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COOPERATION IN THE DEVELOPMENT OF INDUSTRIAL AND AGRICULTURAL MINERALS IN EASTERN AND SOUTHERN AFRICA

TABLE OF CONTENTS

		Page
I.	INTRODUCTION	1
II.	USES OF INDUSTRIAL MINERALS AND THEIR ROLE IN ECONOMIC DEVELOPMENT	2
III.	OVERVIEW OF THE SUBREGIONAL INDUSTRIAL MINERALS POTENTIAL AND CURRENT PRODUCTION OPERATIONS	5
IV.	STRUCTURE OF THE INDUSTRIAL MINERALS SECTOR IN THE SUBREGION	19
V.	ISSUES FOR DEVELOPING THE INDUSTRIAL MINERALS SECTOR AND STRATEGIES FOR ENHANCING COOPERATION	36
IV.	CONCLUSIONS	43
	REFERENCES	44

ABBREVIATIONS AND ACRONYMS

BGS	British Geological Survey
CDC	Commonwealth Development Corporation
COMESA	Common Market for Eastern and Southern Africa
ESAMRDC	Eastern and Southern African Mineral Resources Development Centre
GDP	Gross Domestic Product
GNP	Gross National Product
Ha	Hectare
IDRC	International Development Research Centre
IFC	International Finance Company
IFDC	International Fertiliser Development Research Centre
IGO	Intergovernmental Organisation
IMR	Institute of Mining Research
Kg	Kilogramme
Km	Kilometre
Kt,t	Kilo tonnes, tonnes
mm	millimetre
MULPOC	Multinational Programming and Operational Centre
NPK	Nitrogen, phosphorous and potassium
ODA	Overseas Development Adminstration
pH	Degree of acidity
SAB	Soda Ash Botswana
SADC	Southern African Development Community
SEM	Scanning Electron Microscope
STAMICO	State Mining Corporation
tpy	Tonnes per year
TEM	Transmission Electron Microscope
UNECA, ECA	United Nations Economic Commission for Africa
UNIDO	United Nations Industrial Development Organisation
XRF	X-ray Fluorescence

I INTRODUCTION

Industrial and agricultural minerals have one thing in common; they belong to the category of minerals which are not mined for the extraction of metallic values, but for the physical and chemical properties they possess. For this reason, a favoured and more descriptive definition of this group of minerals is the term non-metallic minerals, rather than industrial minerals. Quite often, the two terms are used interchangeably, a convention which has been adopted for this report. Since agricultural minerals are industrial minerals, the distinction between the two groups of minerals, as implied in the title of the report, is superfluous and has not been emphasised in the report. Thus both the terms industrial and non-metallic minerals are used liberally to include all types and form of agricultural minerals.

Although energy minerals are mined not with the intention of extracting metallic values, they have not been included in the report. This is partly because of controversy whether they belong to the industrial minerals category. More important, however, their inclusion would greatly widen the scope of the report.

The member States of the Eastern and Southern African subregion are both individually and collectively well endowed with non-metallic mineral resources which could play a critical role in the development of their economies. Their exploitation and domestic use has, however, always been grossly incongruous with this endowment. This fact has been known for a long time although the reasons have not always been visible. Due to this discrepancy, the ECA has over the years organised meetings and workshops, at the request of member Sates, at which non-metallic minerals have been discussed. These have, for example, included the Regional Workshop on the "Enhancement of the Contribution of African Non-Fuel Mineral Sectors Towards the Region's Economic Advancement", held in Harare, Zimbabwe, between 30 July and 3 August, 1990 and the biennial conferences on the Development and Utilisation of Mineral Resources in Africa.

At these meetings a number of positive recommendations for developing the non-metallic minerals sector were made. The discussions did not, however, address the inherent structural weaknesses of the sector and the specific role which cooperation could play to increase the exploitation and use of non-metallic minerals both at national and subregional levels. This prompted the member States, through the Twenty-Eighth Session of the Commission/Nineteenth Meeting of the ECA Conference of Ministers responsible for Economic Planning and Development, to include in the programme of work and priorities for the Lusaka-based MULPOC for the biennium 1994/95, a study devoted to "Cooperation in the Development of Industrial and Agricultural Minerals in the Eastern and Southern African Subregion".

This report presents the findings of the study. In executing the study, missions were undertaken to several member States, namely; Namibia, Tanzania, Zambia and Zimbabwe to assess their industrial minerals potential. In addition, extensive literature sources, in respect of other countries including Malawi and Mozambique, were consulted so that a representative opinion of the subregional status of the non-metallic minerals sector could be formed. Specific aspects of the sector addressed in the study include the resource potential and production of non-metallic minerals; the structure of the industry and its major weaknesses; and the strategic areas on which cooperation could be predicated.

The major conclusion is made that cooperation at the national and subregional level represents the missing link to developing this crucial but marginalised sector of the minerals industry. At the national level, cooperation should be directed at harnessing the efforts of all major actors in the sub-sector; increasing the availability of economic information and improving the policy framework so that private capital does not discriminate against the non-metallic minerals sector. At the regional level, cooperation should be directed at ameliorating the severe deficiencies in national capacities, particularly in human resources development and research facilities; small market absorbtion capabilities for non-metallic mineral products; and inadequacies in economic infrastructure.

II USES OF INDUSTRIAL MINERALS AND THEIR ROLE IN ECONOMIC DEVELOPMENT

Although industrial minerals are characteristically low unit-value minerals, they are indispensably catalytic to the economic development of a given country. Globally, non-metallic minerals account for the major part of non-fuel production, both in terms of volume and value. This is not surprising given the diversity of their use, particularly in the key economic sectors of agriculture, manufacturing, construction and mining.

In agriculture, non-metallic minerals are used as fertilisers to improve soil fertility, as conditioners to correct the pH and salt content of soils and to conserve water and plant nutrients. The three most important plant nutrients, namely phosphorous, potassium and nitrogen (NPK), are derived from industrial mineral sources. In the manufacture of phosphatic fertilisers, phosphate rock and sulphuric acid, an iron pyrites derivative, are commonly used. Potassium is derived from sylvite and potassium-bearing silicates. Although the bulk of nitrogen production is from non-mineral sources, a significant proportion of production is from the mineral saltpetre. The wide range of non-metallic mineral resources utilised as soil conditioners include lime for reducing soil acidity; zeolites for increasing the ion exchange capacity of soils

and to conserve plant nutrients; and expanded perlite for limiting water loss by evaporation in ornamental plants in horticulture. Bentonites, scoria and pumice are used to increase the moisture retention capacity of soils, particularly in areas of severe water stress, while diatomites and zeolites are useful carriers for pesticides and herbicides. Non-metallic minerals are also used in the manufacture of stock feed as grit.

Perhaps the widest diversity of use of non-metallic minerals is in manufacturing of consumer and industrial products. Clays and limestone are used in the paint, plastic and rubber industries as fillers, filters and absorbents and in the manufacture of paper products as a coating agent. Silica sand, kaolin, limestone, dolomite and feldspar find wide application in the manufacture of glass and ceramic products while bentonite is used in the oil drilling industry as a drilling mud. Many more non-metallic minerals find use in the chemical industry including the manufacture of soaps and detergents, toothpaste, textiles, leather tanning, beauty and pharmaceutical products.

In the construction sector, limestone, dolomite and granite are used as aggregate for road construction, in buildings as dimension stone, for cement manufacture with other additives such as gypsum, while bricks for both commercial and domestic buildings are made from clays, sand and gravel.

The mining and metallurgical sectors are dependent on the availability of non-metallic minerals from which refractory bricks for melting furnaces are made. These include andalusite, dolomite, kyanite, magnesite and bauxite. Further use of non-metallic resources in the mining industry include their addition during the smelting of metallic ores to lower melting temperatures, and also enable the formation of a slag layer which is essential to the separation of the pure liquid metal from impurities.

Within traditional communities, non-metallic minerals have been used since time immemorial for the production of brick and mortar for the construction of shelter and in earthenware for cooking utensils. Indeed, lime burning is still a common feature in traditional communities of the subregion.

The range of uses cited above is illustrative Yet it is clear that industrial minerals are not only used in practically all sectors of an economy, but individual minerals find use across several economic sectors. Furthermore, they are used in the manufacture of everyday products which are used across the entire strata of social and industrial communities. It is precisely this diversity of use which makes non-metallic minerals the pillars of industrialisation and economic advancement; their ability to forge linkages across the entire spectrum of socio-economic activity.

Weighed against higher unit value minerals such as base metals, precious metals and minerals, and diamonds, it is paradoxical that industrial minerals are rarely accorded a commensurate level of priority in key economic planning activities. For developing countries, high unit value minerals are exploited principally to earn foreign exchange for the national economy. Their operations are generally skill, capital and technologically intensive. This is because in nature, the minerals occur in low concentrations. To obtain a unit of product, multiple processing stages and a large throughput are necessary. As mining proceeds, increasingly lower grade materials, at progressively higher input costs, have to be worked. These factors demand large scales of operations to maintain low production costs per treated unit and hence maintain competitiveness. High freight costs and large transportation distances to overseas markets, also add to the need to produce low bulk products.

The retained value of high unit value mining ventures to a developing economy is, however, exaggerated. In terms of product dissipation within a national economy, base metals and other high unit value mineral industries are characterised by a lack of linkages with other economic sectors and tend to exist as enclaves. The minerals are strictly exploited for commodity purposes irrespective of whether international prices are remunerative, and quite often they are not. Their real contribution to economic development, particularly as measured in the standard of living of the civil society, is not often visible. Examples abound with a prime one perhaps being Zambia with a long history of a very large copper mining sector. At present, the country is one of the poorest in the subregion with a GNP per capita of US $243 (1992) and a cycle of poverty which is deepening rather than abating.

In contrast, because of their low value and high bulk, non-metallic minerals are generally mined for consumption within a limited geographical extent. They cannot be transported over long distances without financial losses except in some cases where their unit values are sufficiently high to cover the cost of such transportation. Often, much of the value-added benefit they create is entirely locally dissipated. This enhances the retained value accruing to the national economy from their production operations. The retained value is further enhanced by the fact that their production is generally less skill, capital and technologically intensive and can be initiated using relatively lower capital outlays, simple technologies and labour intensive methods. They thus contribute to a greater degree of employment creation and diversification, broaden the tax benefits to the state, enhance the building of human and technological capacities and enhance the process of industrialisation. This makes their increased production in subregional countries not only attractive but imperative.

III OVERVIEW OF THE SUBREGIONAL INDUSTRIAL MINERALS POTENTIAL AND CURRENT PRODUCTION OPERATIONS

The Eastern and Southern African countries are well endowed with a diversity of industrial minerals some of which are exploited to support economic activity. It is not possible within the scope of this report to describe this resource base completely. However, a reasonable understanding of the resource base and the operations of the industry can be gleaned by examining a representative sample of member States from the subregion. In this connection, the industrial minerals sector of six countries, namely Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe have been assessed. The countries were chosen on the basis of a number of factors which have a significant bearing on the exploitation and use of industrial minerals. These include the resource endowment, the level of economic activity and the size and capability of the mining industry in each country. At one end of the spectrum would be Malawi, traditionally perceived as an agricultural economy with relatively no significant mineral wealth, and certainly no notable mining industry. At the opposite end would be Zimbabwe with a historically acknowledged and richly diversified mining sector, coupled with a well-balanced and vibrant economy.

