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GENERAL INFORMATION ON CERTAIN MINERALS WHOSE UTILIZATION IS GROWING OR TENDING TO GROW

(submitted by the Government of Rwanda)

GENERAL INFORMATION ON CERTAIN MINERALS WHOSE UTILIZATION IS GROWING OR TENDING TO GROW

by
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Introduction

Mining is one of the main bases of the economic development of Rwanda. It employs more wage earners than any other industry and takes second place in exports after agriculture.

Nevertheless, the mineral wealth of Rwanda comprises a fairly small number of substances. The minerals which have been worked since the origin of mining in Rwanda in about 1930, are cassiterite, wolfram, colombo-tantalite, beryl, amblygonite, gold and bismuth. Monazite, although discovered quite early, has not yet been worked.

More or less certain indications exist for the ores of Cu, Pb, Zn, Th and various rare earths, but the size and workability of the deposits have not yet been determined. A large research project has been undertaken to permit the maintenance and development of the existing mining industry, the working of known deposits that are not mined to any great extent, such as beryl and amblygonite, exploration for substances for which there are only indications, that is, whose existence is known: uranium, copper, zinc, lead, primary gold, carbonatite, peat containing monazite, clays for ceramics, special volcanic materials, as well as the search for new substances for which there are very few indications but which have increasing applications in modern industry.

Of these new and rare minerals we shall mention here those which are known, giving particular prominence in each case to those which have been found in Rwanda.

We shall speak of:

1. Minerals and ores of the rare earths associated with cerium:

   yttrium, europium, gadolinium, ytterbium, neodymium, praseodymium, lanthanium ... ;

2. Beryl .
3. Colombite and colombo-tantalite;
4. Titanium;
5. Minor minerals or ores.

1. Minerals and ores of rare earths associated with cerium

The two principal ores of cerium are monazite, present in Rwanda in the alluvium to the west of Butare, and bastnaesite, a complex carbonate, present in Burundi in a primary pegmatite deposit worked by Somuki.

Small quantities of monazite and bastnaesite occur with other ores, sometimes in association; this is especially the case with bastnaesite, known by the generic term of "rare earths".

In Rwanda, monazite occurs with hematite, zircon and ilmenite in the form of non-workable traces.

It is concentrated mainly in alluvium so that its origin can be traced to a degradation by erosion of the granite massifs of the Rusizi system. Another possible origin is the numerous veinlets of quartz which intersect the rocks in several places.

The uses of the rare-earths in electronics, optics, the nuclear industry, and sometimes in chemistry, are well known.

World consumption is now of the order of 2,300 tons of oxide concentrates. We shall cite the corresponding metals in order of importance, yttrium being well in the lead with more than half of the total indicated.

a) Like europium and gadolinium, yttrium has applications in the colour television industry, notably for tubes. The oxide of high purity has nuclear applications. It is also used for polishing high precision optical lenses, and certain types of mirrors.

It can also be used in the colour industries. It is used in metallurgy for very special alloys, and in certain petroleum cracking towers in which it notably improves the recovery yield by facilitating catalysis. Yttrium oxide is worth $42 - 45 per lb, according to the degree of purity. Yttrium metal is worth $75 - 300 per lb. After double distillation, its price is $500 per lb.

The oxide of europium is valued at $1,000 per lb.
Europium metal is valued at $1,200 - 3,500 per lb.

b) Other rare metals

These are utilized chiefly for their luminescent properties. Along with europium, already mentioned, we find terbium, neodymium and praseodymium. The principal applications are in the optical, the cut glass, and some plastics industries.

Research is being actively pursued on these products which have recently been isolated by chemistry, and new applications may be expected.

Certain radio-isotopes such as ytterbium 169 are used in radiography; others are used in the treatment of cancerous tumors.

c) Cerium

This is extracted principally from monazite, and to some extent from bastnaesite. It is used especially in the manufacture of lighter flints, thanks to its very marked pyrophoric properties.

Monazite is obtained chiefly from beach deposits on the coasts of Australia, Brazil and India. Its price is about $200 - 500 per ton, according to grade.

Treated chemically, the compounds obtained have a much higher value:

Pure hydrate of cerium sells in 100 lb lots at $1.45 - 1.70 per lb.

Pure cerium oxide for optical uses sells in 50 lb lots at $1.90 per lb. Cerium oxide of high purity is sold at $9 per lb, while cerium metal (99.9 per cent) sells for $70 per lb.

2. Beryl

The principal ore of beryllium is a complex silicate called beryl, found in sodolithic pegmatites in the rock form; this ore is worked in Rwanda in the Congo-Nile watershed. (The average annual production is 150 tons).

In the form of gems, it constitutes a highly-valued jewellery stone- aquamarine, emerald, morganite, etc. - that does not seem to have been found in Rwanda.

The BeO content of rock beryl is of the order of 10-12 per cent. Prices are variable, according to the tenor, the order of magnitude being $250 per ton.

Consumption is about 10,000 tons per year. Beryl oxide powder (20 mesh) is worth $10-15 per lb. Beryllium metal (97 per cent) is valued at $62 per pound in lots of 1,000-2,000 lb. The applications of beryl are numerous, but the treatment for obtaining powdered oxide, oxide of nuclear purity, and the metal, is complicated and expensive. The oxide of nuclear purity is used as a moderator in atomic reactors, especially in France and the United States. In this field, its uses derive from its great stability; its power of reflecting and moderating nuclear reactions rank it with graphite and heavy water, but its low weight leaves it without competition for the construction of nuclear propelling engines.

