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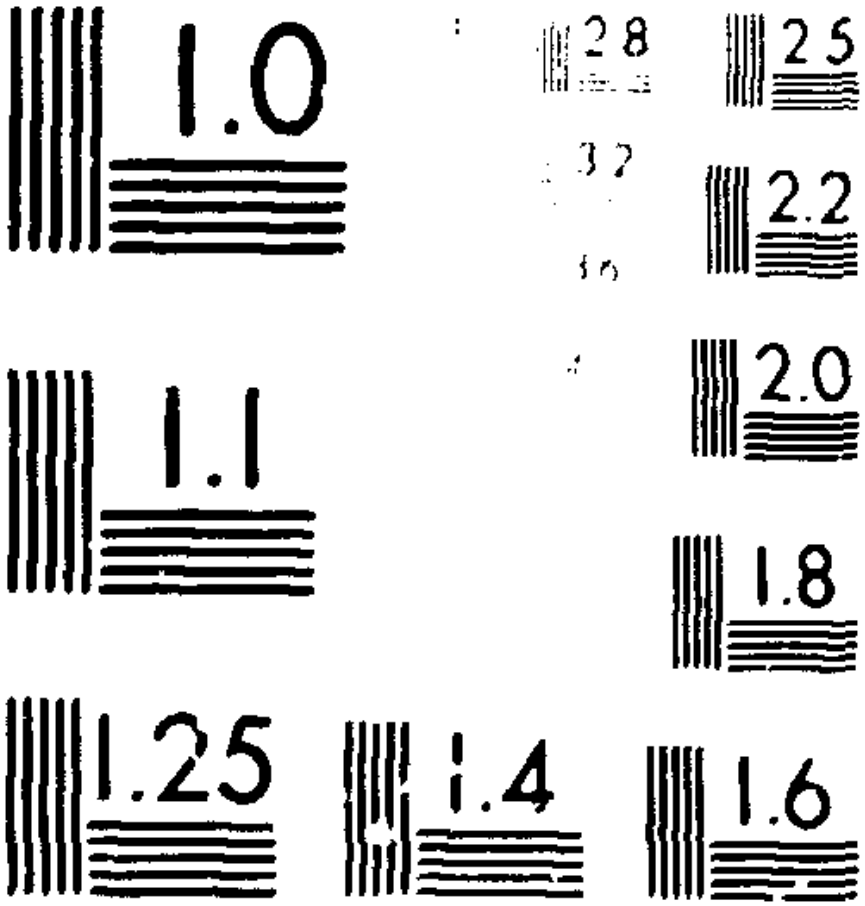
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Distr.
LIMITED

ID/WG.370/10
29 April 1982

ENGLISH

United Nations Industrial Development Organization

Workshop on Research, Utilization and Processing of Non-Metallic Minerals with Special Focus on Building Materials for the Construction Industry*

Belgrade (Yugoslavia), 10-16 May 1982

OCCURRENCES OF NON-METALLIC MATERIALS IN ZAMBIA**

by

Elias Mbumba***

* Organized by the United Nations Industrial Development Organization (UNIDO) in co-operation with the Government of the Socialist Republic of Yugoslavia.

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*** Field Geologist, Minex Department, Zimco Limited, Lusaka Zambia

V.82-25256

ABSTRACT

A brief outline of the geology of Zambia is given. Occurrence of limestone, dolomite, magnesite and talc in the Katanga Supergroup; pegmatite minerals mica and feldspar, asbestos, kyanite, bismuth, graphite, glass sand, and intrusives of phosphate, fluorspar, gypsum in the Basement Complex are described. Everywhere in the country deposits of clays, gravel and stone are abundant.

Although a detailed mineral inventory is lacking, the potential for a number of non-metallics in the processing minerals such as ceramics, glass and foundry, refractories etc. and in construction materials is enormous. In conclusion, an appeal is extended to international organisations and friendly governments to assist Zambia in exploiting these minerals.

INTRODUCTION

Zambia 750,000 sq km in extent, is situated in Central Africa south of the Sahara. It is a major producer of copper and cobalt and her economic development is heavily dependent on the exploitation of these valuable metallic minerals for export. The contribution tc her economic development of the non-metallic sector as a generator of economic development and employment at present is almost negligible. But this cannot be taken to mean that the non-metallic sector has not been growing. On the contrary, the search and utilisation of the non-metallic materials especially for internal use (and to a lesser extent for export) has relatively increased since independene.

