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*An account of the Struy lead mines, Inverness-shire,
and of wulfenite, harmotome, and other minerals which
occur there.*

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[Read November 2, 1944.]

THE Struy lead mines (Six-inch Ordnance Survey, Inverness-shire, sheet 17) are situated on the west side of Strath Glass, about two miles south-west of Struy village, and comprise three distinct sets of small long-abandoned workings, two of them being in the nature of trials only. All three workings are shown on the six-inch map, and are on veins traversing the Moine schists. The Geological Survey Memoir of the district says that four veins may be traced on the hill face between the Dùn south of Struy school and Crelevan; if this is correct there are two outcrops I have not seen. The mines are on what was until a few years ago part of Lord Lovat's estate. The date of their discovery is not known, but they were apparently worked about the year 1818 by Thomas Alexander Fraser (afterwards 12th Lord Lovat) at the same time as his graphite mine in Strath Farrar; most of the work seems, however, to have been done by him between 1838 and 1845, when miners were brought from England and housed in cottages specially built for them in Struy village. In 1864 the Loch na Mèine workings were cleared and prospected, but since then no further work has been done. The earliest reference to the mines which I have been able to find is contained in G. and P. Anderson's 'Guide to the Highlands and Islands of Scotland' (London, 1834, pp. 229, 539-540) in which it is stated that 'they were then abandoned, having been worked by Mr. Fraser of Lovat who found them unprofitable owing to their small size, and the extreme hardness of the gneiss rock'; and again 'Near Little Struy, a lead mine, situate in a thick vein of heavy spar, traversing gneiss, was some years ago opened by Mr. Fraser of Lovat, but it has been abandoned owing to its unproductiveness'. There is also a brief account of the mines in the Geological Survey Memoir of the district,¹ and a reproduction of this with a few additional notes appears in the Special Reports on the Mineral Resources of Great Britain.² It is probable that some further information could be obtained by a search through the documents in Lord Lovat's estate office at Beaulieu from which,

¹ Mem. Geol. Surv. Scotland, The Geology of the country round Beaulieu and Inverness, 1914, pp. 98-99.

² The lead, zinc, copper and nickel ores of Scotland, 1921, pp. 108-109.

through the courtesy of Major Dewar, I have obtained a poor transverse and longitudinal section of the Loch na Mèine workings, undated but subsequent to 1864, and also some assay results. The following particulars of the workings and of the minerals found there are the result of careful examinations which I made in the summers of 1935 and 1936.

Loch na Mèine.—This, the most important of the three workings, lies at an elevation of about 1100 feet above sea-level, 430 yards north of the west end of Loch na Mèine, on the high ground about midway between Strath Glass and Strath Farrar, and is reached by a rough track leading up from Struy. Here is to be seen a hush running west down the hill, the site of two filled-in shafts which are connected by a shallow adit-level, and the remains of a water-wheel for pumping, water to work which was brought by a leat from Loch na Mèine (Loch na Mèine is in part if not wholly artificial as its eastern end is formed by a dam); also reservoirs, a dressing floor on which there still remains some broken ore, and a curiously designed and apparently unfinished smelter chimney, wrongly described in the Geological Survey Memoir as the ruins of an engine house.

Of the three this was the only mine which seems to have produced any marketable ore, but from the small size of the dumps, corroborated by the section, very little actual stoping appears to have been done. The engine shaft was sunk to a depth of about 18 fathoms, the other or older shaft on the incline of the vein to 14 fathoms. Besides the adit, a level from the engine shaft communicates with the bottom of the older shaft, and from the engine shaft another level at a depth of 11 fathoms has been driven east a few fathoms. There are two chutes of ore shown on the section, the principal in the older shaft, and another at adit-level in the engine shaft. The total length of the workings is only 20 fathoms. The vein here cannot actually be seen, but has an approximately east and west direction with a dip to the south of about 33° from the vertical. The vein-filling consists largely of pink and white baryte and quartz with embedded masses and coarse cleavage cubes of galena, and small quantities of black blende, also included masses of quartz-muscovite-granulite. The galena is said from assays to have yielded from 7 ounces to 22 ounces 11 pennyweights of silver to the ton of ore.

