7. RURAL ENTERPRISE AND AGROBUSINESS DEVELOPMENT INSTITUTIONS (R.E.A.D.I.) PROJECT

MALAWI/U.S.A.I.D.

RURAL ENTERPRISE
AND
AGROBUSINESS DEVELOPMENT INSTITUTIONS
(R.E.A.D.I.) PROJECT

PROMOTING SMALL AND MEDIUM SCALE MANUFACTURING OF

PRODUCTS FROM

THE MINERALS AND ROCKS OF MALAWI

July, 1990

FOREWORD

The purpose of preparing this document is to increase the awareness of informal, small and medium scale entrepreneurs of products which can be produced from the minerals and rocks found in Malawi. The document reviews the opportunities and potential for private sector development and transformation of these mineral and rock resources into export and domestically consumed product.

For further information users of this promotional document are encouraged to contact the Ministry of Trade, Industry and Tourism, Ministry of Forestry and Natural Resources, The Department of Mines, The Associated Chamber of Commerce in Malawi or their local DEMATT, SEDOM or INDEFUND offices for further information on individual mining and rock opportunities.

Donald E. Henry
PROJECT COORDINATOR

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1. GENERAL

1.1 PURPOSE

This study was commissioned by the Rural Enterprises and Agro-business Development Institute (READI Project)/U.S.A.I.D Malawi as part of their programme to assist Malawian entrepreneurs in starting up businesses in the small-to medium-scale mining sector. The READI programme involves providing guidance, training, and assistance to select entrepreneurs in preparing and identifying potential investment capital sources.

This study has therefore been restricted to describing inventories of mineral resources in the "industrial minerals and rocks" group, suitable for exploitation on a small scale, using relatively simple technologies, and with nominal initial financial investments ranging from as low as MK1,000 to as high as MK500,000. The report emphasizes the exploitation of these mineral resources to meet current and future local demand level. The purpose of this report is to help:

— identify mineral deposits which can be mined by small-to medium-scale (Malawian) entrepreneurs, (including limestone, vermiculite, kaolinitic clays, gypsum, glass sands, coal, gemstone, and graphite deposits).

— indicate the quality and quantity of all the resources identified,

— identify appropriate technologies for mining and processing each mineral where such technical information is available, especially those minerals that the Geological Survey Department has tested,

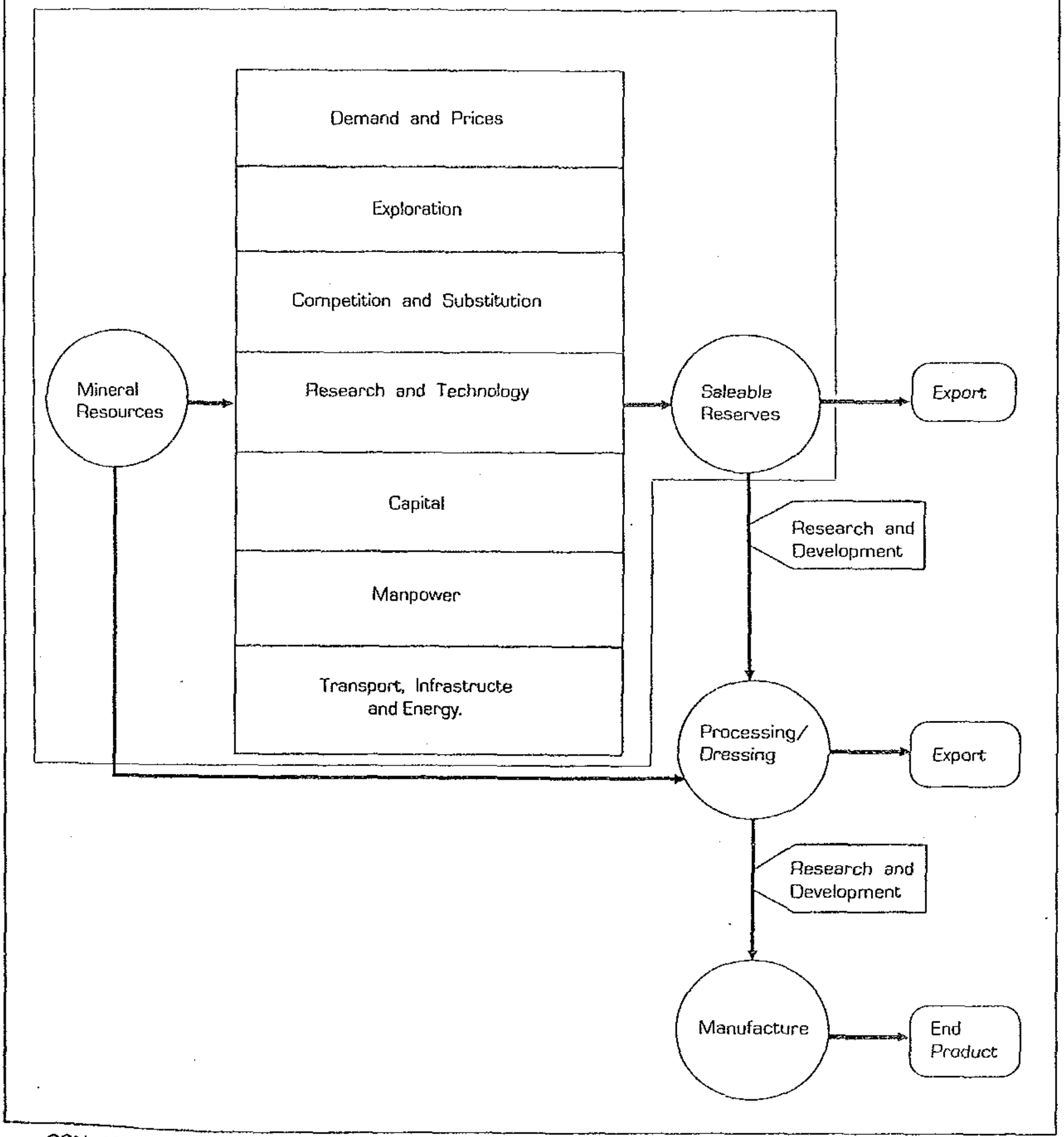
— identify possible uses of such minerals in Malawi by

— various industries and their potential for export,

— identify existing and additional infrastructure (including land, workshops, storage sheds, electricity, waste, waste disposal facilities, transport) needed to mine and process the minerals.

In promoting small-scale, import substitution industries, it is essential to note that most of these ventures will have the greatest chance of success in urban and peri-urban environments, close to the manufacturing industries. Although industrial minerals have high intrinsic values, they often have low in-place value; they are bulky and hence expensive to transport over long distances. So any decision to exploit industrial mineral resources must be based on a full analysis of markets, a deliberate choice of the resources to be exploited, selection of appropriate technologies and suitable transport arrangements. Factors that relate to the success of mining projects are given in Fig. 1.

Figure 1. Factors Affecting Development of Mineral Resources



GSN 1097C Geological Survey Dept. Malawi 1982 K.A.T.