Very limited geological researches of non-metallic materials have been undertaken, and these have been as a result of the demand for a specific raw material for the local industry. In some cases such demand had come from an already existing industry such as clay for an already existing ceramic industry. This paper deals mainly on a regional basis, with the occurrences of the non-metallic materials in Zambia

PHYSIOGRAPHY

Zambia constitutes a portion of the Central African plateau standing at an average level of 1,000 m above mean sea level. The main rivers draining the country are:

The Zambezi River which rises in the extreme north-west corner of the country and flows southwards through the

western part of the country and then eastwards and eventually northeastwards before it flows into Mozambique. On its eastward and northeast courses, it cascades over the mighty Victoria Falls and then flows through Kariba Lake one of the largest man made lakes in Africa. It is here that the Zambezi constitutes the major portion of the southern boundary of the country. Its drainage area is underlain by sediments of Jurassic-late carbonaferous and tertiary-recent age

The central part of the country, mostly underlain by late Precambrian to lower Paleozoic rocks is drained by the Kafue River which flows into the Zambezi. In the east and south-east of the country, the plateau is interrupted by series of relatively deep trough-like valleys which are thought to be of tectonic origin. The most prominent of these troughs is that of the Luangwa River. The northern portion of the country is mainly drained by the Luapula river which flows from Lake Bangweulu northwards through lake Mweru into Zaire.

GENERAL GEOLOGY

The oldest rocks dated (1800 m.y.) in Zambia, are exposed in the northern portion of the country and belong to the Bangweulu Block. These rocks consist of granites, gneisses and volcanics overlain by undeformed near-horizontal quartzites and interbedded sandstones and shales. The second oldest rocks belong to the Basement Complex (1300 +40 m.y.) which is made up of crystalline rocks consisting of sediments, gneisses, lavas and intrusives altered by repeated metamorphism. These rocks are mainly exposed along the eastern and south-eastern side of the country and are flanked on the west by successively younger formations, belonging to the Katanga Supergroup, Karroo and Kalahari systems.

The Katanga Supergroup(840-465 m.y.) consists of metasediments lying and unconformably over the Basement Complex and has been subdivided into the Roan, Mwashia and Kundelungu groups, oldest to youngest in that order. The Karroo rocks are near-horizontal, unmetamorphosed, continental sediments (interbedded mudstones and sandstones) and overlying basalts. These rocks are found in downfaulted valleys of the main rivers e.g. the Zambezi, Kafue and Luangwa. The Kalahari rocks are confined to the western part of the country and consist of unconsolidated, wind-blown sands associated with consolidated sands and gravel cemented by chalcedony, iron oxides and lime.

OCCURRENCES OF NON-METALLIC MATERIALS

The expression non-metallic materials is commonly equated to industrial minerals and rocks. (R L Bates, 1973). An awareness of the existence and nature of the mineral raw materials is important in the planning of their exploration

and development. At the moment, in Zambia, too much reliance has been placed on high-price metals like copper, cobalt that the country's economy is disproportionate and highly sensitive to price variations in these metals. The reason for this unfortunate situation at the moment could be that the market for industrial minerals within Zambia is relatively small so that the spill-over effect of the mineral industry as a generator of economic development and employment is almost negligible. But it would be folly to gloss over the importance of mineral raw materials in the national economy because Zambia has just reached the threshold of her economic development, and quite obviously is going to increase her industrial mineral consumption. On the other hand, the export potential for some of the minerals is also quite good. The industrial minerals and rocks which are important in Zambia are limestone, dolomite, magnetite, talc, kyanite, feldspar, fluorspar, clays, gypsum, mica, phosphate, asbestos, bismuth, graphite, sand, gravel and stone. Other non-metallic materials are granites, syenites, barite, vein quartz, and salt (Fig. 2).

1 Limestone, dolomite, magnesite and talc:

These probably form the most important group of the industrial minerals and rocks found in Zambia. Almost all the limestone, dolomites, magnesites and talc in Zambia occur in the Katanga Supergroup, more particularly from the lower Kundelungu. Extensive reserves for limestone have been proven in the Kundelungu in Lusaka, Mumbwa, Kafue Solwezi and Copperbelt areas. The limestone is to be used

as raw material for cement; fertilizers, crushed stone aggregates, metallurgical fluxes and structural products. Another occurrences of limestones and dolomites is found in the basement complex and occurs as narrow but often attenuated bands of crystalline limestone associated with gneisses, schists and amphibolites. These are to be found on the flanks of the Zambezi Valley, in the area east of the Luangwa River, around Lundazi Nyimba and Mazabuka-Monze areas. This type of occurrences however, does not form massive or extensive deposits.

The only known occurrence of magnesite in the country is located within the limestone around Lusaka City. The magnesite (with less than 5% $CaCO_3$) was investigated in detail and the work proved the reserves to be small and patchy.

However this occurrenne is an indication that similar concentrations of magnesite may be present elsewhere in the limestones of Zambia.

