

ATPC

Work in Progress

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Mineral Exploitation, Environmental Sustainability and Sustainable Development in EAC, SADC and ECOWAS Regions

D.K. Twerefou



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List of Acronyms

JPOI	Johannesburg Plan of Implementation
ICMM	International Council on Metals and Mining
EITI	Extractive Industry Transparency Initiative
KPCS	Kimberly Process Certification Scheme
SDI	Spatial Development Initiative
NEPAD	New Partnership for Africa's Development
UNCTAD	United Nations Conference on Trade and Development
ALSF	African Legal Support Facility
ISG	International Study Group to Review Africa's Mining Regimes
AfDB	African Development Bank
EAC	East African Community
ASM	Artisanal and Small-Scale Mining
SADC	Southern Africa Development Cooperation
COMESA	Common Market for Eastern and Southern Africa
FDI	Foreign Direct Investment
ECOWAS	Economic Community of West African States
ECCAS	Economic Community of Central African States
UNECA	United Nations Economic Commission for Africa
WCED	World Commission of Environment and Development
SD	Sustainable Development
FAO	Food and Agriculture Organization
UNEP	United Nations Environmental Programme
EIA	Environmental Impact Assessment
EPC	Environmental Protection Council
AU	African Union
PRSP	Poverty Reduction Strategy Paper
GDP	Gross Domestic Product
REC	Regional Economic Communities
AMN	African Mining Network
AUC	African Union Commission

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Chapter 1: Introduction

1. Africa is endowed with almost all the minerals in the world today, accounting for about 59 per cent of the world's platinum; 62 per cent of its aluminum silicate; more than 50 per cent of all vanadiumites and vermiculites; more than 50 per cent of diamonds, palladia and chromites and more than 20 per cent of gold, uranium, cobalt and manganese. Half the world's reserves of chromites, diamonds, vanadiumites, manganese and gold are found in Southern Africa. Over the past five decades, most of the foreign direct investment to Africa has gone to the mining sector. Many African countries have undertaken mineral extraction through tax revenues, job creation, technology transfer and foreign exchange acquisition among other actions. These have helped the growth and development of mineral-rich countries in Africa.

2. In development literature, a country rich in natural resources should, all things being equal, be better off than one poorly endowed. The simple reason is that natural resource is a form of capital that, if well exploited, can generate wealth and thus bring about development. Unfortunately, this somehow does not seem to be the case in Africa where after over seven decades of mineral exploitation, the continent remains the poorest in the world. World Bank information indicates that about 40 per cent of Africa's inhabitants live on less than a dollar a day. Except for a few countries, the situation is the same for mineral-rich and non-mineral-rich countries. Added to this is the fact that mineral exploitation has led to pollution of almost all environmental media – air, water, land and forests - with a more serious impact on communities directly affected by mining. Though efforts are being made through legislation and policy development to address the issue, implementation is handicapped mainly by the need to create wealth from the natural resources and to distribute such wealth to ensure intra- and inter-generational equity. Also, monitoring of mining firms ensures compliance with environmental regulations and the governance of mining regimes ensures macroeconomic stability and sustainable development (ECA, 2008).

3. It is in this regard that UNECA, in promoting trade in minerals, decided to undertake this study to assess the impact of mining on African economies and the associated social, environmental and cultural challenges with a view to optimizing benefits and ensuring sustainable development. The study is specifically aimed at establishing coherent trade and environmental policies to ensure environmentally sustainable mineral exploitation.

4. The report has six sections. Coming after the present introduction is section 2, which provides an overview of mineral resources in Africa. Section 3 examines the mining industry in relation to sustainable development and section 4 discusses environmental governance in Africa. Challenges in ensuring sustainable mining is discussed in section 5 and the last section concludes the paper and makes policy recommendations.

Chapter 2: Overview of Mineral Resources in Africa

5. Africa abounds in different kinds of mineral resources, making the extractive sector the backbone of economies endowed with such resources. Appendices 1 and 2 provide the classification of minerals by UNCTAD and the mineral resources of Africa, respectively. It can therefore be concluded that Africa has all the varieties of minerals. In 2005, the African continent produced about 18 per cent and 54 per cent of the world's gold and diamond, respectively, and about 28 per cent and 78 per cent of global manganese and platinum, respectively (table 1). Furthermore, about 51 per cent and 40 per cent of world production of chrome and vanadium and about 18 per cent of global cobalt production comes from Africa. Africa is also a continent with a considerable proportion of its mineral resources unexploited. The continent holds over 55 per cent and 60 per cent of the world's gold and diamond reserves and 82 per cent and 88 per cent of global manganese and platinum reserves (table 1). In addition, about 95 per cent and 44 per cent of chrome and vanadium deposits in the world are located in Africa and about 42 per cent of global cobalt reserves are also found on the continent (UNECA and AU, 2008). Also, Africa harbours the world's reserves of 42 per cent of Bauxite, 38 per cent of Uranium, 73 per cent of palatinum, 42 per cent of Gold reserves, 88 per cent of Diamonds, and a staggering amount of non-ferrouse metals such as 44 per cent of Chromite, 82 per cent of manganese, 95 per cent of Vanadium, 55 per cent of Vanadium and 62 per cent of Aluminum.¹ Africa accounted for about 8 per cent of world gas reserves and 9 per cent of world oil reserves in 2006. These figures may have been underestimated due to limited geological survey.

Table 1: Africa as a protagonist in Mineral Resources, 2005

Minerals	Africa % of World Reserve	Africa's Rank Reserve World Production	Africa % of Production	Africa's Rank
Gold	55+%	1	18%	1
Diamond	60+%	1	54%	1
Manganese	82%	1	28%	2
Platinum	88%	1	78%	1
Chrome	95%	1	51%	1
Vanadium	44%	1	40%	1
Cobalt	42%	1	18%	1

Source: Department of Mineral and Energy, Republic of South Africa.

¹. ROAPE No. 117 2008 – Ray Bush

6. The continent of Africa also ranks first in the global production of a number of mineral resources such as gold, platinum, vanadium, cobalt, diamonds and chrome. In 2002, Africa's share of world production of bauxite and phosphate ore was about 11 per cent and 30 per cent, respectively. This figure did not change much by 2008. In addition, about 17 per cent of world uranium production occurs in the African continent with almost half of that production coming from the Niger. The leading producer of gold is South Africa followed by Ghana, and Morocco accounts for 60 per cent of Africa's production of phosphate ore. About 96 per cent of Africa's bauxite production comes from Guinea, the world's second largest producer of the commodity. In 2002, Africa was responsible for 8 per cent and 10 per cent of world's production of oil and gas, respectively. The large deposits of mineral resources in Africa indicates that the continent has a wealth of natural capital which, if exploited sustainably, could turn the continent around.

Chapter 3: Mining and Sustainable Development

7. The basic ideas and concept of 'Ecologically Sustainable Development' was popularized by the World Commission on Environment and Development (WCED) report, which came to be known in environmental circles as the Brundtland report - Our Common Future (WCED, 1987). According to the report, Sustainable Development (SD) is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The report contributed significantly to the recognition of the need to integrate economic, social and environmental concerns in development processes. The definition of SD implies that there should be intra- and inter-generational equity as stated by the Nobel Laureate Amartya Sen.

8. The next section examines the impact of mining on the economic, environmental and social development, three main pillars of sustainable development.

3.1 The Economic Impacts of Mining

9. The high position of Africa on the world mineral production rankings (particularly of gold, diamond, platinum, chrome, vanadium and cobalt) has been largely aided by mining reforms implemented in many resource-endowed countries on the continent. The increased global resource extraction since 1908 as echoed by Padoan (2008) in response to mineral reforms could largely be linked to increased mineral production in Africa. The reforms involved enactment of laws and restructuring of support institutions in the mining sector basically to reduce State participation and regulation, lower standards of operation and obligations and provide protection and incentives for transnational mining companies. Consequently, various pieces of legislation have either been radically revised or promulgated and mining sector support institutions restructured. One significant feature of the mining reforms in Africa was the liberalization of the investment climate as a fundamental means of attracting foreign direct investment.

Through liberalization, hitherto State-owned companies have been privatized. Privatization of the mines resulted in the proliferation of mining companies of foreign origin and increased the economic benefits of mining inter alia through increased export earnings, government revenue and foreign exchange earnings.

3.1.1 Contribution of Mining to Export Earnings

10. Extraction of both oil and non-oil minerals is the economic backbone of many resource-endowed countries, accounting for a considerable proportion of their foreign exchange earnings. As indicated in appendix 3, earnings from mineral export rank first in 28 countries, second in 19 countries and third in 20 countries. Details of the rankings of minerals in the export earning of various regions in Africa are contained in appendix 3. Quantitative figures on the contribution of mining to export earnings for the various regions in Africa are also contained in table 3. The table shows that the share of mineral exports in Africa's total exports increased from 10.9 per cent in 1995 to about 11.0 per cent in 1999 and further to 12 per cent in 2006. Of the subregions, SADC recorded a highly impressive performance with an increased share of mineral exports in total exports which surged significantly from 18 per cent in 1995 to 29 per cent in 2006. This impressive export performance of the SADC subregion was driven by increased mining activities in such countries as South Africa, Botswana, Zambia and Namibia.

11. South Africa as the largest gold producer in Africa recorded at least US\$16 billion from export of primary mineral products and US\$4.4 billion from export of processed minerals in 2005. Overall, the mining industry in SADC contributes about 60 per cent of foreign exchange earnings and 10 per cent of gross domestic product. The economies of Angola, Botswana, the Democratic Republic of the Congo, Namibia, South Africa, Tanzania, Zambia and Zimbabwe obtain about 22 per cent - 90 per cent of their foreign exchange directly from mineral exploitation. The other subregions' performance over the decades has been quite disappointing as the share of their mineral exports in total exports declined, with ECOWAS and ECCAS being the worst performers.

Table 2: Share of Mineral Exports in Total Exports, 1995 – 2006 (%)

Year	Africa	AMU	COMESA	ECCAS	ECOWAS	SADC
1995	10.9	3.1	11.3	14.0	11.6	18.3
1996	12.1	3.3	11.5	12.5	11.3	22.6
1997	11.1	3.2	11.4	13.0	9.6	21.9
1998	10.5	4.6	16.3	14.5	9.5	17.8
1999	11.0	2.9	9.4	13.5	5.5	24.9
2000	9.1	2.1	7.1	9.8	4.9	19.8
2001	13.0	2.3	8.6	10.8	7.1	29.1
2002	10.9	2.5	10.8	10.6	7.0	23.8
2003	11.6	2.0	8.4	9.3	6.2	26.5
2004	11.5	2.1	8.8	8.5	3.6	27.3
2005	10.8	2.1	7.9	6.9	4.9	26.7
2006	12.0	2.4	9.6	5.6	5.8	29.1

Source: UNCTAD (2009).