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It is assumed that labor for small scale mining is available throughout the country, as there are many Malawians with mining experience, gained while working in mines in neighbouring countries. This is best illustrated by the high skill levels demonstrated by workers who were surveyed at the Kaziwiziwi and Mchenga Coal Mines in 1985 and early 1988.

Legislation that is sympathetic to the small scale miner and processor is in place. The Mines and Minerals Act, Cap. 61:01 lists three categories of licenses:

- Mineral Permits;
- Non-exclusive Prospecting Licenses and Mining Claims;
- Mineral Rights, comprising:

under mineral rights are three sub-categories of licenses:

- Reconnaissance Licenses;
- Exclusive Prospecting Licenses; and
- Mining Licenses.

The first two categories of licenses are the most suitable choices for Malawian entrepreneurs with modest resources and capabilities, while the last category largely suits medium-to-high cost operations. The ***Mineral Permits*** category covers the digging of building materials and are mainly issued to traditional brickmakers and stone crushers through District Commissioners. The ***Non-Exclusive Prospecting Licenses (NEPL)*** and ***Mining Claims*** category is designed for the small-scale prospector and miner. The latter may be issued by the Commissioner for Mines and Minerals to Malawian citizen or companies; for others, the Minister of Forestry and Natural resources must be consulted. The licenses are valid for one year. The holder of a NEPL also has the circumscribed right to register a ***Mining Claim.*** It is illegal to prospect or mine a mineral without a license, except for traditional activities such as excavating clays for construction of homes in villages. (See Appendix A-3 for more information about Permits and Licenses.)

1.2 DEFINITIONS

There are three main categories of mineral resources: "metallic ores", "industrial minerals and rocks" and "energy minerals (including fossil fuels)". The metallic ores include gold, silver, copper, nickel, iron ores; to date no significant quantities of these have been found in Malawi. Industrial minerals include limestone, ceramic clays, building clays, vermiculite, kyanite, corundum, glass sands and gypsum; these are found in substantial quantities in Malawi and can be developed using simple technologies. Coal, uranium and petroleum are the energy minerals; so far, only coal and uranium have been located in Malawi.

The term "industrial minerals" is not as strictly defined as the terms "ore" or "fossil fuel" (Kuzvart, 1984). The characteristic feature of an industrial mineral lies in its physical properties, e.g., the insulation properties of vermiculite, the refractory nature (resistance to heat) of magnesite or kyanite, and the plasticity of clays, etc. Ores are characterized by the chemical properties of the metals.

Kuzvart ***(opcit)*** defines four categories of industrial minerals:

1. Raw materials that are used in industry in variously prepared forms of minerals (e.g. talc as a filler, glass sands for glass or abrasives);

2. Raw materials that serve as a source of non-metallic elements such as pyrite as a source of sulphur, fluorite for fluorine, and apatite for phosphorus;

3. Non-metallic raw materials that are sources of metals (e.g. bauxite as a source of aluminum, although it is also a source of refractories);

4. Building materials (e.g. granite, gravel and sand, brickclays, etc.).

The term "non-metallic minerals" is often synonymous with "industrial minerals". However, some raw materials may at times fall into the "ores" group, while at other times they may be an "industrial mineral. For example, chromite is both a source of the metal "chromium" and a refractory material. This report will use the foregoing terminology in relation to current practices in the commercial sector. The afore mentioned four categories of industrial minerals are modified into five primary areas of use in Malawi:

— chemical industry;
— refractories;
— fillers;
— building materials; and
— ornamental stone

1.3 IMPORTANCE OF INDUSTRIAL MINERALS

Industrial minerals are generally the least understood of all natural resources in developing countries. Consequently, most industrial minerals remain unexploited, while a high priority has been given to development of metallic and energy minerals for export to industrialized countries. That many Malawians may not perceive industrial minerals as a potentially lucrative investment area is a development problem often ignored by planners and financiers.

At present, over 80 percent of the consumption of industrial minerals takes place in industrialized countries. Additionally, many developing countries import a variety of commodities with a high proportion of industrial mineral materials in them. These commodities could be manufactured locally.

The importance of industrial minerals may best be illustrated by comparative world production figures in Table 1.1.

Table 1.1: World Production of Industrial Mineral Commodities

Commodity	Amount	
building materials	9.0	billion tonnes
fossil fuels	6.9	billion tonnes
industrial minerals	7.5	billion tonnes
ore concentrates (Fe, Mn ore)	0.93	billion tonnes
steel	0.6	billion tonnes
other metals (excluding Fe, Al, Ti, Cr, Ta, U and Zr)	0.019	billion tonnes

(after Kuzvart, 1984, p.20).

Furthermore, in the U.S.A., non-metallic mineral resources represent more than twice the value of ores in the Gross National Product, even though the United States is very rich in ore minerals.

In Malawi industrial minerals are generally consumed indirectly in the form of imported commodities. These include glass, fertilizers, ceramic ware, plastics, lime, acetylene, paints, chalk, ink, pesticides, soaps and detergents and pharmaceuticals. The value of these imports has ranged from K12 million in 1980, to over K13 million in 1987 (Table 1.2). Industrial minerals make up a large proportion of the ingredients of these imports. These raw materials could be supplied from Malawian deposits.

1.4 CONSTRAINTS ON MINERAL DEVELOPMENT

The development of mineral resources in Sub-Saharan Africa has been primarily directed towards the extraction and export of "metallic" ores: gold, copper, nickel, chromite uranium, diamonds, etc. As there is a ready and strategic demand for these minerals in industrialized countries, they have often attracted the most investments from international mining houses, in contrast to the "industrial minerals" which are most abundant in Malawi. Secondly, even those prospects with export potential, such as rare earths (RE), vermiculite, bauxite and uranium, have rarely been aggressively promoted, hence there was very little private sector exploration taking place prior to the 1980s.

Malawi's abundant resources of limestone, vermiculite, ceramic clay, graphite, pyrite and pyrrhotite could contribute significantly to local industrial development.

The failure to develop these resources to date has been due to a number of factors.

For example:

— The development of industrial minerals often goes hand in hand with that of metallic ores. Ceramic clays, kyanite, and limestone are some of the key resources in the smelting of ores, production of refractories; other industrial minerals are additives for fertilizers and pesticides.However, at present there is no coordinated effort to monitor potential demand and develop strategic plans for production of mineral-based commodities.

— Traditionally, Malawian manufacturers depend on the supply of raw materials from their mother companies in Europe, the U.S.A., Japan or South Africa. The demand for local raw materials is a recent phenomenon, thrust on the industry by economic difficulties.

— Often educated people are reluctant to take up business initiatives in the mining sector, and small scale mining is left to those who may least understand the need for improved technologies. Consequently, inefficient and poor quality production operations are common in the small-scale mining sector.

The biggest obstacles to overcome in order to develop industrial minerals seem to be a lack of technological methods and practices; an absence of coordinated research efforts; and the inability to convert research information and results into realistic commercial ventures.

