UTILISATION OF THE STRONTIUM MINERALS OCCURRING IN TRICHINOPOLY DISTRICT, MADRAS.

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Almost all the workable strontium deposits of the world are of sedimentary origin. Generally strontium occurs as the sulphate, celestite and the carbonate, strontianite. Even though both these minerals of strontium are rare, celestite seems to be more common than strontianite. Its presence in minute traces in surface waters is also recognised. It is present in large quantities in some springs and well waters. The manner in which the minerals celestite and strontianite occur in sedimentary rocks varies widely. In many cases the crystals of these minerals occur throughout the sedimentary rock formations of a particular area. They also occur as large lumps and as continuous rock masses interstratified with other formations. Sometimes these occur as fairly good crystalline aggregates on the surface of eroded sedimentary rocks along with gypsum.

Strontium either as celestite or as strontianite occurs in all the countries of the world. But its occurrence is rather limited. Only a few countries possess large deposits of these minerals. Some of the larger deposits occur in places which are very inaccessible and so they are not being worked at present.

Till recently it was considered that the occurrence of strontium was rare in India. In 1939 the author of this paper discovered the presence of a large deposit of strontium minerals in the cretaceous rocks of Trichy District. Before the discovery of this deposit, there were only three recorded occurrences of strontium minerals in India. Blanford of the Geological Survey of India, in one of his memoirs, refers to an occurrence of strontium as having been found by Fedden in Western Sind. It is reported that it occurs only very sparingly and as scattered crystalline lumps on the surface of the Kirtar limestone hills of Kohistan. The occurrence of a small quantity of strontium minerals was also found by A. B. Wynne in red clays of Tertiary age in Kohat District, N.-W. Frontier Province. Jones reports the occurrence of small quantities of strontium sulphate along with large quantities of barium sulphate in the nodules dredged off Colombo. The occurrences mentioned above are very limited and so no economic exploitation of these deposits was attempted. At present almost all the strontium consumed by India is imported, but statistics are not available to find out the quantities involved.

While engaged in a mineralogical and chemical study of the phosphatic nodules from Trichinopoly, the author noticed the presence of a crystalline white mineral which filled up the septarian cracks in the nodules. This mineral was also found to occur as fan-like radiating aggregates even in nodules which were free from the septarian cracks. On examination it was identified to be celestite. On the average, the phosphatic nodules hold about 3% celestite and in some cases it is as high as 15%. Previous investigators of the phosphatic nodules had mistaken this mineral for gypsum which is also found along with celestite. The presence of celestite in the phosphatic nodules led the author to look for its occurrence outside the nodule also, viz., in the clay beds in association with gypsum. A trip to the area was arranged and a detailed examination of the clay beds N.-E. of Utatur, a village situated about 20 miles to the N.-E. of Trichy, revealed the presence of large quantities of celestite.

The mineral celestite occurs here along with gypsum as lumps of varying sizes. Masses weighing from 50 to 60 lbs. are also met with. A block of celestite weighing about 75 lbs. has been kept at the Indian Institute of Science Museum for exhibition. These masses are invariably made up of radiating and parallelly arranged columnar crystals of celestite. The individual columnar crystal of such masses has a maximum thickness of about 0·5 cm. and a maximum length of about 7 cm. Unaltered and washed specimens give on analysis about 95% $SrSO_4$. But most of these lumps of celestite were found to be in varying stages of alteration, the main product of alteration being a fibrous strontianite. In many places the original celestite blocks have been completely altered to strontianite and in some they have given place to a yellow amorphous earthy material. This material was also found to be composed mainly of strontium carbonate with a large admixture of silica and other impurities. The celestite and its alteration products are found occurring in small isolated heaps over a large area covering sixteen to twenty square miles. Their occurrence is rather abundant in an area of nearly 2,000 acres adjoining Karai and Thirani villages. On a rough preliminary survey, it is estimated that this deposit contains about a million tons of celestite and some strontianite. On the average these minerals contain about 45% strontium oxide which is equivalent to nearly 80% $SrSO_4$. Researches carried out at the Indian Institute of Science by the author indicate that it is possible to treat the powdered strontium minerals from Trichy with a view to remove most of the objectionable impurities such as silica, clay, calcium phosphate and calcium carbonate, by cheap physico-chemical processes and obtain a concentrate containing over 96% strontium sulphate.

Though the area in which the celestite and strontianite occur was surveyed so long ago as 1865 by the Geological Survey of India, the presence of these minerals was not even suspected (except in one case where a photograph of a lump of celestite has been published by Ramaswami Sivan in some other connection) in these areas, the deposits being generally mistaken for gypsum

which also occurs in this locality in considerable quantities. The gypsum is for the past few years being worked by some private companies which have been assigned the lease of this area only for the mining and exploitation of gypsum. In the course of a survey of this area in December 1939 the author found that these companies, being ignorant of the identity of the celestite and strontianite found in large quantities amidst the gypsum, had as a rule collected them in dumps as of no value, while a percentage of these minerals was also being mixed up by inadvertence with the gypsum that was mined and removed, because of the inability of the pickers employed by these companies to distinguish in all cases between gypsum on the one hand and the other two aforementioned minerals on the other. But now, after the discovery of the strontium minerals was announced, some of these companies have applied for and obtained mining rights for these minerals also.

Detailed investigations carried out by the author at the Indian Institute of Science showed that the finely powdered celestite from Trichy is easily decomposed by heating it in a 10% solution of ammonium carbonate. Complete decomposition was effected after heating the solution for two hours. The resulting solution contained most of the strontium as strontium carbonate precipitate and all the sulphur as ammonium sulphate in solution. Thus, most of the ammonia used as ammonium carbonate could be recovered as ammonium sulphate which could be considered as a valuable by-product. The strontium carbonate is the most important compound of strontium so far as its industrial utilisation is concerned. Because, it is the starting material for the preparation of the other compounds of strontium. The strontium oxide, which is extensively employed for the manufacture of beet sugar and for the complete extraction of sugar from cane molasses, is prepared from strontium carbonate by heating the latter in the presence of steam and coal. Strontium oxide is also prepared by igniting the nitrate, but this process is not practised for the large-scale production of the oxide. Strontium hydroxide, obtained by adding water to the oxide, is the material which is actually employed in the sugar industry. The sugar combines with the strontium hydroxide to form strontium saccharate, which being difficultly soluble separates out. This is then filtered out and treated with carbon dioxide, when strontium is deposited as carbonate. The sugar in the solution is recovered by filtering off the solution, evaporating it and then treating it in a refinery. The other use for strontium salts (especially strontium nitrate) is for the production of red light of fireworks. Strontium salts are also used in medicine.

America and other countries, which produce beet sugar on a large scale, are big consumers of these strontium minerals as they are essential for the production of this kind of sugar. Especially in America the demand for strontium salts is very great. As India is not a big consumer of strontium salts most of the strontium, either in the state of concentrated celestine powder or as manufactured strontium carbonate could be exported at a great profit.

The latter process is more advantageous since the by-product (ammonium sulphate) resulting from this process is a valuable fertiliser.

The author of this paper has also worked out a process for the preparation of strontium carbonate from the Trichy celestite using soda ash. This process has been handed over to a company at Trichy which would shortly start producing strontium carbonate. The author of this paper has also worked out processes for the manufacture of the other compounds of strontium, viz. chloride, nitrate and the hydroxide, from the Trichy celestite.