On the occurrence of native gold at Hope's Nose, Torquay, Devonshire.

(With Plate VI.)

By Arthur Russell.

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SOME thirty-five years or so ago small quantities of free gold were found in calcite in or near a crush-breccia filling an east and west fault, in the patch of Middle Devonian limestone which forms that portion of the coast known as Daddy Hole Plain directly south-east of Torquay. The name of the actual discoverer I have been unable to ascertain, neither do any specimens appear to have been preserved; but the late Mr. T. Harrison, the then proprietor of the Queen's Hotel, Torquay, and several other persons subscribed about £100, and a small amount of prospecting work was carried out, apparently with little result. The only reference to this discovery which I know of is a brief one in 'The geology of the country around Torquay' (Mem. Geol. Survey, 1903, p. 48).[1] To Mr. B. W. Stedham of Torquay I am indebted for the additional particulars given and also for pointing out to me the exact spot, which is on the side of a fissure formed by a large pinnacle of rock standing away from the cliff below the old quarry.

The occurrence which forms the subject of the present note was discovered in a curious way. In April, 1922, Professor W. T. Gordon of King's College, London, with a party of students, was pointing out the geological features of Hope's Nose, a headland two miles east of Torquay, and in examining a small calcite vein, of which many traverse the Middle Devonian limestone on the foreshore at this spot, the chance blow of a hammer revealed the calcite to be tenaceous owing to the presence of many sprigs of gold. A brief record of this find was published by Professor Gordon in 'Nature' (London, 1922, vol. 109, p. 583, 1 fig.). Stress of other work prevented him,

[1] This record has been repeated in at least one local guide-book and in W. G. Shannon's Short guide to the geology of Torquay, 1925, p. 7.

however, from more carefully examining the spot. In 1927, with Professor Gordon's concurrence and in company with my brother Sir Charles Russell and Captain G. M. Puckle, a careful examination of Hope's Nose was made, and specimens of arborescent gold were obtained from five distinct calcite veins within the space of about forty yards. In 1928, permission having been most courteously given by Major H. A. Garrett, the Borough Engineer of Torquay, a couple of shot holes were put in on the most promising looking of the veins, and a number of very remarkable specimens of arborescent gold were obtained. The exact spot at which the gold occurs is on the flat rocky shore just above high-water mark, east of and adjoining the old limestone quarry, and at a point where the first small indent above the Torquay sewage outfall is marked on the six-inch Ordnance Map (Devonshire, Sheets 116 S.E. and 122 N.E., 1906).

The geological structure of Hope's Nose has been often described, and it is sufficient to say that its eastern seaboard is formed of thick-bedded pale grey to pinkish compact Middle Devonian limestone containing corals. About the sewage outfall and south of it the limestone becomes thin bedded and slaty. On the flat rocky shore the thick-bedded limestone is traversed by a number of calcite veins and strings, which from the presence of slickensided faces appear to be of the nature of minor fault fissures. They have a direction about 20° north of west (magnetic) and vary in width from less than an inch to a foot or more, the width of the veins increasing as they run seawards, where for the most part the sea has completely eroded the vein-filling, leaving open sea-swept chasms. The strike of these veins can be traced for roughly only about 30 yards, from low-water mark to the low cliff dividing the foreshore from the quarry, at which latter point they are cut off by a fault. Of these veins, five have yielded specimens of free gold, in each case within a few yards of the base of the low cliff where the vein-filling has not been removed by the agency of the sea. Many very similar calcite veins are to be seen in the adjacent quarry, but although careful search was made, no trace of gold has been seen. Very close scrutiny is necessary to detect the gold, which stands out from the eroded calcite on the outcrops, since it is often masked by a coating of lichen or sea-slime, while some of the richest specimens were obtained from remnants of the vein-filling adhering to the limestone walls, the whole central portion having been eroded away by the sea.

The calcite which fills the veins has a mottled appearance and is of

two varieties, coarse cleavage pinkish-brown, and fine-grained cream-buff, the gold being invariably confined to the latter. The predominating pinkish-brown calcite was apparently the first to crystallize out and it forms the outer portions of the veins. Where cavities exist it assumes drusy-surfaced scalenohedra surmounted by curved-faced primary rhombohedra. The colour is due to included red haematite. The fine-grained cream-buff calcite usually occupies the central part of the veins and also fills the interstices between the coarse pinkish-brown crystals; it is developed, however, much more sparingly and is rarely continuous for any distance. Here and there are small cavities filled with yellowish or brownish highly ferruginous dolomite, which forms small distinct rhombohedra, or has altered to a friable ochre which in one case carries minute crystals of gold. Aragonite also occurs in some parts of the veins, forming snow-white silky radiating masses; and as flos-ferri, one cavity having yielded small worm-like stalactites of grotesque form. Some of the veins, particularly where narrow, are partially filled with calcite very heavily charged with minute scales of haematite forming a dense dull-red iron-ore, and one specimen of this shows dendritic crystallized gold. The only other mineral observed in these veins is muscovite, which occurs as minute scaly rosettes.

