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Boracite from a boring at Aislaby, Yorkshire.[1]

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CUTTINGS from their Eskdale no. 2 boring, Aislaby, near Whitby, at a depth of 4095–4100 feet from the surface were presented to the Geological Museum by the D'Arcy Exploration Co. Limited, in response to a request for a specimen from the Permian Saliferous Series which might contain polyhalite, a mineral already recorded by Professor C. E. Tilley from this boring (Min. Mag., 1943, vol. 26, p. lvii). The cuttings were examined by Dr. J. Phemister who found no polyhalite in them, but a small quantity of a mineral which he thought was probably boracite. In response to a request for additional material the company very kindly supplied further cuttings from depths in the bore between 4090 and 4160 feet. The bore journal records at this depth interbedded salt and anhydrite; the cuttings consist only of anhydrite with some dolomite and quartz and scarce boracite, the salt having been removed in solution. Thirteen samples having an approximate total weight of 146 grams yielded by hand-picking 0·3715 gram of boracite, i.e. 0·25%.

The boracite occurs as colourless to greyish-white translucent crystals suggesting isometric form and having a corroded appearance with dull vitreous lustre. Colonies of these crystals sometimes appear, the size of the groups ranging up to about $\frac{3}{8}$ inch in length. Their hardness is about equal to that of quartz, and the crystals scratch the blade of a pocket-knife with ease.

The specific gravity was taken by means of a specific gravity bottle from which air was excluded by a vacuum pump before filling up with distilled water. The value obtained was 2·95.

Mr. C. O. Harvey made a micro-chemical analysis (Lab. no. 1316) on 0·14 gram of the material, and his report is as follows:

SiO_2.	$Fe_2O_3+Al_2O_3$.	MnO.	CaO.	MgO.	B_2O_3.	Cl.	Less O for Cl.	Total
0·5	2·3*	trace*	0·2*	31·0	60	8·6	2·0	100·6

* Figures obtained spectrographically in collaboration with J. A. C. McClelland.

[1] Communicated by permission of the Director, Geological Survey and Museum.

'Atomic ratio Mg : B : Cl = 7·1 : 16 : 2·2. These figures indicate that the sample is boracite, but the analysis shows an excess of Mg and Cl. It seems unlikely that the departure from the ideal ratio 7 : 16 : 2 is due to experimental error, but confirmatory work should be done if the discrepancy is of sufficient interest to rouse controversy.' Details of the method of analysis have been given by C. O. Harvey (1943).

Separate crystals were crushed and examined microscopically in oils. Twinning was observed, in some cases simple, but often repeated and complex, yielding between crossed nicols a lattice pattern resembling that of microcline. The mineral is biaxial, with a large optic axial angle and positive sign. Refractive index values were found to be α 1·658, β 1·662, γ 1·668, $\gamma-\alpha$ 0·010 (sodium-light).

Some of the crushed material was mounted in Canada balsam (slide no. E19994) and a series of readings on selected fragments made on the universal stage. Eight measurements of the optic axial angles enclosing the acute bisectrix gave an average value 2V 82½°, the values ranging from 80° to 85°. Four measurements of the angle enclosing the obtuse bisectrix gave the average value 2V 82°, but the range of variation was considerably greater, namely 79° to 88°. Corrections were made for refractive index (1·649) of the glass sphere used.

Recent work on boracite has had reference mainly to crystal structure and chemical composition, and for the optical properties we are still dependent on the values obtained by Mallard, Marbach, and Boeke (Rosenbusch, 1927). It is apparent that the refractive indices show considerable variation as seen from the following table, and it is unfortunate that optical determinations have not accompanied the recent work on internal structure.

	α.	β.	γ.	$\gamma-\alpha$.	2V.
Boracite (Locality ?)[1]	1·6622	1·6670	1·6730	0·0108	83° 34′
„ (Aislaby)	1·658	1·662	1·668	0·010	82½°

The chemical analyses of boracite also vary, but the data are not sufficient to correlate optical with compositional differences. The chemical formula for the mineral was discussed by Gruner (1928) who, from an analysis by G. Ward of boracite from Eime near Hanover and as the result of X-ray examination, proposed the formula $Mg_6Cl_2B_{14}O_{26}$ in place of the formula $Mg_7Cl_2B_{16}O_{30}$ originally given by Heintz (1859). Gruner pointed out that chlorine was in excess of that required by Heintz's formula, and showed that the latter conflicted with the X-ray measurements. Gruner's formula was supported by more recent work by Mehmel (1934), who further suggested that the differences in composition shown by the fourteen chemical analyses available might be explicable by solid solution of the components $Mg_6Cl_2B_{14}O_{26}$ and $Mg_7Cl_2B_{16}O_{30}$. It will be observed from the following table that the boracite from the Eskdale bore contains $MgCl_2$ in almost the mean of the proportions demanded by these two formulae.

[1] E. Mallard (1883, p. 134), calculated from his measurement $\beta-\alpha$ 0·00597, incorporating Des Cloizeaux's values n 1·667 (taken as β) and V 41° 47′. (On p. 129 he gives Des Cloizeaux's V as 41° 26′.) A. Des Cloizeaux in his 'Nouvelles recherches sur les propriétés des cristaux' (1867, pp. 517, 719) and 'Manuel de minéralogie' (1874, vol. 2, p. 4) gave for 'monorefringent' boracite at 15° C. n 1·663 (red), 1·667 (yellow), 1·675 (blue), but no value for 2V.

	$MgCl_2$.	MgO.	B_2O_3.	Total.
$Mg_7Cl_2B_{16}O_{30}$	10·65	27·05	62·30	100
Boracite (Aislaby)	11·8	26·7	61·5	100
$Mg_6Cl_2B_{14}O_{26}$	12·14	25·71	62·15	100
Boracite (Eime)	12·35	26·39	61·26	100

There does not appear to be any previous record of the occurrence of boracite in the British Isles.

References.

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