Mineral commodities are only one part of the required raw materials that are necessary for the production of consumable goods. There is, however, a lack of an integrated approach in determining actual demand of raw materials. For instance, because mining strategists and agricultural consumers do not communicate, agriculture's need for fertilizers, fillers and conditioners are not met by local resources and the mining industry misses out on local demand.

The only way to solve these problems is to maintain a consistent and continuous system of human resources development, through M.E.D.I., DEMATT, SEDOM and the rural technical schools. However, this requires a pool of trainers as well as mineral development research centres.

Table 1.2: Imports of Industrial Minerals and Mineral Products

Commodity	1980		1984		1985		1986		1987	
	Quantity	Value (MK)	Quantity	Value (MK)	Quantity	Value (MK)	Quantity	Value (MK)	Quantity	Value (MK)
Salt	12,970	1,578,519	15,848	3,986,483	24,590	5,283,564	11,726	2,839,636	14,402	4,890,656
Graphite	-	-	1	566	-	-	1	3,523	-	457
Clay	-	-	63	27,976	85	30,101	53	47,449	54	35,007
Chalk	-	-	12	3,406	-	-	2	556	37	20,699
Ornament Stone etc.	-	-	359	79,599	519	115,120	398	155,546	342	142,624
Magnesite Product	-	-	-	-	-	80	71	82,796	71	116,372
Gypsum	-	-	3,205	404,246	2,076	273,934	3,102	413,207	3,096	448,563
Lime	3,143	526,068	3,293	723,956	2,172	503,877	1,931	393,251	3,953	1,153,327
Cement	30,629	2,933,959	4,382	586,567	10,839	1,225,221	23,318	2,223,273	16,044	2,111,925
Coal	65,383	3,189,323	41,266	4,220,308	32,752	4,159,153	27,746	3,050,539	24902	2,733,715
Sulphur	-	-	2.973	2,793	13.15	9,924	9.343	9,173	26.253	43,487
Sulphuric Acid	473,203	558,433	131.136	103,678	264.75	321,036	130.655	128,979	268.657	743,611
Glass/Glassware	-	2,561,862		2,732,740		2,448,780		n/a		n/a
Ceramic Product	1,121.5	957,125		1,692,059		1,101,708		n/a		n/a
Total Value in MK		12,305,289		14,564,377		15,472,498		9,347,928		12,440,443

— National Statistical Office-Source.
— Values are in Malawi Kwacha.
— Ornamental Stone include Quartzite, Dolomite (marble), Steatitite (soap-stone), sands, granite, mica and feldspar.
— Magnesite/magnesium carbonate (natural).
— All quantities are in tonnes except for sulphur, sulphuric acid and ceramic products which are given in Kgs.

2. LIMESTONE AND DOLOMITE

2.1 RESOURCES

Limestone and dolomite resources of Malawi are estimated to be over 800 million tonnes, mainly found as metamorphic marbles in the southern part of Malawi (Figs.2 and 3). All the resources may be divided into 5 types as follows:

- metamorphic marbles: (The term marble is used in the geologic sense, and not in the trade sense of a rock which can take a polish for decorative purposes.)
- carbonatites: igneous rock vents enriched in sovites (calcites of undoubted igneous origin);
- *sedimentary limestones;*
- vein calcite;
- travertine, (light coloured) tufa and (porous) soil limestones.

The most widely used limestones and dolomites are the metamorphic marbles and sedimentary limestones, hence further discussions will mainly refer to these.

In the commercial sector of Malawi, a clear distinction is emerging with respect to the terms:

(i) limestone
(ii) dolomite
(iii) chemical grade lime
(iv) building lime
(v) ordinary lime

These terms do not presume any geological or genetic interpretation of the raw material. This report maintains the meaning of these terms as they are applied in the Malawian commercial sector:

- Limestone is a term reserved for rocks in which the carbonate fraction is composed primarily of the mineral calcite ($CaCO_3$), with the magnesian (MgO) content less than 5 percent. (If the proportion of dolomite minerals is between 5 and 10 percent then the rock may be referred to as a magnesian limestone.)
- Dolomite is reserved for those rocks which are composed primarily of the mineral dolomite, $CaMg(CO_3)_2$ theoretically, some 21.9 percent MgO and 30.4 percent CaO;
- Chemical grade lime is as defined in the specifications given by the South African Bureau of Standards (see Tables 2.3 and 2.4);
- Building grade lime is as defined in the specifications of the South African Bureau of Standards.

Figure 2. Main Limestone, Brickclay, Talc, Kyanite and Phosphate Resources of Southern Malawi