12. Table 2 aggregates mining contribution to the exports of both resource-rich and non-resource-rich countries in Africa. Disaggregated figures on only resource-rich countries in Africa would have shown a significant contribution of mining to total exports. For example, the contribution of mining to export earnings averaged about 40 per cent of total exports in the 1990s in Ghana. The corresponding figures for Angola, Botswana, Namibia, South Africa and Zambia are 43.2 per cent, 37.7 per cent, 16.3 per cent, 6.5 per cent and 6.1, respectively.

13. Mining contributes significantly to foreign exchange earnings in gross terms but its contribution in net terms might not be that significant given the generous incentives offered to mining firms, especially in an attempt to retain part of sales earnings from mineral products in foreign accounts. Specifically, lease holders are permitted by many fiscal regimes to retain a minimum of 75 per cent of their mineral proceeds in offshore accounts for the acquisition of machinery, equipment, spare parts, raw materials, debt servicing, dividend payments and remittances for expatriate staff. This has enabled many mining companies to retain most of their earnings in offshore accounts, leaving very little in local accounts to cover local operating costs. The little left for local purchases in real terms could be very minimal in some countries since the import content of local purchases such as petroleum products, explosives and other goods are not taken into account. Thus, while mining contributes substantially to gross foreign exchange, the real benefits accruing to the nation may be very little.

3.1.2 Contribution of Mining to Government Revenue

14. The mining sector reforms of the 1990s included enhancement of the fiscal regime. By the end of 1995, about thirty-five African countries had revised their mining codes and enhanced incentives for mining investors. Competition among developing countries for foreign investment in the mining sector in the wake of the reforms saw the Governments of many resource-endowed African countries scaling down corporate income tax liabilities and royalty rates and providing more specific fiscal allowances aimed at reducing the general tax liabilities of mining sector operators. Other duties such as mineral duties, import duties and foreign exchange tax that prevailed and contributed significantly to Government revenue were either reduced or completely scrapped. In Ghana, for instance, as part of measures to attract foreign investment in the mining sector in the 1990s, the Government provided generous tax incentives for foreign investors. These included reduction in corporate income tax, royalty rates, mineral duties and foreign exchange tax. Initial capital allowance to enable investors to recoup their capital expenditure was also increased.

15. To some extent these created a conducive atmosphere by easing the industry's access to deposits, financial mobility and the capacity to produce at a profit. Consequently, mining industries were able to operate effectively and to contribute to government revenue through reduced corporate income tax, personal income tax of mine workers, mineral royalties and increased dividends. On the average mining contributed about 12.1 per cent of government revenue from 1990 to 2004 in Ghana, about 48.3 per cent from the 1998/1999 to the 2008/2009 fiscal year in Botswana. The high contribution of mining revenue to total revenue in Botswana is due to the high value addition to diamonds. Apart from countries such as Namibia, Botswana and South Africa which have added value to their primary products and the oil-producing countries, the contribution of many mineral-resource-rich countries in sub-Saharan Africa to government revenue is less than 15 per cent.

16. The perception is that government revenue from mining in many African countries is not fully optimized as a result of the generous fiscal incentives. According to Campbell (2003), legal and fiscal frameworks intended to create a favourable investment environment were provided at the expense of States' capacity to raise revenue and thus hampered development. One major problem with mining revenue for many Governments is its volatility which largely results from declining prices of mineral products, particularly gold, in the world market.

3.1.3 FDI Inflows

17. Foreign direct investment (FDI) was considered the main driving force for the mining industry's liberalization in Africa. The sector has been a major source of FDI over the years, accounting for about 65 per cent of all FDIs in Africa in the 1990s. FDI inflows into the continent increased from a modest \$11 billion in the 1970s to \$80 billion in the 1980s and leaped further to \$100 billion in the 1990s. In

Ghana the share of mining in total FDI averaged 67.7 per cent from 1996 to 2006 but in Zambia the figure was 22.1 per cent from 2002 to 2006.

Table3: Share of Mining in Total FDI

Year	Mining (Millions of \$US)	Total (Millions of \$US)	Share of mining (%)
2002	6,900,000	20,841,997	33.1
2003	656,766	2,941,416	22.3
2004	2,362,133	14,026,245	16.8
2007	25,000,000	293,353,300	8.5
2008	5,000,000	16,860,000	29.7

Source: Compiled with data from the Zambia Development Agency.

18. In many African countries, FDI inflows came along with the establishment of large-scale mining companies employing capital-intensive methods with minimal labour requirement. The proliferation of these large mining companies and procurement of large sites with their crowding out of small-scale indigenous mines have caused some disaffection in many mining communities.

3.1.4 Employment

19. The contribution of mining to employment generation is mixed and mostly marginal. While real incomes in the mining sector appear to be higher than the national average in many countries, the overall employment impact is limited compared to other sectors such as industry, services and agriculture due mainly to the capital-intensive nature of mining operations.

20. In SADC, for example, the mining industry contributes about 5 per cent of employment. In South Africa, mining employs 443,300 people, 36 per cent of which in gold mines; Diamond 5 per cent; PGM 35 per cent; Coal 13 per cent; others 11 per cent (Mabuza, 2008). In Zambia, growth in the mining industry has brought about a substantial increase in employment from both mining and mining-related activities. Formal sector employment (in the mining sector) increased by over 30 per cent during 2001-2006. In Ghana, data on direct employment in the mining sector shows that employment in the sector decreased from about 22,285 in 1995 to about 14,311 in 2002 but later increased to about 20,000 in 2008. Majority of the employees, about 95 per cent are in gold mining. In spite of the massive injection of capital into the mining sector in Ghana, it accounts for only 5 per cent of formal sector employment.

21. While increased FDI inflows into Africa and the growing effect on mineral export and foreign exchange earnings have been hailed as a success of mining reforms, many have questioned the employment-

generation effect of mining activities in Africa. The contribution to employment-generation in large-scale mines is relatively low mainly as a result of the capital-intensive nature of the industry. Many post-reform mining projects in Africa are surface operations which have relatively limited capacity to generate employment. Mining also displaces a large population and denies them access to land, an important employment security for rural people. Indeed, some have argued that the net employment effect of mining is negative given the massive displacement of small miners to marginal sites as well as the abandonment of agriculture as a source of livelihood by many rural communities. The employment potential of the mining sector could be beneficially exploited if policies are drawn up to encourage forward and backward linkages that have the potential to create jobs.

22. Mining brings many other economic benefits such as the development of infrastructure, which continues to be a major problem in most African countries. Many mining companies have, as part of their corporate social responsibility, provided infrastructure to support community development and, in some cases, have negotiated with communities on benefits. Indeed, road and rail links must often be established, water and power provided, and the 'human' infrastructure improved through the provision of medical and education facilities for efficient mining operations to take place. In Ghana, for instance, AngloGold-Ashanti has invested in sporting facilities including a sports stadium and Goldfield Ghana limited was the main sponsor of the Ghana national team in the 2006 Football World Cup in Germany and is continuing support for the team for the South Africa 2010 Football World Cup. In South Africa, the mining industry, as part of its selected pillars of economic growth, invested in the 2010 World Cup in that country through additional infrastructure to drive and sustain economic growth. In the Copperbelt of Zambia many infrastructure has been developed by mining companies for the use of mining communities. Similar examples can be found in almost all mining communities in Africa.

23. In a nutshell, mining has generated considerable revenue to nations in terms of FDI inflow, export earnings and contribution to government revenue. Increases in FDI inflow and export earnings have led to an increase in trade and has made available foreign exchange needed to import capital and service foreign debts. However, the sector can further increase the economic benefits if value is added to its product.

3.2 Impacts of Mining on the Physical Environment

24. Although mining provides a variety of socio-economic benefits, its environmental and social costs, if not well handled, can be massive in terms of land conversion and degradation, habitat alteration and water and air pollution. In Africa, the mining sector is generally thought to be the second largest source of pollution after agriculture. The sector is resource intensive and generates high concentrations of waste and effluents. For example Kuhndt et al (2008) argue that during the extraction process up to smelting, a ton of copper generates about:

- 100-350 tons of residues
- 50-250 tons of extraction waste
- 30-100 GJ of energy
- 200-900 m³ of mineral dressing waste and slag; and
- Up to 300 kg of sulphur dioxide

25. The best way to assess environmental impact is probably the use of money values and market prices. Unfortunately, such an approach while possible in theory is very difficult in practice due to distortions in prices and market imperfections. In developing economies, especially in Africa, market prices are even more distorted with the extremely uneven distribution of wealth and access to resources. Also, the irreversible losses due to use or misuse of resources are difficult to quantify in monetary terms. The problems of valuation are aggravated by the lack or limited knowledge of the interrelationships between the various biological elements and with the ecosystem, and how economies interact with the environmental system (Norgaard, 1989). For these and other problems analysis of the environmental impacts of mining will center more on the qualitative aspects.

26. Mining, from the exploration to the closing stage, has a serious impact on the environment. This impact can be direct through the value chain activities - prospecting; exploration; site development; ore extraction; mineral dressing; smelting; refining/metallurgy; transportation; post-mining activities and indirectly through the impact of the degradation on the socio-cultural development of communities. In general, degradation arising from mining includes air pollution; discharge into surface and ground water; land and forest degradation; noise pollution; solid and liquid waste disposal; generation, storage, transportation and disposal of toxic substances as well as social-cultural problems such as health, conflicts, alcoholism and inequality. All these have negative implications for sustainable development and various livelihoods and, therefore, require urgent attention. Details on the environmental impacts follow.

3.2.1 Air Pollution

27. Various activities in the minerals value chain produce gases that pollute the environment. Many mines transport the ore to the processing site and use a lot of fossil fuel in the production process. The combustion of fossil fuels generates sulfuric, carbonic and nitric acids and other volatile organic compounds and heavy metals that pollute the environment. These gaseous compounds combine with water in the atmosphere and come back to the earth in the form of acid rain which can destroy natural and built-up areas, especially materials made from marble and limestone such as monuments. Fossil fuels too contain radioactive materials, mainly uranium and thorium that are released into the atmosphere. In 2000, about 12,000 metric tons of thorium and 5,000 metric tons of uranium were released worldwide from burning coal some of which were due to extraction activities. Also, coal gasification and combustion in

underground mining pollutes the atmosphere and the aluminum smelting and refining process produces effluents such as sulphur dioxide, slugs and chemicals. They also generate hydrogen fluoride (HF) in the molten electrolyte process.

