sleaze/.

Conclusion

The opening of a mine always gives rise to a series of social and environmental impacts that vary according to local and national contexts. However, the literature that deals specifically with Africa is limited, unlike other parts of the world. African governments will nevertheless be able to make mining projects part of a national strategy for sustainable development if they have a better understanding of how such projects operate, how they are governed, and what their impacts are.

In this chapter, we have addressed the question of how mining codes determine the governance of mining in Africa, highlighting the importance of international norms. We have also examined the implementation of mining projects, illustrating the challenges associated with environmental impact assessments and negotiations with local communities. We have discussed the territorial impact of mining, including pressure on land and water resources, changes in ownership regimes, and environmental pollution and its impact on health. We also touched upon the socioeconomic changes brought about by mining, including changes to traditional economic activities, social tensions, inflation, and economic inequalities.

Against a backdrop of competition between the world's major economies to secure access to mineral resources, this summary of the numerous challenges facing mining projects in Africa should act as a warning against the risk of deliberately turning a blind eye to the industry's negative impacts in order to rapidly achieve this objective. Such an omission could jeopardize efforts to combat climate change, measures to protect biodiversity and, more broadly, work to achieve the SDGs set out in Agenda 2030, by repeating the mistakes of the past that led to abusive economic exploitation of developing countries.

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Mineral processing: Outlook and strategies

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Chapter 4

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Mineral processing: Outlook and strategies

Introduction

Creating local added value from the mineral wealth located in Africa's subsoil is undoubtedly the key to industrialization. In recent years, however, there has been very little discussion of refining and further processing minerals at the point of production. Instead, there has been greater emphasis on adopting national and international rules for responsible supply chains, and on ensuring that income obtained from the sale of subsoil assets is collected in a transparent manner and transferred into national budgets. The prospect of processing has arisen with respect to traditional minerals (iron, aluminum, copper, gold, diamonds, etc.), and also for development minerals (gypsum, barite, etc.) in respect of which African economies have the opportunity to join the global value chain. It is now also of interest in relation to the new strategic transition minerals (cobalt, lithium, graphite, etc.), for which some countries are already discussing setting up processing plants, notably for producing batteries. The mining sector is being encouraged to seize these processing opportunities in order to take advantage of its human, physical, technological, and financial resources, with the dual aim of realizing the sector's development potential, and helping achieve the Sustainable Development Goals (SDGs). This might be considered somewhat wishful thinking given that all actors (from countries and states to investors, operators, and citizens) are pursuing the same objective. Africa's minerals are already part of global value chains (GVCs), since most production is exported. The following questions therefore need to be addressed:

- How are the GVCs for these products organized?
- What role do African countries play in the mineral supply strategies of major economies?
- What processing capability is there in African countries?
- What policies need to be put in place to support mineral processing?

To answer these questions, we will begin this chapter by discussing the way in which mineral processing GVCs are organized, and the position of African countries within them. In the second section we will look at the investment strategies being implemented in Africa for "critical" minerals and other metals. The third section will provide an overview of current mineral processing projects and the outlook for them. In the fourth and final section we will review the policies needed to support this mineral processing agenda, in terms of trade policy and logistics and energy infrastructure.

1. How are global value chains organized?

In this first section we will focus on describing how the global value chains (GVCs) for the various major metals present in Africa are organized, and show the position of African countries within them. We will consider the production chains for each mineral separately, since they each make different economic contributions and have different features at each stage.

1.1. The stages of processing in the mining sector

The organization of production chains is an interesting question to consider, as a rough comparison of production and export figures for minerals and mineral concentrates shows that, with the exception of copper and manganese, more than 85% of minerals mined in Africa are exported directly. While some of the mineral production is of course exported to other African countries, most is exported outside the continent. (It should be noted that the differences in the amounts of these two variables can also be explained by storage or stock management operations, and not solely by local consumption.)

Table 1. ***Production and exports in 2020 (USD millions)***

MINERAL	PRODUCTION	EXPORTS
Lead	174	173
Silver	221	194
Tin	395	385
Zinc	1,143	620
Nickel	1,220	954
Aluminium	2,797	3,590
Cobalt	2,899	2,711
Platinum	3,606	3,431
Iron	5,254	8,655
Palladium	5,580	4,872
Chromium	6,523	4,480
Manganese	12,072	4,993
Copper	16,815	1,515
Gold	40,339	54,283

Source: Authors based on S&P and UN Comtrade data.

The ore extracted from a mine is rarely directly used as a finished product (metals and minerals), but must first undergo an initial processing stage in a processing plant, which is a preliminary stage in metallurgy. This initial processing may be carried out on site in Africa. Metallurgy also includes other activities such as smelting, refining, and the manufacturing of finished and semifinished products. Based on research carried out by the European Commission (2020), Tables 2 and 3 show the major operations involving ores. The production of tradable products can be divided into four stages, namely:

(i) extraction and (upstream) concentration with ore processing;

(ii) processing[1] into a bulk base commodity or into an intermediate product such as a metal alloy (upstream/midrange);

(iii) manufacturing: conversion into a refined product, ready for purchase by a manufacturer (midrange);

(iv) use: manufacturing of the finished product ready to be made available to consumers (downstream).

In order to help the reader understand the position of African economies in the GVCs of these minerals, Table 2 presents a breakdown of the production chain for ten minerals that accounted for 95% of mineral exports (by value) from Africa over the period 2018–2021, and Table 3 presents the same information for ten further minerals of interest. These tables do not include the final stage relating to use of the finished product by companies at the end of the GVCs. The World Customs Organization's Harmonized System (HS)[2] classification codes are specified in the tables.

Bauxite is the main raw material used to produce primary **aluminum** (aluminum can be recycled easily into secondary aluminum, a process done extensively when prices are high), and typically contains more than 40% aluminum oxides (Al_2O_3). It is refined into an intermediate product, alumina, or aluminum oxide (Al_2O_3), which is then reduced to aluminum by electrolysis.

Cobalt is mainly extracted as a by-product of copper or nickel mining. Data from 2017 show that 56% of the global primary supply of cobalt comes from copper mines, and 37% from nickel mines (source: S&P Global Market Intelligence). Only 7% of global cobalt supply comes from mining operations where cobalt is the main product (Morocco). Ores and concentrates containing cobalt are generally processed into intermediate products before they can be turned into refined products. Cobalt products include *(i)* cobalt metal in the form of cathodes, briquettes, ingots, granules, and powder; and *(ii)* cobalt chemicals such as cobalt oxide, cobalt carbonate, cobalt chloride, cobalt sulfate, cobalt hydroxide, cobalt oxalate, and cobalt acetate.

1. Mineral processing consists of a series of mechanical procedures designed to ensure that the material can be exploited commercially, which involve processing the raw material into metals or concentrates. Depending on their mineralogical form, copper and cobalt can, for example, be either oxides or sulfides.
2. Commodity description and coding system used worldwide.

The **copper** ores mined typically contain between 0.5% and 3% copper. Once the ore has been extracted, the first phase of mineral processing is concentration, which increases the copper content to around 25 to 35%. Concentration is carried out at the mine site and includes crushing and grinding stages, followed by physical and chemical processing involving concentration and recovery. During the subsequent smelting process, the copper concentrate is transformed into a "matte" containing 50–70% copper. Conversion into pure copper (using a hydrometallurgical or electrometallurgical process) produces refined copper cathodes (99.99%).

Chromium is obtained by extracting chromite, a mineral made up of chromium and iron. The main product obtained from refining chromite ore is ferrochromium, which is an essential component in the manufacturing of stainless steel, a key material in a variety of industries and end uses. Chromium gives stainless steel its corrosion-resistant properties. In general, the presence of chromium as an alloying element in steels and nonferrous metals increases their strength and resistance to corrosion, temperature, and wear.

Iron ore is graded at the extraction stage (first stage). The second intermediate stage in the value chain is the production of pig iron, direct reduced iron, granules, and iron powder. At the processing/refining stage (third stage), grading includes raw steel, defined as steel in its first solid (or usable) form, including ingots, semifinished products (blooms, billets, and slabs) by continuous casting, and liquid steel for castings. Products from downstream steel mills are considered to belong to the processing stage (stages 1, 2, 3, etc.).

At the extraction stage, **manganese** is sold in the form of manganese ores. It is used in the manufacturing of alloys (ferromanganese and silicomanganese) that are mixed in blast furnaces or electric furnaces during the manufacturing of cast iron and steel.

Phosphate rock is used in mineral fertilizers, animal feed, and other applications such as detergents, chemicals, and food additives. Elemental phosphorus, which is obtained from phosphate rock, is used in the manufacturing of chemicals.

The **platinum** group metals (PGMs), or platinum group elements (PGEs), comprise six elements: platinum (Pt), palladium (Pd), rhodium (Rh), ruthenium (Ru), iridium (Ir), and osmium (Os). Almost all platinoids derived from raw materials (i.e., from mining production) are sold as refined metal produced by integrated mining and metallurgical operations. Since refining takes place mainly in the countries of extraction, these are also the main exporting countries.

Gold is graded at the extraction stage and processed into high-grade bullion (95%). Refined gold (99.9%) and its alloys are sold in a wide variety of forms, including raw gold, plated gold, powder, granules, bars, rods, wires, plates, strips, foils, tubes, and pipes. Most gold is sold in its refined form. Gold is mainly used in the manufacturing of bullion (central banks) and jewelry. The demand for gold for technological purposes is relatively low (7.6%).

Rough **diamonds** undergo an initial sawing process that involves cutting them into several pieces so as to slowly turn them into beautiful, faceted gemstones. Next, the rough diamonds undergo an abrasion process to make the separate stones round in shape. The next step in the cutting and polishing process is to form facets in the diamonds.

1. La transformation d'un minerai consiste en une série de procédures mécaniques visant à rendre le matériau exploitable commercialement ; il s'agit de transformer la matière brute en métaux ou en concentrés. Selon leur forme minéralogique, le cuivre et le cobalt peuvent, par exemple, être des oxydes ou des sulfures.
2. Système de désignation et de codification des marchandises applicable au niveau mondial.

Table 2. ***Breakdown of the production chain (1)***

ORE	EXTRACTION RAW MATERIAL	PROCESSING PROCESSED MATERIALS	PRODUCT MANUFACTURING (FINISHED OR SEMIFINISHED)
Aluminium	Bauxite (26.06)	Residus (26.20.40), Alumina (28.18), Fluorite (28.26.12), Chlorite (28.27.32)	Semifinished: Aluminium (76.01-76.02) Finished: aluminum sheets, bars, and rods (76xx)
Cobalt	ores and concentrates (26.05)	Cobalt intermediates: hydroxides and oxides (28.22), chloride (28.27.39), sulfates (28.33.29), carbonates Metals (cathodes, briquettes, ingots, granules, and powders), cobalt mattes (81.05.20)	Finished: chemical battery, superalloy, hard materials (81.05.30)
Copper	Copper ores and concentrates (26.03)	Oxydes et hydroxydes, sels de cuivre (28.25.50 Cuivre brut (74.02), mattes (74.01), affiné (74.03)	Finished: sheets, tubes, pipes, copper powder (74xx)
Chromium	Chromium ores and concentrates (26.10)	Chromium oxides and hydroxides (28.19) Ferrochromium, foundry sand, refractory chromite, chromium-plated metal (72.02.41)	Stainless and alloy steel products, casting molds, bricks and mortars
Iron	Iron ores (26.01)	Iron oxides and hydroxides (28.21) Pig iron; iron from direct reduction; granules and iron powder; raw steel (72)	Steel products (flat, laminated, cast, and rolled steel) (73)
Manganese	Manganese ores (26.02)	Manganese oxides (28.20.10) Ferromanganese (72.02.30)	Finished: steel construction, non-steel alloy, metal article (81.11), batteries (85.06.10)
Phosphate	Phosphate rock (25.10)	Phosphorus (28.04.70)	Mineral fertilizers (31.03)

ORE	EXTRACTION RAW MATERIAL	PROCESSING PROCESSED MATERIALS	PRODUCT MANUFACTURING (FINISHED OR SEMIFINISHED)
Platinium[3]	Platinum (71.10.11), Palladium (71.10.21), Rhodium (71.10.31), Ruthenium, Iridium, Osmium (71.10.41)	Refined, unrefined, or powdered metal (28.43)	Semifinished: semimanufactured metals (71.10.xx) Finished: anode coating for the chlor-alkali industry; crucible for crystal growth; process catalyst
Gold	Ores and concentrates (26.16.90)	Unwrought form: impure metal (gold plate) and refined metal (71.08.11-12) Gold compounds (28.43.30)	Semifinished: bars, rods, wires, sheets, ingots, foils, tubes, pipes (71.08.13) Finished: gold plates (71.09)
Diamonds	Rough diamonds (71.02)	Polished and cut diamonds (71.04.20-90) (71.05.10)	

Note: Customs HS code in parentheses.
Source: Authors.

Barite is a naturally occurring barium sulfate ore. Most barite ores are extracted from sedimentary rocks with impurities such as quartz, sulfide and carbonate minerals, and clay. Once the natural barites have been extracted, they are generally sorted by physical separation from the other compounds (by separation, gravity, or flotation) and crushed, either at the mine site or nearby, to obtain crushed barites, micronized barites, barite aggregates, and so on. In the chemical industry, barite is used to prepare barium compounds, particularly barium carbonate.

Most economically significant **nickel** deposits are located *(i)* in magmatic geological environments (nickel sulfides), and *(ii)* in laterites (nickel oxides). Processed nickel is found in raw form (alloyed or unalloyed), in the form of nickel powders or flakes, nickel oxides and hydroxides, nickel chloride, nickel sulfate, or ferronickel.

3. "Platinum" includes six elements: platinum (Pt), palladium (Pd), rhodium (Rh), ruthenium (Ru), iridium (Ir), and osmium (Os).

Tantalum is mostly a coproduct (coltan is a composite of columbite [Nb] and tantalite [Ta]) because it occurs in the form of a complex mineral,[4] found together with niobium, tin, or lithium in ore bodies. At the processing stage, the intermediate products of tantalum are materials (oxides and fluorides) processed prior to the production of tantalum.

The **rare earths** are a group of seventeen chemical elements, including—in addition to yttrium (Y) and scandium (Sc)—the fifteen lanthanides[5] (elements with atomic numbers between 57 and 71). Customs codes make no distinction between ores, concentrates, and purified oxides. The ore (clay type) is generally low in metals and requires initial processing on site.

The **titanium** market can be divided into two parts: titanium oxide (for pigments) and titanium metal (for alloys). The titanium processing stage consists of slag, ash, and residues containing mainly titanium oxides, ferrotitanium and silicon ferrotitanium, and titanium in raw form.

The most important **tungsten** ores are wolframite and scheelite. The ore is crushed and ground, then beneficiated by gravity or flotation. Ore beneficiation increases the tungsten content of the concentrate. Tungsten intermediates include tungsten oxides, tungstates, tungsten powder, tungsten carbide, and ferrotungsten.

There are three types of **natural graphite** for commercial use, classified according to purity and flake size: flake graphite, amorphous graphite, and vein graphite. At the extraction stage, the relevant customs codes come under the heading "natural graphite," which includes the powder and flake forms. Processed natural graphite products are intermediates in the manufacturing of a wide range of value-added products for special technical applications. The refined forms of natural graphite can be divided into the following types: purified graphite, expandable and flexible graphite, and spherical graphite.

4. Coltan ('columbite–tantalite') is a black or reddish-brown ore from which niobium and tantalum are extracted. It is formed by the combination of two minerals, columbite (Nb_2O_6) and tantalite ($[Ta, Nb_2]O_6$), in variable proportions.
5. The lanthanide group includes lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb), and lutetium (Lu).

Zinc is the fourth most widely used nonferrous metal after iron, aluminum, and copper, and is generally mined as a coproduct alongside lead and copper (copper, lead, and zinc are often found together but may be distributed in varying proportions). Zinc metal is recovered from zinc ores and as a by-product of other nonferrous metals using hydrometallurgical or pyrometallurgical techniques, once sulfur has been removed from the concentrates by roasting or sintering.

Table 3. ***Breakdown of the production chain (2)***

ORE	EXTRACTION RAW MATERIAL	PROCESSING PROCESSED MATERIALS	PRODUCT MANUFACTURING (FINISHED OR SEMIFINISHED)
Barite	Barite ores and barium sulfate (25.11)	Barium sulfate (28.33.27) Semifinished: barium chloride, oxides (28.16), and carbonates (28.36.60)	
Gypsum	Gypsum (25.20)		Gypsum for plaster and plasterboard, and for cement (68.09.11)
Nickel	Nickel ores (26.04)	Unwrought nickel (75.02), nickel flakes (75.04), ferronickel (72.02.60), nickel oxides and hydroxides (28.25.40), chloride (28.27.35), sulfates (28.33.24)	Finished: nickel plates, tubes, and wire (75xx)
Zinc	Zinc ores and concentrates (26.08)	Unwrought zinc (79.01)	Zinc alloys, zinc oxides and sulfates (28.17) Zinc plates, bars, rods, and profiles (79xx)
Tantalum	Tantalum ores and concentrates (26.15.90)	Tantalum oxide and fluoride (28.25.90)	Tantalum carbides, ingots, and powder (81.03)
Rare earths	Minerals and oxides (28.05.30)	Interalloyed rare earth metals (28.05.19) Compounds, inorganic or organic, of rare earth metals (28.46)	Compounds for catalytic converters; oxides and compounds for glass additives (36.06.90) Phosphorescent powder (32.06.50)

ORE	EXTRACTION RAW MATERIAL	PROCESSING PROCESSED MATERIALS	PRODUCT MANUFACTURING (FINISHED OR SEMIFINISHED)
Titane	Titanium ores and concentrates (26.14) Slag (26.20.99)	Titanium oxides, sulfides, and carbides (28.23) Ferrotitanium (72.02.91) Titanium metal (81.08.20)	Finished: titanium bars, rods, sheets, and tubes (8108xx)
Tungsten	Tungsten ores and concentrates (26.11)	Oxides and hydroxides (28.25.90), Ferrotungsten (72.02.80) Metal (tungstates) (28.41.18) Carbides (28.49.90) Powder (81.01.10)	Tungsten articles (81.01)
Graphite	Natural graphite ores and concentrates (25.04)	Purified spheroidal graphite powder, graphite sheet (38.01)	Tungsten articles (81.01) Finished: battery cells, lubricants
Potash	Potassium ores and concentrates (28.15)	Chloride (31.04.20), muriate of potash, potassium sulfate (31.04.30) Potassium bromide (28.27.51)	Fertilizers (31.04)

Source: Authors.

1.2. The regions of international trade for the segments relating to these products

In this section, we will use the segmentation presented in section 1.1 to investigate the trade flows for various important minerals between Africa and the main regions of the globe. We will focus solely on the first three stages: extraction, processing, and manufacturing of semifinished or finished products subsequently used in a range of industries. Moving into processing and then manufacturing would be a major step for African economies, since the emergence of industries using these finished products, manufactured at the end of the production chain, requires many more elements than simply the finished products.

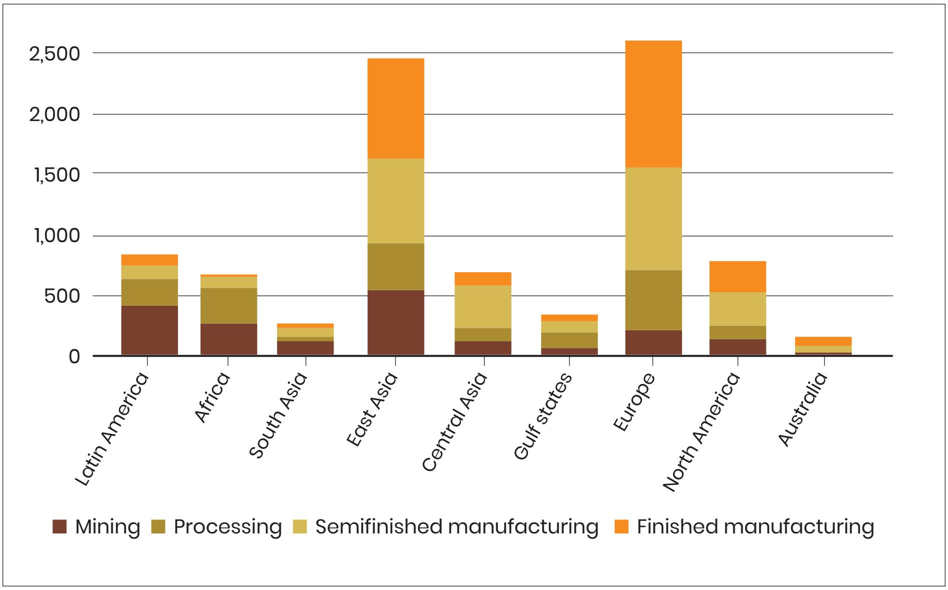
1.2.1. Overview

For the thirty minerals included in section 1.1, of the USD 8 trillion in cumulative global exports over the period 2018–2021, Western Europe is the largest exporter of minerals and mineral-based finished products,[6] ahead of East Asia.[7] Latin America[8] and Africa[9] come next, followed by North America,[10] the rest of Europe, and Central Asia.[11] The percentage of each production segment does of course differ from region to region, with Europe, North America, and Australia exporting relatively little unprocessed ore, for example.

The best way to illustrate these different positions along the production chain is to present each actor's share of global exports in each segment. This enables us to distinguish clearly between the economies of Latin America, Africa, and South Asia (India), which are concentrated at the start of the chain, those of East Asia (including China), Central and Eastern Europe, and the Gulf states (the United Arab Emirates [UAE] and Saudi Arabia), which appear throughout the chain, and the economies of Western Europe, North America, and Australia, which appear at the end of the chain.

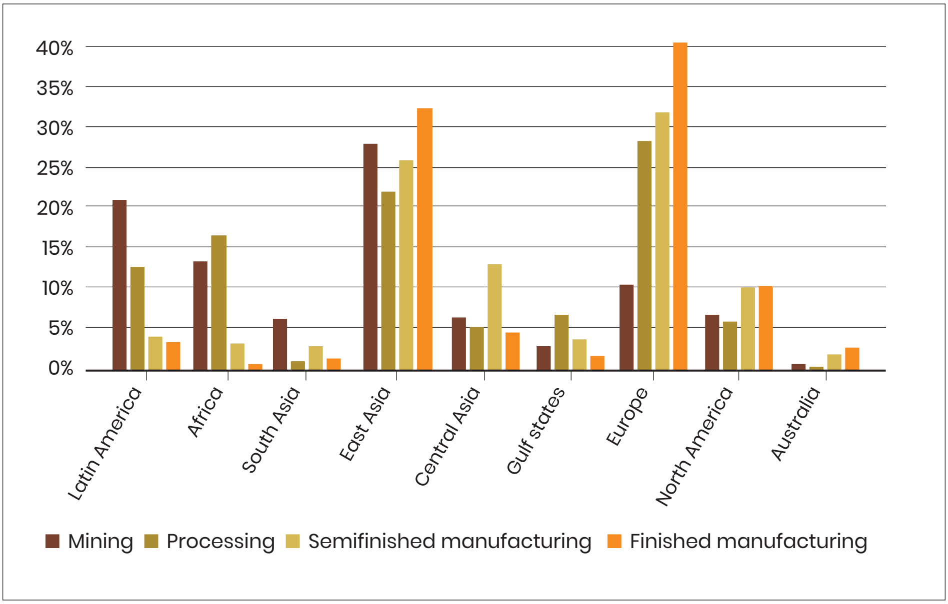
6. Including Germany (19%), Switzerland (13%), Italy (8%), the United Kingdom (8%), Belgium (8%), and France (6%).
7. Including China (34%), Japan (13%), South Korea (9%), Indonesia (5%), Thailand (3%), and Malaysia (3%).
8. Including Brazil (33%), Chile (22%), and Peru (15%).
9. Including South Africa (46%).
10. Including the United States (59%) and Canada (41%).
11. Including Russia (49%), Turkey (16%), Ukraine (11%), and Kazakhstan (10%).

Graph 1. ***Exports 2018–2021 (USD billions)***



Source: Authors based on UN Comtrade data.

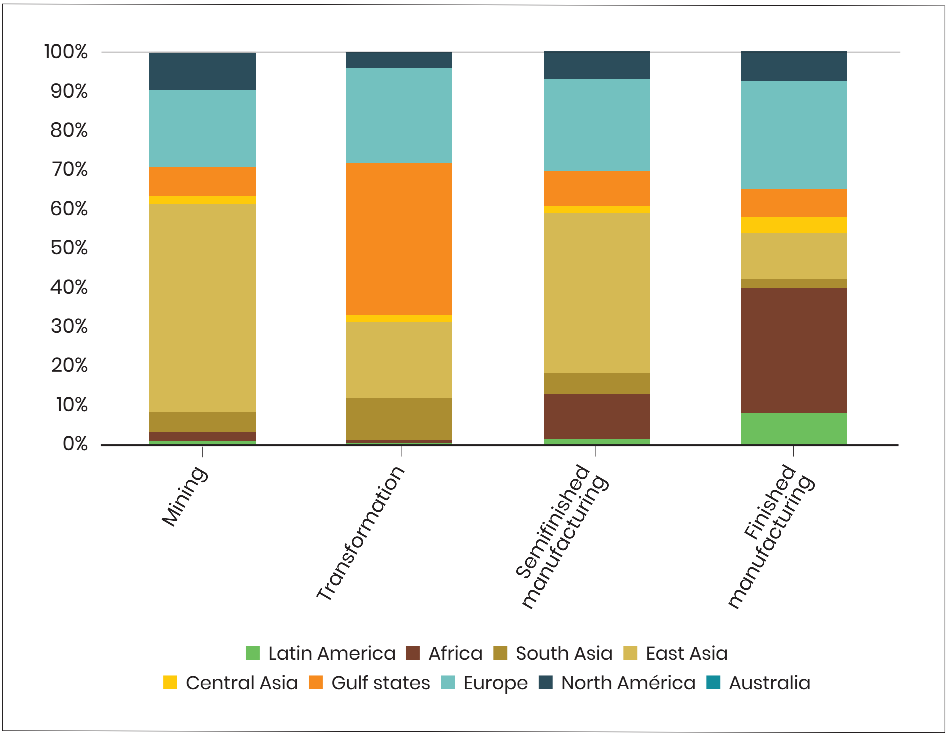
Graph 2. ***Breakdown by segment of each actor's share***



Source: Authors based on UN Comtrade data.

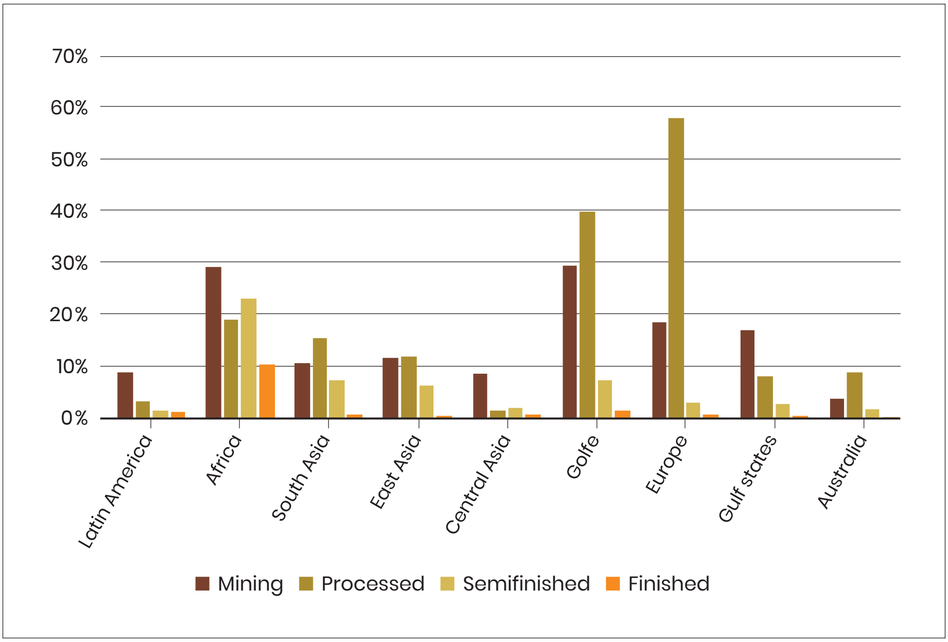
To better appreciate Africa's position in global production chains, we first need to look at where African exports go. Destinations vary according to the type of goods: **50% of extracted minerals are exported to China, 40% of processed minerals go to the Gulf states (mainly raw gold metal), and 25% to Europe.** The small volume of exported semifinished products go to China and to Europe, and the very small number of exported finished products (from North Africa) go to Africa and Europe. It is interesting to note that it is not China that is mainly dependent on African exports for its imports; instead the economies of the Gulf states and Europe are in this position, followed by China and India.

Graph 3. ***Destinations of African exports***



Source: Authors based on UN Comtrade data.

Graph 4. ***African exports as a share of imports***

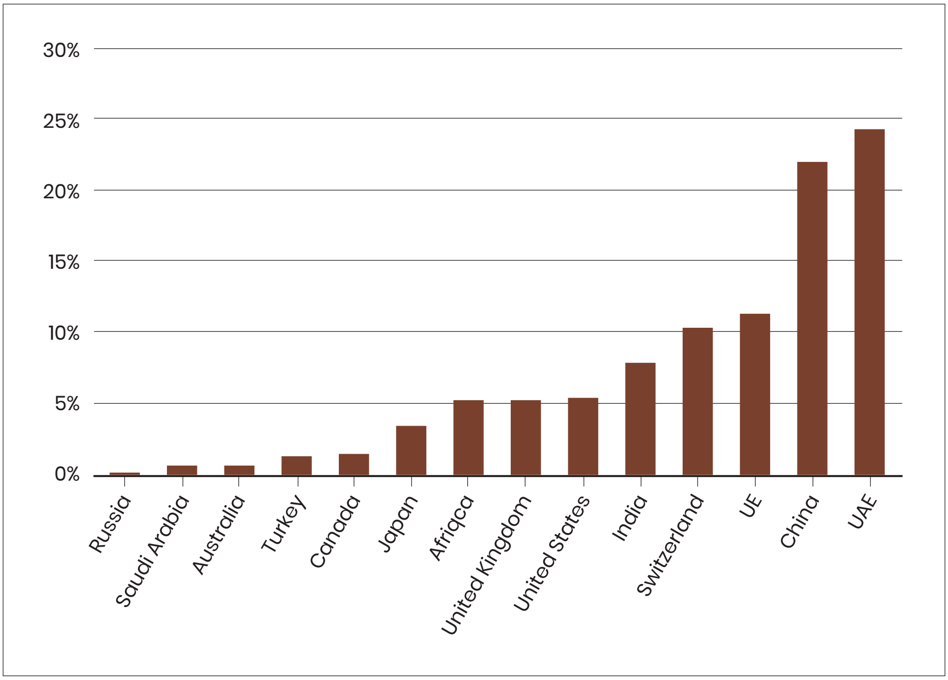


Source: Authors based on UN Comtrade data.

1.2.2. The main markets for African exports

Almost half of Africa's mineral and metal exports by value go to the UAE (24%) and China (22%). Europe remains the main destination (26%), including the European Union (11%), Switzerland (10%), and the United Kingdom (5%). India (7%), the United States (5%), and Japan (4%) are also important markets, and inter-African trade now accounts for 5% of trade in these products.

Graph 5. ***Destinations of mineral exports from Africa***

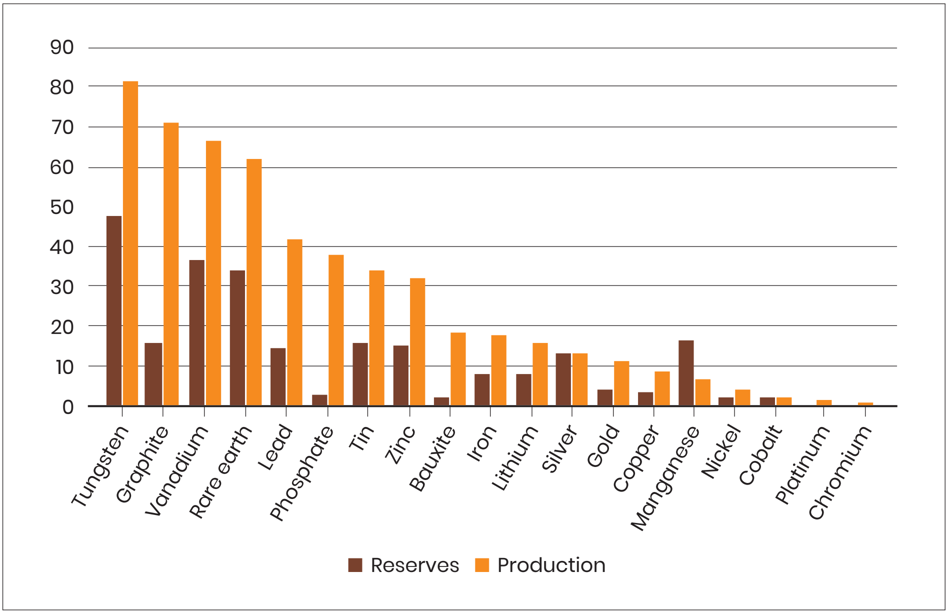


Source: Authors based on UN Comtrade data.

We will now examine the roles played by these different actors in the international mining sector, and their trade flows with Africa.

East Asia: China and Japan

Graph 6. ***China's contribution to the global mining sector***



Source: Authors based on World Mining Data, USGS.

China is one of the largest producers of minerals and metals globally. In 2020, the country was the world's leading global producer of aluminum, accounting for 56.7% of global production, coal (coking coal[12] 53.7%; steam coal[13] 52.5%), tin (34.1%), graphite (70.7%), gold (11.4%), phosphate (38.1%), lead (41.5%), tungsten (81.7%), rare earths (62.2%), vanadium (66.1%), and zinc (32.2%). China was also the second-largest producer of silver (12.9%); the third-largest producer of iron (14.8%), bauxite (18.5%), copper (8.3%), and lithium (15.5%); and the fourth-largest producer of manganese (6.3%) and tantalum (10.7%).

12. Coking coal, or metallurgical coal, is used as a raw material in steel manufacturing.
13. Steam coal is mainly used in thermal power plants and in certain industries (cement, for example).

China is home to several mining giants, **ten of which were ranked in the global top 50 mining companies** by market capitalization in January 2023: Zijin Mining (diversified), Shaanxi Coal (coal), Yanzhou Coal (coal), Ganfeng Lithium (lithium), Tianqi Lithium (lithium), China Northern Rare Earth (rare earths), Huayou Cobalt (cobalt), Shandong Gold Mining (precious metals), CMOC Group Limited, formerly China Molybdenum (copper), and Jiangxi Copper (copper).

One of the distinctive features of China within the global mineral landscape is its **heavy investment in the mineral processing industry.** Globally, it is the leading refiner of aluminum (56% of global production), bauxite (54%), cobalt (67%), copper (41%), germanium (89%), lithium (62%), manganese (60%), molybdenum (38%), nickel (32%), rare earths (90%), and vanadium (59%).

The mining industry is a minor sector of the Japanese economy, and is in decline. With the exception of gold mining (7,590 kg in 2020, i.e., 0.24% of global production, ranking 46th out of 97 countries), **the mining of metal ores fell at the start of the twenty-first century**.[14] Extraction in Japan of iron, copper, lead, zinc, and coal, the latter being the most heavily mined mineral in the country for most of its industrial era, ceased after 2000. However, Japan continues small-scale mining of silver (0.02% of global production in 2020, ranking 51st out of 68 countries) and industrial minerals (arsenic, bismuth, bentonite, kaolin, salt, sulfur, and talc).

