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Compreignacite: a second occurrence, from St. Just, Cornwall

WHEAL EDWARD (NGR SW 360327) and West Wheal Owles (NGR SW 362329) are adjacent workings within the Wheal Owles sett, St. Just, Cornwall. The mines lie on a contact between granite and hornfels and worked mineralized fissure veins trending NW–SE which carried Sn and Cu. Some veins also carried uranium mineralization and 5 cwt. (*c.* 250 kg) of uranium ore was produced in 1878 and 1879. The mines ceased production in 1893 (Dines, 1930, 1956).

Spoil heaps around Wheal Edward incline shaft occasionally yield uranium minerals, and a specimen showing patches of a yellow botryoidal mineral was collected from here in 1971 by J. R. Knight and donated to one of us (GR). The infrared spectrum of the yellow mineral suggested a hydrous uranyl oxide, and the X-ray diffraction (XRD) pattern was similar to that of becquerelite (NHM X-ray film no. 5507F), but identification was not taken further at the time. Recent re-examination of this specimen by energy-dispersive X-ray analysis (EDX) and XRD (NHM X-ray film no. 8787F) has shown it to be compreignacite, $K_2(UO_2)_6O_4(OH)_6{\cdot}8H_2O$.

The mineral formed yellow translucent spherules up to 0.1 mm across on a dark mineralized hornfels containing chalcopyrite, siderite, pitchblende and K-feldspar. Small amounts of cuprosklodowskite were associated with the compreignacite, and uranophane, brochantite, connellite and calcite were also present on the specimen.

Compreignacite is a rare mineral, hitherto found only at the Margnac deposit, Compreignac, France (Protas, 1964; Granger and Protas, 1965), where it occurred, along with other yellow oxidation products, in alteration rinds surrounding uraninite nodules.

Further specimens of compreignacite (identified by EDX and XRD; NHM X-ray film no. 8788F) have recently been found at West Wheal Owles, St. Just, Cornwall. The specimens were obtained *in situ* in a backfilled stope on the Cargodna lode at approximately 12 m above adit level.

Compreignacite from West Wheal Owles most commonly forms thin crusts of transparent, bright yellow or golden-yellow, highly reflective crystals. The crystals are small ($\leqslant$ 1 mm), short prismatic, terminated by a basal pinacoid and often intergrown. In some crystals the pinacoid is bounded by prism faces giving it a rhombic or irregular hexagonal outline. However, the prism faces are often rounded producing an almost elliptical profile (Fig. 1). In the scanning electron microscope the crystals invariably show fracturing parallel to the pinacoid. Compreignacite possesses perfect cleavage on (001) and the observed fracturing may be an artefact due to instability in the vacuum or electron beam. Billietite, $Ba(UO_2)_6O_4(OH_2)_6{\cdot}4H_2O$, which is isostructural with compreignacite, shows a similar fractured appearance in the SEM, as does Margnac compreignacite (NHM specimens, BM 1957, 353 and BM 1969, 50 respectively). Cracks are also sometimes seen on (001) parallel to *a* and *b*; billietite shows this feature on heating to about 100°C, presumably as a result of dehydration (Vaes, 1949).

Euhedral compreignacite crystals are rare at West Wheal Owles, but rudimentary angle measurements on electron micrographs of several examples indicate that the prism forms {110}, {130} and less commonly {120} may be present along with {010} in various combinations and with variable development. Equal development of {110} and {010} produces pseudo-hexagonal tabular crystals (which often show small pyramidal modifications); these forms are frequently well developed in billietite (Frondel, 1958). The common elliptical outline is evidently derived from the rhombic habits, presumably by subsequent partial dissolution of the crystals.