28. Though the use of fuelwood in mining has been abandoned in many mines, its use in the past generated a lot of gaseous compounds that polluted the atmosphere. Kojwang (2000) reports that until the introduction of coal in about the year 2000 the mining industry in Namibia consumed about 24,000 tons of charcoal yearly. The release of these gases has an immense adverse impact on mining communities. In Zambia for example, Mufulira in Kitwe is an area of intense sulphur dioxide plume covering approximately 12,000 hectares. The air is heavily polluted in this area which barely supports vegetation growth. The mentioned impact is either localized or national in nature. The most important impact of this gas release is climate change which is the average change in weather experienced by a region over a long period of time. This well-documented impact is enormous and far reaching hence the importance of reducing gaseous pollutants caused by mining.

3.2.2 Water Pollution

29. According to the South African Department of Environment and Tourism in 2008, the potential impact of mining on the water environment depends on the phases of mining activity, namely:

- (a) The act of mining itself;
- (b) Seepage of contaminated water from mine residue deposits resulting from mineral processing/beneficiation;
- (c) Dewatering of active mining operations; and
- (d) Flooding of closed mine voids and discharge of untreated mine water.

30. Many mining companies practice the heap leach method of gold beneficiation which could contaminate ground water while the use of mercury by small-scale miners contaminates surface water. Also, in underground mines, water pollution results from in-situ leaching due to leakage into aquifers and discharge of wastewater. These are serious chemical pollution affecting mining communities. In addition to this, run-offs of sodium cyanide from leach pads may contaminate local streams used by mining communities while leakage of cyanide gold-bearing solution through the heaps pollutes ground water. In order to reduce cyanide pollution, High Density Polythene (HDPE) is used to prevent cyanide leakage. However, Acquah (1993) shows that HDPE is vulnerable to seepage due to pinhole leaks and poor seaming techniques.

31. Accidental burst of tailings dam also tends to pollute local rivers and streams used by mining communities. In Tarkwa in the Wassa West District of Ghana the accidental burst of a tailing dam in 2001 led to the release of thousands of cubic metres of mine waste into the Asuman River contaminating

it with cyanide and heavy metals. Since this river is the main source of drinking water for the community about a thousand people were deprived of drinking water and many aquatic lives, including fishes and crabs, were lost.

32. Water pollution through effluence discharge of mine waste, tailings and the dredging and sluicing into surface water is a major environmental concern. Dzigbodi – Adjimah (1996) contends that in Ghana fishes have disappeared from the Ankobra River along the stretch from Prestea to the coast and the Offin River along the stretch from Dunkwa to the coast and that the rivers are silting up. This, he attributes mainly to the discharge of mine tailings and pollution resulting from dredging and sluicing operations. A study in the Kerio valley in Kenya revealed the presence of high levels of iron in the river and its environs. The Kerio River water had 0.883 parts per million (ppm) of iron, which is about three times the World Health Organization (WHO) recommended value of 0.3ppm. The levels of fluoride and heavy metals emitted into the environment from Fluorspar Mining Plant in Kerio Valley were also high. Furthermore, in the Copperbelt of Zambia effluent from the mines ends up in the Kafue River, a source of drinking water for about 40 per cent of that country's population.

33. Small-scale mining activities pollute rivers and streams by discharging solid suspension and mercury during sluicing and amalgamation. This leads to siltation, coloration and chemical pollution of streams and rivers that provide drinking water for mining communities (Aryee et al, 2002). Unfortunately, many of the small-scale mines are not well regulated and, in some countries, not registered to enable the authorities to monitor their activities. Shoko (2002) states that in Mozambique, Tanzania and Zimbabwe gold mining using mercury is a serious threat to water quality.

34. Acid mine drainage is also a major environmental problem in mining communities. Acid rain drainage results from various activities, including the oxidation of waste rock containing sulphide used in road construction in mining areas. Acid mine drainage tends to degrade soils, pollute aquatic habitats and allow heavy metals to seep into the environment. Many countries, including Ghana, South Africa, Zambia and Zimbabwe, have either reported cases of acid mine drainage or the susceptibility of their mine environments to it. Boocock (2002) highlights the problem of acid mine drainage caused by abandoned coal and gold mines in South Africa. Information from the South African Department of Environment and Tourism (2008) indicates that until the completion of storage and pumping facilities in early 2008 to contain and manage an average of 15 mega-litres a day (MUD) of decant, acid mine drainage from mine shafts found its way into a natural water course and flowed through a game reserve towards the Cradle of Humankind World Heritage Site. One serious environmental characteristic of acid mine drainage is its stiff resistance which makes it very expensive to clean up. Boocock (2002) reports that in the United States the cost of remediation of acid mine drainage, which affects some 20,000 km of watercourses, was estimated at \$2 billion-\$35 billion in 1998.

35. Water used by many mines is either from rivers, lakes, underground workings or boreholes and although mostly renewable, the mine's water requirements sometimes exceed availability provoking

conflicts with other users. For, example aquifer dewatering largely attributable to surface mining in the Tarkwa mining enclave in Ghana, characterized by the excavation of vast lands and the creation of large craters, reduce the ability of boreholes, streams and hand-dug wells to recharge, leaving most of them unproductive or with reduced yields (Akabzaa, 2000). In the Copperbelt of Zambia, the competing demand by the mining industry and the mining community for natural resource use, especially water, energy and food has led to the unsustainable use of water resources (Makumba, 2007).

36. Mining in coastal areas also affects that environment. In Namibia and Western South Africa, diamond mining in coastal sand dunes and dredging inshore seabed sediments generate about a million carats of diamonds a year but seriously affects the coastal environment in several ways. Many coral reefs are affected by pressures from population growth, coastal development and marine-transported litter. Winning of sand and coral for construction purposes is also damaging coastal habitats and the environment although many States have established stricter legislation and licensing. In Sao Tome, sand winning and coastal erosion are reportedly threatening coastal infrastructure and environment in the southern part of the main island.

37. Mining activities use large quantities of water and pollute the environment by releasing effluent and chemicals into water bodies and underground water. This reduces the quality and quantity of fresh water resources available for use and, in some countries, has reduced the availability of water for local communities. If this continues the mining industry could deplete available resources and increase water scarcity in the near future.

3.2.3 Land Degradation

38. Evidently, a vast majority of the rural poor in Africa earn their livelihood directly from the rich natural resources – land and forests - through farming, hunting and related activities. Mining, both small and large scale, degrades lands and forests and destroys the vegetation, including economic timber species and the ability of natural forest to regenerate. It also renders the land unproductive by removing the top soil and doing other damage. In terms of land degradation, mining activities cover vast areas through:

- (a) Prospecting/exploration activities, including pits and trenches;
- (b) Mine site surface facilities, including mine surface excavations and amenity buildings;
- (c) Processing plants, storage sheds, dumps and dams, and residential/commercial areas;
- (d) Water and sewage treatment plants;
- (e) Refuse disposal sites;
- (f) Power line access ways; and
- (g) Access roads and railways.

39. At the exploration stage, removal of vegetation for survey lines; soil erosion resulting from tracks created by vehicles; spillage and leakage of fuels, oils and drilling fluids which pollutes soils and water bodies; sewage disposal and heavy metal and sediment drainage from waste rock dumps seriously pollute the environment. Surface mining, widely practiced today, disfigures the topography and surface drainage leads to deforestation and soil erosion, dust generation, long-term compaction, subsidence and reduced agricultural productivity. Also, underground mining leads to land subsidence caused by the removal of underground material without backfill.

40. Mineral dressing processes produce effluent, tailing dumps and ponds which occupy large land surfaces. These tailing dumps and ponds usually contain heavy metals and other chemicals such as cyanide and thiosalts highly likely to degrade land and water bodies. Many African countries do not collect data on tailing dumps from mining, making it difficult to know the actual area in Africa covered by tailings. A report by the South African Environmental Affairs and Tourism Department (2005) indicate that in 1997 about 471 million metric tons of mine waste, slime dams and waste rock dumps covering about 47,000 hectares were generated and that over 200,000 hectares of natural habitat were transformed by mining activities. The situation is similar in the Copperbelt of Zambia. Over time, the mining industry in Zambia has accumulated about 32 overburden dumps containing about 1,899 million metric tons of overburden and covering an area of about 206,465 hectares. Also, there are about 21 waste rock dumps containing about 77 million metric tons of rocks and covering an area of about 388 hectares. Furthermore, there are about 45 dumps/dams containing about 791 million metric tons of tailings, and covering an area of approximately 9,125 hectares (Sikaundi, 2008).

41. Waste dumps and ore stockpiles can also cause land sterilization and the destruction of a series of ridges, the building up of heaps of mine dumps and the creation of waste ponds lead to the destruction of beautiful and valueless sceneries. In South Africa for example, more than 50,000 tons of salts seep out of tailing dams in the Vaal region yearly. This seepage contaminates water, soil and vegetation in these communities. Though little information is available on land use in these areas, it is most likely that these lands are unsuitable for food crop cultivation.

42. Many mining companies construct rail and road ways to mining sites and sometimes through isolated areas. The construction and usage of rail and road ways depending on traffic density and types of users could have considerable effect on wildlife. Road and rail ways built through isolated and protected areas could drastically affect game animals such as lechwe, impala or warthog, in that it exposes these animals to hunters and fishes in rivers become more accessible to commercial and sports fishermen. In some cases mining in or near aquifer rocks has caused water problems and earthquakes. For example, in South Africa mines located in or near the dolomitic rocks of the Transvaal Sequence, an important aquifer, pose a threat to communities around the area since they rely on it for their water supplies. Large-scale mining in Gauteng and surroundings, for instance, has resulted in subsidence in the dolomite rock causing localized sinkholes and earthquakes (Department of Environment and Tourism, 2008).

43. Stagnant and effluent pools left behind constitute a danger to wildlife and humans and will remain unproductive for vegetation growth for several years and the excavation of open pits causes disfigurement and dereliction of land, making the spoils very inhospitable to vegetation growth (Tuffour, 1997).