Malawi

Although the industrial mineral resources of Malawi are not inconsiderable, mining in general is at a nascent stage with small scale activities in lime burning and medium scale operations in quarrying for aggregate and cement production. The main reported minerals include vermiculite, phosphates, bauxite, heavy mineral sands, glass sands and kaolinitic clays, limestone, kyanite and graphite (1).

Vermiculite occurs at several locations at Garafa, Phate, Matembe, Kapirikamodzi and Njiza in the Mwanza District. Total reserves have been estimated at 2.5 million tonnes of 10% vermiculite with a grain size greater than 0.5mm. Beneficiation studies have not been conducted and would be required prior to exploitation (1).

Phosphate deposits occur at Tundulu as igneous apatite with an average grade of 15-20% P_2O_5 and reserves of just over 1 million tonnes (1). The phosphate material has been used for many years in direct application tests on perennial crops such as tea. However, the deposit is rather small to support any major phosphate industry. About 200,000 tonnes of fertiliser are consumed in Malawi each year.

Bauxite of a commercial grade is available at Mulanje where reserves are estimated at 28 million tonnes with an average

composition of 43.9% Al_2O_3 (1). This appears to be the largest bauxite deposit in Eastern and Southern Africa. A detailed feasibility study is currently being undertaken as part of a SADC initiative.

Heavy mineral sands, containing the titanium minerals rutile and ilmenite, have been reported in several places. The best known deposit lies between Kachulu point and Linthipe River with reserves estimated at 70 million tonnes and average grades of 3.27% ilmenite and 0.31% rutile (1).

Glass sands occur in a number of dambos in the Mchinji area with reserves reported to be substantial. Kaolinitic clays, for the ceramic industry, occur at Linthipe in Dedza, and Nkande and Senzani in Ntcheu. At Linthipe, total reserves have been estimated at 14 million tonnes (1). Other industrial minerals of significance include limestone which is widely distributed in the country and is used for cement production in the clinker factory at Changalume, and traditional lime burning in many parts of the country. Proven limestone reserves stand at only 20 million tonnes but the resource base is estimated at 600 million tonnes. Graphite is reported at Katengeza with reserves of 350,000 tonnes and a grade of 3% graphite (1).

Table 1 gives a list of the major industrial minerals produced in Malawi in the last few years.

Table 1: Industrial Mineral Production in Malawi

MINERAL	1989	1990	1991	1992	1993
Cement (Kt)	102	102	98.31	115	127
Limestone (Kt)	121	145	175	117	121
Lime (Kt)		4	5.29	3.25	2.5
Aggregate (m^3)	145,068	64,562	100,091	85,599	380,308

Source: Malawi Country Profile - in reference 15

Mozambique

The industrial minerals resource base of Mozambique is large but remains unexploited partly on account of the country's insecurity situation which persisted for many years until the UN supervised elections in 1994. Some of the major resources include heavy mineral sands, phosphate, graphite, gypsum, limestone, kaolin, bentonite, silica sand, fluorite, bauxite and construction materials. Current mining activities are, however, limited to marble, bentonite, graphite and bauxite (2).

Heavy mineral sands, containing the minerals ilmenite, rutile, zircon and monazite occur extensively in Mozambique, in sufficient quantities to place the country into a major producer category. The most promising deposits are located between Quelimane and Quinga, and the Angoche region. Total titanium resources in Mozambique are estimated at 348 million tonnes (2). Detailed information is generally available on the heavy mineral sands. A number of them, unfortunately are relatively low grade and would require upgrading (3). Heavy mineral sands have in recent years attracted significantly renewed exploration interest from multinational companies including Edlow Resources (USA), Gencor (SA), Kenmare Resources (Ireland), and Aquater Spa (Italy). Some of the exploration work is reported to have advanced to feasibility stage (2).

Two economically interesting deposits of phosphates occur in crystalline limestone at Muande and Evate. The reserves at Muande are 4.15 million tonnes of apatite-magnetite ore with an average P_2O_5 content of 5%, while that at Evate is reported to contain 155.41 million tonnes of similar ore at a grade of 9.32 % P_2O_5 (3). The phosphate from carbonatite deposits is generally too low in grade for commercial exploitation while the guano deposits are small in extent. The commercial viability of the Muande and Evate deposits has not been evaluated.

With good quality graphite present in many parts of the country, Mozambique has a long history of graphite mining. The best known deposits occur in Angonia, Monapo and the Lurio belt with total reserves of about 40 million tonnes (2). The Lurio belt contains some thirty occurrences with resources estimated at 30 million tonnes of graphite at an average grade of 9.5%. One of the occurrences at Ancuabe has been developed by Kenmare Resources into a producing mine. The main graphite body at Angonia has been the subject of a pre-feasibility study and is amenable to dressing, and is located in an area with excellent infrastructure.

Mozambique boasts of rich gypsum resources, particularly in the deposits south of the river Save, discovered during oil and gas drilling. Prognostic reserves of 250 million tonnes appear overestimated and require detailed evaluation. However, the total

gypsum/anhydride resources in the Pande-Temene gas fields have been estimated at 140 million tonnes (3). Despite the large resource potential of the country, gypsum for cement manufacture is imported into the country.

Reserves of glass sands, especially in the coastal belt are inexhaustible but the sands need treatment to make them suitable for various industrial applications, particularly for the manufacture of clear glass (3). Investigations have been undertaken on sands at Marracuene in the vicinity of Maputo to supply a container glass factory and a local foundry. Reserves are estimated at 11.4 million tonnes (2). Limestone for the container glass factory comes from Salamanga, feldspar from Ribaue in North Mozambique while soda and sodium sulphate are imported.

Limestone resources in Mozambique are wide spread and are sufficient to cover the country's needs for cement and lime production, and other industrial uses in ceramic and glass manufacture. Estimated reserves reportedly measure in thousands of millions of tonnes (3). The country has three cement factories located at Matola in Maputo, Dondo near Beira and at the port of Nacala. The limestone for the factories comes from Salamanga, Muanza and Nacala deposits, respectively. Lime production is undertaken at the Dondo and Maputo factories and is used in the building, agricultural and sugar industries. Production at the three factories appears to have stalled in the late eighties. High purity limestone, with potential for use as filler in paper, rubber and plastics products occurs at Cheringoma.

Bauxite resources in Mozambique total about 6.13 million tonnes (2) and occur in several localities. The only deposit in production is at Serra de Moriangane in Manica Province, mined by a Zimbabwean Company for use in the production of aluminium sulphate in Zimbabwe. Other areas with bauxite occurrences are Monte Salambidua in Tete Province and Monte Mauzo in Zambezia Province.

A sizeable bentonite deposit occurs at Boane, 40 km south-west of Maputo. Total reserves in the Boane area are estimated at 15 million tonnes (3). A bentonite factory producing 12,000 tonnes per year of processed bentonite, mainly for foundry use, is installed. This appears to the only bentonite processing plant in the subregion. The bentonite is of the calcium type and a plant for sodium activation is available.

Smaller deposits of industrial minerals of economic interest in Mozambique, with estimated reserves, include fluorite (1.45 mt), Kaolin (4.4 mt), asbestos (0.5 mt), black granite (2 mt), perlite (0.95 mt), mica (72,000 t), and feldspar (12,000 t) (2).

Mozambique has one ceramic factory at Umbeluzi, about 30 km west of Maputo, producing mainly wall tiles and minor quantities of tableware. Although the country possesses excellent resources of ceramic raw materials, the factory does not have a section for the preparation of ceramic bodies because it was designed to use pre-mixed batches imported from Portugal. In 1981 tests were undertaken in Czechoslovakia to substitute for the imported raw materials (3). Various ceramic materials were tested including clay from Umbeluzi, limestone from Salamanga near Maputo, kaolin from Muiane and Nacala in Nampula province, and sand from Marracuene near Maputo. Although the wall tiles made were of comparable quality to those using the mixture from Portugal, there were no resultant production facilities.

Mozambique also has a fertiliser plant built in 1966 and located at Matola, 15 km north-west of Maputo. The main products of the plant with an industrial minerals content are ammonium sulphate and single superphospahte fertilisers, and sulphuric acid. Manufacture of these products used imported raw materials of sulphur and phosphate rock despite the latter's large potential in the country. Due to limitations of foreign exchange to purchase raw materials and undertake maintenance, the sulphuric acid, ammonium sulphate and single superphosphate plants shut down in 1983 (16).

Table 2 gives an indication of the industrial minerals produced in Mozambique.

Table 2: Non-Metallic Mineral Production in Mozambique

MINERAL	1989	1990	1991	1992	1993
Bauxite (t)	5,501	6,586	7,760	8,340	5,990
Bentonite (t)	130	126	660	1,500	0
Marble (m^3)	687	488	278.9	919	0
Graphite	*	*	*	*	*

* Production figures not available

Source: Mozambique Country Profile - in reference 15

Namibia

The industrial minerals sector of Namibia has undergone some promising expansion but is far from reaching its full potential. The contribution of the sector to total mineral export revenue stands at 2% (4) with government determined to increase this to some 10% in the medium term. The major mineral potential includes lithium minerals, salt and soda ash, fluorspar, graphite, wollastonite, dimension stone, lime and cement.

Lithium occurs in the zoned pegmatite deposits in the Karibib district. These have been mined continuously for over 40 years to produce petalite, amblygonite and lepidolite (4). Current operations at Rubikon Mine are focused mainly on petalite for which a ready export market exists. The operations are labour intensive, and technically uncoordinated. The reserves have not been fully evaluated although there are plans to do so followed by introduction of planned mining operations and possibly a mill.

Salt is recovered on a large scale from coastal solar evaporation pans at Swakopmund, Cape Cross and the Walvis Bay enclave. Current output is in the range of 145,000 tonnes per year (4). Existing potential from current facilities is four-fold but this is dependent on securing additional export markets. The potential for soda ash is represented mainly by the brine pans at Otjivalunda where total reserves of sodium salts are around 6 million tonnes (4). Small quantities have been produced from this source in the past but improvement of the road infrastructure would be an incentive to resuming production.

Large deposits of fluorspar occur at Okorusu Mountain of which the largest of three orebodies contains reserves of 2.9 million tonnes averaging 61% CaF_2 (4). A new open pit mining operation, producing 50,000 tonnes per year of acid-grade fluorspar, was brought on stream in 1988 in a joint venture between Namibian, South African and European investors.

Graphite potential is represented mainly by the deposit at Okanjande where reserves are sufficient to support a 500,000 tonnes per year mining operation for 30 years (4). A feasibility study and pilot plant tests were all positive. Implementation of the project has, however, stalled pending identification of overseas markets.

