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## Basaluminite from Cambrian rocks near Harlech

HIGHLY shattered black shales believed to be of the Clogau Group of the Middle Cambrian (Matley and Wilson, 1946) are exposed in a small roadside pit on the slopes of Moel Goedog near Harlech, Merioneth, North Wales (O.S. 1 in./1 ml Sheet 116, grid reference SH 610329). The site lies immediately east of the Moel Goedog West fault mapped by Matley and Wilson on the western fringe of the Harlech Dome. From material sampled in 1964 at this quarry, a piece of strongly iron-stained and iron-oxide encrusted mudstone was found when split to contain a single vesicle (*c.* 2 × 1 cm diameter) filled with a white earthy mineral.

X-ray powder photographs (Phillips 11·48-cm camera) showed the mineral to give a pattern identical with that of basaluminite,  $\text{Al}_4\text{SO}_4(\text{OH})_{10}\cdot 5\text{H}_2\text{O}$  (Hollingworth and Bannister, 1950), except for the presence of an additional very weak line at 4·2 Å and barely visible lines at 7·8, 7·4, 4·5, and 2·10 Å; the very weak line observed by Bannister at 7·18 Å was not found.

It is not known whether the additional lines on the Harlech mineral are lines of basaluminite unrecorded in the original data or are due to an unidentified mineral other than basaluminite, present as a minor constituent in the cavity. Some of the additional weak lines might have been attributed to aluminite ( $\text{Al}_2\text{SO}_4(\text{OH})_4\cdot 7\text{H}_2\text{O}$ ) but other strong aluminite lines are absent. Differential thermal analysis (Netzsch equipment, 10 °C per minute heating rate) of the Harlech material gave a curve with endotherms at 205° (3), 305° (4), 415° (1) and 880 °C (2) (figures in parentheses indicate relative peak height). Recently (Pei-Lin Tien, 1968), what appears to be the first published d.t.a. of basaluminite indicated endotherms at 125° (3=), 170° (3=), 220° (4), 355° (1) and 940° (2). A d.t.a. curve by the same author for hydrobasaluminite shows a very strong endotherm at 155 °C and a weak double endotherm at 890 and 940 °C. Curves published for aluminite (Cocco, 1952, and Gedeon, 1955) are not identical with each other but have similar twin endotherms at *c.* 130-70 °C that are

absent from the curve for the Harlech material. The general similarity of the published basaluminite curve and that for the Harlech mineral supports the X-ray identification, peak-temperature differences presumably resulting from differences in technique and equipment. A mean refractive index for the Harlech mineral was determined as just below 1.525. Hollingworth and Bannister gave a mean R.I. for the type material as 1.519, and Pei-Lin Tien gives 1.520. The value given for aluminite by Winchell (1939) is 1.464. This again supports the basaluminite identification.

Unfortunately the amount of the mineral available is very limited and further attempts to find more basaluminite at the site, either in loose rock or from rock *in situ* have been unsuccessful. It was initially thought significant that the country rock here is very fractured, with a great deal of water moving through the shale at the quarry, in contrast to the remainder of the hillslope, since much of the shale has earthy grey and white coatings on cleavage faces. However, these do not contain detectable basaluminite by X-ray photographs but consist of chloritic and illitic clay or dolomite or both. As a result of disturbance by intermittent working of the pit for local farm use, it is hoped that more basaluminite may be found for detailed study, or that, encouraged by this note, a search in other locations in the Harlech Dome may be fortunate. It is thought that the mineral occurs as a relatively old alteration product within one or more of the Cambrian beds and is not due to recent or contemporary formation on cleavage faces.

The original locations for basaluminite, in fissures in Jurassic ironstone at Irchester, Northants, and in segregations in chalk at Clifton Hill, Brighton (Bannister and Hollingworth, 1948; Hollingworth and Bannister, 1950) are still apparently the only sites recorded in Britain. Although the recent study from the U.S.A. (Pei-Lin Tien, 1968) has given more data for basaluminite and hydrobasaluminite and lists in its bibliography two locations for the mineral in the U.S.A. and one from Russia, an occurrence in Cambrian strata in Wales indicates the possibility that basaluminite may be more widespread in Britain than previously thought. It is suggested by Pei-Lin Tien that basaluminite occurs as a dehydration product 'as debris on dry slopes below the hydrobasaluminite deposits' but the Harlech occurrence in a vesicle from freshly shattered rock suggests that not only simple sub-aerial dehydration is responsible for its formation.

It is of interest concerning the occurrence of this aluminium mineral in a Cambrian rock from the Harlech dome that Mohr (1964) in a geochemical study of the Manganese Shales, a lower Cambrian horizon, notes that ore deposition required the presence of colloidal silica and aluminium hydroxide, the precise form of the aluminium component being uncertain. Mohr also states that the temporarily isolated basin of deposition of the Cambrian strata favoured concentration of sulphur. It is possible that conditions favouring co-existence of Al and S in suitable forms to yield basaluminite may have occurred during a relatively prolonged period in the basin of the present Harlech Dome.

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## Chlorine in tourmalines from SW. England

CHLORINE has been shown to be present in certain hydroxy-silicates such as amphiboles and biotites but we have been able to discover only one previous analysis for chlorine in tourmalines. Kuroda and Sandell (1953) found 60 ppm chlorine in a black tourmaline but Correns (1956) suggests that this may perhaps be due to inclusions.

TABLE I. Chlorine and leachable chlorine in tourmalines from SW. England. Sample numbers after Power, 1968. Col. a: Environment from which sample originated. P: pegmatite, A: aplite, G: granite, T: topazfels, Q: quartz-tourmaline rock, V: tourmaline vein, C: contact zone, H: hydrothermal. Col. b: Leachable chlorine as a percentage of total chlorine content

No.	a	Cl, %	No.	a	Cl, %	No.	a	Cl, %	b	No.	a	Cl, %	b
18/P	P	0.040	77/P	T	0.051	80/P	V	0.033	—	69/P	V	0.102	3
20/P	P	0.031	51/P	Q	0.046	T5	V	0.061	—	100/P	H	0.071	10
57/P	P	0.032	53/P	Q	0.031	56/P	P	0.049	7	T2	H	0.051	10
301	P	0.024	75/P	Q	0.052	14/P	A	0.038	6	T3	H	0.038	13
11/P	A	0.040	9/P	V	0.042	54/P	Q	0.030	0	26/P	H	0.070	48
13/P	A	0.039	12/P	V	0.031	15/P	C	0.073	13	49/P	H	0.059	6
89/P	G	0.045	23/P	V	0.062	17/P	C	0.078	4	96/P	H	0.035	—
55/P	G	0.040	27/P	V	0.040	99/P	C	0.067	22				

To investigate the distribution of chlorine in tourmalines, thirty-one samples of iron-rich tourmaline from the granitic rocks of SW. England have been analysed using the colorimetric procedure outlined by Huang and Johns (1967) modified for use on a Technicon 'Autoanalyser' (Fuge, unpublished).

The results (table I) show that the chlorine content of the tourmalines analysed ranges from 0.024 to 0.102 %, much the same order as that found in biotites. Only