On the occurrence of Phenacite in Cornwall.

By Arthur Russell.

[Read June 7 and November 15, 1910.]

THE mineral phenacite (beryllium ortho-silicate) has not previously been recorded from the British Isles.[1] The following notes contain an account of its characters and mode of occurrence at five distinct localities in Cornwall. The occurrences are described in the order of their discovery.

Cheesewring Quarry, Linkinhorne, Cornwall.

During the early part of 1905, while examining the Cheesewring Quarry, in company with Mr. F. H. Butler, who on a previous visit had discovered bertrandite at this locality, I paid special attention to the discovery, if possible, of any other beryllium minerals. I was fortunate enough, after much searching, to find a specimen showing three small crystals that at once suggested the mineral phenacite; a surmise which on examination proved correct. The three crystals of phenacite, the largest of which measures $2\frac{1}{2}$ mm. in length by $1\frac{1}{2}$ mm. across, are colourless and of prismatic habit. They show the prism forms a $\{11\bar{2}0\}$ and m $\{10\bar{1}0\}$, which are deeply striated vertically, and are terminated by the rhombohedron of the first order r $\{10\bar{1}1\}$, the faces of which are large and somewhat rough. The crystals are optically positive. The specific gravity is 2·98.

The crystals lie horizontally on a dark green chloritic crust, and are closely associated with small doubly-terminated prisms of quartz, small octahedra of pale violet fluor, with here and there a thin plate of bertrandite, the whole occupying a joint-plane in a coarse-grained

[1] A crystal said to resemble Uralian phenacite, but possibly only beryl, was found by Dr. M. F. Heddle at Hillswickness Point, Shetland. It had rough faces, and was embedded in mica-slate (R. P. Greg and W. G. Lettsom, 'Manual of the Mineralogy of Great Britain and Ireland,' 1858, p. 478). This is not confirmed in Heddle's 'Mineralogy of Scotland', 1901.

muscovite-tourmaline-granite. The mineral appears to be very rare at this locality, for although I have since visited the quarry, which is extensively worked, and made careful search on no less than twenty occasions during the last five years, no more specimens have come to light.[1] The exact spot at which the specimen was found was in the quarry amongst the débris on the east side. The association of phenacite with bertrandite, octahedral fluor, and quartz in granite, recalls the occurrence at Mount Antero, Chaffee Co., Colorado,[2] although beryl, the common associate at Mount Antero, is totally absent from the Cheesewring Quarry.

South Phoenix Mine, Linkinhorne, Cornwall.

In 1906, more than a year after the discovery of phenacite at the Cheesewring Quarry, while examining some lode material which had recently been brought to the surface during the clearing out of an old shaft at South Phoenix Mine, Linkinhorne, Cornwall, I was rewarded by finding six specimens, all of which showed numerous phenacite crystals. These crystals are of long-prismatic habit, the largest being 4½ mm. in length by ½ mm. in diameter, and are plentifully scattered over the surface of the vein-stuff. They lie for the most part horizontally, and in some cases are attached to, or even penetrate small quartz crystals. The crystals are either perfectly colourless and transparent, or yellowish from a thin superficial film of iron oxide. Mr. L. J. Spencer, to whom I am particularly indebted for his ready help with regard to the crystallographic description of this and the other specimens here described, undertook the measurement of a crystal, with the result that the following forms[3] were identified: a {11$\bar{2}$0}, m {10$\bar{1}$0}, r {10$\bar{1}$1}, d {01$\bar{1}$2}, p {11$\bar{2}$3}, s_1 {3$\bar{1}$21}, x {12$\bar{3}$2}. Three faces of x and r are largely developed, those of the remaining rhombohedra being small (fig. 1).

[1] Mr. Hawkey the late manager, and Mr. Bennett the present manager of the quarry, have been most kind in affording me every facility in my search.

[2] S. L. Penfield and E. S. Sperry, Amer. Journ. Sci., 1888, ser. 3, vol. xxxvi, p. 321.

[3] Another crystal showed the same forms, but with only one face of r developed. On this distorted crystal the goniometric determinations varied somewhat from the calculated values for phenacite; for instance, the three angles xx' gave 76° 58′, 76° 58′, 76° 49′ (instead of 75° 57′). On all the other Cornish crystals of phenacite which were measured normal angles were obtained. The development of vicinal faces thus seems to accompany the distorted growth of the crystals, as previously observed on phenacite from German East Africa (Mineralogical Magazine, 1906, vol. xiv, p. 178).—L. J. S.