Occurrences of talc have been located in a number of places:

i) In the Lusaka area at Lilayi, Chipapa and Leopards Hill area, the deposits occur as high grade seatite blocks in dolomitic limestones or as highgrade talc-pyrophyllite mixture. Total reserves are about 2.3 million short tons.

ii) In Mufulira, the talc is found as bands of almost pure talc schist up to 4 m in thickness in dolomite formation of the Kundelungu group.

2 Kyanite and sillimanite:

Kyanite (Al_2O_5 Si O_2) has the same chemical composition as sillimanite but differs in crystal structure and physical properties.

The kyanite deposits deserving interest have been investigated and are found in several areas around Lusaka and elsewhere at the base of the Katanga supergroup and these areas are:

a) Kafue area:

About 1,000 tons of bouldery float ore is present which has been weathered from kyanite schists and quartz-kyanite veins in pelites bodering northern and eastern flanks of a dome (Mpande). Some selected pure kyanite samples gave 54.3% Al_2O_3 from six kyanite pods. However, other samples showed low Al_2O_3 and up to 8.8% of Fe_2O_3.

The deposit is localised and the surface concentration is highly irregular. The deposit was considered to be uneconomic because of low tonnage, in accessibility and beneficiation problems.

b) Leopards Hill area, 69 kms east of Lusaka. Several millions of tons are available here either as float ore or as large needles in kyanite schist and pegmatitic veins. Selected sea green transparent variety gave 61% Al_2O_3, 37.1% SiO_2. and 1.8% Fe_2O_3. Average grade is 17-23% Al_2O_3. Owing to the large tonnage available the deposit warrants further investigation, particularly with respect to extraction (Metallurgical tests resulted in 55% recovery of kyanite with an average of 20% Al_2O_3) and beneficiation methods Brown, 1966).

c) Mwembeshi River area 59 kms north-west of Lusaka:
Kyanite occurs as needles in the soil and in veins, and although the grade is high as 61% Al_2O_3, the kyanite content of the veins and schists is very low.

d) Chilwesha Area
Kyanite-bearing quartzite within basement rocks occur some 30 km south-west of Luanshya as sparsely distributed bands. Investigations revealed the occurrences to be patchy and laboratory beneficiation tests on bulk samples on the recovery of the kyanite to be poor.

Kyanite bearing schists and quartzites are common in most metamorphic terrains they cannot however, be exploited as the kyanite in this case only represents the grade of metamorphism and no individual lumps or pods are developed. Sillimanite occurrences in Zambia are rare, but when present are found as needles in schists.

3 Pegmatite minerals-mica and feldspar:

Many of the areas of basement complex rocks in the country are characterised by abundant pegmatites in which mica, feldspar or both are of common occurrence, though by no means always of workable grade or size.

Important feldspar localities are in Siavonga-(at present being mined and used in glass making) mita Hills and Serenje areas which contain feldspar suitable for use in the manufacture of pottery and enamel.
The in situ reserves of the pegmatites in the Mita Hills are 34,880 tonnes averaging 0.22% ferric oxide after rough cleaning of muscovite in the field and those in Serenje area, have reserves of 4300 tonnes /with average ferric oxide content of less than 0.29%. Mineable reserves are estimated to be 25% less than the in situ figures.

The most important known occurrences of mica are:-

i) Serenje area; the micas in pegmatites are found within a belt of 3 kms wide and 48 kms long, parallel to the Luangwa Valley, 37 kms south-east of Serenje. Although the mica is of good quality, the reserves are small.

ii) Lurdazi area; the muscovite pegmatites are well zoned and are found in a belt 14 kms wide and 40 kms long, 80 kms north of Lundazi. Nearly 300 pegmatites have been located, and some of them have been worked by the local population.

iii) Feira District: about 90 kms from Feira, the mica pegmatites are reported to contain large size ruby mica. However, the pegmatites in this area have not been investigated in detail.

iv Choma Area: Several places east and north-east of the Choma Boma contain pegmatites. Mica had been worked in the past by underground methods.

v) Lower Luangwa Area:

The country-rocks consist generally of gneisses and schists and the pegmatites strike approximately eastwest. The mica is brown to brown-green and is distributed fairly evenly throughout the quartz core usually in small books. Although mica had been mined the quality is not good.

4 Clays:

Geological conditions in Zambia are such that clay deposits are normally of residual origin derived from the composition of alumino-silicates within metamorphic or granitic rocks. The relatively better quality clays being found in isolated dambo areas in which natural sorting of the weathered material has occurred through transportation and selective sedimentation.
Although dambo areas are common in the country, deposits of clays examined are mostly near towns.

Clays may be subdivided on the basis of their uses as shown below

i) Ceramic Clays

ii) Structural clays

iii) Refractory clays (fire clays)

iv) Filler/coating clays

v) Light-weight concrete aggregate clays

vi) Clays for cement manufacture.

