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TITANIUM MINERALS IN SIERRA LEONE

(submitted by the Government of Sierra Leone)

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## Titanium Minerals in Sierra Leone\*

History

Rutile which is one of the two minerals containing a substantial amount of Titanium, is mined in Sierra Leone by the **Sherbro Minerals Company** which is incorporated in Sierra Leone and is a wholly-owned subsidiary of the **British Titan Products Company Limited** of York, England, and the **Pittsburg Plate Glass Company Limited** of Pittsburg U.S.A. The share capital is held 80% by the Pittsburg Plate Glass Company and 20% by the British Titan Products Company. The original prospecting license was taken out by the British Titan Products Company in partnership with the **Columbia Southern Chemical Corporation** of the United States in 1955, but in 1958 the Columbia Southern Chemicals Corporation sold out its interest to the Pittsburg Plate Glass Company Ltd. Sherbro Minerals Company had to invest about \$10,500,000 to bring the mine into production.

The first reports of the occurrence of titanium and associated minerals in Sierra Leone were in the early 1930s, when ilmenite was discovered in the Peninsular area of Sierra Leone as a constituent of the beach sands. Relatively little notice was paid to its discovery at the time as deposits were very patchy and of little economic significance. Some ilmenite was shipped during the Second World War when it was difficult to obtain supplies for the allied war effort from the customary places such as Malaya, India and Ceylon. Only a few hundred tons were shipped, and these were mainly bagged shipments. Recovery of ilmenite was not pursued after the end of the World War as the premium prices paid during the war were not maintained when the customary markets became accessible.

In 1952 after spasmodic attempts by individuals to mine ilmenite had proved futile, the Geological Survey, during its routine work of prospecting, collected samples of heavy mineral concentrates from streams and the head-

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waters of rivers draining the Kasila series which is a distinct Geological formation of precambrian age extending from the north-western part of Sierra Leone across the country in a narrow strip, which varies from 10 to 35 miles in width, to the southern tip of the country. These samples were found to consist essentially of the Titanium minerals, rutile and ilmenite with small amounts of Zircon and Monazite; gold was also present in trace quantities in most of the samples. In 1954, the British Titan Products Company became interested as a result of the reports made by Geological Surveys, and Dr. F.R. Joyce an eminent mining Geologist was sent to Sierra Leone to do a reconnaissance of the areas from which the samples were taken. After taking further samples of the heavy minerals in the area and studying aerial photographs of the coastal section of Sierra Leone between Shenge and the Liberian border, it was decided that British Titan Product Company should prospect further.

A Special Exclusive Prospecting License of over 2,000 square miles was granted to the Company in 1955, and between 1955 and 1964 when a mining agreement was negotiated with the Company, reconnaissance drilling and intense prospecting by Banker Drilling was carried out. During this period it was established that a major deposit of rutile and ilmenite had been uncovered. A conservative estimate of the extent of the deposits is put at 15,000,000 tons of mineable rutile. This is all the more significant when it is realised that the present world production of the rutile is approximately 260,000 tons per annum.

Construction of plant and mine buildings started in 1964, and by May 1967 the first commercial shipment of rutile was made. The rated capacity of the plant is 100,000 tons of rutile per annum but there are already plans for doubling the production as soon as the initial difficulties of starting a new mine is overcome, and the rated capacity attained.

#### Geology and Analysis:

The rutile being mined by Sherbro Minerals Company occurs in alluvial deposits, a rare, if not unique, mode of occurrence for a rutile ore body.

(Most of the rutile being mined elsewhere is recovered from beach sands and is frequently associated with ilmenite.) Although the deposit was discovered by the Geological Survey in 1951, in the course of monazite prospecting, little is known about the detailed geology, as all the prospecting has been done by the Company now mining the deposit.

Titanium is one of the most common mineral elements and is seldom found in a concentrated form; it usually occurs as fine black specks in rock and as the rock disintegrates under the influence of weather the contained titanium particles accumulate in alluvial deposits in the form of a darkly-coloured sand mixed with other products from the decomposition of the rocks. With the passage of time the clay, silt and other lighter products of decomposition are washed away during the process of concentration and accumulation. The deposits in Sierra Leone generally follow this rule except that being a relatively recent product of weathering the heavy minerals are found with considerable quantities of clay and sand. The Sierra Leone deposits are derived from the Gneisses and Crystalline schists of the Kasilla series geological formation. Chemical analysis showed that the beach sands on the coast contained ilmenite consisting 60% Titanium Dioxide and that the concentrates from the streams and rivers further inland consisted essentially of rutile with lesser amounts of ilmenite which averaged about 52% Titanium Dioxide. The proportion of rutile to ilmenite was greatest in the Gbangbama and Mogbwemo areas where it was as high as 6 - 1 and became progressively less towards the north and west. Analysis of the rutile showed that it contained between 92% and 98% Titanium Dioxide.

A typical deposit contains the following:-

Ilmenite	-	28.1%
Garnet	-	10.3%
Monazite	-	1.4%
Rutile	-	36.8%
Zircon	-	19.7%
Quartz	-	3.4%

Corundum is also present in very small quantities.

