water persistently retained owing to the finely divided state of the mineral.

Dept. of Mineralogy,
British Museum. A. A. Moss

[1] Berg. hütten. Ztg., vol. 17, p. 53.

The nature of chlorospinel.

Chlorospinel was described in 1840 by G. Rose,[1] as a new grass-green variety of spinel from the Slatoust district, south Urals, characterized by the presence of considerable Fe_2O_3 and absence of FeO; two density determinations gave 3·591 and 3·594, in fair agreement with the densities calculated for the two analyses by H. Rose (table I, anals. 2 and 3) on the assumption (which is likely to be only approximately true) of a linear variation in density from $MgAl_2O_4$ 3·55 to $MgFe_2O_4$ 4·51: anal. 2, 3·63; anal. 3, 3·68. It has not been reported elsewhere and though it was synthesized by J. Morozewicz[2] no density or optical data were obtained on the synthetic material.

There are hardly any other original references to chlorospinel in the literature. N. Koksharov[3] states that it occurs 'in der Umgegend der Kussinsker Hütte' and both N. Koksharov[4] and P. Eremeyev[5] refer to its occurrence in chlorite-schist at the newly-discovered Praskovie-Evgenevsky mine, Shishimsk Mts., but the identification is not based on an analysis, and must be regarded as uncertain.

Recently N. G. Sumin,[6] confirming and extending work by L. L. Shilin,[7] has shown that two distinct green spinels occur in the Shishimsk area; one, occurring in ore-veins with chlorite and magnetite, has refractive index n 1·724 and was classified by Shilin as a common magnesium spinel; Shilin's analysis of the perovskite–magnetite–spinel ore shows it is not a zinciferous spinel, and its low refractive index suggests that it contains little FeO, so despite its green colour it cannot be classified with the ceylonites found elsewhere in the Slatoust region[3,4,5]. The second green spinel, from the chlorite-schist, has n 1·782, and agrees well in appearance and associations with Rose's chlorospinel; but an analysis by V. A. Moleva (table I, anal. 4), made on material in the Museum of the Academy of Sciences, U.S.S.R., collected in the first half of the nineteenth century, shows it to be a gahnospinel; Sumin therefore concludes that H. Rose's analyses were in error, and that his chlorospinel was in fact a gahnospinel.

TABLE I. New analytical, X-ray, and optical data for chlorospinel; together with other analyses of chlorospinel and of gahnospinel.

	1.		1.	2.	3.	4.	5.
MgO	26·5 %	Mg	7·8	7·8	8·2	4·5	5·3
FeO	1·8	Fe··	0·3	—	—	0·8	0·3
ZnO	0·8	Zn	0·1	0·04*	0·1*	2·7	2·8
MnO	0·3	Mn	0·05	0·06†	—	0·1	—
Al_2O_3	60·7	Al	14·1	14·8	13·5	15·3	15·7
Fe_2O_3	7·2	Fe···	1·1	1·3	2·2	0·6	—
TiO_2	1·2	Ti	0·2	—	—	0·04‡	—
Insol.	1·2	O	31·3	32	32	32	32
Sum	99·7	Sp. gr.	3·63	3·59		—	3·967

$D_{4^\circ}^{24^\circ}$ 3·63 ± 0·01. n 1·729 ± 0·002. a 8·105 ± 0·005 Å.

* Cu. † Ca. ‡ Co.

1. Chlorospinel (B.M. 21993), Shishimsk Mts.; new analysis by D. I. Bothwell, and empirical unit-cell contents.
2-5. Atomic ratios to 32 oxygen.
2, 3. Chlorospinel, Shishimsk Mts.; G. Rose (H. Rose anal.), 1840.
4. Gahnospinel, Shishimsk Mts.; N. G. Sumin (V. A. Moleva anal.), 1955.
5. Gahnospinel, Ceylon; B. W. Anderson and C. J. Payne (M. H. Hey anal.), 1937; n_D 1·7465.

It seemed to us very unlikely that so competent an analyst as H. Rose should have failed to detect some 17 % of ZnO. Moreover, Sumin did not determine the density, which for a gahnospinel of this composition should be[8] between 3·9 and 4·0, against Rose's 3·59; and the refractive index should be around 1·76, against Sumin's 1·782 (apparently not on the material actually analysed).

