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DEVELOPMENT OF THE NON-METALLIC MINERALS AND THE SILICATE INDUSTRY IN TANZANIA

VOLUME II

A PROFILE OF THE SILICATE INDUSTRY IN TANZANIA

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INTRODUCTION

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A developing country needs reliable and detailed information regarding the availability of industrial and agricultural raw materials for planning its development programmes. The availability of mineral deposits in economic qualities and quantities can determine not only the country's industrial development but also its success in agricultural development.

The base case must be to have the whole country generally geologically mapped. Initial mineral reconnaissance is usually undertaken by National Geological Survey which then leads to detailed exploration work. In Tanzania about seventy-five percent of the country is geologically mapped by the Mineral Resources Division of the Ministry of Energy and Minerals, but financial constraints have prevented the implementation of meaningful detailed exploration work to determine with certainty the mineral potential of the country. Lack of funds and modern field exploration equipment as well as inadequate laboratory facilities for carrying out the required physical, chemical and technological tests have hindered progress in the development of Tanzania's mineral resources.

The country's non-metallic mineral sector, which is highlighted in this book, has attracted very little financial support in the past, and in consequence the available geological information is scanty and inadequate for planning of the industry's development. In Part I of this book the authors have reviewed the available data on some of the most important non-metallic minerals. These minerals are also among the most important raw materials for the 'silicate industry' discussed in Part II. However, there are other non-metallic minerals which are important raw materials for the 'silicate industry'. These include magnesite, bauxite, sillimanite–kyanite group, graphite, soda ash, talc, vermiculite, diatomite, asbestos, dimensional and ornamental stone, etc.

A large quantity of natural soda ash deposit in the form of crust and brines exists in the Lake Natron, in the northern border with Kenya. Exploration work carried out in the past has revealed that the deposit contains not only large quantities of sodium carbonate and sodium chloride (with at least 136 million tonnes of Na_2CO_3 and 24 million tonnes of NaCl), but also significant quantities of other sodium salts, including sulphates, fluorides and phosphates, all of which would be of economic interest. The source of these salts is alkaline springs associated with the East African Rift Valley System and it is estimated that some 5,000 tonnes of salts are added to the lake from the springs every day.

The State Mining Corporation is currently working out a programme for exploiting these natural resources in order to meet the rapidly growing demand for purified soda ash now standing at about 20,000 tonnes per annum. With the expanding glass industry, pulp and paper industry, soap industry, etc., which are the main consumers of soda ash, the demand is expected to go up considerably in the next few years.

Magnesite ($MgCO_3$) deposits of possible economic grade occur as veins and stringers in ultrabasic intrusions in the Precambrian rocks of Tanzania, particularly in the Usagaran System. Some of the better known occurrences are those of Chambogo, Longido, Lobolosoit, Kijungu, Lossongonoi, Haneti and Itiso. Reserves are estimated at over 1,000,000 and 5,000,000 tonnes at the Chambogo and Lobolosoit prospects respectively. Beneficiation tests by flotation have succeeded in producing a concentrate assaying about 48 % MgO and 1.2 % SiO_2. The State Mining Corporation is currently investigating the economic viability of exploiting these deposits mainly for export.

Crude magnesite has been used in small quantities in pharmaceuticals for the preparation of such chemicals as Epsom salts. Dead-burned magnesite is used almost entirely as a refractory mortar. It can be used directly as a grain product or as a constituent of brick, ramming mixes, gunning mixes or castables. The refractories made from magnesia have a wide variety of uses, the main uses being in cement, glass, steel, and copper industries.

Magnesia based refractories have the quality of withstanding effects of basic slags at high temperature and are said to be more economical in respect of cost of refractory per tonne of product. Magnesite is also used as a source of magnesium metal.

World demand for magnesite is expected to continue rising, particularly in the manufacture of refractories, paper, cement, rayon, in the chemical industry, for water treatment, in the construction of large aircrafts of the Jumbo type (Li-Mg and Al-Mg alloys), motor vehicles, etc.

Kyanite minerals which include kyanite, sillimanite and andalusite are anhydrous aluminium silicates with the formula $Al_2O_3SiO_2$. Dumortierite ($HAl_2Si_3Al_6BO_{20}$) and topas ($Al_2(F,OH)_2SiO_4$) are also included in this group because they are closely allied in composition and thermal behaviour.

Kyanite is widely spread in the metamorphic rocks of Tanzania. A deposit of possible economic significance has been recorded at Hedaru in the Same District where it forms bands of kyanite in schists and gneisses, in association with quartz, with or without sillimanite. It also occurs in other areas including Makanya, Handeni, Lushoto, Mbulu, Mpwapwa and Sumbawanga.

The widest use of the kyanite group is in the manufacture of refractory mortars, cements, cast and plastic ramming mixes, etc. where it forms between 10–40 %; the rest being refractory clays and coarser grog materials.

