Brammallite (sodium-illite), a new mineral from Llandebie, South Wales.

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During a study of the petrography and mineral constituents separated from various shales overlying the coal-measures of South Wales, Dr. Alfred Brammall noticed on several hand-specimens from Llandebie a white infilling to fissures or a coating on slickensided surfaces which could be readily detached from the matrix. Chemical examination showed that this coating, unlike the shales themselves, contained more sodium than potassium. The present note gives an account of subsequent chemical, X-ray, and optical work, which confirms Dr. Brammall's suggestion that the white incrustation contains a new sodium-rich mineral allied to mica. It is not, I hope, an unfitting tribute to his work in this field as well as to his interest in recent advances in mineralogy that I have named this mineral brammallite. A short account of its nature and relationship to illite, which is the chief constituent of the shale itself (see preceding paper, p. 297), will now be given.

Examination under the binocular microscope revealed that most of the incrustation consists of a soft fibrous mineral; and, when this is detached with a knife, small compact tufts of elongated plates about $\frac{1}{2}$ mm. long, reminiscent of small fragments of satin-spar, can be distinguished and isolated for optical and X-ray work. Not sufficient material, however, was available for a micro-chemical analysis. Dr. M. H. Hey carried out an alkali determination on 15 mg. of carefully picked fragments and obtained Na_2O 5·22, K_2O 2·58%.

Although the individual flakes making up the tufts are rarely over 1/100 mm. across, several tufts pressed under a cover-glass yielded negative biaxial optic pictures with large values of 2V. The tufts before compression and consequent distortion give approximately straight extinction. The elongation of the plates is positive and maximum and minimum values of the refractive index measured in sodium-light are 1·579 and $1{\cdot}561 \pm 0{\cdot}002$ respectively. The plates are elongated in a direction parallel to the obtuse bisectrix which for muscovite would correspond to the direction of the a-axis.[1]

An X-ray photograph of a tuft rotated vertically about its axis of elongation always shows well-oriented equatorial streaks and arcs corresponding to the first layer-line at about 5·2 Å. (fig. 1). A strong reflection at 10 Å. and the general character of the photograph relates it closely to that of illite. The basal spacing

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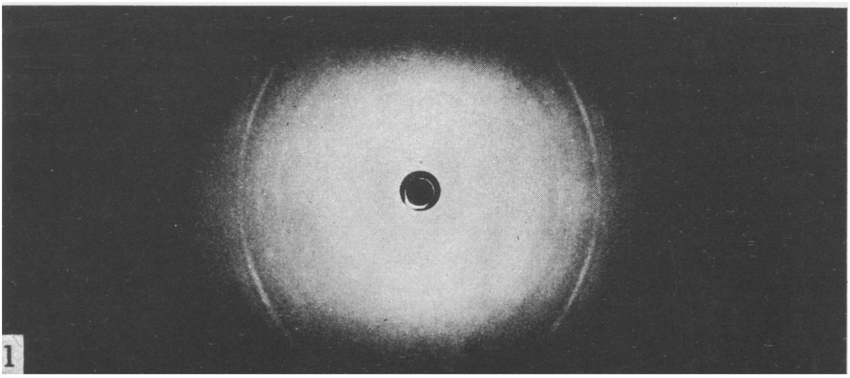
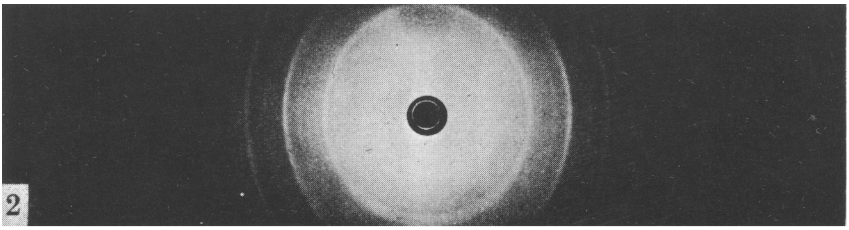
[1] N. Aruja informs me that gümbelite is a fibrous variety of muscovite with elongation also parallel to the a-axis.

is, however, distinctly lower, 19·2 instead of 19·9 Å. Planes of the type (*hk*0) yield streaks which coincide with those of illite, so that the *a* and *b* spacings of both minerals are the same. Powder photographs show better the resemblance of the two minerals, and at the same time reveal the difference in their basal spacings (figs. 2 and 3).





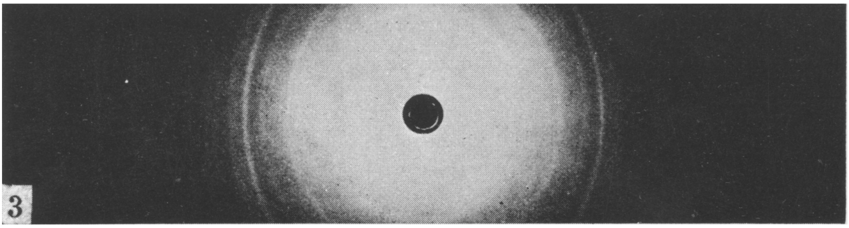


FIG. 1. Rotation photograph of a tuft of brammallite about the *a*-axis.
FIG. 2. Powder photograph of brammallite.
FIG. 3. Powder photograph of illite.

All taken with unfiltered iron radiation in a cylindrical camera, diameter 6·04 cm. Actual size.