Compreignacite is also found (rarely) as tiny subhedral blocky crystals, flattened on {001} and elongated along an axis perpendicular to *c* with

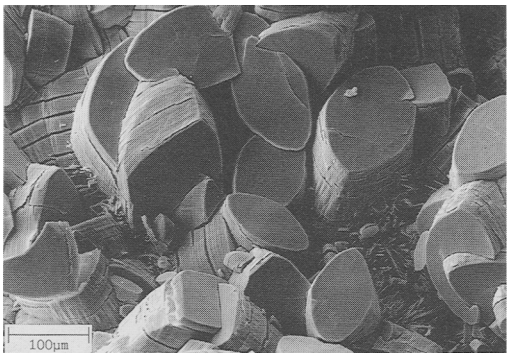

FIG. 1. Short prismatic crystals of compreignacite from West Wheal Owles, St. Just, Cornwall, showing elliptical profile and basal fracturing.

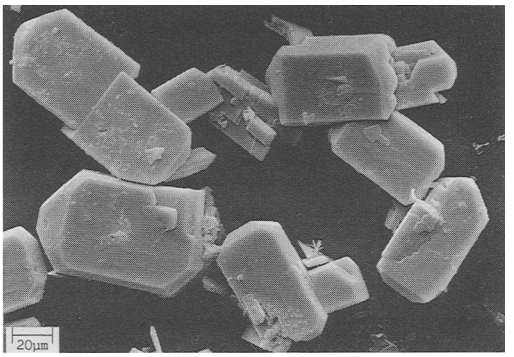

FIG. 2. Compreignacite from West Wheal Owles, illustrating the less common blocky habit.

variably developed modifying pyramidal faces (Fig. 2; cf. figure 1 of Protas, 1964). These crystals are often intergrown in small groups.

Protas (1964) observed that compreignacite from Margnac frequently formed twins on {110} producing tabular crystals with a pseudo-rhombic outline, but with well developed {102}. Repeated twinning on {110} produces aragonite-like pseudo-hexagonal crystals. None of the Wheal Owles compreignacite shows any morphological evidence for twinning.

At West Wheal Owles, compreignacite is found in intimate association with the uranyl silicates cuprosklodowskite and (less often) uranophane, both of which occur as mats and spherules of divergent crystals among and partially covering compreignacite crystals. Compreignacite is evidently the earliest formed of these minerals. Uranophane is also an intimate associate of compreignacite at Margnac. Other associated minerals include zeunerite, schoepite, brochantite, connellite and a Ce-rich agardite. Specimens often show morphological evidence that the uranyl silicates and other associated minerals were deposited from percolating fluids. All compreignacite found at West Wheal Owles occurred on open surfaces. The action of meteoric water subsequent to the initial formation of the compreignacite may explain the ill-defined faces of the crystals (which is in contrast to the sharp, well-developed crystals found at Margnac). Some of the crusts of compreignacite may have been formed by *in situ* alteration of uraninite. However, the rarer, blocky crystals are often found thinly scattered over quartz or friable matrices and may have been formed some distance from primary uraninite by deposition from percolating meteoric waters.

Compreignacite from West Wheal Owles is usually found on a matrix of mafic hornfels containing inclusions of flesh-coloured potash-feldspar. At Margnac, decomposition of potash-feldspar in the surrounding rocks was thought to be the source of K^+ ions necessary for the formation of compreignacite (Protas, 1964). A similar mode of formation seems likely at Wheal Owles.

Uranium species recorded previously from Wheal Owles include torbernite, uraninite, (Collins, 1871), uranopilite (Frondel, 1952, 1958) and cuprosklodowsite (Ryback and Tandy, 1992). Species recorded from Wheal Edward include torbernite, uraninite, autunite (Collins, 1871), metazeunerite (Wolloxal, 1988) and possibly phosphuranylite and saléeite (Ryback and Tandy, 1992). Minerals attributed to 'zippeite' have also been recorded at Wheal Owles (Collins, 1871), but such records should be regarded as non-specific, merely implying minerals of zippeite-like appearance. Frondel (1958) noted that uranopilite may have been confused with zippeite at this location in the past.

Samples of compreignacite from West Wheal Owles have been deposited at the Natural History Museum, London and the University Museum, Oxford.

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