53552

UNITED NATIONS
ECONOMIC
AND
SOCIAL COUNCIL

Dist.
LIMITED

E/CN.14/MIN/15
2 September 1968

ENGLISH
Original: FRENCH

ECONOMIC COMMISSION FOR AFRICA
Seminar on New Metals and Minerals
Addis Ababa, 5-10 February 1968

A NOTE ON NEW METALS AND MINERALS IN MADAGASCAR

(Presented by the Malagasy Republic)

M68-184

BERYLLIUM, CERIUM, NIOBIUM (COLUMBIUM), HAFNIUM, SCANDIUM, THE RARE EARTHS, TANTALUM, TITANIUM, YTTRIUM AND ZIRCONIUM IN MADAGASCAR

Summary

Beryllium and monazite (with graphite and mica) are two of the most important products of the Malagasy mining industry.

The rare earths, mainly in the form of columbo-tantalates, are fairly frequently met with in Madagascar. They show unusual types of mineralization. Apart from their mineralogical curiosity value, the uses to which the rare earths are now put make them of increasing interest. Beryl, an ore of beryllium, together with the rare-earth minerals, form deposits in pegmatites distributed in "fields" at random along the magmatic front that traverses the Island.

Economically speaking, Malagasy beryl and monazite are at present experiencing marketing difficulties because of the low prices offered by consumers.

BERYLLIUM

In 1962, Madagascar, with an output of 758 tons[1/], took fourth place among world producers of beryl. In 1966, the prices offered by the American brokers specializing in the purchase of such ores were too low, and production dropped to 12,192.5 kg.

OCCURRENCE

Malagasy beryl occurs exclusively in pegmatites. Prospecting for these began at the beginning of the century for gem stones, was resumed in 1913 for uranium minerals and was later continued in search of muscovite. By 1921, most of the pegmatitic fields had been logged, and A. Lacroix gave the first account of them in his "Minéralogie de Madagascar" ("Mineralogy of Madagascar"). From 1947, prospecting for pegmatites, and later for beryl, was resumed by the Commissariat à l'Energie Atomique (French Atomic Energy Authority) (CEA). In 1953, the Malagasy Geological Service undertook a systematic survey of the beryl-bearing pegmatite fields. Finally, in 1956, BUMIFOM (and subsequently BRGM - Bureau des Recherches Géologiques et Minières (Geological and Mining Survey Office)) continued this survey. None of this work brought to light new pegmatite deposits of any size. Among the various types of pegmatite encountered, trizonal, bizonal, or unzoned massive occurrences, so-called "block" veins (after the Russian terminology) and homogeneous or unzoned veins can be distinguished. All these varieties are widely met with throughout the world. The peculiar feature of the Malagasy pegmatite fields is the

1/ All tonnages quoted in this note are metric tons of 2,204 lb.

absence of tin- or tungsten-bearing varieties, minerals of these two metals occurring only exceptionally.

EXPLOITATION AND ECONOMICS OF BERYLLIUM IN MADAGASCAR

Only 12 tons of beryl were mined in 1966, the lack of return at the low prices offered by consumers having discouraged producers.

Cumulative production of beryl in Madagascar had reached 6,276 tons by 1963; more than half this quantity came from eight pegmatite deposits: A4, F3, Marivolanitra, Ampandramaika 1, Antsakoa 1, Analila-Analalava, Ambondrona and Androfia).

Malakialina A4 was the largest working. It was shut down in 1963, causing an abrupt fall in the production of Malagasy beryl.

	1961	1962	1963	1966
		tons		
Pegmatite A4	415	363	77	—
Total production	758	674	411	12

CONCLUSION

None of the recent surveys or prospection having brought to light any new deposit of note, the future of Malagasy beryl is tied to known deposits. There are still large reserves in the many ore-bodies being worked by open-cast or underground methods.

The current slump in the Malagasy beryl market is due to the low prices offered by the United States of America, the principal consumer. This slump way however be overcome fairly soon, if the rise in prices over the past few months continues.

Hence the problem of beryl in Madagascar is economic, not geological.

