

The identity of cryptomorphite and ginorite.

By M. H. HEY, M.A., D.Sc., and F. A. BANNISTER, M.A., Sc.D.

Department of Mineralogy, British Museum.

[Read March 27, 1952.]

HENRY HOW, professor of chemistry and natural history in the University of King's College, Windsor, Nova Scotia, described in 1861 the occurrence of a new calcium sodium borate, which he named cryptomorphite from the microscopic size of the crystals.¹ The mineral was found in narrow seams of mirabilite (glauber-salt) at the junction of anhydrite and gypsum in Clinton quarry, Windsor, where he had also discovered ulexite in 1857.² The cryptomorphite occurred as inclusions about the size of a small bean, between the gypsum and crystals of mirabilite.

The powder pattern and spacing data of a specimen labelled cryptomorphite from Windsor, purchased from Professor C. U. Shepard in 1860, were found in 1944 to be quite different from those of ulexite. It was subsequently pointed out to us, both by Dr. W. T. Schaller and Mr. N. R. Goodman who also were interested in this mineral, that this specimen (B.M. 40260) is principally anhydrous sodium sulphate. It is not surprising, therefore, that its powder pattern should be quite different from that of ulexite. Powder photographs, taken in the Mineral department, of further samples from B.M. 40260 and from a larger amount of white powder also labelled cryptomorphite B.M. 52546 and purchased from How himself in 1879, led to the same conclusion. The main constituent of both these was derived from mirabilite, which under the normal conditions of storage in a museum would certainly dehydrate to thenardite.

So far, chemical, optical, and X-ray powder photographs had not revealed the presence of a borate in either specimen. A small sealed tube found with B.M. 52546 in 1934 and registered as B.M. 95939 was

¹ H. How, Natro-boro-calcite and another borate occurring in the gypsum of Nova Scotia. *Amer. Journ. Sci.*, 1861, ser. 2, vol. 32, pp. 9-13; *Edinburgh New Phil. Journ.*, 1861, vol. 14, pp. 112-116. Contributions to the mineralogy of Nova Scotia. *Min. Mag.*, 1877, vol. 1, pp. 257-260.

² H. Haw [i.e. How], On the occurrence of natro-boro-calcite with glauber-salt in the gypsum of Nova Scotia. *Amer. Journ. Sci.*, 1857, ser. 2, vol. 24, pp. 230-235.

the last specimen to be examined and this yielded a powder pattern easily distinguished from those of thenardite and ulexite.

In the meantime, Dr. Schaller had examined a supposed ginorite from Sasso Pisano, Lardarello, Tuscany, and identified it as priceite. We also found only priceite on a specimen labelled ginorite (B.M. 1934,980), which had been sent to the department by Prince Piero Ginori Conti. At this stage, the status of ginorite as a mineral species seemed uncertain, although, on the basis of the chemical analyses of cryptomorphite and ginorite, one of us had suggested the possible identity of the two minerals.¹ Fortunately, Professor S. Bonatti of Pisa was able to send us sufficient of the original ginorite for chemical and X-ray examination and this gives the same powder pattern as cryptomorphite (B.M. 95939) already mentioned. G. D'Achiardi's optical data² for ginorite clearly distinguishes it from priceite and gives 78° as the angle of the cleavage rhomb plates, close to Robb's measurement of 80° for cryptomorphite as recorded by H. How in 1861. The X-ray powder data given in table III also clearly distinguishes ginorite and priceite.

TABLE I. Chemical analyses of ginorite and cryptomorphite.

| | 1. | 2. | 3. | 4. | 5. | 6. |
|-----------------------------------|--------|--------|--------|--------|--------|-------|
| B ₂ O ₃ ... | 63.00 | 64.06 | 58.54 | 63.64 | 53.98 | 65.5 |
| CaO ... | 15.40 | 16.00 | 14.75 | 16.03 | 14.21 | 17.0 |
| MgO ... | — | — | — | — | 0.62 | — |
| Na ₂ O ... | — | — | 0.16 | 0.17 | 7.25 | — |
| SO ₃ ... | — | — | — | — | 3.98 | — |
| H ₂ O ... | 19.40 | 19.27 | 18.54 | 20.16 | 19.96* | 17.5 |
| CO ₂ ... | — | 0.15 | — | — | — | — |
| insol. ... | 2.20 | 1.07 | 8.34 | — | — | — |
| | 100.00 | 100.55 | 100.33 | 100.00 | 100.00 | 100.0 |