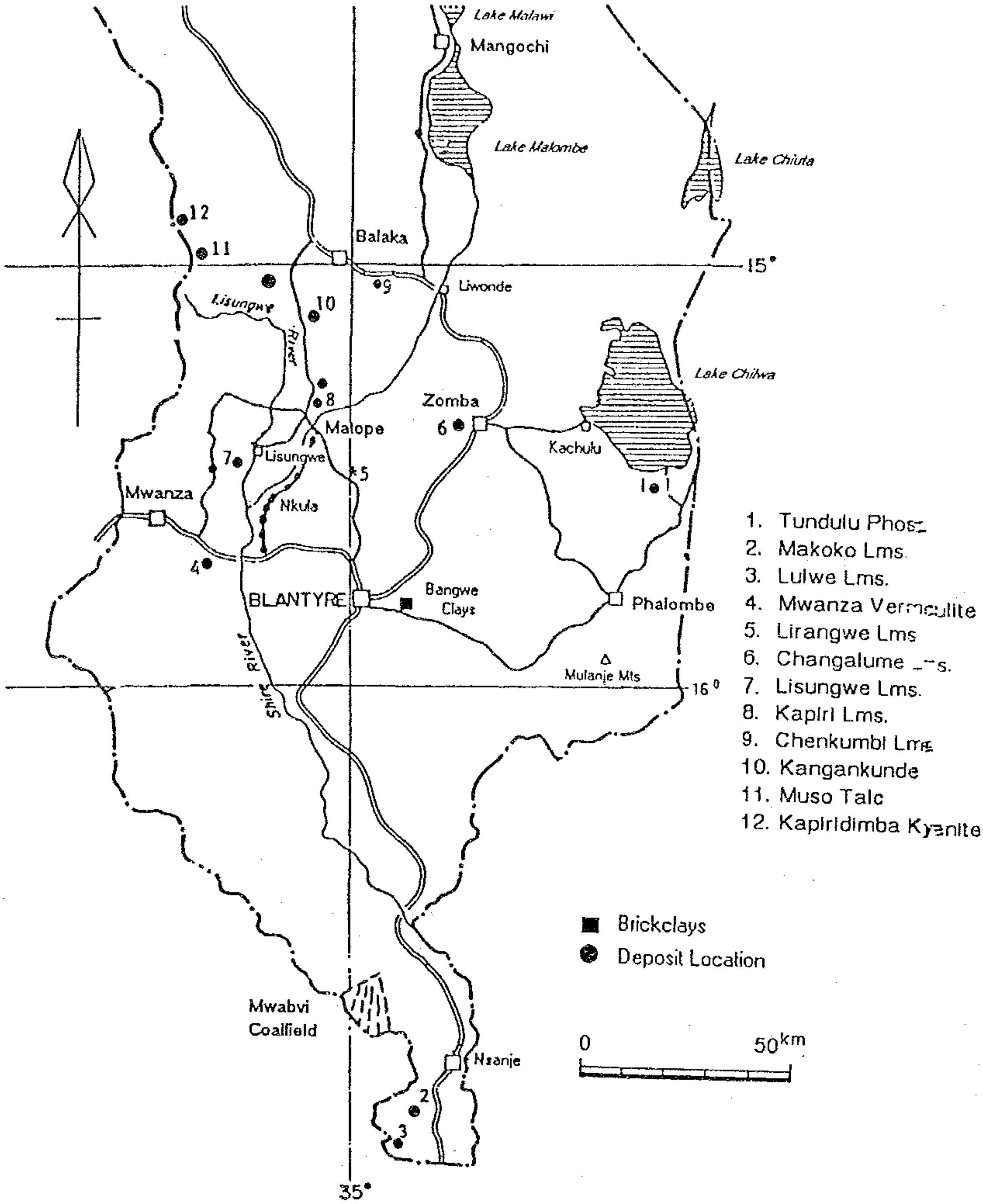

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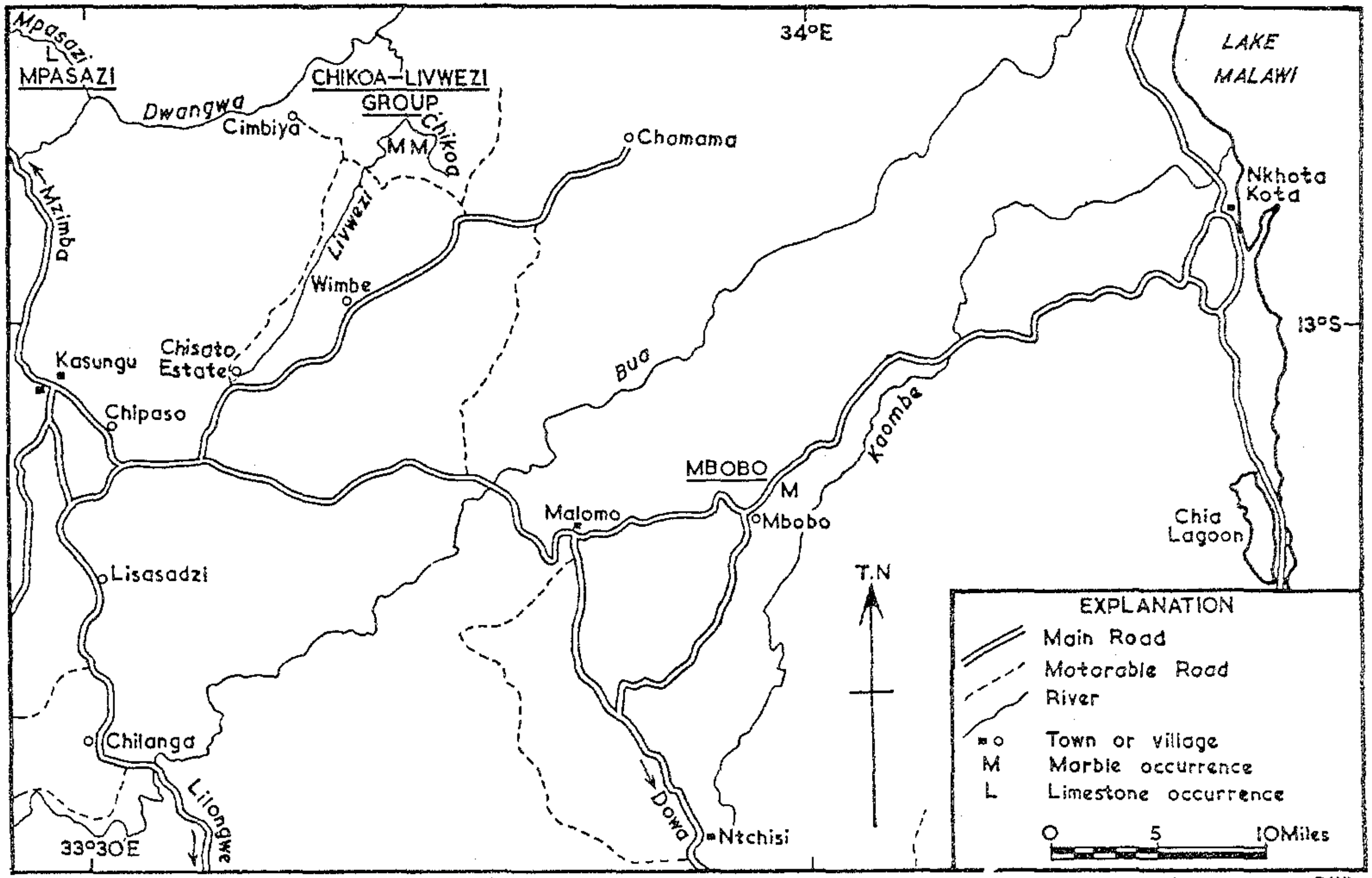
Figure 3. Location Map for Marble and Limestone in the Kasungu-Ntchisi Areas



GSN.901 J. Geological Survey Dept. Malawi 1972. DWL.

Most of the limestone and dolomite deposits which have been located by drilling and/or trenching have only been partially evaluated. The reserves and quality of these deposits are presented in Tables 2.1. and 2.2. Exploitation of limestone and dolomite is greatest at Lirangwe, Chenkumbi, Kholombidzo and Changalume (for cement production).

Table 2.1 Limestone: Total Estimated Resources

Deposit Location	District	Est. Resources (mil. tonnes)	Percent CaO	Percent MgO	Percent Inso-luble
Changalume	Zomba	100	49.4	0.8	5.8
Chenkumbi	Machinga	300	46.1	6.3	-
Chikoa	Kasungu	25	53.1	0.3	2.5
Livwezi	Kasungu	18	53.7	0.5	1.8
Matope/Nkula	Blantyre	180	31.8	20.0	-
Lirangwe	Blantyre	5	31.7	19.1	3.2
Makoko/Malawi	Nsanje	20	47.2	5.6	3.8
Golomoti	Dedza	15	48.1	1.2	1.7
Uliwa	Karonga	5	45.6	1.9	10.6
Ngana	Karonga	6	45.4	1.3	16.3
Mwesia	Karonga	15	39.2	1.6	18.9
Chilwa Island	Zomba	25	52.1	0.2	3.3
Kangankunde	Machinga	5	46.4	1.2	10.8
Kapiri	Machinga	10	28.7	21.7	2.1
Lulwe Hills	Nsanje	2	51.9	0.9	2.6
Lisungwe	Blantyre	40	30.2	20.2	2.2
Nsengwa	Mwanza	30	-	-	-
Total Estimated Resources		801			

2.2 USES AND SPECIFICATIONS OF LIMESTONES AND DOLOMITES

"Literally any object that exists in man's home or his office (or virtually any manufactured product) has required lime or limestone (including dolomite) in some phase of its manufacture, directly or indirectly, either as a prime or incidental processing material. In fact, lime and limestone's basic essentiality has been likened to one leg of a 6-legged stool on which industry revolves; the other essential legs being iron ore, salt, sulphur, petroleum, and coal - these are the six building blocks of industry and commerce" (Boynton, 1980).

