Sustaining the Minerals Industry of Ghana – A Challenge to Stakeholders

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Amankwah, R. K. and Suglo, R. (2020), "Sustaining the Minerals Industry of Ghana – A Challenge to Stakeholders", *Proceedings of 6th UMaT Biennial International Mining and Mineral Conference*, Tarkwa, Ghana, pp. 107-115.

Abstract

The minerals industry in Ghana has been active for several centuries and within this period more emphasis has been placed on the traditional minerals like gold, bauxite, diamonds and manganese. About 98% of the traditional minerals produced in Ghana are exported in the primary state without any value addition. However, there are many other minerals that can be profitably mined and processed at the small and medium-scale levels, which are not receiving the needed official attention and remain undeveloped in many parts of Ghana. This paper discusses the numerous minerals available in Ghana and the challenges involved in their development and how stakeholders (i.e. policy makers, mineral engineers and the business community) can work together to develop them into useful products and thereby maximize the potential benefits of the sector such as job creation, enhancement of revenue generation, rural industrialisation and the sustenance of the minerals industry of Ghana.

Keywords: Minerals industry, Traditional minerals, Sustainable development, Mineral engineers

1 Introduction

The minerals industry is a very important sector of every country's economy because the development of most countries is directly linked with the development of their mineral resources. Ghana derives benefits like increased foreign exchange earnings, employment opportunities and internal generation of revenue by way of taxes, duties and royalties from the minerals industry.

Available figures indicate that currently Ghana produces over 60 tonnes of gold annually accounting for about 95% of the country's mineral revenue. The total revenue from the traditional minerals account for about 40% of the country's foreign exchange earnings and 5.7% of the gross domestic product (Aryee, 2001). While the main focus over the past years has been on the exploitation of the primary minerals in Ghana, there are many other industrial mineral deposits in the country that have not attracted the attention of policy makers on the one hand, and local and foreign investors on the other. Besides, the nation does not derive the maximum economic and social benefits from the minerals industry because about 98% of the primary minerals are exported in the unrefined or unprocessed state.

Though other minerals, especially industrial minerals, have a great potential to contribute towards rural industrialisation of the communities where they are located if they are developed, the nature of occurrence of many of these deposits and the available reserves do not make their exploitation amenable to large-scale mining but only by small or medium scale mining techniques. Unfortunately, the mineral laws of Ghana prevent foreigners from investing in small-scale mining operations (Anon., 1989). In addition, many people in the business community of Ghana are not aware of the existence of these minerals, their uses and the available markets for them.

The minerals industry deals with non-renewable resources that are subject to depletion in the course of production. Thus for every tonne of ore that is mined from a particular deposit, there is one tonne less left to mine. The non-renewable nature of mineral resources places a limit on the growth of these industries and hence their sustainability.

A lot of literature is available on sustaining the minerals industry in various countries (Brooks, 1964; Miller, 1976; Bambrick, 1977; Vogley, 1984; Doggett, 1992; Kesler, 1994). Earlier work on sustaining the minerals industry of Ghana mentioned political interference, poor infrastructural facilities, over reliance on foreign capital and expertise, and general mismanagement

as some of the factors militating against the progress of the industry (Sraku-Lartey, 1997).

This paper seeks to project the mineral wealth of Ghana and bring to the fore their location, economic importance and how the policy makers, mineral engineers and the local business community can work together to sustain the minerals industry. Sustaining the sector is considered in the context of the minerals supply process, depletion of reserves and linkage effects with other sectors of the economy. Environmental, social and economic issues are factored into the minerals supply process. For Ghana to reap the full benefits of the minerals industry, it is important for the mineral resources sector to be managed in a very sustainable manner.

2 Minerals Deposits in Ghana

Ghana is endowed with abundant mineral resources some of which are being exploited on both small and large-scale while others are yet to receive the needed attention. Some deposits are vast and can be exploited on a large-scale. However, in many cases the location, nature of occurrence of the deposits, the total proven reserves and ore grades make their exploitation feasible only by small-scale mining techniques. It is important to note that some of these mineral deposits do not need huge foreign capital infusion to turn them into viable ventures. The location of the various mineral resources that are discussed in this paper are shown in Fig. 1 (Kesse, 1985; Anon., 2002a).