Known wollastonite resources are located at Goabeb near Swakopmund and at Mon Repos in the Karibib district. The former has drill-indicated reserves of 29,000 and there are plans to recommence mining operations on a small scale (4). The latter has estimated resources of 20,000 tonnes and is worked on a small scale labour-intensive basis, much in a non-coordinated fashion. There is a mill at Usakos which plans to produce a high quality long fibre

product for export to ceramic markets in Italy and Spain, and South Africa.

Namibia has large resources of dimension stone comprising mainly marble and granite. Most of the quarries are located between Karibib and Swakopmund with much of the output exported as blocks. Production averages about 20,000 tonnes per year although it has been steadily increasing (4). There is one processing plant at Karibib. A white dolomite marble quarry near Windhoek is exploited for the production of terrazzo while some low grade marble is quarried in the Karibib area to produce plaster and filler for the paint industry. Other areas of high potential for granite include Rehoboth and Okonjeje in the northwest.

Limestone is quarried for the cement factory located at Otjiwarongo with a production of 50,000 tonnes per year. The plant is operated by a partnership of local investors and Decovo Investments, a South African company (4).

Table 3 gives an overview of industrial minerals production in Namibia in the last few years.

Tanzania

Tanzania has a good industrial minerals resource potential although most of the mineral deposits have neither been fully explored nor developed. The mineral industry went through a general decline, particularly in the seventies and early eighties due to the existing political and economic climate. Since the late eighties, however, there has been renewed interest in exploration from both national and outside investors but this has been almost exclusively restricted to gold, diamonds and base metals (5).

High purity resources of limestone and dolomite occur in the Morogoro region for use both as dimension stone and high quality refractory grade limestone. Deposits of high quality travertine occur near Mbeya, in the south of the country. Lower quality limestone is liberally available and is used for cement production in Dar-es-salaam, Tanga and Mbeya with reserves of 20, 40 and 50 million tonnes, respectively. Cement production at the three factories has in recent years been affected by a variety of

Table 3: Major Industrial Minerals Produced in Namibia

MINERAL	1989	1990	1991	1992	1993
Amblygonite (t)	131	53	20	5	5
Aragonite (t)	0	0	19	90	0
Beryl (t)	0	25	6	0	0
Fluorspar (t)	25,679	27,107	27,816	37,680	43,466
Granite (t)	9,154	5,437	7,890	7,313	2,958
Gypsum (t)	0	0	0	380	558
Lepidolite (t)	41	81	33	93	87
Marble (t)	12,573	12,881	10,031	0	13,359
Mica (t)	0	0	0	2	0
Petalite (t)	1,226	1,134	1,139	1,064	649
Salt (t) (Common)	134,142	150,612	132,699	113,564	110,195
Salt (Table Fine, t)	750	980	2,230	1,843	2,097
Salt (Rock, t)	7,210	5,632	6,439	5,428	4,083
Quartz (t)	0	107	0	0	358
Wollastonite (t)	0	0	305	416	824

Source: Ministry of Mines and Energy, Annual Report 1993-1994, Republic of Namibia.

problems including power shortages (Dar-es-salaam), marketing and technical problems (Mbeya and Tanga). Artisanal lime burning is also common, particularly in the coastal region.

Deposits of beach sands have been reported in several places along the coast. The most important of these are in the Msimbati area where reserves of 33.5 million tonnes averaging 1.39% ilmenite, 0.22% rutile and 0.18% zircon have been delineated (6). The Dar-es-salaam-Bagamoyo area is also reported to contain 14 million tonnes of reserves with similar grades. For both the areas, much further investigations are required before feasibility and mining operations could be considered.

A number of clays, mainly bentonite, fullers earth and kaolin have been identified. Bentonite occurs at Lake Manyara, Gelai and Sinya while fullers earth accompanies phosphate occurrences at Minjingu (5). The Pugu kaolin deposit in Dar-es-salaam is reported to contain substantial but un-evaluated reserves of kaolin. It is currently worked at a small scale to produce kaolin mainly for the local paper, ceramic, paint, rubber and plastics industries, and silica sand by-product for the foundry industry. A feasibility study to expand production to more than 100,000 tpy was completed several years ago. Finances and a larger market have been limiting factors to implementing the findings.

There are two major types of phosphate deposits; carbonatites and sedimentary phosphates. The best known carbonatite deposit is at Panda Hill in the Mbeya district where low grade reserves have been estimated at 57 million tonnes (6). There is only one sedimentary deposit of phosphate at Minjingu in the Arusha district which contains 10 million tonnes of ore at grades ranging from 7 to 32% P_2O_5 (6). The Minjingu deposit has been worked by opencast methods and a dry processing method yielding a phosphate concentrate of around 30% P_2O_5. However, due to the closure of the Tanzania Fertiliser Company in Tanga, the major domestic market for the concentrate, the Minjingu mine ceased production in 1990 except for small quantities of material for direct application (5).

Tanzania is also reported to host substantial resources of graphite, principally in the Usagaran and Ubendian gneiss complexes. At Merelani Southeast of Arusha, coarse flakes of graphite occur in association with the gemstones tanzanite and tsavorite in weathered rock. SAMAX Ltd, a London-based company, in collaboration with the State Mining Corporation (STAMICO) and African Gems Ltd of the UK, have been developing a 240,000 tonnes per year open pit mine to produce a 99% graphite concentrate for overseas markets with a tanzanite by-product. Mining reserves are estimated at 12 million tonnes at 8% graphite with an additional 3.1 million tonnes at 12.5% graphite (5). Other graphite occurrences have been reported at Ndoloto in the Morogoro region

and Nachingweya in the Lindi region. The commercial potential of these deposits has not been evaluated.

There are substantial quantities of evaporites in Tanzania the majority of which occur in the highly saline rift valley lakes. Sporadic small scale extraction of soda ash from lake Natron is reported. The lake is said to contain 168 million tonnes of total salts of 20.1% Na_2CO_3, 11.2% NaCl, 0.41% K and 25% NaF (6). Problems of access, energy supply and distance from consumption centres appear to have hindered large scale commercial development. Other potential brine sources include Lake Ayasi and the Bahi swamp. Table salt is also produced at Nyanza and in the coastal region

Other notable industrial minerals of Tanzania include gypsum at Makanya, Itigi and Kilwa; feldspar in the numerous pegmatites of the Usagaran system; and extensive silica sand deposits. These minerals are sporadically mined at small scale levels for the cement and container glass industries. Previously, the minerals have been used in the manufacture of ceramic products, mainly tableware and sanitaryware at Morogoro. Unfortunately the ceramic factory closed down in 1990 due to technical and other difficulties.

Table 4 gives an overview of the industrial minerals production of Tanzania.

Zambia

A substantial number of non-metallic minerals are known to occur in Zambia but owing to a large base metal mining industry, non-metallic minerals have largely remained under-exploited. Also, unlike the base metal deposits which are well characterised, most of the industrial mineral deposits in the country have not been evaluated. Nevertheless non-metallic minerals produced in Zambia include limestone, gypsum, fluorite, talc, magnetite, silica sand, pyrite for sulphur, feldspar and ceramic clays (8).

Limestone and dolomite occur quite liberally, particularly around Lusaka, the Copperbelt, and Northwestern provinces. In the Lusaka and Copperbelt provinces, the limestone resources are used in the manufacture of cement and aggregate, and the production of lime for use in agriculture, the sugar and mining industries. High purity limestone is also processed for use in the manufacture of rubber products, mainly tyres, and consumer products such as scouring powders. In recent years the dimension stone sector has received much attention. Currently, marble and sodalite blocks are quarried around the Lusaka area for export. There are plans to establish a marble cutting factory in Lusaka (15).

Table 4: Non-metallic Mineral Production in Tanzania

MINERAL	1988	1989	1990	1991	1992
Cement (Kt)	189.3	540	540	540	540
Kaolin (t)	603	1,629	2,096	1,814	1,770
Gypsum (t)	19,57	5,895	36,15	35,26	35,20
Lime (t)	3,000	2,505	1,466	870	870
Phosphate (t)	5,851	6,101	32,83	2,000	2,000
Salt (t)	19,77	2,001	39,31	64,41	64,40
Sand (glass) (t)	12,04	13,10	6,365	4,263	4,200
Soda Ash (t)	300	300	300	300	300

Source: Tanzania Country Profile - in reference 15

Gypsum occurs at Lochinvar in surficial layers of clay. Reserves over part of the deposit are estimated at 174,000 tonnes at 23.1% gypsum. Provisional estimates for the deposit are put at 1.5 million tonnes at 15% gypsum (8). The deposit is intermittently worked to produce gypsum for the cement industry. Gypsum for the manufacture of plaster of paris and moulds for ceramic castings is imported. Tests were conducted by the School of Mines, University of Zambia in 1984 to determine the washing and burning properties of Lochinvar gypsum for the production of plaster of Paris. Although the results were favourable, there appears to have been no follow-up.

Deposits of pyrite occur at several locations. The best known is at Nampundwe where the pyrite is mined for the manufacture of sulphuric acid used in the production of fertilisers and in the mining industry.

Phosphate resources in Zambia are substantial with major deposits at Nkombwa in Northern Province and Kaluwe in the Eastern Province. Nkombwa is reported to contain 200 million tonnes of ore while the reserves at Kaluwe are in excess of 100 million tonnes.

The deposits are of carbonatite origin, of low grades and have complex mineralogies, particularly that at Nkombwa, and require research into beneficiation technologies. Successful processing tests and a feasibility study have been undertaken on the smaller deposit at Chilembwe. The deposit, however, contains only 1.5 million tonnes of ore at an average grade of 12% P_2O_5. Scales of economy dictate that it can only be exploited on a small scale level.

Raw materials for the ceramic industry are available at a number of locations. Most of the materials have been well characterised, particularly through several feasibility studies covering a number of industrial products including sheet glass, container glass and electrical insulators (7). However, information on reserves is largely unavailable. Silica sand occurs in the Kapiri Mposhi area and is currently mined by Kapiri Glass Products for use in the manufacture of container glass and ceramic products. Feldspar minerals are common in numerous pegmatite districts. Two deposits intermittently worked are in Serenje, in the Central Province and Siavonga in Southern Province. Ball clay is known to occur at several locations including Mansa and Chalata while kaolin resources are available at Chalata, Kapiri Mposhi and Masuku in Choma (7). The ball clay and kaolin deposits are also intermittently mined by several small scale operators for use in the glass, ceramic, paint and rubber industries. Due to financial and technical difficulties, the larger of the two ceramic factories was recently placed on a care and maintenance basis pending privatisation.

Table 5 gives a list of non-metallic minerals currently exploited in Zambia.

Zimbabwe

Zimbabwe has a large, vibrant and well diversified mining industry. The breadth of the mining base of the country can be illustrated by the fact that there are well over 1,400 operating mines (1993) producing more than forty different types of minerals for both export and domestic consumption (11). About 86% of the operating mines are gold mines located in the greenstone belt which is reported to have the highest known gold production per km^2 in the world (15). Zimbabwe also has the world's largest high grade chromite resources and the second largest platinum reserves. In the area of non-metallic minerals, Zimbabwe ranks second in the world production of lithium minerals and is the fourth largest producer of asbestos (1990) (11).

