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## Cumengéite from Cornwall

THE rare mineral cumengéite (formulated as  $Pb_{19}Cu_{24}Cl_{42}(OH)_{44}$  by Winchell and Rouse, 1974) has been found associated with other secondary minerals in the oxidized section of a vein carrying Pb-Cu-Sb mineralization. This is the first reported British occurrence of cumengéite (Dean, 1982) and this note presents additional chemical information on the find.

The deposit is located in the parish of Budock at Newport Beach (National Grid Ref. SW799303), approximately 2 km southwest of Falmouth, Cornwall. Middle Devonian shales, siltstones, and sandstones forming part of the Mylor Beds are exposed in the cliffs at Newport Beach, and have undergone low-grade regional metamorphism. The resulting phyllites show extensive small-scale folding with well-developed false cleavage oblique to the bedding. The bedding dips at about 50° to the southeast, whilst the cleavage dips approximately 60° in the same direction but is locally highly variable and associated with minor faulting (Edmonds *et al.*, 1975; Hill and MacAlister, 1906). Minor late-stage siliceous hydrothermal fluids bearing metallic elements, probably associated with the Upper Carboniferous emplacement of the Carnmenellis granite (Edmonds *et al.*, *op. cit.*), were intruded into these beds.

Little mining activity has been reported within the parish of Budock. Wheal Penrose, 1 km west of Newport Beach, near to Maenporth, is said to have produced Pb-Zn-Cu ores, but there are no records of yields (Dines, 1956). A lode was worked at the Swanpool mine, 1 km southwest of Falmouth, for Pb and Ag, and Wheal Pennance consisted of three trial shafts on an extension to this lode (Stephens, 1886). Shallow trial adits at sea level can still be seen along the coast at

Newport Beach; one of these explored a series of small quartz lenses, in one of which the cumengéite was found.

Primary minerals in this lens include galena, bournonite, and tetrahedrite, with minor chalcopyrite, pyrite, and pyrrhotine. Galena and tetrahedrite are well crystallized, the latter reaching 2 mm in size. Bournonite rarely exhibits crystal faces and occurs mainly in a massive habit. Quartz was the only observed gangue mineral.

The secondary minerals which have been found along with Fe(III) oxyhydroxides are cerussite, bindheimite, cumengéite, malachite, and atacamite. Cerussite is abundant and frequently forms twinned crystals up to 8 mm in size. Some of the cerussite is blue, but the origin of this colouration is not yet understood. This mineral often lines quartz vughs, in one of which was also found a single crystal of anglesite. Bindheimite,  $Pb_2Sb_2O_6(O,OH)$ , is the most abundant secondary species and forms thick, sulphur-yellow to yellow-orange, poorly crystalline crusts and masses with a resinous lustre, which often contain a core of bournonite in various stages of alteration. Cumengéite occurs as pale blue microcrystalline crusts coating bournonite, cerussite, quartz and the rock matrix, but is most frequently associated with bindheimite. Malachite and atacamite are intimately associated with bindheimite when it is present with cumengéite, and the four minerals often coalesce into an apparently amorphous mass.

The comparatively rare chloro-carbonate phosphogénite,  $Pb_2CO_3Cl_2$ , was also found in the oxidized assemblage. Single crystals up to 3 mm in size were frequently found lining quartz vughs and perched on quartz crystal groups.

The presence of bindheimite, cumengéite, and

atacamite was revealed by X-ray powder diffraction and microprobe methods. A partial analysis by microprobe of cumengéite intergrown with cerussite gave Pb 58.5, Cl 18.5, and Cu 17.7%; silver was not detected. The higher Pb values and correspondingly smaller Cu and Cl analyses with respect to the assumed stoichiometry (Winchell and Rouse, 1974) may be accounted for by the higher lead contribution due to the intergrown nature of the analysed cumengéite with cerussite.

The chloride ion, essential for the formation of cumengéite and atacamite, is clearly derived from sea-water which at high tide covers the section of the vein in which the minerals occur. In this respect, the locality is akin to that at Laurium, Greece, where cumengéite and other rare Pb(II) and Cu(II) halides occur in altered slags which have been dumped in the sea (Yedlin, 1973; Kohlberger, 1976). Cumengéite was first described from the Boleo deposits of Baja California where halite abounds in the rocks surrounding the mineralization, and is presumably the source of the chloride (Wilson and Rocha, 1955).

The new Cornish locality for cumengéite (and that at Laurium) is of some interest since studies of its chemical stability have recently been reported (Humphreys *et al.*, 1980; Abdul-Samad *et al.*, 1981). Chloride ion concentration is about 0.5 molal in sea-water, which has a pH of 8.0 to 8.4 (Krauskopf, 1979); such values are entirely consistent with the stability fields of cumengéite established by the above authors. It is apparent that the thermodynamic model developed by them is applicable to mineral assemblages of this type. Boléite,  $Pb_{26}Cu_{24}Ag_9Cl_{62}(OH)_{47} \cdot H_2O$ , and epitaxial pseudoboléite,  $Pb_5Cu_4Cl_{10}(OH)_8 \cdot 2H_2O$ , are also

expected to occur in the same environment should sufficient silver ion be present, but were not observed in the Cornish occurrence.

The presence of phosgenite in the oxidized sequence is also of some interest as its formation in this mineral assemblage confirms that reduced  $H_2CO_3^{(aq)}$  activities (Abdul-Samad *et al.*, 1982) are necessary for the formation of the complex halides of Pb(II) and Cu(II).

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## Tourmalinites from Belgium and from SE Ireland— a discussion

It has been recently postulated that tourmalinites found as pebbles in Devonian conglomerates in Belgium originated as a result of sub-volcanic

hydrothermal metasomatism of rocks of variable composition and origin (Fieremans and De Paep, 1982). These authors note that their conclusion