Japan is, however, **a key actor in metal refining**. The country has more than twenty refineries and smelters that process a variety of ores. Globally, it is the second-largest refiner of titanium (23% of titanium refined); the third-largest refiner of copper (6%), iron (5%), and cobalt (4%); and the fourth-largest refiner of silver (10%), nickel (7%), and zinc (4%). Its expertise in refining makes it a **leading producer of transition minerals such as selenium (22% of global production in 2020, rank 2/16), tellurium (15%, rank 2/8), cadmium (7%, rank 3/18), indium (6%, rank 3/8),** and, to a lesser extent, germanium (2%, rank 3/5) and gallium (0.99%, rank 4/5)—these ores come from the reprocessing of residual sludge from the electrolytic refining of lead, nickel, cobalt, and primarily copper.[15] One Japanese firm, **Sumimoto Metal Mining** (base metals), was included among the world's top 50 mining companies by market capitalization in January 2023.

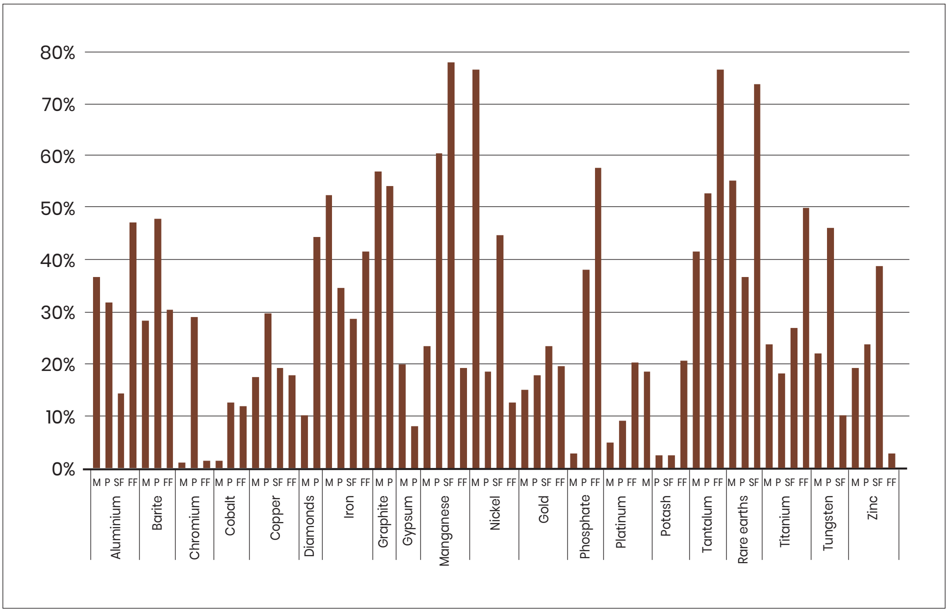
14. "Japan: Resources and Power," Britannica, accessed January 30, 2025, https://www.britannica.com/place/Japan/Resources-and-power.
15. "Cadmium," Minerals Education Coalition (MEC), accessed January 30, 2025, https://mineralseducationcoalition.org/elements/cadmium/.

Trade with Africa

At the extraction and processing stage, **East Asia is the main destination for mining products (accounting for 35% of African exports)** for the following seven ores: aluminum, chromium, cobalt, copper, manganese, platinum, and iron. These African exports also account for a significant proportion of East Asian imports (often between 50% and 90%). East Asia has specialized in processing these energy-intensive metals (doing so by subsidizing the energy, from coal, used in the processing). The region is also the main destination for other African minerals such as tantalum, tungsten, nickel, zinc, graphite, titanium, and rare earths. China is also a major destination for "gold" products, though mainly in the form of raw metal rather than ores, and for rough diamonds, which are reexported after polishing and cutting.

These imports from Africa account for 8% of the region's mining imports, and are very high for some minerals: cobalt (98% of the region's imports), chromium (81%), manganese (65%), platinum (45%), and phosphate (51%). Africa is a major supplier of tantalum (45%) and titanium (47%). **East Asia reexports few of these processed ore**s, except in the form of finished products, with the region accounting for **30% of global exports**. An even larger percentage stays in the economy to supply the sectors that use these finished products (such as battery production, and the automotive industry).

Graph 7. ***East Asia's share of Africa's mineral exports***



Key: M: mined ore; P: processed ore; SF: semifinished products; FF: finished products.
Source: Authors based on UN Comtrade data.

Europe: The European Union (EU), Switzerland, and the United Kingdom

Production

The EU is a small-scale producer of ores. It is a major producer of chromium, copper, lead, silver, and zinc. However, most metallic ores that supply the European metals industry are imported. The main European mining countries are Austria, Finland, Greece, Ireland, Poland, Portugal, and Sweden, where metal mining contributes more than 1% to the global production of a particular mineral.[16]

The Fennoscandian Shield—which encompasses Norway, Sweden, Finland, and northwest Russia—is considered to be Europe's most promising region, as new globally significant deposits continue to be discovered: a major discovery of several minerals (38 Mt of copper, 45 Mt of zinc, 24 Mt of ma-

16. "Metallic minerals," European Commission, accessed January 30, 2025, https://single-market-economy.ec.europa.eu/sectors/raw-materials/related-industries/minerals-and-non-energy-extractive-industries/metallic-minerals_en.

gnesium, and 3.1 Mt of cobalt) was made on the Norwegian seabed in early 2023.[17] The Nordic countries are world leaders in mining technology, and the region leads Europe in the production of mineral raw materials and refined metals.

Table 4. ***EU production in 2020***

MINERAL	PRODUCTION (t)	SHARE (%)
Silver	1,961	7.47
Zinc	750,997	5.96
Lead	208,962	4.4
Copper	868,370	4.18
Chromium	492,870	4.12
Tungsten	1,849	2.11
Nickel	50,079	2.01
Iron	22,196,240	1.46
Cobalt	1,559	1.21
Gold	32	0.99
Platinum	1	0.77
Graphite	5,757	0.61
Phosphate	363,200	0.52
Bauxite	1,566,715	0.41
Lithium	280	0.15
Tin	200	0.07
Manganese	8,450	0.04
Rare earths	0	0
Vanadium	0	0

Source: Authors based on World Mining Data.

17. Nerijus Adomaitis, "Norway Finds 'Substantial' Mineral Resources on its Seabed," Reuters, January 27, 2023, accessed January 30, 2025, https://www.reuters.com/markets/commodities/norway-finds-substantial-mineral-resources-its-seabed-2023-01-27/.

Europe had two companies in the top 50 global mining companies by market capitalization in January 2023: Switzerland's Glencore (third) and Sweden's Boliden (thirty-eighth). Europe's refining industry is relatively underdeveloped. Finland is the world's second-largest cobalt refiner (accounting for 9% of global production) and the fifth-largest chromium refiner (7% of global production).

The important role played by **Switzerland in the trading of minerals** is worthy of note. **Switzerland is the global leader in commodities trading, with its share of the global metals market estimated at 60%.**[18] The Swiss companies with the highest turnover are mainly commodities traders such as Vitol, Trafigura, Gunvor, Mercuria, and Glencore. The distinction between trading and mining companies is often unclear, however: the merger of Glencore (then a trading company) and Xstrata (a mining company) in 2013 is emblematic of the trend toward vertical integration in the mining sector.

The United Kingdom makes only a minor contribution to global mining production within its borders. It ranked 38th out of 41 countries for aluminum production in 2020, 46th out of 47 for lead, 67th out of 68 for silver, 92nd out of 97 for gold, and 20th out of 21 for coal (coke). Thanks to its historic expertise, developed through its former colonies, the United Kingdom nevertheless still has firms that are leaders in the mining sector, such as **Anglo American** (diversified) and **Antofagasta plc** (copper), which were among the top 50 global mining companies by market capitalization in January 2023.[19] The country has not developed a metal refining sector.

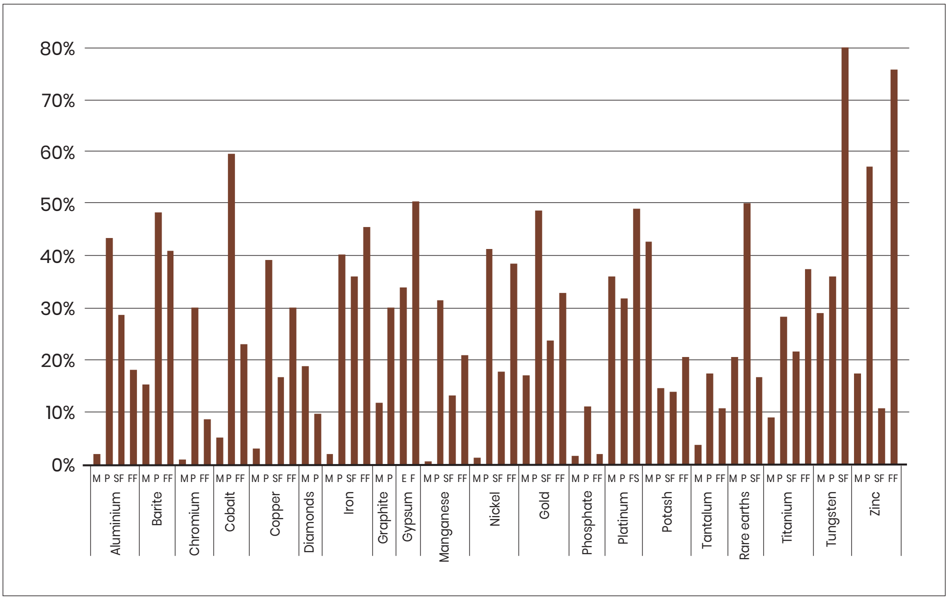
Trade with Africa

Europe (including Switzerland) **is the second-largest market for African exports of mining products, as the destination for 22%** of African exports of aluminum, iron, copper, and manganese ores, as well as phosphates and PGMs (it is the leading destination for platinum metal). By contrast, Europe does not import cobalt and chromium ores from Africa. The large number of gold refineries in Switzerland explains why 96% of gold ore exports from Africa are shipped to this country. Europe is a major destination for other less valuable ores, such as tantalum, titanium, and potash.

18. "La Suisse, plaque tournante des matières premières," *Public Eye,* accessed January 30, 2025, https://www.publiceye.ch/fr/thematiques/negoce-de-matieres-premieres/la-suisse-et-la-malediction-des-ressources/plaque-tournante-des-matieres-premieres.
19. "The Top 50 Biggest Mining Companies in the World," *Mining.com*, accessed January 30, 2025, https://www.mining.com/top-50-biggest-mining-companies/.

Africa is a relatively small player in supplying mining products to Europe (6% of imports), but a key provider of certain minerals: notably aluminum (58% of bauxite imports come from Africa), manganese (79%), titanium (47%), tantalum (59%), and also PGMs (25%) and phosphates (49%). **Europe is the leading exporter of finished products** based on these minerals, accounting for at least **30 to 40%** of global exports of finished products for all mined ores, attesting to the strength of Europe's capabilities and expertise in processing these minerals.

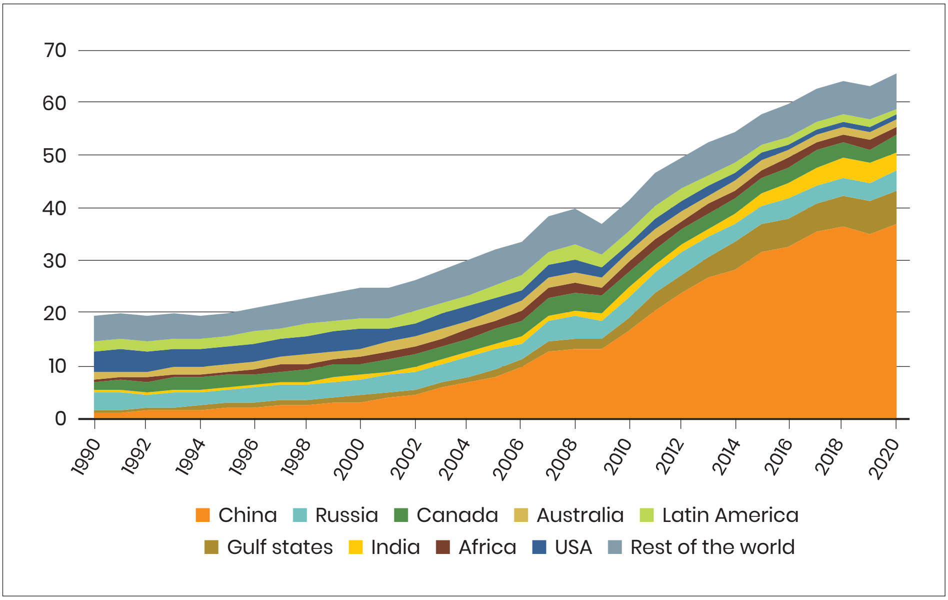
Graph 8. ***Europe's share of Africa's mineral exports***



Key: M: mined ore; P: processed ore; SF: semifinished products; FF: finished products.
Source: Authors based on UN Comtrade data.

The Gulf states: The United Arab Emirates (UAE) and Saudi Arabia

Graph 9. ***Global aluminum production (megatonnes, Mt)***



Source: Authors based on the British Geological Survey (BGS).

The economies of the **Gulf states** are primarily based on oil production, and their mining industries are underdeveloped in relation to the potential contained in their subsoil.

The Gulf states have used their high-performance refining infrastructure to **establish themselves as world-leading aluminum producers:** in 2020, the UAE was the world's fifth-largest aluminum producer (out of forty countries) with 3.8% of global production, Bahrain the world's seventh-largest producer (2.3% of production), Saudi Arabia the eleventh-largest producer, and Oman the nineteenth-largest producer. Over the past decade, the region has seen very dynamic growth in aluminum production, becoming the second-largest aluminum-producing region behind China, which massively dominates the market (56.7% of global production in 2020).

In addition to aluminum, **the Gulf states are medium-scale producers of industrial minerals**. They all produce sulfur: Saudi Arabia and the UAE are the world's fourth- and fifth-largest producers, with 8.5% and 6.7% of global production respectively in 2020. Kuwait, Oman, and Saudi Arabia produce salt, while Oman and Saudi Arabia produce kaolin and gypsum. Saudi Arabia is also the world's seventh-largest phosphate producer (3.3% of global production in 2020).

Only Saudi Arabia and, to a lesser extent, **Oman, have a relatively well-developed mining sector for essential minerals**, although both remain very small-scale mining countries. Oman produces chromium (1.3% of global production in 2020) and manganese (0.01% of global production). Saudi Arabia produces bauxite (1.4% of global production in 2020), gold (0.4% of global production), copper (0.4%), zinc (0.3%), silver (0.03%), and iron (0.02%).

The Gulf states are home to a number of major firms, particularly in the aluminum industry, including Aluminium Bahrain (ALBA, Bahrain), Emirates Global Aluminium (EGA, UAE), Qatalum (Qatar), and Sohar Aluminium (Oman), but only the Saudi Arabian company **Ma'aden** was listed in the world's top 50 mining companies by market capitalization in January 2023 (in eighth place).[20] Ma'aden is 67.2% owned by the Saudi state and is the largest multi-commodity mining and metals company in the Middle East. It is one of the world's fastest-growing mining companies, with revenues of SAR[21] 26.7 billion (USD 7.12 billion) in 2021.

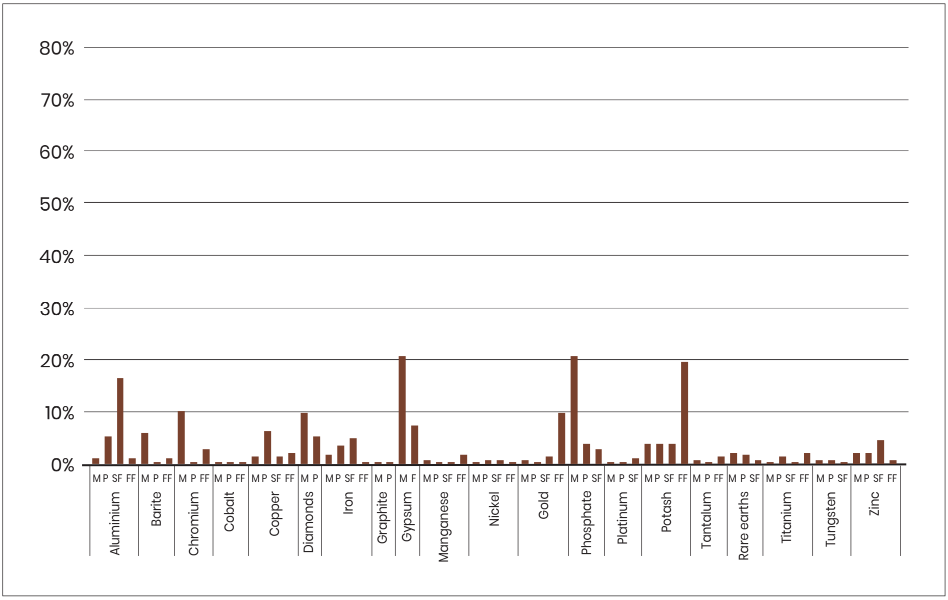
Trade with Africa

The third-largest market for African exports of mining products is **the Middle East (20% of exports)**, with **gold and rough diamonds accounting for 85%** of the continent's exports to this region (72% and 13% respectively). Very few of these products are subsequently reexported, even in finished form, and therefore remain in the economies of the Middle East.

Africa is the region's main supplier of gold (45%) and diamonds (37%), as well as copper (49%), chromium (98%), phosphate (90%), bauxite (79%), and titanium (40%). The region has cheap energy for smelting, and so can easily process raw materials into **finished products, accounting for 5% of global exports.** It should be noted that the region exports a great deal of aluminum made from Guinean bauxite.

20. Ibid.
21. Saudi riyal (the official currency of Saudi Arabia).

Graph 10. ***The Gulf states' share of Africa's mineral exports***



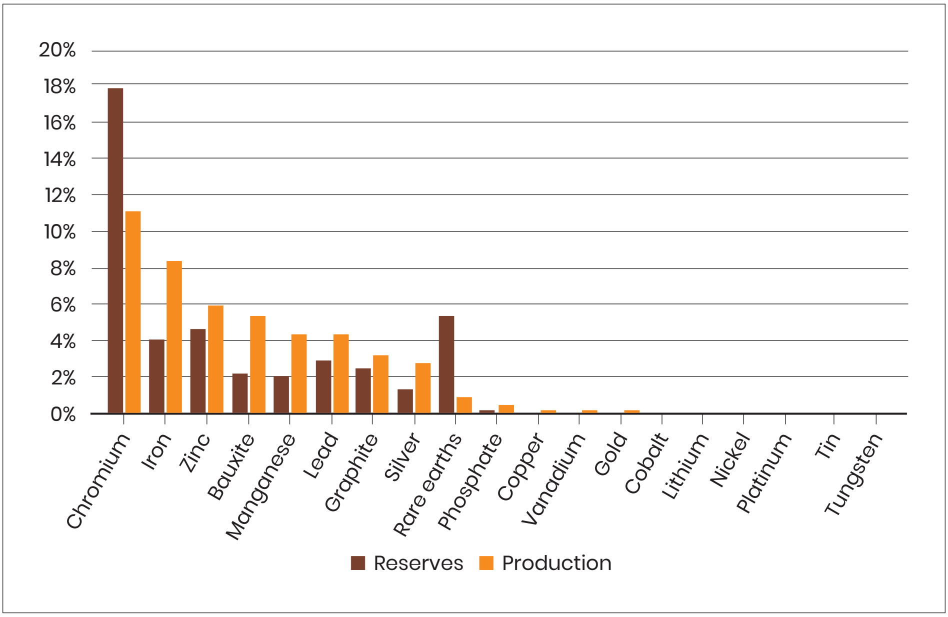
Key: M: mined ore; P: processed ore; SF: semifinished products; FF: finished products.
Source: Authors based on UN Comtrade data.

South Asia: India

India is a major producer of minerals, mainly for domestic consumption. In 2020, it was the world's second-largest producer of steam coal (11.7% of global production); the third-largest producer of aluminum (5.5%) and **chromium** (11.2%); the fourth-largest producer of iron (8.4%); the fifth-largest producer of coking coal (4.3%), **graphite** (3.2%), manganese (4.4%), **vanadium** (0.1%), and zinc (6%); and the sixth-largest producer of bauxite (5.4%), lead (4.4%), and **rare earths** (0.9%). It also produces uranium (for which it is the tenth-largest producer, with 0.8% of global production).

India had two mining firms in the top 50 global mining companies by market capitalization in January 2023: **Coal India** (coal) and **Vedanta Resources** (base metals).

Graph 11. ***India's contribution to the global mining sector***



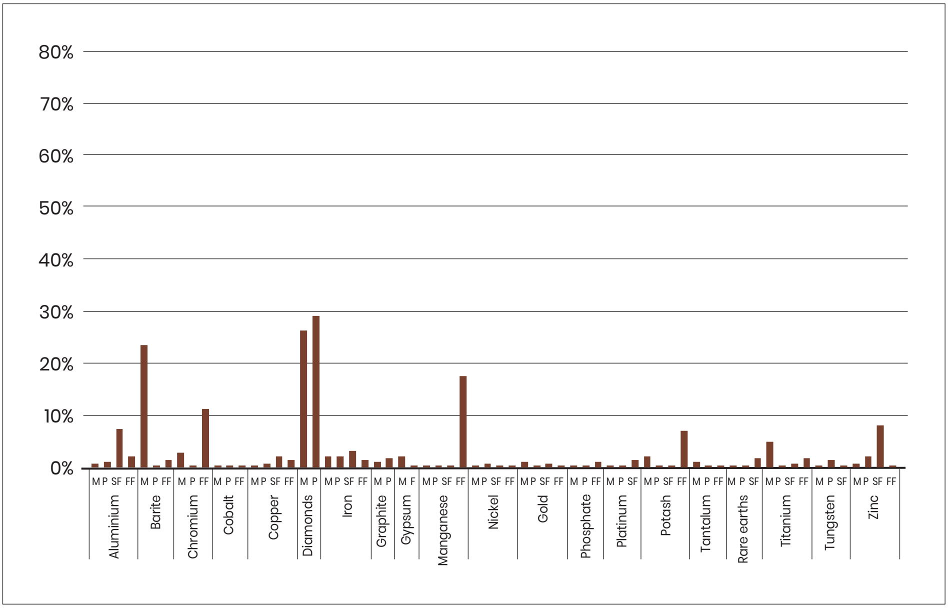
Source: Authors based on World Mining Data, USGS.

India has also developed its refining sector. It is the **world's leading refiner of silver** (21% of refined silver); the second-largest refiner of aluminum (6%) and iron (6%); the third-largest refiner of manganese (5%); and the fourth-largest refiner of chromium (7%), bauxite (5%), lead (5%), and zinc (4%).

Trade with Africa

India is now **the fourth-largest market for African exports of mining products, accounting for 7%**. These consist mainly of gold (13%), diamonds (9%), manganese (10%), graphite (13%), and particularly phosphates (39%). **Africa supplies 10% of South Asia's mining products**, mainly in the form of the minerals bauxite (66%), manganese (65%), copper (52%), phosphate (57%), iron (31%), and titanium (46%). **South Asia accounts for little in the way of global mining exports (3%)**: phosphates are not reexported once they have been processed, though manganese and diamonds are.

Graph 12. ***South Asia's share of Africa's mineral exports***

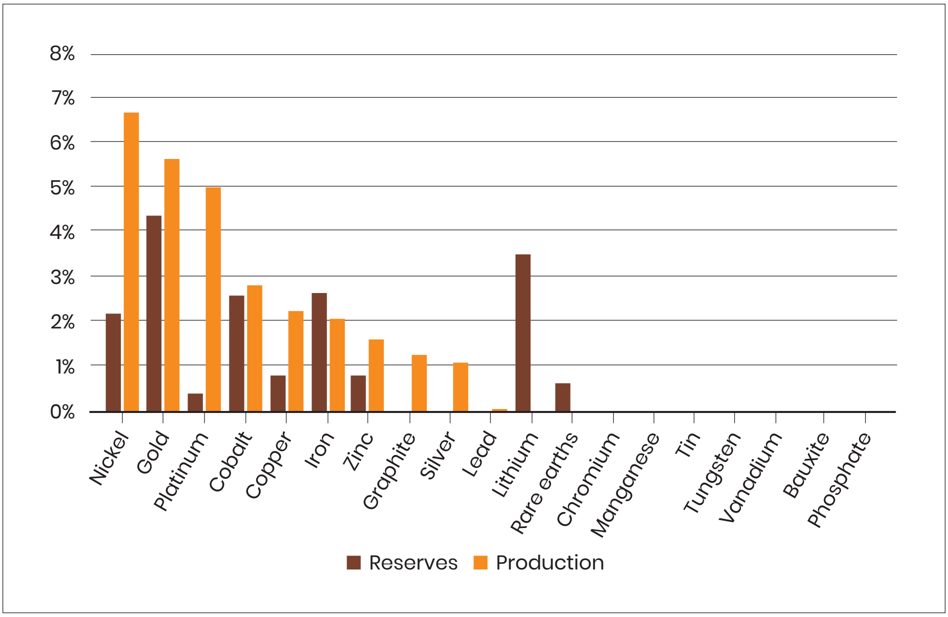


Key: M: mined ore; P: processed ore; SF: semifinished products; FF: finished products.
Source: Authors based on UN Comtrade data.

North America: Canada and the United States

Canada is a historic mining nation, and one of the world's leading producers of minerals and metals. It is one of the few Western countries to have substantial deposits of cobalt, graphite, lithium, and nickel within its borders. In 2020, it was the world's second-largest producer of niobium (6.8% of global production), which is an important metal for the aerospace industry, and the fourth-largest producer of indium, a vital input in the manufacturing of semiconductors. It was also the third-largest producer of palladium (10.7% of global production); the fourth-largest producer of aluminum (4.8%), platinum (5.1%), rhodium (3.5%), and uranium (8.6%); and the fifth-largest producer of cobalt (2.9%) and gold (5.7%). Canada also produces coking coal (seventh-largest producer in 2020, with 2.5% of global production), iron (ninth-largest producer, with 2.1%), graphite (also ninth-largest producer, with 1.3%), nickel (sixth-largest producer, with 6.7%), and titanium (also the sixth-largest producer, with 5.7%).

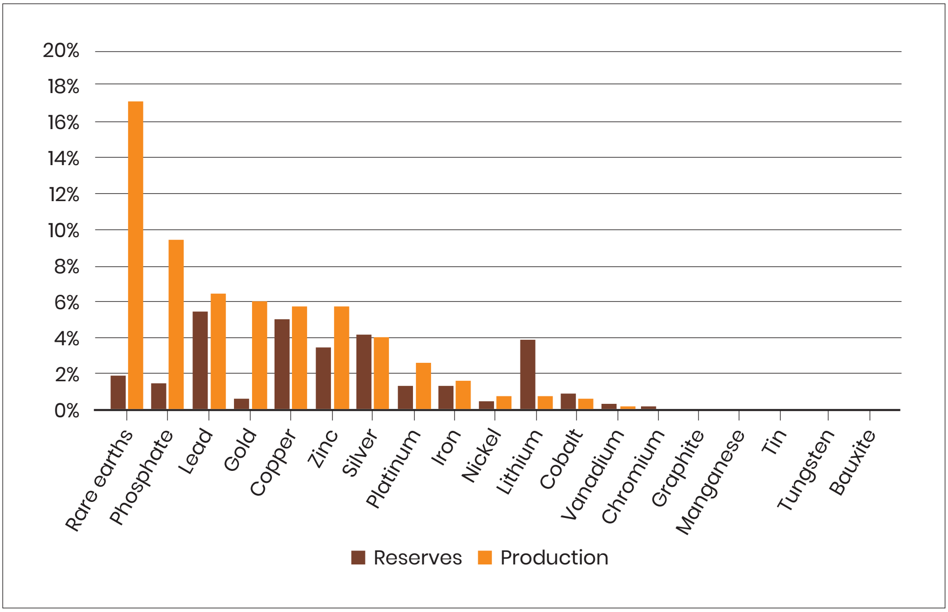
Graph 13. ***Canada's contribution to the global mining sector***



Source: Authors based on World Mining Data, USGS.

As a result of its mining expertise, Canada boasts a number of world-leading mining companies, nine of which were among the world's top 50 mining companies by market capitalization in January 2023: **Nutrien** (fertilizers), **Barrick Gold** (precious metals), **Franco-Nevada** (gold-focused royalty and streaming portfolio), **Agnico Eagle** (precious metals), **Teck Resources** (diversified), **Wheaton Precious Metals** (multinational specializing in streaming precious metals), **First Quantum Minerals** (copper), **Ivanhoe Mines** (copper), and **Cameco** (uranium). Canada is the world's second-largest niobium refiner, contributing 11% of refined niobium, the third-largest refiner of zinc (5%) and cobalt (4%), the fourth-largest aluminum refiner (5%), and the fifth-largest nickel refiner (5%).

Graph 14. ***The United States' contribution to the global mining sector***



Source: Authors based on World Mining Data, USGS.

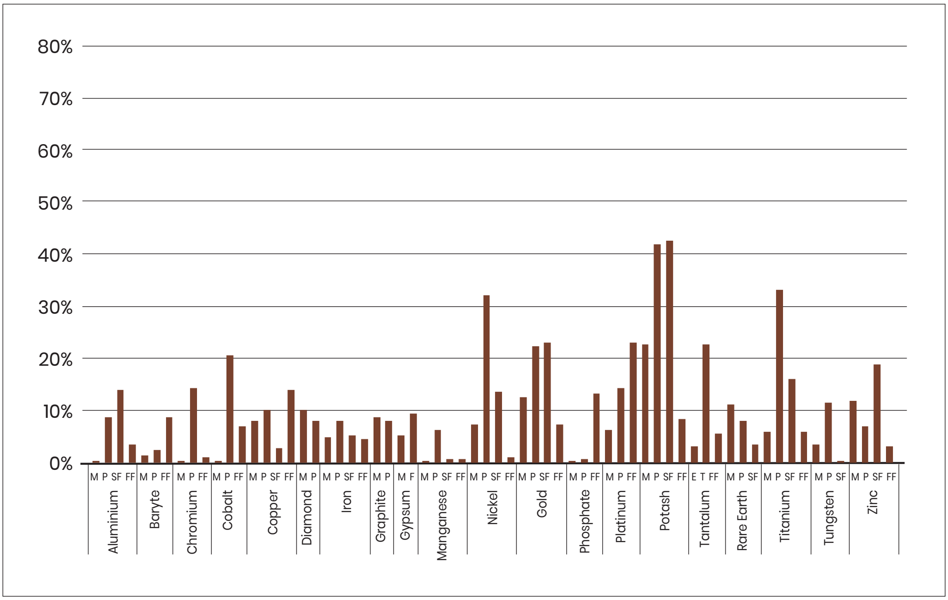
The United States is one of the world's largest producers of minerals and metals. In 2020, the country was the world's **second-largest producer of rare earths** (17.3% of global production); the third-largest producer of phosphate (9.4%); the fourth-largest producer of palladium (7.3%), coal (6.9% of steam coal and 4.9% of coking coal), gold (6%), and lead (6.5%); and the **fifth-largest producer of copper (5.8%)** and platinum (2.5%). However, it is important to note the **downward trajectory** of the American mining sector: between 1991 and 2019, the number of metal firms in the United States fell by 55%, and the number of employees working in the sector by 20% (Hache et al. 2022).

The United States is home to several world-leading mining firms, six of which were ranked in the world's top 50 mining companies by market capitalization in January 2023: **Freeport-McMoRan** (copper), **Southern Copper** (copper), Newmont (precious metals), **Albermarle** (lithium), **Mosaic** (fertilizers), and **Cleveland-Cliffs** (iron). The United States has a relatively well-developed refining sector. It is the world's second-largest refiner of lead, accounting for 10% of all refined lead; the third-largest refiner of silver (18%) and iron (5%); and the fifth-largest refiner of titanium (5%) and copper (4%).

Trade with Africa

The United States and Canada are Africa's fifth-largest export market for mining products **(7% of exports)**, including iron (10%), processed manganese (35%), platinum (25%), tungsten (33%), titanium (22%), and barite (38%). **Africa is a minor supplier of mining products** to the region **(5% of imports)**, but a leading supplier of chromium ore (94%), manganese (86%), platinum (41%), tantalum (57%), and titanium (70%). Between them, **the two countries account for only 9% of global exports** of mining products: while they process them, they do not generally then export the finished products, but use them to supply their own economies.

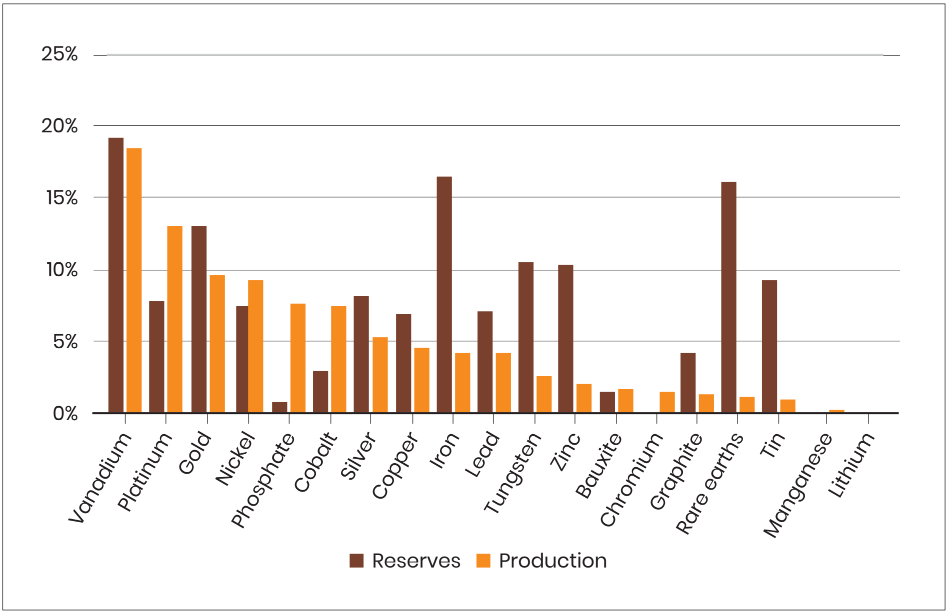
Graph 15. ***North America's share of Africa's mineral exports***



Key: M: mined ore; P: processed ore; SF: semifinished products; FF: finished products.
Source: Authors based on UN Comtrade data.

Central and Eastern Europe: Russia

Graph 16. ***Russia's contribution to the global mining sector***



Source: Authors based on World Mining Data, USGS.

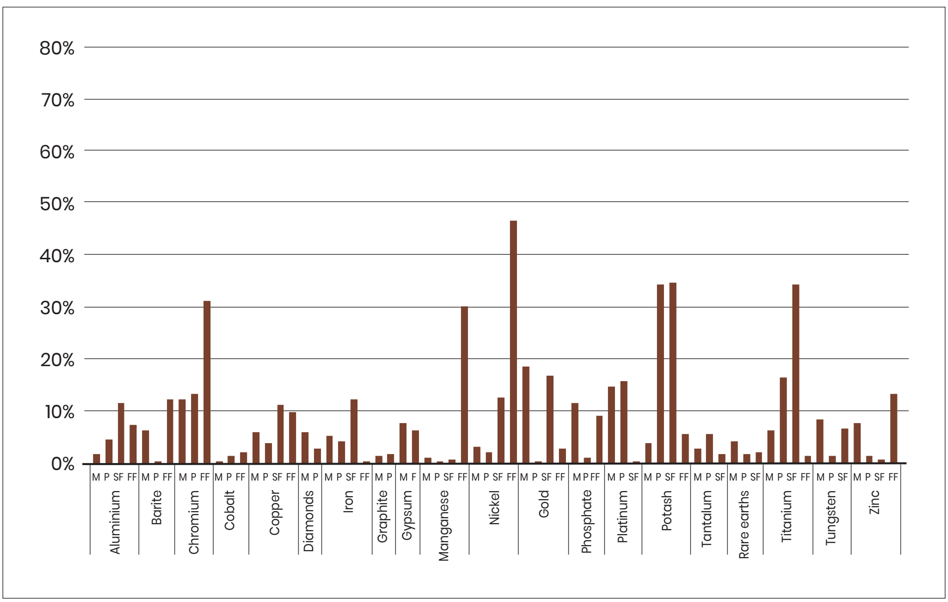
Russia is a major producer of minerals, accounting for almost 14% of the global total (Josefson and Rotar 2021). In 2020, it was the world's leading producer of **palladium** (41% of global production) and diamonds, both industrial-grade (27%) and for the jewelry market (30.2%). Russia was also the second-largest producer of aluminum (6% of global production), **cobalt** (7.5%), **platinum** (13.1%), rhodium (8.6%), and **vanadium** (18.5%), and the third-largest producer of coking coal (8.6% of global production), nickel (9.4%), **niobium** (0.7%), gold (9.6%), and **tungsten** (2.6%). It was the fourth-largest producer of phosphate (7.7% of global production) and mercury (1.3%), and the fifth-largest producer of **silver** (5.3% of global production), iron (4.3%), and **rare earths** (1.2%).