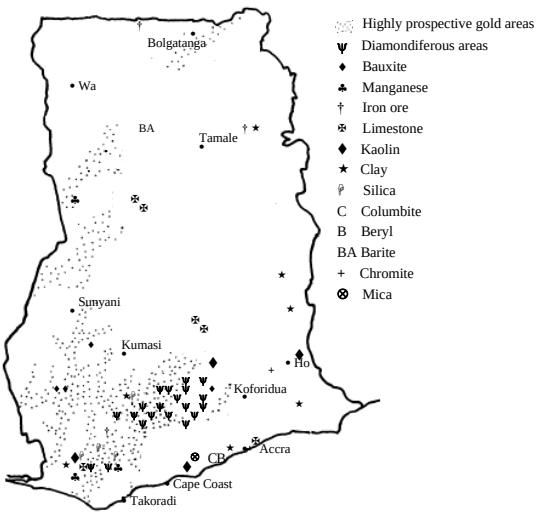

Fig. 1 Major Mineral Deposits in Ghana

2.1 Traditional Minerals

Some of the traditional minerals have been mined on both small and large-scale for a very long time in Ghana. Others are yet to be fully explored, developed and possibly mined.

2.1.1. Diamonds

Diamonds occur mainly in the Birimian rock system in Ghana. The concession of Ghana Consolidated Diamonds Limited, Akwatia, falls within the Upper Birimian system. According to company reports, proven reserves in the diamondiferous gravels amount to about 25 million cubic meters grading about 1.1 carats per cubic meter. Reserves in the Middle and Lower Birimian series total 11.7 million carats and 13.7 million carats respectively but these are yet to be fully developed for mining.

2.1.2 Gold

Gold is the mineral that has received the greatest attention in Ghana and it is found mainly in the Tarkwaian and Birimian rock systems of the country. Though gold has been mined in Ghana for many centuries, there are still vast reserves of it that are amenable to both small and large-scale mining techniques. As at the year 2000, there were 14 large-scale mines and 420 licensed small-scale miners and hundreds of illegal small-scale miners working on the gold reserves throughout the country.

2.1.3 Bauxite

Bauxite is found in many places in Ghana such as the Sefwi Bekwai area in the Western Region. The Sefwi Bekwai deposit is currently being mined by the Ghana Bauxite Company and the available reserves of 29.5 Mt are sufficient to support a mine life of 100 years. Other deposits include those at Nyinahin near Kumasi and in the Atewa range. The Nyinahin deposit has a total inventory of 350 Mt at an average grade of 48.9% to 51% alumina and 2.8% to 4.4% silica while that in the Atewa range has about 150 Mt ranging in grade from 40.8% to 45.7% alumina and 1.8% to 3.9% silica (Kesse, 1985). There are several types of bauxite depending upon the end use. Metallurgical-grade bauxite is used for aluminum production while refractory-grade bauxite is used in the ceramic and refractory industries. The grade of alumina in bauxite ores in Ghana falls below the refractory-grade. Other uses of bauxite include abrasives for sanding, cement production and aluminum-based chemicals.

2.1.4 Manganese

Two manganese deposits occur in the Yakaw area near Dixcove in the Western Region of Ghana. These have estimated reserves of about 5.5 Mt

with 42% manganese content and 1.0 Mt containing 32% manganese content respectively. Two other deposits are found in the Northern Region with total reserves of over 13.8 Mt and the manganese content ranges from 30 to 45%. The only operating manganese mine in Ghana is at Nsuta near Tarkwa with 37 Mt of manganese ore reserves (Kesse, 1985). Since mining activities began in 1916, the mine has produced and exported about 28 Mt of high grade manganese oxide ore. The types of manganese ore exported include the battery grade (Mn > 52%), metallurgical grade (47 – 52% Mn) and the chemical grade (40 - 46% Mn). With the oxide ores almost depleted, the mine has begun mining and processing the low-grade carbonate ores which are available in large quantities on the mine. The average manganese content of the carbonate ore is 34.5% (Amankwah *et al.*, 1999).

