MINERALOGICAL NOTES.

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I.—The New Mineral.

In 1903 Mr. W. D. Holland (who has long taken an interest in the mineralogy of the Bambarabotuwa district) obtained a quantity of a heavy black mineral occurring in cubic crystals, which he naturally identified as uraninite (pitchblende). Samples were sent to Sir W. Crookes, Sir W. Ramsay, and others, and the whole amount available (some 5 cwt.) was purchased by the latter chemist. Samples were also sent through the Mineralogical Survey to the Imperial Institute for examination and analysis.

In a letter published in *Nature*, p. 510, March 31, 1904, Professor Dunstan published the following analysis of two samples, made by Mr. G. S. Blake at the Imperial Institute :—

I.			II.		
ThO_2	...	76·22	ThO_2	...	72·24
CeO_2			CeO_2	...	6·39
La_2O_3, Di_2O_3	...	8·04	La_2O_3 Di_2O_3	...	0·51
ZrO_2	...	trace	ZrO_2	...	3·68
UO_3	...	12·33	UO_3	...	11·19
Fe_2O_3	...	0·35	Fe_2O_3	...	1·92
PbO	...	2·87	PbO	...	2·25
SiO_2	...	0·12	SiO_2	...	1·34
			Insol. residue	...	0·41
		99·93			99·93
S. gr.	...	9·32	S. gr.	...	8·98

These analyses showed that the mineral was not pitchblende, and Professor Dunstan suggested the name of *thorianite* for the new mineral.

In a letter in *Nature*, p. 533, April 7, 1904, however, Professor Ramsay published the preliminary results of his examinations, stating that a much smaller percentage of thorium occurred in the mineral, and that no appreciable amount of cerium, lanthanum, and didymium entered into its constitution ; but the presence of one or more new elements was indicated. The mineral was strongly radio active, but contained only a trace of radium, the radio-activity due to this source being certainly not 5 per cent. of the

total. The period of decay of the emanation appeared to point to the presence of a radioactive element closely resembling thorium X. Helium was yielded when the mineral was heated alone, 3·5 c.c. per gram being obtained ; when fused with hydrogen potassium sulphate, it yielded 9·5 c.c. per gram.

In a subsequent letter (*Nature*, April 14, p. 559) Professor Ramsay admitted that a considerable amount of thoria was present, in addition to the new elements, which may be identical with those recently discovered by Professor Baskerville. A partial analysis which was made in M. Curie's laboratory gave 79 per cent. oxides of rare earths (principally thoria) and 14 per cent. of uranium oxide. A rough preliminary analysis made by Professor Sir W. Ramsay is as follows : oxides like thorium oxide 76·4 ; uranium oxide 14·9 ; ferric oxide 6·1 ; lead, arsenic, &c., 2·0 ; insoluble (not $Si\ O_2$) 0·7. At present the constitution of the new mineral and so also its commercial value cannot be regarded as definitely established ; we must await the completion of further work in London.

With regard to the analyses made at the Imperial Institute I may say that I have not observed any trace of zircon occurring as an impurity in the mineral, and do not think the $Zr\ O_2$ found can be due to the presence of inclusions of zircon, but rather that the zirconia enters into its composition. On the other hand, many crystals have a slight amount of limonite attached to the surface, and even if these be carefully excluded there are others containing small cavities lined with limonite which may in part account for the variations in specific gravity observed, so that a small percentage of iron oxide in the analyses may be regarded as an impurity.

The properties of the mineral not already quoted are referred to below :—Colour black, streak greenish gray. Hardness, 5·5–6. Crystallizes in the cubic system, crystals rarely exceed 7 mm. along a cube edge. Some crystals consisting of two interpenetrating individuals appear to be twins, but this has not been as yet confirmed by measurements. Fracture uneven, tending to conchoidal. Brittle. Lustre resinous to submetallic. Infusible. Dissolves readily in salt of phosphorus bead, vigorously giving off bubbles, doubtless of helium ; the bead in O. F. is yellow when hot, green when cold, being the reaction for uranium. In borax bead yellow hot, pale greenish-yellow cold. Insoluble in acids.

