

*Epheosite (soda-margarite) from the Postmasburg district,
South Africa.*

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THE material on which the following description is based was presented by Dr. A. L. Hall to the Department of Mineralogy at Cambridge, and I am greatly indebted to him and to Prof. A. Hutchinson for affording me the opportunity of describing it. The first account of the occurrence was given by Dr. Hall,¹ recording from Aarkop, Magoloring, 'a beautiful delicately rose-coloured mica . . . in compact dark bluish-grey ore as thick, short, columnar aggregates not unlike little books of mica with pseudo-hexagonal outlines and showing the characteristic perfect basal cleavage . . . the material was found on the higher slopes defining the west side of Martha's Kloof'. This description was amplified somewhat in a later publication,² with the addition of an analysis (see below). As noted therein the mineral also resembles that described by Chudoba³ as a manganophyllite allied to the phlogopite group, but the fuller description given below reveals important differences.

The specimens which I have investigated consist of aggregates of pale pink to pinkish-brown crystals in mica-like platy or sometimes prismatic habit, apparently hexagonal, up to 13 mm. in diameter and 10 mm. in length, with a very irregular and corrugated prism-zone. The very good basal cleavage yields rather brittle cleavage-flakes. In very thick vertical sections the colour is pinkish-brown,

¹ A. L. Hall, The manganese deposits near Postmasburg, west of Kimberley. *Trans. Geol. Soc. South Africa*, 1927, vol. 29 (for 1926), p. 36. [Min. Abstr., vol. 3, p. 397.]

² L. T. Nel, The geology of the Postmasburg manganese deposits and the surrounding country. Geological Survey of South Africa, Pretoria, 1929, p. 81. [Min. Abstr., vol. 4, p. 232.]

³ K. Chudoba, Über 'Mangandiaspor' und Manganophyll von Postmasburg (Griqualand-West, Südafrika). *Centr. Min., Abt. A.*, 1929, p. 17. [Min. Abstr., vol. 4, p. 148.]

with, apparently, no pleochroism; in thin sections and cleavage-flakes it is colourless. Specific gravity = 3.00; hardness = 5—7, variable on different faces.

Chemical composition.—An analysis by H. G. Weall, F.I.C., of the Government Laboratories, Johannesburg, gave the figures in column I below. Those in column II were obtained in an independent partial analysis carried out by me to confirm the essential identity of the mineral.

	I.	II.
SiO ₂	29.4	28.9
TiO ₂	0.1	
Al ₂ O ₃	50.6	} 51.6
Fe ₂ O ₃	0.55	
FeO	0.35	
CaO	1.4	
MgO	0.4	—
MnO	0.1	—
Na ₂ O	8.65	9.2
Li ₂ O	1.5	0.9
K ₂ O	trace	0.3
H ₂ O—	1.25	—
H ₂ O+ (ignition)...	5.3	—
F	0.2	—
	99.80	

Optical properties.—Cleavage fragments invariably show, at least in the marginal portions, a multiple lamellar twinning, the composition-plane being some face in the zone between the prism and basal plane, and inclined to the basal plane at moderate angles, giving undulose extinction in the different lamellae. Measurements on the universal stage establish the presence of more than one twin-law; in the most frequent the composition-plane makes an angle of approximately 66° with the basal plane. Twins on both (*hhl*) and (*hhl̄*) are present in the same individual.

Untwinned portions show an acute bisectrix interference-figure, with Bx_α nearly perpendicular to the cleavage-plane, and a small axial angle. The plane of the optic axes is perpendicular to (010) of the hexagonal cleavage-flake; optic sign negative. Nothing was seen, despite careful search, of the optic anomalies described by Chudoba in his material. 2E for sodium-light varied in six measurements from 42° 32' to 43° 8', with dispersion 2V red less than 2V blue.