The vein-stuff on which the phenacite crystals occur is exceedingly typical of the Phoenix group of mines. It consists principally of greyish-white greasy-looking quartz, stained along its cracks with yellow films of limonite, and containing veins of blue 'peach', patches of black tourmaline, and also a little cassiterite, which latter is, however, invisible to the naked eye. The cracks or surfaces on which the phenacite crystals are developed are coated with small quartz crystals, the interstices being filled with earthy yellow limonite, and occasionally a little kaolin. The exact source of the mineral was a small heap of low-grade tin-stuff derived from Rodder's Shaft on an east and west tin-lode (South Prosper

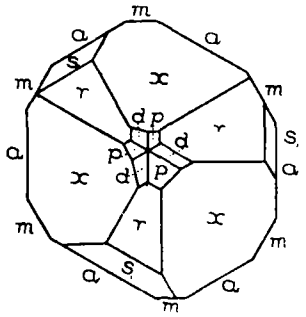

FIG. 1.—Phenacite from South Wheal Phoenix, Cornwall.

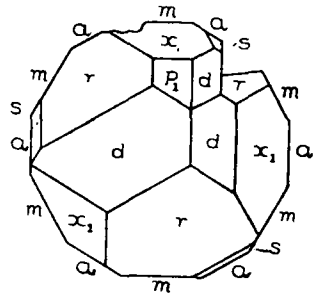

FIG. 2.—Phenacite from St. Agnes, Cornwall.

(Plans of crystals of long-prismatic habit.)

Lode) traversing the granite. The shaft is situated close to and just north of Cheesewring village, Sheet xxviii NW, Six Inch Ordnance Map.

Although the Cheesewring Quarry and South Phoenix Mine are only three-quarters of a mile apart, and both in the same granite mass, it is interesting to note that from the point of view of association the two occurrences are quite dissimilar. In the case of the Cheesewring Quarry the phenacite occurs in cracks in the granite in conjunction with quartz, fluor, and bertrandite; while at South Phoenix Mine it occurs in a tin-lode associated with quartz, tourmaline, and cassiterite. The fact that phenacite is observed to penetrate crystals of quartz proves it to be contemporaneous in formation with the latter mineral.

St. Agnes, Cornwall.

In 1909 the writer acquired an old collection of Cornish minerals, formerly the property of the late Mr. Alfred Fox, of Falmouth. In this collection was a very remarkable specimen labelled 'Topaz on Quartz

from St. Agnes'. A mere glance was sufficient to show that the crystals were not topaz, and examination proved them to be phenacite. The specimen measures 9 × 8½ cm., and consists of a clean group of opaque white quartz crystals, the largest of which is 6 cm. in length. Perched upon these, and even penetrating them, are no less than forty beautifully developed phenacite-crystals of a pale wine-yellow colour. There is no rock attached to the specimen, and the only other minerals present are a few very small crystals of mispickel, and some small spheres of dark-green, scaly chlorite. The crystals are of long-prismatic habit, and are deeply striated vertically. They vary in size, the largest measuring 7 × 2 mm. Though externally of a pale wine-yellow colour, on rubbing between the fingers they become perfectly colourless and transparent, the colour being evidently due to an external film. The following forms were observed by Mr. Spencer, to whom I submitted a crystal which afforded excellent measurements: a $\{11\bar{2}0\}$, m $\{10\bar{1}0\}$, r $\{10\bar{1}1\}$, d $\{01\bar{1}2\}$, p_1 $\{2\bar{1}\bar{1}3\}$, s $\{21\bar{3}1\}$, x_1 $\{\bar{1}3\bar{2}2\}$. Three faces of each of the rhombohedra are developed with the exception of p_1, of which there is only one face present (fig. 2). In some cases two or more crystals have grown together, while some of the single crystals have deep channels running vertically down the prism-faces. The specific gravity is 2·98. Without a more precise locality than St. Agnes, it is unfortunately impossible to say from what kind of rock the specimen was obtained. Most of the St. Agnes mines are in killas, with the exception of a few in the western part of the parish, which are sunk in granite about St. Agnes Beacon. There is also a small outcrop of granite to the north-east at Cligga Head.

South Crofty Mine, Illogan, Cornwall.

Quite recently through the kindness of Mr. J. H. Collins I have been able to examine a remarkable specimen of a mineral which has proved to be phenacite. The specimen, though unrecognized, had been in Mr. Collins's possession for about forty years, and was found by him on a dump at South Crofty Mine, Illogan, Cornwall. The appearance and general character of the phenacite is very unlike that of the other specimens described in this paper, and, as far as I am aware, unlike the form in which the mineral presents itself at any foreign locality.