Manganese is used in steel making and also in making various alloys and compounds of aluminum and copper. One of the most widely used compounds of manganese is manganese dioxide which is used in dry cell batteries, paints, dyes, photographic developers, bricks and glass making. Manganese sulphate is used as paint and varnish dryer and in some fertilisers. One of its compounds, potassium permanganate, serves as a disinfectant and deodorizer, and is used in water purification. Manganous nitrates and oxides act as catalysts in the production of petrochemicals, plastics and synthetic fibers.

2.2 Industrial Minerals

Industrial minerals are principally non-metallic and are classified according to their end uses as construction materials, agricultural minerals, chemical minerals, ceramics and refractory minerals, etc. These minerals play an important role in the supply of basic raw materials for use in construction, agricultural and environmental applications, and in used plastics and paints. They range from common minerals like limestone, gravel and salt to rare and unique ones like chromite and columbite-tantalite (Carr, 1994; Ednie, 2002).

2.2.1 Iron Ore

About 1,270 Mt of iron ore are found around Shieni in the Northern Region of Ghana. At Pudo in the Upper West Region, there are 4.5 Mt of iron ore containing about 34% magnetite and 4.5% titanium oxide (Kesse, 1985). Vast reserves of iron ore comprising about 42% magnetite also occur at Oppong Manse in the Western Region. The glut in world steel production and the relatively more accessible deposits in other parts of world have kept foreign investors away from developing the iron deposits in Ghana.

2.2.2 Dimension stones

Rocks that can be quarried as dimension stones cover about 17% of the land surface of Ghana. Unfortunately, only one out of the over 80 medium to large-scale quarries in the country cut and polish dimension stones for industrial purposes. Dimension stones that are cut, dressed and polished into various shapes and sizes are used in the housing and road construction sectors as building and decorative materials. Available information indicates that the total annual export of dimension stones from Africa is valued at $300 M (Anon., 2002b). Unfortunately, Ghana does not benefit from it.

2.2.3 Brown Clay

Brown clay deposits occur virtually in all the regions of Ghana. A study by the Geological Survey Department indicates that there are about 110 clay deposits in the country with reserves totaling over 1 billion tonnes. In the Greater Accra Region the main deposits are in Big Ada and Ada Kasseh/Bedaku with reserves of 51.2 and 42.7 Mt respectively. About 51.7 Mt of clay deposits are found in Winneba, Kasoa and Oduponkpehe in the Central Region and 33.9 Mt at Obuasi Asokwa in the Ashanti Region. Reserves in the Volta Region include 97.7 Mt at Kadjebi and 35.9 Mt around Hohoe. The main clay deposit in the Eastern Region is at Somanya with reserves totaling 34.9 Mt while the total reserves in the Nzema area of Western Region are over 650.8 Mt. The clays are found to be suitable for the production of floor and wall tiles, sanitary ware, pottery, filler and ceramic. Other small markets for clay products are asphalt-emulsion additives, brick, catalysts, china plates, drilling mud, electrical porcelain, glazes, pesticide carriers and refractories.

2.2.4 Limestone

Limestone reserves estimated at 1.5 Mt and containing 57% calcium oxide are found in the valleys of the Afram River. Proven reserves at Nauli in the Western Region are 25 Mt while 15 Mt exist at Bongo Da and 6.0 Mt at Buipe in the Northern Region. Carbonate rocks are a source of chemical lime for chemical processing industries requiring neutralization, coagulation, causticisation, dehydration, absorption and also in cement production. About 10 Mt of dolomitic limestone containing 35% calcium oxide are found at Oterpolu in the Eastern Region that can feed the local terrazzo industry. Other significant limestone deposits are found near the Fo River (1.5 Mt) and

at Daboya (0.2 Mt) in the Northern Region. If the deposits in the Northern and Eastern Regions were mined and processed they would be enough to meet the raw materials requirements of the local cement factory, West African Cement Company (WACEM), which has an installed capacity of 2.4 Mt per annum (Anon., 2002c).

2.2.5 Kaolin

Kaolin deposits are found at Kibi (3.5 Mt) in the Eastern Region and Saltpond (1 Mt) in the Central Region. Other deposits are known to occur at Anfoega in the Volta Region and in the Nzema area in the Western Region but their reserves have not been quantified. Currently, it is only the kaolin deposit at Saltpond that is being exploited by the Ghana Industrial Ceramic Manufacturing Company on large-scale. These deposits have been found to be suitable for use in paint, plastics, pharmaceuticals, rubber, cement and paper industries.