Allt Tigh Cumhaig burn.—This working is situated on the northern loop of the Allt Tigh Cumhaig burn, about 350 yards up from the Struy to Cannick road, $1\frac{1}{2}$ miles south of Struy village. The vein here traverses muscovite-biotite-schist and is intimately connected with, and partly incorporates, two pegmatite veins. It is well exposed both in the bed and sides of the burn, the course of which it follows for some distance. The vein has a direction about 30° north of west (magnetic) and is nearly vertical, varying in width from 1 foot at the north-east end of the exposure to 12 feet at the south-west end, where a level, now partially choked at the mouth, has been driven on it from the bed of the burn. In the Geological Survey Memoir it is assumed, on apparently slender grounds, that this vein is identical with that of Loch na Mèine. The vein-filling consists of pink baryte, with nests of crystallized quartz, many strings of black blende, smaller quantities of galena, a very little pyrite, strings of calcite, and numerous fragments of grey silicified schist, giving it in part a brecciated character. Fig. 1 is a photograph of a specimen showing one of the minor veinlets enclosed in muscovite-biotite-schist; here the succession from both walls is calcite, blende, baryte. The vein is an interesting one, and in addition to the minerals mentioned,

contains small crystals of harmotome. Many interesting specimens of the vein-stuff and of the minerals contained therein may be obtained from loose material derived from the old level, and which has been carried down the burn to its lower end near the road.

The first burn north of Allt Tigh Cumhaig.—Here, about 470 yards up from the Struy to Cannick road, a trial level has been driven from the bed of the burn. The vein, which follows the course of the burn for a short distance, traverses

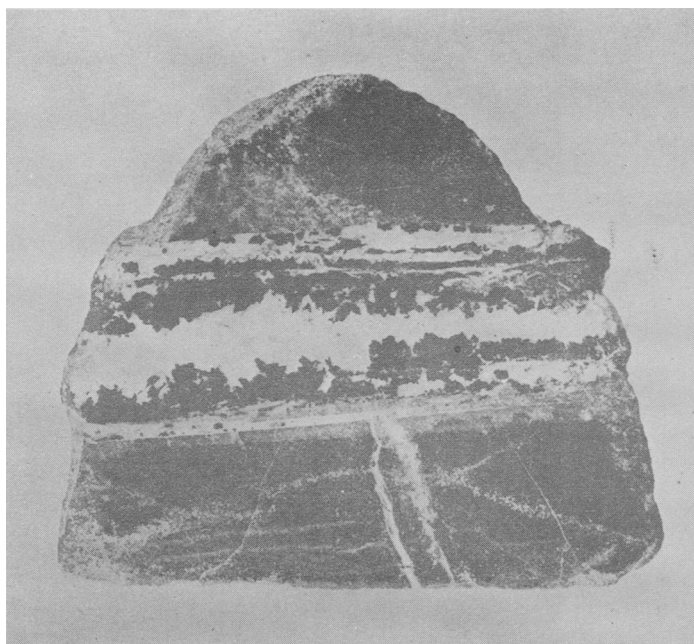


FIG. 1. Veinlet, with margins of calcite, intermediate zones of black blende, and centre of baryte, in schist from Struy lead mines, Inverness-shire. $\times \frac{1}{2}$.

muscovite-biotite-schist and is accompanied on its south side by a pegmatite vein consisting of pink feldspar, silvery mica, and quartz. It has a direction a little south of east, dips south at a steep angle, and is $2\frac{1}{2}$ feet wide where exposed. The vein-filling is in part brecciated and consists of strings of pink and white baryte and white calcite, with a very little black blende and galena and many included fragments of greenish silicified micaceous grit. The level, which is still open, has been driven for some little distance; the dump, however, though still fresh, contains little or no ore and the vein was obviously very poor. The only other minerals observed were traces of chalcopyrite and marcasite.

BLLENDE.

Blende occurs abundantly at the level on Allt Tigh Cumhaig burn. It forms brownish-black strings and veinlets in pink lamellar baryte particularly in the portion of the vein enclosed in pegmatite where it is often in direct contact with

the coarse pink felspar. Occasionally it forms small 5 mm. black (111) twinned crystals showing repeated re-entrant angles and associated with crystals of calcite, baryte, and harmotome. Black blende also occurs in much smaller quantity at the Loch na Mèine working and at the level on the first burn north of Allt Tigh Cumhaig.

CALCITE.

At the level on Allt Tigh Cumhaig burn on the surface of the black crystallized blende there are sprinkled numerous small, up to 5 mm., beautiful water-clear symmetrical stout hexagonal prisms ($10\bar{1}0$), (0001) of calcite which often support crystals of harmotome. From the level on the first burn north of Allt Tigh Cumhaig a specimen was obtained showing a cavity in platy baryte, lined with crystals of calcite ($1\frac{1}{2}$ cm.) and baryte, the calcite crystals showing the simple but unusual combination of the hexagonal prism ($11\bar{2}0$) with the scalenohedron ($21\bar{3}1$) and basal plane (0001) (fig. 2).