NIOBIUM (COLUMBIUM) AND TANTALUM

DEPOSITS

Two types of deposit are found in Madagascar:

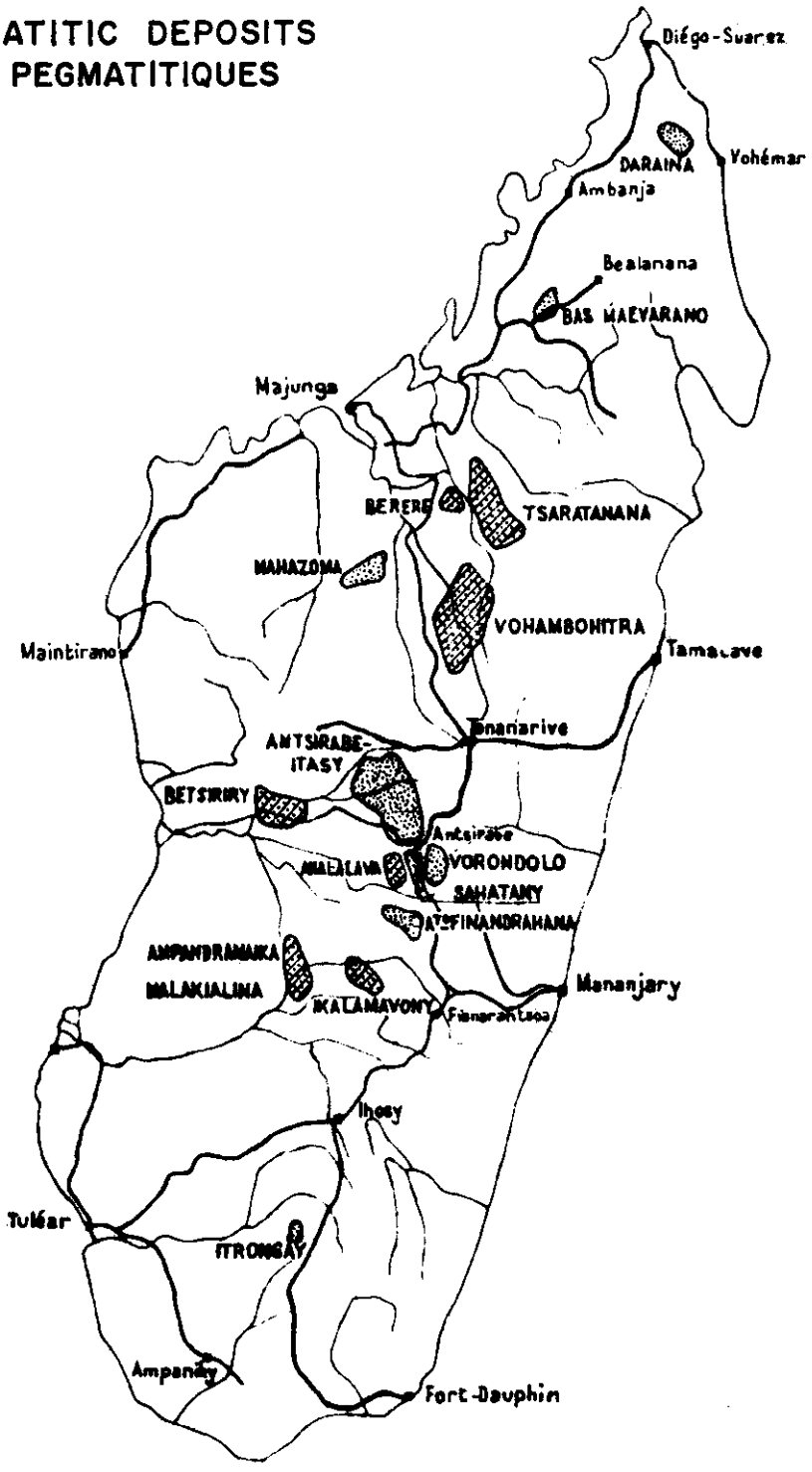
- Pyrochlore, in young alkaline intrusive rocks in the province of Ampasindava, near Ambanja, in the north-west of the Island;and

- The pegmatites of the "Hauts Plateaux".

1. THE ALKALINE INTRUSIVE COMPLEX OF AMPASINDAVA

The alkaline intrusive complex in the province of Ampasindava displays, in the Bekolosy range, an occurrence of pyrochlore on the roof of a granite

MAIN PEGMATITIC DEPOSITS
CHAMPS PEGMATITIQUES



CART-M-68-17

sill with sodic-amphibole. The sill is the end product of the final differentiation of a Tertiary syenite. The ore occurs as a bed of running sand 7 metres thick, assaying 0.20 per cent of Nb_2O_5 in 10 million tons of run-of-mine.