Russia had two mining companies in the world's top 50 by market capitalization in January 2023[22]: **Norilsk Nickel** (nickel) and **Polyus** (precious metals). Russia is the world's second-largest aluminum refiner (6% of refined aluminum), the third-largest nickel refiner (9%), the fourth-largest titanium refiner (8%), and the fifth-largest refiner of iron (4%) and bauxite (2%).

Trade with Africa

Russia and Turkey are relatively minor markets for African mining products (2%), with the exception of **nickel (22%), phosphate (10%), potash (31%), and manganese (6%). Africa is a minor supplier of Russia and Turkey (accounting for 2% of their imports)**, but has an important position in relation to manganese (91%), phosphate (52%), nickel (47%), titanium (41%), and graphite (19%) ores.

Graph 17. ***Central and Eastern Europe's share of Africa's mineral exports***



Key: M: mined ore; P: processed ore; SF: semifinished products; FF: finished products.

Source: Authors based on UN Comtrade data.

22. *Mining.com*, "The Top 50 Biggest Mining Companies in the World."

Table 5. ***Exports from Africa***

MINERAL	% OF AFRICAN X	STAGE	AFRICAN X AS % OF GLOBAL X	AFRICA		EAST ASIA	
				Br (%)	Pr (%)	Br (%)	Pr (%)
Aluminum	5	M	50%			70	49
Iron	12	M	5%			78	5
		SF	2%	17	11	35	3
Chromium	3.5	M	78%			90	81
		P	44%			81	51
Cobalt	2.2	M	93%	24	98	76	98
		P	55%	2	89	93	73
Copper	12.3	M	2%	24	53	66	2
		P	21%	8	85	52	21
Manganese	3.6	M	68%			73	65
		P	7%	10	16	8	3
Gold	34.1	M	20%			3	1
		P	17%			11	7
		SF	7%	17	88	24	9
Diamonds	10.3	M	16%	6	34	31	18
Platinum	11.2	M	34%			51	45
		P	26%			20	27
Phosphate	1.3	M	51%			17	51
		P	33%	6	67	11	15
Tantalum	0.6	M	46%			67	45
Tungsten	0.1	M	9%			61	13
Nickel	0.7	M	8%			63	6
Zinc	0.6	M	8%			76	11
Titanium	0.9	M	49%			36	47
Rare earths	0.1	M	3%	19	39	39	2
Graphite	0.1	M.	13%			50	15
Gypsum	0.1	M	6%	81	33	7	1
Potash	0.2	M	1%	19	1		
Barite	0.1	M	13%	12	42		

Key: X: exports; Br: breakdown of African exports by region (large % in orange); Pr: African exports as proportion of region's imports (large proportion in blue); M: mined ore; SF: semifinished products; P: processed ore

Source: Authors based on UN Comtrade data.

EUROPE		MIDDLE EAST		EASTERN AND CENTRAL EUROPE		SOUTH ASIA		NORTH AMERICA	
Br (%)	Pr (%)	Br (%)	Pr (%)	Br (%)	Pr (%)	Br (%)	Pr (%)	Br (%)	Pr (%)
16	58	4	79	4	59	4	66	2	16
18	13					2	31		
22	1	7	2	5	1	5	3	10	3
3	63	2	98	3	37			2	93
8	23							8	43
3	9							2	10
6	1								
14	15	17	49			6	52	2	5
8	79			6	91	10	65	2	86
33	7	6	3	7	3	4	13	35	17
96	47								
23		49	45	2	13	13	17	4	8
58	6								
18	22	26	37			9	7	9	8
21	21			1	13			24	41
49	29							25	25
20	49	8	90	10	52	39	57		
17	31			2	28			7	33
20	59					2	19	6	57
4	16			2	6			33	6
13	19			22	47	6	6	2	4
20	5							3	3
28	47	4	40	6	41	2	46	22	70
31	5							5	3
23	11	3	18	5	19	13	31	8	10
11	3								
41	40	29	4	31	6				
22	12	2	1	9	14			38	16

1.3. The integration of African minerals in global chains (2018–2021)

We will now examine in detail the **ten minerals that account for over 95% of the value of African exports and 15% of global exports of these minerals** over the period 2018–2021. Africa is **mainly involved in mining and processing** these minerals (except for aluminum and diamonds), and sometimes in the manufacturing of semifinished products (copper, platinum, and phosphate).

Aluminum accounts for **5% of Africa's mining exports**, with **42% of these exports in the form of bauxite ore** (USD 13.9 billion for 2018–2021), 70% of which goes to China (as with exports from the rest of the world, at 71%). Guinea exports 95% of the continent's bauxite and meets 50% of global demand for this ore, providing 65% of the supply to the EU, Ukraine, the UAE, and India. **Aluminum exports are also substantial** in terms of value (USD 13.7 billion for 2018–2021), half of which goes to China. These exports, mainly from South Africa (35%) and Mozambique (32%), meet only 4% of global demand, but 12% of the demand from China.

Table 6. ***Destinations of bauxite (USD billions)***

	AFR	RoW	WORLD	Sh. AFR	Sh. RoW	Pr. AFR
Others	13	1,132	1,145	0%	8%	1%
Africa	6	29	35	0%	0%	17%
United States	15	743	758	0%	5%	2%
Brazil	40	12	53	0%	0%	77%
Canada	198	339	537	1%	2%	37%
India	531	253	784	4%	2%	68%
UAE	557	22	579	4%	0%	96%
Ukraine	599	291	890	4%	2%	67%
EU	2,178	1,176	3,354	16%	9%	65%
China	9,846	9,786	19,632	70%	71%	50%
World	13,982	13,784	27,766			50%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Table 7. ***Destinations of aluminum (USD billions)***

	AFR	RoW	WORLD	Sh. AFR	Sh. RoW	Pr. AFR
Others	1,675	138,140	139,815	12%	47%	1%
Africa	69	2,561	2,631	1%	1%	3%
United States	334	12,976	13,310	2%	4%	3%
Brazil	565	6,652	7,218	4%	2%	8%
Canada	585	3,964	4,549	4%	1%	13%
India	737	11,817	12,554	5%	4%	6%
UAE	824	8,365	9,189	6%	3%	9%
Ukraine	1,021	20,322	21,343	7%	7%	5%
EU	1,055	40,576	41,631	8%	14%	3%
China	6,881	48,928	55,809	50%	17%	12%
World	13,748	294,301	308,048			4%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
DSh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Cobalt accounts for **2.2% of African exports, including 90% in processed form** (intermediate cobalt and metals worth USD 13.7 billion). Almost 90% of these cobalt exports go to China, which sources almost exclusively from Africa, unlike Japan, the EU, and the United States (which also source from Australia and Russia—until 2022 in Russia's case, following the war in Ukraine). **The Democratic Republic of Congo (DRC) alone exports 88% of processed African cobalt.**[23] The DRC also has a monopoly on raw cobalt ore (98% of African exports and 93% of global exports), 75% of which is exported to China and 24% to other economies in Africa (Morocco and Zambia) for processing.

23. Followed by Madagascar, Morocco, and Tanzania with 3% each.

Table 8. ***Destinations of cobalt ore (USD billions)***

	AFR	RoW	WORLD	Sh. AFR	Sh. RoW	Pr. AFR
Others	0	81	81	0%	80%	0%
Japan	0	-	0	0%	0%	100%
UE	0	0	0	0%	0%	1%
Turkey	0	0	0	0%	0%	72%
United States	0	2	2	0%	2%	3%
Rest of Asia	8	0	8	1%	0%	99%
Korea	15	9	24	1%	9%	62%
Africa	314	7	320	24%	7%	98%
China	990	2	992	75%	2%	100%
World	1,327	102	1,429			93%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Table 9. ***Destinations of processed cobalt (USD billions)***

	AFR	RoW	WORLD	Sh. AFR	Sh. RoW	Pr. AFR
Others	-	2,542	2,542	0%	23%	0%
Brazil	45	123	168	0%	1%	27%
Korea	94	1,695	1,789	1%	16%	5%
Rest of Asia	117	247	364	1%	2%	32%
Malaysia	164	36	200	1%	0%	82%
United States	196	1,813	2,009	1%	17%	10%
Africa	226	28	253	2%	0%	89%
Japan	229	1,825	2,054	2%	17%	11%
EU	539	1,857	2,396	4%	17%	23%
China	12,161	751	12,913	88%	7%	94%
World	13,772	10,917	24,689			56%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Chromium accounts for **3.5% of exports from Africa, with 40% (USD 9.5 billion) exported as ore, and 60% (USD 13.9 billion) in its processed metal form** (or as oxides). Although, as with cobalt, 86% of the ore is exported to China, as is also the case for 71% of the world's chromium, the metal is exported to a wider variety of destinations, including Indonesia, the EU, Japan, and the United States (44% to China). In total, 94% of the chromium in ore or metal form comes from South Africa and 6% from Zimbabwe, which together meet 78% of global demand for the ore and 44% for the metal.

Table 10. ***Destinations of chromium ore (USD billions)***

	FR	RoW	WORLD	Sh. AFR	Sht. RoW	Pr. AFR
Others	276	22	298	3%	1%	93%
Africa	19	2	21	0%	0%	91%
Japan	35	51	86	0%	2%	40%
Russia	95	440	535	1%	16%	18%
United States	137	5	143	1%	0%	96%
India	140	28	168	1%	1%	83%
EU	150	193	343	2%	7%	44%
Turkey	150	1	151	2%	0%	99%
Indonesia	301	28	329	3%	1%	91%
China	8,216	1,914	10,130	86%	71%	81%
World	9,519	2,685	12,204			78%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Table 11. ***Destinations of chromium metal (USD billions)***

	AFR	RoW	WORLD	Sh. AFR	Sh. RoW	Pr. AFR
Others	-	3,601	3,601	0%	20%	0%
Africa	34	52	86	0%	0%	39%
Canada	44	97	141	0%	1%	31%
Rest of Asia	36	808	844	0%	5%	4%
Korea	899	1,476	2,375	6%	8%	38%
Japan	1,066	2512	3,578	8%	14%	30%
United States	1,069	1,390	2,459	8%	8%	43%
EU	1,517	1,217	2,733	11%	7%	55%
Indonesia	3,172	1,097	4,269	23%	6%	74%
China	6,054	5,628	11,681	44%	31%	52%
World	13,889	17,878	31,767			44%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Copper accounts for **12.3% of mining exports from Africa. A total of 15% is exported as copper ore (USD 6 billion) and 85% as ore processed into raw copper (USD 70 billion).** As with cobalt, a substantial proportion of the ore (24%) is exported to other African countries for processing (Zambia), and to China (64%): 43% of raw copper exports go to China, which also absorbs 41% of raw copper from the rest of the world. Overall, Africa meets 21% of global demand for raw copper. The continent's exporters of the ore are the DRC (48%), Mauritania (14%), Morocco (10%), Eritrea (9%), South Africa (9%), and Zambia (5%), while the exporters of the metal are countries that can process the ore but do not produce many metal products, notably the DRC (35%), Zambia (32%), Congo (15%), South Africa (6%), Namibia (4%), and Tanzania (3%).

Table 12. ***Destinations of copper ore (USD billions)***

	AFR	RoW	WORLD	Sh. AFR	Sht. RoW	Pr. AFR
Others	0	77,223	77,223	0%	28%	0%
Cambodia	12	43	56	0%	0%	22%
India	27	8,371	8,398	0%	3%	0%
Australia	50	291	341	1%	0%	15%
Malaysia	53	1,442	1,496	1%	1%	4%
Rest of Asia	236	3,452	3,687	4%	1%	6%
EU	397	29,983	30,379	6%	11%	1%
Africa	1,548	1,392	2,940	24%	1%	53%
China	4,108	155,014	159,123	64%	56%	3%
World	6,432	277,210	283,642			2%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Table 13. ***Destinations of raw copper (USD billions)***

	AFR	RoW	WORLD	Sh. AFR	Sht. RoW	Pr. AFR
Others	3,289	108,042	111,331	5%	41%	3%
Thailand	1,189	9,279	10,468	2%	4%	11%
Vietnam	1,471	5,357	6,28	2%	2%	22%
Saudi Arabia	2,409	341	2,750	3%	0%	88%
Korea	2,605	6,870	9,475	4%	3%	27%
India	4,341	4,005	8,346	6%	2%	52%
Africa	5,830	1,032	6,862	8%	0%	85%
EU	9,144	18,112	27,256	13%	7%	34%
UAE	9,384	1,386	10,770	13%	1%	87%
China	30,494	107,692	138,186	43%	41%	22%
World	70,156	262,117	332,273			21%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Platinum accounts for **11.2% of exports from Africa. It is mainly exported as ore (86%) (USD 64 billion), but 10% is also exported in the form of semimanufactured metals (processed locally) (USD 9.8 billion)**. Japan and the United States are major markets for ores (50% between them), the United Kingdom is an equally important market for both ores (10%) and semifinished metals (47%), and China is obviously another substantial market (20% for both ores and metals). The continent's only exporter is South Africa, which alone meets 34% and 26% respectively of the global demand for ores and semifinished metals.

Table 14. ***Destinations of platinum ore (USD billions)***

	AFR	RoW	WORLD	Sh. AFR	Sh. RoW	Pr. AFR
Others	4,061	34,355	38,416	6%	28%	0%
Africa	0	209	209	0%	0%	100%
BRAZIL	1,031	1,377	2,409	2%	1%	43%
Korea	1,193	4,973	6,166	2%	4%	19%
Hong Kong	3,806	15,234	19,041	6%	12%	20%
EU	5,266	15,240	20,506	8%	12%	26%
United Kingdom	6,343	12,542	18,885	10%	10%	34%
China	11,053	9,947	21,000	17%	8%	53%
United States	14,761	21,115	35,876	23%	17%	41%
Japan	17,012	9,374	26,386	26%	8%	64%
World	64,527	124,366	188,893			34%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Table 15. ***Destinations of semifinished platinum metal (USD billions)***

	AFR	RoW	WORLD	Sh. AFR	Sht. RoW	Pr. AFR
Others		7,331	7,331	0%	26%	0%
Africa	1	657	657	0%	2%	100%
Rest of Asia	97	404	501	1%	1%	19%
Switzerland	114	1,775	1,889	1%	6%	6%
EU	159	872	1,031	2%	3%	15%
India	235	710	945	2%	2%	25%
Canada	948	1,978	2,926	10%	7%	32%
United States	1,461	5,113	6,574	15%	18%	22%
China	2,171	1,676	3,847	22%	6%	56%
United Kingdom	4,665	7,958	12,622	47%	28%	37%
World	9,851	28,474	38,325			26%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Iron accounts for **12% of exports from Africa, both in the form of the ore (USD 37.4 billion)** and semimanufactured metals (USD 35.4 billion). China is by far the largest market for the ore (64%), while the metals are exported to various regions—China again, of course, but also the EU (22%) and other African countries (17%) for further processing. Most iron ore is exported by South Africa (80%) and Mauritania (15%). The semifinished metal is also exported by South Africa (68%), and by countries that process their own ore along with ore from South Africa: Egypt (12%), Libya, Zimbabwe, Algeria, and Tunisia (each 3%). It should be noted that Africa is not a major global supplier of iron (meeting 5% of the global demand for iron ore).

Table 16. ***Destinations of iron ore (USD billions)***

	AFR	RoW	WORLD	Sh. AFR	Sht. RoW	Pr. AFR
Others	-	61,416	61,416	0%	10%	0%
Turkey	295	4,898	5,192	1%	1%	6%
AUSTRALIA	309	54	363	1%	0%	85%
United Kingdom	367	3,275	3,642	1%	1%	10%
India	594	1,324	1,918	2%	0%	31%
Africa	1,548	1,392	2,940	4%	0%	53%
Japan	2,125	45,729	47,854	6%	7%	4%
Korea	2,480	28,885	31,365	7%	4%	8%
EU	6,479	37,653	44,132	17%	6%	15%
China	23,876	459,751	483,628	64%	71%	5%
World	37,434	645,016	682,450			5%

LKey: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Table 17. ***Destinations of semifinished steel metal (USD billions)***

	AFR	RoW	WORLD	Sh. AFR	Sht. RoW	Pr. AFR
Others	3,594	954,470	958,064	10%	59%	0%
Korea	1,021	60,723	61,744	3%	4%	2%
Japan	1,281	29,092	30,373	4%	2%	4%
India	1,394	43,998	45,393	4%	3%	3%
Turkey	1,517	74,847	76,364	4%	5%	2%
United States	3,204	110,216	113,421	9%	7%	3%
Indonesia	3,272	36,182	39,454	9%	2%	8%
Africa	6,036	47,868	53,904	17%	3%	11%
China	6,306	119,464	125,770	18%	7%	5%
EU	7,824	153,700	161,524	22%	9%	5%
World	35,450	1,630,560	1,666,010			2%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Phosphate accounts for **just 1.3% of exports from Africa, mainly in the form of ore (USD 5.8 billion) and a small amount in the form of fertilizer products (USD 1.2 billion)**, but these meet half of the global demand. Export of this ore is unique in its destinations, with most exports going to Latin American countries (in particular Brazil) and Asia excluding China (Indonesia, Malaysia, and India). The ore exporters are North African countries (Morocco 60%, Egypt 15%, and Algeria 8%) and Togo (9%). Processed products are exported by Morocco (50%) and Egypt (45%).

Table 18. ***Destinations of phosphate ore (USD billions)***

	AFR	RoW	WORLD	Sh. AFR	Sht. RoW	Pr. AFR
Others	–	766	766	0%	14%	0%
Africa	27	4	31	0%	0%	88%
Turkey	317	39	356	5%	1%	89%
Indonesia	329	496	825	6%	9%	40%
Brazil	365	378	743	6%	7%	49%
Ukraine	427	100	526	7%	2%	81%
Korea	563	625	1,188	10%	11%	47%
Malaysia	626	404	1,030	11%	7%	61%
EU	1,245	1,023	2,268	21%	19%	55%
India	1,983	1,652	3,634	34%	30%	55%
World	5,882	5,484	11,335			52%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Table 19. ***Destinations of fertilizer products (USD billions)***

	AFR	RoW	WORLD	Sh. AFR	Sht. RoW	Pr. AFR
Others	41	1,750	1,791	2%	35%	2%
Malaysia	44	113	157	2%	2%	28%
Argentina	45	139	183	2%	3%	24%
Paraguay	48	138	187	2%	3%	26%
United Kingdom	50	135	185	2%	3%	27%
Uruguay	67	42	109	3%	1%	61%
Africa	147	73	221	6%	1%	67%
United States	180	344	524	7%	7%	34%
Indonesia	230	678	909	9%	14%	25%
EU	380	374	754	15%	8%	50%
Brazil	1,230	1,188	2,418	50%	24%	51%
World	2,463	4,975	7,438			33%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Manganese accounts for **3.6% of exports from Africa, 95% of it in the form of ore (USD 23.4 billion)**. China is the destination for 62% (similar to global exports: 65%), but smaller amounts are also exported to India, the EU, and Africa. Africa is the main global supplier of manganese, meeting 67% of global demand. The countries producing this ore on the continent are South Africa (61%), Gabon (25%), Ghana (8%), and Côte d'Ivoire (3%).

Table 20. ***Destinations of manganese ore (USD billions)***

	AFR	RoW	WORLD	Sh. AFR	Sht. RoW	Pr. AFR
Others	0	0	0	0%	0%	0%
Ukraine	427	100	526	2%	1%	81%
Korea	563	624	1,187	2%	5%	47%
Malaysia	626	404	1,030	3%	3%	61%
Japan	774	237	1,010	3%	2%	77%
Russia	948	86	1,035	4%	1%	92%
Africa	1,548	1,392	2,940	7%	12%	53%
EU	1,863	127	1,990	8%	1%	94%
India	2,185	1,149	3,334	9%	10%	66%
China	14,457	7,498	21,956	62%	65%	66%
World	23,391	11,617	35,008			67%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Pure diamonds are a highly significant source of revenue for Africa, accounting for **10.3% of the value of the exports from the continent's mining sector (USD 68.7 billion)**. Half of these exports go to the UAE and China, with smaller volumes to the EU, India, and the United States. Africa's diamond-exporting countries are South Africa (48%), Botswana (27%), Angola (12%), Namibia (6%), Lesotho (3%), and the DRC (2%).

Gold is **the most important source of export revenues (34%), with 86% in the form of processed raw metal (USD 195.5 billion), 3% as ore (USD 6.4 billion), and 11% as semifinished products (USD 25.6 billion)**. Africa is the world leader in the ore and metal, meeting around 20% of global demand. While the destinations for exports of the ore and finished products are similar (China, the EU, and the United Kingdom), their rank differs for the different elements (ore, finished product, or raw metal): the EU is the main export destination for the ore, while the United Kingdom imports more semifinished products. In contrast, the raw metal (the most valuable form) is exported to the UAE, Switzerland, and India. The African countries exporting gold ore are South Africa (92%) and Tanzania

(6%). The raw metal is exported by more than a dozen countries: South Africa (25%), Ghana (11%), Mali (10%), Guinea (9%), Burkina Faso (6%), Egypt (4%), and Tanzania, Sudan, Uganda, Niger, and Zimbabwe (3% each). The African countries with the physical capacity to manufacture and export semifinished products are South Africa (81%), Namibia, Tanzania, and Kenya (5% each).

Table 21. ***Destinations of rough diamonds (USD billions)***

	AFR	RoW	WORLD	Sh. AFR	Sht. RoW	Pr. AFR
Others	775	46,589	47,364	1%	7%	2%
Switzerland	478	5,771	6,249	1%	1%	8%
Singapore	1,627	3,020	4,647	2%	0%	35%
Hong Kong	1,648	63,743	65,390	2%	10%	3%
Africa	4,151	7,955	12,106	6%	1%	34%
United States	6,098	71,225	77,324	9%	11%	8%
India	6,340	90,761	97,100	9%	14%	7%
EU	12,568	37,351	49,919	18%	6%	25%
China	17,351	15,093	32,444	25%	2%	53%
UAE	17,673	341,508	45,998	26%	54%	38%
World	68,709	636,427	438,542			16%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Table 22. ***Table 22. Destinations of gold ore (USD billions)***

	AFR	RoW	WORLD	Sh. AFR	Sht. RoW	Pr. AFR
Others	302	6,699	7,001	5%	27%	4%
UAE	0	134	134	0%	1%	0%
Korea	2	272	273	0%	1%	1%
Africa	3	16	19	0%	0%	16%
Malaysia	4	530	534	0%	2%	1%
Georgia	5	39	43	0%	0%	10%
Rest of Asia	34	1,023	1,057	1%	4%	3%
China	188	11,036	11,224	3%	44%	2%
United Kingdom	738	1,688	2,426	11%	7%	30%
EU	5,162	3,616	8,778	80%	14%	59%
World	6,438	25,052	31,490			20%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Table 23. ***Destinations of gold metal (USD billions)***

	AFR	RoW	WORLD	Sh. AFR	Sht. RoW	Pr. AFR
Others	6,151	153,738	159,889	3%	16%	4%
Africa	1,647	1,548	3,195	1%	0%	52%
United States	2,564	57,086	59,651	1%	6%	4%
Hong Kong	3,374	80,912	84,287	2%	9%	4%
Turkey	3,907	49,336	53,243	2%	5%	7%
Canada	4,479	20,727	25,206	2%	2%	18%
China	15,294	139,597	154,891	8%	15%	10%
India	24,685	121,760	146,445	13%	13%	17%
Switzerland	43,640	257,421	301,061	22%	28%	14%
UAE	89,772	52,638	142,410	46%	6%	63%
World	195,514	934,764	1,130,278			17%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Table 24. ***Destinations of gold products (USD billions)***

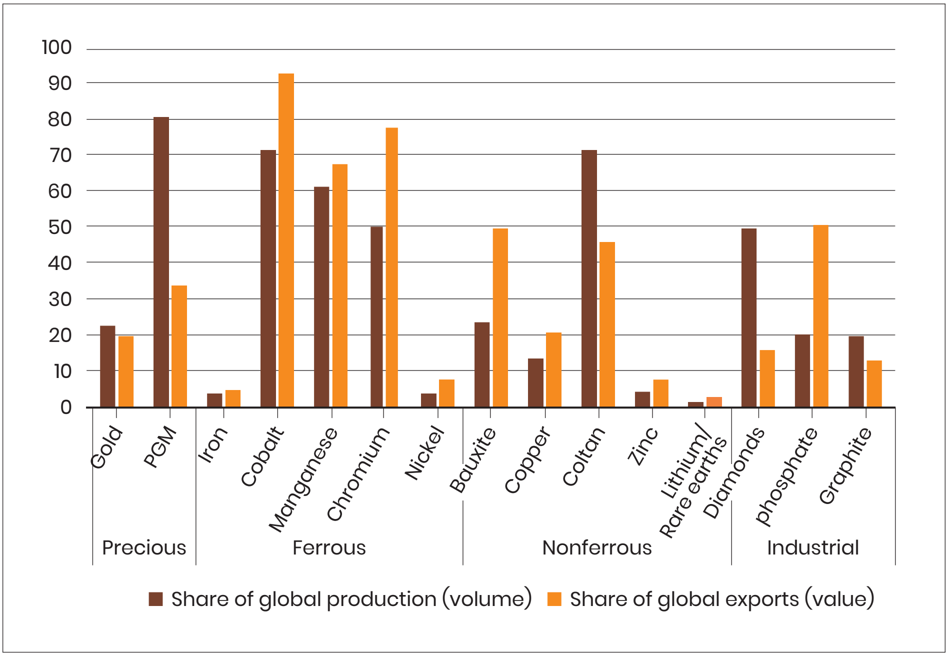
	AFR	RoW	WORLD	Sh. AFR	Sht. RoW	Pr. AFR
Others	250	246	496	1%	0%	50%
United States	20	8,235	8,255	0%	2%	0%
KOREA	44	1,751	1,795	0%	1%	2%
UAE	59	2,775	2,835	0%	1%	2%
Azerbaijan	157	2,861	3,018	1%	1%	5%
Singapore	428	48,343	48,771	2%	14%	1%
Africa	3,319	1,581	4,900	13%	0%	68%
China	5,532	1,809	7,341	22%	1%	75%
EU	3,840	43,761	47,602	15%	13%	8%
United Kingdom	11,613	225,890	237,503	46%	67%	5%
World	25,263	337,252	362,515			7%

Key: AFR: exports from Africa; RoW: exports from rest of world;
Sh. AFR: share of exports from Africa;
Sh. RoW: share of exports from rest of world;
Pr. AFR: proportion of exports from Africa meeting global demand.

Source: Authors based on UN Comtrade data.

Africa is a major supplier of certain precious metals (gold and platinum), ferrous metals (cobalt, manganese, and chromium), nonferrous metals (bauxite, copper, and coltan), and industrial minerals (diamonds and phosphate). Although it is a long way from being a key actor, this could change as a result of recent and future investment, particularly in critical minerals and/or those involved in the energy transition.

Graph 18. ***Africa's share of global production and exports (%)***



Note: PGM: Platinum Group Metals.
Sources: Authors based on UN Comtrade data and USGS.

2. Current investment strategies in Africa

In this section, we will examine the investment strategies for the supply of strategic minerals being pursued by China, the United States, the EU, Australia, Canada, the United Kingdom, and Japan. This will enable us to clarify the need for mineral-producing countries to expand their involvement in the processing stages, and to promote the idea of import substitution industrialization.

In recent years, there has been a growing emphasis on the need to secure the minerals that are vital to the "green" technologies driving the energy transition. The North Atlantic Treaty Organization (NATO) and Shanghai Cooperation Organization (SCO) have voiced concerns about the security of mineral supplies, and various countries have implemented mining and mineral strategies that specifically target minerals they have identified as critical or strategic. The aim of this section is to examine Africa's role in these international strategies.

2.1. Africa's role in state strategies for critical and strategic minerals

In recent years, the strategic nature of minerals, and the need to safeguard their supply, have become increasingly important issues for many governments. As international geopolitical tensions intensify, more and more governments are implementing strategies to secure their supplies of critical minerals.

2.1.1. Africa's role in the supply of "critical" minerals

Table 25. ***Africa's position among the main producers of "critical" minerals***

CRITICAL MINERAL	PRODUCTION	RESERVES
Chromium	South Africa (41.1%), Turkey (18.7%), Kazakhstan (15.1%)	Kazakhstan (41.1%), South Africa (35.7%), India (17.9%)
Cobalt	Democratic Republic of the Congo (68.7%), Russia (4.3%), Australia (3.9%)	Democratic Republic of the Congo (49.3%), Australia (17.4%), Cuba (7.2%)
Copper	Chile (28.1%), Peru (11.9%), China (8.2%)	Chile (20.5%), Australia (10.6%), Peru (10%)
Natural graphite	China (61.7%), Brazil (8.5%), India (2.8%)	Turkey (30%), China (24.3%), Brazil (24%)
Lead	China (41.6%), Australia (10.4%), United States (5.5%)	Australia (28.9%), China (21.7%), Peru (7.2%)
Lithium	Australia (81.4%), Chile (5.8%), China (2.9%)	Chile (57.1%), Australia (19.3%), Argentina (14.3%)
Magnesium	China (86.6%), Russia (6%), Israel (1.9%)	North Korea (27.1%), Russia (27.1%), China (11.8%)
Manganese	South Africa (28.2%), China (15.8%), Australia (12.5%)	South Africa (32.1%), Brazil (13.6%), Australia (12.3%)
Molybdenum	China (41.5%), Chile (19.8%), United States (15.7%)	China (48.8%), United States (15.9%), Peru (14.1%)
Nickel	Indonesia (31.6%), Philippines (12%), Russia (8.3%)	Indonesia (23.6%), Australia (21.3%), Brazil (12.4%)
Rare earths (elements)	China (60%), United States (12.7%), Myanmar (11.4%)	China (36.7%), Brazil (18.3%), Vietnam (18.3%)
Selenium	China (36.2%), Japan (23.3%), Russia (10.9%)	China (26.3%), Russia (20.2%), Peru (13.1%)

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CRITICAL MINERAL	PRODUCTION	RESERVES
Silver	Mexico (26.3%), Peru (13.5%), China (12.1%)	EU (19.6%), Peru (19.6%), Australia (15.9%)
Tin	Chine (27,8%), Indonésie (25,1%), Birmanie (16,2%)	China (23.4%), Indonesia (17%), Australia (7.9%)
Titanium	China (43.9%), Australia (13.1%), Mozambique (9.3%)	Australie (28,4%), Chine (26,1%), Inde (9,7%)
Zinc	China (32.9%), Peru (11%), Australia (10.4%)	Australia (27.8%), China (19.1%), Mexico (8.7%)

Note: African countries are listed in orange

Source: Authors based on work by Kowalski and Legendre 2023.

Africa as an actor to consider in the supply of "critical" minerals

More specifically, in this section we will examine the mining and minerals strategies implemented by thirteen actors: Australia, Brazil, Canada, China, Europe (the EU, Switzerland, and Norway), the Gulf states (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE), India, Japan, Morocco, Russia, South Africa, the United Kingdom, and the United States. Of these thirteen actors, ten have published a list of clearly identified critical minerals.[24] As a sign of the growing importance of securing critical minerals (CMs), **of the ten lists of CMs examined here, only three have not been updated since 2022** (the Indian and Chinese lists date from 2016, and the Japanese list from 2020), the most recent being the list published by the European Commission (EC) in early 2023. Most other countries have been drawing up CM lists for much longer.

24. Note that, depending on the country, governments and policies may refer to "critical minerals," "rare metals," "strategic minerals," or "critical raw materials." For ease of reading, here we refer to all of these as "critical minerals" (CMs).

Table 26. ***List of minerals identified as "critical" by various countries***

	SOUTH AFRICA	AUSTRALIA	BRAZIL	CANADA	CHINA	EC	UNITED STATES	INDIA	JAPAN	UNITED KINGDOM	African production
Alumina		x									*n.d.*
Aluminum			x	x	x	x	x				x
Antimony		x		x	x	x	x		x	x	
Arsenic						x	x				x
Barite/Barium						x	x		x		x
Bauxite						x					x
Beryllium		x				x	x	x	x		x
Bismuth		x		x		x	x		x	x	
Boron						x			x		*n.d.*
Limestone								x			*n.d.*
Carbon									x		*n.d.*
Cesium				x			x		x		*n.d.*
Coal (Coke)	x					x					x
Chromium	x	x		x	x		x	x	x		x
Cobalt	x	x	x	x	x	x	x		x	x	x
Copper	x		x	x	x	x					x
Tin			x	x	x		x			x	x
Feldspar						x					x
Iron	x		x		x						x
Fluorite				x		x	x		x		*n.d.*
Gallium		x		x		x	x		x	x	
Germanium		x		x		x	x	x	x		
Graphite		x	x	x		x	x	x		x	x
Hafnium		x				x	x		x		*n.d.*
Helium		x		x		x					*n.d.*

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	SOUTH AFRICA	AUSTRALIA	BRAZIL	CANADA	CHINA	EC	UNITED STATES	INDIA	JAPAN	UNITED KINGDOM	African production
Indium		x		x			x		x	x	*n.d.*
Lithium	x	x	x	x	x	x	x		x	x	x
Magnesium		x		x		x	x		x	x	*n.d.*
Manganese	x	x	x	x		x	x		x		x
Molybdenum			x	x	x				x		
Nickel	x		x	x	x	x	x		x		x
Niobium		x	x	x		x	x	x	x	x	x
Gold			x		x						x
PGM	x	x	x	x		x	x		x	x	x
Phosphate			x			x					x
Phosphorus						x					*n.d.*
Lead	x										x
Potash				x							
Potassium			x								*n.d.*
Rhenium		x						x	x		*n.d.*
Rubidium							x		x		*n.d.*
Scandium		x		x		x	x				*n.d.*
Selenium									x		*n.d.*
Silicon						x					*n.d.*
Silicone		x	x					x	x	x	*n.d.*
Sulfur			x								x
Strontium						x		x	x		*n.d.*
Tantalum		x	x	x		x	x	x	x	x	x
Tellurium				x			x		x	x	
Rare earths	x	x	x	x	x	x	x	x	x	x	x

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	SOUTH AFRICA	AUSTRALIA	BRAZIL	CANADA	CHINA	EC	UNITED STATES	INDIA	JAPAN	UNITED KINGDOM	African production
Thallium			x						x		*n.d.*
Titanium		x	x	x		x	x		x		x
Tungsten		x	x	x	x	x	x		x	x	x
Uranium	x		x	x							x
Vanadium	x	x	x	x		x	x		x	x	x
Zinc	x			x			x				x
Zirconium		x			x		x	x	x		*n.d.*

Metals considered vital for the energy transition by the IEA
African production below 10% of global production in 2020
African production between 10 and 50% of global production in 2020
African production above 50% of global production in 2020
No African production

n.d. not determined

Sources: National governments, International Energy Agency (IEA), and World Mining Data (2020).

These lists vary widely, ranging from thirteen identified minerals (India) to fifty (United States).[25] Some lists, such as the US one, explicitly exclude mineral fuels, while the South African, Brazilian, Canadian, and EC lists include them. The lists examined here include a total of fifty-seven minerals. **Only rare earths are common to all ten CMs lists.** Cobalt and lithium are included in nine of the ten lists; niobium, PGMs, tantalum, tungsten, and vanadium in eight of the ten; and antimony, chromium, graphite, manganese, and nickel in seven of the ten. Twelve minerals are considered critical by only a single country.