Two large deposits have so far been conclusively proved; they are the Lanti deposit in the Lanti river basin to the south, and the Mogbwemo deposit which is being mined at present, slightly to the north. The analysis given above is from samples of the Lanti deposit. Analysis of the Mogbwemo deposit records a higher percentage of quartz and a smaller percentage of ilmenite.

Investigations in the license indicates that there are at least 14 stream systems that are worthy of careful prospecting; for the most part these streams lay between the Jong River on the East and the Sembehun Creek on the west. There exists a heavy mineral shade extending from the southern boundary of the Kasila Gneisses and Schists up to six miles inland. Rutile has been found in these deposits varying from 0.5% up to 9% by volume.

The Kasila Series is overlain unconformably on the seaward side by horizontally bedded sediments of marine and estuarine origin. These sediments, the Bullom Series, range from Tertiary to Recent in age, and it is difficult to distinguish between them and recent superficial deposits.

The main rutile deposits, which are in places capped by indurated laterite, consist of fine sands, silt and clay and are up to 70 feet thick. The rutile occurs throughout the deposit. In places it bottoms on a rutile bearing clayey garnet "sand" which is a residual product formed by the decomposition of garnetiferous horizons within the gneisses.

#### Exploration:

Exploration of the area was done under a Special Exclusive Prospecting License and started early in 1956. The deposits that have been uncovered and proved have shown that this is a major deposit of rutile and ilmenite and regardless of whether more deposits are found a viable mine can be established. An intense reconnaissance drilling programme initiated in 1958 using mobile power augers mounted on Land Rovers was carried out for two years; samples were collected and analysed in Freetown, Pittsburgh

and London. After the extent of the rutile-bearing formation had been determined reconnaissance drilling was followed up by delineation drilling. During most of the exploration before mining started the Company employed between 5 and 13 senior supervisory officers and a labour force varying from 45 to over 100.

#### Mining & Milling:

The deposits are mined mainly by a suction dredge and to a much smaller extent by draglines. The whole extraction and mining process consists of three distinct stages. The first stage is the dredge which was built particularly for the project. The deposit is sucked up and the first stage of the separation is done by equipment mounted on the dredge. The resultant concentrate is pumped to the wet plant where it is further concentrated. At this stage, which is the second, the composition of the feed is largely heavy minerals like Zircon, Ilmenites, Garnets and Quartzite sand which is the main gangue mineral. This is then treated by a series of cone classifiers and Humphrey Spirals which get rid of the sand. The concentrate is then transferred to the dry plant by bucket wheel which forms the third stage for the final stage of the concentrating process. The dry plant is made up almost entirely of groups of magnetic and electrostatic separators. The magnetic separators to remove the ilmenite by taking advantage of its magnetic properties, and the electrostatic separators separate the other minerals from the rutile by taking advantage of the differences in electrical conductivity. At this point the rutile averages about 96% Titanium Dioxide. It is then kept in specially constructed bins to await shipment.

Because of the nature of the deposit and the occasional hardpan encountered, it has been found necessary to blast ahead of the dredge in some places to loosen up the laterite cap and also to cut down on the wear of the cutting edge of the dredge.

The dredge consist of a 20 inch suction piece, two Nordberg 1200 horsepower engines installed for electricity generation, and to supply power for the main suction pump, with assorted equipment mounted on pontoons. The wet mill consists of three floating barges; the screening and desliming barge, the concentrator feed barge and the concentrator barge. These are equipped with scalping screens, classifiers, launders and various sizes of pumps. Riechert Cone Concentrators which are extensively used in Australia are employed for rough separation and the feed is then pumped to the spirals for cleaning. The tailings which consist mainly of sand is pumped into a tailing's dump. The next stage on the wet plant is the scrubbing section which consists of dewatering classifiers, attrition cells, agitators and a stacker conveyor for stock piling.

The dry mill where the final concentration and separation of rutile from other heavy minerals is done consists of a kiln for drying the ore, a rotating feeder, magnetic conveyors for magnetic separation and high tension conveyors for electrostatic separation.

#### Economics & Marketing:

Titanium dioxide which is the main component of rutile has replaced older pigments such as white lead, zinc oxide etc., as a white paint pigment and its main use at the present time is as the pigment component of white paint. It has however in recent years been used increasingly for the manufacture of titanium metal by the chlorination process, and has been in very great demand as an additive to high tensile steel alloys for the manufacture of jet engines, welding rods etc. It will probably be the metal for the manufacture of rockets and satellites for inter-planetary transport. Because of this, the price of the mineral has pushed up considerably but with the Sierra Leone production going into the world market, it is expected that the price will be stabilised. Bagged shipments of rutile sell at an average of £40 to £43 per ton, but bulk shipments from Sierra Leone based on long term contracts, are at present selling for considerably less. Sierra Leone rutile is at present exported

mainly to the United Kingdom and the United States. Contracts have been placed with both the Pittsburgh Plate Glass Company and the British Titan Products Company who will at all times be buying a significant proportion of the production. This has ensured the viability of the mine and a ready market for its product. Interest in Sierra Leone rutile has also been shown by several European countries, and West Germany, France and Belgium have had small shipments.

Conclusion:

The prospects for titanium are very bright and with the added use of it in its metal form, its potential has become very much greater. Sierra-Leone is extremely lucky to have such vast reserves of rutile and will no doubt obtain **immense** financial and economic benefits from its exploitation.