Of the above, ceramic clays, structural clays, refractory clays and filler clays are known to occur in various parts of Zambia.

i) Ceramic Clays

Deposits examined and known are Chalata (China Clays) in Mkushi area; Loshi (Siliceous ball Clay) in Mansa District; Masuku Mission (Kaolin of China Clay type and Solwezi District Clays. For all these deposits the reserves are large; while Maamba mudstone at Maamba Colliery; Chiyengi clays in Luapula Province; Kapongo caves (meta-bentonite) the reserves are small, these ceramic clays are mostly of medium grade.

ii) Structural Clays

Most of the deposits in Zambia are suitable for the manufacture of structural products and are mined from dambos. Suitable clays are reported around Lusaka (small deposits), where a geologically controlled topography has favoured the accumulation of the clay in depressions in underlying carbonate rocks. Kabwe central brick-fields area has large reserves which are underlain by a fine to medium-grained micaceous schist; Kaale and Chimonge valleys in the Mbala District; Kankomo, in Kitwe District is a large superficial clay deposit overlying a weathered shale; Nega Nega deposit, is of very large reserves, and is situated on the railway between Kafue and Mazabuka; Solwezi district clays;

Kasama clays although of several small deposits a large deposit of nearly 1 million Cu metres has been located in the Lukashya River Valley in Kasama.

iii) Refractory clay (fire clay); These are similar to ceramic clays, but have ability to withstand higher temperatures. It is difficult to be certain that refractory clay has been reported, but a Chipapa deposit south-east of Lusaka could be a source of refractory brick material in Zambia.

iv) Filler/coating clays

The Mkushi river illitic clays are used as filler clays. Deposits totalling 160,000 long tons which have been derived from seritic schists are present and preliminary study of Lochinvar clay, suggests that it could be classified as a filler/coating clay. No light-weight concrete aggregate clays and clays for cement manufacture have been reported, but possible sources could be around Mazabuka (Kafue Polder) and the clays developed from the weathering of basalts in the South-Western part of Zambia.

5 Gypsum

Gypsum is used in Zambia mainly as an ingredient in cement manufacture, its role being to act as a retarder; but its main use elsewhere in the world is applied in the manufacture of plaster of paris.

It is presently being mined and processed at Lochnivar Mine near Monze, where it occurs as gypsiferous clay or gypsite in layers up to 1.3m. The gypsum is found as

crystals and the content in the gypsiferous clay is variable and ranges up to 40% gypsum. The deposit has reserves of over 322,000 tonnes. Borehole occurrences of gypsum have also been recorded in the Western Province, about 50 km west of Sioma. A 15 cm - thick bed has been recorded in Upper Karroo Sandstone and in Maamba gypsum has also been reported in the Luangwa Valley.

6 Fluorspar

Green, yellow, purple and white fluorite has been recorded in fault veins in basement rocks of the Kariba area. The fluorite occurs in boulders derived from fluorite bearing veins as well as in the veins themselves which range in size from a few millimetres to more than ten meters wide. The veins are discordant to the country schist which they intrude. The reserves, in preliminary investigations estimated them at 12,000 tonnes and 800 tonnes for vein fluorite and boulder fluorite respectively. The geological information so far indicates that the fluorspar could be used in glass-making.

7 Phosphates:

Phosphate in the form of the mineral apatite ($s(Ca_5(PO_4)_3$ F,Cl,OH) is a common accessory in carbonatite intrusions of the Rufunsa and Luangwa Valley areas. It also occurs as vein-intrusion in the Petauke area.

Apatite is specially abundant in the soils of the Kaluwe carbonatite of the Rufunsa area and the richest samples of more than 10% P_2O_5 are found in the middle facies of the intrusion. The reserves, are large and beneficiation tests are still going on.

In Petauke, the deposits occur 75 km north-east of Petauke Boma, in Chilembwe. The phosphate is found in apatite-rich veins which are tectonically controlled. The mineralogy of these veins which are intrusive in syenites include pink-feldspar with little quartz and occasional green amphiboles. Estimated reserves are 200,000 tonnes of phosphate with the P_2O_5 grade ranging between 15 and 25% and averaging 15%. Exploration is still going on.