25. In the US list, the rare earths and PGMs that have been grouped together in the table and in our analysis are listed separately.

Of the fifty-seven minerals identified, twenty-nine are produced in significant quantities by African countries, and for twenty-two mostly industrial minerals there is no accurate documentation of African production. **In 2020, African countries supplied more than half the global production of chromium, cobalt, manganese, platinum, and tantalum—minerals identified as critical by a large number of countries**. The concentration of cobalt production in the DRC and platinum production in South Africa is explicitly mentioned in several government policies. To a lesser extent, Africa also plays an important role in the supply of arsenic (based solely on Moroccan production), bauxite, copper, gold, phosphate, titanium, and uranium. It should also be noted that the continent does not produce the following seven CMs: antimony, bismuth, gallium, germanium, molybdenum, potash, and tellurium. However, projects of this kind may emerge in the next few years: the Kipushi mine (DRC), which is currently being prepared for reopening, might produce germanium, for example.

The critical nature of a mineral is mainly assessed *(i)* in light of its importance to the industries a country deems strategic (defense and aerospace, electronics, wind and solar power generation, automobile industry, etc.), and *(ii)* in terms of the risks to supply chains, either because of dense geographical concentration, or because of potential shortages linked to limited production of the mineral globally. Whether or not a country includes a mineral in its CM list depends on how it is positioned: **geographical concentration and growth in global demand can be perceived as both an opportunity and a threat, depending on the country's position in the global supply chain.** Countries with substantial mining resources, such as South Africa, Australia, Brazil, and China, include some CMs in their lists to exploit their competitive advantage. India, Japan, the United Kingdom, and the EU, on the other hand, include minerals on which they are dependent, and whose supply they fear may be disrupted.[26]

26. Ana Elena Sancho Calvino, "What Makes 'Critical Materials' Critical?," *Zeitgeist Series Briefing #5*, Global Trade Alert, November 30, 2022, accessed January 30, 2025, https://globaltradealert.org/reports/148.

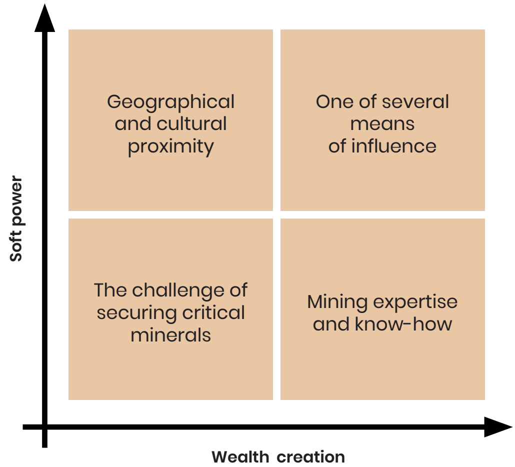
2.1.2. The African mining sector in national mineral strategies

The African mining sector is viewed in different ways in different national mineral strategies. Drawing up a list of CMs is part of a broader process of formulating a national CM strategy. Four main elements can be identified in the various national strategies: *(i)* increasing the extraction and processing of domestic mineral resources; *(ii)* supporting R&D and innovation to improve the recycling of materials, find substitution solutions, and develop new mining technologies to exploit currently unprofitable resources; *(iii)* safeguarding national production capacity, or even building up strategic reserves; and *(iv)* optimizing exports and foreign direct investment (FDI).[27]

As might be expected, countries that currently have an advantage in mining production are primarily focused on maintaining their dominant position and ensuring that the economic benefits of rising demand are passed on to their economies: this is the case for South Africa, Australia, Brazil, Canada, and China. Conversely, actors such as Japan, the United States, India, and Europe, which are more heavily dependent on mining imports, are seeking to develop their mining sector and diversify supply in order to minimize risks.

Africa is rarely explicitly mentioned in national mining policies. However, different perceptions of the continent can be identified, based on the guidelines in each country's national mining policy. Broadly speaking, there are four different perceptions of the African mining sector.

27. Ana Elena Sancho Calvino, "What Policies Have Governments Adopted to Secure Critical Materials?," Global Trade Alert, *Zeitgeist Series Briefing #6*, November 30, 2022,: accessed January 30, 2025, https://globaltradealert.org/reports/149.



Several countries, primarily China, Russia, India, and the Gulf states (Saudi Arabia and the UAE), **see Africa as a region in which to extend their spheres of influence**. These countries have investment strategies that go far beyond the mining sector, and aim not only to create wealth but also to spread their soft power across the continent—China's Belt and Road Initiative (BRI) is a prime example of this strategy. Mining and influence in African countries are closely intertwined: consider, for example, the opaque way the Wagner militia receives payment for its services by being awarded mining concessions in Sudan and the Central African Republic (CAR), or Russia's powerful influence in Mali and Burkina Faso, where Russian companies have operated gold mines for over a decade. The Gulf states have used increased diplomatic relations to engage in land grabbing to gain control over mineral resources, as well as over agricultural resources and drinking water, which are vital for development of the Arabian Peninsula. Investment in mining is therefore part of a wider strategy, and one component in a country's strategy for establishing itself in a range of sectors. Chinese exploitation of Guinean bauxite is a good illustration of this diversified investment strategy: the Santou bauxite project in Guinea, which is led by TBEA Co. Ltd, includes the construction of a bauxite mine, an alumina refinery, roads, a railroad, a deepwater port, and a 7 MW hydroelectric power plant.

For mining countries such as Canada and Australia, their entry into the African mining sector is being driven more by **the opportunity to leverage mining know-how to take advantage of African mineral resources.** This is also the motivation behind the entry of globally important Swiss and British mining companies. Africa has abundant mineral resources that have barely been exploited, and mining is often more profitable than elsewhere because of the high grade of the deposits. Investment in certain African countries, such as Zimbabwe, may also appeal to investors because of limited competition. Consequently, natural resources are fundamental pillars of relations between Canada, Australia, and African countries. It should be noted, however, that issues of governance, transparency, and the political instability inherent to African countries can put off some investors: US companies, reluctant to take such risks, have very few operations in Africa. The issues of corruption, social responsibility, and environmental impact (corporate social responsibility [CSR]), which are particularly prevalent in Africa, may also heavily influence a firm's decision about whether to establish a presence on the continent, since it has to take reputational risks into account. Revealingly, Africa is the region with the most countries—eight—among the ten least attractive jurisdictions for mining investment, according to the Fraser Institute (2022); Zimbabwe, Mozambique, South Sudan, and Angola are considered to be the least attractive countries by this Canadian think tank.

Japan, the EU, and the United States, which are heavily dependent on mineral imports, mainly see Africa through the prism of **securing their supply of CMs**. All these actors are supporting the development of their own domestic mining sectors, but are well aware that this will not be sufficient to meet their mineral needs. They are therefore seeking to diversify their supply of minerals in order to move away from overdependence on a single country, and Africa seems an interesting partner in this respect—except for cobalt and platinum, where African countries (the DRC for cobalt, and South Africa for platinum) enjoy very high market shares. The Japanese, European, and US strategies are therefore less concerned with direct investment in the African mining sector than with imports of coveted African minerals.

Finally, the African mining sector might be seen as the **ideal place for African mining companies to expand, given their mining know-how and their cultural and geographical proximity** to other African countries. Generally speaking, however, African countries and mining companies have been unable to develop mining strategies that go beyond their own national borders. As might be expected, African countries prioritize the development and regulation of their own domestic mining industries. National mining companies are few in number, and their top priority is their own survival and expansion within their own frontiers. The same issues apply to other mining countries: Indonesia and the countries of Latin America face similar difficulties in moving beyond their own borders. While Brazil once had a foothold in the African mining sector, its presence is now very limited, and most of its investment goes into the Americas. The notable exceptions are South Africa and Morocco. South Africa does not have a government strategy to encourage expansion in Africa, but South African companies have expanded extensively across the continent. In contrast, Morocco is supporting its national mining firms, and encouraging them to invest in other countries on the continent.

2.2. Africa's position in global mining investment

2.2.1. Africa as a major destination for global mining investment

Africa is the world's third-largest destination for mining investment, despite relatively small exploration budgets and low levels of greenfield investment. In terms of global mining FDI recipients, Africa received 13.9% of all mining FDI between 2018 and 2022: this makes the continent, with a cumulative amount of USD 77 billion of FDI, the third-highest recipient after Latin America (USD 114 billion) and Canada (USD 80 billion).

We note the **prevalence of brownfield investment, which accounts for 55.8% of FDI in mining in Africa:** Africa is the only destination where brownfield investment is greater than greenfield investment. **Africa is also one of the destinations that attracted the lowest exploration expenditure over the period under review**, at USD 4.7 million, i.e., almost a third of the amount spent on exploration in Latin America. In addition, only 22.4% of exploration expenditure over the period studied was devoted to completely unexplored areas (grassroots): 32.8% of exploration expenditure involved projects at an advanced stage of development or undergoing feasibility studies, and 44.8% of expenditure involved exploration close to existing mine sites. This reflects the low appeal of Africa over the last five years compared with other destinations such as Latin America and Canada. A low level of exploration and a preponderance of brownfield investment are indicative of a mining sector that will be revitalized less rapidly over time than other destinations that receive better-targeted FDI.

At first glance, Africa does not seem to be benefiting from the renewed global interest in minerals. Instead, its share of global mining investment fell to 14.4% of global mining investment over the period 2008–2012 (USD 152 billion), compared with 19% between 2013 and 2017 (USD 104 billion).

Table 27. ***Breakdown of global mining FDI by destination between 2018 and 2022***

DESTINATION OF MINING FDI	EXPLORATION BUDGET		BROWNFIELD INVESTMENT		GREENFIELD INVESTMENT		TOTAL FDI	
	Amount (USD millions)	Share (%)	Amount (USD millions)	Share (%)	Amount (USD millions)	Share (%)	Amount (USD millions)	Share (%)
Latin America	11,833.4	27.0	47,524.6	19.3	54,690.1	20.6	**114,048.1**	**20.5**
Canada	7,738.4	17.6	25,362.8	10.3	46,896.5	17.6	**79,997.7**	**14.4**
Africa	4,700.3	10.7	43,020.9	17.5	29,415.3	11.1	**77,136.5**	**13.9**
United States	5,224.3	11.9	29,116.6	11.9	42,244.6	15.9	**76,585.5**	**13.8**
Australia	7,502.7	17.1	28,378.7	11.6	36,195.0	13.6	**72,076.4**	**13.0**
Rest of the world	6,909.3	15.7	72,252.6	29.4	56,678.7	21.3	**135,840.6**	**24.4**
TOTAL	**43,908.4**	**100.0**	**245,656.2**	**100.0**	**266,120.2**	**100.0**	**555,684.9**	**100.0**

All amounts are expressed in USD millions and relate to the period 2018–2022, unless otherwise specified.

Source: Authors based on S&P Capital IQ Pro data.

2.2.2. Africa's major importance in platinum, bauxite, and diamonds

The most significant investment in Africa is largely in gold (USD 20.9 billion between 2018 and 2022), copper (USD 13 billion), and platinum (USD 11.5 billion), with the same ranking found in exploration budgets. **Africa received almost all global investment in platinum (97%).** However, it attracted only 42.5% of all spending on platinum exploration: in addition to existing projects, investors are looking for other sources of platinum for future exploitation, as part of an effort to diversify global supply chains to mitigate the risk of dependence on South African platinum. Gold and copper projects, on the other hand, ultimately attract little in terms of global investment, accounting for 17.1% and 7.6% of global investment respectively, and 11.7% and 7.8% of expenditure for exploration of the two minerals.

Africa attracted all investment (USD 1.7 billion) in bauxite, 93.5% of investment in diamonds (USD 1.6 billion), and 89% of investment in heavy sands (USD 1.9 billion). Africa's share is significantly lower if transition minerals are considered as a whole, with the continent accounting for 11.4% of the global total allocated to transition minerals. It should be noted, however, that transition minerals account for almost half (45.9%) of mining investment in Africa, with copper and platinum leading the way, and some investment also going into manganese, rare earths, lithium, graphite, palladium, zinc, and others.

Table 28. ***Africa's share of global mining investment (excluding exploration expenditure) by mineral between 2018 and 2022***

MINERAL		AFRICA		LATIN AMERICA		AUSTRALIA	
		USD millions	(%)	USD millions	(%)	USD millions	(%)
Ferrous metals	Manganese	1,345.9	**38.4**	0.0	**0.0**	649.0	**18.5**
	Rutile	642.6	**49.8**	0.0	**0.0**	0.0	**0.0**
	Nickel	468.6	**1.8**	1,903.8	**7.1**	4,328.7	**16.2**
	Iron	312.8	**1.2**	1,126.9	**4.3**	18,604.8	**70.4**
	Vanadium	288.4	**6.1**	599.5	**12.7**	2,191.9	**46.5**
	Niobium	250.0	**10.8**	0.0	**0.0**	0.0	**0.0**
	Chromium	9.7	**100.0**	0.0	**0.0**	0.0	**0.0**
	Tungsten	1.4	**0.1**	0.0	**0.0**	583.7	**63.0**
	Molybdenum	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**
	Cobalt	0.0	**0.0**	0.0	**0.0**	1,380.1	**99.3**
	Titanium	0.0	**0.0**	0.0	**0.0**	475.9	**66.7**
	Tantalum	0.0	**0.0**	110.0	**100.0**	0.0	**0.0**
Nonferrous metals	Copper	13,034.5	**7.6**	60,504.6	**35.1**	4,803.8	**2.8**
	Bauxite	1,716.5	**100.0**	0.0	**0.0**	0.0	**0.0**
	Rare earths	1,341.0	**25.3**	419.0	**7.9**	912.6	**17.2**
	Lithium	1,207.8	**3.2**	7,321.3	**19.7**	5,322.0	**14.3**
	Zinc	814.1	**12.4**	1,837.8	**28.0**	313.5	**4.8**
	Ilmenite	498.8	**58.0**	0.0	**0.0**	361.0	**42.0**
	Tin	445.8	**53.0**	56.0	**6.7**	38.9	**4.6**
	Lead	92.6	**6.5**	0.0	**0.0**	735.6	**52.0**
	Scandium	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**

All amounts are expressed in USD millions and relate to the period 2018–2022. unless otherwise specified. Investment does not include exploration expenditure. The minerals that the IEA considers essential for the energy transition are highlighted in mustard yellow.

Source: Authors based on S&P Capital IQ Pro data.

CANADA		UNITED STATES		REST OF THE WORLD		TOTAL
USD millions	(%)	USD millions	(%)	USD millions	(%)	USD millions
350.0	**10.0**	0.0	**0.0**	1,161.3	**33.1**	**3,506.1**
0.0	**0.0**	0.0	**0.0**	647.7	**50.2**	**1,290.3**
7,365.2	**27.5**	1,070.3	**4.0**	11,612.8	**43.4**	**26,749.3**
4,197.6	**15.9**	90.3	**0.3**	2,093.5	**7.9**	**26,425.9**
0.0	**0.0**	652.1	**13.8**	986.5	**20.9**	**4,718.4**
1,195.8	**51.4**	878.6	**37.8**	0.0	**0.0**	**2,324.4**
0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**9.7**
0.0	**0.0**	32.5	**3.5**	308.7	**33.3**	**926.3**
0.0	**0.0**	3,071.0	**100.0**	0.0	**0.0**	**3,071.0**
0.0	**0.0**	9.5	**0.7**	0.0	**0.0**	**1,389.6**
0.0	**0.0**	237.2	**33.3**	0.0	**0.0**	**713.1**
0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**110.0**
12,612.5	**7.3**	31,808.3	**18.5**	49,624.4	**28.8**	**172,388.0**
0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**1,716.5**
1,481.7	**28.0**	1,145.7	**21.6**	0.0	**0.0**	**5,299.9**
1,640.0	**4.4**	13,815.4	**37.2**	7,868.2	**21.2**	**37,174.6**
1,354.1	**20.7**	461.7	**7.0**	1,775.0	**27.1**	**6,556.3**
0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**859.8**
23.9	**2.8**	0.0	**0.0**	276.3	**32.9**	**840.9**
0.0	**0.0**	0.0	**0.0**	586.4	**41.5**	**1,414.6**
677.1	**100.0**	0.0	**0.0**	0.0	**0.0**	**677.1**

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MINERAL		AFRICA		LATIN AMERICA		AUSTRALIA	
		USD millions	(%)	USD millions	(%)	USD millions	(%)
Precious metals	Gold	20,886.3	**17.1**	20,995.8	**17.2**	15,746.2	**12.9**
	Platinum	11,494.5	**97.0**	64.5	**0.5**	0.0	**0.0**
	Palladium	1,104.0	**39.1**	0.0	**0.0**	0.0	**0.0**
	Silver	144.4	**3.0**	2 499.0	**51.5**	620.9	**12.8**
Industrial minerals	Potash	4,572.9	**51.3**	655.0	**7.4**	1,419.4	**15.9**
	Heavy sands	1,975.2	**89.0**	0.0	**0.0**	0.0	**0.0**
	Diamonds	1,599.8	**93.5**	0.0	**0.0**	68.8	**4.0**
	Phosphate	1,217.5	**4.6**	165.3	**0.6**	520.1	**2.0**
	Graphite	1,187.2	**20.7**	0.0	**0.0**	645.4	**11.3**
	Zircon	0.0	**0.0**	0.0	**0.0**	1,295.5	**100.0**
Comb. min.	Coal	4,453.6	**23.8**	1,422.0	**7.6**	3,456.0	**18.5**
	Uranium	1,330.6	**20.0**	2,534.3	**38.2**	99.8	**1.5**
TOTAL		**72,436.2**	**14.2**	**102,214.7**	**20.0**	**64,573.7**	**12.6**

All amounts are expressed in USD millions and relate to the period 2018–2022, unless otherwise specified. Investment does not include exploration expenditure. The minerals that the IEA considers essential for the energy transition are highlighted in mustard yellow.

Source: Authors based on S&P Capital IQ Pro data.

CANADA		UNITED STATES		REST OF THE WORLD		TOTAL
USD millions	(%)	USD millions	(%)	USD millions	(%)	USD millions
28 802.9	**23.5**	12,947.5	**10.6**	22,929.5	**18.7**	**122,308.2**
287.9	**2.4**	0.0	**0.0**	0.0	**0.0**	**11,846.8**
1,558.9	**55.2**	158.9	**5.6**	0.0	**0.0**	**2,821.8**
38.6	**0.8**	1,165.0	**24.0**	382.1	**7.9**	**4,850.1**
23.0	**0.3**	990.1	**11.1**	1,246.7	**14.0**	**8,907.1**
0.0	**0.0**	0.0	**0.0**	245.0	**11.0**	**2,220.2**
42.0	**2.5**	0.0	**0.0**	0.0	**0.0**	**1,710.6**
1,859.5	**7.0**	106.2	**0.4**	22,700.0	**85.4**	**26,568.6**
1,461.0	**25.5**	1,070.4	**18.7**	1,359.1	**23.7**	**5,723.2**
0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**1,295.5**
5,128.2	**27.4**	1,345.0	**7.2**	2,920.3	**15.6**	**18,725.1**
2,159.4	**32.5**	305.7	**4.6**	207.8	**3.1**	**6,637.6**
72,259.3	**14.1**	**71,361.2**	**13.9**	**128,931.3**	**25.2**	**511,776.5**

2.2.3. Very different levels of importance in investors' international strategies

An important component of the CM procurement strategies of different countries involves securing these minerals by investing in foreign projects via national mining companies. China's approach has thus been to integrate its industrial mining ecosystem into its critical raw materials policies: Chinese firms can often be seen as the armed wing of China's mineral procurement policy. This strategy is also pursued by other countries, such as Japan, which has long adopted a strategy of securing the mineral resources it lacks through investment by Japanese mining companies via the Japan Organization for Metals and Energy Security (JOGMEC),[28] an agency that comes under the Japanese Ministry of Economy, Trade and Industry (METI). For most international actors, however, it is difficult to establish such a direct link between CM policy and investment by national mining companies, since the largest mining companies are multinationals. The fact remains, however, that hosting the international stock exchanges where key mining sector transactions take place necessarily influences the policies pursued by international actors—the United Kingdom, for example, proposes to make the City of London the capital of responsible finance for CM in its "Resilience for the Future: The UK's Critical Minerals Strategy" policy paper. In this section, we will therefore examine the investment made by various mining companies through the prism of their country of domicile. While we are well aware that this approach has its limitations and obscures finer levels of understanding—the fact that the funds raised by Australian juniors are largely of Chinese origin, for example—we nevertheless consider it to be an initial step toward understanding the sources of the main investment in Africa. We would stress that the countries mentioned in this section are those in which the mining companies are domiciled, but that these companies are often multinationals that may have subsidiaries domiciled in different countries.

28. Japan's agency for materials and energy security.

In terms of the value of investment[29] made over the last five years, **Canada is unquestionably the leading investor in the African mining sector, followed by the United Kingdom and Australia.** While the sums spent by Canadian, British, and Australian mining companies in Africa are roughly similar, their relative contribution to global investment varies greatly: they account for more than a third (36.9%) of British investment globally, but represent less than 10% of total Canadian mining investment, and some 16% of Australian mining investment.[30] Canada and Australia are by far the world's largest mining investors, and are pursuing a strategy of investment diversification. They have a presence in most mining countries, and are investing heavily. Africa is just one of their investment destinations, and Canadian and Australian mining companies have not, on the whole, developed a specific policy toward Africa. Raw materials, on the other hand, are a fundamental pillar of economic and diplomatic relations with Africa. Canadian and Australian companies are particularly active in gold and diamonds, along with copper in the case of Canada, and coal and manganese for Australia. Companies domiciled in Canada and Australia currently operate thirty-five and thirty mines respectively in Africa. These are spread across the continent, with a strong focus on West and Central Africa for Canadian operators, and South Africa for their Australian counterparts.

The United Kingdom, meanwhile, is a smaller investor than Canada and Australia, but has made Africa its top mining investment destination (36.9% of British global investment). **The United Kingdom is therefore the second-largest investor in terms of investment made between 2018 and 2022, but also in terms of the number of active mines operated by British companies in Africa.** This can mainly be explained by the United Kingdom's historical ties with Africa, and in particular South Africa, where fifteen of the fifty-five active mines are operated by British companies. British companies' strong influence on the African mining sector—particularly through Anglo American—contrasts with the **virtual absence of US**

29. Investment amounts should be treated with caution. The nationality of the investor is taken as that of the country of domicile of the firm holding the largest share of the mining property where the investment was made at the time it was announced. This does not include investment made by companies with minority shares at the time of the transaction (or negotiation), and may therefore artificially inflate the investment figures of companies with the largest shares. It also does not include subsidiaries domiciled in third countries.
30. The investment percentages in this section refer to investments by value (USD) based on data provided by S&P Capital IQ Pro.

companies from Africa. The United States spends just 2.8% of its investment in Africa, where American companies operate nine active mines. This limited presence can be explained not only by the strong incentives provided by the US government to help revive its domestic mining sector by investing in it as a priority (47.8% of US investment over the period 2018–2022), but also by the highly risk-averse nature of US companies. The United States is, however, aware of the strategic nature of minerals produced in Africa, and has announced its intention to strengthen its presence in the sector. **The Inflation Reduction Act (IRA)**, passed by the US Congress in August 2022—which requires US manufacturers of electric vehicles (EVs) to ensure that at least 40% of the components (inputs) in their batteries are sourced in North America, or from countries that have signed a free trade agreement with the United States—does not make this increased presence any easier to achieve, however, as only Morocco has signed a trade agreement of this kind. The signing of agreements with the DRC and Zambia in December 2022 to bypass the requirements of the IRA and thereby facilitate investment in these two countries is a significant first step, but it remains to be seen whether it will be followed up. It also remains to be seen whether the US authorities will decide that the broader agreements so far concluded with various African countries can be regarded as genuine free trade agreements, and thus as falling within the scope of the IRA.

China's "Going Out" policy, combined with the spectacular increase in domestic demand in the mid-2000s, led it to increase its investment in mines in other countries, mainly in the Pacific Rim (Australia, Canada, and, more recently, Latin America), in neighboring countries (Mongolia, Laos, Tajikistan, Vietnam, etc.), and in Africa, first in Southern Africa and more recently in West Africa. Although **China** has reduced its mining FDI since 2014 as part of an attempt at investment rationalization, it **nevertheless continues to be a major investor in the mining sector, particularly in Africa, which attracted almost a third (30.2%) of Chinese mining investment between 2018 and 2022.** China is particularly active in cobalt production in the DRC and platinum production in South Africa, and is increasing its investment in Guinean bauxite. Chinese mining investment is part of a broader policy of investment in African infrastructure, pursued in particular through the BRI. India's mining investment strategy is largely inspired by the Chinese model, albeit on a smaller scale. Indian operators are mainly active in coal (Coal India), iron (Tata Steel), and African zinc (Vedanta Resources).

South Africa is another major actor in African mining. **South African companies operate the largest number of active mines on the continent (235), and invested USD 9.9 billion in Africa between 2018 and 2022**, accounting for more than half (54.3%) of total investment in the mining sector. They are naturally mainly active within South Africa itself, but also operate mines throughout the continent, thanks to the expertise of globally significant companies such as Anglo American Platinum, Impala Platinum, Gold Fields, and AngloGold Ashanti. This strong presence can be explained by geographical proximity and South African mining expertise. Logically, proximity also explains why Africa is so important in the mining investment strategies of Morocco and the UAE. The two main actors in Morocco's mining sector, the Office Chérifien des Phosphates (OCP) and Managem, have developed Africa strategies, while the UAE's mining investment in Africa (and, to a lesser extent, that of Saudi Arabia and Qatar) is part of a more general strategy to establish a foothold in the African raw materials sector.

Russia is a major mining country that has been active in gold in West Africa for over a decade via Nordgold—in 2020, for example, the company controlled 16% of Burkina Faso's gold production. **Russian mining investment has, however, declined in Africa, with the continent attracting just 0.5% of total Russian investment between 2018 and 2022.** This relative decline can be explained by the fact that Russian mining assets in West Africa have suffered from a volatile security situation: Nordgold, for example, had to close its Taparko open-pit gold mine in Burkina Faso in 2022. It can also be assumed that the international sanctions imposed as a result of the war in Ukraine are a barrier to Russian investment: in June 2022, for example, the Russian company Vi Holding withdrew from the Great Dyke Investments joint venture, which held the license to mine the largest platinum deposit in Zimbabwe. Although this was not explicitly stated as being linked to economic sanctions, it is nevertheless evidence of a general decrease in Russian investment in the gold industry. It should be noted, however, that the same global context is spurring Russia to strengthen its ties with African countries, and may also encourage it to use its gold mining operations to circumvent sanctions.

Europe's[31] **strong foothold in the African mining sector is mainly due to the strong presence on the continent of Swiss company Glencore**, which controls twenty-four of the forty-six mines operated by European companies. Europe is also overrepresented in Africa because a number of firms or subsidiaries from other countries are domiciled in Luxembourg. A host of small and medium-sized French, Finnish, Cypriot, Dutch, Swedish, German, Belgian, Irish, Romanian, and Portuguese firms hold mining assets in Africa, mainly in chromium, copper, diamonds, and coal. The EU is seeking to improve its trade with African mining countries by encouraging the diversification of supply chains. Japan is similarly attempting to secure its supplies by signing bilateral agreements, in particular with Namibia, South Africa, and the DRC. Japanese mining companies have a relatively limited presence as operators of African mining projects, but JOGMEC encourages Japanese companies to participate in mining projects abroad, often in a minority capacity. For example, Japan (Sumitomo Corporation) and South Korea (Korea Resources Corporation) are involved in one of the world's largest lateritic nickel mines in Madagascar: the Ambatovy mine, which also has an on-site refinery.

31. Here the term Europe is used in its widest sense to encompass the EU countries, Norway, and Switzerland.

Finally, we note the **lack of mining investment in Africa from Brazil, and from the countries of Latin America more broadly**. Although, for a time, Brazil's cultural closeness to Portuguese-speaking Angola and Mozambique enabled Brazilian firms to expand into the African mining sector, this trend has not withstood the corruption scandals and ecological disasters in Brazil (the dam failures at Bento Rodrigues in 2015 and Brumadinho in 2019, both in the state of Minas Gerais), which the Odebrecht Group (Brazilian construction giant) and the Vale Group have had to address.

Table 29. ***Breakdown of investment by the main mining investors between 2018 and 2022***

INVESTOR	AFRICA		LATIN AMERICA		AUSTRALIA	
	USD millions	(%)	USD millions	(%)	USD millions	(%)
Canada	20,462.9	**9.5**	53,177.5	**24.6**	1,125.6	**0.5**
United Kingdom	18,382.6	**36.9**	8,237.1	**16.5**	5,773.7	**11.6**
Australia	18,331.5	**16.0**	20,027.8	**17.5**	55,166.0	**48.2**
South Africa	8,879.9	**54.3**	4,196.9	**25.7**	2,884.0	**17.6**
China	4,312.8	**30.2**	1,279.9	**9.0**	620.0	**4.3**
EU	1,348.1	**22.0**	1,130.3	**18.5**	0.0	**0.0**
United States	1,330.2	**2.8**	2,889.9	**6.1**	4,217.7	**9.0**
Morocco	397.0	**100**	0.0	**0.0**	0.0	**0.0**
India	392.4	**37.0**	0.0	**0.0**	0.0	**0.0**
Japan	313.8	**50.4**	154.1	**24.7**	61.9	**9.9**
UAE	36.0	**0.5**	0.0	**0.0**	4.0	**0.1**
EAU	12.0	**100**	0.0	**0.0**	0.0	**0.0**
Brazil	0.0	**0.0**	5,379.8	**65.3**	9.2	**0.1**
TOTAL	**74,411.7**	**15.3**	**98,556.1**	**20.3**	**69,946.0**	**14.4**

All amounts are expressed in USD millions and relate to the period 2018–2022, unless otherwise specified. Here, the amounts include investment and exploration budgets.

Source: Authors based on S&P Capital IQ Pro data.

CANADA		UNITED STATES		REST OF THE WORLD		**TOTAL**
USD millions	(%)	USD millions	(%)	USD millions	(%)	USD millions
67,126.6	**31.0**	47,349.2	**21.9**	27,281.2	**12.6**	**216,522.9**
877.9	**1.8**	2,299.4	**4.6**	14,216.4	**28.6**	**49,787.1**
5,594.4	**4.9**	2,483.1	**2.2**	12,745.3	**11.1**	**114,348.0**
3.8	**0.0**	329.6	**2.0**	58.7	**0.4**	**16,352.9**
13.3	**0.1**	0.0	**0.0**	8,042.7	**56.4**	**14,268.6**
61.4	**1.0**	19.4	**0.3**	3,561.9	**58.2**	**6,121.0**
1,779.0	**3.8**	22,517.9	**47.8**	14,353.1	**30.5**	**47,087.9**
0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**397.0**
0.0	**0.0**	0.0	**0.0**	668.1	**63.0**	**1,060.5**
27.7	**4.4**	27.6	**4.4**	37.7	**6.1**	**622.8**
10.8	**0.1**	0.0	**0.0**	7,905.5	**99.4**	**7,956.3**
0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	**12.0**
2,734.3	**33.2**	2.6	**0.0**	118.7	**1.4**	**8,244.6**
78,300.8	**16.1**	**75,086.2**	**15.4**	**89,794.4**	**18.5**	**486,095,3**

3. Mineral processing in Africa

What are the prospects for creating greater added value in African economies, and for processing raw materials? In order to make the most of their mineral resources, African countries need to develop a local mineral processing industry. There are two reasons for this: *(i)* first, across the sector value chain as a whole, the revenue from extraction is limited in comparison with the other stages in the production chain for goods derived from mineral processing; and *(ii)* second, this would enable the emergence of the continent's long-awaited industrialization.[32]

3.1. Processing capacity in Africa

Africa has large quantities of the minerals needed for the energy transition and green industries. Africa has 6% of the world's copper reserves, 53% of its cobalt, 25% of its bauxite, 21% of its graphite, 46% of its manganese, 35% of its chromite, 79% of its phosphate, and 91% of the reserves of PGM (source: USGS). In addition to these reserves, Africa has an even greater share of current production of many of these minerals, including 70% of cobalt production. Although the continent is not yet a major producer of lithium, this mineral is mined in Zimbabwe and Mali, and Namibia, Ghana, and the DRC also have lithium resources. Rare earth elements (REEs) are mined in Angola and Burundi, though the countries are not major producers, and projects are under development in Malawi, South Africa, Tanzania, Madagascar, Morocco, and Mozambique.

While Africa is part of the GVCs for green and transition minerals, **its role is concentrated at the beginning of the value chains, at the stages of exploration, extraction and, to a certain extent, processing.** A number of firms in Africa, including the state-owned company Kiira Motors in Uganda, are converting buses and light trucks with internal combustion engines into EVs. These activities should be seen as emerging industrial operations that demonstrate technical and manufacturing capabilities that can be developed with supportive policies, skills, infrastructure, and favorable investment environments.

32. Jean-Raphaël Chaponnière and Marc Lautier, 2022, *Quelles perspectives d'industrialisation tardive pour l'Afrique subsaharienne?*, "Hors-Série" collection no. 17 (Paris: Agence française de développement).

For a long time, Africa has primarily been an exporter of minerals, with little refining and few links to domestic industry. The transition to green energy and the growing demand for essential minerals represent a crucial opportunity for Africa to strengthen its position in green technology value chains.

The emergence of a competitive value chain for batteries, electric cars, and renewable energy in Africa is an effective way of increasing the number of better-paid, more highly skilled jobs in regions dominated by mining, thereby strengthening the resilience of local economies. This will help reduce poverty and improve the well-being of local people, particularly vulnerable groups such as young people, once they have been trained and have gained the required skill sets. It is therefore important for African countries to break the vicious circle of overdependence on exports of natural resources by creating more value on the continent, strengthening production capabilities, and developing inter-African exports and trade through the African Continental Free Trade Area (AfCFTA).

The DRC is at the heart of the dynamic battery value chain, accounting for almost 70% of global cobalt production and 50.7% of global reserves. Annual global demand for cobalt in 2050 is expected to be 460% of annual global production in 2018. Africa also has significant reserves of other strategic minerals (see Table 30), providing an opportunity to create a strong regional value chain for batteries, EVs, and renewable energy, build production capacity, and increase exports and inter-African trade through the AfCFTA.

Table 30. ***Percentage share of global reserves***

	DRC	GABON	GHANA	MADAGASCAR	MOROCCO	MOZAMBIQUE	SOUTH AFRICA	TANZANIA	ZAMBIA	ZIMBABWE	2050: projected annual global demand as a % of annual global production in 2018
Cobalt	50.7			1.4	0.2		0.5				**460%**
Copper	2.2								2.4		**7%**
Graphite				8.1		7.8		5.3			**494%**
Lithium										1.0	**488%**
Manganese		4.7	1.0				40.0				**4%**

Source: Authors based on Columbia Center on Sustainable Investment (CCSI) data, 2021.

The analysis of processing potential should not, however, be restricted to the energy transition minerals alone, since it is also vital for Africa to develop its processing capacities for minerals it is already producing in large quantities (platinum and gold), and for construction materials (iron and steel).

In many respects, China is the global refiner of essential minerals (see Table 31). It accounts for 54% of global aluminum refining and smelting capacity, 62% of global lithium refining capacity, 67% of global cobalt refining capacity, over 80% of graphite production and refining, and a large proportion of the refining capacity for many other minerals (USGS 2022). Although political initiatives are beginning to weaken China's position with regard to lithium and solar energy materials, the refining capacities of the United States, the EU, and the advanced economies of Asia lag well behind. For obvious reasons of energy independence and national security, Western governments and the private sector are trying to stimulate the development of downstream capacity outside China.