1. Ginorite, Sasso Pisano, Tuscany. Analyst, — Gallori (G. D'Achiardi, 1934).
2. " " " " Analyst, P. Rossoni (G. D'Achiardi, 1934).
3. " " " " Analyst, M. H. Hey, 1951. B.M. 1952, 89. An X-ray powder photograph identifies the insoluble residue as a mixture of quartz and muscovite.
4. Analysis 3 recalculated to 100 %, after deducting insolubles.
5. Cryptomorphite, Windsor, Nova Scotia. Analyst, H. How, 1861. * Probably includes some SO₃.
6. Analysis 5 recalculated to 100 %, after deducting 16.60 % thenardite (equivalent to 7.25 % Na₂O).

The chemical data given in table I are not, taken by themselves, conclusive of the identity. The new analysis of ginorite made on the material

¹ M. H. Hey, An index of mineral species & varieties arranged chemically. London, 1950, p. 65.

² G. D'Achiardi, Ginorite, nuovo borato di calcio di Sasso Pisano. Periodico Min. Roma, 1934, vol. 5, pp. 22-32. [M.A. 5-484.]

sent by Prof. Bonatti confirms the mineral to be a hydrated calcium borate; our analysis approaches that of P. Rossoni, after deduction of insoluble material. Table II summarizes the optical data now available for cryptomorphite and ginorite.

TABLE II. Optical data for cryptomorphite and ginorite.

| Locality. | Refractive index. | Mean size. | Shape. | Observer. |
|-------------|---|------------|---|------------|
| Nova Scotia | Not measured | 0.12 mm. | Thin rhomb plates '80° or more' | Robb |
| Nova Scotia | $n_1 \sim 1.526$ $n_2 \sim 1.579$ | 0.015 | Thin rhomb plates with sharp outline, 79° | F. A. B. |
| Tuscany | α 1.517 β 1.524 γ 1.577 $2V_\gamma$ 42° ± 2° | ~0.1 | Compact, yielding cleavage flakes some with 78° | D'Achiardi |
| Tuscany | $n_1 \sim 1.526$ $n_2 \sim 1.579$ | ~0.05 | Compact, yielding cleavage flakes some with 77° | F. A. B. |

Note. The longer diagonal of the rhomb plates has positive elongation, and so far I have noticed the extinction directions always bisect the angles of the 'cryptomorphite' crystals and the rhomb cleavage flakes of ginorite. The symmetry of ginorite may perhaps be orthorhombic, not monoclinic, as D'Achiardi supposed.

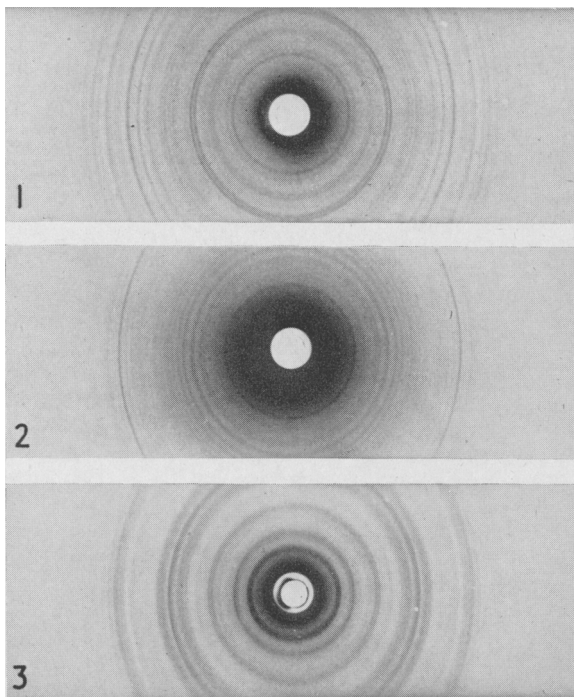
TABLE III. X-ray powder data for ginorite and priceite.

