On a compact chlorite from Bernstein, Austria.

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With a chemical analysis by G. T. Prior, M.A., D.Sc., F.R.S.

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THE material which is the subject of the present note was presented to the British Museum (Natural History) in November 1923, by Captain Eric C. Palmer, of the Styrian Jade Company, Bernstein, Burgenland, Austria. Bernstein is situated 92 kilometres south of Vienna, on the present borders of Styria and Upper Austria, and 22 kilometres west of the frontier town of Guns. Previous to the Treaty of Versailles, Bernstein was in Hungary, Comitat Vas (Eisenburg). Its Hungarian name is Borostyánkő.

In 1854, Johann Cžjžek,[1] in a paper entitled 'Das Rosaliengebirge und der Wechsel in Niederösterreich', had described the geology of the district, and given some account of the rocks, including a description of the occurrence at Bernstein of serpentine in the midst of an area of hornblende-schists, chlorite-schists, and gneiss. In describing the serpentine he remarks, 'Weiter von Bernstein treten zwischen den dunkel- und heller grünen Serpentin auch chloritische Serpentine auf mit paralleler schiefriger Structur und mit Uebergängen in dichten Chlorit von dunkelgrüner, in dünnen Splittern von licht smaragdgrüner Farbe mit welligen Spaltungsflächen'.

Several descriptions of the serpentine of Bernstein have been published, but no further mention of chlorite appears until 1886, when Dr. Vincenz Wartha[2] published an analysis made by Jakob Szilassi of the so-called 'precious serpentine' of Borostyánkő (Comitat Vas). He compared it with a 'precious serpentine' of similar appearance found at Gurtipohl,

[1] J. Cžjžek, Jahrb. k.k. Geol. Reichsanst. Wien, 1854, vol. 5, p. 504.

[2] V. Wartha, Über die Mineralien der Serpentin-Chlorit-Gruppe. Földtani Közlöny, 1886, vol. 16, pp 7–11 (Hung.), and pp. 79–83 (Germ.).

near St. Gallenkirch, Montafon valley, Vorarlberg, which is now worked as an ornamental stone under the name of 'Miskeyite'.[1] Wartha showed that both these 'precious serpentines' are members of the chlorite group, and placed them, according to their alumina-content, between ripidolite and prochlorite. He gave no description of the material from Bernstein beyond the density, 2·693. The results of Szilassi's analysis are given in the subjoined table.

The so-called 'precious serpentine' of Bernstein is now being worked by the Styrian Jade Company, and is being used for making vases, bowls, and other small ornaments. The material supplied by Captain Palmer is of two varieties. One is dark ivy-green, generally opaque, but translucent on thin edges, and showing a tendency to develop schistose structure with undulose parting-planes; the other variety is pale apple-green, translucent, and more compact. The hardness of the dark variety is $2\frac{1}{2}$. The specific gravity (D^{14}_4), determined on a small polished ornament weighing 44 grams, is 2·695.

Thin fragments of the dark-green chlorite, when examined under the microscope, are found to consist of a mass of very minute flakes or fibres with negative elongation, low double refraction, and a mean refractive index very slightly greater than 1·575. The optical properties could not be determined in greater detail, but the 'fibres' giving negative elongation probably are cross-sections of thin flakes of an optically positive mineral with the acute bisectrix normal to the flakes.

The dark-green stone, on examination under the microscope, was seen to be very free from inclusions, and Dr. G. T. Prior kindly undertook to make a quantitative analysis of a carefully selected sample. His results are given in column I, and in column II are shown the figures obtained by Szilassi and published by Dr. Wartha in the paper referred to above.

	I.	Molecular ratios.			II. (J. Szilassi, 1886).
SiO_2	32·29	... 0·5352	0·5352	31	... 30·45
Al_2O_3	17·39	... 0·1702	0·1736	10	... 18·96
Fe_2O_3	0·55	... 0·0034			... 2·21
FeO	3·66	... 0·0509	0·8917	51	... 3·70
MnO	0·16	... 0·0022			... —
MgO	33·81	... 0·8386			... 32·20
CaO	trace				... —
$H_2O+250°$ ...	12·02	... 0·6711	0·6711	39	... 12·79
$H_2O-250°$ ..	0·29				... —
	100·17				100·31

[1] F. Berwerth, Tschermaks Min. Petr. Mitt., 1912, vol. 31, p. 112.

The mineral analysed by Dr. Prior can be represented by the formula

$$39H_2O . 51RO . 10R_2O_3 . 31SiO_2,$$

or approximately $4H_2O . 5RO . R_2O_3 . 3SiO_2$, which is the formula given by Dana for both pennine and clinochlore. In Tschermak's classification, the analysis would fall at the transition-point of his pennine and clinochlore groups, as it can be represented as consisting of equal numbers of his serpentine and amesite molecules. Compared with the most recent analyses of chlorites published by V. Iskyul,[1] the Bernstein mineral resembles the clinochlore more than it does the pennine, and it is probable that it is to the clinochlore group that it must be referred.

Various authors describing compact chlorites have adopted Kenngott's name of 'pseudophite' (false serpentine). Hintze gives references to seven localities, including Bernstein (Borostyánkő). A study of the analyses of these so-called pseudophites shows that none of them gives such good molecular ratios as those obtained from Dr. Prior's analysis, and further, that such approximate formulae as can be obtained indicate that three of them would fall in Tschermak's clinochlore group, and four would be classed as pennine. Kenngott's original pseudophite, from Berg Zdjar in Moravia, was classified by him as compact pennine, but the name has not been restricted to that species of chlorite in particular, nor does there seem any good reason for so limiting its application. It seems convenient to use the name for compact chlorites of whatever species.

With the pale translucent variety of the chlorite are found hard, whitish patches, which are a source of considerable trouble in the works, as they spoil the saws used in cutting the stone. These consist of about fifty per cent. pale buff lime-garnet intergrown with a white or very pale green chlorite. The nature of the garnet was confirmed by qualitative analysis made on material separated as far as possible from the chlorite in methylene iodide, and analysis of a sample of one of the white patches confirmed the presence of abundant magnesia, water, and only a trace of iron and manganese.

The garnet of these patches is as rounded grains averaging about 0·07 mm. in diameter, is quite colourless in thin section, and is optically isotropic. The chlorite is compact, but some small fissures have allowed the development of a few minute silvery flakes 0·5 mm. across. These are optically positive, uniaxial, or biaxial with a small optic axial angle, and refractive indices α' 1·575 to 1·580, γ near and slightly greater than 1·580. This value for the refractive index is a little higher than that

[1] V. Iskyul, 1917. See Min. Abstr., 1924, vol. 2, p. 215.

obtained on the compact, dark-green chlorite. It is probable that the colourless chlorite of the white patches differs somewhat in composition from the green chlorite which has been analysed, but it would be difficult to confirm this idea in view of its intermixture with the garnet.

Information of the field relations and mode of occurrence of the compact chlorite are not yet available.