44. Mining activities, especially in underground mines and using the caving mining methods, have generated inaccessible hazardous lands vulnerable to subsidence. For example, Zambia lost about 89 people in 1970 in a caving-related accident. Furthermore, in South Africa small waste coal dumps cause both pollution and safety problems, as waste coal may spontaneously ignite (Sinkala, 2009).

3.2.4 Forest Degradation

45. Africa covers an area of about 2,978 million square miles about 21.8 per cent of which is made up of forest, about 16.8 per cent of the global forest cover. With a net loss of about 4.0 million hectares a year, Africa is the continent with the second largest net loss in forest cover. Nigeria and the Sudan were the two largest countries with the highest loss in natural forest during the period 2000-2005 largely as a result of subsistence agriculture (FAO, 2007).

46. Almost all mining activities result in the destruction and degradation of forest resources. Land clearance for construction in mine sites leads to forest degradation and soil erosion, causing sediment loading in water bodies and the non-protection of watersheds. Deforestation also causes a reduction of carbon sequestration and the resulting effect of global warming and climate change. Destruction of entire forests as a result of surface mining and the use of wood as support in some mines have caused a substantial reduction in fuel wood and charcoal, which many of our rural folk depend on for their energy requirements. Sinkala (2009) argue that the destruction of vegetative cover in sensitive water catchment areas and forests in the Lamba Water Catchment area in the Copperbelt Province of Zambia due to peri-urban expansion caused by existing mining activities is an example of land and forest degradation.

47. Unplanned and uncontrolled urbanization in mining areas stimulates unsustainable use of forest and non-forest products and has led to the exploitation of these resources beyond allowable limits. A study by Limpitlaw (2004) has revealed that with a population of at least one million people in the Zambian Copperbelt, charcoal demand is about 36,500 tons a year. This translates to about 3,400 hectares of woodland a year.

48. Efforts are under way to address the deforestation problem. According to FAO (2007), a number of countries have stepped up afforestation of degraded areas for soil conservation; established windbreaks and shelterbelts to protect agriculture areas; stabilized sand dunes; and stepped up urban and peri-urban planting of trees to improve amenity services. In the mining sector to be specific, some mining companies have carried out land rehabilitation and revegetation in an attempt to reduce the long-term environmental

effects of land and forest degradation. However, many mining companies are yet to adopt the method even though it can be done with very little addition to cost.

3.2.5 Chemical pollution

49. Large-scale mining generally produces large volumes of waste and chemical pollutants. These may cover vast tracts of land and can have devastating effects on ecosystems. Hazardous chemicals used in the mining sector include heavy metal and mercury. These and chemicals, when not properly managed during production, transportation, application, storage and disposal can contaminate water and soils, a very important habitat for aquatic life and can enter the human food chain with deadly consequences (UNEP, 2006).

50. Mercury which is mainly used in gold extraction, especially in small-scale gold mining, is a poisonous substance whose toxic effects could damage the brain, kidney, lungs and other vital organs. The problem with mercury is its long life of about 30 years from the time of immersion. In 2005 about 3,439 metric tons of mercury was used in the world of which, 29 per cent was attributed to gold extraction by small-scale mining worldwide. The mercury emission map of Africa indicates that mercury emissions are concentrated in the mineral belts of Africa, stretching from South Africa through Central to West Africa, and then North Africa with the highest concentration in South Africa, Zimbabwe, the Democratic Republic of the Congo, Nigeria, Ghana and Algeria.

51. Many studies demonstrate the existence of mercury poisoning in Africa. A study by UNEP (2006) on small-scale miners in the Insiza District of Zimbabwe identified symptoms characteristic of mercury poisoning. Of those sampled, 60 per cent had general body weaknesses, 55 per cent had nausea symptoms, 50 per cent had lost teeth and 45 per cent had a history of respiratory diseases. A study by Ikingura et al (1997) on gold ore tailings in Tanzania revealed high mercury concentrations of about 31.15 mg/kg, with an average concentration of 10.27 mg/kg. According to Manu et al (2007) this indicates that a significant amount of mercury is left in the tailings after the amalgamation process. Studies by Manu et al (2007) in Obuasi, Ghana, reveal very high concentrations of metals in tailing dumps. There, the arsenic content of soils was about 2,409 mg/kg and that of mercury 22.2-to 44.0 mg/kg. These values are by far greater than the natural concentrations of mercury in soil systems in the area. In general, mercury pollution and land degradation are reported in almost all small-scale gold mining areas in West Africa, East Africa and Southern Africa.

52. Mineral extraction is also associated with various toxic chemicals that are harmful to health. Toxic substances such as arsenic, cadmium, lead and sulphuric acid contaminate water and soil, and affect human health. Also, heavy metals pose serious threats, particularly to both born and unborn babies. The concentration of fluoride and heavy metals in soils, plants and water in the vicinity of fluorspar mining

and processing in the Kerio valley in Kenya has been found to be mainly due to the discharge into the river by the mining company (Redorbit, 2006). A study at the Migori gold belt of Kenya by Ogola et al (2002) found the following high levels of tailings: Lead - 510 mg/kg, Arsenic - 76.0 mg/kg and Mercury -1920 mg/kg. In stream sediments, the levels of these metals were: lead - 11,075 mg/kg, Arsenic - 1.87 mg/kg and Mercury 348 mg/kg. These values were above the background levels of these metals in the soil systems in the area.

53. A report by UNEP (2006) has established that the town of Kabwe, Zambia, faces a serious problem of lead and zinc poisoning from former mining activities due to poor pollution control. In Liberia, the mining settlements of Iraq and Baghdad, the lack of regulation for small-scale miners has resulted in the discharge of large amounts of suspended solids into watercourses, and the release of large amounts of mercury into the environment (SDI, 2005). In some communities, chemical containers from mining companies are often re-used by households to fetch water resulting in poisoning. Although about 11 million poisoning cases occur yearly in Africa, very few African countries have poisoning treatment centres.

54. On-shore and off-shore petroleum exploration and exploitation also cause serious pollution of the coastal environment. A study by Nsikak et al (2007) on the quality of seafood resources and sediments of the Qua Iboe river mangrove swamps reveal serious pollution due to offshore petroleum activities such as - solid waste dumps and incessant oil spills on the biotic resources and overall ecological perturbations. Analysis of petroleum hydrocarbons and heavy metal loads reveal that mean metal levels in benthic sediments are higher during the wet season than the dry season together with the overall average concentrations. In general, the levels of heavy metals and total petroleum hydrocarbons (TPH) in the estuary were high compared to similar ecosystems in the rest of the world.

55. Unfortunately, research to ascertain the impact of this chemical pollution on humans is not being given the required attention. Studies need to be conducted on the impact of chemical pollution especially by testing crop fields on which tailings have been discarded for heavy metals as these metals may become bio-available with time and enter the food chain.

3.3 Social Impacts of Mining

56. Mineral extraction does not only directly affect the biophysical environment of rural communities but also indirectly affects the socio-economic and socio-cultural environment of communities as well. Such social impacts range from health, conflicts, problems related to drug use and alcoholism and other social vices like robbery and divorce.

3.3.1 Health

57. The flow of liquid and gaseous pollutants into the environment poses health and safety risks for those living in and near it. These pollutants include air pollution due to emissions such as sulphur dioxide from processing plants, run-offs from mine processes and leakages from rock and tailing dumps that contain various elements and chemicals detrimental to human health. Inhaling large amounts of siliceous dust and sharing poor quality air in the mines are some of the major causes of health hazards among miners. Gold mining activities usually produce silica-rich respirable dust particles that can cause silicosis and tuberculosis as well as aggravate the situation of people with respiratory diseases such as asthma. In areas where surface mining and small-scale mining are practiced, vector-borne diseases such as malaria and schistosomiasis are common. This is largely due to the stagnant ponds which are breeding grounds for mosquitoes.

58. Gold mining, especially by small-scale miners, poses a serious health risk to the miners and the community in which they operate. It is estimated that gold panners use about six tons of mercury yearly. With about half of the mercury lost through the amalgamation process and careless handling, it could be one of the serious chemicals that pose health risk to mining communities. This becomes even more serious when panners dilute the mercury with water to increase quantities. Mixed with water, mercury becomes very detrimental to human beings and plants.

3.3.2 Conflicts

59. One result of openness in the mining sector is the rampant social conflict that exists in mining communities. The widespread discontent in those communities is the result of their total or partial alienation from actively taking part in decisions affecting them believing falsely that planners or policymakers know best. Many mining communities feel cheated by not taking part in decisions affecting their livelihood or not benefiting adequately from their “God given” natural resource on which their livelihoods depend. As a result, some mining communities resort to legal and non-legal actions in their bid for self-determination and the control of their own resources. These conflicts have resulted in the destruction of property and in death and have seriously affected livelihoods in some mining communities. In fact, many of the wars that plagued Africa in the 1980s and 1990s – Sierra Leone, Liberia, Guinea, the Democratic Republic of the Congo as well as the current strife in the Niger Delta in Nigeria, to mention but a few, could be wholly or partly attributed to non-transparent and unequal mineral wealth distribution. Conflicts in mining communities arise from four main issues - distribution of royalties, land use, resettlement and the survival of small-scale mines.

60. Conflicts on Royalties: Mineral resources development in any country is regarded as an “enclave” activity, in that, it and its impact are primarily restricted to the immediate area of operation while the benefits, primarily tax revenues, accrue to the national government. To resolve this problem some countries have established Minerals Development Fund to recycle some of the mineral royalties to support local

development. For example, in Ghana the Government has established the Minerals Development Fund by an act of parliament. In other countries, communities have been given the right to negotiate for benefits with the mining companies through their leaders. Dissatisfaction among various factions on the distribution of the fund and/or benefits has resulted in internal conflicts.

Box 1: Conflict on mineral royalties in Ghana

In 1992 the Ghanaian Government established the Minerals Development Fund (MDF) from mineral royalties. The aim was to recycle 20 per cent of all mineral royalties to support mining communities, mining sector institutions and to address specific issues caused by mining. Of this amount 50 per cent goes to support mining sector institutions and to address specific problems caused by mining activities; 10 per cent goes to cover administrative expenses of the Office of the Administrator of Stool Lands (OASL), and the remaining 40 per cent is shared among Stool Lands Traditional Authorities and the District Assembly in the ratio of 25, 20 and 55 per cent, respectively, as dictated by Article 267 (6) of the 1992 constitution and section 8 of Act 48.