Alluvial concentrations of pyrochlore also occur on the upstream side of rocky bars, but are of only minor importance.

The Bekolosy pyrochlore contains 53 per cent of Nb_2O_5, 11.5 per cent of Ce_2O_3, 10 per cent of TiO_2, 5 per cent of La_2O_3, 5 per cent of CaO and 3 per cent of Ta_2O_3. The ratio is in the neighbourhood of 17.

This deposit is comparable to that of the weathered riebeckite granite, containing 0.26 per cent of Nb_2O_5 at Kaffo, in Nigeria.

2. PEGMATITES

Two main ores of niobium and tantalum are associated with pegmatites: euxenite and fergusonite.

EUXENITE

After betafite, euxenite is the most widely distributed uranium ore in Madagascar, having accounted for a small part of the earlier production of these two minerals. It contains from 18-20 per cent of yttrium earths and a small amount - 2 per cent - of cerium earths. Extraction of the uraniferous pegmatites has been abandoned, and worked-out deposits on the surface and in the weathered zone accessible to hand miners can no longer be counted on.

FERGUSONITE

Fergusonite is frequently met with in the potassic pegmatites of Madagascar, but is never abundant. It is found in the uraniferous pegmatites of the Itasy, which were worked from 1913 to 1921. In recent operations at the Berere beryl field, the Antsakoa, Ambatoharana, Befilao and Analila pegmatites have yielded a very small quantity, which has not been measured. The last-named deposits have now been shut down.

MINING AND MARKETING OF COLUMBO-TANTALATES IN MADAGASCAR

In 1966, 1,156 kg of columbo-tantalates were mined.

CONCLUSION

World reserves of Nb_2O_5 are estimated at 14,577,000 tons. There are no corresponding figures for tantalum. Malagasy columbites are often rich in Ta_2O_5.

Malagasy columbite-tantalites should be regarded as a tantalum ore. There are several thousand tons of low-grade ore in the waste from the pegmatite workings in the fine-grained zones of the large pegmatitic ore-bodies.

RARE EARTHS; CERIUM; YTTRIUM

Monazite, which is widely distributed in the world, contains a substantial amount of cerium earths. It is very common in Madagascar, and practically all the alluvial concentrations on the crystalline floor have appreciable proportions of it.

Bastnaesite, a carbonate of the rare earths, has recently become very prominent on the Malagasy rare-earth market.

MONAZITE

The only large deposits occur on the ancient beaches and dunes of the south-south-east coast. There, the monazite is associated with ilmenite and zircon.

The presence of monazite sand was first reported by CEA in 1952. A survey of the beaches indicated estimated reserves of 32,000 tons in two deposits: one at Antete, the other at Vohibarika.

The monazite is mainly the end product of the granites and charnockites of the Anosyenne Mountains.

