A notice of the occurrence of native arsenic in Cornwall; of bismuthinite at Shap, Westmorland; and of smaltite and niccolite at Coniston, Lancashire.

By Arthur Russell.

(With a chemical analysis by Dr. H. F. Harwood.)

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Native Arsenic from Cornwall.

NATIVE arsenic has hitherto ranked as a distinctly doubtful British species. The following notes contain, however, an account of its occurrence at two localities in Cornwall. John Garby in his 'Catalogue of Minerals found in Cornwall'[1] states that native arsenic had been found in Dolcoath mine, Camborne, associated with ores of cobalt. Greg and Lettsom repeat this statement with a doubtful qualification.[2] J. H. Collins[3] also mentions Cooks Kitchen mine, Illogan, as another doubtful locality. The occurrence as an associate of smaltite and native bismuth, minerals that have on several occasions been found in Dolcoath, is by no means unlikely, although, as far as I have been able to ascertain, no specimens of native arsenic from any of these reported localities have been preserved.

At the end of 1921 or early in 1922 there was found in the Burraton Combe quarry, St. Stephen's by Saltash, Cornwall, a heavy, metallic mineral which, although it apparently attracted a certain amount of notice among the quarrymen, was for the most part thrown away upon the quarry dumps. Soon afterwards, specimens of the mineral in question were brought to Mr. A. Spencer Cragoe, a mining engineer living in Liskeard, who submitted a sample to Messrs. Sulman & Picard for determination, their report being that the mineral was native arsenic. In June 1924, Mr. Cragoe in a letter to the 'Mining Magazine' (vol. 30,

[1] J. Garby, Trans. R. Geol. Soc. Cornwall, 1848, vol. 7, p. 86.

[2] R. P. Greg and W. G. Lettsom, Manual of the Mineralogy of Great Britain and Ireland, 1858, p. 369.

[3] J. H. Collins, Mineralogy of Cornwall and Devon, 1871, part 2, p. 10.

p. 344) headed 'Native arsenic in Cornwall', gave a brief record of the occurrence, although he had not then visited the locality. The mineral was described by him as 'typical columnar crystals . . . up to 3 in. or more diameter . . . from . . . a small vein . . . some inches up to a foot thick, in an elvan quarry outside Saltash'. Later Mr. Cragoe obligingly communicated to me some further particulars, together with a specimen, and in August last I made a personal examination of the locality. In the 'Mining Magazine' for September (vol. 31, p. 152) there appeared a further letter from Mr. Cragoe upon the same subject.

The quarry, which was first opened about 1905, works a typical fine-grained ophitic dolerite (greenstone) extensively used in the district for road-metal. The native arsenic occurred in a nearly vertical joint or lens traversing the quarry in an approximately north and south direction with a small dip to the west, the rock in the vicinity of this joint being somewhat altered and of a rusty-brown colour. The mineral extended for about 50 feet along the strike and to a height of 15 to 20 feet from the floor of the quarry, the depth of which is about 100 feet. The greatest width was about 8 inches, tapering away to the present walls of the quarry, which now show no trace of any mineral and merely a close joint.

The native arsenic, of which perhaps five or six cwt. was found, forms large, dense masses, externally greyish-black in colour and showing a rough columnar jointing with curved surfaces of separation. Other surfaces are extremely rough and pitted, the pits being occupied by yellowish-brown dolomite, calcite as coarse cleavage-masses, and small quartz crystals. More rarely, the specimens show reniform surfaces and deep hackly furrows, the latter evidently once occupied by dolomite or calcite. When freshly broken, the mineral exhibits a bright tin-white colour and crystalline, fibrous structure, at right angles to which it splits into distinctly reniform layers. The largest mass I saw, which was quite pure and from which pieces had been broken, weighed over 40 lb. and measured $10\frac{1}{2} \times 6 \times 6$ inches. No vestige of a crystal has been observed. The 'crystals' mentioned by Mr. Cragoe are merely the rough columnar masses. Traces of arsenolite are present on some of the specimens, either in the form of very thin, white, vitreous crusts, or as minute, acicular crystals. A considerable part of the joint appears to have been occupied by calcite as large, coarse cleavage-masses, in one of which bright, crystalline, granular mispickel is disseminated in small amount. A good deal of calcite and dolomite was observed in the smaller joints in the quarry; also some small, acute pyramidal crystals of aragonite.