Several elongated fragments of the new mineral were photographed in X-rays and some showed the presence of quartz and kaolinite, so that the association is the same on these specimens as for illite within the shale. Hence, beyond recognizing the mineral as a sodium-rich member of the illite group from its X-ray pattern and the alkali determination, the analysis of the crust as a whole does not lead us to a more exact knowledge of the chemical composition of the mineral.

Nevertheless it can be isolated as small fragments free from quartz and kaolinite and can be distinguished with certainty from normal illite by its lower birefringence, as well as by its X-ray pattern.

So constant in spacings and relative intensities are the photographs of normal illite from shales and muds, whether they come from Illinois, Germany, or South Wales, or the bottom of the Indian Ocean, that the discovery of a better crystallized mineral closely allied to illite, but readily distinguished chemically and physically, is of considerable interest.

Some workers have suggested that illite is only very fine-grained muscovite and that the absence of certain reflections is due to the exceeding thinness of the constituent flakes. This seemed improbable, for the pipetting technique applied to powdered muscovite yielded a sample which shows all the muscovite lines slightly broadened by the small size of the flakes. No lines can be said, however, to have disappeared. Hence illite is neither muscovite nor hydromuscovite.

In brammallite we have a mineral which is sufficiently well crystallized to yield optic pictures on single birefringent flakes although they are too small for single crystal X-ray photographs. Hence, the few powder lines observed are not related to grain-size, but are probably due to the irregular stacking of the layers of the structure along the *c*-axis. Both illite and brammallite are for this reason mica-like clay minerals and as Nagelschmidt and Hicks mention in the preceding paper (p. 302), are comparable to montmorillonite and halloysite. It has already been suggested that structural intergrowths of illite and montmorillonite may occur in sediments. Similar intergrowths have been also observed between vermiculite and biotite and between vermiculite and chlorite.

Table I gives the optical data and cell dimensions for brammallite, illite, hydromuscovite, muscovite, and paragonite. As the ratio of Na/K atoms decreases the *c*-spacing increases. Whereas in the three true mica minerals the refractive index increases with increase in Na/K ratio, the reverse is so for brammallite and illite from South Wales. Hence both the optical properties as well as the X-ray photographs distinguish between a true mica and the two known members of the illite family so far isolated. It has been shown, however, that the refractive indices of illite decrease with increase in water content, the lowest values recorded[1] being, α 1·544, γ 1·574, close to those of brammallite. Hence it is the sodium content and X-ray data that distinguish brammallite from illite with certainty. I have found no measurable differences in the X-ray patterns of either mineral on heating to 700° C., so that unlike montmorillonite the basal spacing does not diminish appreciably with loss of water.

Table II gives the X-ray powder data of brammallite. Probable indices have been assigned (in brackets) to those lines which appear on the equator and first layer-line of a fibre photograph of brammallite, taken with filtered iron radiation, whence the probable unit-cell dimensions have also been derived.

The name sericite has been applied in the past to fine-grained micas which, in the absence of optical and X-ray data correlated with their chemical composition, might have been any one of the species listed in table I. The name has had its use in the field and in thin-section work, but where it is possible to determine the species more exactly, the name sericite should no longer be used.

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[1] R. E. Grim and W. F. Bradley, Journ. Amer. Ceramic Soc., 1939, vol. 22, p. 157; Rep. Investig. State Geol. Surv. Illinois, 1939, no. 53. [M.A. 7–423.]

TABLE I. X-ray and optical data of brammallite, &c.

	a. Å.	b. Å.	c sin β. Å.	Na_2O. %	K_2O. %	Na/K atoms.	α.	γ.	γ—α.	2V.
Paragonite[1] ...	5·12	8·87	18·95	6·28	2·17	2·59	—	1·605	—	—
Brammallite ...	5·2	9·0	19·2	5·22	2·58	1·79	1·561	1·579	0·018	large
Illite[2]	5·2	9·0	19·9	1·05	6·22	0·15	1·572	1·600	0·028	small
Muscovite[3] ...	5·18	9·02	19·95	0·95	10·81	0·08	1·5628	1·5988	0·036	43° 3′
Hydromuscovite[4]	5·19	9·03	20·2	0·46	8·06	0·05	—	1·580	—	large

[1] W. T. Schaller and R. E. Stevens, Amer. Min., 1941, vol. 26, p. 541 [M.A. 8–227]. X-ray data by F. A. B. on a specimen from Monte Campione, Switzerland.

[2] X-ray data by F. A. B. on illite from Llandebie shale.

[3] X-ray data by W. W. Jackson and J. West, Zeits. Krist., 1930, vol. 76, p. 211 [M.A. 4–467], on muscovite from Hundholmen, northern Norway. Optical and chemical data by Harry von Eckermann, Geol. För. Förh. Stockholm, 1927, vol. 49, p. 229 [M.A. 3–356], on muscovite from pegmatite, Finnbo, Dalecarlia, Sweden.

[4] A. Brammall, J. G. C. Leech, and F. A. Bannister, Min. Mag., 1937, vol. 24, p. 507.

TABLE II. X-ray powder data for brammallite.

Spacing Å.	Intensity.	Spacing Å.	Intensity.	Spacing Å.	Intensity.
10·2 (002)	s	2·69	vw	1·95	w
4·8	w	2·54 (131)	ms	1·68	w
4·4 (110)	s	2·43	m	1·64	m
3·6	w	2·34	m	1·49 (060)	s
3·2 (006)	s	2·20	w	1·28	mw
2·81	w	2·10		1·26	vw
				1·24	w