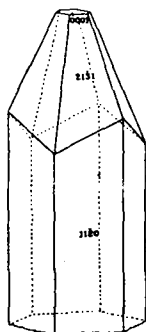


FIG. 2. Calcite.

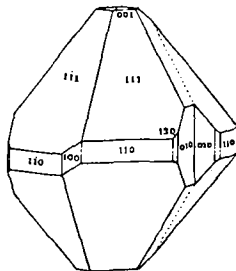


FIG. 3. Cerussite.

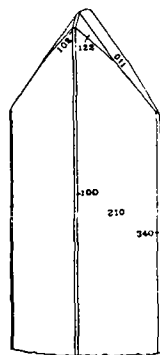


FIG. 4. Anglesite.

Crystals from Struy lead mines, Inverness-shire.

CERUSSITE.

Cerussite occurs in small patches throughout the galena-baryte vein-stuff at the Loch na Mèine working. It also forms small, up to 5 mm., colourless crystals of varied habit in pyromorphite-lined cavities. These crystals are prismatic in the direction of the *c*-axis and either simple or twinned on *m* (110); they show the forms¹ *b* (010), *c* (001), *m* (110), *x* (012), *k* (011), *i* (021), *p* (111); others are pyramidal in habit and twinned on *m* (110) (fig. 3).

ANGLESITE.

A single specimen only was found at the Loch na Mèine working. It shows minute, up to 2 mm., colourless to greyish bladed crystals occupying a cavity in galena and baryte, with a little quartz, cerussite, and a coating of pyromorphite on which are minute crystals of wulfenite. The anglesite crystals, two of which were measured, are elongated in the direction of the *c*-axis and show the forms

¹ Axial ratios and letters for this and the other minerals here described as in Dana's System of mineralogy, 6th edition, 1892.

a (100), λ (210), h (340), o (011), and y (122). The faces (100), (210), and (340) are deeply fluted vertically from repetition (fig. 4).

PYROMORPHITE.

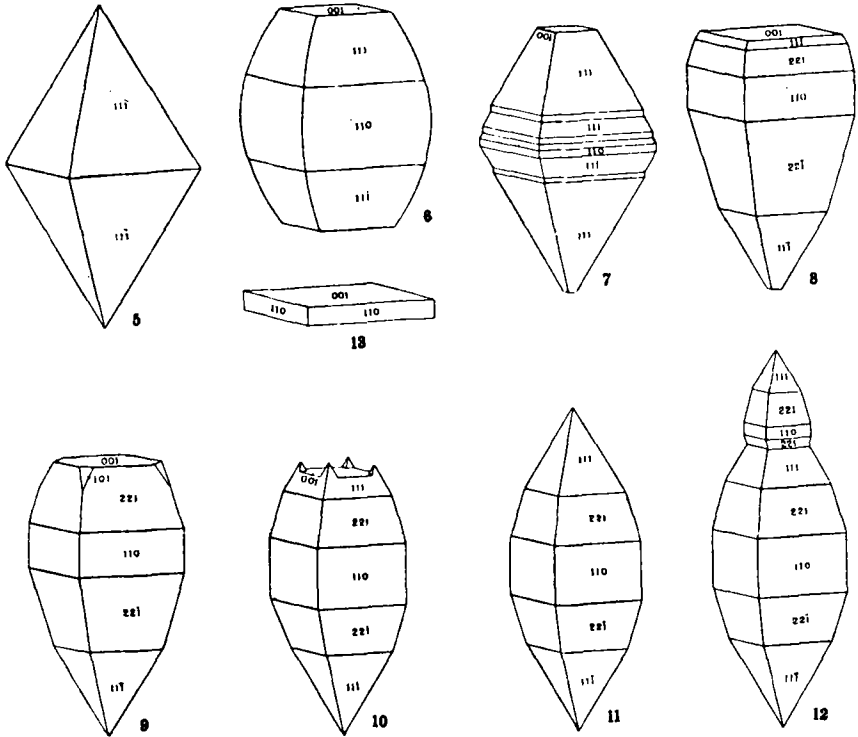
Pyromorphite is abundant on the galena-baryte-quartz vein-stuff at the Loch na Mèine working. It forms crusts of minute grass-green stout hexagonal prisms, also siskin-green slender tapering prisms investing pyramidal crystals of quartz, and more rarely minute golden-yellow transparent prisms associated with cerussite and wulfenite.