The specimen (No. 2123 in Mr. Collins's collection) measures 6 × 5 cm., and exhibits on one side a mass of long, white, radiating, prismatic crystals, some of which measure as much as 2½ cm. in length. One

prism more isolated than the rest has a diameter of 2 mm., and shows the forms m {10$\bar{1}$0} and a {11$\bar{2}$0}, the prism-faces in this case being fairly smooth and bright, and the crystal quite colourless. A fragment showed the mineral to be optically positive, with fairly strong refraction, about 1·65, equal to monobromonaphthalene. Cleavage indistinct and imperfect; fracture conchoidal. Hardness about 7½; scratches quartz with difficulty. The specific gravity is 2·98. Mr. W. F. P. McLintock, to whom Mr. Collins had previously submitted the specimen, has also identified it as phenacite, and informs me that he removed sufficient material to determine the presence of beryllium chemically.

The matrix consists almost entirely of dark green chlorite, containing numerous small bright crystals of mispickel and a good deal of disseminated brown cassiterite. A little quartz is present in immediate contact with the phenacite, and in one place there is a small patch of nearly colourless fluor. South Crofty Mine, which is still at work, is in killas, but strikes the granite at a depth of about 140 fathoms. In the year 1870, about the time that Mr. Collins found the specimen, the lower workings were well within the granite, which suggests that the phenacite occurred in a lode in that rock.

St. Day United Mines, Gwennap, Cornwall.

Quite recently yet another Cornish locality for phenacite has been discovered. A peculiar interest attaches to the find, inasmuch as the specimens, which are exceedingly fine, have, though unrecognized for about forty years, formed part of the national mineral collection in the Natural History Museum. The specimens, two in number, were originally labelled apatite from Redruth, Cornwall, and were purchased by the Museum authorities from Richard Talling, of Lostwithiel, the one in 1867, the other in 1872. Subsequently Mr. William Semmons pointed out that he had himself collected one of the specimens from a lode containing wolframite at the St. Day United Mines [1] about the year 1864, and that it had passed into Talling's hands. The specimens were described as apatite by Mr. Semmons in a paper entitled 'The Apatites of Cornwall in relation to their environments'.[2] Thinking the appearance of the crystals was very similar to those on the St. Agnes specimen of

[1] About the year 1856, Messrs. Pryor & Co., of Redruth, took over the old mines—Poldice, Wheal Unity, Wheal Gorland, and Wheal Maid, and consolidated them under the title of St. Day United Mines.

[2] W. Semmons, Journal Liverpool Geol. Assoc., 1892, vol. xii, p. 33.

phenacite in my possession, I obtained Mr. Spencer's permission to examine the specimens more closely, when it was at once evident that they were phenacite, and not apatite.

The specimen (British Museum number 41069) purchased in 1867 consists of a mass of long quartz crystals cemented together, and coated over with globular, light-green, scaly chlorite; studded over the surface of which are numerous very beautiful crystals of phenacite. They are perfectly colourless and transparent, and of long-prismatic habit. A crystal detached from this specimen was measured by Mr. Spencer, and showed the forms $a\{11\bar{2}0\}$, $m\{10\bar{1}0\}$, $r\{10\bar{1}1\}$ large, $d\{01\bar{1}2\}$ small. The largest crystal measures $1\frac{1}{4}$ cm. in length by $1\frac{1}{2}$ mm. in diameter. A few of the phenacite crystals are seen to grow directly out of the uncoated quartz crystals. A little massive mispickel occurs on the back and sides of the specimen, and is the only other mineral present.

The specimen (British Museum number 44675) purchased in 1872 is an exceedingly beautiful one, and consists of a mass of very pale green to almost colourless fluor, one side of which is crystallized in cubes with well-developed dodecahedron faces $\{101\}$. Sprinkled over these cubes, and partially embedded in them, are numerous phenacite crystals, some perfectly colourless and transparent, others, the larger ones, slightly turbid in appearance. A crystal measured by Mr. Spencer showed the forms $a\{11\bar{2}0\}$, $m\{10\bar{1}0\}$, $r\{10\bar{1}1\}$ large, $x\{12\bar{3}2\}$ small. The largest crystal measures $1\frac{3}{4}$ cm. in length by $2\frac{1}{2}$ mm. in diameter, and has a polysynthetic development of the terminal rhombohedron faces. One transparent cube of fluor, about 1 cm. along the side, has included in it four beautiful little crystals of phenacite, and also a little chlorite. Besides the chlorite, quartz in broken prisms is the only other mineral present.