2.2.6 Silica and Quartz

Silica sand and feldspars abound in the western part of the Western Region. Silica reserves at Abosso, Petepong, Asomasi and Kuranti are estimated to be 34.4, 72.6, 37.4 and 246.3 million cubic metres respectively. These deposits contain up to 99.2% silica. They also contain varying amounts of iron oxide. More than 1 Mt of high quality quartz occurs at Bodwesango, near Obuasi in the Ashanti Region. Silica sand is mainly used for manufacturing glass. Other uses of silica and quartz include foundry, filtration, hydraulic fracturing, recreational, ceramics, abrasives, fillers and chemicals as well as in the production of solar cells, digital watches, clinker and ferrosilicon.

2.2.7 Salt

Common salt is produced in large quantities from the evaporation of seawater in ponds and lagoons along the coast of the Gulf of Guinea. It is estimated that Ghana can produce over 1 Mt of salt per annum (Anon., 2002d).

2.2.8 Barite

Barite occurs near Daboya in the Northern Region of Ghana, along the White Volta River. The estimated reserves of the mineral are about 0.3 Mt, though detailed exploration work is required to establish the actual reserves in the area (Kesse, 1985). Barite is used mainly for well drilling as a weighting agent for oil and natural gas. It is also used as an additive to cement, paint primer, barium chemicals, rubber and urethane foam as a weighting material.

2.2.9 Chromite

Ores containing about 45% chromite occur as bands in pyroxenite and hornblende in the Agbenu-Afubu range in the Volta Region and this can support local electrochemical industries (Kesse, 1985). It is also used in making acid resisting steel.

2.2.10 Pegmatitic Minerals

There is an estimated 1.5 Mt of spodumene with 6% lithium dioxide and low reserves of beryl, albite and microcline available in the pegmatites at Ejisimanku near Winneba. Columbite-tantalite is found in the weathered pegmatites of Akim-Oda in the Eastern Region and also in the beach sands around Winneba and mica occurs at Ampia and Ajumako in the Central Region. However, more detailed exploration is required to fully quantify these reserves (Kesse, 1985).

3 Investment in Minerals Sector of Ghana

Though Ghana is endowed with all the mineral resources mentioned in previous sections, there are currently only one large-scale manganese and bauxite mines and virtually no other mineral is mined on commercial scale in Ghana except gold. Foreign investment has mainly been in the gold industry and about 95% of the foreign direct investments in the minerals industry have been in gold mining alone. The gold industry has received more attention mainly because it is considered by policy makers to be the main mineral that can generate the much-needed foreign exchange for government. Accordingly, gold mining has, unfortunately, been widely over-publicized as the major mineral offering investment opportunities in Ghana to the detriment of the other minerals.

It is a fact, however, that there are vast deposits of industrial minerals such as salt, kaolin, limestone and brown clays which do not require high capital outlays to develop them for exploitation. These deposits can be mined extensively and processed into finished and semi-finished products for local consumption and also for sale within the West African sub-region. It is therefore necessary to encourage local investment in the mining and processing of these industrial minerals to maximise the revenue generated by the minerals industry of Ghana.

4 Local Demand for Minerals

Virtually all of Ghana's primary minerals (i.e. gold, diamonds, manganese and bauxite) and a large portion of the country's secondary mineral products are exported. The main secondary

commodity is aluminum, which is refined locally from imported alumina.

Available data shows that bauxite is not consumed or utilised in any significant quantities locally and that the local consumption of manganese is less than 1% of the mined output. The local consumption of kaolin is estimated to be at least 15,000 t/yr and 98% of that is imported. About 100,000 t (50%) of the common salt produced in Ghana is consumed locally while the remainder is exported. Though gold is used locally for the production of jewelry and traditional ceremonial artifacts, the actual local consumption is difficult to quantify due to undocumented sales by artisanal gold dealers. There is also no reliable data on the consumption of the other minerals though they can be utilised in several innovative ways.