WULFENITE.

Wulfenite occurs at the Loch na Mèine working as very small, not exceeding 2 mm., crystals, which, minute as they are, appear both beautiful and interesting when viewed under the microscope. Their colour is orange-red, rarely golden-yellow with blotches of red; and their habit, except in the case of one crystal, is acute pyramidal, which is distinctly rare for this species and has not previously been observed at the four other British localities, where the crystals are always tabular in habit. The crystals either project from, or lie flat on, thin crusts of minutely crystallized green pyromorphite, which invests baryte, small bipyramidal crystals of quartz, or hacked quartz from which baryte has been leached. On other specimens single crystals of wulfenite project from cavities in massive baryte lined with ochre. Sometimes as many as 25 minute crystals are present on a square inch of the pyromorphite-covered surface. The wulfenite appears to have been the last mineral formed. In a few cases wulfenite crystals are penetrated by and have grown round prisms of pyromorphite. The crystals are sharp and well defined and consist of the acute pyramid (111) either alone (fig. 5); or usually in combination with (221), the prism (110), and base (001) (figs. 6-12). The faces (111) are slightly curved except at the apex and merge by repetition into those of (221) and (110), giving the whole crystal a curved outline, some in fact being almost barrel-shaped (fig. 6). The apparent hemihedral development is shown in the crystals figs. 7-10, fig. 9 being one of the few crystals on which the form (101) has been noted. Fig. 10 shows a curious castellated termination. The basal plane (001) is never smooth, the surface being either square-pitted or studded with innumerable extremely minute (111) pyramids. The faces of (110) are horizontally striated from repetition with the adjoining pyramids, while on most of the crystals the surfaces of (110), (221), and (111) are covered with raised and overlapping outlines of acute pyramids giving them a scaly appearance. In fig. 12 we have a compound crystal with a well-defined waist. In some crystals two parallel pyramids (111) terminate a single prism (110). Fig. 13 represents the only tabular crystal that has been observed; it is orange-yellow in colour. The measurements obtained from each of the faces are poor; but good enough to identify the forms with certainty. Micro-chemical tests were made for molybdenum and lead, and an X-ray photograph kindly taken by Mr. F. A. Bannister confirms the identity of the mineral.

All the specimens were obtained from masses of ore lying in the old ore bin, or by digging into the heather and peat round one of the shafts. It was hoped that an extended search might yield larger crystals, but although about 50 specimens were found showing the mineral, none of the crystals exceed 2 mm. At the only other known Scottish locality for wulfenite, the Lauchentyre mine, Gatehouse of

Fleet, Kirkcudbrightshire, the mineral is extremely rare and occurs as minute orange-yellow tabular crystals on yellow pyromorphite investing quartz. The Loch na Mèine wulfenite resembles in habit a crystal figured by A. Lacroix, from Sidi Rouman mine, Constantine, Algeria.¹



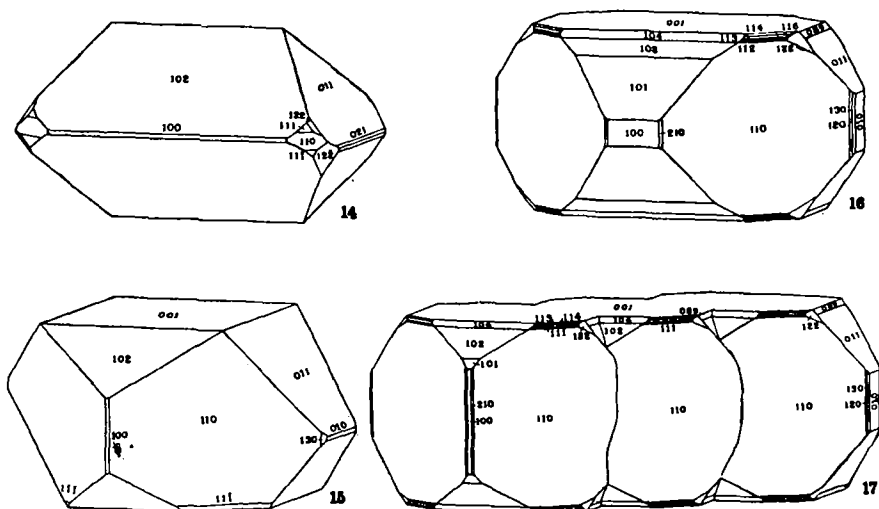
Figs. 5-13. Crystals of wulfenite from Struy lead mines, Inverness-shire.

BARYTE.