Table 31. ***Leading mineral refiners***

MINERAL	LARGEST REFINER (% OF GLOBAL SHARE)	SECOND-LARGEST REFINER (% OF GLOBAL SHARE)
Antimony	China (67)	Tadjikistan (23)
Bauxite	China (54)	Australie (15)
Beryllium	United States (50)	Kazakhstan (25)
Cobal	China (67)	Finland (9)
Copper	China (41)	Chile (9)
Germanium	China (89)	Russia (5)
Lithium	China (62)	Chile (26)
Maganese	China (60)	Ukraine (6)
Molybdenum	China (38)	Chile (20)
Nickel	China (32)	Indonesia (16)
Nobium	Brazil (88)	Canda (11)
Rare earths	China (90)	Others (10)
Vanadium	China (59)	EU (9)

Sources: CEPII, based on European Commission data and information from Eurometaux for lithium.

As well as mineral processing in Africa, **there are also a number of local metal processing plants at the metallurgy stage**. There are gold refineries in some African countries, copper refineries in the DRC and Zambia, a tin smelter in Rwanda, and smelters for iron ore and other metals in countries such as South Africa and Ghana.

The construction of refineries, which often enjoy high-level political support, should be encouraged, since they offer governments a means of extracting value from their own mineral wealth rather than simply exporting unprocessed raw materials. However, if refineries are not monitored properly, there is a risk that this will exacerbate problems around smuggling and may ultimately result in the funding of conflicts. In addition, and more broadly for all the supply chains considered here, there is also the issue of potential production over-capacity at the global level. This is particularly true for gold. A significant number of gold refineries in Africa are not economically viable, and ultimately cannot survive, since supplies are not reaching them in sufficient quantities.

3.1.1. Copper processing

Copper ore produced in Africa is rarely exported in its raw form. **The DRC and Zambia have significant capacity for smelting, which is the stage prior to refining**. Copper ore is therefore processed into anodes and cathodes before being exported. The DRC was considering banning exporters of raw ores. Both countries also have refining capacity. Another factor that needs to be taken into account is the refining capacity of other African countries, including those that produce little or no copper. Egypt and South Africa have several large refineries, which are mainly supplied by copper produced in other African countries.

However, this is nowhere near enough to expand processing operations, either in terms of the number of refineries in Africa or the refining capacity of the existing plants. And the number of processing plants for strategic minerals is even lower. The cost of ore smelting—which transforms copper concentrate into pure metal—is currently very low, benefiting African producers that do not have local smelters, since they are able to send their concentrates to China for processing at a lower cost.

Ultimately, Zambia and the DRC only process a small proportion of their total refined copper production into semifinished products. Moreover, while mining production increased in the 2010s, the share of exports of semifinished products declined. In 2017, Zambia's exports of these products—almost exclusively in the form of copper wire—accounted for less than 2% of copper exports by value, down sharply from their peak in 2005 (8%). The DRC's exports accounted for less than 0.5% of copper exports by value, compared with more than 4% between 2003 and 2005.

Box 1. Zambia and copper

After privatization was completed in 2000, **the copper industry saw a massive influx of investment**, and production levels soared (400,000 t in 2004). Zambia was thus well placed to benefit from the subsequent **copper boom, enabling it to enjoy a decade of economic growth. The owners of Zambia's four main mines at the time (Barrick Lumwana, First Quantum Minerals Kansanshi, Mopani Copper Mines, and Konkola Copper Mines) injected USD 12.4 billion** into the economy between 2000 and 2014. Some of this investment was used to refurbish the aging infrastructure of mines in the Copperbelt region, but most of the capital was used to expand and build new mines in **the "New Copperbelt" in the country's North-Western province**. With production figures of 760,000 t in 2013, Zambia returned to levels comparable to those recorded in the late 1960s, and the number of people employed in the industry rose to **90,000**.

In 2021, Zambia's total copper production stood at **800,696 t**.[33] According to S&P Capital IQ Pro, this came mainly from a **dozen mines** out of a total of **twenty working copper mines and forty-eight active copper mines**.[34]

Half of production (434,847 t, or 49.6% of the total) came from the **Sentinel** (232,688 t) and **Kansanshi** (202,159 t) mines, owned 100% and 80% respectively by the Canadian group **First Quantum Minerals (FQM)** (the remaining 20% of the Kansanshi mine is owned by the state-owned company **Zambia Consolidated Copper Mines Investments Holdings [ZCCM–IH])**. The Canadian group **FQM dominates the Zambian mining sector**: it already accounts for half of total copper production, and plans to strengthen its position in the sector following its announcement of new investment of USD 1.35 billion in the Kansanshi mine over a twenty-year period.

In 2020, **13% of production** (109,769 t) came from the **Lumwana mine**, 100% owned by **Barrick Gold**, another Canadian group specializing in gold production (the world's second-largest producer) and copper (the world's twenty-second-largest producer).

33. Note that, if the estimated values from the S&P Capital IQ Pro database are taken into account, the figure comes to 876,773 t, which is higher than the 800,696 t provided by the Central Statistical Office (CSO). The percentages are therefore based on the 876,773 t value.

34. In the mining industry, a distinction is made between the stage of development of a mining project (feasibility study, target-setting, construction, operation, etc.) and its status (active, inactive, ongoing maintenance, suspended for reasons of litigation or lack of profitability). Mining projects are "long-term" projects: it is possible to have active projects under development (there is work in progress on the mine site) and fully developed projects (at the mining stage) that are inactive for a variety of reasons (accident, exhausted reserves, low profits, etc.).

Barrick Gold is particularly active in Canada, Argentina, Chile, and the United States, as well as in the DRC, Mali, Tanzania, and Zambia, posting revenues of USD 12 billion and a gross operating income (GOI) of USD 6.4 billion in 2021. The Lumwana mine is the group's only investment in Zambia. It was built in 2006, came under the full control of Barrick Gold in 2011, and currently employs **4,400 people**.

The four mines operated by China Nonferrous Mining Corporation Limited (CNMC)—Chambishi, Muliashi North, Baluba, and Mwambashi—accounted for **15% of production** in total. The Chinese group operates solely in Zambia's Copperbelt (eleven mines or mining projects) and in the DRC (six mines or mining projects), and produces copper and cobalt. With revenues of USD 4.1 billion and a GOI of USD 1.1 billion in 2021, CNMC is undoubtedly a major group, but is much smaller than Barrick Gold or FQM in terms of global reach.

Mopani Copper Mines' two deposits (Nkana and Mufulira) accounted for **10% of production**—Mopani posted total production of 87,618 t in 2021. The Mopani mining company was controlled by Swiss mining giant Glencore until March 2021, when it was sold to the **state-owned mining investment company ZCCM–IH** for USD 1.5 billion in debt and a token dollar in cash. The mine, which has been operating for over eighty years, needs an investor to take over from Glencore to finance its expansion, estimated at USD 300 million: this would unlock potential production of 225,000 t of copper per year.

The Nchanga open-pit mine accounted for **7% of total production**. It is owned by the Zambian company Konkola Copper Mines (KCM), itself 79.4% owned by the **Indian group Vedanta Limited**, with the remaining 20.6% held by the Zambian state-owned company ZCCM–IH. KCM is also Zambia's leading **cobalt** producer, with output valued at USD 375 million in 2020.

The DRC exported a relatively large proportion of its copper production in the form of concentrates, while Zambia mainly exported refined metal. Trade data for the 2010s indicates that the average price per tonne for concentrates from the DRC was only EUR 1.5 million, just over a quarter of the price for refined copper. As a result, the DRC's total copper export earnings stood at USD 6 billion in 2017, compared with USD 8 billion for Zambia, despite the fact that the DRC produced a higher tonnage of copper and has richer ores in terms of copper content.

Box 2. The DRC and copper

With the world's seventh-largest copper reserves (31 Mt) and the world's largest cobalt reserves (3.5 Mt), the DRC is a **major copper producer** (ranked fourth globally and the leading African producer) and the **world's leading producer of cobalt**. The majority of the country's copper–cobalt operations are located in the Copperbelt, in the south of the DRC, in the former Katanga province (which was divided into four new provinces in 2015). The copper content in Copperbelt deposits is among the highest in the world—with some reserves exceeding a copper content of 5%. Not all copper deposits contain cobalt, but a large proportion of the cobalt produced in the DRC comes from industrial copper mining. **Copper and cobalt production has risen sharply** in recent years, fueled by a sharp rise in global prices and increasing global demand driven by the energy transition.

According to the DRC's Ministry of Mines, copper production in 2021 was carried out by **thirty-seven firms**. The largest actors are **foreign firms, with the state-owned company Gécamines holding a minority stake in most projects. The proportion of Chinese companies** involved in the DRC's copper sector is growing rapidly. The largest foreign companies include China Nonferrous Metal Mining Group (China), China Railway (China), CMOC Group Limited (China), Eurasian Natural Resources Corporation (ENRC) (United Kingdom), Gécamines (DRC), Glencore (Switzerland), Ivanhoe Mines (Canada), Jinchuan Group (China), and Zhejiang Huayou Cobalt (China).

South Africa produces very little copper compared with Zambia and the DRC but, in terms of value, **it exports more semifinished copper products**. Zambia and South Africa combined accounted for 0.5% of global refined copper exports in 2017. The DRC's exports of semifinished products remained negligible. Nonetheless, 40% of semifinished copper exports go to the EU, and between 6% and 10% each of China, Taiwan, and the United States. China is the largest producer of semifinished products, with inputs derived largely from copper ores and metals that are imported and then processed. It has not exported most of its semifinished products directly, instead using them in the manufacturing process for machinery and other appliances intended for export. In Egypt, an American company, **General Metals Corporation**, operates the Cairo copper refinery as part of a joint venture with the Egyptian state.

We have seen that Zambia and, to a lesser extent, the DRC have developed refining capabilities for the first stage of processing ores into raw copper. **There have been calls since the 1970s to extend copper processing in Southern Africa to semifinished products in order to diversify exports and increase regional value added**. Increased copper beneficiation has featured in virtually all Zambian development plans and policies. The DRC has not put as much emphasis on manufacturing as Zambia, probably because it does not yet refine all its exports. **In 2017, however, the DRC did temporarily ban exports of copper concentrates to promote local refining.**

The strategy of expanding the production of copper-based semifinished products in order to increase revenue raises two issues. First, the desirability of such efforts depends on both the likelihood of their success and the opportunity costs of forgoing investment in other industries; while copper manufacturing offers some opportunities, it is also not a direct route to industrialization in the region. Second, any expansion of copper processing could promote greater industrialization by increasing demand for the capital goods industry in Southern Africa.

In practice, although Zambia and the DRC have supplied capital goods and services to their mining sites, historically South Africa has always dominated regional production of machinery (equipment and materials). In the 2010s, it supplied more than a third of the machinery imported by Zambia and the DRC, mainly for mining. **Effective strategies to link up investment in the manufacturing of semifinished products with South African capital would require a more coherent regional approach** focused on improved financing and institutional support for exporters, as well as higher levels of financing for technological development. Policy coordination would in turn require that all countries involved derive some benefit.

3.1.2. Gold processing

The governments of gold-producing African countries have long complained that the precious metals contained in their rocks are being illegally mined and smuggled out on a massive scale, sometimes by criminal operations, often at high human and environmental cost. By refining the gold—in some cases forcing producers and traders to sell their gold to local refineries—these governments hope to recover lost revenue. According to the Industry, Minerals, Entrepreneurship and Tourism directorate of the African Union Commission (AUC), some new refineries have invested in systems to ensure they process gold from legal and environmentally responsible miners, with one way to stop smuggling being to have a number of refineries in Africa.

Some of Africa's new gold refineries are located in South Africa, a major gold producer that already has a substantial refining industry. The South African authorities granted nineteen gold refining licenses in the year to March 31, 2019,[35] as many as in the previous three years combined.

Four gold refineries account for 66% of business relationships with the mining companies involved in gold mining in Africa. The Swiss foundation SWISSAID conducted an investigation based on customs statistics, databases, and reports from 32 mining companies and various governments, and identified 142 business relationships between 116 African industrial gold mines and sixteen refineries worldwide between January 2015 and March 2023. T**he largest refinery in terms of the number of business relationships is based in South Africa** (Rand Refinery), **with the other three located in Switzerland.**

The Fidelity Gold Refinery makes **Zimbabwe the third leading location for refining** in Africa. **The Gold Trade Act** regulates the possession of and dealing in gold. Mining companies do not export the gold they produce themselves, but are required to **sell it to the state**. Since 2014, all Zimbabwean gold must be sold to **Fidelity Printers and Refiners (FPR)**, which has a monopoly on the purchase, refining, and export of gold[36] —unless specifically authorized, any gold leaving the country outside FPR channels is therefore considered to be smuggled. The unfavorable system provided by the FPR is regarded as one of the main drivers of illegal flows of money (an unintended consequence).

35. The tax year in South Africa runs from April 1 to March 31 of the following year..
36. Zimbabwe exports its gold indirectly on the international market via Rand Refining in South Africa, since it lost its membership of the London Bullion Market Association (LBMA) in 2008, and therefore is unable to sell its gold directly on the international market.

Box 3. Box 3. Zimbabwe Environmental Law Association (ZELA)

The Zimbabwe Environmental Law Association (ZELA) had warned of the risks posed by FPR's monopoly, which *(i)* imposed **a minimum purchase rate** and effectively excluded the smallest miners, *(ii)* **failed to pay sellers on time**, as it was obliged to settle part of gold sales in USD, and *(iii)* charged **a gold buy-back price well below** the price recorded on the international market (USD 54 per gram, compared with an international market price of between USD 58 and 60 per gram in 2019). In addition, the FPR's **"no questions asked" policy** made it impossible to trace the origin of the gold and combat illicit trade and crime. The NGO **International Crisis Group (ICG)** believes that Zimbabwe's desire to control gold exports **is blocking investment and costing the state more than USD 1.5 billion each year, and is one of the main causes of problems in the country's gold industry, including gang violence.**

Elsewhere in sub-Saharan Africa—where until 2012 there were only a handful of refineries—no fewer than twenty-six refineries are now operating or under construction in fourteen countries (from Mali to Tanzania), including in states that mine little gold within their own borders, according to a 2019 Reuters survey of public reports. Officials in at least three further countries, including Madagascar and Côte d'Ivoire, have publicly stated that they are interested in hosting a refinery. In Tanzania, Mwanza Precious Metals Refinery (MPMR) told SWISSAID that it aims to process both artisanal and industrial gold. Interesting developments are also underway in **Ghana**. In 2021, the South African mining company Gold Fields reported that it was in discussion with the Ghanaian government about the arrangements for selling some of the gold produced in Ghana to a South African refinery in order to add value locally.

Of the twenty-two refineries surveyed by Reuters, thirteen claimed to be able to process more than 1,400 t of gold a year, with a value of around USD 70 billion (Reuters 2019 survey). **This means they could process around twice Africa's estimated total gold production** and almost a third of global supply.

However, since informal miners often operate through smuggling networks to avoid tax and government scrutiny, officials and industry sources say that some refineries inevitably risk joining these shadowy channels. In view of the large number of refineries competing for gold to process, there is little incentive for any of them to check the source of the gold.

Box 4. Informal gold purification

Two responses to the Reuters survey demonstrated a lax approach. One small Zambian operator, Bupe Chipando, who runs the Alinani Precious Metals Limited mining company in Kenya, said he was not yet purifying gold, but simply melting down blocks of impure metal and shipping them abroad. The Kenyan authorities reported being aware of at least two other African refiners who were doing the same thing. Another operator, Robert Baker, the CEO of Bekora Miners in Cameroon, said that most of the gold his refinery processed was not declared to the customs authorities in order to avoid paying tax on the exported metal.

Africa's new refiners operate within networks of buyers willing to pay a premium for gold, including smugglers. One refinery in Mali explained it was hard to compete with smugglers. Kankou Moussa Refinery (KMR) in Mali says it plans to invest over EUR 400 million (USD 445 million) to create a network of centers that will buy gold and train miners to work safely. Its chief executive noted, however, that smugglers and money-launderers pay up to 3% above the market price.

The OECD has established global standards on sourcing and recommends that refineries be audited against them. We note that **the only African refineries to have followed this recommendation thus far have been in South Africa.**

3.1.3. Aluminum processing

Although Africa has huge bauxite deposits, it lacks aluminum production facilities due to irregular power supply, obstacles to financial investment, and political instability. Numerous aluminum smelters are scattered across the continent, but most have not reached their actual production capacity, and some have even ceased operations, including Bayside Aluminium in South Africa and Aluminium Smelter Company of Nigeria (ALSCON) in Nigeria. Africa produced around 1.64 Mt of aluminum in 2019. Over the past decade, African aluminum production has remained relatively stable, fluctuating between a low of 1.64 Mt in 2012 and a peak of 1.81 Mt in 2013.

In South Africa, Hillside Aluminium has played a key role in the aluminum industry for over twenty years. The Richards Bay aluminum plant in the province of KwaZulu-Natal, located some 180 kilometers north of Durban, produces high-quality primary aluminum for export markets. Some of the liquid metal is supplied to Isizinda Aluminium to support the development of South Africa's downstream aluminum industry: the company in turn supplies aluminum slabs to Hulamin, a local firm that manufactures products for the domestic and export markets. The smelter uses alumina that is mainly imported from Worsley Alumina (Australia) to produce high-quality primary aluminum. Hillside Aluminium's production capacity is around **720,000 t per year**, making it the largest producer of primary aluminum in the southern hemisphere.

Mozal Aluminium[37] is **Mozambique**'s biggest industrial employer. The aluminum smelter is located just twenty kilometers west of Maputo, the capital of Mozambique. The smelter was the largest private investment project in the country and the first major FDI project (USD 2 billion), assisting with the reconstruction of Mozambique after a period of turmoil. The smelter was originally commissioned to produce 250,000 t per year, before being enlarged in 2003–2004. Today, it is the largest aluminum producer in Mozambique and the second largest in Africa, with **a total annual output of around 580,000 t**. It accounts for 30% of the country's total official exports and consumes 45% of the electricity produced in the country. Mozal Aluminium has also begun to supply Mozambique's first downstream aluminum firm, the development of which is expected to boost the local economy.

Egyptalum (Egyptian Aluminium Company)[38] is the largest aluminum producer **in Egypt** and one of the biggest in Africa, with a **total annual production capacity of 320,000 t**. The firm's operations are powered by the Aswan High Dam.

37. South32 (Australia) holds 63.7% of Mozal Aluminium's shares, while Industrial Development Corporation of South Africa Limited holds 24%, Mitsubishi Corporation (through MCA Metals Holding GmbH) 8.4%, and the Government of the Republic of Mozambique 3.9% in preference shares.
38. Egyptalum is a subsidiary of the Metallurgical Industries Holding Company, with both companies reporting to the ministry responsible for the public sector.

On January 25, 2021, the Minister of Public Business Sector announced that the Egyptian government was preparing to implement a plan to modernize Egyptalum, which is a state-owned firm for the aluminum industries, with the aim of *(i)* opening up its shares to private investors, and *(ii)* listing it on the Egyptian Exchange (EGX), Egypt's main stock exchange, under the name Egypt Aluminium (EGAL).

The aluminum plant operated by Volta Aluminium Company Limited (VALCO)[39] **in Ghana** is a major industrial district in a developing country (DC). VALCO has a **nominal annual capacity of 200,000 t of primary aluminum**; however, it is currently operating at only 20% of this capacity, and the construction of an industrial unit of this size now requires investment of USD 1.2 billion. The Ghanaian government is using VALCO as a focal point for the Integrated Aluminium Industry (IAI) project, believing there is a potential synergy with the country's bauxite reserves at the Kibi Suhum and Nyinahin deposits, estimated at over 700 Mt.

In Cameroon, the Compagnie Camerounaise d'Aluminium (ALUCAM) (Cameroonian Aluminum Company)[40] is based in the city of Édéa, sixty-seven kilometers from Douala, the country's economic capital. ALUCAM's production capacity is around **100,000 t per year**, but it has not reached its production target as a result of irregular power supply. In 2020, Cameroon exported 49,300 t of aluminum produced by ALUCAM, down from almost 52,000 t the previous year.

In Guinea, the government also wants to promote the **processing** of mining products. As a result, the **Boffa-Boké project** was initiated in 2019 with the laying of the foundation stone for the railroad intended to link the Santou II and Houda (bauxite ore) mining deposits to the river port of Dapilon (125 kilometers); the project also includes plans for the construction and operation of an alumina refinery with a capacity of 1 Mt per year and investment of USD 900 million. In the same vein, the Chinese firm **Xinjiang TBEA Group Co. Ltd** has presented a feasibility study for its "Aluminum Industrial Park" in the Télimélé prefecture.

39. VALCO is a limited liability company (LLC) owned by the Ghanaian government; it continues to play a key role in the government's efforts to develop an Integrated Aluminium Industry (IAI) in Ghana.
40. Founded by the French company Péchiney in 1954.

3.1.4. Iron and steel processing [41]

Demand for iron and steel is growing rapidly in Africa. In 2021, African countries imported iron and steel worth a total of USD 18 billion, compared with USD 15 billion in 2017.

South Africa is one of Africa's largest steel producers, with steel-consuming industries contributing ZAR[42] 600 billion (USD 44 billion) to the country's gross domestic product (GDP). Prior to 2020 the South African steel industry was a net exporter, but has become a net importer as it has been impacted by the closure of a number of plants. As a result, South Africa saw a sharp drop in steel production in 2022 (down 16.3%). The industry faced increasing pressure from a decline in the number of local infrastructure projects, the high cost of inputs, and global price competition.

Zimbabwe is poised to become Africa's largest steel producer, and one of the biggest actors in the global sector. A multi-billion-dollar steel plant is currently under construction in Manhize, in the center of the country, and could meet all the country's needs, as well as those of most other countries in Africa and even beyond. It is expected to produce around 600,000 t of steel per year, not including other related products. It should enable the country to emerge as a dynamic industrial center, producing a wide range of value-added "made in Zimbabwe" steel products for local and international markets.

Egypt has a huge steel plant in the southern suburbs of Cairo, owned by Egyptian Iron & Steel Company SAE. It opened in 1954 and produces products derived from iron (cast iron in particular) and steel for the (domestic) Egyptian market and, to a lesser extent, for export. Egypt relies on two sources for its supplies: *(i)* some comes from local production of iron ore, located near Bahariya Oasis, and *(ii)* the rest is imported, largely from Oman, which is home to a large iron mine.

South Africa has signed a plan that aims to revive the local steel industry and increase steel production. The priorities set out in the plan include consideration of supply and demand, the AfCFTA agreement, and a steel fund designed to support industry projects.

41. "Africa Steel Market Report and Forecast 2025-2034," Claight Corporation, accessed January 30, 2025, https://www.expertmarketresearch.com/reports/africa-steel-market#%3A~%3Atext%3DThe%20Africa%20steel%20market%20size%2C45.9%20million%20tons%20by%202028
42. The South African rand, the country's official currency.

In Guinea, the main iron ore project under discussion is the **Simandou** project, named after the 100-kilometer-long mountain range in Southeastern Guinea where the deposit is located. Simandou is considered the world's **largest undeveloped deposit** of high-grade iron ore, with an estimated annual production capacity of 100 Mt. It has remained **undeveloped** for years due to allegations of corruption, property ownership disputes, the region's remote and difficult-to-access terrain, the 2021 Ebola epidemic, the country's political instability, and, most importantly, the considerable capital required to undertake the project. It is currently the largest integrated mining–infrastructure project under construction in Africa. At full production, the project will **double Guinea's current GDP** and create almost 45,000 jobs[43] across all sectors of the economy—by way of comparison, the Extractive Industries Transparency Initiative (EITI) estimates that the industrial mining sector employed 15,409 people in 2020. The project will also generate work in subcontracting and provisioning. **The infrastructure associated** with the project is also expected to stimulate the economy as a whole, particularly agriculture, forestry, livestock farming, and trade.

After a series of twists and turns and changes of ownership, the consortia formed by the firms **Simfer** and the **SMB-Winning Consortium** and the firm China Baowu Steel Group (the world's largest steel producer) signed an infrastructure construction agreement with the Guinean government in late 2022.[44]

43. "Simandou Sud," Ministère des Mines et de la Géologie (MMG) (Ministry of Mines and Geology), Republic of Guinea, accessed January 30, 2025, https://mines.gov.gn/.
44. "Chinese, Foreign Consortiums Reach Deals with Guinean government on Simandou Iron Ore Project's Infrastructure Buildup," Global Times, December 25, 2022, accessed January 30, 2025, https://www.globaltimes.cn/page/202212/1282558.shtml.

Box 5. The multiple components of the Simandou project

- The **northern blocks** (blocks 1 and 2) are held by the **SMB-Winning Consortium**, which is made up of the Singaporean company Winning Shipping (which has strong ties to China), the French transport and logistics company UMS (United Mining Supply), and Shandong Weiqiao, a major Chinese aluminum company—all three of which are already joint shareholders in Société minière de Boké (SMB) (Boké Mining Company) in Northern Guinea. Another consortium led by China Baowu Steel Group plans to invest in the consortium by acquiring 49% of the SMB consortium's two subsidiaries, WCS InfraCo and WCS MineCo, subject to joint approval by the Guinean and Chinese governments.
- The **southern blocks** (blocks 3 and 4) are owned by **Simfer**, a joint venture in which the Rio Tinto group has a 53% stake, the remainder being held by the Chinese firms Chinalco and Baowu.
- A new 650-kilometer multipurpose railroad, the **Transguinéen**, linking Southeastern Guinea to the Guinean coast, from Beyla to Forécariah.
- A new multipurpose **deepwater port**, the Port of Morébayah, located in the Forécariah Prefecture, which will be the first Guinean port to provide access for large cargo ships. This will give Guinea sole control over the process of exporting iron ore from the Simandou deposit.

3.1.5. Nickel, tantalum, lithium, and cobalt processing

The strong global demand for these minerals, which are abundant in some African countries, is prompting these countries to consider developing local processing operations. As no project of this kind has yet been launched, in this subsection we will simply demonstrate the importance of these minerals to certain economies, potentially providing them with enough market power to propose investment partnerships that would result in local processing businesses.

Zambia plans to become a major actor in the global production of electric cars following the opening of the Enterprise nickel mine in Kalumbila **in July 2022**. Once the mine is fully operational (production started in July 2023), it should be **one of the largest nickel mines in Africa**. With proven and probable reserves of 344,500 t of nickel content, the project is designed to process 4 Mt of ore and produce approximately 30,000 t of nickel per year—by way of comparison, Africa's largest nickel mine, the Ambatovy mine in Madagascar, produced 30,367 t in 2021. Enterprise is expected to provide almost 18,000 direct and indirect jobs, while making Zambia one of the continent's leading nickel producers and the world's tenth-largest producer of this highly sought-after mineral.[45] **First Quantum Minerals (FQM)**, which wholly owns the mine (100%), has invested USD 250 million in the project, which forms part of its expansion strategy in the country, with total investment of USD 1.35 billion planned.

Coltan is an **ore** from which **niobium** (of which the DRC is the world's fourth-largest producer) and tantalum (of which the DRC is the world's largest producer) are extracted. Tantalum, which is highly resistant to heat and corrosion, is produced from coltan and is highly sought-after in the manufacturing of electronic components (accounting for between 60 and 80% of the global tantalum market) **and aerospace components**. The DRC is estimated to have 60% to 80% of global coltan reserves. Its **industrial production (148.7 t) is very low compared with artisanal production** (1,291 t), which accounts for 89.7% of the DRC's total production.

The DRC established itself as a **major cobalt producer in 1926** and, from 1942, the DRC, then a Belgian colony (former Belgian Congo), supplied at least 50% of the world's cobalt.

However, the industry suffered a sharp decline in the 1990s as a result of a series of accidents at the Kamoto and KOV open-pit mines—caused by chronic underinvestment in infrastructure since the industry was nationalized in 1967—and the two wars of 1996–1997 and 1998–2002. Production has, however, recovered rapidly in recent years. Between 2013 and 2020, cobalt production in the DRC **rose from 56,000 t to 98,000 t**.[46] Production at the **Mutanda** mine (located forty kilometers from the city of Kolwezi, in Lualaba Province) increased from 13,700 t in 2013 to 27,300 t in 2018, making it the world's largest cobalt mine. In the medium term, **an increase in production is expected**, driven by the expansion of Swiss company Glencore's Mutanda and Kamoto mines (12,000 t per

45. "Zambia to be a Champion of Nickel Production in Africa HH," Copperbelt Katanga Mining, July 27, 2022, accessed January 30, 2025, https://copperbeltkatangamining.com/zambia-to-be-a-champion-of-nickel-production-in-africa-hh/.
46. Figures from the Congolese Ministry of Mines, taken from Andrew L. Gulley, "China, the Democratic Republic of the Congo, and Artisanal Cobalt Mining From 2000 Through 2020," PNAS 120, no. 26 (2023), https://doi.org/10.1073/pnas.2212037120

year), the Metalkol RTR project (3,000 t per year) belonging to Luxembourg-based firm Eurasian Resources Group (ERG), and development of the Mutoshi project (12,000 t per year) led by Chemaf, the Congolese subsidiary of Shalina Resources (UAE). Expansion will also come from Chinese firms: Congo Dongfang International Mining (CDM) (4,000 t per year), the Deziwa project led by China Nonferrous Metal Mining Group (3,000 t per year), the Musonoi project owned by Jinchuan Group, and the large-scale Pumpi mining complex owned by Wanbao Mining's subsidiary, Compagnie minière de Kambove (COMIKA) (Kambove Mining Company). The success of these mine expansion projects depends on a **combination of legislative, financial, and logistic factors**: securing exploration and mining permits, infrastructure, raising capital, the regulatory role of the governments in power, the availability of the materials needed for construction, and the projected trend in global copper and cobalt prices.[47] Zhejiang Huayou Cobalt Co, Ltd (Zhejiang), which was founded in 2002, is **China's second-largest cobalt producer**, behind CMOC Group Limited. Zhejiang controls the copper–cobalt mines at Luiswishi (fifth-largest global producer of cobalt) and Kambove in the DRC, as well as the Arcadia lithium mining project in Zimbabwe. Following accusations by Amnesty International in 2016[48] that it was making direct and indirect use of child labor by purchasing artisanally mined ores, the firm founded the **Fair Cobalt Alliance (FCA)** with Signify, Fairphone,[49] and The Impact Facility, with the aim of reducing the environmental risks associated with this rare metal, and improving conditions for workers in the industry.

Growing **demand for lithium is prompting** many mining companies to turn their attention to untapped reserves in Africa. **The DRC does not currently produce lithium, but it has reserves that are currently being assessed**. The Australian firm **AVZ Minerals Limited (AVZ)** is carrying out a feasibility study on the **Manono-Kitolo** project, located in the south of the DRC, where **lithium has been shown to be present** (lithium oxide reserves of 9.8 Mt). The Manono deposit is believed to be one of the richest lithium deposits in the world. In October 2022, AVZ secured financing of USD 240 million from the Chinese

47. Andrew L. Gulley, "One Hundred Years of Cobalt Production in the Democratic Republic of the Congo," *Resources Policy* 79, no. 103007 (2022), https://doi.org/10.1016/j.resourpol.2022.103007
48. "'This is What We Die for': Human Rights Abuses in the Democratic Republic of the Congo Power the Global Trade in Cobalt," Amnesty International, 2016, accessed January 30, 2025, https://www.amnesty.org/en/documents/afr62/3183/2016/en/.
49. A sustainable and eco-friendly cell phone brand.

group Suzhou CATH Energy Technologies. The Chinese company **Zijin Mining** also announced that it had obtained two lithium mining permits close to the Manono project. **In Zimbabwe, most lithium production** comes from the Bikita mine, owned by **Bikita Minerals Limited**, a Zimbabwean company set up exclusively for this project that employs 400 local people. Bikita Minerals Ltd is not a major player, unlike other companies that are currently exploring Zimbabwe's subsoil to devise future projects involving lithium.

Box 6. An industry that attracts a wide variety of actors

Several small Australian companies have gained a foothold in the Zimbabwean lithium industry: **Prospect Resources** (turnover USD 312 million; GOI USD -1.4 million) is active in Zimbabwe with the **Step Aside** lithium project and the **Chisanya** rare earths and phosphate project, and **Mirrorplex Pty Ltd** is active with the **Shamva** lithium project. Meanwhile, Canadian firm **CAT Strategic Metals Corporation** has a 60% stake in the Kamativi project.

3.1.6. Platinum processing

There is already substantial processing of platinum group minerals in South Africa. The projects currently under development should further reinforce this trend.

South Africa is the world's largest supplier of platinum. South Africa's platinum industry is dominated by the three largest global platinum producers, Anglo American Platinum (Amplats), Impala Platinum (Implats), and Lonmin. There are several smaller firms in the industry that focus on exploration and operate joint ventures with the large companies (Conradie 2016). South Africa's platinum mines are integrated in such a way that exploration, mineral extraction, processing via crushing and concentration, and smelting and refining of base and precious metals are carried out by the mining companies. Some of them undertake this process on the mine site. They then supply the refined platinum to their customers in the form of sponges, bars, and grains (Conradie 2016).

The challenge for South Africa is thus not the processing of platinum ore into metal, but the development of downstream industries using platinum products. The links between South Africa's upstream platinum industry and the related manufacturing sector (processing mined products into manufactured products) are very weak. South Africa continues to lose out on the economic opportunities offered by its platinum wealth due to a lack of demand from the manufacturing sector for these platinum products, despite the fact that the South African platinum industry has great potential to stimulate the country's economic transformation.

In Zimbabwe, platinoids are mainly found in the **Great Dyke**, a geological feature[50] that crosses the country for around 530 kilometers in a north–south direction, and varies in width between three and twelve kilometers along its length. The Great Dyke is the **world's second-largest platinum deposit**, with some 2.8 billion t of PGM ore. The platinoid content is lower than that of South African ores, at typically less than four grams per tonne, of which around 55% is platinum. Nickel and copper content is generally higher than in South African ores.

Zimbabwe's oldest platinum mine is the **Mimosa** mine, located in the southern part of the Great Dyke, within the Wedza geological complex. The Mimosa mine is owned equally by **Impala Platinum** and **Aquarius Platinum**. Since 2002, Mimosa's production has been steadily increasing: approximately 100,000 ounces (oz) of platinum per year (equivalent to 2,835 kilograms) are extracted from the mine, which is one of the **world's lowest-cost** platinum producers. In 2020, 122,408 oz of platinum (the seventeenth-highest production globally) and 96,000 oz of palladium (ranked sixteenth highest globally) were mined. In the 1990s, a second mine, the **Hartley Platinum Project**, was operated by a joint venture between the Australian group **BHP Billiton** and the Australian company Delta Gold. Exploitation began in 1995, but underground operations were suspended in June 1999. BHP's share of the project was sold to **Zimbabwe Platinum Mines** (Zimplats), a spin-off firm from Delta Gold's platinum assets, which began developing a new open-pit and underground platinum mine further south, at **Ngezi**. Operations began at Ngezi in 2001, following the purchase of part of the project by Impala Platinum and South African bank Absa. In 2011, the Ngezi mine produced 185,000 oz of platinum, and an expansion project is underway to increase production to 270,000 oz of platinum per year. In 2020, the mine produced 275,806 oz of platinum (ranked ninth highest globally) and 236,440 oz of palladium (seventh highest globally). A third platinum mine, **Unki** (an underground mine), owned by **Anglo American Platinum**, began operations in 2010: it produced 50,000 oz of platinum in 2011 and 87,300 oz of platinum in 2020 (ranked nineteenth highest globally) and 77,200 oz of palladium (twentieth highest globally).