The District Assemblies, which received a substantial part of this amount, treat it as part of their traditional source of revenue and therefore use it on the entire district instead of the affected communities. It is also alleged that chiefs who are custodians of the land usually treat these funds as their personal property and fail to use it in the interest of the communities. This has resulted in confrontations and conflicts between the communities and the District Assemblies on the one hand and the communities and their chiefs on the other.

61. Many extractive companies have been criticized for their use of mercenaries, warlords and corruption to gain access to lucrative oil and mineral deposits. This has resulted in a well-documented history of intrigue and abuse in Africa (Drohan, 2003; Moody, Hochschild, 1998). The growing illicit trade in mineral resources, particularly diamonds, was said to have contributed to conflicts in Sierra Leone and the Democratic Republic of the Congo (DRC). Some skeptics have even argued that developing countries with large mining sectors are found to have less resilient and diversified economies and are generally economically worse off than countries without large mining sectors (Ross, 2001 in Weitzner, 2002).

62. In response, several agencies have made efforts to clean up the industry's reputation, by establishing a voluntary regulatory framework for mining activities that include codes of conduct, certification regimes and other measures aimed at enhancing corporate social responsibility in addition to the already existing body of rights and duties to which corporations are informally bound, including a series of UN

conventions and agreements, as well as the anti-corruption and anti-bribery measures and non-binding Principles of Corporate Governance of the OECD (International Peace Academy, 2002). One such effort is the Kimberley Process Certification Scheme, which, in effect since 2003, aimed at ending the illicit trade in diamonds through a process of certification of rough diamonds by the country of origin.

63. Land Use Conflicts: Improved surface-mining technologies have made mining of low-grade ores possible. Large tracts of land, which hitherto were used as farmlands, have now been leased to mining companies as a result of the new technology. Mining concessions are usually very large though less than 50 per cent are used for actual mining. The remaining land is usually used as dumps, workshops, warehouses and other facilities. This deprives the affected communities from having access to land for agriculture and other economic activities on which their livelihoods depend. In some cases, local inhabitants need permission to farm on their lands under concession and crops grown are mostly restricted to seasonal crops, thus limiting the ability of the communities to grow perennial crops with high economic returns. This has resulted in land use conflicts between mining companies and the communities. Non-availability of land in mining communities coupled with underdeveloped property rights has also resulted in serious conflicts among inhabitants of some communities.

64. Resettlement: Large-scale open-pit mining by some companies sometimes requires relocation and resettlement of the communities to be affected. For example in the Tarkwa area, a total of 14 communities involving 30 thousand inhabitants were either relocated or resettled during 1990 - 1998 (Akabzaa, 2000). Obviously, the movement of a whole settlement from one place to another will affect their socio-economic structure if adequate measures are not taken to ensure proper re-settlement of affected families. Change is not an easy exercise, especially when it is involuntary. Many criticisms have been associated with resettlement and relocation programmes in mining communities. Though some of them are mere criticisms, others are real, genuine and require attention (Aubynn, 2002).

65. One major problem associated with resettlement and compensation payment is the valuation of property, for compensation, especially buildings to be affected by mining. While some of the companies prefer using the market value of houses which are low because they are made of sandcrete or wattle with raffia leaves, rural communities prefer the user values of their property which amounts to the provision of bedroom for bedroom in the case of resettlements. Also, the problem of providing alternative farmlands for farming which is the main economic activity of mining communities makes livelihood difficult. There are also instances where farmers have received significant compensations to settle themselves but fail to do so and resort to legal and civil agitation for more compensation, sometimes characterized by violent confrontation with mining firms (Tsekpo, 2002). All these have resulted in suspicions between government officials and communities and between the chiefs and their people, and have rendered the negotiation and implementation of resettlement and relocation schemes very costly to both companies and communities. In Ghana for example, the resettlement schemes of the Damang and Kyekyewere villages in the western region of Ghana by the Abooso Gold Limited and the GFL, respectively, provides

good examples of sustainable resettlement schemes, while that of TGL and Ghana Australia Gold has left much to be desired.

66. **Survival of Small-Scale Mining:** In many countries, prior to the privatization of mining companies, small-scale mining though illegal in some countries at that time existed peacefully with the State-owned mines. For example, in Ghana the State Gold Mining Corporations in Tarkwa had a special arrangement with small-scale miners under which portions of their concessions were given to them for mining. In return, the small-scale operators sold their products to the mines at a special price. Restructuring of the mining sector which resulted in de-emphasis of government interest in mining in the mid-1980s and cost cutting measures adopted by the privatized mining companies resulted in large-scale retrenchment. Since these people have no other source of livelihood apart from mining, many of them resorted to mining in concessions of the large mines since most of the prospective land, especially for gold mining, has been given to the large-scale mining companies.

3.3.3 Other Social Impacts

67. There are many other social impacts of mining. Influx of both locals and expatriates into mining areas without their spouses has fostered prostitution in such areas. In some cases, women who go to the mining areas with the objective of securing jobs as a result of the booming local economy resort to prostitution on knowing that such jobs do not exist, and resident women with no husbands and no support from any quarters practice prostitution to sustain themselves and their children. As a result STDs and HIV are common in mining areas with the attendant socio-cultural impacts.

68. Drug use among workers, especially those in small-scale mining is on the increase as many of them believe that drugs such as cocaine and marijuana stimulate and help them to do the daunting and difficult jobs they found themselves in. Unfortunately, it is common to see some of them overusing drugs and causing problems in the community and in their families. Long hours of shift work in the mines have resulted in family dislocation and disintegration as well as musculo-skeletal disorders and alcoholism (Forson, 2002). Unfortunately, although medical tests are conducted before employment is offered in many mining companies, many of them do not conduct periodic or exit medical examinations to ascertain the health of their workers.

69. Migration into mining communities and reduction in agricultural activities, largely attributable to large-scale mining has resulted in high food prices and rent for local inhabitants, especially those not working with the mines. Traders have also taken advantage of the high-income inequality² in mining towns attributable to the differences in incomes in mining areas to price their commodities high and to favour those with high incomes. These, among others, have somehow reduced the standard of living

² There exists a high income disparity between mine workers and those working in the government and informal sectors because the wages of most mine workers are high and in some cases indexed to the dollar.

of rural folks not working in the mines, rendering them more susceptible and vulnerable to poverty. Resettlement of communities and loss of farmlands as a result of mining disrupt economic activities of communities and cause unemployment since mining, especially surface mining, is capital intensive and requires skilled labour, which many rural communities do not have.

70. Noise disturbance and vibrations caused by blasting of rocks in mining areas lead to cracks in buildings. Also, crushers in mine sites and noise generated from traffic movements to and from the mining site is a great nuisance to mining communities (Andoh, 2002). Blast-related noise remains high in some mining areas and continues to be a nuisance to mining communities. According to Tsidzi and Adofo (1993) noise in mining areas interfere with human activities such as sleep, speech and hearing as well as stress-related diseases like hypertension. Continuous compressed air drilling, transport haulage and blasting produce high noise of the order 100-110 which can cause deafness, and light and illumination from welding operations can cause blindness.

Chapter 4: Environmental Governance

71. Mining in Africa began in the colonial period (before 1906). During that period there was widespread environmental damage and very little was done to reduce environmental degradation. This phenomenon continued to the post-independence period in many African countries largely as a result of dictatorial regimes and the virtual immunity of Governments to public pressure. Also, many African leaders were preoccupied with problems other than environmental and social conservation. Moreover, environmental conservation was just beginning to receive attention in the international arena. The United Nations Conference on the Human Environment, held in Stockholm, in 1972, provided greater credibility in putting thoughts into conserving the environment. These and other concerns prompted accountable Governments and mining companies to take steps to develop a framework for reducing environmental damage (Frick, 2002).

72. The Stockholm conference provided a greater impetus for countries to take the issue of environment seriously. Many countries began to establish environmental councils to regulate environmental pollution. Ghana, for example, established the Environmental Protection Council (EPC) in 1974. This marked the beginning of Ghana's commitment under the Stockholm declaration, and a response to the international call for environmental stewardship by mainstreaming environmental issues in its developmental agenda. However, the Council virtually remained an advisory body till 1994 when it was made an agency with full regulatory powers.

73. Policies relating to mining under the structural adjustments in the 1980s put less emphasis on addressing environmental degradation caused by mining activities. This is because the basic aim of many

Governments at that time was to encourage investment in the sector and tying up mining investment to strict environmental laws could discourage such investments since pollution abatement comes as an additional cost to investors. Since the 1990s many Governments have established environmental agencies and enacted Environmental Impact Assessment (EIA) policies and laws. New and existing mining projects are now required by law to provide an EIA and Environmental Management Plan (EMP). EIAs have to some extent helped countries to better evaluate the benefits and costs associated with mining and to adopt measures, such as restoration and rehabilitation, to avoid and mitigate harmful impacts. For example, with the help of EIA, South Africa was able to stop the development of titanium mine along the eastern shores of St. Lucia, an area renowned for its biological diversity. The area was declared a World Heritage Site in 1999 (UNEP, 2006).

74. Many Governments have through the Poverty Reduction Strategy Papers (PRSPs) recognized the effects of mining on deforestation, land degradation, contamination of water sources, ecosystems destruction and such other issues as compensation for farming villages affected by mining rights within mining concessions and displacement of villagers from their homes, farms and grazing lands. Governments have also made it a policy to continuously review the institutional, legal, fiscal and financial regimes under which mining operates to ensure international competitiveness and relevance to national development goals, including equitable sharing of the benefits derived from mining by all parties. For instance, Zambia in its 2008 budget reviewed the windfall tax to increase government revenue. According to ECA and AU (2008), African countries have realized that some mining companies are departing from their previous approaches to development and community relations, variably characterized as “strictly business.”

75. Though much has been done through legislation to better address the environmental and social problems arising from mining, implementation of these laws has been weak due mainly to lack of coordination among mining support sector institutions, inadequate capacity of environmental protection authorities and weak Environmental Impact Assessment (EIA) and monitoring.

76. Coordination among mining sector institutions: Mining affects a variety of environmental media and resources such as land, air, water and forest. These cumulatively have negative impacts on the livelihood and social structure of mining communities and therefore require a multi stakeholder approach in the institution of investment policies. Unfortunately, coordination among the sector’s institutions is weak and in many countries the involvement of forestry, land and environmental ministries, departments and agencies in the granting of mining license is also weak. Moreover, chiefs, opinion leaders and the community as a whole are not adequately involved in investment negotiations in the mining sector. In some countries, mining contracts are negotiated in the President’s office neglecting the institutions mandated to undertake these negotiations. This undermines the functioning of mining institutions.