THE MALAGASY MONAZITE MARKET

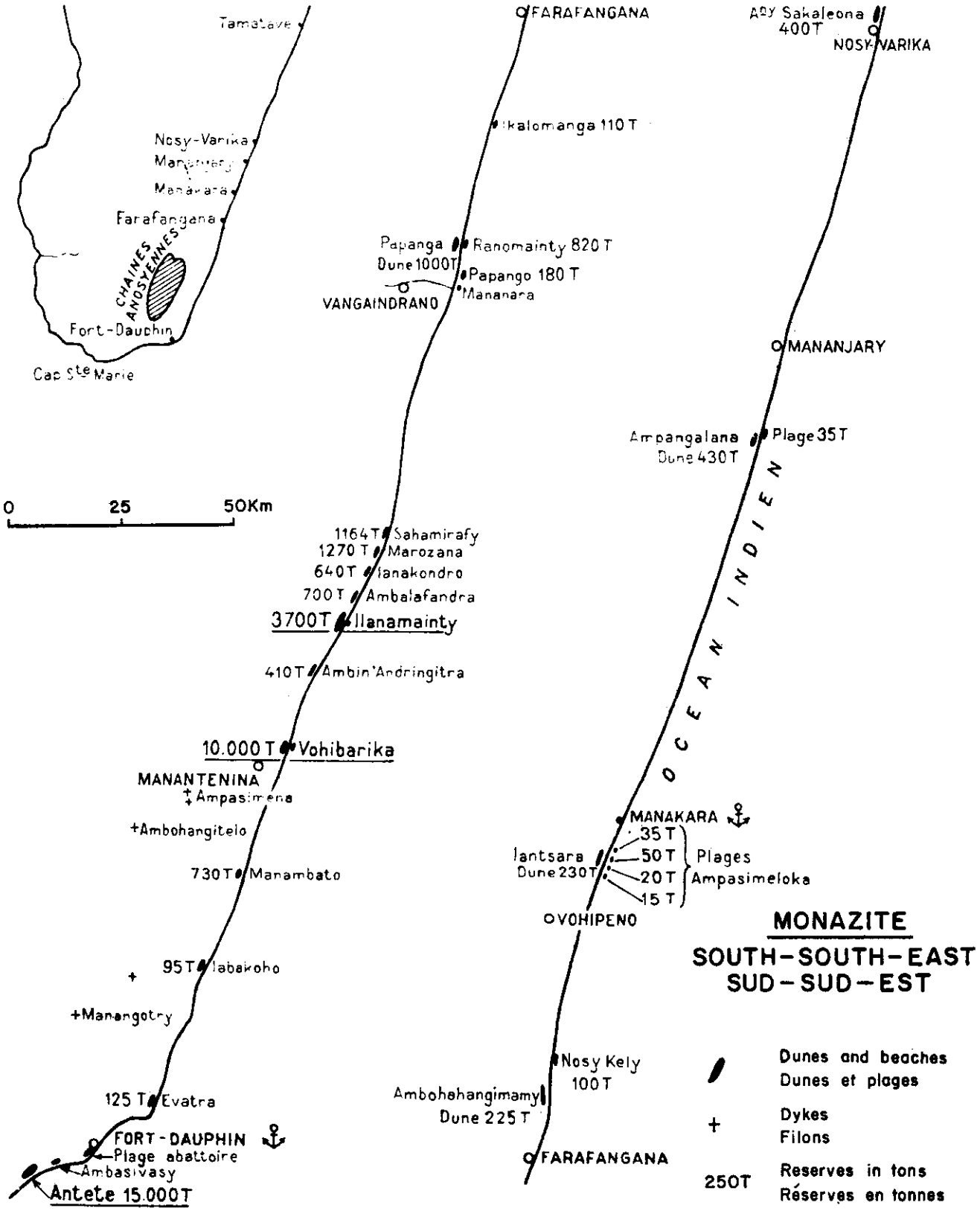
The situation is difficult. Malagasy monazite is meeting stiff competition from foreign production, especially from Australia. Prices have fallen so low that it no longer pays to work the Malagasy mineral.

At the moment, operations have been halted. Reserves are still very large.

BASTNAESITE

Bastnaesite has been worked in a very special type of fluocarbonate pegmatites found only in the Ambatofinandrahana region. These pegmatites from thin veins coarsely intercalated between the foliations of an alkaline granite. The main deposits are at Andakatany and in the Imorana valley. They are: Marovalava, Itorendrika, Lesada and Ifasina. The Itorendrika bastnaesite contains 40 per cent of Ce_2O_3 and 36 per cent of $(La, Dy)_2O_3$.

A resumption of the mining of this ore has yielded 30 tons of bastnaesite in the Ambositra region. 10,139 kg were exported to the USA in 1966.


Tamatave
Nosy-Varika
Manakara
Farafangana
CHAINES ANOSYENNES
Fort-Dauphin
Cap Ste Marie
FARAFANGANA
Ikalomanga 110 T
Papanga
Dune 1000T
Ranomainty 820 T
Papango 180 T
Mananara
VANGAINDRANO
ABY Sakaleona
400T
NOSY-VARIKA
MANANJARY
Ampangalana
Dune 430T
Plage 35T
0 25 50Km
1164T Sahamirafy
1270 T Marozana
640T Ianakondro
700T Ambalafandra
3700T Ilanamainty
410T Ambin'Andringitra
10.000T Vohibarika
MANANTENINA
Ampasimena
Ambohangitelo
730T Manambato
95T Iabakoho
Manangotry
125 T Evatra
FORT-DAUPHIN
Plage abattoire
Ambasivasy
Antete 15.000T
OCEAN INDIEN
MANAKARA
35 T
Iantsara
Dune 230T
50 T
20 T
15 T
Plages
Ampasimeloka
OVOHIPENO
Nosy Kely
100T
Ambohahangimamy
Dune 225 T
FARAFANGANA
MONAZITE
SOUTH-SOUTH-EAST
SUD-SUD-EST
Dunes and beaches
Dunes et plages
Dykes
Filons
250T
Reserves in tons
Réserves en tonnes