Although Zimbabwe has a large non-metallic minerals resource base, most of the deposits are not fully evaluated. Nevertheless, the country has some 55 operating mines in the non-metallic

Table 5: Non-Metallic Mineral Produced in Zambia

MINERAL	1989	1990	1991	1992	1993
Cement (t)	404,600	385,937	375,000	366,914	347,000
China & Ball Clay (t)	367	350	250	120	200
Feldspar (t)	120	20	60	70	11
Gypsum (t)	15,000	15,000	14,000	14,000	13,000
Lime (t)	239,000	320,000	250,000	184,000	212,000
Pyrite for Sulphur (t)	74,952	70,828	72,060	72,483	74,000
Talc (t)	73	114	160	89	366

Source: Zambia Country Profile - in reference 15

minerals sub-sector producing about 25 different types of minerals (10). In terms of volume and value, some of the major non-metallic minerals produced include asbestos, graphite, lithium, phosphates and iron pyrites.

Asbestos occurs principally in the southern part of the greenstone belt in the Masvingo mining district. Within the district, there are three operating mines, namely; Shabanie at Zvishavane, Gath at Mashaba and Vanguard at Mberengwa. Total annual production is around 157,000 tonnes per year with more than 90% of production exported to more than 70 countries around the world (11). Some of the asbestos produced is used in the manufacture of asbestos cement products such as roofing sheets and tiles.

Graphite occurs in the south-western part of Magondi Basin along with some gold, copper and tin. Lynx Mine is the only graphite mine in Zimbabwe (1993) and is located in the Hurungwe district, some 60 km north-west of Karoi (11). Annual production

stands at around 7,000 tonnes of concentrate compared to around 18,000 tonnes produced in 1989 (15). More than 90% of the mine output is exported.

Lithium occurs in pegmatites with the only mine located at Bikita, 70 km east of Masvingo (11). Production is around 18,000 tonnes of concentrate per year, and is all exported.

Zimbabwean black granite is renowned for its intense black colour and fine texture. It occurs in dolerite sills at Mutoko. In recent years, production of black granite has intensified with current production, mainly for export, standing at 40,000 tonnes (15).

The phosphate resources of Zimbabwe are primarily of carbonatite origin and are contained in about six deposits, namely Chishanya, Dorowa, Gungwa, Katete, Nanuta and Shawa. Most of the deposits have, however, not been assessed except for Dorowa and Shawa. The deposit at Dorowa is reported to contain 72.8 million tonnes of ore at an average grade of 6.56% P_2O_5 while at Shawa, there are 20.3 million tonnes with an average grade of 10.8% P_2O_5 (9). The deposit at Dorowa is commercially mined by Dorowa Minerals Limited using the open cast method. Phosphate concentrates, containing 35% P_2O_5 are produced from a milling and flotation plant. The concentrates are processed into a single super phosphate fertiliser in Harare by the Zimbabwe Phosphate Industries Limited. It is of note that Zimbabwe appears to be the only country in the subregion, excluding South Africa, where phosphate fertiliser is produced from indigenous resources. As earlier reported, the other production facilities, located in Mozambique and Tanzania, closed down in 1983 and 1990, respectively.

Commercial deposits of pyrites occur in Mazowe at the Iron Duke Mine 45 km north of Harare. The deposit is worked by Anglo American Corporation with about 85% of the production used by Zimbabwe Phosphate industries in the manufacture of sulphuric acid for the production of phosphate fertiliser (9).

Other non-metallic minerals produced in commercial quantities in Zimbabwe, including locations, are magnesite (Kadoma, Mberengwa), Kyanite (Karoi), clay (Gwanda), vermiculite (Buhera), corundum (Mutoko, Beitbridge), feldspar (Harare), talc (Nyanga), limestone (Redcliff, Chinhoyi, Buhera), Silica (Gweru) and dolomite (Chinhoyi) (10). The Zimbabwe Mining Development Corporation has been promoting a project to manufacture refractory bricks from local magnesite and kyanite resources. A feasibility study has been undertaken and is under evaluation. If the project proceeds, this would be the first refractory brick factory in the subregion outside of South Africa.

Although limestone is abundantly available and mined for aggregate and cement manufacture, high purity lime for the metallurgical industry is imported into Zimbabwe (12). There is potential for neighbouring countries such as Malawi, Mozambique and Zambia to fulfil Zimbabwe's requirements of lime. The ceramic minerals of feldspar, limestone, dolomite and clays are used in the manufacture of ceramic products, particularly tableware and sanitaryware. Good quality kaolin for this purpose is largely unavailable in Zimbabwe and is imported from South Africa (12).

Table 6 gives an indication of the range of non-metallic minerals produced in Zimbabwe.

IV STRUCTURE OF THE INDUSTRIAL MINERALS SECTOR IN THE SUBREGION

Main Features of the Subregional Industrial Minerals Sector

It is clear from the resource potential reviewed above that the occurrence of non-metallic minerals in the Eastern and Southern African subregion is generally wide-spread. This fact has always been known. Comparison of the production data to the resource potential reveals, however, that the major part of this resource base has largely remained unexploited and has therefore been of little economic benefit to the member States and the subregion as a whole. Minerals in the ground do not represent active wealth unless they are developed for use in the manufacture of tradeable goods.

There are a number of characteristics which are observable in the non-metallic minerals sector described above:-

a) For many of the industrial mineral deposits, very little exploration has been undertaken. The reserve base is often not known. As a result, descriptors such as "vast", "immense", "inexhaustible" tend to be liberally used when describing their economic potential. Most of the deposits are in actual fact small and can be economically worked only on a small scale basis. There are a few cases, however, where deposits are large and well characterised. Examples include the deposits of bauxite in Malawi, graphite and bentonite in Mozambique and phosphate in Zimbabwe.

b) If geological characterisation, is inadequate, technical evaluation is mostly non-existent. Most of the non-metallic

Table 6: Production of Non-Metallic Mineral in Zimbabwe

MINERAL	1989	1990	1991	1992	1993
Asbestos (t)	187,066	161,071	141,697	150,158	156,881
Barytes (t)	1,900	320	866	232	120
Black Granite(t)			79,907	90,694	40,032
Clay(t)	104,865	99,854	100,604	82,956	113,470
Corundum (t)	9	54	1,567	2,873	5,995
Feldspar (t)	2,697	2,197	3,820	2,696	1,553
Fireclay (t)	19,100	19,914	23,304	15,954	9,257
Graphite (t)	18,147	16,384	12,903	12,346	7,142
Iron Pyrites (t)	47,561	66,571	69,851	66,345	72,588
Kaolin (t)	17		65		
Kyanite (t)	1,869	160	2,463	1,990	875
Limestone (kt)	1,369.6	1,251.6	1,427.6	1,365.9	1,036.1
Lithium (t)	29,647	19,053	9,186	12,837	18,064
Magnesite (t)	33,423	32,639	23,295	8,973	6,276
Mica (t)	1,471	1,301	506	495	510
Phosphate (t)	133,791	147,767	116,938	142,322	153,471
Quartz (t)	61,683	122,694	142,064	159,468	95,149
Talc (t)	1,513	1,767	1,676	2,203	1,349

Source: Zimbabwe Country Profile - in reference 15

minerals produced in the subregion are of the type which require very limited or no evaluation. In this category would fall limestone for the construction sector, dimension stone, pyrite for sulphur burning, clays for brick manufacture, gypsum for cement manufacture, asbestos and graphite. Technical evaluation encompasses a wide range of tests starting from chemical and mineralogical characterisation, to the determination of technological parameters which result in the demarcation of the range of (potential) uses. The main effect of lack of technical evaluation is that likely uses of the available minerals are not well-defined other than in vague generalities. One therefore often hears of the "folly of importing fertilisers when local resources are abundant".

c) The great majority of industrial minerals which require higher levels of technical evaluation are not produced in significant quantities in the subregion. This includes, particularly, the fillers and extenders category and non-metallic minerals used in the chemical and food industries where chemical specifications are more stringent. It also includes the ceramic industry where regular technical evaluation of raw materials is a pre-requisite to successful operations and products of a guaranteed quality. It is therefore not surprising that ceramic plants in Mozambique, Tanzania and Zambia have had severe product quality related and other technical difficulties in their production operations.

d) The range and type of non-metallic minerals produced in the subregion is limited. The physical quantities of non-metallic minerals produced are themselves generally small and erratic except in a few cases. Over a period of time production has, in some cases, ceased altogether.

e) One of the few cases in which production quantities are significant is in construction materials, particularly limestone for aggregate and cement manufacture. Practically all countries surveyed, and certainly most countries of the subregion have lime and cement manufacturing plants, traditional lime burning and small scale brick production facilities.

f) Other than for cement raw materials, production quantities are significant only in cases where the minerals involved are not consumed locally but are mined as export commodities. This is the case with dimension stone production in Mozambique, Namibia, and Zimbabwe; fluorspar in Namibia; graphite in Mozambique and Zimbabwe, and asbestos and lithium minerals in Zimbabwe. As a matter of interest, planned new production of graphite in Namibia and Tanzania and heavy mineral sands in Mozambique fall into this category. It is of further interest to note that these minerals are bound by one common factor;

their unit values are relatively high. It is therefore evident that these minerals are primarily exploited to earn foreign exchange.

g) Non-metallic mineral production is most diversified in Zimbabwe. A point of significance is that currently, Zimbabwe is the only country in the subregion, excluding South Africa, which produces phosphate fertilisers. This contrasts sharply with the general abundance of phosphate ores in the subregion. Zimbabwe's production of phosphate fertiliser probably reflects the diversified nature of it's economy relative to those of the other member States.

In 1989, SOFREMINES undertook a SADC-wide study on Investment Opportunities in the Field of Industrial Minerals. The mineral groups covered in the survey were construction materials, ceramic and refractory materials, fillers and extenders for the paint, rubber, plastic, paper and soap industries. The main focus of the survey was to assess the volumes of these minerals imported into the SADC region in order to arrive at the potential for import substitution for non-metallic minerals and products.

Their main finding was that some 28 different industrial mineral categories were required by the various countries to maintain their industrial productive capacity. This compares unfavourably with the narrow and limited range of non-metallic minerals produced by the member States. The major requirements identified by SOFREMINES, excluding limestone for cement manufacture and phosphate for fertiliser production, were chemical lime, ball clay, fillers and extenders, magnesite, soda ash, dolomite, kaolin and silica. All SADC countries imported non-metallic minerals to various extents. The main imports were fillers, fluxes and glazes; ceramic products and refractory materials; high purity limestone for metallurgical and chemical uses; titanium dioxide for paint, rubber and paper manufacture; and borax for chemical uses.

The negative features of the non-metallic minerals sector enumerated above are manifestations of an industry which has failed to develop to its acknowledged potential. It is an industry in a state of crisis due to severe structural weaknesses inherent within the sector. To understand why the sector cannot develop, a diagnosis of the weaknesses is imperative.