5 A Case for Salt Winning

Salt winning is used here to present a case for the many minerals in Ghana that can be exploited extensively for local consumption or processed into secondary and tertiary products for export. The uses and importance of salt have multiplied with the advent of industrialisation. Currently, only 6% of the world's annual salt production is consumed by humans while the rest is used industrially as one of the five basic ingredients of the chemical industry together with sulphur, coal, limestone and petroleum.

Ghana has the potential to produce over one million tonnes of salt annually from the evaporation of seawater due to the suitable climate and other geographical conditions that prevail in the country. Unfortunately, Ghana currently produces only 200,000 tonnes of which 100,000 t is exported in the crude form to countries within the West African sub-region (Anon., 2002d). Currently, there are only two large-scale salt producers in Ghana. There is a ready market for salt in the neigbouring countries like Nigeria which requires over 1 million tonnes of salt per annum for domestic consumption alone. This makes it the largest consumer of salt in the West African sub-region. Presently, Nigeria imports about $1.5 billion worth of salt for domestic and industrial use from other countries because there are no major producers within the West African sub-region (Bartels, 2002).

One major problem inhibiting the expansion of the salt industry is land acquisition. However, the government of Ghana is currently taking steps to make the acquisition of land for mining and other uses easier and also to establish land banks. Under the new system, the land will be handed over to entrepreneurs interested in the salt industry for the creation of salt ponds. It is expected that the provision of land and machinery to local entrepreneurs interested in salt production will help increase the production of salt to about 600,000 tonnes by the end of 2002 and to over one million tonnes by the year 2006 (Anon., 2002b).

5.1 Adding Value to Salt

The salt exported from Ghana is mainly in the raw form. However, the value of the salt exported can be increased by the addition of potassium iodate to form iodated salt. There are also several innovative ways in which salt can be used. The largest industrial consumer of salt is the chloro-alkali industry. The chemical industries in Ghana depend largely on the products of the chloro-alkaline industry for the supply of their raw materials. Currently, the chemical industries are heavily dependent upon imported raw materials. Salt being the main raw material in the chloro-alkali industry can easily provide the necessary linkage especially in the production of caustic soda. The major consumers of caustic soda are soap and detergent factories, plastics, paints and pharmaceutical industries. Large quantities of caustic soda are used in the textiles, paper and metallurgical industries and in the production of synthetic fibres. Between 1992 and 1997, Ghana imported about 51,000 tonnes of caustic soda and currently imports over 15,000 tonnes per annum (Acquah, 1998).

Investment in the chloro-alkali industry has been constrained by lack of local market for chlorine, a major product of the chloro-alkali plant. Chlorine is used as a raw material in the production of organic solvents, pesticides, insecticides, plastics and linoleum. Other uses are in the production of plastics, resins, detergents and polyvinyl chloride (PVC). As well, chlorine is used in the pulp and paper industry, and in water and sewage treatment. Thus there is a ready market for chlorine in Ghana since all the aforementioned items are produced in Ghana from imported raw materials. Since 1994, Ghana has been importing, on the average, 2,000 tonnes of hydrochloric acid per annum. The Ghana Water Company imports over 300 tonnes of chlorine gas and 800 tonnes of bleaching powder annually for treating domestic water supplies.

As postulated by Acquah (1998), there is the need for linkages with the prospective demands in the Economic Community of West African States (ECOWAS) since the demand for these products in Ghana is too small for a chloro-alkali plant. Within the ECOWAS, Nigeria imported 112,443 tonnes of caustic soda costing $55,172 million between 1984 and 1987 while Senegal imports about $4.2 million worth of caustic soda per annum. Cote d'Ivoire

spent over $1.2 billion to import various chemicals and related products between 1986 and 1989 representing about 8% of total ECOWAS imports. Thus, the processing industries in the West African sub-region have a considerable capacity for the utilisation of these chemicals.

Ghana has 40 plastic industries with a total installed capacity of over 26,000 tonnes. The plastic industries import annually about 15,000 tonnes of resins for the manufacture of various thermoplastic products such as plastic water tanks, crates, PVC pipes and polyethylene bags. A chloro-alkali plant of 120,000 t/yr capacity is estimated for the ECOWAS region (Acquah *et al.*, 1996). Production of thermoplastics promises to be the main consumer of chlorine from such a chloro-alkali plant when set up.