We have therefore re-examined all the specimens of chlorospinel in the British Museum collections, and find all contain only small amounts of ZnO: B.M. 21993, from Shishimsk, bought of A. Krantz in 1848, has 0·8 % ZnO; B.M. 37185 and 37187, from Shishimsk, both from N. Koksharov's collection, have 1·4 % and 0·5 % respectively; and B.M. 89197, from the Slatoust region, acquired by R. P. Greg in 1850, has 0·8 %. A complete semimicro-analysis of B.M. 21993 was therefore made, together with refractive index and X-ray and density determinations on the material prepared for analysis. The results, included in table I, show that a third distinct green spinel occurs in the Shishimsk area, besides green common spinel and Sumin's green gahnospinel; and this third spinel is G. Rose's chlorospinel, which was correctly analysed and is a valid variety.

Department of Mineralogy,
British Museum.

D. I. BOTHWELL
M. H. HEY

[1] G. Rose, Ann. Phys. Chem. (Poggendorff), 1840, vol. 50, p. 652.

[2] J. Morozewicz, Tschermaks Min. Petr. Mitt., 1898, vol. 18, p. 38.

[3] N. Koksharov, Min. Russlands, 1853, vol. 1, p. 211.

[4] Idem, ibid., 1866, vol. 5, p. 368.

[5] [P. Eremeyev] П. Еремѣевъ, Зап. Имп. Мин. Общ. (Verhandl. Russ. Min. Gesell.), 1869, new ser., vol. 4, p. 201.

[6] [N. G. Sumin] *Н. Г.* Сумин, Труды Мин. Муз. Акад. Наук СССР [Trans. Min. Mus. Acad. Sci. USSR], 1955, vol. 7, p. 161 [M.A. **13**–189]. According to Sumin, the original discovery of chlorospinel by Bardot de Marin in 1833 was at the Praskovie-Evgenevsky mine; but Rose merely gives the locality as Slatoust, while Koksharov and Eremeyev, writing in the 1860's, describe this mine as 'newly discovered'.

[7] L. L. Shilin [Л. Л. Шилин], [Compt. Rend. (Doklady) Acad. Sci. URSS, 1940, vol. 28, p. 346]; abstr. M.A. **8**–174.

[8] B. W. Anderson and C. J. Payne, Min. Mag., 1937, vol. 24, p. 547.

Mordenite, ptilolite, flokite, and arduinite.

Mordenite and ptilolite were first recognized as identical by Bannister[1] from a study of X-ray powder and rotation photographs. This observation was recorded in a footnote to a paper on heulandite by Hey and Bannister,[2] and was confirmed by Waymouth, Thornely, and Taylor,[3] who examined ptilolite from San Piero in Campo, Elba (B.M. 1914,321), mordenite from Aros, Isle of Mull (B.M. 47614), and type flokite (B.M. 1932,1297). They determined single crystal X-ray data for the Mull mordenite, but X-ray powder data were not recorded until 1954, when Harris and Brindley[4] gave results for the Mull mordenite above, together with cell dimensions derived from them. Dr. Hey has drawn attention to the fact that no X-ray data have hitherto been obtained on type specimens of mordenite or ptilolite, or on material from the type localities. This precaution is particularly desirable in view of the confused early history of mordenite.

Flokite[5] has also been recognized as identical with mordenite[1,3,6] and Bannister[7] has suggested that arduinite is impure mordenite. Stringham[8] compared arduinite from the type locality with a red zeolite from Tintic, Utah; he found that they gave identical X-ray powder patterns and optical data, but that both the unit-cell dimensions and the space group are the same as those of mordenite, and a chemical analysis of the Tintic material gave a composition near that of type mordenite.[9] Though Stringham had no authentic mordenite for comparison, he concluded that Billows' analysis[10] is in error, and arduinite is mordenite coloured by a little hematite.

Accordingly I have examined samples of all four species, namely: B.M. 43716, Mordenite, Morden County, Nova Scotia (type material