Major Structural Weaknesses of the Industrial Minerals Sector

The Overwhelming Paucity of Economic Data

The development of a non-metallic minerals deposit is not very different from higher value mineral deposits. It is an investment

opportunity which requires the availability of economic information on the basis of which a decision to invest can be made. It is therefore subject to similar laws of investment which dictate that the deposit must demonstrate financial viability, and must have an identified market.

In a typical mineral development project, the starting point is a quantitative determination of the economic potential of a deposit by a systematic exploration and evaluation programme. The information gathered is used to estimate the quantity and quality of economic reserves, together with the profile of the orebody. In turn this information is useful in designing efficient mining and processing operations, and ultimately in the financial assessment of the project.

Unfortunately, industrial minerals in the subregion do not attract much exploration expenditure. This is partly related to the perennial inadequacy of resources in government mining departments. More important, however, is that for most mineral development projects, exploration expenditure is invariably financed by private risk capital in return for generous concessions from government. Such risk capital is naturally governed by opportunity cost decision-making and is grossly favoured by short pay-back periods and high rates of return. Except for a few non-metallic minerals that command respectable prices on the world market, most non-metallic minerals do not simply fall in this category.

There is a further complication in the evaluation of non-metallic mineral deposits. For base metals, gold and diamonds, the quality or grade is determined by one parameter; the content of the valuable mineral. Being primarily end-user materials, the quality of a non-metallic mineral deposit is determined by a wide variety of user-driven physical and technological properties. Thus in the estimation of reserves, cognisance of the end use must be taken into account. For a kaolin deposit, for example, the measured reserves for paper coating, ceramic and filler applications may well be different due to differences in the technical properties demanded by the end uses. This is also the case in the assessment of the quality of a limestone reserve for metallurgical and sugar industry applications; for use in the manufacture of cement or aggregate for road construction.

The paucity of economic information is not only restricted to the quantity and quality of reserves. Due to the diversity of uses, The range of specifications which determine the applications for non-metallic minerals is wide even for one mineral used in different manufacturing applications. Furthermore, specifications may vary from one consumer to another. For the most part, information on specifications of raw materials for various products is unavailable. This forces manufacturers to use inferior raw

materials with the consequence of poor quality and uncompetitive products.

The conspicuous lack of economic information on quantities, quality, specifications and range of uses of non-metallic minerals resources is probably exacerbated by the general lack of data bases. In most countries of the subregion, geological information on available non-metallic minerals resources and market-oriented data on the needs of industry is not available. Where such information may be available, it is patchy, unsystematic and not structured to relate directly to the needs of industry. It is also not stored in efficient information storage and retrieval systems. The net result is that potential investors are deprived of information for decision-making thus limiting the levels of investment in the sector.

The Debilitating Lack of Technological Capacity

One of the major limiting factors to the development of non-metallic minerals in the subregion is the lack of capacity to acquire, and manage technologies for the transformation of these minerals into products required by the industrial and social communities in the member States. There are two obvious and major reasons for this; unavailability of trained and technologically literate manpower and the absence of active research and development facilities dedicated to non-metallic minerals.

a. Unavailability of Trained Manpower

From the point of view of basic technical skills, academic training institutions dedicated to geosciences are few and far in between. Most countries of the subregion have training facilities for geologists at degree level. However, university training in mining and mineral processing disciplines is available only in Zimbabwe and Zambia, with a further institute planned for Namibia. At technician's level, training facilities are available only in Tanzania, Zambia and Zimbabwe. Mozambique offers training at diploma level only in geology.

The result is that there exists a serious skew in the availability of geoscience graduates in favour of geology disciplines, particularly in geophysics, geochemistry and economic geology. Geologists far outnumber mineral processing and mining engineers. At the intermediate level, mining and metallurgical technicians, and mine surveyors are also in short supply.

Other than a shortage in terms of absolute numbers, the curriculum of the few academic training institutions, particularly in extractive metallurgy and mineral processing, does not address

the specific needs of the non-metallic minerals sector. None of the degree level academic institutes include courses in industrial minerals technology or ceramic manufacture. As a matter of fact, the current crop of ceramists that the author has met in the subregion originated from allied fields such as metallurgy, chemical engineering and chemistry. The serious inadequacy of technical skills can be illustrated by the case of Zambia Ceramics Limited. The factory had only one qualified person with a diploma in ceramic technology and he was the General Manager!

If the basic technical skills are in short supply, critical higher level skills are more or less absent. These are in a number of key areas such as geostatistics, particularly in mineral reserve estimation; mine and mineral process design, flow sheet development and equipment specification, production planning, project management, engineering and plant construction. If it is assumed that an exploration target yields reasonable reserves to fulfil an identified demand in the national economy, these skills cannot be dispensed with in bringing a mine from conceptual to the production stage. In developed economies these high level skills are abundantly available in the form of private consulting companies. Additionally, large scale mining houses often maintain their own complement of such skills to suit their own requirements. Within the subregion, such skills are only moderately available in a few countries, notably Zambia and Zimbabwe.

One major outcome of the lack of numbers in mining and processing disciplines, and the structure of geoscience training courses, is that technical entrepreneurship in the minerals field is glaringly lacking. Practical, business-oriented engineers and geo-scientists, equipped with financial and business management skills are simply absent.

b) Lack of Non-Metallic Research and Development Facilities

As has been earlier pointed out, non-metallic minerals are generally associated with a wide range of products and tradeable goods. The industry is characteristically end-user driven with the outcome that specifications must generally conform to the appropriateness of use. This characteristic of the non-metallic minerals industry results in a large dispersion of specifications to suit the various end uses. As a result, there is a far greater need in the industry to link utility to available mineral resources in a manner that takes account of constraints in both the intended product specification and planned manufacturing technology. This makes it imperative to identify the user's needs and, on the basis of this, and the mineral resource base, determine the best processing technology to produce the identified raw material specification or its nearest substitute. This procedure is not

possible without the presence and use of appropriate laboratory facilities.

Due to the diversity of use, the range of properties of industrial minerals which must be measured in the laboratory is large. This is compounded by the fact that one mineral may be used in different applications, all requiring different properties to be measured. This makes it difficult to establish a laboratory which will cover evaluation procedures for all minerals. Generally, a non-metallic minerals laboratory will be biased towards a set of properties determined by the range of applications of the mineral products under consideration.

Notwithstanding these considerations, the requirements of a basic non-metallic minerals R&D laboratory include the following:-

a) a mineralogical section to determine the main mineral assemblies and the presence of associated minerals.

b) chemical evaluation to provide chemical compositions.

c) a beneficiation section to determine the optimal processing methods for a given product specification. Preferably, beneficiation should be possible to pilot plant level to yield sufficient quantities of products for pilot commercial testing and in the process, yield engineering parameters for plant design.

d) an applications section to evaluate the technological parameters aimed at defining potential applications or developing new products. The section should be capable of manufacturing prototypes, where necessary, for commercial adaptation.

Not all the sections may be necessary depending on the minerals under evaluation and the specific end uses. For example, dimension stone does not require beneficiation, while mechanical strength measurements are usually sufficient for aggregate used in road construction. Kaolin used in paper manufacture will require mineralogical, chemical evaluation and beneficiation while kaolin used in structural ceramics will, in addition, require the manufacture of prototypes during technological tests.

These considerations widen the equipment requirements for a non-metallic minerals laboratory, particularly for evaluating technological properties. Consequently, the cost of establishing laboratory facilities often appears prohibitive, particularly for subregional countries where the actual uses and finance are usually limited. Fortuitously, availability of skills and finance can be balanced to determine the type of facilities to be installed. At the cheap end, a basic mineralogy laboratory can exist with

microscopes substituting for expensive X-ray diffractometers, while a basic chemical laboratory can survive on gravimetric methods of analysis in place of state of the art multichannel XRF units. Unfortunately, both the basic mineralogy and chemical laboratories are skill-intensive while instrumental laboratories require less analytical skills but are restrictively more expensive and require infrastructural facilities, such as reliable utilities. The return on investment is, however, compensated by the benefits in the large numbers of samples that can be processed, the preciseness of data, and when computer interfaced, an infinite scope for manipulating the data.

Despite the graduated choice of laboratory facilities to suit a broad range of individual needs and cost, the subregion is very deficient in laboratory infrastructure for non-metallic minerals testing. This may partly be explained by historical factors, where the previous colonial governments established facilities more suited to the extraction of high unit value minerals. It is, however, not the reason for the continuing absence of such facilities. A few industrial minerals laboratories exist including those at the Cement Institute in Ethiopia, SARUJI Training Institute in Tanzania, National Council for Scientific Research in Zambia and the Government Laboratory in Zimbabwe. In addition, one or two universities, notably in Zimbabwe and Zambia have small capacities in non-metallic minerals research. These laboratories are, however, poorly equipped and their general state renders them ineffective.

The lack of a technological capacity, both in terms of skills and laboratory space, accounts for why most of the non-metallic minerals produced in the subregion undergo very little or no technical evaluation. This has resulted in a dependency on external laboratories. The poor performance of ceramic plants, whose operations heavily rely on laboratory raw material characterisation and quality control, can be explained on this basis. Typically, initial raw material characterisation, to determine the design parameters of the factories, was undertaken abroad. Token laboratories were installed at the plants to monitor raw material and product quality. Due to improper equipment use and the lack of maintenance capacities, the laboratories quickly became incapacitated. This happened in both Tanzania and Zambia. Production operations depended on raw materials whose physical properties were unknown. Predictably, the product quality was often poor and uncompetitive. The end result was inescapable factory closures.

Further examples of externally-dependent R&D are plentiful in the subregion. For about a decade, the International Fertiliser Development Centre (IFDC), the International Development Research Centre (IDRC) and the British Geological Survey (BGS) have been promoting the use of indigenous phosphate resources as fertiliser

materials in nearly all the member States of the Eastern and Southern african subregion. Numerous agronomic trials have been conducted in what are termed direct application tests. Where agronomic performance could be improved by conversion of the phosphate minerals into more soluble products, samples were sent abroad for evaluation and sometimes manufacture of agronomically suitable products. Awareness workshops, to which all subregional member States were invited, were periodically held. The outcome, in terms of increased food production using local fertiliser resources, is disappointing and disproportionate to the commendable effort expended over such a long period of time.

Other examples of externally oriented R&D include the long-running BGS/ODA supported "Minerals for Development" programme (13) and the UNIDO-Czechoslovakia joint programme. On both the programmes, extensive tests have been undertaken to determine various industrial applications for a wide range of non-metallic minerals from the subregion. These have included bentonite, graphite, diatomite, limestone, talc, brick clays, kaolin, and vermiculite. The countries submitting samples for evaluation have included Ethiopia, Kenya, Malawi, Mozambique, Tanzania, Zambia and Zimbabwe. In the tests, a variety of characterisation instruments, including some state of the art scanning electron microscopes (SEM) and transmission electron microscopes (TEM) have been used. At times, innovative beneficiation equipment, yet to go into commercial production, has also been used. Needless to say, specifications for a range of applications, which largely conform to western levels, have been achieved. In terms of actual numbers of operating non-metallic mineral plants, the achievements are not visible. There is no evidence either that these well-intentioned efforts have created any significant capacities in the evaluation of non-metallic minerals within the subregional institutes.

