# *Serendibite, a new borosilicate from Ceylon.*

By G. T. Prior, M.A., F.G.S., and A. K. Coomáraswámy, B.Sc., F.G.S., F.L.S.

[Read February 4, 1902.]

*Mode of Occurrence.*—This new mineral was discovered at Gangapitiya, near Ambakotte and about 12 miles east of Kandy, Ceylon. In this locality quarries have been dug for the well-known Ceylon moonstone, which occurs in large porphyritic crystals in an acid granulite.

Bands of this granulite, which is composed mainly of quartz and felspar in finely granulitic and occasionally graphic structure, alternate with bands of limestone up to 18 inches wide. Between limestone and granulite occur contact-zones consisting, next to the limestone, almost entirely of a colourless diopside, but near the granulite of a mixture of diopside with other minerals, viz. blue spinel, a little apatite, occasionally scapolite or plagioclase, and the blue mineral which is the subject of the present note. Hand-specimens may be collected showing this relation. The serendibite occurs in sufficiently large amount to give a deep blue colour to the contact-zones [1].

*Physical Characters.*—The association of the serendibite with the diopside and spinel is of such an intimate nature that no definite crystals could be isolated from the material at our disposal.

Examination of fragments of the mineral and of thin slices of the rock in which it occurs, shows that it is biaxial and probably anorthic. Besides the marked pleochroism, from very pale yellow (nearly colourless) to deep indigo-blue, the most notable feature to be observed in thin slices is the remarkable polysynthetic twinning, which is quite as intimate as that of a plagioclastic felspar.

The mineral occurs for the most part in irregular grains. In parts of the rock, however, radiating detached grains of the serendibite are seen

[1] Further details as to the mode of occurrence of the mineral will be found in Quart. Journ. Geol. Soc., 1902, vol. lviii, p. 421.

to belong to one individual crystal and to form a sort of ophitic structure with the diopside; while occasionally more definite crystals have been formed which show in thin slices traces of a prism or pinacoid, along which they are elongated and parallel to which occurs the twinning. Such crystals often show traces of two terminal faces. In the section of the crystal shown in the accompanying figure these terminal faces are inclined to each other at an angle of about 104°, and to the adjacent side planes at angles of about 138° and 122° respectively. In this crystal the extinction is nearly symmetrical and about 15° for the two sets of twin-lamellae, each of which shows the emergence of an optic axis nearly central: the pleochroism was from very pale yellow (nearly colourless) for vibrations parallel to the line of extinction to sky-blue at right-angles: compensation with the quartz-wedge took place at right-angles to the line of extinction.

Thin section of a crystal of serendibite between crossed nicols, one set of twin-lamellae being in the position of extinction. (Magnification about 12 diameters.)

As at present imperfectly determined (owing to the lack of crystals), the physical characters of serendibite are as follows:—

Biaxial, probably anorthic; polysynthetic twins with twin-plane probably a pinacoid; cleavage, none; fracture, subconchoidal; hardness, nearly that of quartz, $6\frac{3}{4}$; density, 3·42 (determined on 0·2710 gram); lustre, vitreous; colour, blue, varying in different varieties from pale sky-blue to deep indigo-blue; transparent; pleochroism, in one variety very pale yellow (almost colourless) to pale sky-blue, in another variety pale brownish-yellow to deep indigo-blue; refraction, near that of diopside, and between monobromonaphthalene and methylene iodide, about 1·7; double refraction, weak.

*Chemical Composition.*—The mineral is infusible: it is only slightly attacked by acids, even hydrofluoric: heated in the closed tube, it gives a little water with doubtful traces of etching from fluorine: fused with calcium fluoride and acid sulphate of potash it imparts to the flame the green colour characteristic of boron. The presence of boron was confirmed by fusing the powdered mineral with sodium carbonate, extracting the melt with water, acidifying with acetic acid and distilling with methyl alcohol; the distillate was treated with lime to fix the boracic acid and evaporated to dryness; the residue, treated with sulphuric acid, imparted a green colour to the flame of methyl alcohol, and, dissolved in hydrochloric acid, gave the characteristic red colour to turmeric paper.

Material for analysis was carefully selected as follows. Fragments of the rock were crushed and the powder retained between sieves of 30 and 60 meshes to the inch; pure grains of serendibite were then picked out with a fine brush and examined, grain by grain, under the microscope and tested for pleochroism and double refraction. Of material picked out in this way only 0·3304 gram was available for the main analysis, and 0·2406 for the alkali determination. The amount of material at our disposal did not allow of a satisfactory direct determination of the boracic acid.

The result of the analysis (G.T.P.) is as follows:—

| | | Molecular ratios. | |
|---|---|---|---|
| $SiO_2$ | 25·33 | 0·42 | |
| $Al_2O_3$ | 34·96 | 0·35 | |
| FeO | 4·17 | 0·06 | 0·69 |
| CaO | 14·56 | 0·26 | |
| MgO | 14·91 | 0·37 | |
| $Na_2O$, $Li_2O$ | 0·51[1] | | |
| $K_2O$ | 0·22 | | |
| Loss on ignition | 0·69 | | |
| $P_2O_5$ | 0·48 | | |
| F? | not determined | | |
| $B_2O_3$ (by diff.) | (4·17) | 0·07 | |
| | 100·00 | | |

[1] Calculated as if wholly $Na_2O$: the presence of lithium, however, was clearly indicated by the spectroscope.

A provisional formula is

$$10(Fe,Ca,Mg)O.5Al_2O_3.6SiO_2.B_2O_3.$$

This may be written

$$6(Fe,Ca,Mg)SiO_3.4MgAl_2O_4.2AlBO_3$$

suggestive of a combination of aluminium borate with molecules having the composition of diopside and spinel, the two minerals with which serendibite is so intimately associated. The mineral has some relationship with tourmaline in being a borosilicate of alumina, magnesia, and alkalies (including lithia). It has been formed as a contact mineral instead of tourmaline[1], probably owing to the basic conditions induced by the presence of the limestone. In many of its physical characters, colour, hardness, and density, the mineral is very similar to sapphirine.

It is hoped that more material (and especially crystals) may soon be available in order that the description of the mineral may be made more complete.

The name 'serendibite,' given to the mineral, is derived from 'Serendib,' an old Arab name for Ceylon.

[1] Tourmaline was also found very sparingly in the contact-zones, but the few crystals observed occurred only in soft material apparently filling cracks in the harder rock.