The finding of the above-mentioned specimens suggested that others of the so-called apatite from Cornwall might prove to be phenacite. I, therefore, examined the collection of British minerals (originally the Ludlam collection) in the Museum of Practical Geology, and was successful in finding, thanks to the kindness of Mr. W. F. P. McLintock, two further examples of the mineral. Of these, one bearing Talling's number 743 is from the St. Day United Mines, and is exactly similar to the specimen number 41069 in the Natural History Museum. The other was labelled 'Cassiterite, Apatite, and Quartz from Cornwall', but in reality consists of numerous deeply-striated prisms of phenacite embedded in black blende, which is both massive and crystallized, and in part coated with iridescent chalcopyrite. The rest, the bulk of the specimen,

consists of quartz. The prisms of phenacite are colourless to slightly brownish or turbid; the largest measures 10 × 2 mm.; they are mostly broken, and without terminations. In a cavity, however, there is one crystal that exhibits a fairly large rhombohedral face, probably $r\{10\bar{1}1\}$, also a very small crystal terminated by somewhat rough rhombohedral faces, the form of which could not be determined with any certainty. The general appearance and character of the associated black blende suggests Wheal Gorland as being the locality: this, however, is conjecture, and is mentioned merely for what it is worth.

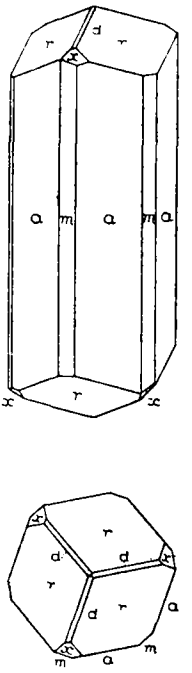

FIG. 3.—Phenacite from Wheal Gorland, Cornwall.

Wheal Gorland, Gwennap, Cornwall.

During August 1910 I visited the St. Day United Mines with a view to the possible re-discovery of phenacite, and after an extended search I was rewarded by finding a single well-defined specimen at Wheal Gorland. This mine, after a long period of abandonment, is at present being worked for wolframite by Messrs. Edgar Allen & Co., of Sheffield, the well-known firm of steel-makers. It comprises the northern part of Old Wheal Gorland, a mine famous in days gone by for the number of fine and rare minerals that it produced. The specimen of phenacite was lying amongst a small pile of rejected ore on the surface, but I am able to state, thanks to Captain James A. Temby, the manager of the mine, the exact spot underground whence this was obtained and its mode of occurrence, namely, a stope between the 10 and 20 fathom level, about eight fathoms east of the western shaft. The country-rock is granite close to its junction with killas, and the lode consists of wolframite, chalcopyrite, blende, quartz, fluor, and chlorite, also occasionally some native copper and cuprite. Captain Temby most kindly afforded me every opportunity for making a careful examination of the underground workings, but I was unsuccessful in finding any further specimens of the mineral. Unfortunately, from the collector's point of view, here as in most other mines nowadays the ore-bearing portions of the lode are trammed straight from the shaft's mouth to the crushers, while the waste material

is packed away in the worked-out stopes, and there is, therefore, little promising material in which to look for specimens.

The specimen to be described measures 12 × 9 cm., and consists of pale-green massive fluor, opaque white quartz crystals, chalcopyrite, black blende, and light-green earthy chlorite containing numerous small crystals of mispickel. The phenacite crystals, which are of long-prismatic habit, lie horizontally on, or are partially embedded in, quartz crystals; others, which are mostly much fractured, are embedded in blende or chalcopyrite. The crystals are mostly colourless, but some are slightly yellow. The largest measures 9 × 1¼ mm., and is doubly terminated; it has several transverse cracks and contains clouded areas due to internal flaws. The following forms, all of which are represented by smooth and bright faces, are present on a small crystal which was detached for examination: a {11$\bar{2}$0}, m {10$\bar{1}$0}, r {10$\bar{1}$1} large, d {01$\bar{1}$2} very small, x {12$\bar{3}$2} medium (fig. 3). The prism-faces a and m are very deeply striated, giving the crystals a fluted appearance. The development of the terminal rhombohedron faces varies very considerably in the individual crystals; the r faces are, however, always prominent. Viewed from the top, certain of the crystals present a somewhat unsymmetrical appearance. On the crystal detached and examined only one face of x is developed, while d is represented by three very narrow faces. It is quite probable that the specimens previously described from the St. Day United Mines came from that part of Wheal Gorland now at work. Mr. Semmons's recollection of the occurrence, moreover, confirms this.

In conclusion, I would add that a careful search amongst old Cornish collections will probably result in the finding of more specimens of phenacite. The mineral, when in small crystals, such as those shown on most of the specimens described, is not easy to recognize at first sight, and it is probably for this reason that it has so long escaped notice as a British species.