A good attempt at creating internal capacities are the pilot research facilities for the production of Partially Acidulated Phosphate Rock fertiliser (PAPR), a cheap but agronomically effective fertiliser, which have been installed at the Eastern and Southern African Mineral Resources Development Centre (ESAMRDC) in Tanzania, the Institute of Mining Research (IMR) in Zimbabwe and the School of Mines in Zambia. These facilities, particularly those at the School of Mines in Zambia are unique and if effectively used, could act as a springboard for increased exploitation of phosphate resources in the subregion. Yet there are no programmes in place for their shared use among the member States despite the fact that the facilities are at present grossly under-utilised.

Further disappointing examples of the lack of resolution to develop local capacities can be demonstrated by the experiences of ESAMRDC in Dar-es-salaam, Tanzania. Started as subregional mining R&D institute in 1980, with the support of ECA, ESAMRDC decided in 1987 to add a non-metallic minerals laboratory to its laboratory

infrastructure (14). Construction of the laboratory infrastructure was completed in 1991. After slow progress , UNIDO assistance was obtained in 1991 to equip and provide experts to the laboratory to enable it perform the functions listed earlier. After several years of vacillation, the laboratory is not yet operational due primarily to lack of financial support from the ESAMRDC member States to fulfil counterpart obligations. Such paradigms of enthusiastic use of external R&D facilities in preference to developing and sustaining domestic capacities are clearly not infrequent in the subregion.

The Suffocating Smallness of National Economies

It has been said earlier that industrial minerals offer the greatest scope for forging economic linkages in a national economy because they are used in the manufacture of everyday commodities. This assertion is predicated on the assumption that non-metallic mineral products are readily available and the capacity to dissipate them within the domestic economy exists.

Two major determinants of the absorptive capacity of industrial mineral products by an economy are its volume and structure. The volume may be represented by the aggregate worth of goods and services it generates; the GDP while its structure relates to the composition of the GDP. Table 7 gives a number of comparative economic indicators for the countries for which non-metallic mineral production statistics have been earlier given. It has been assumed that the range of indicators contained in Table 7 is reasonably representative of the economies of the subregion. GDP figures given in Annex I for the entire subregion do not contradict this premise.

The GDP figures given in Table 7 broadly agree with those indicated by the Economist Intelligence Unit country profiles for the year 1993/94 and 1994/95. The GDP per head was obtained by dividing the GDP by the indicated population figures.

Table 7 indicates that the characteristic features of subregional economies are those typical of under-developed economies. They have small GDP's with low GDP's per capita which in many cases are below the national poverty datum line. The national populations in the subregion are in the majority of cases small and predominantly dispersed in rural communities. As a matter of fact, only in four subregional countries, namely Ethiopia, Kenya, South Africa and Tanzania do national populations exceed 20 million people. The majority of countries in the subregion have been undertaking structural reform programmes which, it is commonly acknowledged, have resulted in a deepening poverty for the majority of the citizens and escalations in the stock of debt.

Table 7: Comparative economic indicators[a] for countries included in the survey.

	MALAWI	MOZAMBIQUE	NAMIBIA	TANZANIA	ZAMBIA	ZIMBABWE
GDP ($m)	1,851.0	1,052.0	2,107.0	2,712.0	2,086.0	5,690.0
GDP/Head($)	205.7	66.6	1,505.0	99.0	242.6	547.1
Population (m)	9.0	15.8	1.4	27.4	8.6	10.4
Total Exter.Debt ($m)	1,699.0	4,928.0	550.0	6,700.0	7,040.0	4,005.0

a. Figures are for the year 1992

Sources: GDP figures are from COMESA statistics. Population and external debt are from the 1993/94 and 1994/95 Country Profiles of the Economist Intelligence Unit.

Characteristically the total national debt for a number of countries is now several times their GDP and aid programmes account for as much as 60 % of GDP. Almost all countries continue to experience negative balances of trade. These negative factors all point to a severely diminished market potential for tradeable goods, including non-metallic minerals products.

In terms of the composition of the GDP, the major economic activity for most countries in the subregion is agriculture. Examination of the data for the origins of GDP given in Annex II for the six case study countries confirms this. At face value, this is a significant opportunity for developing non-metallic minerals because they are a major input into agriculture in terms of fertiliser use. Within the subregion, fertiliser consumption is very low and is estimated at 12-20 kg/ha, compared to about 250 kg/ha in western Europe (9). The major part of agricultural production in the subregion is from subsistence farmers who use little or no fertiliser. As earlier mentioned, there is only one phosphate fertiliser plant in the subregion. Several studies have been undertaken by both SADC and COMESA (16) to promote the establishment of fertiliser plants. However, progress has been

curtailed by a general lack of financial and technical capacities, coupled with small national markets which cannot justify the capital intensity of the industry due to diseconomies of scale. Currently COMESA are supporting an initiative to construct a multinational phosphate fertiliser plant at Tororo in Uganda. The fact that the project has been on the drawing board for some eight years is not, however, a good omen particularly in a subregion where success stories are not frequent.

Since industrial minerals are associated with a wide range of consumer products, the manufacturing sector can generally be assumed to represent the degree of diversification of the non-metallic minerals sector. Assessment of the origins of GDP presented in Annex II shows that the share of manufacturing in the countries surveyed, and generally in the whole subregion, accounts for a very small fraction of the GDP. Only in a few cases, notably Zambia and Zimbabwe (and also Kenya) does manufacturing account for 20-30% of GDP. This observation is related to the low levels of industrialisation of the subregional countries. Indeed the fact that Zimbabwe has one of the largest and best integrated manufacturing sectors in sub-Saharan Africa probably explains why a number of non-metallic minerals are produced in that country.

The major conclusion to be drawn from the above statistics is that most of the economies of the subregion do not simply have the individual absorptive capacity to support a diversified non-metallic minerals industry. Given the wide range of non-metallic mineral products required by domestic industries, national demand in many cases would be too small and disaggregated to consider local manufacture.

The situation is exacerbated by the lack of trade links among the member States of the subregion. Table 8 shows estimates of the total import and export figures of the COMESA region. Both the import and export figures were obtained by adding the individual trade data of each member State with the other COMESA countries as well as with the rest of the world. The aggregated data therefore <u>includes</u> intra-COMESA trade in the indicated non-metallic mineral products.

Trade statistics in the subregion are incomplete due to the difficulties of data collection and storage. The indicated figures are estimates based on information available at the United Nations Statistical office in New York.

Notwithstanding these weaknesses, there is a major trend observable in the data. There is a persistently extreme imbalance between exports and imports of the listed products with the exception of portland cements. There are small and insignificant fluctuations in the export figures. These are not, however, sufficient to detract from the ominous conclusion that countries in

Table 8: Export and Import Data for Selected Industrial Minerals Products for the COMESA Region

Product	Value of Exports and Imports ('000 US $)	1991	1992	1993
Non-refractory Bricks/Tiles	Exports	2	10	61
	Imports	19,612	26,531	21,807
Refractory Bricks/ Construction Materials	Exports	37	314	15
	Imports	15,663	17,908	13,248
Asbestos/Fibre Cement	Exports	190	131	155
	Imports	7,602	6,502	2,633
Ceramic Plumbing Fixtures	Exports	0	0	0
	Imports	9,670	11,447	7,722
Ceramic Tableware	Exports	2,154	70	100
	Imports	4,898	7,475	5,404
Portland Cements	Exports	17,717	23,815	20,283
	Imports	13,353	26,992	15,809

Source: Extracted from COMTRADE Export/Import Estimation Data Base System at the UN Statistical Office, New York.

the subregion do not generally trade in non-metallic minerals products either within or outside the subregion. The corollary conclusion is that members States import the major part of their non-metallic mineral requirements from outside the subregion; mainly from developed economies although this is not reflected in the statistics. Whatever the reasons, and there are many, for this unfortunate situation, the member States have deprived themselves of trade opportunities which are catalytic to the growth of the non-metallic minerals sector. Larger markets would promote larger scales of economy of production and enable existing productive capacity to operate more competitively based on comparative advantages. Economic cooperation and integration is clearly a pre-requisite to the development of the full potential of the sector.

A sad example where economic cooperation would have mitigated against a small national economy is the Sua Pan Soda Ash project in Botswana. The plant was built in 1990 at a cost of US $286 million.

It had an installed capacity of 300,000 tpy, largely targeted at the southern african market, and in particular, South Africa. However, due to market saturation in Europe and America, and the dumping of soda ash on the South African market, Sua Pan could not sell competitively in that country. Since the domestic market for soda in ash Botswana is very small, the company applied for voluntary liquidation in 1995. Other examples of ceramics and phosphate manufacturing plants which have closed down in the subregion have been given earlier.

<u>The Inadequate Policy Framework</u>

The low levels of exploitation and utilisation of non-metallic minerals in the subregion can partly be traced to inadequacies in the legislative and economic framework. Partially, the inadequacies are due to historical legacies which emphasised the selective mining of high unit value minerals for consumption in external economies. These were primarily base metals, precious metals and minerals. The legislative structures, which were put in place and largely continue to exist, were designed to support this bias. For most countries in the subregion, the exploitation of non-metallic minerals has continued to occupy this surbodinate position.

In recent years, a number of member States have sought to create a competitive mining environment by introducing tax incentives such as early tax relief and accelerated capital redemption, foreign exchange retention schemes, and less inertia in the allocation of various permits required in the normal course of mine development. These schemes, however, are aimed at attracting the large international mining houses. Largely as a result of these incentives, foreign companies have begun to make investment in exploration in the subregion but this is heavily biased in favour of high unit value minerals. The prime targets have been gold, diamonds and platinum; not industrial minerals.

National policy attitudes and perceptions have contributed to the problem. Distressed by severe shortages of foreign exchange in the national economies, most member States have continued to view mining first and foremost as a major source of foreign exchange, and not as a means to developing inter-sectoral linkages. Thus mineral development projects have continued to be selected to deliberately enhance foreign exchange earnings even under conditions where this is not possible. Due to the low financial returns, the development of non-metallic minerals has mostly been left to local entrepreneurs with limited mining and processing skills. The obsession to view the mining of non-metallic minerals in terms of foreign exchange has resulted in missed opportunities to develop import substituting linkages to enable the growth of national economies.

The few local entrepreneurs themselves operate in a harshly discriminating economic environment. They lack both financial and technical support for starting mining operations. Many of the subregional economies have no financial markets from which long term loan capital can be sourced. Short and medium term loans may be available from local commercial banks. The terms of lending, however, require collateral which most local entrepreneurs do not simply have. Short term borrowing is further complicated by the prohibitively high interest rates prevailing in the subregion. These average between 30 and 40% in most of the member States.