Hydrogen is another product in the electrolysis of brine. It is used in the synthesis of ammonia, hydrogenation of oils, production of margarine and hydrochloric acid, and in the petroleum industry. The use of hydrogen depends on the capacity of the chloro-alkali plant. For example, a 40,000 t/yr ammonium factory could be integrated with a 300,000 t/yr chlorine plant (Acquah, 1998).

6 Role of Mineral Engineers

The value chain in the discovery, mining and processing of minerals begins from the geologists and geological engineers through mining engineers to mineral engineers.

6.1 Encouraging Local Investment

Mineral engineers should educate and convince local entrepreneurs with facts from well conducted feasibility study reports on the available reserves of the industrial minerals in Ghana to enable them invest in the sector. Local investors would be ready to invest in long term ventures to mine and process these minerals into marketable secondary and tertiary products if convincing information is made available to them. Local investors and engineers can take advantage of the Ghana government's Export Development Investment Fund that is designed to assist entrepreneurs involved in salt mining and other related projects (Anon., 2002d).

6.2 Quality Control and Quality Assurance

Once a plant has been commissioned, a very important consideration for the management of industrial products is quality control and quality assurance. Quality control and assurance is more important to industrial minerals than with the precious metals (e.g. gold) that many Ghanaian mineral engineers are accustomed to. This is because it is always possible to determine precisely the amount of gold in bullions. Secondly, variability in a given gold consignment may not be an issue since analyzing the grade of each unit or bar in the consignment can offset it. Marketing of gold has also been designed such that gold can be sold in any form provided the content and grade can be established quantitatively (Mensah-Biney, 2002).

Unlike gold and other precious metals, the exact grade of an industrial mineral product cannot be easily determined quantitatively. However, there are some physical and chemical specifications that control the value of industrial mineral products. The major ones are the physical characteristics of the product, consistency and the chemical impurities present. Since quality of the mineral of interest may vary widely from deposit to deposit and even within the same deposit, quality control and quality assurance are very important in the marketing of industrial minerals. Therefore, it puts a great responsibility on mineral engineers not only to run the industrial mineral plants efficiently but also to ensure that both the quality and consistency of the products are maintained within acceptable levels.

6.3 Management and Markets

Management of an industrial mineral project and marketing of the products requires sophisticated skills to generate profits for shareholders and this can be a challenge to mineral engineers. Due to the large volume and relatively low value of industrial mineral products, the survival and growth of any industrial mineral venture depends upon the business strategies and marketing skills of the engineers. Thus, it is not just enough to produce the industrial minerals but sophisticated and innovative management and marketing skills are required to market the products and compete in the open market since there are no ready markets for industrial mineral products. Proactive marketing skills are also needed to bring in manufacturing industries that will patronise the products of these mines.

The large volume of industrial mineral products to be marketed also demands that the transportation costs incurred in getting the products to the users be factored into the siting of such concerns. Hence, as much as possible, the end users of the products should be situated within an economically viable location. The generally accepted norm is that the industrial mineral products should not be transported over distances exceeding 161 km to the end users otherwise the transportation costs become excessive and could easily make the business uneconomic (Mensah-Biney, 2002).

Thus, subject to other economic and technological constraints, it would be more beneficial to site an alum producing plant around Awaso or Nyinahin where bauxite occurs and to set up a glass manufacturing plant within a few kilometers from a possible silica mine at, say, Kuranti in Ghana.

6.4 Adding Value to the Minerals

Another role that the mineral engineer can play is in innovative ways of adding value to the minerals. To ensure effective and sustainable development, and utilization of the mineral resources in Ghana, it is important to add value to minerals and to reprocess some of the waste materials. For example, setting up a hydrometallurgical plant in Ghana for the production of alumina would be a capital-intensive project with a long payback period. Capital for such a project will be difficult to raise locally. Work done by Acquah *et al.* (1996) shows that the bauxite in Ghana is suitable for the production of alum. Thus, the bauxite could be processed into alum to feed the local waterworks and also for export in the sub-region. Value can be added to many of the other minerals as in the case of iodated salt. Also there should be value addition to gold and manganese by setting up gold refinery and enhanced processing of manganese in Ghana.