Some account of the localities and mode of occurrence may be given next. The mineral occurs in greatest abundance in loose waterworn crystals in the bed of the Kuda Pandi-oya, a tiny stream near Kondrugala, Bambarabotuwa, Sabaragamuwa, where it often forms the bulk of the heavy residue ("Nambu") remaining in the gemming basket after washing. It collects also in hollows and

potholes in the bed of the stream, which in its upper part is so small as not to contain running water in dry weather. It occurs also in fragments of a ferruginous conglomerate formed in the stream bed, and containing waterworn rock fragments and crystals of zircon, thorite, &c.

The mineral was traced to within a short distance of the head of the ravine, but no sign could be found of any rock containing it *in situ*, and a more extensive search for the matrix would probably be a long and expensive matter, owing to the thick soil, landslips, and thick jungle. I have little doubt, however, that it is derived from some granitic or pegmatite-like rock, such as those in which zircon and allanite have been found.

The mineral was detected in smaller quantities in washings from the Alupola-dola (some distance above the path) and in the Kuda-oya between Batataragala and the said Kondrugala path. Two or three crystals were also seen in gem washings from Massena estate, but more could not be obtained. A single crystal was found in a washing taken from the Pita-ela between Walawe and Morahela estates near Balangoda.

Since uraninite is *rarely* found in cubic crystals, it is most probable that the mineral recorded by me as uraninite from Gampola (*Spolia Zeylanica*, vol. I. part IV., 1904), is in reality the new mineral. It there occurred in a pegmatite consisting mainly of orthoclase, quartz, and biotite, with apatite, tourmaline, &c., as accessory minerals.

I have seen other specimens from Ceylon of a mineral resembling this one, but regarded as uraninite; some of these are massive, and cannot be definitely claimed as uraninite or thorianite without chemical analysis; so that it is far from unlikely that new localities will be found where one or both may be met with in greater abundance.

In the Kuda Pandi-oya it is associated with quantities of zircon (well-developed large crystals, with some excellent twins on e (101)), and with more waterworn crystals of thorite, a mineral which I at first identified as monazite. A crystal of the supposed monazite stated to be from Bambarabotuwa was sent to the Imperial Institute for examination, and Mr. G. S. Blake's analysis gave the following result, the mineral being identified as thorite:—

ThO_2	...	66·26	SiO_2	...	14·10
CeO_2 &c.	...	7·18	H_2O	...	6·40
ZrO_2	...	2·23			
UO_3	...	·46			99·89
Fe_2O_3	...	1·71			
CaO	...	0·35		S. gr.	4·98
P_2O_5	...	1·20			

The form of the crystals, however, shows that the mineral is not tetragonal; it appears to be orthorhombic or monoclinic. The oriented sections which I am having prepared will probably clear up this point. In any case I do not at present regard the mineral as thorite, although its chemical composition is undoubtedly similar to that of thorite.

As has already been pointed out, the occurrence of thorium-bearing minerals (one said to contain a higher percentage of thoria than any mineral previously known) in Ceylon is of great scientific interest, and if they are present in sufficient amount will be of considerable commercial importance owing to the use of thoria for the manufacture of incandescent gas mantles. The 10 or 12 per cent. of uranium oxide alone gives a value of £20 or £30 a ton. The very small amount of radium present is of no practical importance.

II.—Corundum, Sillimanite, &c.

Remarkable corundum-sillimanite rocks were found at Haldummulla (Uva). They occur all down the slope of Haldummulla estate, but not *in situ*, being derived from some point in the inaccessible hill above; the fallen blocks are found as far down as the western end of Kalupahane estate. The minerals sillimanite, corundum, orthoclase-microperthite, garnet, rutile, and ilmenite enter into the composition of these rocks. The principal types met with are: sillimanite-corundum rock, sillimanite-garnet rock, and sillimanite rock; orthoclase-microperthite is present in subordinate and varying amount; ilmenite and rutile are accessory and do not occur together, but mutually replace each other; the corundum and garnet also do not occur together in the same rock. The corundum forms violet-coloured hexagonal crystals, usually less than $\frac{3}{4}$ inch in diameter; the crystals have often a tabular developement, the forms c (0001), a ($11\bar{2}0$), and r ($10\bar{1}1$) are characteristic; rhombohedral cleavage is well developed. The sillimanite occurs in parallel and radiating groups and single individuals, the latter generally idiomorphic (prismatic, giving rectangular cross sections). The crystallization is much coarser than is usual for sillimanite; the largest crystals may reach a length of 2 inches or more and diameter one-tenth inch. The sillimanite has in the rock a pale gray colour, but is colourless in thin flakes. A more detailed account of these rocks will be elsewhere given.