Project financing is usually available from international development lending institutions such as the International Finance Company (IFC) and the Commonwealth Development Corporation (CDC). The lending threshold for these institutions is, however usually higher than the requirements of local entrepreneurs who are precluded on the basis of their small capital needs. If local entrepreneurs had access to larger subregional markets, their capital needs would be larger on account of increased scales of economy. This would increase their accessibility to funds due to higher capital needs which would meet the lending threshold. In practice, the international institutions are averse to lending to non-metallic mineral operators citing reasons of currency exposure. Cashflows for non-metallic mineral businesses are often in local currencies which are not acceptable to the international lending institutions. Again cooperation in trade and market integration could reduce the levels of currency exposure and attract venture capital from international finance houses.

One policy area in which the neglect in non-metallic minerals mining is conspicuous is in the lack enforcement of mining laws. Legislation for non-metallic minerals mining is itself lax relative to high unit value minerals. This is particularly so in the aggregate quarrying industry. The various permits required for other forms of mining, namely prospecting, exploration, and mining licences, are often not applicable except for the mining licence. Reporting structures are mostly non-existent while for high unit value minerals, regular reports to the ministry must include quantities of minerals produced, details of remaining reserves, extraction methods used and their efficiency, and the effect of operations on the environment. The lack of supervision, particularly in the aggregate sector, results in quarries often springing up without thought to environmental considerations, particularly from dust fall-out and ecological balance. These weaknesses are a reflection of flaws in the government administrative structures and are partly attributable to under staffing and a lack of financial resources.

The Lack of Industrial Infrastructure

Non-metallic mineral deposits, like other mineral deposits, occur in remote areas where infrastructural development is often non-existent. In the case of high-value mineral resources, the development of infrastructure may be supported by the investment project itself. This, for example, happened in the case of Orapa and Juaneng in Botswana, based on diamonds, the Adola Goldfields in Ethiopia, Mwadui in Tanzania based on diamonds and the Zambian Copperbelt, with copper resources. Indeed, much of Zimbabwe's development can be traced to the long mining history, particularly of gold. Unfortunately, non-metallic minerals do not have the same capacity to carry infrastructural development.

The result is that many non-metallic mineral deposits are not brought into production even where the deposit may be large and a market exists. This, for example happened in the case of Lake Natron soda ash in Tanzania. The deposit is located in the North-east corner of Tanzania, in an area where there are no roads and utilities. In neighbouring Kenya, the Lake Magadi soda deposit has been exploited on a large scale for many years with the bulk of the production exported to neighbouring countries and overseas.

In addition to roads, insufficiency of utilities has also contributed to the lack of development of non-metallic mineral resources. In Tanzania, for example, a newly constructed sheet glass factory in Dar-es salaam failed to commence production due to the lack of electrical power to the factory. After years of inactivity, the factory's process control system deteriorated and the kiln structure started warping. Presently, the factory needs rehabilitation although it has never been in production. This was unfortunate because the subregion as a whole has virtually no sheet glass factories. Other non-metallic industries to suffer from an insufficiency of power supply in Tanzania include the cement plants, particularly at Wazo Hill in Dar-es-salaam. Production has had to be reduced drastically since power rationing was introduced in 1992, due to insufficient generating capacity, partly precipitated by drought conditions.

Botswana has also had to suffer due to a lack of infrastructural development. The economics of the Sua Pan project mentioned earlier were complicated from the start by the fact that the mine had to carry infrastructural development. This included the development of housing and roads for a small settlement to serve Soda Ash Botswana Mine (SAB). A compounding factor in the performance of the company was the high energy tariffs prevailing in Botswana due to the high cost of thermally generated power. Coupled with relatively high wages obtaining in the country, the result was a severe erosion of market competitiveness even in South Africa, where Botswana enjoys preferential tariffs as a member of the Southern African Customs Union.

V ISSUES FOR DEVELOPING THE INDUSTRIAL MINERALS SECTOR AND STRATEGIES FOR ENHANCING COOPERATION

In the preceding sections, the status of the subregional industrial minerals sector, the potential role that industrial minerals can play in the development of an economy and the structural weaknesses of the industry in the subregion, have all been reviewed. To further develop the sector and, particularly expand its role and contribution to the national economies, and the subregion as a whole, the inherent weaknesses in the industry must be addressed and strategies for removing any impediments formulated. There are a number of prerequisites which are not only essential to the development of non-metallic minerals but on whose basis effective cooperation could be built. It must also be understood that cooperation in the context of this report, is used to denote the enhancement of dialogue and interdependence both at the national and subregional levels.

Actions at the National Level

Harnessing Economic Information

One of the identified major constraints to the development of industrial minerals is the lack of economic information which is crucial in the identification of investment opportunities. Although the range of economic information required is diverse, an excellent start would have been made if the following information was gathered through national surveys. Due to the sheer volume of information required, priority could be given to those products which would have the greatest impact on the national economy in terms of multiplying economic linkages, maximising foreign exchange savings or enhancing subregional production capacities. Critical information required include:-

a. consumption figures of non-metallic minerals in the national economy by the various key economic sectors. This should include raw material requirements of the existing manufacturing sector, agricultural requirements, the construction sector and mining industry, all which are major consumers of non-metallic minerals. The information gathered should include form, volume and value of non-metallic minerals consumed.

b. specifications of the (potential) non-metallic mineral products used by the various economic sectors.

c. quantity, quality and type of non-metallic minerals available to the national economy. This should include their locations and the existing infrastructure to support exploitation.

d. profiles of potential technologies for converting the available non-metallic minerals into useable products by the national economy. Such profiles should also include equipment suppliers present locally or within the subregion.

The information gathered should be stored in digital data bases for quick retrieval and dissemination. Means of disseminating the information to potential investors must be established and publicised. This could take the form of public awareness campaigns, including regular meetings and workshops with manufacturers, potential investors and consumers. To collect the above economic data co-operation is clearly required between consumers of non-metallic minerals products, manufacturers, government departments including statistical offices, ministries of commerce and industry, geological surveys and mining departments, and non-metallic minerals research institutes.

Improving the Policy Environment

Although a number of non-metallic minerals may have the potential to earn foreign exchange, governments should, however, recognise that their own national economies cannot develop without the exploitation and use of non-metallic minerals. It is therefore imperative that they seek to create a conducive policy environment in which enhanced exploitation and use of these minerals can take place. Some of the measures which could ameliorate this are:-

a. establishment of an Industrial Minerals Development Board or Committee to coordinate all activities related to the exploitation and use of non-metallic minerals. One of the main functions of the Board would be to promote the development of industrial minerals, particularly by encouraging co-operation among all the major actors in the sub-sector. The functions described above would be largely supervised by the Board, which would also act as a secretariat for the data bases and a focal point for a national information network for the sub-sector.

b. the Board should also encourage the establishment and use of national standards to harmonise specifications for products made from non-metallic minerals. This would improve product predictability, promote product acceptance and directly increase the consumption of industrial minerals.

c. the Board should seek links with financial institutions to establish a private-sector based revolving fund to provide preferential loan capital to entrepreneurs to promote the emergence of non-metallic minerals industries. Such funds could be provided under concessionary interest rates for the purchase of mining equipment or as working capital.

d. to promote increased investment in the sub-sector, governments must strive to provide sector-specific economic incentives such as reduced sales tax on non-metallic mineral products and generous capital equipment allowances and tax holidays. This would open-up the industry to wider participation by potential investors.

e. governments must endeavour to provide and maintain the infrastructure in potential mining areas particularly with respect to roads, utilities and communications. This would reduce the need for non-metallic mineral ventures to carry the burden of infrastructural development, which such minerals generally have little or no capacity to bear.

Improving Availability of Technical Services

It is quite clear that the industrial minerals sector is disadvantaged in relation to the other mining sectors notably, the precious metals and minerals, and the base metal industries. The latter sectors are able to attract international mining companies and are therefore dominated by medium and large scale mining companies with well-organised operations and quite often possess in-house technical support services. In contrast, non-metallic minerals mining cannot often attract international capital and is therefore dominated by local entrepreneurs and para-statal mining companies for whom there is little or no technical support. As a result growth of the sector has been curtailed and in a number of cases, the sector has been shrinking with a number of production facilities closing down.

To stimulate growth of the sector, technical support services of a wide range must be made available. The most important include:-

a. geological services comprising prospecting, exploration and mineral deposit characterisation and evaluation, and mineralogical services.

b. mining services particularly in the areas of quantitative estimation of resources, mine development, equipment specification and plant construction, and safety and the environment.

c. processing services, particularly in mineral process design, flowsheet development, plant design and equipment specification.

d. consultancy-related services including feasibility studies, project management, engineering and plant construction.

e. extension services to operating plants, particularly of a trouble-shooting nature and support to resolve plant operational problems.

Due to the wide range of services, it is unlikely that they can be effectively provided by government departments, particularly given the latter's perennial problems of inadequate funding and staffing levels. In a mature private sector-driven mining economy, the listed services would be provided by the private sector, either in-house for larger mining houses or by external consulting companies.

In the majority of countries in the subregion, private sector based support services, are largely absent. This obliges government geological surveys and mining departments to provide the professional services which are often inadequate. In a number of countries, these services can be provided by external institutes and universities such as is the case in Ethiopia, Tanzania, Zambia and Zimbabwe. Governments should seek to ensure that these institutes are well-supported and that co-operation is enhanced between the institutes, government facilities and the limited available private-sector facilities. In the longer term, Governments must work towards creating an environment in which the private sector, through individual or collective entrepreneurship, can provide the services on a commercial basis.

Establishing a National Non-metallic Minerals Research Laboratory

Although the range of tests to determine applications for non-metallic minerals is large, each member State must establish a small dedicated laboratory aimed at fulfilling the needs of existing industrial and agricultural production within the domestic economy. Such laboratories are largely absent in the subregion. The laboratory would naturally have to balance the cost of equipment installed, availability of skills and range of tests possible. Excellent examples of basic low cost industrial mineral laboratories include the ones at the Government Metallurgical Laboratory in Harare, the National Council for Scientific Research in Lusaka and the Saruji Training Institute in Dar-es-salaam. Among the functions of the laboratory would be:-

a. raw material evaluation including measurement of chemical, physical and technological properties of non-metallic minerals.

b. developing a limited range of products, preferably to pilot stage.

c. acting as a training facility for operators from industry.

d. compiling manuals of quality control procedures at operating plants and providing operational research to such plants.

e. compiling compendiums of methods for the testing of non-metallic minerals and on technologies for the processing of non-metallic minerals.

f. working in close co-operation with the other agencies such as geological surveys, government mining departments, manufacturers and industrial mineral development Boards to promote the domestic use of non-metallic mineral resources.