77. Weak EIA process: Many countries have well-documented guidelines for implementation of EIA by mining firms. However, implementation is poor and leaves much to be desired in terms of scoping,

baseline studies and community participation, which are very essential to the process. In spite of scoping claims in many EIA reports, the socio-economic, cultural and environmental problems meant to be addressed through scoping persist in many mining projects (Salami, 2001). Kenney (1988) identified the constraints of the EIA process in many developing countries as:

- (a) Lack of political will or of awareness of the need for environmental assessment;
- (b) Insufficient or non-participation of the public in the scoping process;
- (c) Lack of or inadequate legislative framework to enforce guidelines where they exist;
- (d) Lack of an institutional base to support EIA;
- (e) Insufficient skilled manpower to support the EIA process; and
- (f) Lack of scientific data, information and financial resources to support the EIA process.

78. Discussions with environmental officers show the existence of major loopholes in the EIA process. The media for soliciting information from local communities which are mainly the national press and District Assemblies are rarely accessible to the local people and many educated people are not interested in the process. Consequently, very little input is obtained from the public when EIA reports are published. Also, consultations are sometimes held with key individuals, especially chiefs and opinion leaders who are mostly beneficiaries of royalties and benefits but are not directly affected by the project. Mining communities also allege that such consultations publicly highlight the benefits of mining activities but play down their negative aspects. Furthermore, concerns raised by the community during such consultations are often overlooked by the mining firms.

79. Furthermore, the technicality of EIA reports placed at specific points for the public to comment makes it difficult for the rural folk who are mainly illiterate and semi-illiterate to understand them. Provisions in some environmental guidelines that stipulates that companies are not obliged to accept all recommendations of an audit report and the fact that many environmental agencies treat Environmental audit reports as confidential has to some extent rendered the process a mere formality. These among others has made some mining communities to believe that EIAs are just a mere conditionality imposed by International Financial Institutions for the acquisition of loans for mining activities and not a document to ensure that mining is conducted in a sustainable manner.

80. **Weak Capacity of Environmental Protection Institutions:** The capacity of Environmental Protection Institutions in terms of requisite technical personnel and finance is often limited given the operational definition of the environment which is quite broad in scope and coverage. The staff strength of many of these institutions is woefully inadequate for them to efficiently perform their duties. In Ghana, for example, the mining department of the Environmental Protection Council has eight experts overseeing all mining³ activities in the country. The department is inadequately resourced to

³ Mining here includes all minerals.

undertake monitoring and evaluation of environmental degradation and to carry out critical verification of environmental reports.

81. Local and international pressure has sometimes been used to make these weak institutions to act to ensure that mining is done in a sustainable manner. Many mining communities have through legal and illegal means pressurized mining companies, coercing them to respond to the community's demand for a share of the proceeds from mining.

Chapter 5: Benefits and Challenges of Environmental Sustainability

82. Compared to other economic activities, mining requires special attention given the enormous benefits and challenges that it brings and the major problem of ensuring that the benefits are shared equitable among all stakeholders. Being an exhaustible natural resource mineral availability and efficient exploitation increases economic benefits such as employment, output, incomes and FDI. However, the environmental and social costs are enormous and the management has not been transparent in many African countries.

5.1 Benefits and Challenges of an Integrated and Diversified Mining Industry

83. Analysis of the benefits and challenges of an integrated and diversified mining industry that is more profitable to mineral-rich countries in Africa should involve examining the challenges of ensuring sustainable mining.

84. History shows that the main aim of the colonial masters was to make Africa a primary product producer to feed the industries in Europe and elsewhere. They thus put emphasis on supporting the extraction and export of raw materials rather than the development of an industry that could contribute to a national development or even create greater domestic value-added through local beneficiation and manufacturing. This emphasis has not changed to date.

Many resource-endowed African countries have not been able to avail of the value chain concept in mining to reap the full benefit of the industry in terms of GDP growth, foreign exchange earnings, national revenue generation and employment creation.

85. According to the value chain concept it is possible to derive competitive advantage by arranging value-adding activities in a sequential chain in order to satisfy the requirements of a customer. Both the value adding activities and the linking of these activities may be sources of competitive advantage. Based

on the value chain concept, mining enterprises may be structured as a range of primary activities for the generation of value and a range of supporting activities that do not directly generate value but support value-generating activities.

86. The mining value chain is generically made up of eight stages - locating a viable mineral deposit containing a saleable product(s); valuating the profitability of a project, based on the identified mineral resource; establishing the mine plan; mining the mineral resource containing saleable product(s); transporting the mined orebody stockpile to destination; beneficiating/refining the saleable product(s) and safe disposal of residues; marketing the product and disinvesting in mining. Each of these stages also involves a series of activities and services contributing to the development of the national economy. For example, the actual mining stage involves activities such as ore crushing and milling. Apart from South Africa, Botswana and Namibia where mining activities have gone beyond the refining stage, many African countries, in the value chain analysis go up to the refining stage which includes smelting and casting in the case of the iron value chain.

87. However, value addition is high in the refining and marketing stages which have eluded many African countries. There is little information about value addition to mining at various stages of the mining value chain. The work by Sooli (see table.4.) on value addition in emerald mining by ASM in the Copperbelt of Zambia which produces about 20 per cent of the world yearly production of emerald tells the story. As indicated, 79 per cent of value addition is undertaken by the home country with about 77 per cent of the value addition being undertaken by home countries at the processing, wholesale and retail stages.

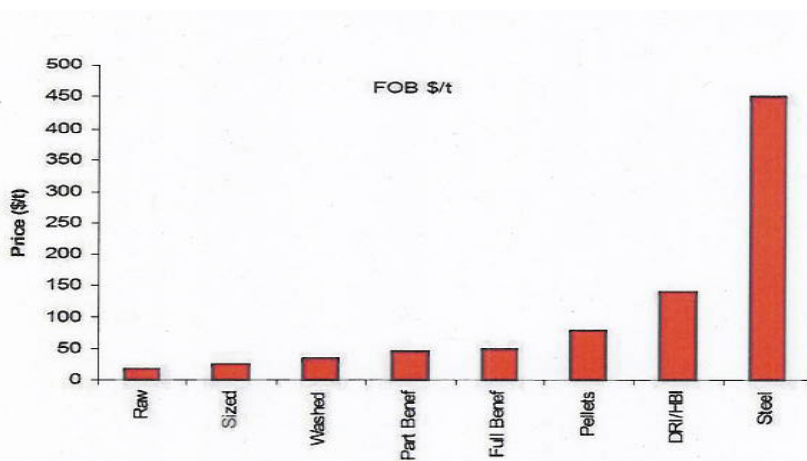
Table 4: Value Addition in Emerald Mining - Host Versus Home Country

Actor	Host Country	Home Country/ Export	Total Value
Input provider	2.5	1.0	3.5
Surveying	2.0	0.7	2.7
Mining	8.3	0.0	8.3
Processing	4.5	16.3	20.8
Middlemen &			
Wholesalers	1.5	32.7	34.2
Retailers	2	28.5	30.5
Total	20.8	79.2	100

Source: Sooli, 2007.

88. Also, information from the South Africa Department of Minerals and Energy (2007) indicate that \$20/t iron ore appreciates to about \$450/t when processed into steel (see table 4). This suggests that a steel exporting country could gain over 2000 per cent if it exports the product in a refined form as steel rather than in its raw state. Sadly, most of the iron produced in Africa is not processed into steel. The inability of Africa to participate adequately in the value chain is due fundamentally to a number of factors, including infrastructure constraints, inadequate human capital and regulatory framework, governing mining activities on the continent.

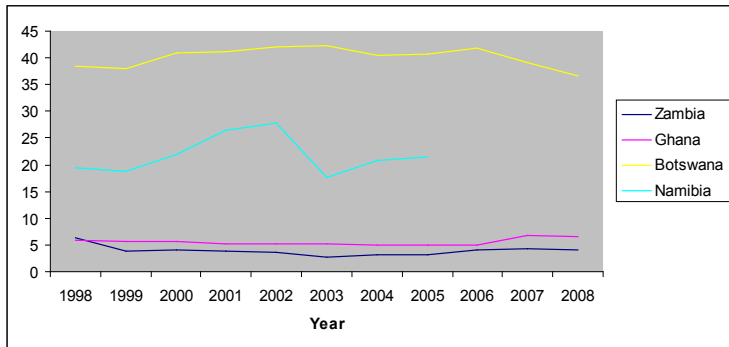
Figure 1: Value Addition in Iron Ore Value Chain



Source: South Africa Department of Minerals and Energy (2007).

89. Most of the mineral products in Africa are exported in raw state with no value addition needed to create the forward and backward linkages. Figure 2 shows the contribution of mining to GDP for some selected countries. From the figure it is evident that this contribution to the GDP of Botswana and Namibia is relatively high compared to the other countries such as Ghana and Zambia. For the SADC countries, the contribution of mining to GDP is about 10 per cent. The trend is the same for many mineral-rich countries in Africa. The high contribution of mining to GDP in Botswana is primarily due to the high value addition to diamonds.

Figure 2: Contribution of Mining to the GDP of Selected African Countries



90. The inability of the mining sector to add value to its products, which is adequately reflected in the marginal increase in its contribution to GDP, somehow explains its limited capacity to generate additional local employment. For example, in Ghana starting from 1981, the yearly growth rate of the mining and quarrying sub-sector averaged about 3.17 per cent. Over the same period, the sector's contribution to GDP increased by only about 0.3 per centage points while employment decreased by about 0.1 per cent a year. During 1992-1999, the mining and quarrying sector grew by about 5.85 per cent a year on the average. However, its contribution to GDP increased marginally by 0.3 per centage points while its share in total employment grew by only 0.2 percentage points. Overall, given the capital intensity of mining and quarrying activities and the 6.7 per cent yearly average growth recorded from 1984 to 1999, the sector has only 1.9 per cent share of employment in 2000 with its contribution to GDP staggering at 5.6 per cent. Similar trends can be found in many mineral-rich countries in Africa. This, to some extent has limited job creation and consequently growth and development, as evidenced by the low contribution of mining to GDP and the widespread poverty that exists in Africa.