The deposits will need to be beneficiated in order to produce a kyanite concentrate free of the intergrown quartz. Beneficiation tests of the Hedaru deposit by floatation have given concentrates containing 50–59 % $Al_2O_3SiO_2$. Reserves have not been established, and only some limited quantity (200 tonnes) have been estimated at the Hedaru prospect. Detailed geological investigations would therefore need to be carried out in order to establish the actual economic potential of these deposits. World demand for kyanite for the manufacture of refractories is expected to go up annually, particularly refractories for iron and steel, in glass and ceramics and in metallurgy or other metals.

Another mineral mainly occurring in the Usagaran schists, gneisses and crystalline limestones which has not been discussed in the text is graphite. Graphite is extremely refractory, being little affected by temperatures up to 3,000°C. It is not affected by acids and other reagents. It is a good conductor of electricity.

Economic deposits occur as flakes disseminated in metamorphied sedimentary rocks or disseminated in marble. The best known deposits are those of Nangaga in Masasi and Chikingula Hills in Nachingwea, Ndanda and Chikundu in Mtwara, Ndolola in Mahenge, Eastern Uluguru Mountains, Mpwapwa in Dodoma Region, Shambarai in Arusha and in a number of localities in Same and Mwanga Districts. In some localities it occurs as high grade graphite-bearing bands ranging from few centimeters to tens of meters in width. Detailed exploration and beneficiation tests to assess the viability of exploiting these deposits will need to be carried out. Graphite is used for the finishing of the inner surface of moulds in metallurgy and in the manufacture of crucibles for melting and casting of metals. It is also used in lubrication, in manufacture of pencils, paints, batteries, carbon brushes and electrodes.

One other non-metallic mineral or rock of industrial importance which has not been discussed in this volume is phosphate raw materials. The major source of phosphate (P_2O_5) is the guano type of rock phosphate. The Minjingu phosphate deposit associated with Neogene Lake beds in the Arusha region is the only guano type deposit which has been properly studied. It is currently being exploited by the State Mining Corporation and supplying raw materials to the fertilizer plant in Tanga. The deposit extends over an area of 300 m by 600 m and the phosphate layers occur in seven or more horizons.

There are three workable beds ranging from 1 m to 3 m in thickness. Mineral association include hydroxyl apatite ($Ca_5(PO_4)OH$) and carbonate apatite or dahlite ($Ca_{10}(PO_4)_6(CO_3)H_2O$). It occurs in two types of phosphate rock: a fine-grained friable type with P_2O_5 averaging 21 %. The soft phosphate is easily upgraded by dry screening method. Workable tonnage is estimated to exceed 4 million.

Another potential source of P_2O_5 is the apatite occurring in association with carbonatite bodies and crystalline limestone and marble formation. The Panda Hill carbonatite in Mbeya and the Sangu–Ikola carbonatite near Lake Tanganyika have appreciable quantities of apatite, the latter having values up to 5–7 % of the rock. Beneficiation tests on the Mbeya deposit have produced concentrates containing up to 80 % apatite on laboratory scale.

The Zizi apatite bearing marble near Morogoro, interbarded with hornblende and biotite gneisses, measuring over 30 m in thickness and extending over a distance of more than 1,000 m, has been investigated several times. The material contains up to 4.5–10.5 % P_2O_5 and reserves up to the depth of 30 m have been estimated at about 2,000,000 tonnes of apatite rock. Beneficiation tests carried out by gravity concentration indicated that it is possible to produce a concentrate containing over 25 % P_2O_5.

It is estimated that world consumption of phosphate will continue rising by 5 % per year, and in developing countries by over 10 %.

The current national drive to revive the economy through improving agriculture puts the demand for fertilizers at a much higher level than before. Not only will the traditional fertilizers raw material need to be aggressively investigated and exploited but there is also a need to start using the other potential non-metallic minerals and rocks, hitherto not used for fertility improvement, such as bentonite, perlites, zeolites, tuffites, basalts, carbonate rocks, feldspar, gypsum, etc., which could be used for soil with certain deficiencies, and as animal feed additives.

Associated with the phosphate deposits at Minjingu is bentonitic clay which forms interculations up to 3 m thick. It is estimated that the bentonitic clay deposit in this area could be several millions of tonnes. This bentonite is the Ca^{++} type (as compared to the Na^{+} type), and therefore ideal for use in soil improvement for agriculture.

The Na^{+} type which has much higher swelling capacities than the Ca^{++} type (forming gel-like masses when added to water), and therefore most suitable in deep-well drilling as drilling mud, is not known to occur in Tanzania. Bentonite is also known to occur at Gelai at the shore of Lake Natron and at Sinya east of Namanga border post where it overlies a meerschaum formation. The reserves at Sinya have not been estimated but they are large. At Gelai at least 300,000 tonnes are estimated to exist.