| Ginorite, Tuscany. | | | | Priceite, Oregon. | | | |
|--------------------|-----------|-----------|-----------|-------------------|-----------|-----------|-----------|
| <i>I.</i> | <i>d.</i> | <i>I.</i> | <i>d.</i> | <i>I.</i> | <i>d.</i> | <i>I.</i> | <i>d.</i> |
| vs | 7.18 Å. | vw | 2.62 Å. | vvs | 10.91 Å. | vvw | 2.53 Å. |
| s | 5.36 | vvw | 2.58 | ms | 5.96 | mw | 2.47 |
| vw | 4.92 | vvw | 2.53 | mw | 5.47 | vw | 2.41 |
| w | 4.68 | vw | 2.47 | vvw | 4.86 | m | 2.31 |
| vvw | 4.29 | vwb | 2.36 | w | 4.51 | vvw | 2.24 |
| w | 4.08 | vw | 2.28 | w | 4.30 | ms | 2.18 |
| mw | 3.90 | w | 2.24 | m | 3.67 | vw | 2.06 |
| mb | 3.57 | w | 2.16 | ms | 3.49 | vw | 2.02 |
| vvw | 3.42 | s | 2.09 | w | 3.38 | vw | 1.98 |
| m | 3.28 | vw | 2.03 | vvw | 3.07 | mw | 1.94 |
| vvw | 3.18 | wb | 1.96 | vw | 2.97 | vw | 1.876 |
| mw | 3.12 | vvw | 1.92 | w | 2.89 | w | 1.855 |
| w | 2.98 | vvw | 1.821 | mw | 2.79 | wb | 1.807 |
| w | 2.88 | | | w | 2.73 | vw | 1.758 |
| vw | 2.81 | | | w | 2.68 | w | 1.730 |
| vw | 2.73 | | | vw | 2.60 | | |

These measurements of spacings and intensities (figs. 1 and 2) were obtained in a cylindrical camera, diameter 6 cm. with filtered copper radiation, Cu-K α , 1.542 Å.

H. How's analysis of cryptomorphite should not be rejected entirely, although there is little doubt that it is an analysis of a mixture, and its

interpretation is not quite clear. On the one hand, the observed SO_3 is not sufficient to form thenardite with all the Na_2O , while, on the other, the evidence from the Italian material appears to indicate that the borate present contains little or no alkali. However, owing to shortage



FIGS. 1-3. Powder photographs of calcium borate minerals. 1. Priceite, Curry Co., Oregon, U.S.A. 2. Ginorite, Sasso Pisano, Tuscany. 3. Ulexite, Iquique, Tarapacá, Chile.

All three were taken in a 6-cm. diameter camera with filtered copper radiation $\text{Cu-K}\alpha$, 1.542 \AA .

of material, How necessarily determined H_2O by ignition and the other constituents on the ignited residue. Direct experiments showed that when Na_2SO_4 is fused with borax and excess B_2O_3 an appreciable amount of SO_3 is volatilized, and it therefore appears probable that How's SO_3 figure is low, and his H_2O correspondingly high. Assuming that the soda is wholly present as thenardite, there would be 16.60 % of the latter, and the last column of table I shows that after deduction of this, How's analysis is in fair agreement with Rossoni's and Hey's analyses of

ginorite. It is clear from How's papers that he was at pains to distinguish cryptomorphite from both priccite and ulexite, with which minerals it was confused in his day. He was, however, confident that the mineral contains sodium; though this is not confirmed by our new analysis.

In our opinion, the X-ray powder pattern, the crystal shape, and the optical properties constitute proof of the identity of cryptomorphite and ginorite. We suggest that the name ginorite should be used, rather than cryptomorphite, for the mineral from Nova Scotia, as well as from Tuscany, since the Nova Scotia material was never isolated in a pure state and because hardly any of it seems to have been preserved.