8 Asbestos:

Asbestos, which is the commercial name for fibrous varieties of the minerals olivine and amphibole, occurs in Eastern Province at Chinkombe 48 km north of Petauke and the Mwatezi River area, 80 km northwest of the Chipata (Pagella, 1970). It also occurs in Lusaka area.

i) At Chinkombe, the asbestos occurs primarily as anthophyllite slip fibre associated with basic schist in small pods, veins and lenses. The veins and seams of asbestos range from few centimetres to 50 centimetres wide. However, there is no estimate of total reserves and the ore is of low grade and the ore-zone occurs on steep slopes in a remote area with an inconsistent water supply.

ii) Mwatezi River Area; This is located 88 km from Chipata. The asbestos occurs in small ultrabasic dyke intrusive in granitic paragneiss of the Basement Complex. The asbestos occurs both as slip fibre and cross fibre in the decomposed dyke. The quantity is very small.

iii) Lusaka area; the asbestos is found as anthophyllite

and crystotile in a stockwork of narrow veins within limestone

9 Bismuth:

Bismuth which is used mainly in pharmaceutical preparations and to a lesser extent in fusible or low melting-point alloys elsewhere in the world, is found in Zambia mainly associated with gold occurrences.

Small occurrences are found along the Great East Road 30 kms from Lusaka as bismuthite in pockets and seams in quartz veins associated with brecciation.

The largest occurrence is at Nchoncho, about 120 km from Lusaka along the Great East Road, where the bismuthite-mineralised tourmaline-quartz veins form a prominent ridge in basement gneisses. The mineralisations is however, scattered and irregular and the low-grade ore is patchily distributed. The bismuthite had been mined for two years just prior to the start of the second world war. Since then, limited exploration work has been carried out.

10 Graphite:

Several occurrences of graphite have been recorded in the Eastern Province in the Basement Complex. The graphite occurs as concentrations of flakes in gneisses, schists and granulites. Prominent areas which merits mention are the Njoka in Lundazi District, Sasare and Mumbi in Petauke district.

i) Njoka

The Njoka graphite deposit lies 64 km west of Lundazi Boma. The mineralisation is in form of disseminated

flakes in lenses of graphite gneiss. The lenses form a mineralised zone of 2.4 km long and 60 cm wide. The ore reserves are estimated at 27,000 long tons containing 3,200 long tons of graphite, an average grade of 11.7%.

ii) In the Petauke district the prominent occurrences at about 26 km south-west of Sasare. The graphite occurs as disseminated flakes in a leucocratic granite diorite-gneiss forming a narrow band within a thick series of paragneisses. The graphite gneiss is approximately 1km long and less than 100m wide. Graphitic carbon content from one trench was found to vary from 2.2% to 16.1% with an average of 5.6% over the width of the ore zone.

Another important occurrence lies athwart the basin of the Mvuvye River.

However, no systematic investigation of these and other occurrences have been undertaken.

11 Sand,Gravel and Stone

i) Constructional:

Large and small deposits of sand and gravel are common all over the country occurring in flood plains and of rivers and valleys. No systematic investigations of these materials has been taken in the country, although large quantities of sand, gravel and stone are quarried each year in all parts of the country.

ii) Glass making:

Quartz sands suitable for glass making are present on the flanks of quartzite ridges located 10 km due north of Kapiri Mposhi town. The sands are of high

quality, being free from clay and having a very low iron content. Proven reserves are 3.4 million tons and the silica content of the washed sand is 96.6%. The sands are being used in glass making.

12 Occcurrences of other materials

a) Granites: There are several granite intrusion in the country especially in the Basement Complex in the eastern part of the country. Sodalite (bluish) syenite, nepheline syenites and other varieties of syenites are also present

b) Barite: An occurrence of barite is known to occur at Mporokoso, it assays 94% barite. Barite occurs also in Kafue and the Luapula Province which possibly contains bedded deposits of barite.

c) Vein quartz: Only one area of veins (reefs) seems to have been investigated. The veins occur at Naluama south of the Kafue. Mazabuka road and the SiO_2 content ranges from 96-99%.

d) Salt: No economic deposits of salt are known but 'pans' in the Western, Luapula, North-Western and Northern Provinces have been investigaged. However, the potential is very low.

e) Sulphur: Iron pyrites are currently being mined at Nampundwe for its sulphur content. The pyrite occur as disseminated in banded limestones.

In Zambia exploration and prospecting of non-metallics, are carried out by two major establishments: The Geological Survey Department of the Republic of Zambia, Ministry of Mines; and the Mineral Exploration Department (MINEX) of Zambia Industrial and Mining Corporation (ZIMCO) Limited, a quasi-government organisation.

The Geological Survey Department (GSD) is mainly engaged in regional geological mapping and acts as a government agent in matters relating to geology, plus the granting of prospecting, exploration and mining licences. Acting as a public service, GSD seeks to show the existence of reserves (mineral inventory) and supply information accordingly to interested parties and the public at large.