91. Proper linkage of the mining sector with other sectors within the framework of the value chain will certainly have positive employment implications. For instance, the development of mining support activities such as transport, information systems, research and development (geological service), financial and risk management would not only increase economic activities and GDP from mining, but would also provide jobs for a number of people. The concept of value chain in mining could also be expanded to include re-claiming of mine sites for agricultural purposes through afforestation. In this case, many people would be employed in the forestry sector and productive land would also become available for agricultural activities and boost economic

growth. African Governments' commitment to increasing investment in such infrastructure as roads, railways, power supply, telecommunication and human capital as well as to review the regulatory framework of mining activities would give a major boost to promoting the value chain in mining in Africa.

5.2 Sustainability of the Mining Industry

92. Currently, about 95 per cent of Africa's natural resources are exported for secondary processing. Value addition is quite low which is responsible for the low contribution of mining to GDP. Increases in the demand for mineral resources with low value addition technically means that more and more of the finite resources will be extracted leading to their fast depletion. Also, the high demand coupled with improvement in technology has led to the extraction of lower grade ore which generates more volumes of waste. Nevertheless, revenue generated from mining is not being used sustainably for the benefit of future generations.

93. Though many mineral-producing economies in Africa have been benefiting from mineral revenue for the past seven decades, with the exception of a few countries such as Botswana, Namibia and South Africa, there is little evidence that Africa is benefiting significantly from mineral extraction and investing its mineral wealth effectively and efficiently to ensure poverty reduction and equity between and among generations.

94. There are several reasons for this. The first is that the overall revenue from mining is insufficient due to low value addition and low mineral rents. A recent report⁴ by a group of NGOs led by the Tax Justice Network indicates that Ghana, South Africa and Tanzania have lost about \$359 million, \$68 million and \$30 million, respectively, through lower royalty rates while Malawi and Sierra Leone have lost \$18.8 and \$8 million, respectively, through tax breaks. Also, the Democratic Republic of the Congo lost about \$0.36 million through tax exemption in a single mining contract. The report further states that many mining firms are engaged in secret contracts, corporate mergers and acquisitions and various "creative" accounting mechanisms that facilitate the exploitation of mineral-rich countries.

95. Secondly, mineral revenues are not efficiently used to generate growth due to bad governance. Governance remains a major problem facing African countries. Bad governance resulting from weak institutions and low political will to reform and strengthen governance institutions has made it difficult for mineral revenues to be spent efficiently. This has resulted in

⁴ <http://taxjustice.blogspot.com/2009/03/breaking-curse-tjn4africa.html>.

corruption and rent seeking in many African countries and has deepened poverty and inequality. Information from the Transparency International's 2008 Corruption Perceptions Index⁵ shows many African countries at the lower end of the index. Botswana is one of the countries that are doing well in terms of reducing corruption and hence its 36th position on the index. This has been the trend over the past decade since when there has been little improvement. Comparisons of CPI for Africa for the years 2007 and 2008 indicate that 52 per cent of African countries became more corrupt while 40 per cent became less corrupt. Corruption levels for 8 per cent of the countries did not change over the period. Pedro (2002) argues that many resource-rich countries in Africa face special governance challenges related to weak and poorly enforced laws and policies. A report by UNEP (2006) also indicates that oil- and mineral-dependent countries with weak political institutions often have higher levels of inequality and poverty than non-oil and non-mineral economies at similar income levels.

96. Thirdly, the poor business environment in many African countries is a major problem that hinders efficient use of mineral resources and investments. Many investors consider Africa a high risk zone and are not prepared to establish vertical and horizontal linkages in mining that can generate jobs and increase revenue. The World Bank's African Development Report (2007) on the average ease of doing business for the period 2006-2007 ranks sub-Saharan Africa 136th out of 178 countries. Botswana, Mauritius, Namibia and South Africa have a good ranking. The report further stresses that many African countries are making strides to improve their business environment, with Ghana and Kenya the best performers in this regard.

97. In the fourth place, many mineral-rich countries are not getting their fair share of mineral resources due to the inadequate corporate social responsibility on the part of mining firms. Mining companies exploit the lack of or poor bargaining power of African Governments to deny them a fair share of their resources. In some cases contracts are negotiated with politicians neglecting vital institutions that are important in the negotiation and award of contracts.

98. In general, in spite of the rich mineral wealth of Africa, a little less than half of its inhabitants are living on less than a dollar a day and inequality is high. Analyses of many African development indicators in health, education and infrastructure such as literacy rate, infant mortality rate, life expectancy and enrolment rates show that not much progress has been made. Moreover, many African countries are currently in debt which future generations would have to pay while the mineral resources inherited from their forefathers are not being passed on to

⁵ http://www.transparency.org/news_room/in_focus/2008/cpi2008. Corruption Perceptions Index is a rating published by Transparency International which orders the countries of the world according to "the degree to which corruption is perceived to exist among public officials and politicians."

future generations but rather being depleted. This somehow suggests that mining wealth or capital is not being effectively channelled into physical and human capital to achieve sustainable development.

99. Added to this are the many serious impacts on human health, ecosystems, crops and infrastructure of pollution and degradation of environmental resources, forests, land, water, soils and air on which rural people depend for their livelihood. Unfortunately, these negative environmental phenomena are not adequately addressed by mining companies, making the public to directly and indirectly pay for their cost over time. Such direct and indirect payments affect intra- and inter-generational equity and the achievement of sustainable development. Countries such as Botswana, Namibia and South Africa appear to be striving to turn their mineral wealth into other physical and human capital as evidenced by their high value addition and the increasing creation of wealth for their citizenry.

5.3 Challenges in ensuring sustainable mining

100. Mineral resources are exhaustive and their exploitation unsustainable in the long term. In spite of some achievements since Johannesburg Plan of Implementation (JPOI) it is still faced with challenges to the development of the sector and its contribution to sustainable growth and development. African countries are still faced with the challenge of defining and establishing mineral regimes capable of creating equitable and sustainable mineral wealth. They are yet to diversify and integrate the mining sector with the local and regional economy without compromising other forms of environmental and social capital.

101. Creating direct linkages e.g. the provision of mining inputs, beneficiation and physical infrastructure and indirect linkages e.g. maximization of the mineral infrastructure (transport, power and water) to speed up growth and development in other sectors such as agriculture, forestry and regard to resource processing remains a big challenge for many African countries. They face even greater challenges in the establishment of competitive and transparent systems of concession that maximize benefits to mineral-rich countries and optimize the use of resource rents, including windfall rent, to ensure long-term competitiveness and inter/intra-generational equity through appropriate fiscal instruments.

102. Another challenge to many African countries is the establishment of effective governance systems, including civil society Organizations (CSOs), that can reduce rent seeking, corruption and ensure transparency and accountability. Additionally, there are challenges pertaining to uplifting communities and enhancing post-mining economic activity; establishing instruments and systems to ensure effective participation of affected communities and other stakeholders; balancing and managing conflicting local, sub-national and national concerns and interests; establishing systems to monitor

compliance with environmental and social regulations; developing sustainable energy sources to meet the increasing demands from the mining sector; establishing appropriate Artisanal and Small-Scale Mining (ASM) regimes that facilitate sustainable and vibrant mining; establishing mechanisms to identify and settle mineral-related conflicts and disputes; capacitating the general public to engage in all levels of mineral development; locating resources for investment in Geo-knowledge through greater systematic geo-mapping in order to define known assets and delineate new ones.

103. Other challenges at the regional level include ensuring the sector's sustainable development, providing access to the international market and enhancing its transformational impacts. This will entail, among other things, locating resources for the effective functioning of continental partnerships/initiatives such as the AMP, Inter-governmental forums, AUC-ISG, UNCTAD-AMN, AfDB-ALSF and NEPAD-SDI. It will also entail sensitizing member States to the importance of establishing mineral development funds to ensure sustainability through investment in human resources development, research and development and securing resources to establish a continental fund for world class transaction advisors for the negotiation of large mineral contracts with long tenure. Furthermore, venture capital will need to be established for African entrepreneurs to enter the mining sector and the adoption and application of international standards, conventions and toolkits resulting from initiatives such as KPCS, EITI, EITI++, ICMM will need to be broadened. Finally, the large mineral infrastructure financing constraints will need to be overcome through public-private partnerships (PPPs) and the mineral regime, particularly fiscal, will need to be harmonized.

Chapter 6: Conclusion and Recommendations

104. The substantial amounts of minerals with which African countries are endowed could be used to make an enormous contribution to sustainable growth, development and poverty reduction, provided that the necessary linkages are made with other sectors of the economy and that EIAs are mandatory and effectively enforced. Experience with countries such as Botswana, Namibia and South Africa indicate that effective participation by all stakeholders in minerals investment and the minerals cycle can prevent future conflicts and help optimize the contribution of mining to sustainable development and poverty reduction. In addition, through enhanced mineral rents, mining could contribute significantly to the development of all sectors of the economy.

105. Overall, it is recommended that to ensure environmental sustainability and sustainable development in the exploitation of minerals in Africa the ICMM (2006) concept of material stewardship should be adopted and implemented. This is a concept whereby various stakeholders involved in the minerals value chain undertake activities that enhance the durability and of minerals and metals, increase their recyclable potential, boost production efficiency and use and minimize risks associated with mining

in order to maximize the value of the minerals for both local and investing companies. This implies that mining companies should undertake responsible product design, use, re-use, recycling and disposal of their waste.