Table 2.2: **Limestone: Mineable Reserves (located by rotary core drilling or trenching)**

Deposit Location	District	Estimated Reserves (million tonnes)
Changalume	Zomba	25
Chenkumbi	Machinga	10
Chikoa	Kasungu	5
Liviwezi	Kasungu	5
Nkula	Blantyre	0.6
Matope Bridge	Blantyre	0.7
Golomoti	Dedza	0.5
Total Estimated Reserves		46.8

There are many uses of limestone and dolomite, but only a few of these are appropriate in Malawi:

— **Portland cement** - Limestone is quarried and burnt in kilns at Changalume. The clinker produced is then transported to Blantyre where, after the addition of gypsum, the resulting cement is bagged and sold.

— **Lime** - 70 percent of the lime produced in Malawi is building lime, but it is also used for a variety of purposes including for sugar production when there are import supply problems. The lime is mainly obtained from limestones with an Mg0 content below 5%.

— **Dolomite** is crushed and milled in the Blantyre area for agricultural purposes and for the production of scouring powders. The particles are milled to less than 80 mesh fineness. (See Appendix for mesh size explanation.)

Specifications for the different types of limes, limestone and dolomite used in industry are equivalent to those of the South African Bureau of Standards.

For **bedding mortar** (SABS 523-1972) the minimum combined CaO + MgO content should be 70 percent by weight. The minimum CaO content should be at least 40 percent by weight. At least 75 percent by weight of the particles must be hydrated lime finer than 0.600 mm.

Plaster must have a minimum combined CaO and MgO content of 80 percent. These particles must be finer than 0.075 mm.

Putty plaster should have a compared CaO + MgO content of 85 percent. The CaO proportion must be greater than 50 percent by weight. The particles should be the same as those of plaster.

The chemical and physical properties of lime for chemical, metallurgical and soil stabilization purposes are given in Tables 2.3 and 2.4.

Table 2.3: **Chemical and Physical Properties of Slaked Lime for Chemical and Metallurgical Purposes (SABS 459-1955)**

Lime Component	High-Calcium hydrated lime			Magnesian Hydrated Lime (% Wt.)	Dolomitic Hydrated Lime (% Wt)
	Grade I (% Wt.)	Grade II (% Wt.)	Grade III (% Wt.)		
Min. Available CaO	68.0	66.0	64.0	60.0	-
Min. CaO + MgO	-	-	-	-	64.0
Max. MgO	2.0	3.0	2.0	10.0	31.0
SiO_2 + insolubles	2.0	3.0	3.5	4.5	56.0
Residue on 0.15mm sieve, Max	5.0	8.0	12.0	10.0	10.0

Note: % Wt. + Percentage of total sample weight

Table 2.4: **Chemical Properties of Hydrated Lime for Soil Stabilisation (SABS 824-1967) (% Weight)**

Lime Components	High-calcium Lime (i)	Magnesian Lime (ii)	Dolomitic Lime (iii)
Min. CaO + MgO	75	75	75
Min. Available Lime	50	35	30
Max. Free Water	3	3	3
-0.075 mm particles	50	50	50

i. High calcium lime has a calcium-oxide (CaO) to magnesium-oxide (MgO) ratio greater than 14.0 percent of the total weight of sample.

ii. Magnesian lime has a calcium-oxide (CaO) to magnesium-oxide (MgO) ratio greater than 2.0 but less than 14.0 percent of the total weight of sample.

iii. Dolomitic lime has a calcium-oxide (CaO) to magnesium-oxide (MgO) ratio greater than 1.3 but less than 2.0 percent of the total weight of the sample.

2.3 POTENTIAL DEMAND

At present, demand for chemical grade lime in Malawi is about 3,300 tonnes per annum. 95 per cent of this is consumed by the sugar industry, and the balance by Lilongwe and Blantyre Water Boards, and Southern Bottlers. Production and consumption of building lime in the last three years were as follow:

Table 2.5: Production and Consumption of Building Lime

Year	Production tonnes	Sales in tonnes
1985	N/A	1462
1986	2681	2735
1987	1639	1544

Source: Economic Reports, EP & D.

The construction industry consumes most of the building lime as whitewash, plaster and mortars. Lime is also increasingly being used in agriculture, as dusting in the coal mines, for treatment of sewage by municipalities and for sanitary purposes. However, there are no consumption figures for these latter uses.

The demand for crushed and ground dolomite has dramatically risen in the last two years, largely for agricultural purposes. The quality of the dolomite required ranges from 20% to 40% $MgCO_3$ for this purpose. Other established users of ground dolomite are companies producing scouring powders and terrazzo. The actual and projected demand for dolomite follows in Table 2.6.

Table 2.6: Dolomite Demand: Actual and Projected

Company	Year	Estimated Dolomite Requirements (tonnes)
Optichem	1987/88	1000
	1988/89	3000
Naming'omba	1987/88	120
	1988/89	200
Lever Brothers	1986	244
	1987	217

Almost all the chemical grade lime is imported, mainly from Zambia. Most building lime and dolomite are locally produced at Lirangwe, Chenkumbi and Kholombidzo. It is projected that agriculture's demand for dolomite will grow rapidly in the near future.

2.4 MINING AND PROCESSING

Mining of limestone and dolomite is already well-established and production is adequate for the size of today's market. The shortages which often occur are due to the inefficiencies in the processing operations. Mining involves removing overlaying soils to expose the rock. Sledge hammers are used to reduce the size of the large pieces. When the rock face is too hard or too large to remove easily, a fire is lit on the outcrop until it is hot to the touch. The hot rock is then rapidly drenched with cold water, and the rapid cooling causes the rock to crack, and the resultant pieces are broken and removed. The stockpiling of rock in 2.0 to 2.5 tonne mounds is done on a piece-rate basis.

Limestone is then crushed using small hammers to sizes ranging from 50 to 150 mm, also on a piece-rate basis. Most small miners are aware that, for lime production, only limestone (i.e. calcitic limestone) is suitable. However, quality control at the quarrying stage is a major problem. Miners must ensure that only the high-calcium limestone is quarried. The Geological Survey Department has designs of field testing kits that could be used for distinguishing high calcite from other types of carbonates.