CART-M-68-19

XENOTIME

A rare constituent of uraniferous pegmatites, xenotime is frequently encountered in the gem-beryl pegmatites of the Berere field (at Befilao, Antsakoa, Analila and Ambatoharana), but only as a very minor by-product that cannot be produced on an economic basis.

The xenotime from the high Betsiboka contains 0.4 per cent of thulium, a metal quoted at prices around 16,000 Malagasy francs a gram.

OTHER MINERALS

Other minerals containing rare earths - samarskite, ampangabeite, priorite - are too scanty to be taken into serious consideration. Allanite (orthite) is rare in the pegmatites and phlogopite deposits. This mineral is an accessory of the granite, but does not collect in the alluvial deposits. Betafite contains only very small quantities of the rare earths (1-2 per cent). The pyrochlore at Manongarivo contains only 3 per cent of Ce_2O_3. Eudialyte, an accessory mineral to the alkaline granite (fasibitikite) peculiar to Ampasibitika (Ampasindava), contains 22.5 per cent of cerium earths. In 1966, Madagascar exported 26,800 kg of betafite and 70 kg of orthite as mineralogical specimens.

CONCLUSIONS

Current conditions on the world monazite market have made Malagasy production non-competitive. Similar plants in other parts of the world, especially in Australia, treat the sands to recover such ores as rutile and ilmenite. The monazite being merely a by-product, it can be marketed at prices below those practicable for mines where monazite is the primary ore. At the moment, production of Malagasy monazite is at a standstill. Reserves are still enormous. There seems to be a slight quickening of activity in the case of other rare-earth minerals.

TITANIUM

The titanium problem is not new to Madagascar, and a search has been made there for rutile and ilmenite. Any further prospecting for rutile can probably be ruled out once and for all, as only very poor indications of this mineral are present. The largest discovery, a pegmatite situated to the north of Andriba, only yielded 3.5 tons of rutile before it was worked out. By contrast, ilmenite has real prospects, either from the beach sands of the east and south-east, or in primary formations or in their secondary eluvial or alluvial deposits, massive occurences being decidedly less in evidence.

BEACH SANDS

Surveys carried out by the Geological Service have drawn attention to the eastern beaches, from Vohémar to Mandrare, and to the southern beaches between Mandrare and Onilahy. Two areas were recognized as being of particular interest and were subjected to more thorough prospection as a step towards a feasibility study.

The usual average content of the north-eastern beaches is 44.5 per cent of TiO_2 and 40-42 per cent of Fe. BUMIFOM (Sainte Claire Deville, 1959) planned to treat the ore by reduction with coal to get TiO_2 concentrates from which the iron would be separated and recovered. The process is based on that used for the Allard Lake ilmenites in Canada, which contain 35 per cent TiO_2 and 40 per cent Fe, and which yield concentrates assaying 72 per cent of TiO_2.

MASSIVE DEPOSITS: 1. IN GABBRO - VANGOA

The vast gabbro range of the Vangoa, 90 km north of Miandrivazo, contains iron titanates, which collect in stream gravels or in alluvials. Rock deposits are very small, consisting of inclusions or stringers. The average TiO_2 content is low, lying in the 30 per cent to 37 per cent range.

2. IN THE ANORTHOSITES OF THE EXTREME SOUTH

The anorthositic ranges of the Ampanihy, Fotadrevo, and Bekitro areas contain segregations of ilmenite in tonnages too small to be mined in situ. The secondary placer deposits are not very large. The only deposits worthy of consideration are the ancient terraces of the Manambahy and Volovolo rivers, which show a bed of ilmenite gravel 20 cm thick. Ore reserves are accordingly low; they assay from 44 per cent to 53 per cent of TiO_2.

PRODUCTION

In 1966, 6,187,926 kg of ilmenite, associated with monazite and zircon, were recovered from the beaches at Fort-Dauphin.

This ore was not exported.