Dr. H. F. Harwood's analysis, which is given below, shows that the mineral contains 5·15 % of antimony and is therefore intermediate between native arsenic and allemontite. The specific gravity is 5·636.

Arsenic	94·80 %
Antimony . . .	5·15
Iron	0·15
Sulphur	0·11
Insoluble . . .	0·10
	100·31 Bi, Ni, and Ag absent.

Owing to the small amount of material available for the analysis, the method adopted was that described by Jannasch and Seidel,[1] the arsenic being distilled as chloride from a solution of the mineral containing HCl, hydrazine sulphate, and KBr, and the antimony determined in the residue. Both arsenic and antimony were estimated volumetrically by means of standard $KBrO_3$ solution. Iron, sulphur, and insoluble matter were determined in a separate portion of material. The above analysis has been recalculated after deducting 0·56 % of admixed dolomite.

Early in 1924 in the course of sinking the new engine shaft at Tolgus mine, Redruth, a small lenticular mass of native arsenic about the size of a boy's fist was met with in slate (killas) at a depth of 500 feet. The mass was broken in the course of extraction, but a portion of it given by Mr. M. T. Taylor, the manager of the mine, to Mr. H. R. Beringer led to the identification of the mineral, a fragment being also given to the British Museum. The mineral is fine-grained and possesses a somewhat laminated structure; the colour is tin-white, speedily becoming black. The presence or otherwise of antimony has not, I believe, been determined. A brief notice of this occurrence appeared in the 'Mining Magazine' for April 1924 (vol. 30, p. 196) under the head of 'Native arsenic in Cornwall'.

Bismuthinite from Shap, Westmorland.

The Shap quarry situated on the side of Wasdale Crag, 4½ miles south of Shap station, has long been known as a locality for molybdenite.[2] The following minerals have also been recorded from there by Messrs.

[1] P. Jannasch and T. Seidel, Journ. prakt. Chem., 1915, ser. 2, vol. 91, p. 133.

[2] James Sowerby in vol. 3 of his 'British Mineralogy', 1809, p. 175, plate 288, figures and describes a specimen of molybdenite with pyrite on red granite which he had received with some rock specimens from Kendal. There can be little doubt that this specimen was in reality from Shap and not 'Coldbeck'

Alfred Harker and J. E. Marr[1]: Orthoclase, quartz, fluor, pyrite, chalcopyrite, malachite, mispickel (?), and sphene; of these pyrite is by far the most abundant. The rock, as is well known, is a biotite-granite with large phenocrysts of pink orthoclase.

During an examination I made of the quarry last summer, a mineral, obviously that referred to doubtfully as mispickel by Messrs. Harker and Marr, was observed intimately associated with bright crystalline pyrite and quartz on faces of the rock bordering very narrow quartz veins. The mineral occurs as long, fibrous or foliated, blade-like aggregates up to $4\frac{1}{2}$ cm. in length. The colour is tin-white on freshly fractured surfaces, but assumes a yellowish or bluish tarnish on exposure. The mineral gives the usual bismuth and sulphur reactions. The only other known locality for bismuthinite in the north of England is the Carrock mine, Troutbeck, Cumberland.

Good specimens of molybdenite are still met with from time to time in the Shap quarry. It occurs in the usual bright foliated form, in patches up to 3 cm. across, together with quartz, and often covers considerable faces of the rock. On one specimen which I found, molybdenite forms numerous scaly rosettes with pyrite on a joint-face and also occupies minute cavities in the granite itself; other of the cavities containing pink crystals of orthoclase of adularia habit, plates of muscovite, quartz crystals, violet fluor, corroded calcite, and radiating groups of minute crystals of pale-green epidote.