It is doubtful that small-scale lime producers could consistently produce chemical-grade lime to the specifications given in Tables 2.3 and 2.4. Consequently, studies carried out in the last 2 years focused on improving the efficiency of lime-burning by the traditional producers in order to produce high grade building lime. The ITDG report "Proposals for Upgrading the Small Scale Lime Producers in Malawi" comprehensively covers the production of lime using both the traditional and proposed new methods (ITDG, April 1988).

5. GLASS SAND

5.1 RESOURCES AND RESERVES

There are two large deposits of glass sand in Machinga and Mchinji Districts. The Machinga deposit occurs as the Lake Chiuta/Chirwa sand bar (Fig. 6). It is a 10-20 metre raised beach, some 40 km long. The Mchinji deposit occurs on the eastern pediment of the Mchinji Hills (Fig. 7). Many dambo areas and some swamps along streams and rivers also have accumulations of fluvial sands. Most of the sand horizons are well-developed at the heads of the dambos, close to the hills from which the sands are extracted.

The middle section of the Chirwa sand bar is fairly well-sorted, containing mainly quartz grains. Some 25 million tonnes of glass sand have been delineated in this section in Blocks A, B and C. (Fig. 8). The particle size distribution of the sand are shown in Table 5.1.

Both the western and eastern sections of the sand bar have very coarse to gravelly sand. No reserves have been delineated in these sections.

Quality of glass sand is generally classified by the size ranges of the sand and its chemical composition, particularly that of iron oxides (Fe_2O_3) and aluminum oxides (Al_2O_3). Assuming British Standards specifications, the -30+120 mesh size is preferred for most uses, including glass making. A deposit must contain at least 52 percent of the -30+120 mesh size for it to qualify as a glass sand. Also the fine fraction passing through the 120 mesh sieve should be less than 5 percent.

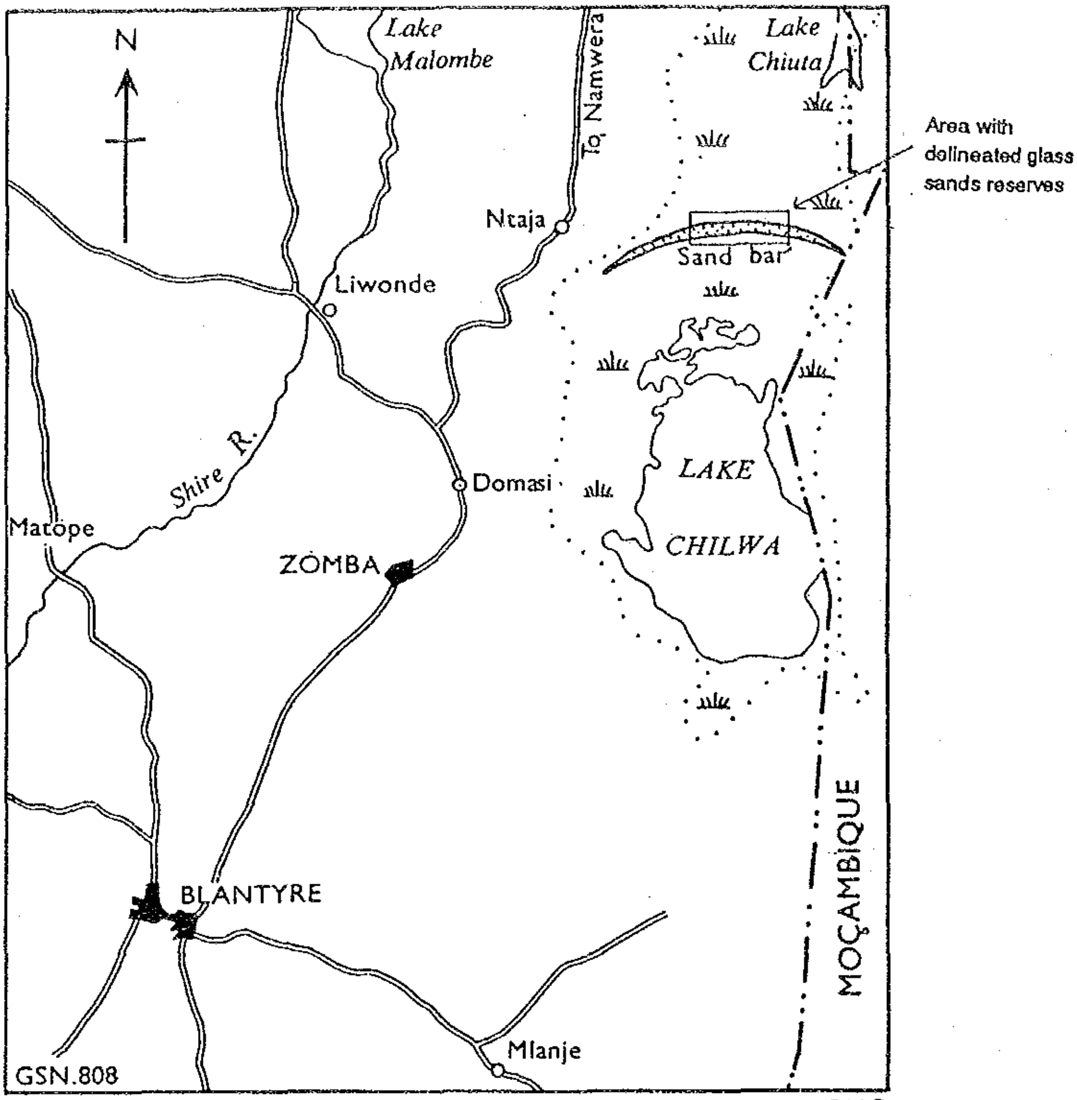
The classification of glass sands in terms of chemical composition is given in Table 5.2. In this case, the Chirwa glass sand may be regarded as 9th Quality amber, although this could be considerably upgraded by intensive beneficiation. The delineated reserves are described in Tables 5.1 through 5.3.

Table 5.1 Particle Size Distribution of the Glass Sand Deposit at Lake Chiuta/Chirwa

Block A

Sieve Size	Pit No. 7	Pit No. 8
+ 30 mesh	8.6	1.9
- 30 + 60 mesh	73.8	63.7
- 60 + 120 Mesh	15.3	30.0
- 120 Mesh	2.3	4.4

Figure 6. Location of Lake Chiuta/Chirwa Sand Bar



Geological Survey Department, Malawi 1969 RHG

13. ROCK PHOSPHATES

13.1 FERTILIZER DEMAND

Future increased crop production in Malawi will rely heavily on the wide application of synthetic fertilizers and pesticides. Factors that will affect achievement of increased food production are: the cost of imports; the development of systems for appropriate use of fertilizers; and the adoption of schemes that promote the use of local raw materials in fertilizer and pesticide formulations.

Fertilizers are essential since soils lose fertility with the increased use of land for agriculture.

During weathering, the primary earth surface materials go through three stages of transformation:

Stage 1 — Original rock constituents are dominant. Only minor plant nutrients are available in partially formed secondary clay minerals.

Stage 2 — Rock constituents wholly decompose, making plant nutrients readily available in clay phases for uptake by plants.