6.5 New Trends in Equipping Mineral Engineers

The syllabuses and course structures used in training mineral engineers locally in Ghana's universities have been expanded to include many other courses in addition to the conventional mining and mineral processing courses. More emphasis is now being placed on courses such as business management and entrepreneurship, project evaluation, financial management and quality control. Others are plant design and control, environmental management and innovative ways of processing local minerals. The 3-year diploma programmes have been converted to 4-year degree programmes to sharpen the engineering base of the programmes without sacrificing their practical outlook. Modular Course programmes, in which courses (called Modules) can be taken in isolation or accumulated towards the award of postgraduate degrees have also been introduced. These modifications in the course structures will put the mineral engineers in a better position to help sustain Ghana's minerals industry. In addition, many of the engineers who went through the old curricula are enrolling into the modular programmes to up-grade their skills (Sraku-Lartey, 2000; Anon., 2001).

7 Policy Frame Work

The industrial mineral reserves in Ghana can be exploited on small, medium and large-scale basis. The current mining laws prevent foreigners from investing in small-scale mining projects. Thus capital for small-scale ventures has to be sourced locally. However, the laws allow local entrepreneurs to seek partnerships with foreigners to invest in medium to large-scale projects. Ghana's Mining and Mineral laws need to be amended to allow foreigners to invest in small scale mining projects and also to give support and incentives such as long tax holidays to local entrepreneurs who are willing to invest in the minerals industry. However, the mining and mineral laws must have stringent conditions for small, medium and large-scale mining operations to be done in a sustainable and environmentally friendly manner.

The local Municipal and District Assemblies in the areas where the mineral resources are located should be the driving force behind the economic development of these resources and not the central government. In this regard, it is important for the Minerals Commission to work together with the Geological Survey Department, the Ghana Chamber of Mines, the local Chamber of Commerce and the authorities of the Municipal and District Assemblies where mineral reserves are identified to prepare the ground work for the exploitation of such minerals. The profitability of any mining venture is directly related to the anticipated success of the exploration, development, production and marketing stages. Thus investments that result in successful exploration programmes are necessary for the survival of the ventures. If a mining project passes through the detailed exploration stage successfully, then it can either grow by horizontal integration through the development and operation of an increasing number of mines or by forward (vertical) integration into further processing of the primary minerals. Growth may also come about by diversification into other areas of industrial activity. Linkage effects with other sectors of the economy are also essential. Backward linkages with some local industries should be established for the domestic production of simple mining and processing equipment, transportation and housing facilities and for research into novel processing techniques. Forward linkages into further processing of materials can also be strengthened as discussed earlier.

The appointment of managers and board members of mining and mineral processing companies should not be based on political affiliations but on professional competence and experience in the

minerals business to create a climate of rural industrialisation in Ghana. Ghanaian managers must continuously demonstrate a high level of management skills and business savvy required to manage these resources efficiently to generate profits as well as to improve the conditions of living in the rural communities where they operate through community development projects like schools, clinics and sporting facilities. Such a policy will allow for the direct application of mineral resources development, for job creation and rural industrialisation.

8 Conclusions

It has been noted in this paper that:

- The minerals industry of Ghana has a very high potential for revenue generation, job creation and industrialisation of the rural areas if properly developed and sustained by the concerted efforts of all stakeholders (mineral engineers, policy makers and the business community).
- A drive for both local and foreign investment in the minerals sector will lead to the creation of many direct and indirect jobs. It will also lead to the expansion of the tax and royalty base of both the central government and the local Municipal and District Assemblies where the mineral deposits are located.
- All stakeholders must see to the formulation of new competitive mining and minerals laws, and the amendment of existing laws that will encourage investments in the minerals sector particularly in the small-scale mining of industrial minerals.
- The central government must offer significant tax reliefs and tax holidays to local small and large-scale mining operators and companies that add value to their mineral products in order to generate more sales revenues, and to support and expand other allied local industries that rely on the products and services of the minerals sector.

The ability to meet the above conditions is a challenge to all stakeholders in the minerals industry ranging from mineral engineers through chiefs and policy makers to the authorities of the Municipal and District Assemblies where the deposits are located and the central government.

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