50. The Great Dyke is without doubt one of the world's most remarkable rock formations.

Box 7. Interest in Zimbabwe from numerous actors

The sector is attracting interest because of the high demand for PGMs, but is struggling to develop because the projects led by Russian, Cypriot, Nigerian, and Kazakh investors in the country have **not yet begun production.**

- The **Great Dyke Investments (GDI)** mining company, a 50/50 Russian–Zimbabwean joint venture, was formed around what was to be the world's largest platinum mine, but implementation of the project has been hugely delayed.
- The Kazakh company **Todal Mining**, a subsidiary of Eurasian Resources Group (ERG), is established at the **Bokai** and **Kinonde** platinum concessions. The Zimbabwean government is currently **threatening to seize** the concessions under the "use it or lose it" principle, since Todal Mining is not developing them.[51] These assets were taken from Anglo American Platinum and assigned to Central African Mining & Exploration, before subsequently being bought a decade ago by Eurasian Natural Resources (which later became Eurasian Resources Group).
- The Cypriot company **Tharisa plc** has issued a USD 50 million bond to raise USD 391 million to build a PGM mine to produce 194,000 oz per year—this bond is the first to be issued on the Victoria Falls Stock Exchange (VFEX),[52] and is guaranteed by the company. Tharisa plc, which coproduces chromium concentrates and PGMs, owns 75% of **Karo Mining Holdings,** which is developing the Karo project on the Great Dyke. The project was launched in December 2022 and was scheduled to be fully operational in July 2024.
- **Bravura Holdings,**[53] a company owned by **wealthy Nigerian businessman Benedict Peters**, has announced investment of USD 1 billion in the Serui platinum mine (Selous). Bravura carried out feasibility studies in 2021 and planned to build the mine rapidly (in eighteen months), with production scheduled to start in 2023. The Serui concession was at the heart of a **legal dispute** between Amari Platinum, the mine's previous owner

51. Ray Ndlovu and Godfrey Marawanyik, "Zimbabwe Might Seize Todal Mining's Platinum Concessions," *BusinessDay*, May 31, 2021, accessed January 30, 2025, https://www.businesslive.co.za/bd/world/africa/2021-05-31-zimbabwe-might-seize-todal-minings-platinum-concessions/
52. The country's second-largest stock exchange, which opened in October 2020.
53. "Bravura Zimbabwe to Settle Zim Concession Dispute," *Mining Zimbabwe*, April 23, 2021, accessed January 30, 2025, https://miningzimbabwe.com/bravura-zimbabwe-to-settle-zim-concession-dispute/.

until the government cancelled its mining rights in 2011, and the state of Zimbabwe. Bravura, which picked up the concession in 2019, has agreed to be a stakeholder alongside the Zimbabwean government to compensate Amari Platinum to the tune of USD 15 million.

4. What policies are needed to support mineral processing?

In order to successfully implement an ambitious mineral extraction and processing policy, developing countries must equip themselves with appropriate transport and energy infrastructure. At the same time, they need to develop frameworks of economic incentives that will attract local and foreign investors, involve the local private sector, include the promising artisanal sector, and prevent an informal framework from developing. They also need to explore arranging long-term alliances between producer countries and the actors involved in processing these strategic minerals for the energy transition.

Some countries are trying to force the hand of the mining companies with restrictive legislation, while others are opting to set up special economic zones (SEZs). In view of the energy costs of smelters and refineries, this is a challenging goal.

In addition, attempting to do more than straightforward mineral processing and create integrated value chains across the whole of Africa is extremely complicated, and the challenges are huge. Further processing of metals locally has always come up against three major obstacles.

The first obstacle is the absence of a large enough local market to justify setting up local processing units (gigafactories).

The second obstacle concerns the high energy requirements of processing plants, at a time when access to electricity is still a real headache for many African countries. According to Oxfam data, nearly 500 million people in Africa will still not have access to electricity by 2040. While this figure suggests a measured analysis is needed, given the potential disparities between countries, it nevertheless raises the question of whether developing a local processing industry for the international market should take precedence over the basic needs of local people.

The third and final obstacle is the lack of overland transport infrastructure. Transporting bulk ores, enriched concentrates, or metals to export locations that are connected to international markets, generally generates very high costs and CO2 emissions, and requires specific transport and logistics chains (trains, containers, trucks, storage areas, specialized port facilities, customs control equipment, etc.). Transport networks in Africa are either old or nonexistent. They need to be upgraded, or new ones built, both to cater for current traffic and absorb these very large flows of minerals, which can sometimes dwarf those of other goods. During the COVID-19 pandemic, transport chains in the mining sector were severely disrupted, highlighting the fragility of certain chains in Africa and globally.

4.1. Energy and transport infrastructure

4.1.1. Mining development in Africa is restricted by energy shortfalls

First and foremost, mining is an energy-intensive activity: *(i)* trucks excavating the land (stripping the topsoil) and underground machinery hewing and transporting ores; *(ii)* draining water seepage in underground and open-pit mines; *(iii)* lifting ore via shafts, lowering personnel, and lighting and ventilating galleries; and *(iv)* upstream crushing and grinding in the first stages of beneficiation. The amount of electricity required for crushing accounts for approximately 10% of global electricity production.

Box 8 Electricity supply: A challenge in the DRC

One immediate infrastructure challenge is how to **increase electricity supply** in a cost-effective manner. Blackouts and other **power shortages** are common, with 40% of firms owning and operating their own backup generators to protect themselves against such risks. This situation is absurd, given that the DRC has the greatest hydroelectric potential in the region, with the ability to generate up to 100 GW of power (the total installed capacity in sub-Saharan Africa is 48 GW). However, only a fraction of this potential has been developed through hydroelectric and thermal power plants. This represents a small proportion of the country's hydroelectric capacity, since most of the thermal power plants are currently out of action due to a lack of spare parts and repeated diesel shortages.[54] The DRC is planning to build the **Grand Inga** dam, the world's largest hydroelectric complex (40 GW), at a huge cost of USD 80 billion. The feasibility study was cofinanced by the World Bank, the European Investment Bank (EIB), and the African Development Bank (ADB), and the DRC government is currently seeking investment partners.

The inefficiency and unreliability of the electricity distribution network is another major constraint: transmission and distribution systems have suffered from a lack of funding and are unable to meet the country's current needs, particularly those of the energy-intensive mining sector.

In South Africa and many other African countries, there have also been significant energy shortfalls in recent years, caused by a lack of capacity or a shortage of available electricity. No African country has energy infrastructure capable of responding to a potential expansion of local mineral refining capacity.

While industrial mining does not necessarily consume a large amount of energy (bauxite mining, for example, consumes just 34 kWh per tonne), the processes used to transform the ore into refined products are very energy-intensive. Here we will focus on bauxite, cobalt, graphite, and nickel because of the projected growth in demand and the emerging development of downstream capacities.

Bauxite refining requires more than 3,000 kWh per tonne of refined product on average, while cobalt needs nearly 4,700 kWh per tonne (Farjana et al. 2019). Most of the world's largest mineral refineries are located in regions where energy is abundant and inexpensive, based on hydroelectricity (Brazil and Canada), coal (Australia and China), charcoal (China), and natural gas (Bahrain and the UAE). Current capacity and future production potential—which is a function of available natural resources (hydrocarbons and powerful river networks) and the ability to attract investment—are therefore major factors in decisions about location.

54. "Democratic Republic of Congo: Country Mining Guide," KPMG International, 2014, accessed January 30, 2025, https://assets.kpmg.com/content/dam/kpmg/pdf/2014/09/democratic-republic-congo-mining-guide.pdf.

Box 9. Ghana and power shortages

On several occasions, Ghana has suffered from **electricity shortages** because of the shortfall in the production capacity of its hydroelectric power plants. The country began to use thermal energy and oil in 1997 to supplement **hydroelectric power**, but the electricity supply failed to meet the needs of the fast-growing economy in the 2000s. In 2001, **the Akosombo dam**, Ghana's main hydroelectric dam, experienced low water levels and was unable to generate at full capacity to meet demand from the country's population. The resultant persistent power outages, or "**dumsors**,"[55] caused losses to the economy estimated at several billion USD up until 2008, when the problem was partially resolved. However, in 2012, following accidental damage to the **West African gas pipeline**—which carries Nigerian gas to power plants in Ghana— the country was once again plunged into darkness.

EIn 2015, Ghanaian President John Dramani Mahama decided to put an end to this situation, having promised to do so during the election campaign. Several power plant construction contracts with independent power producers were quickly signed to increase the country's power generation capacity, which stood at just 600 MW. Today, Ghana produces 2,700 MW, but the **price charged for electricity** by the private producers is very high. Furthermore, the state-owned electricity distributor, Electricity Company of Ghana (ECG), is unable to distribute and sell all the electrical power at its disposal due to a lack of efficient connections, but has to purchase this unused (unconsumed) electricity under the "**take-or-pay**" system.[56] As a result, in 2020, the Ghanaian government still owed the independent power producers almost **USD 1.5 billion**, and began the difficult task of renegotiating its electricity purchase contracts. The dumsors have continued, with direct negative impacts on the country's economic activity and productivity and leading to strong protests from the Ghanaian people.[57]

55. The word "dumsor" is a popular Ghanaian slang word meaning "intermittently," derived from the Ashanti–Twi dialect spoken in the country.
56. Under this mechanism, the seller (in this case, the independent electricity producer) guarantees delivery of a certain quantity of electricity, and the buyer (in this case, ECG, i.e., the Ghanaian government) guarantees to pay the price, regardless of whether it takes delivery.
57. Olivier de Souza, "Ghana, ou la gabegie énergétique," *Agence Ecofin*, modified April 5, 2021, accessed January 30, 2025, https://www.agenceecofin.com/dossier/0204-86812-ghana-ou-la-gabegie-energetique.

Many countries have significant potential for renewable energy generation, but their installed capacity is not sufficient to supply the significant growth downstream in the chain. Current generation capacity falls far short of demand, particularly when African countries are compared with South and Southeast Asian countries (Bangladesh, Sri Lanka, Nepal, Cambodia, Laos, Myanmar, and Mongolia) that also face energy constraints (Hendrix 2022). Guinea supplies electricity to only 45% of its population. The alumina refining capacity that the Guinean government wants (11 Mt per year) would require nearly ten times the country's current total electricity capacity. In the DRC, which also has plans to process minerals, only 19% of the population has access to electricity, and per capita energy generation remains one of the lowest on the continent. Energy supply in Zimbabwe and Zambia, which are also aiming to develop value chains around minerals, is relatively low, and the countries' citizens have very little access to electricity.

In Mozambique, where installed capacity per capita is highest, coverage is only 56% of the average for frontier countries in Asia. The low level of electricity supply in African countries is one of the reasons why the proportion of mines sourcing their own energy from small generators, often running on diesel or heavy fuel oil, trebled between 2000 and 2020 (Signé and Johnson 2021), demonstrating that national grids are not up to the task. The African countries with the potential to meet the processing challenge with regard to electricity are Algeria, Egypt, Libya, Tunisia, Morocco, South Africa, Kenya, and Nigeria.

Table 32. ***Access to electricity, and electricity generation, in Africa and some Asian countries***

COUNTRY	ACCESS (% population)	GENERATION (megajoules/capita.)
Libya	69.7	200,565
South Africa	84.4	111,233
Mongolia	**98.1**	**87,331**
Gabon	91.6	86,723
Algeria	99.8	61,857
Equatorial Guinea	66.7	48,884
Tunisia	100.0	41,628
Botswana	72.0	40,667
Egypt	100.0	38,126
Namibia	56.3	35,234
Laos	**100.0**	**34,104**
Nigeria	55.4	32,438
Morocco	100.0	27,859
Kenya	71.4	24,432
Sri Lanka	**100.0**	**24,277**
Congo	49.5	24,203
Zambia	44.5	23,910
Zimbabwe	52.7	23,070
Uganda	42.1	22,455
Cambodia	**86.4**	**20,893**
Liberia	27.5	20,859
Nepal	**89.9**	**20,512**
Angola	46.9	19,411

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.../

PAYS	ACCÈS (% population)	PRODUCTION (mégajoules par hab.)
Soudan	55.4	19,095
Benin	41.4	17,960
Mauritania	47.3	17,838
Myanmar	**70.4**	**17,290**
Côte d'Ivoire	69.7	17,020
Togo	54.0	16,686
Ethiopia	51.1	16,428
Cameroon	64.7	16,266
Tanzania	39.9	15,487
Mozambique	30.6	15,332
Ghana	85.9	15,236
Guinea	44.7	14,176
DRC	19.1	14,086
Madagascar	33.7	13,572
Somalia	49.7	13,250
Bangladesh	**96.2**	**12,903**
Senegal	70.4	12,590
Mali	50.6	10,185
Burkina Faso	19.0	9,474
Sierra Leone	26.2	8,941
Rwanda	46.6	8,634
CAR	15.5	7,230
Niger	19.3	6,075
Chad	11.1	5,889
Burundi	11.7	5,560

Source: Authors based on World Development Indicators (WDI), World Bank

Many countries do have immense potential in relation to renewable energy, particularly hydroelectricity and solar power. However, the existing energy infrastructure is too small, and building new, well-functioning infrastructure will require huge amounts of investment.

Box 10. Guinea: An energy shortfall being resolved with support from China

Guinea's mining potential is attracting a large number of mining companies, as a result of the significant energy needs identified by these companies. In 2017, only **29%** of Guinean households had access to electricity, with this figure falling to as low as 3% in rural areas, with frequent **outages** causing social upheaval that led to riots in 2019. Guinean President Alpha Condé has prioritized development of the energy industry, focusing mainly on developing **hydroelectricity**. Guinea is often described as West Africa's "water tower" since it boasts **considerable hydroelectric potential** (6,000 MW) and has geological and river features conducive to large-scale projects, particularly on the **Konkouré River**, which has hydroelectric potential of 1,200 MW.[58] The share of hydroelectric generation has risen sharply over the past twenty years, accounting for over 75% of the energy mix[59] in 2015.

Despite this strong energy potential, the **generation deficit** remains significant. Guinea's installed capacity is currently insufficient to cover national needs and therefore to support industrial activity (particularly bauxite processing). The country's main grid, which serves the capital city of Conakry and the western regions, distributed just 712,465 MWh in 2016, compared with an estimated need of 1,320,955 MWh, i.e., almost twice as much.[60] The level of **distribution loss** is also very high: only 57% of the electricity generated ultimately reaches consumers. All wealthy firms and individuals therefore use diesel generators to generate their own electricity. Mining firms have a total installed capacity of roughly 100 MW to **generate their own electricity**, which is the most expensive form of electricity generation.[61]

58. Christophe Châtelot, "La Guinée, 'château d'eau' de l'Afrique de l'Ouest, peine à faire sa révolution hydroélectrique," *Le Monde Afrique*, November 9, 2020, accessed January 30, 2025, https://www.lemonde.fr/afrique/article/2020/11/09/la-guinee-chateau-d-eau-de-l-afrique-de-l-ouest-peine-a-faire-sa-revolution-hydroelectrique_6059127_3212.html.
59. The "energy mix" refers to the breakdown of the different primary energy sources used (hydrocarbons, nuclear, gas, coal, solar, wind, hydro, biomass, etc.) for the energy consumption of a geographical area (a country, a region, or even the world for a broad-based analysis).
60. "Redresser le secteur public de l'électricité en Guinée," Agence française de développement (AFD) project note, accessed January 30, 2025 https://www.afd.fr/fr/carte-des-projets/redresser-le-secteur-public-de-lelectricite-en-guinee.
61. "Énergie," République de Guinée, 2021, accessed January 30, 2025, https://www.invest.gov.gn/communication/energie/6.pdf.

As a result, major infrastructure and electrification works have been undertaken, and major **hydroelectric projects** are in the pipeline. The completion of these projects has been facilitated by the arrival of international mining companies with the **financial standing** required to sign long-term electricity purchasing agreements. These projects face a number of challenges, however, including *(i)* the high cost of building high-voltage lines in the remote areas of Guinea where the iron deposits are located, and *(ii)* managing the issues of **governance** and institutional stability. There is also a risk of creating **unequal access** to electricity by concentrating all energy investment in financially stable mining areas.

The Guinean government has thus drawn up a comprehensive improvement plan for the mining sector, structured around the state-owned firm Électricité de Guinée (EDG) (Guinea Electricity) and a series of large hydroelectric projects. These projects highlight **China's** support for hydropower worldwide, and the role of Chinese investment in large-scale infrastructure projects in Africa, since the key projects in Guinea are in the hands of Chinese firms:

- **The Kaléta dam** was built and financed by **China International Water & Electric Corporation (CWE)**, a subsidiary of the world's second-largest dam construction company, China Three Gorges Corporation (CTG). It began operation in 2015 and supplements the power generated by the Garafiri Dam, which has been operating since 1999. However, the dam does not consistently reach its full generation capacity (240 MW).
- **The Souapiti dam**, the largest in Guinea (and the third to be built on the Konkouré River, upstream of the Kaléta dam), entered its "final completion phase" in 2020 and is already supplying electricity. Its **550 MW** capacity will almost double Guinea's electricity generating capacity. The substantial **human cost** of building the dam has been criticized, particularly by Human Rights Watch[62]: the project was responsible for the largest population displacement in the history of independent Guinea, with nearly 16,000 inhabitants of 101 villages and hamlets having to be relocated. The displaced people also suffered food shortages, since most of the farmland used to grow crops was flooded. The Souapiti project is another example of China's involvement, at two

62. Yasmin Dagne and Leonard H. Sandler, "'We're Leaving Everything Behind': The Impact of Guinea's Souapiti Dam on Displaced Communities," Human Rights Watch, April 16, 2020, accessed January 30, 2025, https://www.hrw.org/report/2020/04/16/were-leaving-everything-behind/impact-guineas-souapiti-dam-displaced-communities.

levels: *(i)* the Chinese firm **CWE** built the dam, and will own and operate the project in conjunction with the Guinean government; and *(ii)* the Export–Import Bank of China (**China Exim Bank**) provided a USD 1.175 billion loan to finance the project, which is part of the BRI. We note that **Tractebel Engie France** is assisting the project owner and is responsible for design review and site supervision.

- Construction of the **Amaria dam** began in 2018, and was also contracted to a Chinese firm, **TBEA**. The dam is expected to have a generating capacity of between 300 and 320 MW and will enable TBEA to meet the energy requirements for its aluminum project: the TBEA Group plans to build a 64 MW thermal power plant alongside construction of the dam.
- Smaller-scale hydroelectric projects—including Gozoguézia on the Diani river (48 MW), Nongoa (8 MW), Poudaldé on the Cogon river (90 MW), Diaoya on the Bafing river (149 MW), Morisanako on the Sankarani river (100 MW), and Singuega on the Makona river (18 MW)—have already been completed or are set to come to fruition in the future.

There are reasonable grounds for concern that increasing generation capacity specifically for a mining project—a feature of many plans to develop downstream capacity—will widen the inequalities between the mining sector and host communities, and will impose significant environmental and social costs, thereby raising the question of social acceptability.

To provide the energy needed to transform their mining industries, African governments should introduce renewable energy technologies and avoid investing heavily in hydrocarbon-based energy infrastructure. Many countries have per capita hydroelectric potential in excess of 6,100 kWh/year (Hoes et al. 2017).

Hydroelectric potential is clearly sufficient to meet these countries' ambitions to increase downstream capacity and provide universal access to electricity for their citizens. However, it is more difficult to attract private sector investment for public utility projects than for refining and/or for smaller power plants planned specifically for mines and refineries.

4.1.2. Transport

As Moreau Defarges (2016) notes, the colonization of Africa and the earliest phase of globalization, which took place during the last quarter of the nineteenth century, profoundly influenced the construction of transport infrastructure in Africa, the majority of which is still in operation today. Although Africa is again experiencing another mining boom, its natural resources were already at the heart of international economic flows and trade in goods back in the nineteenth century, a factor that both supported and influenced the colonial systems put in place by the Western powers.

During this period, colonial governments invested heavily in the development of transport infrastructure to facilitate access to resource-rich territories, and to transport extracted resources to deepwater ports connecting the colonies to the international market. As such, transport infrastructure was almost exclusively built to help gain access to colonized territories and exploit their resources, and, to a lesser extent, to provide national and continental connections in line with the realities and logics specific to African societies (Pourtier 2007).

African transport infrastructure is still profoundly influenced by this original focus, as demonstrated by the continuing importance of the colonial ports of Dakar, Abidjan, Lomé, and Pointe-Noire, and South African railroad lines (Baffi 2014), the Transcamerounais, and the Dakar–Niger and Abidjan–Niger lines, and the fact that some railroad lines are still used today to export the mineral resources mined in the Sahel.

Box 11. Mining and land-use planning in Mauritania

One of the best illustrations of the link between access to a territory, mining, and transport infrastructure development is the Société des mines de fer de Mauritanie (MIFERMA)[63] (Iron Mining Company of Mauritania), which built the railroad line to serve the mining areas in the 1960s. Pourtier (2007) notes that "the railroad crosses the desert, but its regional passenger service is only a minor part of that. The day the mine closes will mark the end of the railroad, since the tourist car attached to the mineral convoys will obviously not justify maintaining the infrastructure," underlining the similarities between this example and the railroad line in Guinea that enables bauxite to be transported to the port of Conakry, and the Coal Line in South Africa, which transports coal from the mines in Mpumalanga to the dedicated port of Richard's Bay.

Maintenance of this major transport infrastructure, and the construction of new lines, are key factors in the development of African mines and the removal of their output.

Algeria plans to build a 1,000-kilometer rail network to facilitate the removal of iron ore from its Gara Djebilet mine, located in Tindouf province. This railroad will connect the mine to Béchar (Béchar province), located on the northwestern edge of the Algerian Sahara.

In **Guinea,** the project to mine the high-grade iron ore deposit (8 billion t) with the consortia WCS, Winning Consortium Simandou (blocks 1 and 2), and Rio Tinto Fer (blocks 3 and 4) includes the construction of a 650-kilometer railroad and a large-scale minerals port in the Forécariah region, south of the capital Conakry. The USD 15 billion project is expected to produce over 100 Mt per year for more than thirty years, among the highest production levels globally, making it one of the world's largest mineral projects, with infrastructure playing a key role in accessing the Chinese and international markets, and in the ultimate success of the project.

In addition to this greenfield infrastructure, several railroad lines in Africa **are set to be upgraded** to enable mining provinces to be opened up, including those in **Zambia**'s Copperbelt **(TAZARA, the Tanzania–Zambia Railway Autho-**

63. Following nationalization in 1974, MIFERMA became the Société Nationale Industrielle et Minière (SNIM) (National Industrial and Mining Company).

rity) and in the **DRC (the Kolwezi–Lobito corridor)**, providing links to the ports of **Dar es Salaam (Tanzania)** and **Lobito (Angola)**. The TAZARA, the longest railroad line in Africa (1,850 kilometers, linking Dar es Salaam to Kapiri Mposhi in Zambia), which was built by Chinese firms between 1970 and 1975, is due to be upgraded by Tanzania and Zambia, the two countries managing the project. Extensions could be explored with a view to opening up Rwanda, Burundi, and Malawi. The planned Bagamoyo port complex, which is expected to handle twenty times more traffic than the port of Dar es Salaam, would ease congestion at the smaller port.

The deepwater port of Lobito (Angola) and the Benguela Railway corridor to the Angolan city of Luau, at the border with the DRC, have been upgraded in recent years. On December 11, 2023, the concession contract for the multipurpose container terminal at the port of Lobito was signed with Africa Global Logistics (AGL), a subsidiary of the MSC Group (the world's leading container shipping company). The concession for the railroad line was awarded by the Angolan government to a consortium formed by Trafigura (Switzerland), Vecturis (Belgium), and Mota Engil (Portugal). This 1,344-kilometer rail corridor will join the Congolese and Zambian rail networks to Ndola (regional capital of the Zambian Copperbelt), at a total length of 1,866 kilometers. This corridor will undoubtedly provide a shorter, faster alternative to the current road and rail transport routes via Dar es Salaam, Beira (Mozambique), and Durban (South Africa), since these ports are already very congested.

Investment in these projects will be vital, since Africa's current logistics performance is very poor. In 2018, Guinea, Zimbabwe, and the DRC all had an **average Logistics Performance Index** (LPI) of between 2.12 and 2.43, placing them lower than 130th of 160 countries ranked by the World Bank. South Africa had the continent's highest score (3.38; 33rd of 160 countries) and Côte d'Ivoire the second highest (3.08; 50th of 160 countries). Egypt, Kenya, Rwanda, and Cameroon could provide alternative logistics hubs at the center of mineral processing areas.

Table 33. ***Logistics performance of African countries and some Asian countries***

COUNTRY	LPI	SHIPPING INDEX
South Africa	3.38	39.1
Côte d'Ivoire	3.08	19.3
Rwanda	2.97	–
Egypt	2.82	66.7
Kenya	2.81	16.5
Benin	2.75	19.1
Laos	**2.70**	–
Burkina Faso	2.62	–
Cameroon	2.60	18.5
Sri Lanka	**2.60**	**70.7**
Mali	2.59	–
Bangladesh	**2.58**	**14.7**
Cambodia	**2.58**	**8.1**
Uganda	2.58	–
Ghana	2.57	37.2
Tunisia	2.57	5.6
Morocco	2.54	69.3
Nigeria	2.53	20.8
Zambia	2.53	–
Nepal	**2.51**	**–**
Congo	2.49	24.0
Algeria	2.45	12.2
Togo	2.45	36.2

.../

…/

PAYS	LPI	SHIPPING INDEX
DRC	2.43	4.8
Sudan	2.43	8.4
Chad	2.42	–
Madagascar	2.39	7.5
Mongolia	**2.37**	**–**
Mauritania	2.33	6.0
Myanmar	**2.30**	**8.5**
Senegal	2.25	17.5
Liberia	2.23	6.6
Somalia	2.21	9.7
Guinea	2.20	9.2
Gabon	2.16	12.9
CAR	2.15	–
Zimbabwe	2.12	–
Libya	2.11	12.4
Eritrea	2.09	3.5
Sierra Leone	2.08	7.3
Niger	2.07	–
Burundi	2.06	–
Angola	2.05	23.4
Mozambique		14.1
Namibia		22.2
Tanzania		15.8

Source: Authors based on World Bank World Development Indicators (WDIs)

Box 12. Rail constraints on iron ore in South Africa

Kumba Iron Ore Ltd., the South African iron ore unit of global mining giant Anglo American plc, reported in early 2023 that stocks of high-grade iron ore continued to build up at its mining operations, with rail and port bottlenecks hampering shipments of the component needed to make steel. South Africa's state-owned rail and port operator Transnet SOC Ltd. suffers from a lack of capacity, exacerbated by maintenance delays and vandalism. The bottlenecks have prompted Kumba Iron Ore to stockpile high-grade iron ore, mainly at its enormous Sishen open-pit mine located close to Kathu in South Africa's Northern Cape province.

These rail constraints meant that iron ore stocks stood at 7.8 Mt on December 31, 2022, compared with 6.1 Mt a year earlier. Rail capacity was mainly affected by derailments and unusually heavy rains in April 2022, which caused extensive flooding and destruction in the east of the country, resulting in significant speed restrictions, while low wagon availability led to an increase in turnaround times. A strike in 2022 also complicated Transnet's operations, resulting in a decline in the firm's logistics performance and a sharp reduction in the volume of mining products handled, from 181.1 Mt in the financial year 2020–2021 to 149.5 Mt in the financial year 2022–2023.

Kumba Iron Ore said it would revise its production outlook over the following three years "to reflect an expected lower Transnet rail performance, given the challenges" ahead in 2022. In 2022, production was expected to be maintained in a range between 35 and 37 Mt for as long as was needed to clear stocks. Production could then increase by 5–6% each year (2024 and 2025) with improved rail performance.

Box 13 Major logistic constraints on mining in the DRC

The DRC is one of the African countries with the **greatest infrastructure challenges**, as it is one of the **most difficult** countries **in which to build** infrastructure. Overland transport has always been complicated by the country's huge size (2.345 million km^2, making it the eleventh-largest country in the world), low population density (44 inhabitants/km^2), and large expanse of forests and rivers. **The frequent conflicts** in the country's history, including in the recent past, have also severely damaged existing infrastructure. **Road and rail infrastructure is in a dilapidated condition and the rail network is archaic. Investment in the country's transport infrastructure** has become a major challenge, and one in which China has already taken an interest.

Mining companies have to deal with **road congestion** caused by deteriorating roads and difficult border crossings. The historic road routes lead to the ports of **Durban** and **Dar es Salaam**, from which the bulk of African copper exports are shipped. **Mombasa (Kenya)**, on the other hand, is the preferred port for loads from Kisangani and the northeast of the country. **The DRC cannot rely on its own ports**: the country's port infrastructure is far too small, and its geography makes connection to the Atlantic coast difficult. The DRC's two main ports, **Boma and Matadi**, have limited capacity and are unable to accommodate direct calls by standard cargo ships [64]: the country therefore has to rely on transshipments from the port of Pointe-Noire in the neighboring Republic of the Congo, using smaller vessels. The seaport of Banana (DRC) also has limited capacity and is mainly used for oil exports.

The DRC has two main railroad companies: **the Société commerciale des transports et des ports (SCPT)** (Trading Company for Transport and Ports)—formerly the Office national des transports (ONATRA) (National Transport Agency)—**and the Société nationale des chemins de fer du Congo (SNCC)** (National Railroad Company of the Congo). **The SNCC is used extensively to export copper** to the port of Durban,[65] but both the SNCC and SCPT networks have proven to be extremely inefficient with regard to logistics. The mining companies are therefore looking forward to the **opening of the railroad line between Kolwezi and Lobito**. In November 2022, a concession contract was signed by Angolan President João Lourenço and a consortium comprising the Swiss oil and metals

64. These ships have their own cargo handling equipment (cranes and derricks).
65. We note that there are very few surveys of the routes used for mining exports, and those that do exist are not recent. It is therefore difficult to find precise, recent sources mapping the main mineral routes.

trading company **Trafigura**, the Belgian rail operator **Vecturis**, and the Portuguese construction group **Mota-Engil**. The first companies to benefit from the opening of the line should be the mining groups in the Kolwezi region, particularly *(i)* **Ivanhoe Mines**, whose Kamoa-Kakula copper complex is only a few kilometers from the railroad line, and *(ii)* **Glencore**, whose Kamoto and Mutanda mines are also close to Kolwezi. Further east, the Chinese form **CMOC Group Limited**, which operates the Tenke Fungurume mine, is also interested, but will probably have to wait before it can export its output to Angola because of the condition of the tracks on the DRC side, which are the responsibility of the SNCC.[66]

Box 14. Upgrading Ghana's railroad lines

Ghana currently has a **947-kilometer** (narrow gauge) **rail network** that dates back to the British colonial era, but only 10% of the network is operational. The condition of the Western Line, which links the port of Takoradi to the city of Kumasi (267 kilometers), has gradually deteriorated due to a **lack of investment** in upgrading and maintaining infrastructure. As a result, the mining companies have turned to the roads to transfer their bulk production, albeit at a higher cost. The Ghana Chamber of Mines reports, for example, that the Ghana Manganese Company (GMC) transported only **15.6% of its cargo by rail in 2019**, with the rest of its deliveries going by road at an average 50% higher cost.

The Ghanaian government is therefore seeking to upgrade the rail corridor: the aim of the **Western Railway Line** program is to modernize and extend the network, and in particular to facilitate the **transport of minerals mined in the west of the country to the port of Takoradi**. Once developed in this way, the network should facilitate the mining of gold and manganese ore at Nsuta and bauxite ore at Awaso, as well as outflows of cocoa produced in the region.

This project is central to the country's development policy, and has resulted in the **largest rail contract** in Ghana's history, with the Ghanaian Ministry of Finance agreeing two loans totaling EUR 598 million for the construction of sections of the Western Railway

66. "Angola, DRC: Trafigura et Vecturis à pied d'œuvre sur le corridor ferroviaire Kolwezi–Lobito," *Africa Intelligence*, November 29, 2022, accessed January 30, 2025, https://www.africaintelligence.fr/afrique-australe-et-iles/2022/11/29/trafigura-et-vecturis-a-pied-d-oeuvre-sur-le-corridor-ferroviaire-kolwezi-lobito,109868318-art.

Line between the **port of Takoradi** and the **Huni Valley** (102 kilometers of standard gauge track), located in the country's Central West region (100 kilometers). The Ghanaian Parliament has also granted a EUR 72.3 million import duty and VAT waiver on materials and equipment imported for this megaproject.[67] The project will be carried out by Ghanaian firm **Amandi Holdings** under a full turnkey contract (EPC, i.e., Engineering, Procurement, and Construction). In 2021, Amandi Holdings was awarded a further contract worth USD 68 million to construct the railroad line linking Manso to the Huni Valley (78 kilometers).

A further agreement was signed in December 2019 with South African operator **Transnet** to regenerate the railroad line between Takoradi and the mining town of Tarkwa (82 kilometers). More recently, in July 2022, the **Thelo DB consortium** (a partnership between the South African group Thelo and the Germany company Deutsche Bahn E&C [DB]) signed a **USD 3.2 billion** contract with the Ghanaian government to renovate the railroad between the **port of Takoradi** and **Kumasi** (339 kilometers). There is already a railroad line between the two cities, but only a 66-kilometer section is currently operational.[68]

67. "Le Ghana sécurise près de 600 millions $ pour le mégaprojet ferroviaire SGR qui desservira le port de Takoradi," *Business News Africa*, July 1, 2021, accessed January 30, 2025, https://businessnewsafrica.net/le-ghana-securise-pres-de-600-millions-pour-le-megaprojet-ferroviaire-sgr-qui-desservira-le-port-de-takoradi/.
68. "Ghana: Thelo DB signera un contrat à 3,2 milliards $ pour rénover le chemin de fer Takoradi–Kumasi," *Agence Ecofin*, July 20, 2022, accessed January 30, 2025, https://www.agenceecofin.com/transports/2007-99918-ghana-thelo-db-signera-un-contrat-a-3-2-milliards-pour-renover-le-chemin-de-fer-takoradi-kumasi.

Box 15. Ghana: Major regional ports whose importance continues to grow

The port of Tema is Ghana's main port, and has seen rapid growth in traffic volumes over the last ten years. While the port of Tema has gradually become the facility through which most imported goods transit, it is the country's second port, the **port of Takoradi**, that specializes in the export of goods. Takoradi also serves as a transshipment point for goods destined for neighboring countries, and is a key link to neighboring landlocked countries—particularly Burkina Faso, Mali, and Niger—because of its strategic location, 225 kilometers west of the Ghanaian capital of Accra and 300 kilometers east of the Ivorian capital of Abidjan.

The bulk of Takoradi's port traffic involves **exports of manganese, bauxite, cocoa, and rough sawn timber**, and imports of clinker, but as the closest port to Ghana's recently discovered oil and gas deposits, since 2007 Takoradi has also played an increasingly important new role as a support hub for the **offshore oil industry**. Vessel traffic has increased by 164%, from 615 vessels in 2008 to 1,626 vessels in 2017; at the same time, total port traffic doubled from 4 Mt in 2008 to 8 Mt in 2017, which was the highest volume ever recorded in the ninety-year history of the port of Takoradi. These performance improvements had a positive impact on the port's role in Ghana's international trade activities in 2017 compared with previous years, accounting for 36% of Ghana's total maritime traffic. Of the 8 million tonnes handled, 4.8 million involved exports (75% of Ghana's total maritime exports) and 3 million involved imports (21% of the country's total maritime imports). [69]

In order to further develop its freight-handling capacity to reduce pressure on the port of Tema and stimulate growth in regional and international trade, a **plan to modernize the port of Takoradi** was launched: a new container terminal to accommodate deep-draft vessels was opened in December 2022 (at a total cost of USD 336 million).

69. Ghana Ports and Harbours Authority, *Ghana Ports Handbook 2018–19* (Land and Marine Publications Ltd, 2018), accessed January 30, 2025, https://www.landmarine.org/lm/ghana-ports-handbook-2018-19/.

Box 16 Guinea: Development of logistics infrastructure through mining projects

The policy of developing the mining sector also requires the development of adequate infrastructure.

Guinea has a poor **logistics infrastructure** network, ranking 145th of 160 countries on the 2018 Logistics Performance Index (LPI)—by way of comparison, in the same year Mali ranked 96th, Senegal 141st, Sierra Leone 156th, and South Africa 33rd (the top African country in the list). The development of roads, railroad lines, and ports therefore represents a substantive challenge for the country's economic development.

