

*Genthelvite and bertrandite from the Cairngorm  
Mountains, Scotland*

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*Summary.* A zinc-rich helvine (genthelvite) has been found with bertrandite in miarolitic cavities in adamellite at Coire an Lochain in the Cairngorm Mountains. The genthelvite occurs as green or brown tetrahedral crystals of sp. gr.  $3.58 \pm 0.01$ . It is isotropic,  $n$   $1.742 \pm 0.003$ ,  $a$   $8.133 \pm 0.005$  Å. Bertrandite crystals are pale brown with sp. gr.  $2.60 \pm 0.01$ ; biaxial negative with  $2V$   $75^\circ$ , and  $\alpha$   $1.590$ ,  $\beta$   $1.603$ ,  $\gamma$   $1.613$ , all  $\pm 0.003$ .

**G**ENTHELVITE [ $Zn_4(Be_3Si_3O_{12})S$ ] and bertrandite [ $Be_4(OH)_2Si_2O_7$ ] have been collected by the writer from the cliffs of Coire an Lochain,  $1\frac{3}{4}$  miles WSW. of Cairn Gorm. In view of the extreme rarity of crystals of genthelvite, and the fact that the only previous records of both minerals in the British Isles are from Cornwall, it is felt that the occurrence is worth reporting. Beryl is not uncommon in the Cairngorm granite pluton and small crystals of blue-green beryl have been found in Coire an Lochain, but not in association with genthelvite or bertrandite.

*Genthelvite*

*Previous discoveries.* Three crystals of genthelvite, the zinc-rich end-member of the helvine group, all from cavities in pegmatite, have been discovered in El Paso County, Colorado. The original specimen was described by Genth (1892), the others by Glass and Adams (1953), and Scott (1957). A notable amount of genthelvite, not as visible crystals, has been recorded by von Knorring and Dyson (1959) from an albite vein and nearby pegmatite in the Jos-Bukuru complex of Northern Nigeria. Eskova (1957) has described irregular segregations and Vasil'ev (1961) xenomorphs from pegmatites in the Kola Peninsula. Tetrahedra of genthelvite have been recorded by Oftedal and Saebø (1963) from three localities in Norway. One is an old specimen the locality of which is uncertain; the others are from nepheline-syenite pegmatites. The only previous occurrence in Great Britain, in an unusual paragenesis,

was described by Kingsbury (1961) from a calc-silicate rock near the Bodmin Moor granite in Cornwall.

The Cairngorm granite of Coire an Lochain can be classed as a mica-poor adamellite. Numerous miarolitic cavities are present and in a number of these crystals of genthelvite were found. The small cavities are lined with pegmatitic material from which project idiomorphic crystals of cairngorm or rock crystal together with microcline, microperthite, and oligoclase. The cairngorm crystals are peculiar in that they are frequently distorted and have tapering prism faces gradually merging into pyramids. Many cavities are partly filled with kaolin, fine rock fragments, and crystals derived from decomposition of their walls. Genthelvite crystals were found loose in this debris as individuals and groups often partly embedded in quartz and feldspar. Other specimens were obtained from material extracted from cavity walls. One cavity contained irregular masses of fine-grained chlorite coating both quartz and feldspar and occasionally enclosing genthelvite. Bertrandite crystals, usually emplaced on genthelvite but occasionally on quartz, are less common and were only discovered in one cavity.

The genthelvite crystals, which vary in size up to 1.3 cm, are combinations of unequally developed positive and negative tetrahedra. One large and dull tetrahedron with irregular faces due to parallel growth, is modified by a less-developed, smooth, and lustrous tetrahedron. Smaller crystals tend to be more perfect and free from parallel growth. The superficial colour is a yellow-brown but fractured surfaces are dark green. One small crystal is translucent pale green; part of another translucent red-brown. Deeply weathered specimens from a collapsed cavity are brown with an incomplete red-brown outer zone. The mineral is brittle, has a vitreous lustre, a hardness greater than 6, and a specific gravity of  $3.58 \pm 0.01$ . It is colourless in thin section, transparent, isotropic with refractive index  $n 1.742 \pm 0.003$ .