Beryllium oxide is an excellent refractory, used in spark-plugs of aircraft engines, high frequency insulators, and combustion chambers, etc.

There are also alloys having very special applications for certain mechanical parts, such as helicopter rotors and submarine screws.

We should note in passing the Cu-Be alloys, which have high resistance to fatigue and wear, the heat-resistant Cu-Co-Be alloys, etc.

3. Columbite and columbo-tantalite

There are three kinds of ores:

The columbites with a very high proportion of niobium, tantalite being present only in very small quantites. This is the Nigerian type of ore.

The columbo-tantalites, in which the proportions of niobium and tantalum are variable, but in the relatively high ratios of 1:3 and 3:1. This ore is often associated with cassiterite, or even with beryl in certain granite pegmatites. In Rwanda, the proportion of tantalum is almost equal to that of niobium, sometimes even a little higher. Production is about 60 tons and can doubtless be increased, if the explorations planned lead to the discovery of new reserves.

The tantalites are ores of tantalum in which the proportion of niobium falls below 33 per cent. It is a much sought-after but very rare ore. Indications have been reported in the north-east of the country, but the tenors in tapiolite especially have proved to be so low that the deposits have never been worked.

Prices vary according to the type of ore; for example, the columbites have a maximum price when the ratio of the oxides $\frac{Nb\ 205}{Ta\ 205}$ is higher than 10:1. In this case the ore is priced at $0.90 to $1.00 per lb of oxide content (1964 price). When the ratio $\frac{Ta\ 205}{Nb\ 205}$ is higher than 3:1 the quotation is on the basis of tantalite. In this case, the ore is priced at $3 - $4.50 per lb of oxide content (1964 price).

The intermediate ores, that is, the so-called columbo-tantalites, are priced individually by lot. World production is of the order of 5,000 tons, of which 4,000 tons consists of columbites. The two principal producers of columbite are Canada and Nigeria, with more than 90 per cent of the world total. Brazil is the principal producer of tantalite.

The main applications of niobium and tantalum are in the space and aeronautical industries. They are used in the form of special alloys resistant to very high temperatures, in the construction of jet and rocket engines. At present the tendency is to use them with metals like zirconium and titanium.

4. Titanium

The two principal ores of titanium are ilmenite and rutile. Ilmenite, like monazite, is obtained chiefly from beach sands (so-called "black sands"), and comes principally from Canada, Australia and India.

Rutile is obtained mostly from Australia, and to a smaller extent from Portugal, India, Senegal and the United States.

Ilmenite is an ore containing of 59.5 per cent TiO_2.

Rutile is an ore of 94 per cent TiO_2.

The main applications of ilmenite are in the fabrication of titanium metals, in the aeronautical industry and space research. It is a metal resistant to very high temperatures. World consumption is of the order of 2.5 million tons and has tended to increase regularly since 1964.

Rutile, with a production of the order of 200,000 tons, has a very wide range of applications in the paint industry (titanium white) as well as in wallpaper and plastics. Consumption is increasing at the same rate as for ilmenite.

Prices FOB Atlantic ports are, respectively.

$23 - 26 per long ton, for ilmenite of 59.5 per cent TiO_2.

$104 per short ton for rutile of 94 per cent TiO_2.

Prices of the metal are:

(In lots of 10,000 lb)

Sponge 99.3% titanium	$1.32 -e per lb
Sheet	$4.90 - 5.10 per lb

5. Minor ores and minerals

This category is mentioned only as a curiosity for most of these substances are secondary metals recovered in the treatment of other metals; for example, gallium, a by-product of aluminium production; germanium, a

by-product of zinc production; rhenium, a by-product of molybdenum production, selenium and tellurium, by-products of electrolytic copper production, other sub-forms of very special compounds deposited in saline lagoon formations, and cesium and rubidium, which are sometimes found in very special pegmatites (scandium).

Conclusions

With regard to the minerals or ores mentioned in this note, it appears that:

Monazite is present in the small flats to the south of Gikongoro and analyses of the crude product are essential to assess the value of the deposits and especially to see if it is associated with rare minerals that might raise the sales price (particularly yttrium); this has not yet been demonstrated.

The presence of bastnaesite has not been established so far but it cannot be excluded a priori; the United Nations project should remove the doubt;

Beryl is present in the watershed in some thirty fairly large pegmatite deposits and in certain deposits worked by diggers; recovery is by hand-picking, the only known method suited to the special conditions of the deposit;

Columbo-tantalites are present, often associated with cassiterite; the market trend is good for products rich in tantalum, and working should be promoted as much as possible wherever the combined value of the cassiterite plus columbo-tantalite content is adequate;

Rutile has not been prospected for, but its value is insufficient to justify even "artisanal" exploration and working, the transport cost being much too high in relation to the FOB value of the product;

The minor ores mentioned are not yet represented, and there are only theoretical probabilities in connexion with possible deposits of copper, lead or zinc, or even uranium, of which there are some positive indications.

The systematic analysis of all types of samples, from all sources, is the only way of producing convincing evidence to justify mining, but the implementation of the project submitted for approval to the United Nations must be awaited for this.

It should also be noted in passing that other products may be of interest for local utilization - peat as a fuel, gas as raw material for onergy and reduction, and limestone and lava for cement - and finally that the discovery of several individually non-workable deposits of heavy substances (such as amblygonite, manganese and chromite) might lead to a modification of transport facilities as to render the working of such products economic.