It should also be pointed out here that the exploration works carried out in the past on most of the non-metallic minerals discussed in this volume have not been detailed enough to give an accurate picture of their future potential. It will therefore be necessary to make a constant review as new information becomes available regarding the qualities and quantities of the various deposits. For example the large quantities of kaolin deposits described by Mwakarukwa near Dar es Salaam and other areas (Chimala, Malangali, etc.) will need further investigation to establish their grades and potential uses. It is estimated that the demand for kaolin will continue to rise particularly in the paper industry and in the ceramics industry. Other known non-metallic minerals deposits of possible economic importance which have not been described in the text include low grade bauxite deposits which occur as a product of weathering of Usagaran gneisses and granites at Aman in Tanga Region, and vermiculites which occur in association with pegmatites in several localities in the Usagaran Rocks. Vermiculites (expanded) should continue to find their use not only in the manufacture of building materials but also as insulation material and for purification of air and water.

Talc ($Mg_3Si_4O_{10}(OH)_2$) sometimes referred to as soapstone, is found in many localities in the metamorphic rocks of Tanzania. In most cases the talc, which is a product of hydrothermal alteration of basic and ultra-basic igneous rocks, is associated with such other minerals as chlorite, tremolite, magnesite, calcite, dolomite, etc. Talc is a very versatile mineral. Presently talc is used in the production of cosmetics, as extender and filler pigments in the paint industry, in the coating and filling in rubber industry, in electronics, in spacecraft and it is an important filler material for plastics. Other uses include bleaching agents, floor wax, water filtration, leather treatment (oil absorption), insecticides, textiles, shoe polishes, welding rod coatings, printing inks, coating for iron ore pellets, etc.

Some of the best known deposits include those of Dodoma (Kikombo, Mayetu-Hombolo, Matumbulu, Kufu-Kisigo), Same (Hedaru), Mbeya (Isenge in the Songwe River near Lake Nyasa), Makete (Near Tandala Mission), Mpwapwa (Ruaha, Chipogolo), Mpanda (Ipolomelo-Manyoni) and Chunya (Kasanga, Lupa Bridge). Reserves are not known although small quantities amounting to 130,000 tonnes are estimated to be at the Kikombo soapstone prospects, 1,000 tonnes at Tandala soapstone and over 300 tonnes at Hedaru talc prospect.

The available information regarding these and other deposits is limited and further exploration work will need to be carried out in order to determine precisely the qualities and quantities of this potentially valuable mineral.

It will be necessary to revive and strengthen the Mineral Resources Division (Geological Surveys Division) so that it continues to provide the basic geological and mineral reconnaissance information which would form the basis for detailed exploration work.

The Division has the advantage of having well qualified professionals, but these are unfortunately at present greatly under-utilized. Their proper utilization should be able to contribute positive results in the mineral development efforts within the next few years.

It will be necessary to invest in modern field exploration tools and equipment and to make improvements in the laboratory facilities for carrying out the necessary physical, chemical and technological studies on the large number of samples that would be collected. The use of efficient and accurate methods for chemical analysis such as spectrometers will be necessary in the extensive exploration work required for establishing a correct inventory of the mineral potential.

The technologies used for the manufacture of cement, glass, ceramics and lime in Tanzania have been outlined in Part II, and present efforts, constraints and future plans and prospects are highlighted. Areas offering prospects for future investment within the silicate industry include diversification of the cement, glass and ceramics industries, and establishment of refractory industry. At present only ordinary Portland cement is being produced. However, it is possible to produce other types of cement, namely:

Editor's Biography

Rumisha Henry Kimambo is General Manager of the Tanzania Saruji Corporation in Dar es Salaam, Tanzania. He was born on 15th February, 1934, in Kilimanjaro Region, Tanzania.

He has an extensive professional background and experience in geological field and management. Mr. Kimambo was the first General Manager of the State Mining Corporation of Tanzania from 1972 to 1976 prior to his present job. He has worked as Assistant Commissioner for Mineral Resources (1971 to 1972) and Chief Geologist (1969 to 1971) in the Geological Surveys of Tanzania.

Mr. Kimambo is a graduate in Geology, University of Glasgow, UK, 1965, M.Sc. in Mining and Mineral Exploration – University of McGill, Montreal, Canada, 1969.

He has attended many short courses, workshops and seminars particularly in the fields of management of public enterprises and development of mineral resources. He is Chairman/Director in a number of Boards and is currently President of the Geological Society of Tanzania.

Mr. Kimambo is the author of "Mining and Mineral Prospects in Tanzania" and "Development of the Non-metallic Minerals and the Silicate Industry in Tanzania, Volume I: Basic Concepts, Strategies and Achievments".

Mr. Kimambo examining rock for use as aggregates at Msolwa Quarry.
Photo: R. E. Mwihambi.