The intimate lamellar twinning makes accurate determination of the refractive indices somewhat difficult, but good results were finally obtained by the Kohlrausch total reflection method on a Hutchinson universal instrument, using an artificially-polished plate (natural cleavage-flakes were always too distorted to give sharp shadows). The figures thus obtained are :

$$\alpha = 1.595, \beta = 1.625, \gamma = 1.627 \pm 0.002,$$

whence $\gamma - \alpha = 0.032$, $2V$ calc. = $28^\circ 32'$ ($2E$ calc. = $38^\circ 54'$).

Structure.—I am indebted to Mr. J. D. Bernal for an X-ray examination, carried sufficiently far to determine a monoclinic pseudo-hexagonal structure, with approximate dimensions :

$$d_{(001)} = 9.70, a = 5.16, b = 8.79 \text{ \AA.},$$

which resemble closely those of the micas, and suggest the presence of a silicon-oxygen sheet.¹

Formula.—The analysis shows that the mineral is much more aluminous than any mica, as noticed by Dr. J. McCrae (L. T. Nel, loc. cit., p. 81). The mineral described by Chudoba as allied to the phlogopite group showed different optical properties, and, moreover, when fused with alkaline carbonates showed a significant manganese content.

If the above analysis is recalculated in terms of the atoms present, on a basis of $O + F = 12$, the following figures are obtained :

Si	1.94	}	9.91
Al + Fe''' + Li	...	...	...	...	4.37
Fe'' + Mg + Mn	...	...	...	...	0.06
Na + Ca	...	...	...	...	1.20
H ...	...	...	...	...	2.34
O + F	...	...	...	...	12.00

and the affinities of the mineral are with the margarite group. For margarite itself, L. Pauling² has suggested a formula which may be written $(OH)_2Ca_2Al_2(Al_2Si_2O_{10})$. The above figures agree with a proportion of oxygen to other atoms of 12 to 10, but Ca is largely substituted by Na, a substitution to be expected on structural grounds from the relative sizes of the ions. The mineral may be described as a soda-margarite; in general physical properties and optical orientation it closely resembles margarite, but differs from it in optic axial angle and in double refraction.

¹ W. L. Bragg, The structure of silicates. Zeits. Krist., 1930, vol. 74, p. 271.

² L. Pauling, Proc. Nat. Acad. Sci. U.S.A., 1930, vol. 16, p. 128. [Min. Abstr., vol. 4, p. 368.] Cf. W. L. Bragg, loc. cit., p. 272.

Discussion.—Material of closely similar composition was described by J. Lawrence Smith in 1851, under the name ephesite. The mineral was found associated with emery at Gumuch Dag, near Ephesus, Asia Minor.¹ The name lesleyite was given by I. Lea in 1867 to material from Unionville, Pennsylvania, which Smith subsequently showed to be identical with his ephesite in composition, except for higher potash. The identity of these substances as species was later questioned by Brush,² who regarded them as mixtures containing corundum. Genth,³ also, relying on incomplete decomposition on fusing with lime and ammonium chloride, estimated the free corundum at amounts as high as 20 %, but his bulk analysis of the whole agrees almost exactly with that of Smith. In the same paper he remarks that some analyses of margarite contain a considerable quantity of alkalis, especially soda, replacing the lime. As pointed out above, replacements of Ca by Na, and, perhaps, also by K, are to be expected from a structural point of view. It seems reasonable, therefore, to use the names ephesite and lesleyite as synonyms of soda-margarite and potash-margarite respectively. The most sodic margarite previously recorded in the literature appears to be the 'clingmanite' of B. Silliman,⁴ containing 6.15 % Na₂O, with 9.87 % CaO.

¹ J. L. Smith, Amer. Journ. Sci., 1851, ser. 2, vol. 11, p. 59.

² G. J. Brush, Appendix I to fifth edition of Dana's Mineralogy, 1888, p. 18.

³ F. A. Genth, Proc. Amer. Phil. Soc., 1873, vol. 13, pp. 387-390.

⁴ B. Silliman, Amer. Journ. Sci., 1849, ser. 2, vol. 8, p. 383. Corrected analysis in 3rd edition of Dana's System of Mineralogy, 1850, p. 362.