Strengthening Technical Training

The serious imbalance in the availability of geoscience graduates in favour of geological disciplines, particularly in geophysics, geochemistry and economic geology must be addressed.

a. Governments must provide increased training opportunities at all levels of the non-metallic minerals industry, particularly in mining engineering and mineral processing. Furthermore, deliberate efforts must be made to introduce industrial minerals technology courses in the curriculum of academic institutes.

b. Academic institutes, where possible, must also seek to provide higher-level hybrid courses such as mineral production management, mineral economics and mineral process design which combine technical aptitude with economic and financial decision-making skills. This would generally have the effect of increasing technical entrepreneurship, not just for the non-metallic minerals sector but for the mining industry as a whole.

c. At the lower end of the spectrum, small scale operators in the sector need to be equipped with basic practically-oriented non-academic mining knowledge, including equipment maintenance and elementary financial skills. Such training programmes could be organised in cooperation with appropriate academic training institutes.

d. Excess middle and lower level mining manpower is increasingly available in large numbers in some of the mining countries of the subregion. Consideration should be given to using this redundant manpower through structured re-training courses aimed at enabling people to start small scale industrial minerals mining operations.

Actions at the Subregional Level

There are a number of areas in which subregional co-operation would add synergy to the development of the non-metallic minerals industry. Subregional co-operation would eliminate individual national weaknesses using strengths of well established mining countries at the same time as promote the collective development of the subregional as a whole. Some of the important areas of co-operation include the following:-

a. multi-disciplinary degree-level university training is available only in South Africa, Zimbabwe and Zambia. Given the paucity of high level training facilities, member States should pool their training requirements to maximise the efficient use of available facilities.

b. equipment requirements for a non-metallic minerals R&D laboratory are broad due to the wide spectrum of the tests required. A co-operative approach in the use of national facilities would eliminate constraints in areas where national laboratories are deficient. Shared use of facilities could be enhanced if joint research activities in the evaluation of industrial minerals were strengthened. Additionally, the use of hard currency could be waived for researchers from member States of the subregion in favour of exchange programmes where possible.

c. for a wider range of tests or those requiring advanced techniques, it would be more cost-efficient for the member States to pool their R&D efforts into one or two well equipped subregional centres of excellence. In this respect, the efforts of the non-metallic minerals laboratory at the Eastern and Southern African Mineral Resources Development Centre in Dar-es-salaam are commendable and need the support of all member States to realise its original objectives and mandate of a subregional centre of excellency. Other facilities capable of fulfilling a subregional role are available in South Africa, notably at MINTEK.

d. the sharing of skills with countries possessing long traditions of mining should be encouraged. Particular attention should be paid to the higher level skills in mine and mineral process design, project engineering and management and consultancy. These skills are the least developed in all the of countries of the subregion. Registers of experts and consulting companies in the subregion, held in some electronic data bank, would facilitate the exercise.

e. member States should develop durable arrangements for the preferential exchange of industrial mineral commodities and products to take advantage of the complementarity of national

mineral resource distribution and the combined market potential of the subregion. Such arrangements could include trade protocols, reduced tariffs and common external tariffs to check dumping practices. Examples where these factors would have worked positively include Pugu kaolin resources in Tanzania, Boane bentonite in Mozambique and Sua Pan soda ash in Botswana. COMESA efforts in the development of subregional trade are therefore commendable and should be supported.

f. member States should strive to achieve standardisation of specifications of industrial minerals products to facilitate cross-border transfer and to enable users of such products to develop product confidence based on reliability and consistency.

g. countries of the subregion should promote the sharing of economic information to create awareness of the potential and opportunities for non-metallic minerals development. They should further promote the harmonisation of legal and fiscal regimes to encourage cross-border investment and joint-ventures based on successes in the major mining countries. Periodic subregional workshops would help in this respect.

h. arrangements for the sharing of industrial and infrastructural capacities, particularly but not only restricted to electricity supplies, should be enhanced. This would alleviate shortages in individual member States, enable the opening up of new capacities or simply maintain production in times of crisis. Registers of equipment manufacturers and suppliers in the subregion would also help. SADC efforts in this direction are therefore commendable.

i. many of the co-operation arrangements discussed above would need a subregional umbrella to facilitate their implementation. A subregional intergovernmental organisation, with a strong mineral resources development programme, such as SADC or ESAMRDC would make an ideal vehicle for co-operation.

j. with its long tradition in promoting subregional economic cooperation and integration, the ECA/MULPOC should be of invaluable assistance in assisting the member States and their IGOs with thematic studies, project proposal documents, protocols for economic cooperation, harmonisation of product specifications and mining laws, and the provision of a range of advisory services. Further capability for a wide range of services is available through the Mineral Unit of the Natural Resources Division of ECA. Member States must use this capacity. Above all they ought to remember that the ECA/MULPOC was established to promote their interests in economic cooperation.

IV CONCLUSIONS

Non-metallic minerals are of obvious importance to the economic development of the member States and the subregion as a whole. They are the major driving force behind any resource-based industrialisation strategy. However, their contribution in this direction has been inconsequential and incomparable to the endowment of the member States. Reasons for this have included the absence of economic data, technical incapacities, particularly in training and research facilities, ill-developed industrial infrastructures and the lack of absorptive capacities of non-metallic mineral products in national economies. Misconstrued perception of industrial minerals as major foreign exchange earners, which they are often not, has also contributed to relegating the sector to a low priority destination for private mining capital.

The majority of the limitations afflicting the industry can be removed by the creation and improvement of domestic capacities and instituting deliberate and well-coordinated cooperation arrangements both at the national and subregional levels. At the national level, such arrangements should be directed at ensuring that all the major players such as training institutes, R&D laboratories, geological survey departments, mining departments, policy makers, industrialists and consumers all co-operate to promote increased opportunities for the exploitation and use of this vital group of minerals. This would require the creation of a national coordinating body or focal point to facilitate the interaction.

At the subregional level, cooperation should be aimed at balancing national inequalities such as deficiencies in mineral distribution, weaknesses in human, technical and financial capacities, increased exchange of products to mitigate against small national consumptions, and the sharing of infrastructural capacities. Indeed cooperation should be viewed by the member States as collective subregional self-reliance fundamental to the increased development and utilisation of national non-metallic mineral resources using subregional synergy for the benefit of individual national economies and the subregion as a whole. In this connection, the role of IGOs such as ESAMRDC and SADC, with strong programmes in mining, with the support of the Lusaka MULPOC, a lead agency in promoting economic cooperation and integration, should prove to be indispensably catalytic.

REFERENCES

1. Phiri Y.R. and Mshali R.S.M., Malawi: Investing in the Mineral Sector, Ministry of Energy and Mining, 1993.

2. Mozambique - Mineral resources Development and Investment Opportunities, Ministry of Mineral Resources, Republic of Mozambique, November, 1994.

3. V.G. Cilek, Industrial Minerals of Mozambique, 1989.

4. Murray R, Mineral Investment in Namibia, Ministry of Mines and Energy, Namibia, March 1993.

5. Tanzania - Country Supplement, Mining Journal, Vol. 320 No.8221, April, 1993.

6. Tanzania - Opportunities for Mineral Resource Development, United Nations Development Programme, 1991.

7. Feasibility Study on Porcelain Insulator Manufacturing Plant in Zambia, Japan Consulting Institute, March 1987.

8. Prospecting for Mineral deposits in Zambia, Geological Survey of Zambia occasional paper no. 123, 1986.

9. International Fertiliser Development Centre, Proceedings of the East and Southeast African Workshop on Fertiliser Minerals, Lusaka, Zambia, 8-10 December, 1987.

10. Mining In Zimbabwe 94/95, Thomson Publications, Harare, 1994.

11. A review of Zimbabwe's Mining Industry, Zimbabwe Chamber of Mines, 1991

12. Investment Opportunities in the Field of Industrial Minerals, SADC, December, 1989.

13. Project Factsheets, British Geological Survey/Overseas Development Association Project: Minerals for Development.

14. Establishment of a Non-metallic Minerals Research and Development Laboratory at the Eastern and Southern African Mineral Resources Development Centre, project document, 1989.

15. SADC-European Union Mining Forum - Changes and Opportunities in the Southern African Mining Sector, Projects and Country Profiles, Lusaka, 7-9 Dec., 1994.

GDP OF COUNTRIES IN THE EASTERN AND SOUTHERN AFRICAN SUBREGION IN CURRENT US DOLLARS (US $m)

COUNTRY	1988	1989	1990	1991	1992
BOTSWANA	2,248	2,749	3,176	3,688	3,700
BURUNDI	1,082	1,114	1,141	1,170	1,097
COMOROS	208	199	244	242	261
ETHIOPIA	5,725	5,995	6,009	6,602	6,723
KENYA	8,519	8,341	8,533	8,029	8,011
LESOTHO	452	495	583	601	677
MADAGASCAR	2,442	2,498	3,080	2,673	2,987
MALAWI	1,334	1,590	1,861	2,192	1,851
MAURITIUS	2,069	2,108	2,559	2,730	3,035
MOZAMBIQUE	1,253	1,297	1,443	1,328	1,052
NAMIBIA	1,989	1,979	2,129	2,247	2,464
RWANDA	2,309	2,324	2,289	1,630	1,552
SEYCHELLES	284	308	373	374	393
SOMALIA	1,038	1,092	917		
S. AFRICA	87,119	89,004	102,115	107,882	114,680
SWAZILAND	692	694	861	942	998
TANZANIA	3,336	2,839	2,590	3,184	2,712
UGANDA	2,480	2,947	2,736	2,566	3,164
ZAIRE	8,859	8,769			
ZAMBIA	3,632	4,345	3,704	3,831	2,086
ZIMBABWE	6,336	6,241	6,814	6,516	5,690

Source: COMESA statistics

16. Southern African Development Co-ordinating Council (SADCC) - Fertiliser Mineral Raw Material Development, Preliminary study, May 1988.

ORIGINS OF GROSS DOMESTIC PRODUCT FOR THE SURVEYED COUNTRIES FOR THE YEAR 1992

Malawi

Origins of GDP	% of total
Agriculture	26.8
Manufacturing	19.3
Utilities & construction	7.0
Transport & distribution	19.1
Government	15.4
Other	12.4
Total	**100.0**

Mozambique

Origins of GDP	% of total
Agriculture	32.6
Industry & fisheries	20.7
Construction	13.2
Transport & communications	18.1
Commerce & others	15.4
Total	**100.0**

Namibia

Origins of GDP	% of total
Agriculture	9.2
Mining & quarrying	20.1
Manufacturing (including fish processing)	6.1
Wholesale & retail trade	12.2
Financial institutions	8.2
Government	25.2
Others	9.0
Total	**100.0**

Tanzania

Origins of GDP	% of total
Agriculture	61.4
Trade & hotels	14.1
Transport	7.1
Construction & utilities	5.9
Manufacturing	4.6
Mining	1.6
Others	5.3
Total	**100.0**

Zambia

Origins of GDP	% of total
Agriculture	28.6
Mining	8.7
Manufacturing	26.2
Construction	1.5
Commerce	9.1
Government & other services	25.9
Total	**100.0**

Zimbabwe

Origins of GDP	% of total
Manufacturing	24.3
Distribution, hotels & restaurants	11.2
Agriculture & forestry	10.0
Public administration	8.9
Mining & quarrying	7.2
Transport & communications	7.2
Other	31.2
Total	**100.0**

Source: Economist Intelligence Unit Country Profiles 1993/94