Baryte is the most abundant mineral in each of the veins, particularly so at the Loch na Mèine working; it does not, however, appear to be present in sufficient quantity to hold out any hope of being commercially workable. It is usually pink in colour, though sometimes white, and coarsely lamellar. At each of the workings it occurs as small colourless transparent crystals not exceeding 8 mm. in length, which are interesting owing to their perfection, habit, and richness in forms, 19 of which have been observed on the crystals measured. Fig. 14 represents a typical crystal from the Loch na Mèine working. This is elongated in the direction of the *b*-axis and shows the forms (100), (110), (102), (011), the two latter largely developed, (021), (111), (122), also narrow faces of (166) between (011) and (122) not shown on the drawing. Figs. 15-17 represent crystals from the level on the first burn north of Allt Tigh Cumhaig. They are often very symmetrical com-

¹ A. Lacroix, *Minéralogie de la France et de ses Colonies*. 1910, vol. 4, p. 273, fig. 7.

pound crystals in parallel position as in fig. 17, and are themselves grouped in parallel strings of many compound individuals with re-entrant angles. All of the faces are bright and smooth and afford excellent reflections; those of (110) are invariably striated parallel to (001). The forms present are (100), (010), (001), (210), (110), (120), (130), (104), (102), (101), (089), (011), (115), (114), (113), (112), (111), (122), (166). Crystals similar to figs. 16 and 17, and showing most of the same forms, also occur with harmotome and blende at the level on Allt Tigh Cumhaig burn.

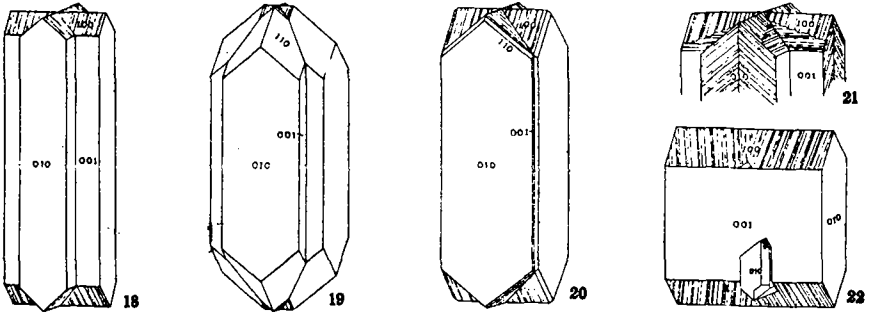


Figs. 14-17. Crystals of baryte from Struy lead mines, Inverness-shire.

HARMOTOME.

Harmotome occurs, though not very plentifully, on the vein-stuff at the level on the Allt Tigh Cumhaig burn. The crystals are small, up to 5 mm., but are very beautiful, exhibiting various modifications of the characteristic complex cruciform twins. They are colourless and often doubly terminated, the appearance of the terminations varying much, depending on the relative development of (100) or (110); likewise the re-entrant angle of (001) may be very prominent or insignificantly developed. Figs. 18-22 show typical examples drawn from actual measured crystals, all of which types may occur on the same specimen. The (100) faces are striated parallel to their intersections with (010); their terminal edges are, however, often slightly inclined away from the centre of the cross, and when this is the case the faces are seen to be fluted in two directions, the upper portion parallel to the intersection with (010), the lower parallel with (001), a step-like medial line forming the boundary between the two and suggesting oscillation between (100) and (001) in the lower half (fig. 21). On (010) the medial line is generally very distinct and slightly raised; the characteristic herring-bone striae, though often distinct, are by no means always visible. Optical examination of this face shows how very complex the crystals are, the sectors overlapping in a most irregular manner with erratic lines of junction. Associated with the cruciform

twins there are smaller $1\frac{1}{2}$ mm. water-clear crystals, combinations of (001), (100), and (010) (fig. 22) which shows two small individuals in twin position with the larger. On these crystals the striae on (100) are considerably out of parallel with the intersection with (010).



Figs. 18-22. Crystals of harmotome from Struy lead mines, Inverness-shire.

The harmotome crystals are implanted on crystals of blende, on baryte or calcite, and sometimes directly on the pink felspathic rock itself. Sprinkled on them and also included in them are minute crystals of pyrite and marcasite. Harmotome, a mineral formed during the very last phases of hydrothermal action, occurs here as elsewhere in veins containing baryte which have an igneous rock for one or both walls, in this case one wall being a pegmatite. The mineral exhibits a remarkable resistance to weathering; hence the freshness of the crystals, despite having lain so long on the dumps.