Stage 3 — Natural, primary plant nutrients become depleted due to repeated cropping; an infertile and leached soil remains.

The major element constituents in these three stages are shown in Fig. 21. Due to leaching, erosion, and consumption of nutrients by plants, the soils eventually lose their fertility and evolve into the refractory silica-alumina-iron oxide-rich (SiO_2 -Al_2O_3) compositions. At this stage, counter-acting processes to re-fertilize the soils are required to improve crop yields on a unit area.

The most important fertilizers imported into Malawi are compounds of nitrogen (N), phosphorus (P) and potassium (K) as shown in Table 13.1. Fertilizer imports and sales by ADMARC and OPTICHEM are the main indicators of fertilizer consumption patterns. From 1972 to 1978, consumption of all fertilizers generally increased at an approximate annual rate of 5.6 per cent to reach 104,000 tonnes in 1978. (This is the equivalent of about 29,714 tonnes P and K). The trend from 1978 to 1985 has been to increase the amount of imported high-analysis N.P.K. fertilizers at the expense of sulphur-based fertilizer (from ammonium sulphate at 21 percent nitrogen (21N) to CAN (26N) and Urea (46N)). The average nutrient content of all fertilizers used in Malawi in 1978 was equivalent to 28.7 kg of NPK per tonne of produce sold. This low level of inputs is undesirable, as the benefits of concentrated synthetic fertilizers are not fully realized.

Figure 21. Major Element Constituents of Soils

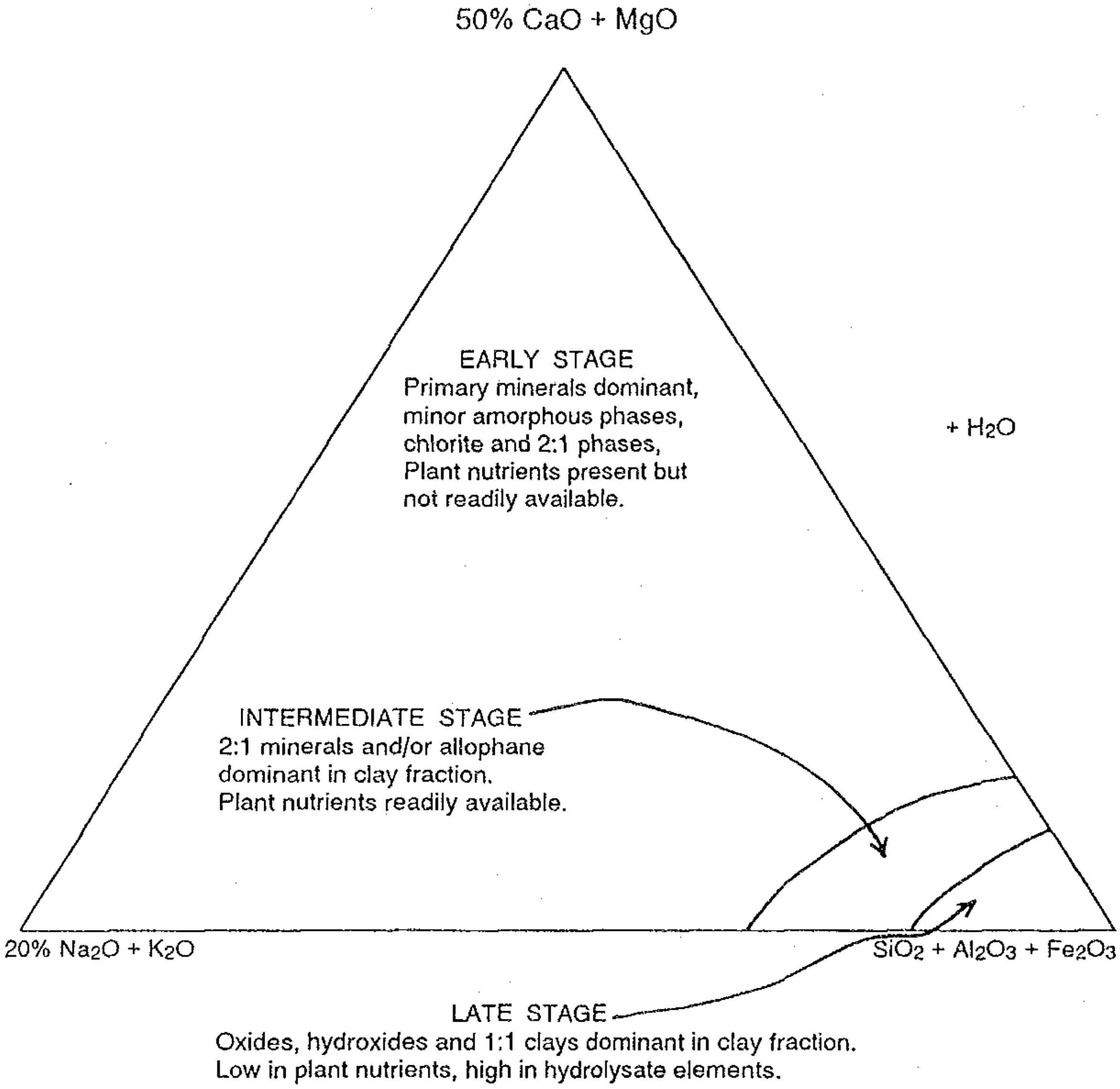


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Table 13.1

Fertilizer Imports by Types

	1978		1979		1980		1981		1982		1983		1984		1985	
Types of Fertilizer	Tonnes	Value	Tonnes	Value	Tonnes	Value	Tonnes	Value	Tonnes	Value	Tonnes	Value	Tonnes	Value	Tonnes	Value
Sodium Nitrate	480	105,947	700	130,227	2,300	460,667	-	-	-	-	556	220,330	-	-	442	240,720
Nitrate	2,846	347,719	11,275	1,510,101	-	79	3,500	813,431	125	23,017	14,318	3,575,290	21	3,486	-	-
Ammonium Sulphate	61,884	7,697,724	11,961	1,494,449	35,142	4,648,866	79,285	15,888,144	43,042	7,438,753	24,846	5,548,648	22,553	7,271,722	8,835	2,562,101
CAN	7,767	931,353	14,800	1,608,382	5,426	1,217,488	2,498	636,926	8,228	2,052,728	36,152	8,623,860	38,090	12,644,282	27,798	10,935,058
Urea	839	208,120	3,420	583,115	10,230	2,422,264	7,678	2,326,949	11,229	3,613,479	7,360	2,426,546	15,868	5,416,087	11,420	5,729,403
Nitrogenous Fertilizers	20,362	719,369	13,696	2,356,805	3,264	764,403	5,500	1,163,910	2,002	414,740	722	182,089	299	114,655	1,316	995,756
Super, Phosphate Single	2,619	202,458	2,201	298,881	1,804	287,711	1,499	263,303	1,491	267,634	796	177,285	788	140,387	1,782	413,675
Super Phosphate Double, Tripple	3,173	440,544	7,809	1,241,669	10,721	2,299,622	9,896	2,322,534	9,424	2,305,636	15,157	5,490,926	6,643	2,121,154	7,196	2,170,600
Phosphate Fertilizers	1,350	197,948	1,818	341,206	2,351	633,689	161	50,812	4,277	795,716	5,386	1,832,181	536	148,236	1,995	701,123
Potassium Chloride	750	80,351	2,300	286,209	2,553	583,488	2,500	557,631	250	52,326	4,098	1,151,198	1,165	3,99,448	3,658	1,733,931
Potassium Surphate	300	44,141	5,368	692,366	3,000	699,211	2,717	799,862	4,524	699,991	3,225	1,233,285	-	-	2,081	1,065,359
Potassic	500	50,422	5,874	1,107,409	4,000	897,402	1,420	434,428	2,750	951,646	2,371	1,055,803	2,136	1,010,688	2,682	1,215,689
Fertilizers (other)	600	179,016	-	-	9	5,188	18	4,205	29,998	8,239,277	48	51,460	22,099	8,504,332	23,502	9,603,008
Total	103,470	14,205,139	81,222	11,650,819	80,000		116,672	25,262,215	117,340	26,854,943	115,098	31,658,901	110,198	37,774,482	92,707	37,366,429
	K137/tonne		K143/tonne		K185/tonne		K216/tonne		K228/tonne		K274/tonne		K343/tonne		K403/tonne	