New X-ray diffraction data are given in table I. A discrepancy exists between the  $d$ -spacings and unit cell parameter given here and the data of von Knorring and Dyson (1959). This is explained by the fact that those workers used an erroneous camera constant (O. von Knorring, personal communication) to calculate their  $d$ -spacings, but did not derive their unit cell from these; their unit cell of 8.12 Å thus agrees with their chemical analysis but bears no relation to the  $d$ -spacings they list.

A chemical analysis by A. A. Moss gave SiO<sub>2</sub> 30.8, BeO 14.2, FeO 9.9, MnO 5.8 ZnO 37.0, S 5.1, sum (less O for S) 100.2. On a basis of 26

oxygen plus sulphur, this gives a formula  $\text{Be}_{6.51}\text{Zn}_{5.21}\text{Fe}_{1.58}^{2+}\text{Mn}_{0.94}\text{Si}_{5.88}\text{O}_{24.18}\text{S}_{1.82}$ . The beryllium content is notably high. In comparison with the original genthelvite of similar paragenesis from Colorado, the present one is poorer in zinc and richer in manganese and iron.

TABLE I. X-ray diffraction data for genthelvite from Cairn Gorm. 11.46 cm diameter camera, Cu- $K\alpha$  radiation, Ni filter. Relative intensities determined from a diffractometer trace.  $a = 8.133 \pm 0.005 \text{ \AA}$

$hkl$	$d$	$I$	$hkl$	$d$	$I$
200	4.07 $\text{\AA}$	3	630, 542	1.213 $\text{\AA}$	1
210	3.64	9	631	1.199	1
211	3.32	100	444	1.174	1
220	2.872	5	710, 550, 543	1.150	2
310	2.574	22	720, 641	1.117	2
222	2.350	8	721, 633, 552	1.107	11
320	2.254	4	730	1.069	3
321	2.172	32	650, 643	1.041	2
400	2.031	5	732, 651	1.032	6
411, 330	1.913	63	811, 741, 554	1.001	8
420	1.821	11	820, 644	0.987	2
421	1.775	3	821, 742	0.982	1
332	1.733	3	653	0.972	1
422	1.660	15	822, 660	0.959	2
510, 431	1.594	6	831, 750, 743	0.946	3
520, 432	1.511	3	662	0.933	3
521	1.485	13	752	0.922	3
440	1.438	17	840	0.910	2
530, 433	1.396	13	910, 833	0.898	3
600, 442	1.355	14	842	0.887	3
611, 532	1.319	10	921, 761, 655	0.877	3
620	1.286	3	664	0.868	2
541	1.256	14	930, 851, 754	0.857	7
622	1.226	2	844	0.830	3

### *Bertrandite*

The bertrandite crystals attain a maximum length of 3 mm, are tabular parallel to {001} and elongated in the direction of the  $a$ -axis. The forms determined by goniometry are {100}, {010} and {001} with occasional narrow faces belonging to {110}, {130}, and {011}. Some crystals show simple twins on {011}. Good cleavage is parallel to {110}, {010}, and {001}. The mineral is transparent, pale brown in colour, and has a vitreous lustre except for {001} on which it is pearly. It has a specific gravity of  $2.60 \pm 0.01$  and a hardness between 6 and 7. The indices of refraction are  $\alpha$  1.590,  $\beta$  1.603, and  $\gamma$  1.613, all  $\pm 0.003$ ;  $2V_\alpha$  75°. An X-ray powder photograph taken of one of the specimens confirmed the identification of the mineral as bertrandite.

Other British records of bertrandite are those from Cornwall by Bowman (1911), Russell (1913), and Phemister (1940).

Specimens of genthelvite and bertrandite have been deposited in the Mineralogy Department of the British Museum (Natural History).

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