The mining companies that have historically operated in Guinea—Péchiney, Compagnie des bauxites de Guinée (CBG) (Guinea Bauxite Company), and Rusal—hence mainly used railroad lines specializing in the transport of ores, enabling them to export 20 Mt of bauxite, **until SMB-Winning revolutionized logistics by using river transport**. This logistics innovation helped bauxite exports from Guinea skyrocket: compared with 12 Mt of ore shipped to China in 2016, SMB-Winning was able to export as much as 42 Mt in 2018. Hundreds of barges loaded with bauxite travel down to the mouth of the Rio Nunez (coastal river) before being unloaded by floating cranes that transfer the precious mineral onto cargo ships. Then, every two days on average, a ship carrying close to 185,000 t of bauxite departs for the Chinese port of Yantai.[70]

The industry has seen the construction of **new mineral ports** along the Guinean coast. SMB-Winning has also built a 135-kilometer **railroad line** between the Santou deposit (Télimélé prefecture) and the Dapilon river terminal in the port of Boké. The construction of roads, railroad lines, and ports is therefore an **integral part** of many Guinean mining projects.

More broadly, the mining firms are being encouraged to explore all opportunities for **pooling** the public and private infrastructure that is already operational, along with new infrastructure such as deepwater ports (Northern Corridor, Boké region), where more than 80% of bauxite projects are concentrated. This is the goal of the updated **Schéma directeur des infrastructures auxiliaires aux mines (SDIAM) (Overall Strategy for Mining Auxiliary Infrastructure)** presented by the Ministry of Mines and Geology in

70. Christophe Le Bec, "Mines—Comment la logistique permet de doper la production: L'exemple de la bauxite guinéenne," *Jeune Afrique*, modified February 12, 2019, accessed January 30, 2025, https://www.jeuneafrique.com/mag/728389/economie-entreprises/mines-comment-la-logistique-permet-de-doper-la-production-lexemple-de-la-bauxite-guineenne/.

July 2018 to reduce the financial, social, and environmental costs of mining projects. CBG, Guinea Alumina Corporation (GAC), and Compagnie de bauxites et d'alumine de Dian Dian (COBAD) (Dian Dian Bauxite and Aluminum Company) have started infrastructure-pooling in the region. Similarly, the Indian mining company Ashapura has asked to pool road infrastructure with SMB, CDM Chine, and Henan Chine, all operating in the Boké region. All infrastructure built by mining companies is managed by the **Agence Nationale d'Aménagement des Infrastructures Minières (ANAIM) (National Mining Infrastructure Planning Agency)**.

The **Southern Corridor** infrastructure construction project aims to replicate this strategy of shared use of mining infrastructure in the south of the country. Mines in the Southern Corridor are located between 150 and 350 kilometers from the Atlantic coast, three to five times farther from the ocean than the mines in the Northern Corridor. As mining exports are shipped exclusively by sea, transport costs are currently too high for these mines to be profitable. The renovation and extension of the **Konta mineral port** (owned by the Guinean state), operated until 2019 by Ashapura, the construction of a 160-kilometer road and a 420-kilometer railroad line linking the port of Konta to the bauxite plateaus of the Kindia and Mamou regions, should open up the region. The project represents an investment of over USD 2 billion over seven years, and is expected to enable the export of 70 Mt of products over ten years, generate USD 7 billion for the Guinean government over the thirty-year concession period, and create 4,500 direct jobs during construction and 2,500 jobs when it is operating. **Marine Contracting & Infrastructure (MCI)**, the Guinean subsidiary of the Emirati Ghantoot Group, signed a contract with the Guinean authorities in 2021 as the sole operator in the Southern Corridor, but MCI is caught up in a legal dispute with its partner Monaco Resources Group (MRG), represented in Forécariah by its subsidiary, the Société des bauxites de Guinée (SBG).[71]

71. Diawo Barry, "Guinée—Mines: L'émirati MCI veut réussir le très cher pari du corridor Sud," *Jeune Afrique*, modified February 17, 2022, accessed January 30, 2025, https://www.jeuneafrique.com/1309790/economie-entreprises/guinee-mines-lemirati-mci-veut-reussir-le-tres-cher-pari-du-corridor-sud/.

4.2. How can mineral processing be encouraged?

One of the major challenges for Africa is to create more value added in its economies by encouraging mineral processing locally. Countries are developing strategies to deal with this question. Some countries are trying to compel the mining companies with restrictive legislation on the export of unprocessed minerals, while others are opting to set up SEZs. One key challenge is to create a sufficiently large market in Africa by developing regional value chains. For example, no single African country has all the minerals needed to produce batteries. Countries will therefore need to pool their mineral supplies to achieve minimum scale and reliability, thereby ensuring that they do not commit too large a percentage of their minerals for export. The AfCFTA agenda and the establishment of cross-border SEZs may offer interesting contexts for mineral processing.

Over time, and supported by appropriate public policies, most of these measures could be viable. However, for some countries, more modest objectives might include expanding the number of suppliers of products and services to mining companies, ranging from transport vehicle providers and spare parts manufacturers to caterers, surveyors, and human resources services, and meeting local requirements in order to lower barriers to entry for local firms. These services may not have the status or economic potential of refining, but they will all help to strengthen local supply chains and add useful value to African countries' exploitation of their own essential minerals.

Box 17. The potential for a battery industry

Battery value chains will be more viable if there is a local market for battery-powered vehicles. However, affordability and the lack of charging infrastructure networks mean that the African market for four-wheeled EVs is likely to remain limited for decades. The value chain for batteries made from nickel, manganese, and cobalt may therefore be limited to the production of battery precursor materials.

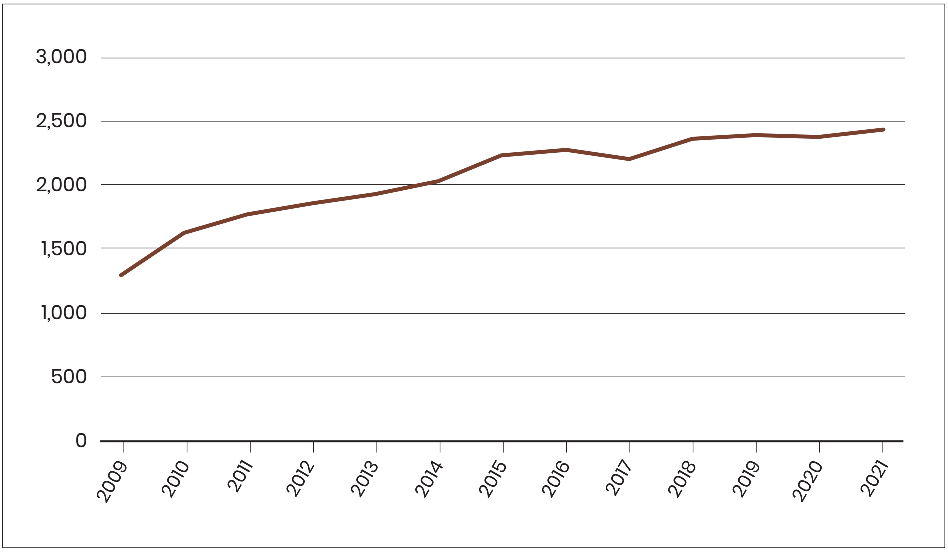
However, with greater potential in the African market for two- and three-wheeled EVs, using lithium, iron, and phosphate batteries—also useful for stationary energy storage—industries based on battery chemistry could be viable. This will require investment in cell manufacturing plants, which could be encouraged by strong support for domestic manufacturers of two- and three-wheeled EVs, further discoveries of lithium deposits, and close regional coordination of lithium refining.

4.2.1. Export restrictions

The strategy some African countries are currently using is to attempt to force the mining companies' hand. One option for African governments is to reduce exports of unprocessed raw materials in the hope that this will boost local industries downstream. In Guinea, for example, the authorities are putting pressure on mining groups to process ores (bauxite and iron) locally, and, in Zimbabwe, a decision was taken in 2021 **to ban exports of raw chromium** (i.e., unprocessed chromium) from July 2022 in order to protect the ferrochromium industry. The aim is to promote the local processing chain, which is the source of the real added value on which the Guinean government intends to capitalize in order to reach its target of USD 12 million in mining revenues by 2023. These restrictions have in fact increased since 2009: there are almost 2,500 in total in Africa across all of the different types of measures (export prohibitions, quotas, taxes, and licenses) and the seventy minerals and metals in the six-digit HS classification.[72]

72. The Harmonized Commodity Description and Coding System (identified by a six-digit code), generally referred to as the "Harmonized System" or "HS," is a multipurpose international nomenclature developed by the World Customs Organization (WCO).

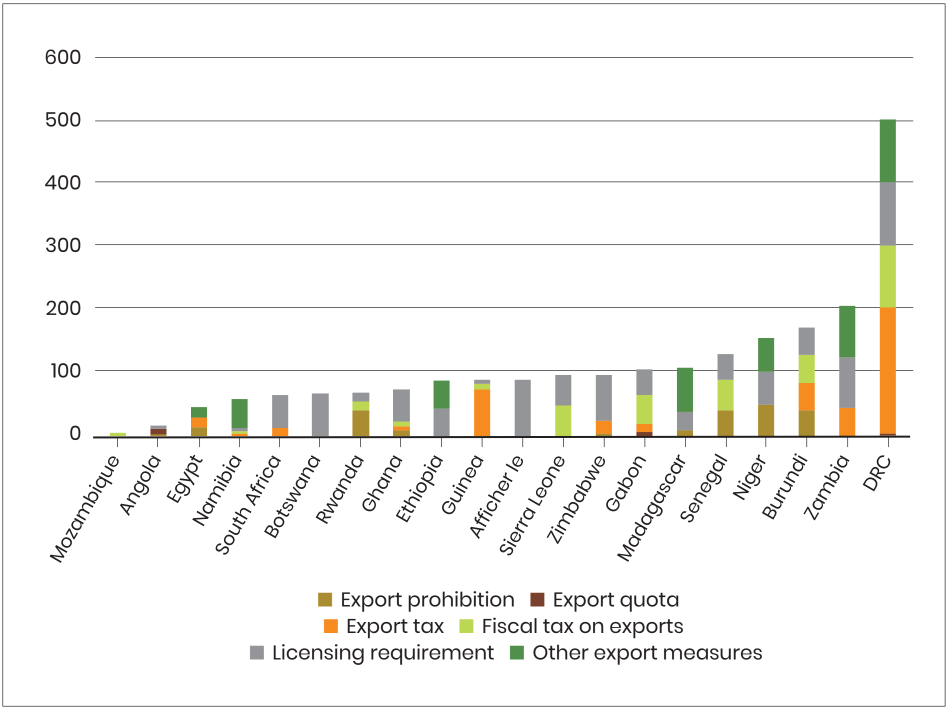
Graph 19. ***Number of export restrictions in Africa***



Source: Authors based on measures involving export restrictions on mineral raw materials, OECD.

Some restrictions are more radical than others, with different African countries opting for different measures. Prohibitions in Senegal, Nigeria, Burundi, and Rwanda are the most severe. The DRC has by far the most forms of restriction of any country, although it has not adopted the most far-reaching types.

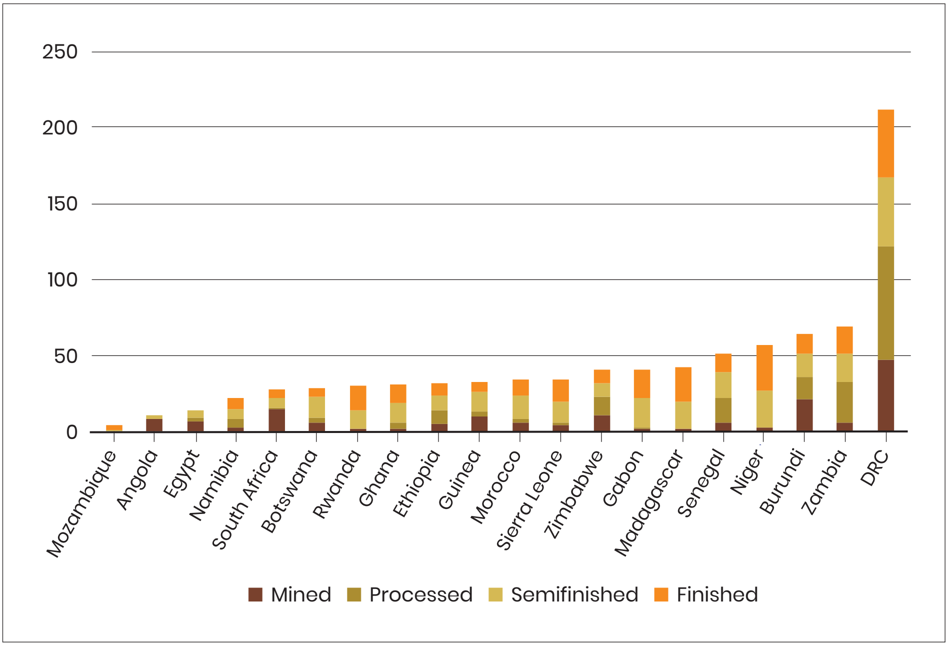
Graph 20. ***Number and types of restriction by country in 2021***



Source: Authors based on measures involving export restrictions on mineral raw materials, OECD.

Strategies also differ from country to country regarding the product processing stage targeted by these restrictions. The measures frequently apply to mined or processed minerals, as is mostly the case in the DRC, Zambia, Zimbabwe, Morocco, Guinea, and Namibia. The opposite is true in Burundi, Nigeria, Sierra Leone, Rwanda, Gabon, Ethiopia, and Botswana, where semifinished or even finished products are more likely to be retained for local manufacturing.

Graph 21. ***The types of product covered by export restrictions in 2021***



Source: Authors based on measures involving export restrictions on mineral raw materials, OECD.

Countries also obviously differ in terms of the minerals and metals covered by these export restrictions. Angola and Namibia use these restrictions more frequently for diamonds, the DRC and Zambia for copper and cobalt, and Madagascar for nickel, rare earths, and titanium.

Table 34. ***Breakdown of export restrictions by country and by mineral in 2021***

	ANGOLA	BOTSWANA	BURUNDI	DRC	EGYPT	ETHIOPIA	GABON	GHANA	GUINEA	MADAGASCAR	MOROCCO	MOZAMBIQUE	NAMIBIA	NIGERIA	RWANDA	SENEGAL	SIERRA LEONE	SOUTH AFRICA	ZAMBIA	ZIMBABWE
Aluminium	1	1	4	5	3	2	2	1	**7**	2	1		1	3	1	3	2	2	3	1
Silver		1						1	2		**6**									2
Barite											2									
Bentonite											1									
Chromium		3	**12**	15		**6**	**6**	3	3	7	3		3	**9**	3	**9**	**6**	**6**	9	**18**
Cobalt		1	4	**21**		2	2	1	1	7	4		1	3	1	3	2		**10**	1
Copper				**56**															**26**	
Diamond	**8**			**30**									**16**					4		**6**
Tin				15											**6**					
Feldspar					1						3									
Graphite																				2
Kaolin					1															
Lithium																				2
Manganese		1	4	5	1	2	**9**	4	1	1	1		1	3	1	3	2	1	3	1
Nickel	1	**7**	4	5		2	2	1	1	**13**	1		1	3	1	3	2	1	3	1
Gold		1		**25**				**6**	**12**									3		**7**
Phosphate					**6**						3									
Platinum		**9**									1							**8**		**18**
Lead		1	4	5	1	2	2	1	1	1	**7**		1	3	1	3	2	3	3	1
Tantalum		1	**13**	15		**8**	2	1	1	1	2	2	1	**9**	**7**	4	4	2	3	1
Rare earths										**8**	2							1		
Titanium		1	4	5		2	2	1	1	**9**	1	2	1	3	1	**7**	**10**		3	1
Tungsten		1	4	5		2	2	1	1	1	2		1	3	**11**	3	2	1	3	1
Zinc	1	1	4	5	1	2	2	1	1	1	1		1	3	1	3	2	1	3	1

Note: The most frequently used measures for each country are shown in orange.

Source: Authors based on export restriction measures for mineral raw materials, OECD.

There is little empirical research on the actual outcomes of these policies. The study by Fliess et al. (2017) describes the use of export control measures such as export taxes, non-automatic export licensing requirements, and export prohibitions for manganese in Gabon, lead in South Africa, copper in Zambia, and chromite in Zimbabwe. Their results suggest that export restrictions are an ineffective tool for stimulating local mineral processing, with no improvement in the expected competitive advantage of processed products that were intended to benefit from export controls on raw materials. In addition, the measures may have undermined the overall performance of the industries in some of the examples investigated, since the export performance of mined minerals has deteriorated.

4.2.2. Special economic zones (SEZs)

One major problem that needs to be addressed is financing. The challenge for governments will be to successfully attract investors willing to commit the funds needed to build and equip factories, as Zimbabwe has managed to do. However, it might be possible to generate higher direct revenues if a number of countries were to join forces to develop industrial processing facilities.

The principle of using infrastructure to stimulate investment via the development of SEZs was introduced in the 2000s. According to UNCTAD[73] (2021), there are 237 legally established SEZs in Africa, half of which are operational, with the remainder in the construction or design phase. Four countries account for the highest concentration of SEZs: Kenya (61 SEZs), Nigeria (38), Ethiopia (18), and Egypt (10). Regionally, East Africa accounts for 50% of the total number of SEZs on the continent, West Africa 24%, and North Africa 10%.

SEZs host foreign and, to a lesser extent, domestic companies in manufacturing (textiles, leather, light engineering, automotive, and agriculture), digital and high-tech services, logistics (transport and storage facilities), distribution and services, and tourism. Most are located close to a seaport or international airport, and have well-developed road and rail infrastructure. Businesses benefit from improved services such as reliable energy, public services, information and communication technologies (ICT), and other related utilities. They also benefit from tax incentives that can be extended, special customs treatment, preferential land use, and the opportunity to employ a low-income workforce.

73. United Nations Conference on Trade and Development.

UNCTAD's handbook on SEZs in Africa (2021)[74] highlights the difficulties encountered during the design, development, and implementation phases of SEZs. UNCTAD provides an in-depth assessment of the earliest initiatives (free trade zones in the 1970s) and those that emerged in the 1990s (export processing zones [EPZs]). The general conclusion is that most African governments have pushed for the development of SEZs as a miracle cure for their economic problems. However, most governments have not undertaken a thorough examination of the potential consequences of setting up an SEZ in their country (benefits and adverse impacts) in order to adapt this development model to their own context and market. The default solution of suddenly duplicating the model has resulted in the creation of organizations with outcomes that are highly debatable and ultimately prove to be very modest. The most glaring failure, however, is that, apart from a few countries that have developed good practices (notably Egypt, Ethiopia, Mauritius, and Morocco), SEZs have not produced any obvious beneficial impact for local economies.

This is the backdrop against which mineral processing SEZ projects are emerging. Over the last decade, dozens of new SEZs have been set up to meet the needs of the mining sector.

The mining sector plays a key role in the development of almost all of **South Africa's SEZs**. Several South African SEZs have been specifically created to encourage innovation in the mining sector. Platinum Valley, located a few kilometers from the capital, Pretoria, aims to revolutionize **the manufacturing of hydrogen fuel cells in Africa**. The SEZ, which is managed by multinational mining company Anglo American, combines two essential elements of the hydrogen fuel cell supply chain: **hydrogen and platinum**. South Africa is home to 75% of known global platinum reserves, making it a prime location for a cluster of hydrogen fuel cell firms.

The Musina–Makhado SEZ in South Africa's Limpopo province will be home to a Chinese coal-fired steel refinery. Chinese firms located in the zone will be able to benefit from the industrial incentives offered by the country. Conversely, the South African government hopes the zone will help the country keep more of the steel supply chain within its borders. Supporters expect the project to create 11,000 jobs. Other South African SEZs, such as the Fetakgomo–Tubatse industrial hub in Limpopo province, also hope to target the mining sector.

74. UNCTAD, *Handbook on Special Economic Zones in Africa: Towards Economic Diversification across the Continent*, 2021, accessed January 30, 2025, https://unctad.org/system/files/official-document/diaeia2021d3_en.pdf.

The Zimbabwean government has granted South African mining company Tharisa, which specializes in **chromium and platinum mining**, SEZ status on the land where one of its mines was located. SEZ status means that Tharisa will benefit from lower tax rates, duty-free imports of raw materials and equipment, and less stringent foreign exchange rules.

The United Nations Economic Commission for Africa (ECA) and the African Import–Export Bank (also known as Afreximbank) have joined forces and ratified a framework agreement for the establishment of an SEZ **for the production of batteries and EVs in the DRC and Zambia**. As producers of over 70% of the world's **cobalt** and 10% of the world's copper, the DRC and Zambia are well placed to move from being exporters of raw materials to being regional and global manufacturers and suppliers of battery precursors, and to reap the economic benefits.

Under the agreement, the ECA and Afreximbank will lead the creation of an operating company in consortium with public and private investors from the DRC and Zambia, as well as international investors such as Afreximbank's development impact investment platform, the Fund for Export Development in Africa (FEDA). The operating company will develop a cross-border SEZ in the DRC and Zambia dedicated to the production of battery precursors, batteries and, in the longer term, EVs. ARISE Integrate Industrial Platform (ARISE IIP), an SEZ developer in Africa and the operator of a minerals SEZ in Haut Katanga province (DRC), will be the technical consultant conducting the feasibility study for the establishment of the SEZs in the DRC and Zambia.

At the same time, production capacity-building will take into account the need to create relevant skills and qualifications, particularly through technical and vocational education and training (TVET). A center of excellence has been set up in the DRC with joint support from the Université de Lubumbashi (UNILU) (DRC) and the Ferdinand Steinbeis Institut (FSTI) (Germany), in collaboration with the University of Zambia (UNZA) and the Copperbelt University (CBU) (Zambia).

The Australian mining exploration company AVZ Minerals is seeking a similar SEZ structure for its lithium mines in the **DRC**. Other countries, such as **Senegal** and **Nigeria**, are in the process of creating new SEZ frameworks specifically targeting the mining sector. The growing trend of setting up SEZs focused on mining is expected to play a major role in the African mining sector in the coming years.

4.2. Regional integration and the AfCTA

The creation of a market large enough to encourage investors to carry out processing locally and supply semifinished or finished products to the African market, presupposes successful regional integration. Furthermore, as no single African country possesses all the minerals needed to manufacture a product, facilitating trade within the continent is crucial. In this section we will begin with an overview of the small amount of significant mining trade on the continent, before going on to examine the emergence of African investors in the continent's various economies, and end with a look at how the AfCTA agenda could contribute to the emergence of continent-wide value chains.

4.2.1. Inter-African mining trade

Analysis of the mineral trade within Africa provides some clues as to the countries involved in the mineral processing agenda. **Inter-African trade accounts for 5% of the continent's exports**. It is an important focus for trade in mined ores such as cobalt (average 24% of exports), copper (28%), manganese (10%), and in semifinished iron and gold products (17%). Minerals are traded on the continent in the form of raw (20%) or processed ores (24%), but also, further downstream in the chain, as semifinished (33%) or finished products (23%). It is important to distinguish between trade in goods that are fully processed in Africa, and trade in goods that arrive already processed and then move around the continent.

Table 35. ***Distribution of inter-African trade over the period 2018–2021***

EXPORTING COUNTRIES (%)		IMPORTING COUNTRIES (%)		PRODUCTS (%)		STAGES (%)	
South Africa	30.4	Namibia	16.2	Iron	31.0	Semi-finished iron	18.3
ZambiA	16.8	South Africa	12.5	Copper	24.3	Processed copper	17.6
NamibiA	10.6	Botswana	12.0	Gold	18.0	Semi-finished gold	13.0
DRC	9.3	Uganda	11.5	Diamonds	12.5	Diamond ore	12.5
Tanzania	5.7	Zambia	9.0	Aluminium	3.5	Finished iron	12.3
Kenya	4.2	Egypt	5.4	Bentonite	3.3	Processed gold	5.0
Botswana	3.5	Rwanda	5.0	Potassium	1.6	Copper ore	4.7
Egypt	3.4	Zimbabwe	4.5	Cobalt	1.6	Finished aluminum	3.3
Eswatini *	2.4	DRC	3.4	Gypsum	1.1	Finished bentonite	3.3
Morocco	1.4	Kenya	2.5	Zinc	0.6	Finished copper	2.0
Zimbabwe	1.4	Tanzania	2.5	Manganese	0.5	Processed cobalt	0.9
Burkina Faso	1.3	Mozambique	1.9	Phosphate	0.5	Gypsum ore	0.9
Tunisia	1.0	Morocco	1.8	Lead	0.3	Finished potassium	0.8
Mozambique	0.8	Eswatini *	1.2	Rare earths	0.2	Cobalt ore	0.7
Uganda	0.8	Nigeria	1.2	Chromium	0.2	Semi-finished potassium	0.7

** Formerly Swaziland*

Source: Authors based on UN Comtrade database.

The main exporter of mining products is **South Africa** (30.4% of trade on the continent). Most of its exports are semi-finished and finished **iron products (22%), which go to Southern and East African countries** (Kenya, Zimbabwe, Botswana, Zambia, Namibia, Mozambique, and Tanzania in particular). South Africa is the world's seventh-largest iron producer (2.4% of global production), and has developed a processing industry and local distribution network. The main producers of iron ore in South Africa are Anglo American (50%) and African Rainbow Minerals (ARM) (26%). The second-largest exporter is **Zambia** (16.8% of trade), which is responsible for **15% of Africa's processed copper** exports: to Namibia (11%), Egypt (3%), and South Africa (1%). Zambia is the continent's leading copper exporter, and its copper refining plants seem to suit other African economies better than those in the **DRC**. The third-largest exporter is **Namibia** (10.6% of trade), which exports diamond ore, mainly to Botswana (4.5%), and semifinished gold to South Africa (4.5%). The DRC is the fourth-largest exporter (9.3% of trade), exporting copper ore to Zambia (4.5%) for refining, and refined copper (refined in the DRC) to Namibia and Egypt (3%). **Tanzania** (5.7% of trade) and **Kenya** (4.2% of trade) are included in this list for their exports of processed gold or semifinished products to Uganda and Rwanda. **Botswana** (3.5% of trade) is the main exporter of diamonds to Namibia and South Africa.

In all, 51% of inter-African trade is based on ten main flows involving ten countries, including Southern Africa (South Africa, Zambia, Zimbabwe, and Namibia), East Africa (Kenya, Tanzania, Uganda, and Mozambique), along with the DRC and Egypt, and four products (gold, diamonds, copper, and iron). It is important to note that most gold trading is unofficial, particularly in West Africa.

Table 36. ***Main inter-African trade flows***

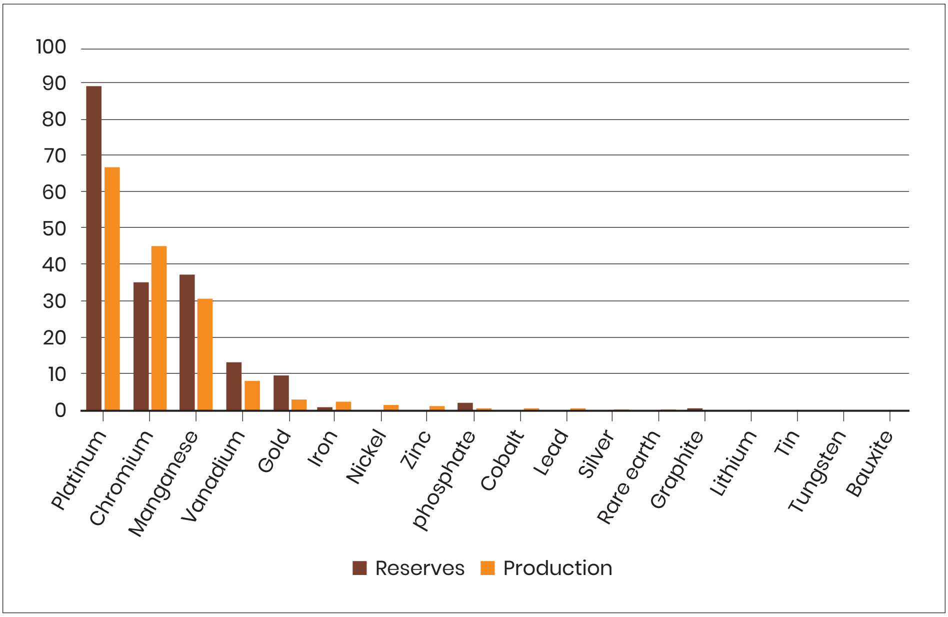
%	EXPORTER	IMPORTING COUNTRIES (% of inter-African trade in mining products)	PRODUCT
6.8	**South Africa**	Kenya (2.2), Mozambique (1.9). Tanzania (1.3), DRC (1.4)	Semifinished iron
8.6	**South Africa**	Zimbabwe (2.7), Botswana (2.2), Namibia (1.6), Zambia (2.1)	Semifinished iron
14.2	**Zambia**	Namibia (10.7), Egypt (2.8), South Africa (0.7)	Refined copper
4.5	**Namibie**	Botswana (4.5)	Diamonds
4.5	**DRC**	Zambia (4.5)	Raw copper
2.3	**DRC**	Namibia (1.2), Egypt (1.1)	Refined copper
4.8	**Tanzanie**	Ouganda (3.4), Rwanda (1.4)	Gold
2.3	**Kenya**	Ouganda (1.7), Rwanda (0.6)	Gold
2,9	**Botswana**	Namibia (1.4), South Africa (1.5)	Diamonds

Source: Authors based on UN Comtrade database.

4.2.2. Inter-African investment

The two main African countries investing in Africa are South Africa and Morocco, and each has its own strategy. While Moroccan firms' investments seem to be a part of government strategy, South African firms' investment strategies are led by in-country actors (who operate there, are registered there, or are financed there).

Graph 22. ***South Africa's share of the global mining sector (%)***



Source: Authors based on World Mining Data

South Africa is a globally important mining producer, with a rich diversity of minerals. In 2020, the country was the world's leading producer of **chromium** (45.5% of global production), **manganese** (31%), **platinum** (67.6%), and **rhodium** (80.9%). It was also the world's second-largest producer of **palladium** (33.2%), **titanium** (11.3%), and zirconium (25.5%); the third-largest (and only African) producer of **vanadium** (8.1%), the fourth-largest producer of industrial-grade diamonds (11%), and the fifth-largest producer of jewelry-grade diamonds (5.5%). The country also boasted a diversified production base, including coal (steam) (the world's sixth-largest producer, with 4.3% of global production), iron (seventh-largest producer; 2.4% of production), gold (eleventh-largest producer; 3% of production), and uranium (eleventh-largest producer; 0.2% of production).

South Africa is home to a number of globally important mining companies, mainly in the precious metals sector, as a result of its dominance in the platinum industry. **Anglo American Platinum, Impala Platinum, Gold Fields, and AngloGold Ashanti** (all four in the precious metals sector) were among the world's top 50 mining companies by market capitalization in January 2023.[75]

South Africa's refining industry is relatively underdeveloped. Nevertheless, the country is the second-largest refiner of chromium (26% of products refined worldwide) and vanadium (9%), as well as the fourth-largest refiner of manganese (4%), the world's leading refiner of these three minerals being China.

The mining sector plays a major role in the South African economy, providing 1.5 million direct and indirect jobs and contributing 8.2% to GDP in 2019. The South African government plans to develop it further in order to take advantage of the great global interest in strategic minerals essential to the energy transition, thereby contributing to the country's growth (South African Economic Reconstruction and Recovery Plan).

On the basis of the acknowledged lack of greenfield investment in South Africa, **the government is focusing on increasing mining exploration in the country**. The aim of strategy for exploration in the South African mining sector, published in April 2022,[76] is to attract mineral investment, accelerate new discoveries, and reignite the country's mineral development by overcoming environmental, social, and governance challenges to increase the attractiveness and competitiveness of the South African mining sector. Its aim is for South Africa to attract 5% of global exploration expenditure by 2027—this target was achieved in 2003, but the country's share has steadily declined since then, stabilizing at below 1% over the past decade.

75. *Mining.com,* "The Top 50 Biggest Mining Companies in the World."
76. Republic of South Africa, Department of Mineral Resources and Energy, *The Exploration Strategy for the Mining Industry of South Africa*, Government Notice no. 2026, April 14, 2022, accessed January 30, 2025, https://www.gov.za/sites/default/files/gcis_document/202204/46246gon2026.pdf.

List of fourteen critical minerals identified by South Africa in 2022

COBALT	COAL	CHROMIUM	COPPER
IRON	LITHIUM	MANGANESE	NICKEL
PGMs	LEAD	URANIUM	VANADIUM
RARE EARTHS	ZINC		

Key: The metals regarded as essential to the energy transition by the IEA are highlighted in orange.

Source: The South African government

South Africa wants to capitalize on its substantial mineral reserves, its 130 years of experience in exploration and mining, its cutting-edge research institutions, and its strategic geographical location in order to offset its energy problems, the incomplete mapping of its mineral resources, its outdated infrastructure, its difficulties in implementing mining policy, and its frequent episodes of community unrest. To achieve this, the country has set itself a number of ambitious targets: *(i)* to increase mapping coverage by 1% per year up to 2027, from 9% to 14%; *(ii)* to increase the number of exploration drilling projects and reintroduce the "use it or lose it" principle to fast-track the use of licenses granted; and *(iii)* to incentivize exploration through government support for junior exploration companies. The strategy also includes fourteen minerals considered to be critical because of their importance in green technologies (cobalt, nickel, copper, zinc, lead, and the rare earths), steelmaking (manganese and iron), energy production (coal, uranium,), batteries (vanadium and lithium), and minerals in which South Africa has a competitive advantage (chromium and PGMs).

South Africa has invested by far the most in active mines in Africa: there are 235 mines operated by South African companies and 228 mines where the largest shareholder is South African—by way of comparison, fifty-five mines are operated by British companies, thirty-six by Canadian companies, and thirty-two by Australian companies. These numbers are, however, subject to the qualification that nationality is understood in this context in terms of the location of the operators' and majority shareholders' head office: this therefore includes subsidiaries of foreign groups incorporated under South African law.

The overwhelming majority of mines owned and operated by South African mining companies are located in South Africa (92% of mining properties). South African companies operate fewer mines in the rest of the continent, mainly in West Africa (Ghana, Guinea, and Mali) and Southern Africa (Botswana, Tanzania, Zimbabwe, etc.).

In terms of minerals, coal (eighty-one mines), gold (forty-eight mines), platinum (forty-two mines), and diamonds (eighteen mines) account for 80% of the mines operated by South African companies. **Energy transition minerals account for 29.3% of mines operated by South African companies**, with a total of sixty-nine mines, including forty-two platinum mines. This figure would be higher but for the fact that the two main minerals involved in the projects currently under development (ninety-three projects operated by South African companies) are coal and gold. Energy transition minerals account for barely a quarter of projects (twenty-three South African-operated projects), with the majority still involving platinum (eleven projects).

Table 37. ***South Africa's involvement in the African mining sector by country and by mineral***

COUNTRY	Number of active mines operated by a South African company	Number of active mines whose main shareholder is South African	MINERAL	Number of active mines operated by a South African company	Number of active mines whose main shareholder is South African
South Africa	216	209	**Coal**	81	76
Ghana	5	8	**Gold**	48	51
Botswana	2	2	**Platinum**	**42**	**43**
Tanzania	2	2	**Diamonds**	18	15
Zimbabwe	2	2	**Chromite/ Chromium**	**11**	**9**
Algeria	1	1	**Copper**	**7**	**4**
Guinea	1	1	**Iron**	6	6
Lesotho	1	1	**Ferrochromium**	5	7
Mali	1	1	**Lead**	4	2
Namibia	1	1	**Nickel**	**3**	**3**
Angola	1	0	**Manganese**	**2**	**4**
Eswatini*	1	0	**Vanadium**	**2**	**2**
Mozambique	1	0	**Zinc**	**2**	**2**
TOTAL	**235**	**228**	**Ferromanganese**	3	3
			Ferrovanadium	2	4
			Phosphate	2	2
			U_3O_8	2	2
			TOTAL	**235**	**228**

** Formerly Swaziland.*
Number of mines as of March 2023.
The minerals regarded as essential to the energy transition by the IEA are highlighted in orange.
Source: Authors based on S&P Capital IQ Pro data.