The role and objectives of Minex Department are complementary and supplementary to those of the Geological Survey Department, but mainly of detailed economic nature. The main objectives of Minex Department are:-

a) To diversify mineral production away from copper and encourage development off the Copperbelt.
b) To promote import substitution, especially of industrial minerals.
c) To follow-up regional surveys of the Geological Survey Department, especially where private investment is lacking.

OUTLOOK

From the fore-going discussion of the occurrences of non-metallic materials in Zambia it can be seen that more detailed work needs to be done on the mineral inventory and evaluation

of the known deposits. Zambia would appear to possess a good potential and variety of non-metallic material resources for local utilisation and to a lesser extent for export. Most prominent among these would seem to be limestone, dolomite, talc, kyanite, the pegmatite minerals mica and feldspar, syenites, granites, sand, gravel and stone.

However the development of these resources in handicapped by:-

i) lack of capital necessary for an exploration programme to determine the reserves and grades of ore present of the different non-metallic materials.

ii) lack of local pilot plant facilities for testing or devising improved quality by beneficiation of the materials. This definitely has a crippling effect in the appraisal of the mineral deposits examined and their direct utilisation on a large scale to replace the imported material.

iii) lack of an evaluated market especially among the neighbouring countries when we consider exporting these materials.

Since independence the utilisation of the non-metallic materials in Zambia has increased and this augurs well for the future inspite of the present world economic recession. However, it should be pointed out that most, if not all, non-metallic material used in Zambia now are imported despite the enormous potential that we have. I wish, therefore, to appeal, to international organisations and friendly governments to come in and exploit the above outlined non-metallic materials so that this may

create employment, raise living standards and improve the balance of trade in Zambian economy. As you may all know, exploration requires intergrated services from organisations with a range of expertise in related disciplines. Therefore Zambia, like most developing countries needs some assistance.

REFERENCES

Barr M.W.C. 1970: Limestone of Lusaka South Forest Reserve and adjacent areas, Zambia Geol. Surv. Dept., Econ. Rept. No. 25, 10pp

Brown, A.G. 1966: Some Kyanite deposits around Lusaka, Zambia Geol. Surv. Dept., Econ. Rept No. 12

Drysdall, A.R., 1960: Graphite of the Petauke District, Eastern Province, Geol. Surv. N. Rhodesia, Rept. 14

-- -- 1964: The Limestone, of Morton Lime works, Lusaka, Zambia Geol. Surv. Dept. Rept No. 3 17pp.

-- -- 1965: The clays of Central Brickfields, Broken Hill, Zambia Geol. Surv. Dept. Rept. No. 8, 102 pp

-- --
and Simpson, J.G
1966: The Kankomo clay deposit, Kitwe District, Zambia Geol. Surv. Dept. Econ. Rept. No. 11

Hickman, C.C.J.,
1967: Clay deposits of the Lusaka area, Zambia Geol. Surv. Dept. Econ. Rept. No. 18

1968: The Chalimbana clay deposit, Lusaka Zambia Geol. Surv. Dept. Econ. No. 21

Klinck, B.A. 1973 : Vein quartz at Naluama Zambia Geol. Surv. Dept. Econ. Rept. No. 41, 6 pp

Maczka, L., 1972 :
and Cap, M. The Mkushi River Illite clays, Zambia Geol. Surv. Econ. Rept. No. 30

1973: Brick clays in the Kasama area, with particular reference to the Lukashya deposit, Zambia Geol. Surv. Dept. Rept. No. 43, 34 pp.

Newman,D., 1964: An occurrence of high-grade limestone west of Lusaka. Zambia Geol. Surv. Dept. Rept. No. 6, 23 pp.

-- --
and Matheson, G.D., 1966: The economic potential of limestones near Lusaka, Zambia Geol. Surv. Dept. No. 10

Pagella,J.F. 1970: The asbestos occurrences of the Eastern Province, Zambia Geol. Surv. Dept. Econ. Rept. No. 22, 17pp.

Simpson, J.G.1964: The Nchoncho bismuth prospect Central Province, Zambia Geol. Surv. Dept. Rept. No. 7 21 pp

1965: Two talc deposits near Lusaka, Zambia Geol. Surv. Dept. Econ. Unit Rept. No. 9, 37 pp.

-- -- 1965: The Njoka graphite deposit, Lundazi.
and Drysdall A.R., District, Zambia Geol. Surv. Dept. Rept. No. 4, 44 pp.

Wribkucjk J.,1969: The Kapiri Mposhi glass sand,Zambia Geol. Surv. Dept. Rept. No. 24 159 pp.

Cooray,P.G.,1975 : Industrial minerals of Zambia, a preliminary review of utilisation and potential, in

"National Council for Scientific Research" seminar, Lusaka 1975.