Sillimanite has been met with in the garnetiferous leptynites in some abundance, over a large area between Bandarawela on the one hand and the Bambarabotuwa district (Sabaragamuwa) on the other; also in small amount in a garnetiferous rock found at

Eraporuwa near Kolonna, Sab:. The mineral is exceedingly rare in the Kandy District (where I have only quite recently discovered it ; it is there found (1) in a curious rock from Dulmure, about 7 miles east of Kandy; this rock may be called *a garnet spinel leptynite*; and is remarkable for the minute graphic intergrowths of green spinel with felspar which characterize it; sillimanite also occurs, but very sparingly and is more conspicuous macroscopically than in a thin section; and (2) in a coarse garnet-leptynite, blocks of which occur by the roadside, but not *in situ*, towards the eastern end of Gregory's road (Upper Lake road, Kandy). In the Uva-Sabaragamuwa District referred to, however, sillimanite is a fairly common and characteristic mineral, though by no means invariably present. The sillimanite-bearing leptynites are characteristic and easily recognized rocks; the colourless, shining, perfectly fresh lath-shaped cleavage surfaces of the sillimanite are very conspicuous in the slightly decomposed granulites. The sillimanite occurs in varying amount, but rarely if ever, however, to the total exclusion of felspar.

III.—Phlogopite.

Particulars of an almost colourless phlogopite mica from Ampitiya, near Kandy, are of sufficient interest to be recorded. The mica is found near a junction of crystalline limestone with granulite (a characteristic situation); the exposure is on the north side of the shallow valley between Ketawala hill and the main road about $3\frac{1}{2}$ miles from Kandy. The mica occurs in six-sided, but not very sharp-edged, tabular crystals, not exceeding 4 inches in diameter. A natural parting parallel to the rays of the percussion figure and to the edges of the crystal, is sparingly developed. The optic axial plane coincides with the leading ray of the percussion figure, being thus in the normal position for phlogopite. The rays of the percussion figure are inclined to each other at angles of not quite exactly 60°; the angle K between the two secondary rays (Holland, "Mica Deposits of India," 1902, p. 18, fig. 2) being from 60° to 62°, the other angles 60° to 59°. There are scattered, gray-coloured, hair-like, and very thin lath-like inclusions, which are arranged in directions parallel and perpendicular to the rays of the percussion figure. The axial angle is small, so that the figure in thin flakes is apparently uniaxial and pieces of some thickness must be examined in order to determine the position of the axial plane. In thick pieces the mica has a greenish tinge, and is faintly pleochroic in shades of very pale brownish-green; thin flakes are quite colourless.

The following analysis was made at the Imperial Institute *:—

Al_2O_3	...	17·88	SiO_2	...	39·39
Fe_2O_3	...	0·21	H_2O	...	3·62
MgO	...	25·86	Moisture	...	0 84
Na_2O	...	1·09			98·79
K_2O	...	9·90			

IV.—Kyanite.

"On Sea-bottoms and Calcretes" J. Lomas, in Professor Herdman's "Report on the Pearl Oyster Fisheries," Roy. Soc., London, 1903.

Kyanite was found by Mr. Lomas as a constituent of sands dredged by Professor Herdman off the coast of Ceylon in 1902; the mineral has not previously been recorded from Ceylon.

In Galle Bay were obtained the minerals, quartz, kyanite, corundum, rutile, tourmaline, and mica; in Trincomalee Bay, quartz (magnetite), garnet, corundum, tourmaline, kyanite, mica; in Palk Bay, quartz, tourmaline, felspar, zircon, corundum, kyanite, mica, ilmenite; in various parts of the Gulf of Mannar, quartz, ilmenite, magnetite, tourmaline, zircon, garnet, kyanite, rutile. These minerals have no doubt, as pointed out by Mr. Lomas, been brought down by rivers from the higher parts of Ceylon, and distributed by currents over the ocean bottom. The absence from these lists of spinel and sillimanite is rather curious.

V.—Chert and Opal.