CONCLUSION

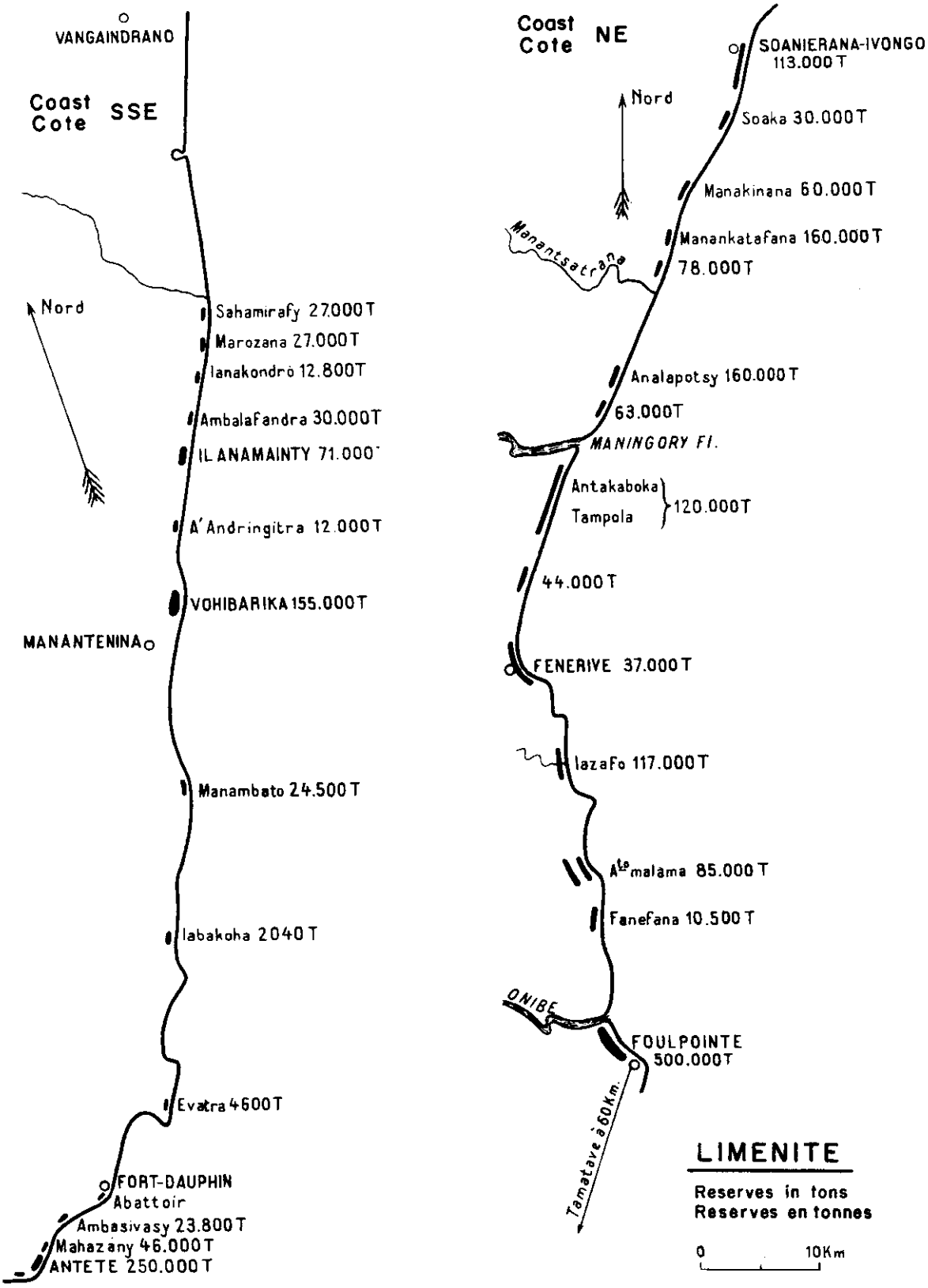
As rutile is found only in very small quantities in Madagascar, it can safely be said that titanium occurs there only in the form of ilmenite.

This has been hit by the same slump as monazite. Reserves are large.