Occasionally, cavities are met with in this quarry lined with fine crystals of pink orthoclase and crystals of smoky-quartz. These orthoclase crystals are either Carlsbad-twins with the forms $b\,(010)$, $c\,(001)$, $m\,(110)$, $x\,(\bar{1}01)$, or Baveno-twins $b\,(010)$, $m\,(110)$, $z\,(130)$, $n\,(021)$, $o\,(\bar{1}11)$ (Dana's letters). Sphene occurs as minute, dark-brown crystals of simple habit up to $\frac{3}{4}$ mm. across, embedded in the pink orthoclase of the rock mass, and is especially abundant on one of the specimens showing bismuthinite. The forms observed are $a\,(100)$, $c\,(001)$, $x\,(102)$, $n\,(111)$. Tourmaline is rare: it forms aggregates of small, black prisms with quartz. Apatite as long, slender, greyish-white, hexagonal prisms 8 mm. in length is present on one specimen with tourmaline and quartz.

Since the above was written, Mr. D. A. Grantham has most courteously shown me a series of minerals which he had collected at the Shap granite

(Caldbeck), Cumberland, as stated in the text. At the Carrock mine, near Caldbeck, molybdenite occurs in greisen, not granite.

[1] A. Harker and J. E. Marr, The Shap granite. Quart. Journ. Geol. Soc. London, 1891, vol. 47, p. 285.

quarry during the last two summers, and amongst them are specimens of bismuthinite which he had already determined as such.

Smaltite and Niccolite from Coniston, Lancashire.

The now abandoned, but once important and extensive, Coniston copper mine is situated about a mile north-west from Coniston. It was worked on a series of veins having a direction approximately north-east and south-west and lying between two large north and south cross-veins; the enclosing rock being Borrowdale ashes and breccias. The vein-filling consists essentially of chalcopyrite with quartz, some calcite, a good deal of blende in places, and fragmentary country-rock. Crystallized minerals appear to have been rare. Greg and Lettsom mention chalcopyrite as having occurred well crystallized, and they figure a crystal with the forms p (111), p_1 ($1\bar{1}1$). The occurrence of cobalt and nickel ores here has hardly found mention in mineralogical literature. In the mineral statistics of the United Kingdom for 1856 it is stated that in 1855 the Coniston mine returned 3 tons of nickel and cobalt ore. In the account books of the mine, for the perusal of which I am indebted to Mr. B. Johns of Keswick, there is, under the date of April 1873, the record of a sale of nickel ore, 6 cwt. 1 qr. 8 lb. for £56 17*s.* 10*d.* and 3 cwt. 1 qr. 2 lb. for £13 1*s.* 5*d.* So far as I am aware, no specimens of this ore appear to have been preserved with the exception of some which I obtained in 1917 and 1923 from Mr. Joseph Hellen, an old Coniston miner. According to Mr. Hellen both niccolite and smaltite occurred in the Bonser vein in the old mine, and also in the Paddy End section, where on the dumps I have myself found traces of erythrite.

The smaltite and niccolite occur intimately associated, eyes or small irregular patches of niccolite being surrounded by smaltite in grey and white crystalline calcite, which contains cavities lined with small crystals of calcite. The exterior of these masses is often encrusted with a pink, greenish, or nearly white mixture of erythrite and annabergite. Other of the specimens consist entirely of beautifully crystallized smaltite with no other mineral except a little superficial erythrite. The crystals are simple cubes with markedly curved faces, brilliant and tin-white in colour with sometimes a slight bluish iridescent tarnish or black coating. The largest cube measures 9 mm. along the edge, these large crystals being thickly encrusted except along their edges with a confused aggregate of small, interpenetrating cubes. These specimens are by far the

best crystallized examples of smaltite so far met with in the British Isles.

Erythrite has already been recorded from the Coniston mine by J. G. Goodchild, who states that it occurred in a cross-vein.[1] The only other minerals I observed are the following. Tetrahedrite occurs in calcite at the Paddy End section as small patches and in the form of minute (1 mm.) bright tetrahedra $o(111)$ with narrow faces of $n(211)$; stilpnomelane, characteristic specimens of which were obtained from the large dumps below the dressing floors; the mineral forming veins with quartz and a green chlorite.

[1] J. G. Goodchild, Contributions towards a list of the minerals occurring in Cumberland and Westmorland. Trans. Cumberland and Westmorland Assoc. Lit. Sci., 1885, no. 9, p. 195.