I have recently shown (Geol. Mag., 1904, Dec. v., Vol. 1, pp. 16–19) that at any rate a part of the chert and opaline rocks which are locally, but in moderate abundance, distributed in the parts of Ceylon with which I am acquainted, are alteration products of crystalline limestones, the carbonates having been removed in solution and replaced by chalcedonic and opaline silica, so that we may find cherts containing the original accessory minerals (spinel, phlogopite, graphite, apatite) of the limestones, but showing no trace of the original carbonates. In other specimens relics of the partially removed carbonates are to be seen. This corresponds to what we know of many cherts that occur amongst sedimentary rocks in England, where it has been shown that the silica (whatever its source) has replaced the original carbonates, which appear to have been corroded and removed in solution. In Ceylon the process appears to have taken place long after the formation of the rock itself.

* I am sorry that the names of the individual chemist or chemists by whom some of the analyses quoted were made have been withheld, and cannot therefore be given.

VI.—Steatite (Talc.)

This mineral occurs in crystalline limestone, or rather dolomite, at Harakgama, Pata Hewaheta, Central Province, both in rounded and ovoid masses less than an inch in diameter, resembling amygdules, and also in small hexagonal prismatic crystals with good basal cleavage, pearly lustre, &c., but terminating irregularly (unlike the rather similar individuals of phlogopite mica in which the basal plane is always well developed). Appearances suggest a secondary origin for the steatite.

VII.—Stilbite.

A rock specimen obtained from Nilhene graphite mine (near Baddegama) some 5 or 6 years ago was covered with small bright transparent crystals. These were examined by Mr. L. J. Spencer, M.A., and found to be stilbite, presenting the forms c (001), b (010), f ($\bar{1}01$), and m (110), and twinned like Dana's figure 3. Stilbite has not previously been recorded from Ceylon.

VIII.—Serendibite.*

This rare mineral, hitherto only known from the moonstone pits at Gangapitiya, Dumbara, Central Province, is found also in the pits at Attaragala near the 11th milepost on the Katugastota-Teldeniya road. The occurrence here is similar to that originally described; the pits are distant from those at Gangapitiya nearly four miles, along the same line of strike.

IX.—Moonstone.

The following is an analysis of Ceylon moonstone (orthoclase felspar) from Gangapitiya, Dumbara, Central Province, made at the Imperial Institute. The material analyzed was clear, colourless, and free from inclusions. The composition is that of an orthoclase rather rich in soda.†

SiO_2	... 65·70	H_2O (combined)	... 0·28
Al_2O_3	... 19·85	H_2O (moisture)	... 0·10
Fe_2O_3	... 0·17		
Na_2O	... 5·20		99·34
K_2O	... 8·04		

* Mim. Mag., vol. XIII., No. 61, 1903.

† It is noteworthy that the analyses of Ceylon orthoclase quoted in Hintze' mineralogy show no soda. The said analyses are, however, quite old.

X.—Kaolin.

A specimen from Alutwela, Teldeniya, Central Province, collected by Mr. James Parsons, was examined at the Imperial Institute with the following results. The material "was of a yellowish pink colour; it contained small quantities of graphite and of ferruginous decomposition products. When mixed with water it furnished a paste which was only slightly plastic. It would only be suitable for the manufacture of common bricks."

Analysis.

SiO_2	...	43·56	H_2O (combined)	...	11·90
Al_2O_3	...	34·77	H_2O (moisture)	...	5·63
Fe_2O_3	...	3·40			
Na_2O	...	0·36			99·90
K_2O	...	0·28			

XI.—Sphene.

This mineral is almost always present in rocks of the Galle group at Galle, and is then sometimes idiomorphic. It is common also in rounded grains in many limestone granulite contact rocks.

Some crystals were observed in a vein of pegmatite exposed in a small graphite pit near Talatu-oya (near Kandy, Central Province), the pegmatite and associated green and white rocks resembling those of Galle, but not containing wollastonite. The pegmatite consisted chiefly of quartz, orthoclase, and pyroxene very coarsely crystallized, with a considerable quantity of graphite in flakes and scales occuping cracks and spaces in the other minerals, and evidently deposited subsequent to their formation. One of the individuals of sphene was measured by Mr. G. F. Herbert Smith and found to present the forms c (001), m (110), and n (111).

XII.—Mispickel.

Mispickel (arsenical pyrite) occurred in a quartz-felspar-tourmaline rock sent in by Mr. W. A. Theobald from Little Valley, Deltota. The material is silvery white, of irregular form, and gives good reactions for arsenic. The greater part of the rock in which it occurs consists of an intergrowth of quartz with black tourmaline—a type not infrequently met with; the presence of felspar (decomposed) is less usual. The arsenical pyrite has not been previously recorded for Ceylon.