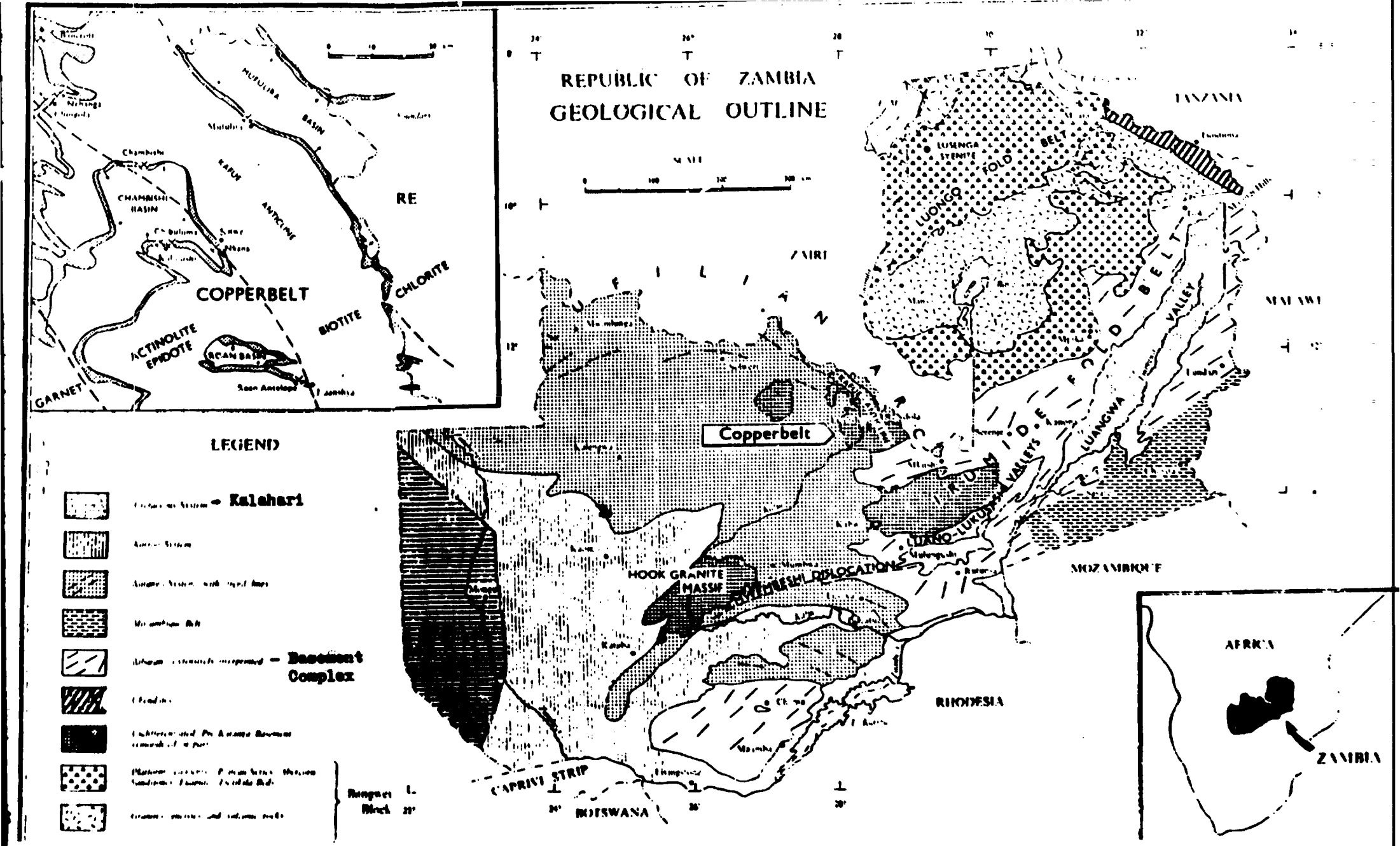
Reeve, W.H., 1963: The Geology and mineral resources of Northern Rhodesia, Bulletin Geol. Surv. No. 3

Drysdall.A.R. 1972: Outline of the Geology of Zambia, Johnson R.L. Geologie en Mijnbouw, vol. 51(3) p Moore, T.A., and 265-276 Thieme,J.G.

Legg, C.A. 1980: The Kaale clay deposit Mbala District in "Symposium on Industrial Minerals, precious metals and gems, 1980 Lusaka.