South African companies invested USD 8.9 billion in the African mining sector (including South Africa) between 2018 and 2022, i.e., **more than half of total investment** (54.3%). South Africa is the leading destination for FDI in Africa (USD 5.7 billion). It should also be noted that Australia account for a significant proportion of this investment.

Table 38. ***Percentage shares of South African mining investment in different destinations between 2018 and 2022***

REGION	EXPLORATION BUDGET	BROWNFIELD	GREENFIELD	TOTAL FDI	SHARE (%)
Africa	405.8	8,441.6	32.5	8,879.9	54.3
including ***South Africa***	185.3	5,527.2	32.5	5,745.0	35.1
Australia	492.5	2,387.2	4.3	2,884.0	17.6
Canada	3.8	0.0	0.0	3.8	0.0
United States	170.7	158.9		329.6	2.0
Rest of world	58.7	0.0	0.0	58.7	0.4
TOTAL	**1,740.2**	**13,475.9**	**1,136.8**	**16,352.9**	**100.0**

Amounts are expressed in USD millions and relate to the period 2018–2022 unless otherwise specified.

ource: Authors based on S&P Capital IQ Pro data.

Africa accounts for 100% of the investment made by South African companies in chromium, coal, diamonds, manganese, nickel, platinum, and vanadium between 2018 and 2022. It also accounts for 45.9% of the investment in the gold industry, through investments made in South Africa, Ghana, Tanzania, the DRC, Guinea, and Mali.

As a result of significant investment in platinum, energy transition minerals account for half (49.2%) of South African investment in Africa between 2018 and 2022, and 78.4% of South African investment in transition minerals worldwide over the same period.

Table 39. ***Africa's share of South African mining investment for various minerals between 2018 and 2022***

INVESTMENT (GREENFIELD AND BROWNFIELD)				EXPLORATION BUDGET			
MINERAL	WORLD	AFRICA	AFRICA'S SHARE (%)	MINERAL	WORLD	AFRICA	AFRICA'S SHARE (%)
Gold	9,215.6	4,227.9	45.9	**Gold**	1,552.2	278.0	17.9
Platinum	**3,994.0**	**3,994.0**	**100.0**	**PGMs**	**140.4**	**110.6**	**78.8**
Vanadium	**121.8**	**121.8**	**100.0**	**Silver**	**1.3**	**1.3**	**100.0**
Coal	69.2	69.2	100.0	**Nickel**	**0.7**	**0.6**	**85.7**
Manganese	**36.8**	**36.8**	**100.0**	**Copper**	**27.8**	**0.0**	**0.0**
Nickel	**9.9**	**9.9**	**100.0**	**Lithium**	2.5	0.0	0.0
Chromite	**9.7**	**9.7**	**100.0**	**Others**	15.3	15.3	100.0
Diamonds	4.9	4.9	100.0	**TOTAL**	**1,740.2**	**405.8**	**23.3**
Copper	**992.0**	**0.0**	**0.0**				
Palladium	**158.9**	**0.0**	**0.0**				
TOTAL	**14,612.7**	**8,474.1**	**58.0**				

Amounts are expressed in USD millions and relate to the period 2018–2022 unless otherwise specified.
Minerals regarded as essential to the energy transition by the IEA are highlighted in orange.
Source: Authors based on S&P Capital IQ Pro data.

Morocco is the world's second-largest producer of phosphate (17.1% of global production), and has the majority of global reserves (69.4%). It also produces limited amounts of **cobalt** (of which it is the world's eighth-largest producer, with 1.9% of global production in 2020), **copper** (0.15%), **manganese** (0.22%), **lead** (0.8%), and **zinc** (0.28%). The country is also Africa's leading producer of **silver** (0.7%) and the only African country that produces arsenic (it is the world's third-largest producer, with 14.8% of global production in 2020).

Morocco's two leading mining companies, the Office Chérifien des Phosphates (OCP) and Managem, are not among the world's 50 largest mining firms in terms of market capitalization. Moreover, Morocco does not rank among the world's major metal refiners.

Morocco's mining strategy is primarily based on development of its domestic mining sector. This already plays a substantial role in the country's economy, providing 40,000 direct and indirect jobs, contributing 10% to Morocco's GDP, and accounting for 80% of exports by volume and 20% by value. The **Plan Maroc Mines 2021–2030 (PMM)** (Morocco Mining Plan)—"Towards a Competitive Model by 2030, Working Toward Integrated Industrialization and Sustainable Growth"—launched in June 2021, aims to address the challenges facing the mining sector in its efforts to increase exploration and map its reserves. The PMM follows ten years of legislation to increase development of the mining sector, notably the Stratégie nationale pour le développement du secteur minier 2015–2020 (National Strategy for Developing the Mining Sector 2015–2020).

It is important to note the strong links between Morocco's two main mining companies and the state. **OCP** is 95% state-owned, while **Managem** is 81.4% owned by the Al Mada investment fund,[77] whose main shareholder is SIGER, a holding company owned by the royal family. Their respective strategies are therefore worth taking into account when considering how Morocco positions itself in regard to mining investment.

What the two firms have in common is their clear ambition to expand into Africa. OCP has a geographically diverse customer base (with South America accounting for 33% of its fertilizer exports in 2021, Asia 22%, Africa 19%, and Europe 16%), but its expansion strategy is aimed primarily at Africa. OCP is active in twelve African countries through its subsidiary **OCP Africa**, which was created in 2016 "to contribute to the sustainable development of African agriculture" and competes with Saudi phosphate groups in particular for control of the East African market. OCP's strategy is more concerned with selling its fertilizers to African countries than with developing other phosphate mines on African soil, unlike **Managem**, which is currently active in eight African countries (in addition to Morocco) where it operates a total of ten mines. The Managem group traces the beginnings of what it calls its "African ambitions" back to its 1997 acquisition of a stake in the Canadian mining company SEMAFO.

77. Formerly the Société nationale d'investissement (SNI) (National Investment Company).

OCP is one of the world's largest phosphate companies (with a global market share of 31%) and is in excellent financial health. The company thrives as the sole operator of Morocco's phosphate mines. There are currently two major active projects in the Moroccan phosphate industry: *(i)* Khouribga, where the OCP Group's mining activity began with its first mine in 1921; today, the Khouribga mining basin is the largest phosphate reserve in Morocco; and *(ii)* the Gantour mining complex, which includes the Benguerir and Youssoufia mines in the world's third-largest phosphate mine. OCP also operates the Boucraa phosphate mine in Western Sahara. The group also processes phosphate into fertilizer at its industrial sites at *(i)* Jorf Lasfar, a fertilizer complex that opened in 1984, has been expanded several times over the years, and has become the world's largest phosphate fertilizer production platform, and *(ii)* Safi, OCP's first chemical complex (phosphate by-products), which opened in 1965.

Managem is deeply embedded in the African mining sector, with projects involving a wide variety of minerals: *(i)* gold at the Wadi Gabgaba mine in Sudan and the Tri-K mine in Guinea; *(ii)* copper at the Pumpi mine in the DRC and the Tizert project in Morocco; *(iii)* cobalt at the Bou-Azzer mine in Morocco, one of the few primary cobalt mines in the world producing cobalt as its main output; *(iv)* silver at the Imiter mine in Morocco; and *(v)* zinc and lead at the Guemassa polymetallic deposit and its three satellite mines (Hajar, Tighardine, and Draa Sfar). In 2015, Managem announced its intention to strengthen its involvement in gold to balance its portfolio, which had previously been dominated by base metals, prices for which are subject to greater fluctuation. Hence, the group is pursuing an active expansion policy, particularly in gold in Africa: in December 2022, it announced the forthcoming acquisition of several strategic gold assets in Africa from Canadian mining group Iamgold. In a deal worth USD 280 million, Managem acquired the gold deposits at Boto (Senegal), Diakha–Siribaya (Mali), and Karita (Guinea), with total estimated resources of 155 tonnes of gold, more than twenty times the Moroccan group's gold production in 2022.[78]

78. Bilal Mousjid, "Pourquoi Managem accélère sur l'or ouest africain," *Jeune Afrique*, modified January 18, 2023, accessed January 30, 2025, https://www.jeuneafrique.com/1406641/economie-entreprises/pourquoi-managem-accelere-sur-lor-ouest-africain/.

Table 40. ***Morocco's involvement in Africa's mining sector***

ACTIVE MINE	COUNTRY	MAIN MINERAL	MOROCCAN OPERATOR AND OWNER
Working mines			
Imiter	Morocco	**Silver**	Managem (80%)
Bou-Azzer	Morocco	**Cobalt**	Managem (99,8%)
Akka	Morocco	**Copper**	Managem (93,5%)
Jbel La'sal	Morocco	**Copper**	Managem (99,8%)
Oumjrane	Morocco	**Copper**	Managem (100%)
El Hammam	Morocco	Fluorite	Managem
Guemassa	Morocco	**Zinc**	Managem (87%)
Khouribga	Morocco	Phosphate	OCP (100%)
Youssoufia	Morocco	Phosphate	OCP (100%)
Benguerir	Morocco	Phosphate	OCP (100%)
Boucraa	Morocco	Phosphate	OCP (100%)
Tri-K	Guinea	Gold	Managem (85%)
Wadi Gabgaba	Sudan	Gold	Managem (65%)
Pumpi	DRC	**Copper**	Managem (20%)
Projects at the development stage			
Bouskour	Morocco	**Copper**	Managem (100%)
Tizert	Morocco	**Copper**	Managem (100%)
Etéké	Gabon	Or	Managem (75%)
Project at the exploration stage			
Block 9. Block 15. Block 24	Sudan	Or	Managem (100%)

Minerals regarded as essential to the energy transition by the IEA are highlighted in orange.
The owner's nationality is determined by the country in which they are domiciled.
Mines are considered to be active if they are not categorized as inactive.

Source: Authors based on S&P Capital IQ Pro data.

All Moroccan investment is made in Africa. It is significant, for example, that Managem presents itself as a "100% pan-African" operator. Between 2018 and 2022, Moroccan firms' exploration budget totaled USD 128.8 million and was spent solely in Africa. Investment, meanwhile, totaled USD 268.2 million and consisted of a greenfield investment in gold in Guinea, and a brownfield investment in lead in Morocco.

4.2.3. The African Continental Free Trade Area (AfCFTA)

The African Continental Free Trade Area (AfCFTA), which came into effect on January 1, 2021, provides a strong incentive for African governments to close infrastructure gaps, streamline supply chains, strengthen production capabilities, and revise regulations on trade, cross-border initiatives, investment-friendly policies, and capital flows. It is worth noting here that, by supporting inter-African trade, the AfCFTA is expected to advance Africa's industrialization agenda through development of the regional value chain (RVC), which is expected to reduce Africa's dependence on primary metal products.

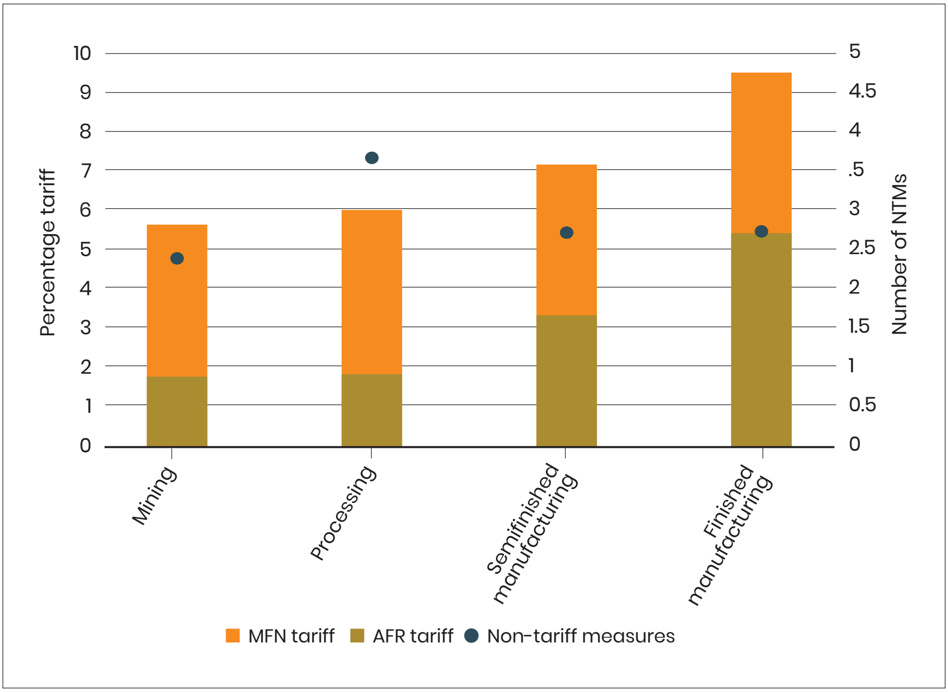
A brief glance at the level of tariffs in Africa along the value chain for mineral-based products shows that the higher up the product is in the chain, the higher the tariffs are between African countries (almost 6% for finished products compared to less than 2% for mined ores). If a country opts to maintain barriers on processed products, this is a major obstacle to the development of value chains. However, the tariffs African countries apply to each other are significantly lower as a result of the existence of regional economic communities (RECs), which offer lower tariffs than the MFN tariffs [79] negotiated at the World Trade Organization (WTO). There is therefore an implicit incentive to create RVCs that could be increased if the AfCFTA worked to ensure inter-African tariffs approached zero.

The other major barrier to trade can be found in the various regulations that can apply to mining products. Regulations can increase the cost of imports if they differ significantly from those applied in the exporting country. Foreign suppliers seeking to export products face additional commercial costs associated with: *(i)* identifying and processing information on standards requirements (information costs); *(ii)* adapting the product or production process to the requirements of the importing country (specification costs); and *(iii)* verifying and proving that these requirements are actually being met (conformity assessment costs).

79. Most-favoured-nation treatment.

There is an average of between two and four of these regulations per product along the chain, and significantly more of them at the stage where ores have just been processed. The results of a World Bank study (2022)[80] on the impact of the AfCFTA suggest that, on average, the reduction in trade costs linked to nontariff measures (NTMs) is 4.9 percentage points for trade in mining products, compared with 2.6 for trade in other goods.

Graph 23. ***Average tariffs and nontariff measures (NTMs) in Africa in 2020***

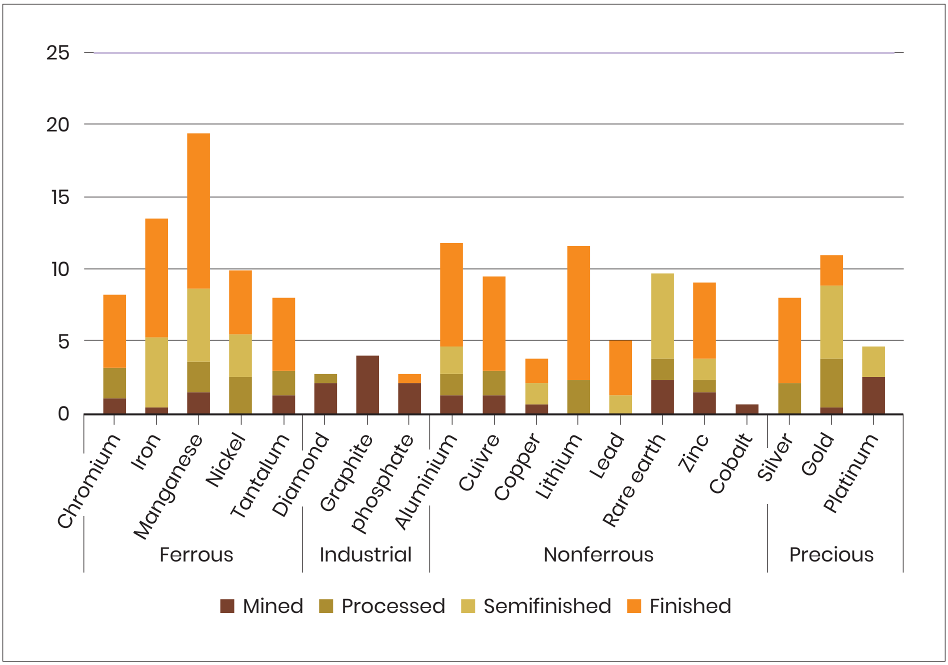


Source: Authors based on World Integrated Trade Solution (WITS) data, World Bank

80. Roberto Echandi, Maryla Maliszewska, and Victor Steenbergen, *Making the Most of the African Continental Free Trade Area: Leveraging Trade and Foreign Direct Investment to Boost Growth and Reduce Poverty* (The World Bank Group, 2022), accessed January 30, 2025, http://documents.worldbank.org/curated/en/099305006222230294/P1722320bf22cd02c09f2b0b3b320afc4a7.

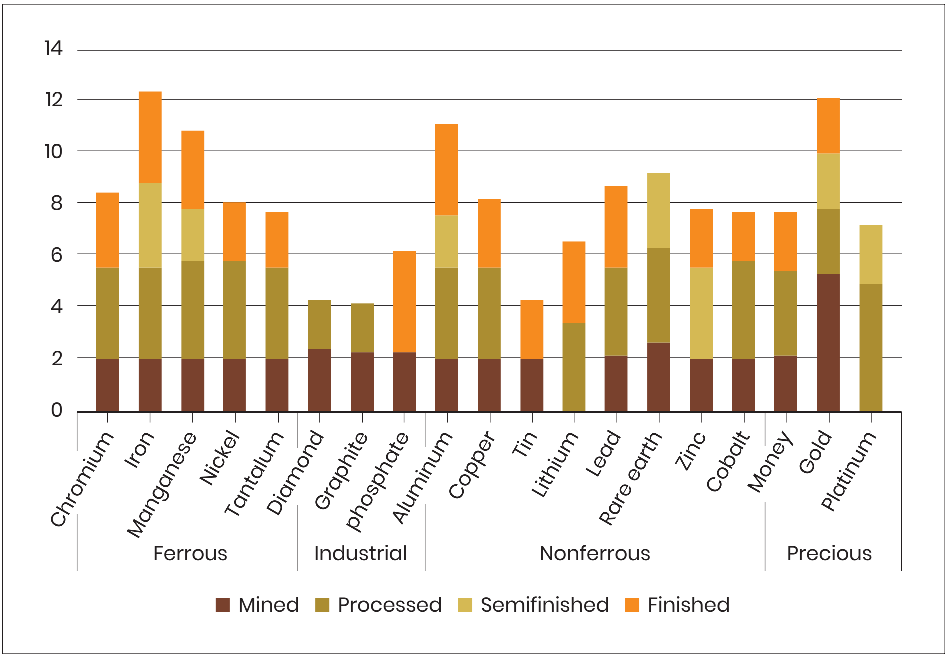
While tariffs are more of a barrier to trade in finished and semifinished products of all minerals, differences in standards and norms are more of a hindrance at the start of the chain, i.e., at the stage involving the trade in mined or just processed ores (except for iron, manganese, and aluminum). The introduction of the AfCFTA should help partly remove these obstacles, and the trade in mineral raw materials in Africa should benefit from these reforms, but the major infrastructure development unquestionably required to facilitate the movement of goods across borders will take time.

Graph 24. ***Breakdown of tariffs in Africa by product and processing stage in 2020***



Source: Authors based on WITS data, World Bank

Graph 25. ***Breakdown of nontariff measures (NTMs) in Africa by product and processing stage, 2020***



Source: Authors based on WITS data, World Bank

Conclusion

Africa hopes to take advantage of its vast metal resources and deposits, in particular those needed for the energy transition, to support a pathway to industrialization based on greater local processing of its minerals, thereby strengthening its role in international value chains.

Africa was the third-largest destination for global mining investment over the period 2018–2021, and accounted for 20% of global exports of metals and minerals. The continent's prominence should prompt African governments to offer foreign investors the opportunity to process minerals locally in order to create greater added value, and generate local and regional economic spin-offs.

A first step would be to encourage mineral refining in Africa. There are already operations of this kind for copper and gold. However, many countries are likely to find it difficult to take on refining because of the shortfall in their energy production, since mineral refining is very energy-intensive. The ambitions of some African countries extend to the production of batteries for EVs, which will also depend on the existence of a nearby market for battery-powered vehicles and will require substantial investment in transport infrastructure. For some countries with fewer natural resources, more modest targets may initially include the development of networks of suppliers of products and services to mining companies, supported by local content requirements to facilitate the involvement of local firms.

As far as incentive policies are concerned, the strategy adopted by some African countries of coercing foreign mining companies by imposing restrictions on their exports of raw minerals has proved ineffective. The strategy now being implemented is to set up SEZs, which have not been very effective in other industries in the past. The creation of the AfCFTA should make it possible to address the lack of a local market large enough to justify establishing local processing units to enable the development of regional value chains.

The analysis of local processing potential cannot be limited to transition minerals alone, however. While it is crucial for Africa to develop its processing capabilities for minerals it already produces in large quantities (platinum and gold), it must also do so for construction materials (iron and steel), particularly as the need for strategic minerals is so great that it could result in the energy transition industries using lithium-substitute components for batteries, for example.

In short, Africa has the potential to create added value, but to do so it will need to strengthen its position on the mineral raw materials market, exploit its competitive advantages, and improve its infrastructure (particularly its energy systems) and general investment conditions (each country's own specific investment codes need to be reformed). Alliances therefore need to be built at both the African and international level.

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List of acronyms and abbreviations

A3T	Tin, Tungsten, Tantalum
ACP	(countries) Africa, Caribbean, and Pacific
ADB	African Development Bank
AFCFTA	African Continental Free Trade Area
AFD	*Agence Française de Développement* (French Development Agency)
AGOG	*Association des Groupes des Orpailleurs de Guinée* (Guinea gold panners employers' organization)
AI	Artificial Intelligence
AIDS	Acquired Immune Deficiency Syndrome
AMDC	African Minerals Development Centre (African Union)
AMV	African Mining Vision (African Union)
ASM	Artisanal and Small-scale Mining
ATAF	African Tax Administration Forum
AU	African Union
AUC	African Union Commission
BEPS	Base Erosion and Profit Shifting (OECD/G20 project)
BGS	British Geological Survey
BIF	Burundian franc (currency of Burundi)
BMLRT	*Bundesministerium für Landwirtschaft, Regionen und Tourismus* (Austrian Federal Ministry of Agriculture, Regions, and Tourism)
BN	Billion(s)
BNE	*Bureau National d'Expertise* (Guinean government agency overseeing precious gem exports)
BRB	Bank of the Republic of Burundi (central bank)
BRGM	*Bureau de recherches géologiques et minières* (French Bureau of Geological and Mining Research)
BRI	Belt and Road Initiative
CAR	Central African Republic

CCSI	Columbia Center on Sustainable Investment
CDF	Congolese franc (currency of the DRC)
CEA	*Commissariat à l'énergie atomique et aux énergies alternative*s (French Alternative Energies and Atomic Energy Commission)
CECIDE	*Centre du commerce international pour le développemen*t (Center for International Trade for Development) (Guinean NGO)
CEEC	*Centre d'expertise, d'évaluation et de certification des substances minérales précieuses* et *semi-précieuses* (Center for Expertise, Evaluation, and Certification of Precious and Semi-Precious Minerals) (DRC)
CEMAC	*Communauté Économique et Monétaire de l'Afrique Centrale* (Central African Economic and Monetary Community)
CERDI	*Centre d'études et de recherches en développement internationa*l (French Center for Studies and Research in International Development)
CFAF	CFA franc (the eight member states of the UEMOA use the West African CFA franc, or XOF, as their currency, while the six member states of CEMAC use the Central African CFA franc, or XAF, as their currency)
CFR	Cost and Freight
CM	Critical Minerals
CNAM	*Conservatoire national des arts et métiers* (French National Conservatory of Arts and Trades)
CO_2	*Carbon dioxide*
CO_2-EQ	*Carbon dioxide equivalent* (unit created by the IPCC)
CONADOG	*Coordination nationale des diamantaires et orpailleurs de Guinée* (Guinean gold panning and diamond mining employers' organization)
CPDM	*Centre de promotion et de développement miniers* (Center for Mining Promotion and Development) (Guinea)
CPG	*Compagnie des phosphates de Gafsa* (Gafsa Phosphate Company) (Tunisia)
CPI	*Corruption Perceptions Index* (Transparency International)

CRD	Centre for Research and Development (Zimbabwe)
CRISP	*Centre de recherche et d'information socio-politiques* (Center for Sociopolitical Research and Information) (Brussels)
CSO	Civil Society Organization
CSO	Central Statistical Office (Zambia)
CSR	Corporate Social Responsibility
CT	Corporate Tax
DC	Developing Country
DFID	Department for International Development (United Kingdom)
DRC	Democratic Republic of the Congo
EC	European Commission
ECA	United Nations Economic Commission for Africa
ECED-	*Eau et croissance économique durable dans la region du Sahel* (Water and Sustainable Economic Growth in the Sahel) (project)
ECOWAS	Economic Community of West African States
EIB	European Investment Bank
EITI	Extractive Industries Transparency Initiative
ENSO	Enquête nationale sur le secteur de l'orpaillage (National Survey on the Gold Panning Sector) (Burkina Faso)
EPC	Engineering, Procurement, and Construction
EU	European Union
EV	Electric Vehicle
EUR	Euro
FARI	Fiscal Analysis of Resource Industries (IMF model)
FCA	Fair Cobalt Alliance
FDI	Foreign Direct Investment
FERDI	*Fondation pour les études et recherches sur le développement international* (French Foundation for International Development Studies and Research)
FIM	*Fonds d'investissement minier* (Mining Investment Fund) (Guinea)
FNDL	F*onds national de développement local* (National Fund for Local Development) (Guinea)

FOB	Free On Board
FODEL	Fonds de développement économique local (Fund for Local Economic Development) (Guinea)
G	Gram
G20	Group of 20
GA	Giga-Annum, equivalent to one billion years
GAC	Global Affairs Canada
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
GHG	GreenHouse Gas
GHS	*Ghanaian cedi* (currency of Ghana)
GIZ	*Deutsche Gesellschaft für Internationale Zusammenarbeit* (German development agency)
GNF	*Guinean franc* (currency of Guinea)
GNI	Gross National Income
GOI	Gross Operating Income
GTC	General Tax Code
GVC	Global Value Chains
GW	Gigawatt
HA	Hectare
HAB	Inhabitant
HDI	Human Development Index (UNDP)
HDER	Highly Dependent on Energy Resources (country)
HHI	Herfindahl-Hirschman Index
HDMR	Highly Dependent on Mining Resources (country)
ICG	International Crisis Group
ICGLR	International Conference on the Great Lakes Region
ICMM	International Council on Mining and Metals
ICT	Information and Communication Technology
ICTD	International Centre for Tax and Development
IDRC	International Development Research Centre (Canada)
IEA	International Energy Agency
IFC	International Finance Corporation (World Bank Group)
IFI	International Financial Institutions

IFPEN	*IFP Énergies nouvelles* (French energy research organization)
IFRI	*Institut français des relations internationales* (French Institute of International Relations)
IGF	Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development
IISD	International Institute for Sustainable Development
IJV	International Joint Venture
ILO	International Labour Office (United Nations)
IMF	International Monetary Fund
INSAF	Institute for Sustainability Africa (think tank, Zimbabwe)
INSD	*Institut national de la statistique et de la démographie* (National Institute of Statistics and Demography) (Burkina Faso)
IPCC	Intergovernmental Panel on Climate Change
IPIS	International Peace Information Service
IRA	Inflation Reduction Act (United States)
IRD	*Institut de recherche pour le développement* (French National Research Institute for Sustainable Development)
IRR	Internal Rate of Return
ISS	Institute for Security Studies
IUCN	International Union for Conservation of Nature
JETP	Just Energy Transition Partnership
JOGMEC	Japan Organization for Metals and Energy Security
K	Thousand(s)
KG	Kilogram
KM	Kilometer
KP	Kimberley Process (see KPCS)
KPCS	Kimberley Process Certification Scheme (see KP)
KWH	Kilowatt hour
LBMA	London Bullion Market Association
LCU	Local Currency Unit
LDGL	*Ligue des droits de la personne dans la région des Grands Lacs* (Great Lakes Region Human Rights League)

LME	London Metal Exchange
LPI	Logistics Performance Index
m	Meter
M	imports
M	Million(s)
M&A	Mergers & Acquisitions
MA	Mega-Annum, equivalent to one million years
MAC	Mining Association of Canada
METI	Ministry of Economy, Trade and Industry (Japan)
METR	Mean marginal Effective Tax Rate
MFN	Most-Favored-Nation treatment
MJ	Megajoule
MDMR	Moderately Dependent on Mining Resources (country)
MMMD	Ministry of Mines and Minerals Development (Zambia)
MPF	Mining Policy Framework (IGF)
MRT	Mining Rent Tax
MW	Megawatt
MWH	Megawatt Hour
NA	Not Available
NATO	North Atlantic Treaty Organization
NBER	National Bureau of Economic Research (United States)
NDER	Not Dependent on Energy Resources (country)
NGO	Nongovernmental Organization
NRGI	Natural Resource Governance Institute
NTM	Non-Tariff Measures
OBM	*Office burundais des mines et carrières* (Burundian Office for Mines and Quarries)
OBPE	*Office burundais pour la protection de l'environnement* (Burundian Office for Environmental Protection)
OBR	*Office burundais des recettes* (Burundian Revenue Authority)
OCP	*Office Chérifien des Phosphates* (Moroccan state-owned phosphate rock mining company)

OECD	Organisation for Economic Co-operation and Development
OMRG	*Office mauritanien de recherches géologiques* (Mauritanian Office for Geological Research)
ORCADE	*Organisme pour le renforcement des capacités de développement* (Organization for Development Capacity-Building) (Burkina Faso)
OSFME	*Observatoire de la sécurité des flux et des matières énergétiques* (Observatory for the Security of Energy Flows and Materials) (France)
OZ	Ounce of Gold (equating to 31.1 g)
PAGSEM	*Programme d'appui à la gouvernance du secteur minier* (Mining Sector Governance Support Project) (Guinea)
PGE	Platinum-Group Elements
PGM	Platinum-Group Metals
PH	Potential of Hydrogen
PPP	Public-Private Partnership
PROJEG	*Programme concerté de renforcement des capacités des organisations de la société civile et de la jeunesse guinéennes* (Joint Capacity-Building Program for Guinean Civil Society and Youth Organizations)
RAMR2D	*Activité minière responsable et développement durable* (Responsible Mining and Sustainable Development) network
RCM	Regional Certification Mechanism
RE	Renewable Energy
REC	Regional Economic Communities (cornerstones of the AU)
REE	Rare Earth Elements
RGI	Resource Governance Index (NRGI)
RINR	Regional Initiative Against the Illegal Exploitation of Natural Resources
RVC	Regional Value Chains
S&P	Standard & Poor's
SAR	Saudi riyal (currency of Saudi Arabia)
SCO	Shanghai Cooperation Organisation

SDG	Sustainable Development Goals (United Nations)
SER	Social and Environmental Responsibility
SDIAM	*Schéma directeur des infrastructures auxiliaires aux mines* (Overall Strategy for Mining Auxiliary Infrastructure) (Guinea)
SDS	Sustainable Development Scenario (IEA)
SEZ	special economic zone
SFI	Sustainable Forestry Initiative
SITC	*Standard International Trade Classification* (classification of goods used by the UN)
SME	Small and Medium-sized Enterprises
SMHPM	*Société mauritanienne des hydrocarbures et de patrimoine minier* (Mauritanian state-owned hydrocarbon and mining company)
SNIM	*Société nationale industrielle et minière* (Mauritanian National Industrial and Mining Company)
SO_2	Sulfur dioxide
SONATRACH	*Société nationale pour la recherche, la production, le transport, la transformation et la commercialisation des hydrocarbures* (Algerian national state-owned oil company)
SPC	Semi-Public Company
T	Tonne (metric ton)
TA	Technical Assistance
TIAM-IFPEN	Times Integrated Assessment Model-IFP Énergies nouvelles
TSM	Towards Sustainable Mining
TVET	Technical and Vocational Education and training
UAE	United Arab Emirates
UEMOA *caine*	*Union économique et monétaire ouest-afri-* (West African Economic and Monetary Union)
UMHK	*Union minière du Haut-Katanga* (Belgian mining company) (DRC)
UN	United Nations
UN	United Nations Commodity Trade Statistics
COMTRADE	Database

UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Programme
UNICEF	United Nations International Children's Emergency Fund
UNIDO	United Nations Industrial Development Organization
UNU-WIDER	United Nations University – World Institute for Development Economics Research
USD	United States dollar
USGS	United States Geological Survey
VA	Value Added
VAT	value-added tax
WCMC	World Conservation Monitoring Centre (UNEP)
WDI	World Development Indicators (World Bank database)
WGI	Worldwide Governance Indicators (World Bank)
WITS	World Integrated Trade Solution (World Bank trade software)
WRI	World Resources Institute
WTO	World Trade Organization
WWF	World Wide Fund For Nature
X	Exports
ZANU-PF	Zimbabwe African National Union – Patriotic Front (Zimbabwean political party)
ZAR	South African Rand (currency of South Africa)
ZCDC	Zimbabwe Consolidated Diamond Company
ZELA	Zimbabwe Environmental Law Association (NGO)
ZIMRA	Zimbabwe Revenue Authority
ZMF	Zimbabwe Miners Federation
ZMV	Zambian kwacha (currency of Zambia)
ZRA	Zambia Revenue Authority

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This Special Report provides a guide to the mining sector in Africa, which developed rapidly in the second half of the 2010s, and has grown again since 2020, on the back of the new metals boom. It presents an overview of the minerals and stakeholders present on the continent and analyzes the macroeconomic impact of this rapid development on exports, growth, employment, and tax revenue.

Françoise Rivière, Head of the Economy and Strategy Unit, Africa Department, AFD

Against a backdrop of great power competition, in particular over securing resources, there is a risk that some of the socioeconomic and environmental impacts specific to the mining industry will be underestimated, or even ignored altogether. This multiauthor volume presents a thorough analysis of the potential for Africa of mineral exploitation and processing, while highlighting the environmental, social, and governance issues involved.

Hélène Djoufelkit, Director of the Economic Diagnostics and Public Policy Department, Research Division, AFD

The mining sector in Africa represents an important possible source of development that does not always live up to its potential and is characterized by major disparities across the 55 countries of the African Union. This work illustrates the desire of states to have greater control over their resources in order to understand the potential of mining, control the value chain, and be able to negotiate contracts with international companies. French and European continent-wide schemes, through PanAfGeo projects, support them in doing so. Another issue tackled by the work is that of investment in Africa throughout the mining value chain, including in infrastructure and energy. When it comes to employment, this work highlights the important segment of artisanal mining, which accounts for over 90% of mining jobs.

Jean-Claude Guillaneau, PanAfGeo and AfricaMaVal Project Coordinator, General Directorate, Institutional International Relations, BRGM

Africa's vast mining resources—which represent around 30% of global deposits—have the potential to act as a driver for inclusive and sustainable growth, and for a structural transformation of the economy and the lives of those living on the continent, as set out in Agenda 2063 and in the African Union's African Mining Vision (AMV). Yet, despite major advances in terms of political reforms and strategy implementation, Africa still faces complex challenges and obstacles that are hindering the realization of these aspirations and visions. The contributors to this work highlight these various challenges, which include barriers to industrialization, employment issues in the sector, the lack of investment, and the complex aspects of taxation, revenue collection, and regional integration. With practical examples taken from the selected countries, and proposed solutions, this work could act as a guide for the African Minerals Development Centre (AMDC), which is responsible for implementing the princips of the AMV, in its quest to advance research and practical solutions for turning the continent's mineral wealth into national wealth, and for transforming the lives of Africans.

Dr. Marit Kitaw, Interim Director, AMDC, African Union

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