106. Ensuring a balance between mineral exploitation and reduction of the social and environmental impacts of mining is achievable, though with some difficulty, and constitutes one of the policy directions that will help ensure sustainable exploitation of Africa's mineral resources. The multi-dimensional nature of the problem requires multi-faceted measures, including legal, institutional and administrative changes by all stakeholders as well as their cooperation. at the regional level such measures should include:

- (a) Enhancing support for continental, regional and country initiatives to revise and reform mineral regimes to create equitable and sustainable mineral wealth from an integrated and diversified mining industry that optimizes linkages;
- (b) Improving regional cooperation with development partners to facilitate systematic geo-mapping in order to define known assets and delineate new ones;
- (c) Establishing capacity for the identification and facilitation of forward and backward direct linkages of mining with other sectors of the economy, particularly, investment in mining inputs, beneficiation and physical infrastructure;
- (d) Establishing resource-based development corridors through PPPs that optimize indirect linkages through collateral use of such mineral infrastructure as transport, power and water to enhance other sectors - agriculture, forestry and resource-processing sectors - of the economy;
- (e) Providing support for the identification and management of conflicts at the national and regional levels;
- (f) Developing a continental energy strategy for harnessing Africa's vast hydro-electric power potential (e.g. Congo River Basin) through a continental transmission grid, to cater for the increasing demand from the mining sector and to replace fossil fuels in other sectors;
- (g) Harmonizing mining regimes, especially fiscal regimes;
- (h) Locating resources for the effective functioning of continental partnerships/initiatives such as the AMP, AUC-ISG, UNCTAD-AMN, AfDB-ALSF and NEPAD-SDP;
- (i) Establishing a continental fund for world class transaction advisors for the negotiation of large mineral contracts with long tenure;
- (j) Establishing a mineral venture capital facility to enable African entrepreneurs (JRCs) to enter the mineral sector;
- (k) Ensuring effective implementation of KPCS in member countries and the establishment of other similar systems in other minerals to address minerals contribution to conflict;
- (l) Facilitating the adoption and application of minerals' conventions emanating from KPCS, EITI, EITI++ as well as other systems such as ICMC toolkits and codes for hazardous substances (Mercury and Cyanide);

At the national level policies should include :

- (a) Developing or implementing resource rent fiscal regimes such as the AUC's-ISG initiative that enhances rents;
- (b) Instituting competitive and transparent systems of concession that optimize revenue, uplift communities and enhance post-mining economic activity;
- (c) Ensuring efficient use of resource rents for long-term competitiveness and inter-generational equity;
- (d) Establishing future/stabilization funds to alleviate the possible impacts of the 'Dutch disease' during resource booms;
- (e) Developing effective institutions that reduce rent seeking and corruption and ensure transparency and accountability;
- (f) Developing effective and consistent monitoring systems that guarantee environmental and social management plan compliance;
- (g) Establishing mechanisms that ensure effective participation by affected communities and other stakeholders;
- (h) Developing appropriate ASM regimes that facilitate sustainable mining;
- (i) Identifying and setting up effective conflict resolution mechanisms, including arbitration;
- (j) Establishing Mineral Development Funds (from mineral revenues) to ensure sustainability through investment in human resources, research and development; and
- (k) Establishing capacity-building schemes to enable the general public to engage in all levels of minerals development.

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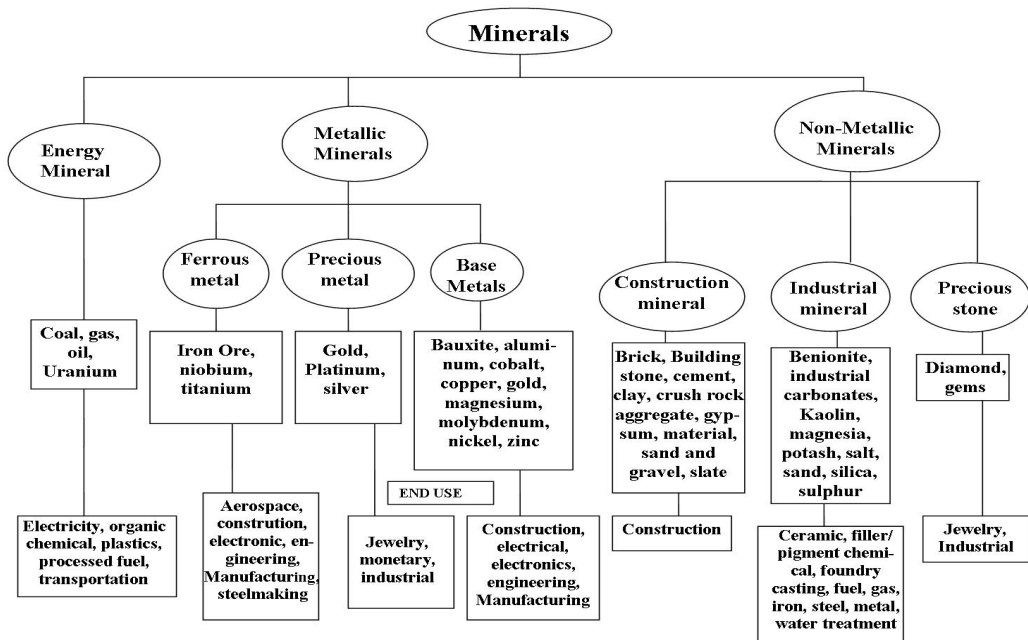
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Appendix 1: Classification of Minerals



Source: UNCTAD

Appendix 2: Major Ore Deposits By Country

Type of Ore	Country found
Iron	Algeria, Angola, Congo Brazzaville, Cote d'Ivoire, Guinea, Liberia, Mauritania, South Africa, Swaziland, Senegal
Lead	Algeria, Angola, Burkina Faso, Congo Brazzaville, Egypt, Morocco, Namibia, South Africa
Zinc	Algeria, DR Congo, Congo Brazzaville, Morocco, Namibia, South Africa, Zambia
Petroleum	Algeria, Benin, Cameroon, Chad, Congo Brazzaville, Egypt, Equatorial Guinea, Gabon, Libya, Nigeria, the Sudan
Diamonds	Algeria, Botswana, DR Congo, Cote d'Ivoire, Ghana, Guinea, Lesotho, Liberia, Namibia, Sierra Leone, South Africa, Swaziland, Tanzania, Zimbabwe
Gold	Angola, Benin, Botswana, Burkina Faso, Burundi, Chad, Cote d'Ivoire, Eritrea, Ethiopia, Ghana, Mali, Mozambique, Namibia, the Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Swaziland, Tanzania, Uganda, Zimbabwe
Nickel	Angola, Botswana, Guinea, Zimbabwe
Chromium	Angola, Madagascar, South Africa, Zimbabwe
Platinum group metals	Angola, Botswana
Manganese	Angola, DR Congo, Gabon, South Africa
Copper	Angola, Botswana, DR Congo, Congo Brazzaville, Mauritania, Morocco, Namibia, Uganda, Zambia
Coal	Botswana, Malawi, Mozambique, the Niger, Nigeria, South Africa, Swaziland, Tanzania, Zimbabwe
Tin	Burundi, DR Congo, Nigeria, Rwanda, Uganda
Bauxite	Cameroon, Ghana, Guinea, Mozambique, Sierra Leone
Gemstones	Cameroon, Kenya, Madagascar, Malawi, Mozambique, Namibia, Rwanda, South Africa, Tanzania, Zambia
Coltan (Columbite-tantalite)	Chad, DR Congo, Rwanda
Cobalt	DR Congo, Zambia
Phosphate	Congo-Brazzaville, Mauritania, Morocco, Senegal, South Africa, Togo, Tunisia, Tanzania

Uranium	Gabon, Guinea, Lesotho, Namibia, the Niger, South Africa
Trona (Sodium-rich mineral)	Kenya
Beryllium	Mozambique
Fantalium	Mozambique
Silver	Namibia
PGMs	South Africa, Zimbabwe
Vamadium	South Africa
Gas	The Sudan, Tanzania, Tunisia

Source: Compiled with data from Geoscience Magazine <http://miningreview.com/mineralmap.php>.

Appendix: 3 Number of countries with mineral earning occupying first, second and third positions in total export earnings

Rank of Mineral Exports	Non-oil Minerals(+ products)	Oil/gas (+products)	Total
SADC			
1st	7	1	8
2nd	6		6
3rd	5	1	6
Central Africa			
1st	1	6	7
2nd	1		1
3rd	4		4
East Africa			
1st		1	1
2nd	1		1
3rd	3		3
North Africa			
1st	1	4	5
2nd	1	2	3
3rd	3	1	4
West Africa			
1st	6	1	7
2nd	6	1	7
3rd	2	1	3
Africa			
1st	15	13	28
2nd	15	3	18
3rd	17	3	20

Appendix 4: Glossary of technical terms

Term	Explanation
Mineral dressing	One of the principal processes in the work of mining that consists of the separation of economically valuable minerals from those with little value.
Smelting	The process of separating the metal from impurities by heating the concentrate to a high temperature to cause the metal to melt.
Molten electrolyte process	The process where a substance containing free ions that behaves as an electrically conductive medium, usually when in a solution is melted and casted.
Heap leach method of gold beneficiation	An industrial mining process used to extract gold from the ore.
IN-SITU leaching	The process of recovering minerals such as copper and uranium through boreholes drilled into the deposit.
Dredging operations	The term given to digging, gathering, or pulling out material to deepen waterways, create channels and so on.
Sluicing operations	The process of washing with water flowing in a sluice
Gist mining activities	The kind of mining activity often undercuts the strata of overlying the sulphur bearing layer.
Carbon sequestration	A geo engineering technique for the long-term storage of carbon dioxide or other forms of carbon, for the mitigation of global warming.
Ecological perturbations	Disturbances caused by mining to the ecosystem.
Metallurgy	The science that deals with procedures used in extracting metals from the ores, purifying and alloying metals, and creating useful objects from metal.
Benthic sediments	Soil, sand and minerals located at the lowest level of a water body usually after rain.
Quarrying sector	A sector primarily engaged in extracting naturally occurring minerals.
Fossil fuel	Hydrocarbon deposit, such as petroleum, coal, or natural gas, derived from living matter of a previous geologic time and used for fuel.
Petroleum hydro carbon	Consists of a very large number of compounds that, by definition, are found in crude oil, as well as other sources of petroleum such as natural gas, coal and peat.
Schistosomiasis	Also known as bilharzia is a type of worm that attacks humans.
Respirable dust particles	Refers to those dust particles that are small enough to penetrate the nose and upper respiratory system and deep into the lungs.

Musculo-skeletal disordered	Impairments of bodily structures that are caused by work itself or by the environment in which work is carried out.
Amalgamation:	The process of separation of precious metals from ore.
Siltation	To fill, cover or obstruct with silt.
Acid rain	Rain or any other form of precipitation that is usually acidic.
Combustion	The process of burning
Heavy metals	Metals with specific gravity greater than about 5.0, especially one that is poisonous, such as lead or mercury.
Volatile organic compound	A range of organic compounds of low molecular weight that are of great concern as pollutants.
Tailings	Large piles of crushed rock that are left over after the metals of interest like lead, zinc, copper, silver, gold and others, have been extracted from the mineral rocks that contained them.
Coal gasification	The process of producing coal gas
Dewatering:	The process of natural, chemical or mechanical removal of water from sludge, there by reducing it to a dump solid with the lowest level of moisture attainable
Disfigurement of land	Having the appearance of a landscape spoiled.
Dereliction of land	The act of abandonment or neglect of land after mining.
Coloration	The use or choice, arrangement and state of being coloured

Editor's note: the statistics on vanadium is repeated in chapter 2, page 5, three lines before Table 1, as follows: 95 per cent of Vanadium, 55 per cent of Vanadium. The author should choose one.