The gold is nearly always present as delicate dendritic or arborescent forms, which are extremely beautiful when partly freed from the enclosing calcite by immersion in dilute hydrochloric acid (Plate VI, fig. 1). Many of these growths are sometimes contained in quite a small piece of the vein-stuff, and in one or two cases attain a length of 5 cm. In general they consist of fern-like structures formed of a central rod with graduated branches and sub-branches all at 60°; each branch and sub-branch being usually terminated by a more or less distinct crystal (fig. 2). Twinning on the octahedron (111) is responsible for this arrangement. Examination under the microscope shows the individual crystals to be much elongated and misshapen, and in most cases they fail to give even moderately good measurements on the goniometer. The following forms have, however, been noted with certainty: (100), (111), (110), (210), and perhaps (311). On two of the specimens of the silver-white gold are some minute simple cubes grouped in parallel position, one of these crystals showing a single face (110).

In colour the gold varies from a bright rich gold to dull yellow; while in one vein it is almost silver-white, in this case being thickly distributed in dendritic form through a nearly white calcite.

The following assays, which were most carefully made for me by Mr. A. W. Dannatt of the Royal School of Mines, are interesting in that they show the gold to be of very exceptional fineness, and that even the silver-white gold (nos. 2 and 3), which from its appearance led one to suspect a high silver content, contains only a comparatively small amount of silver, far below that variety to which the term electrum has been applied. Metals of the platinum group are absent.

		No. 1, Bright rich gold.	No. 2, Silver-white gold.	No. 3, Silver-white gold.
Au	...	98·11	91·59	92·53
Ag	...	1·89	8·41	7·47

Altogether the occurrence is an interesting one, as, apart from the exceptional beauty of the arborescent forms in which the gold occurs, the fact of it being present in calcite veins in Middle Devonian limestone is I believe unique. Conjectures as to the origin of the gold would be futile. The finding of a mineral such as gold in so unexpected a quarter is moreover an object-lesson to the mineralogist in the field and impels one to look for similar occurrences in other of the Middle Devonian limestone tracts of the west of England.

Explanation of Plate VI.

Native gold from Hope's Nose, Torquay, Devonshire.

Fig. 1. Fern-like growths partly freed from the enclosing calcite by the action of dilute acid. $\times 1\frac{1}{4}$. (For this photograph I am indebted to Mr. Gilbert Adams, who took considerable pains with this difficult subject.)

Fig. 2. Isolated sprays. $\times 20$. In the larger spray, the terminal crystals are rhombic-dodecahedra. In the smaller spray, the branches consist of elongated spike-like cubes. (For this photomicrograph I am indebted to Mr. A. F. Hallimond.)

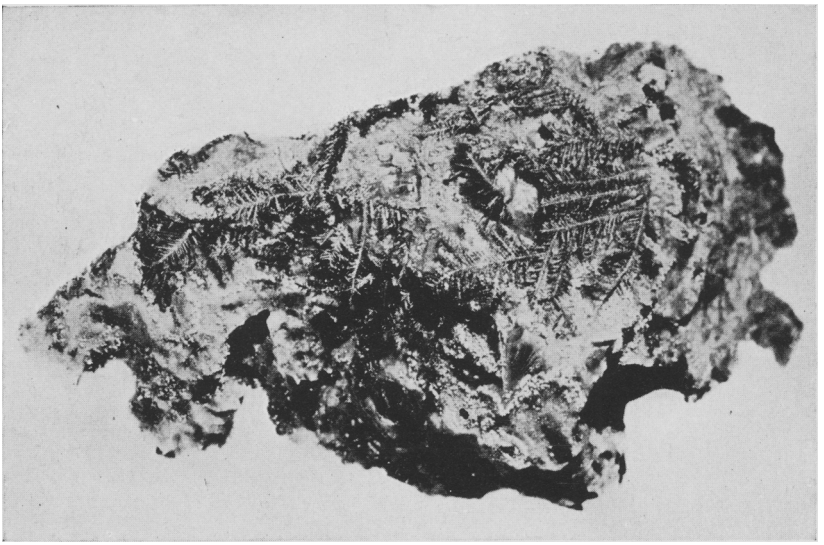

FIG. 1.

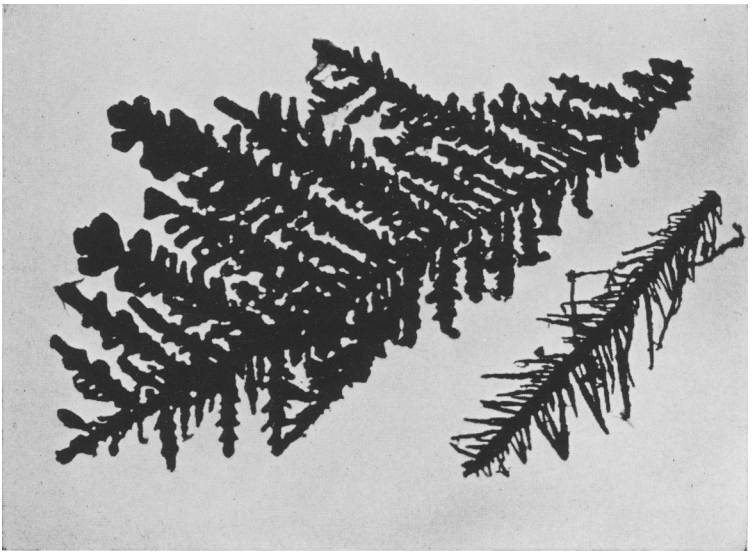

FIG. 2.

ARTHUR RUSSELL: NATIVE GOLD FROM TORQUAY, DEVONSHIRE.