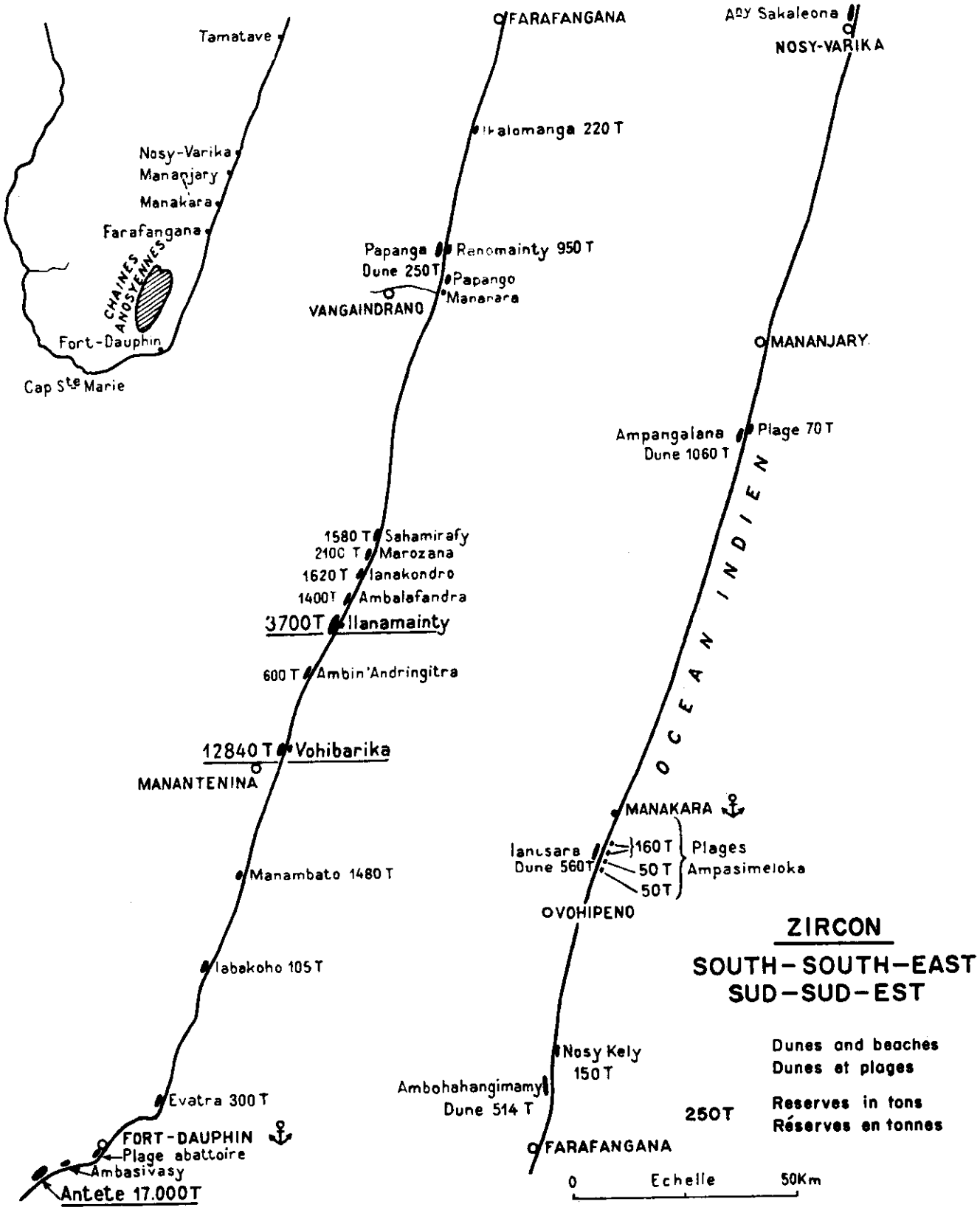
SCANDIUM

The only deposit of scandium is formed by the Befanamo pegmatite, intercalated within the biotite gneiss which occurs in the vast amphibolic series of the high Betsiboka (Vohibory Mountains).