Acknowledgements

I am indebted to N W Wolukawu, Senior Project Geologist (Minex Department) for his useful criticism and suggestions.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GEOLOGICAL OUTLINE
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CHLORITE
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MALAWI
MOZAMBIQUE
RHODESIA
BOTSWANA
Copperbelt
LUSENGA STENITE
FOLD BELT
LUONGO
LUANGWA VALLEY
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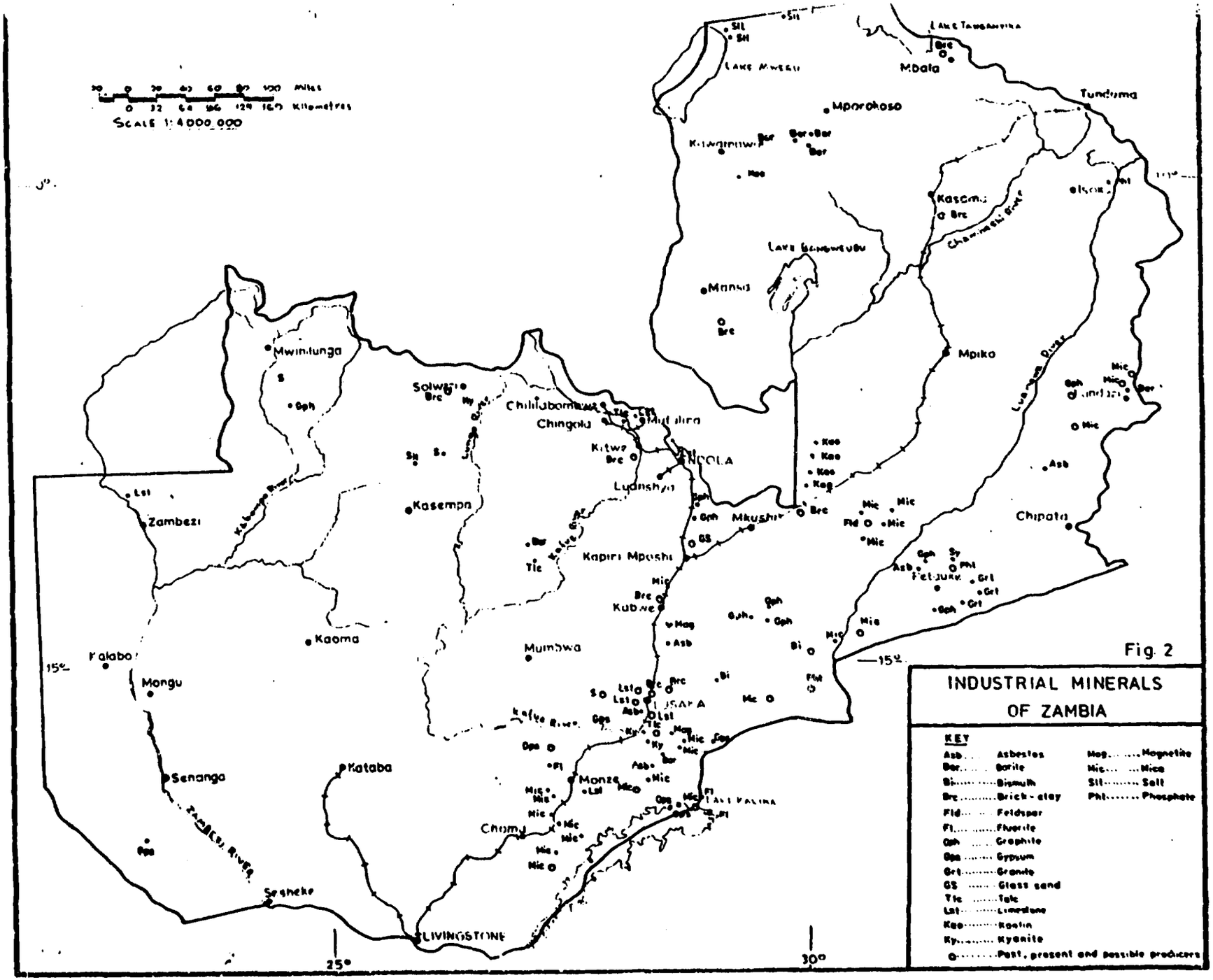
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Kapiri Mposhi
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Luangwa River
Kaoma
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Kalabo
Mongu
LUSAKA
Kafue River
Senanga
Kataba
Monze
Chomo
LAKE KARIBA
ZAMBEZI RIVER
Sesheke
LIVINGSTONE
25°
30°
15°
Fig. 2
INDUSTRIAL MINERALS
OF ZAMBIA
KEY
Asb..... Asbestos
Bar..... Barite
Bi..... Bismuth
Brc..... Brick-clay
Fld..... Feldspar
Fl..... Fluorite
Gph..... Graphite
Gps..... Gypsum
Grt..... Granite
GS..... Glass sand
Tlc..... Talc
Lst..... Limestone
Kao..... Kaolin
Ky..... Kyanite
Mag..... Magnetite
Mic..... Mica
Slt..... Salt
Phl..... Phosphate
o..... Past, present and possible producers