Table 2 - Imports of Agricultural Disinfectants Insecticides

	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
In Liquid Form (litres)	251,673	526,226	283,520	1,008,009	233,214	1,095,615	260,076	1,045,647	432,845	2,177,269	418,960	2,100,009	303,334	2,569,927	333,613	2,430,048
In Powder Form (kg)	1,185,258	1,767,897	427,737	1,584,534	277,872	892,01	85,555	408,891	287,586	1,362,681	203,727	1,179,837	299,558	1,153,942	437,253	1,733,783
Total	-	2,294,123	-	2,592,543	-	61,987,631	-	1,454,538	-	3,539,950	-	3,279,846	-	3,723,869	-	4,163,831

Fertilizer import levels continued to decline from 1982 to 1985, from 117,340 to 92,707 tonnes, respectively. The nutrient content of NPK was 26,488 tonnes in 1985.

13.2 RESOURCES OF ROCK PHOSPHATES (RP)

One of the major constraints for establishing a fertilizer manufacturing plant in Malawi has been lack of investment capital. Because of this, several feasibility studies for projects, for instance a nitrogen plant, have been shelved more than once.

Now, there is an opportunity to examine low-cost techniques for utilizing local mineral resources to produce some fertilizers. A method that is being widely researched is the *direct application of rock phosphates as a phosphorus (P) fertilizer.* Malawi has several mineral deposits rich in phosphorus. Some of the phosphorus (as the mineral **apatite)** is in the soil and in deeply weathered rock overlaying such deposits. When these soils and rocks are milled and applied to farmland, the phosphorus is released from the apatite and becomes available for use by the plants.

The Tundulu phosphate deposit on Nathace Hill (Fig 2.) is the most promising deposit of rock phosphate at present. The levels of phosphorus in some samples are given in Table 13.2. There are, however, other factors that must be taken into consideration in utilizing PR:

- It is the *phosphorus available for release* from the rock that must be determined, rather than the absolute phosphorous content in the rock.
- Acidic soils would seem to be the most likely to benefit from application of PR as the acid would attack the apatite allowing the release of phosphorus at a faster rate.
- PR can be of immediate beneficial use to perennial crops such as tea, coffee, macadamia, fruit trees and forest plantations, rather than for seasonal cereals. PAPR is the most appropriate composition for fertilizing cereal crops.

Other prospective deposits of phosphorus are given in Table 13.2.

13.3 MINING

Presently, the investigations into PR are at the research stage, and various Malawian, American and British institutions are involved in the research work. There are potential opportuities for small scale enterprises to mine, mill and package PR for distribution to farmers. The mining would involve extraction of fairly soft rock within 5 to 20 metres of the surface.

13.4 INFRASTRUCTURE REQUIREMENTS

The Tundulu area is far from electricity. The roads to the area need to be upgraded to carry frequent heavy traffic. There is abundant water from nearby Lake Chilwa. However, land would be expensive as the area is extensively cultivated and has a dense population.

Table 13.2: Phosphate Resources and Percent of Phosphorus (P_2O_5)

Area	District	Estimated Reserves	Percent P_2O_5	Remarks
Tundulu	Mulanje	1.25 mil. tonnes	+ 25	suitable for direct PR
Chingale	Zomba	0.32 mil. tonnes	3.7	eluvial apatite, requiring processing
Mlindi	Mwanza	2.4 mil. tonnes (inferred)	7-14	vein and eluvial apatite
Bilila	Ntcheu	not delineated	0.01-3.32	eluvial apatite
Chirwa Is.	Zomba	not delineated	2.5	in carbonatite
Kangankunde	Machinga	not delineated	1.3-8.9	in carbonatite

16. CONCLUSION

This report largely outlines domestic inventories of "industrial minerals" that offer viable economic exploitation opportunities for small scale entrepreneurs. The mineral resources that can best satisfy local needs, as well as those for which an export potential exists, are also identified. Coal that can be extracted by small scale entrepreneurs, and can be used to meet low-level energy demands, is also included in this inventory. The use of coal is important since it reduces the demand for fuelwood for limestone mining and processing operations.

The "industrial mineral" resources which have the best potential for meeting existing in-country demand, are in order of priority:

— Limestone and dolomites
— Kaolinitic ceramic clays and glass sands
— Brickclays,
— Gypsum
— Rock phosphate
— Pyrite/pyrrhotite

The world demand for vermiculite, graphite and to some extent kyanite is high, and it is expected to remain so well into the 1990s. Vermiculite and "flake" graphite (or crucible graphite) have no competitive substitutes, so in-depth evaluations for the purpose of extracting and exporting these mineral resources should be undertaken.

Gemstones and ornamental stones have export potential. On the other hand, gemstone marketing is complex and there are no data available for evaluating the potential market. The amount of exports in the last year indicates that there is a growing market for Malawian stones in Europe and the U.S.A. Cutting the stones locally will increase the "value added" of the exports; this is an area of investment that has yet to be exploited.

Malawi's imports of minerals and mineral products have been increasing in the last 5 years, totaling over K15 million. However, these same minerals and mineral products can be produced locally, many by small scale enterprises. Small scale enterprises are appropriate since the national demand for most mineral commodities is relatively small. Small enterprises would fit in well in terms of economies-of-scale of production. However, for exportable minerals, both large and small scale operations could be mounted.

Accelerated development of the mineral sector is imperative, and it is evident that development will eventually take place with or without regulated assistance. Mining and mineral processing policies should be coordinated so as to assure environmentally-sound practices in mining, minerals processing and mineral-commodity manufacturing, and to assure that products of the best possible quality are offered for sale.

JICA