Befanamite occurs in crystals upwards of a centimetre long. One specimen weighed 450 grams. Intensive working, with rewashing of the


VANGAINDRANO
Coast SSE
Cote
Nord
Sahamirafy 27.000T
Marozana 27.000T
Ianakondro 12.800T
Ambalafandra 30.000T
IL ANAMAINTY 71.000T
A'Andringitra 12.000T
VOHIBARIKA 155.000T
MANANTENINA
Manambato 24.500T
Iabakoha 2040T
Evatra 4600T
FORT-DAUPHIN
Abattoir
Ambasivasy 23.800T
Mahazany 46.000T
ANTETE 250.000T
Coast NE
Cote
SOANIERANA-IVONGO
113.000T
Nord
Soaka 30.000T
Manakinana 60.000T
Manantsatrana
Manankatafana 160.000T
78.000T
Analapotsy 160.000T
63.000T
MANINGORY FI.
Antakaboka
Tampola
120.000T
44.000T
FENERIVE 37.000T
Iazafo 117.000T
Ale malama 85.000T
Fanefana 10.500T
ONIBE
FOULPOINTE
500.000T
Tamatave à 60Km.
LIMENITE
Reserves in tons
Reserves en tonnes
0
10Km

CART-M-68-18



ZIRCON

SOUTH-SOUTH-EAST
SUD-SUD-EST

Dunes and beaches
Dunes et plages

Reserves in tons
Réserves en tonnes

CART-M-68-20

068-103

waste, exhausted the deposit, which yielded about 40 kg of the mineral.

Befanamite is not at present being mined in Madagascar.

ZIRCONIUM-HAFNIUM

ORE: Zircon ($ZrSiO_4$)

DEPOSITS: (1) Monazite beaches and dunes in the south-south-east

All the deposits mentioned in the section on monazite above contain appreciable quantities, of economic significance, of zircon. The zirconia (ZiO_2) content varies between 55 per cent and 65 per cent.

(2) Alluvial gravels (placers)

At Antetezambato, in the Tsaratanàna region, there is a zircon placer of syenitic origin. Surveyed by BUMIFOM in 1956, known reserves amount to 6,000 tons of zircon. Probable reserves are about 9,000 tons, and possible reserves 12,000 tons. The thickness of the mineralized zone varies from 3 to 10 metres, and the zircon content from 0.2 to 3 kg/m^3.

The concentrated ore assays:

Zr	48.85 per cent	Ti	0.05 per cent
SiO_2	32.60 per cent	Fe	0.69 per cent

It was not possible to determine the hafnium content.

PRODUCTION

In 1966, 704,533 kg of zircon was recovered from the beaches at Fort-Dauphin.

CONCLUSION

There are immense reserves of zircon in Madagascar. But the future of the mineral is bound up with that of monazite.

ANNEX 1

Prospection for beryl and the rare earths

Both beryl and the rare-earth minerals occur in pegmatitic lodes and veins. These lodes and veins are grouped in pegmatitic fields. No working geological rule can be applied that will lead to these deposits. The pegmatites occur only in small volumes. They are scattered, and come to light only where they outcrop. The only sure way of finding the lodes inside the pegmatitic fields is with the naked eye.

There is a device for detecting beryllium: the beryllometer. Its use has been considered for the examination of pegmatitic stream gravels and drill cores.

Mining

The methods used for mining beryl are rudimentary. The lodes are worked by open-casting or by sinking shafts, which always stop short when the water-table is reached. The A4 and F3 deposits at Malakialina alone are worked by underground methods. The ore is sorted by hand.

A very large number of small deposits is worked by handicraft methods; they yield a slender output.

Current operations

A thorough study of the distribution of elements of the rare-earth group in Madagascar, by spectrum analysis, is at present being carried out, under the United Nations Special Fund Project covering prospecting for mineral wealth and underground water, in the south of the Island. By the end of 1967, no less than 313 samples of monazite taken from an area of 47,000 km^2 had been examined spectrographically. Quantitative determinations of Eu, Lu, Yb, Y and Gd are now being completed; the other nine members of the rare-earth group will require the perfection of a special spectrographic method.

ANNEX 2

The surveying and working of the Fort-Dauphin monazite sands

The Fort-Dauphin sands contain monazite, ilmenite and zircon. As the monazite is radioactive, the beaches are surveyed with a scintillation counter. The survey is then followed up by a drilling programme.

The sand is mined with a mechanical shovel. Screening over 60-mesh screens eliminates 50 per cent of the gangue from the run-of-mine.

Subsequently, separation and concentration are carried out by gravimetric methods and passage over sand shaking tables, themselves fed by Humphrey spirals. Finally, an ilmentite-zircon-monazite concentrate is obtained by electromagnetic separation.

This treatment makes it possible to recover 95 per cent of the monazite, zircon and ilmenite content.

The concentrates are dried before shipment.