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Delafossite from Mina Remolinos Nuevo, Atacama province, northern Chile

FEW natural occurrences of delafossite, CuFeO_2 , have been adequately documented, and, in view of recent interest in this oxide (Hey, 1968; Wiedersich *et al.*, 1968), it seems worthwhile to describe briefly a new occurrence at Mina Remolinos Nuevo, Atacama province, northern Chile. A detailed study of this small copper-gold mine was carried out as part of an investigation of the mineralogy and controls of the supergene mineral alteration of copper deposits in the southern Atacama Desert (Sillitoe, 1969).

Mina Remolinos Nuevo exploits one of a group of over ninety tourmaline breccia pipes of Palaeocene age, located in the vicinity of the eastern margin of the early Tertiary or Upper Cretaceous Cabeza de Vaca granodiorite intrusion (Parker *et al.*, 1963). The approximately elliptical pipe has a vertical extent of at least 100 m, and contains hydrothermally altered blocks of granodiorite, which were initially cemented by tourmaline and quartz, paragenetically followed by chalcopyrite and pyrite, and

accessory hematite, magnetite, scheelite, bornite, galena, molybdenite, calcite, dolomite, and baryte.

Oxidized minerals and 'massive chalcocite' (a field term that includes at least five supergene copper sulphides, with djurleite predominating) are present in the pipe from surface to a depth of ~ 90 m. The supergene sulphides represent the remnants of a supergene enrichment zone of pre-Upper Miocene age, which was erosionally truncated during an extensive period of pedimentation (Sillitoe, Mortimer, and Clark, 1968). The 'massive chalcocite' has itself been oxidized, and the lower parts of the orebody have been affected by a later period of formation of powdery copper sulphides near to recent water tables.

The specimens of delafossite, collected from a depth of 81 m (level 4), consist of delicate, botryoidal masses, up to 4 mm in diameter, of a black powder resembling soot. The aggregates encrust prisms of hypogene quartz in cavities between the breccia fragments, and are associated with yellowish-brown goethite. Nearby occur small veinlets and pods of 'massive chalcocite', which is here composed almost entirely of djurleite. The 'massive chalcocite', and remnants of hypogene chalcopyrite, are coated by powdery djurleite and chalcocite. The 'massive chalcocite' is coated by cuprite and, less generally, by powdery tenorite. Fractures and open spaces in this immediate zone are lined with transported cuprite, often in well-formed cubes, dendritic native copper, goethite, an unidentified, porcellanous, clay-like supergene mineral, and minor beudantite.

Examination of polished sections of the spherical masses reveals a mosaic of anhedral delafossite grains, surrounded, in some areas, by a zone of elongate grains, up to ~ 0.5 mm in length, having a roughly radial arrangement. A small part of the delafossite is intimately intergrown with goethite. One delafossite aggregate contains several corroded grains, ~ 0.3 mm in diameter, of supergene djurleite, with cores of hypogene bornite, and marginally altered to flames of normal covellite. Another aggregate of delafossite, rich in goethite, encloses scattered grains of cuprite.

The identification of the delafossite was confirmed by partial X-ray powder data and electron microprobe analysis (Sillitoe, 1969).

It is considered that the delafossite in the Remolinos Nuevo deposit formed during the oxidation of a sulphide enrichment zone, near to the lower limit of the superimposed oxidation. The material described by Rogers (1913, 1922) also occurred close to the base of an oxidized zone, suggesting that this position is a consistently favourable one for the formation of this oxide. The Remolinos Nuevo delafossite was probably deposited directly from downward percolating solutions, although an unknown amount of replacement of the supergene copper sulphides has occurred. The solutions are presumed to have had a low activity of bicarbonate and sulphate ions, because malachite, azurite and brochantite, common constituents of much of the oxidized ore, are absent in the delafossite-bearing assemblages. The rarity of delafossite in the oxidized ores of this and other regions suggests that its formation is dependent upon a restricted set of conditions, which include the presence of both cuprous and ferric ions in the precipitating solution. It is noteworthy that, in an examination of mine waters, Emmons (1917) failed to find traces of the cuprous ion.

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Composition of a dolerite dyke, Mingulay, Outer Hebrides

THE Lewisian gneiss complex of the island of Mingulay, near the southern end of the Outer Hebrides, is cut by three large dolerite dykes of presumed Tertiary age (Bowes and Hopgood, 1968, fig. 2). Those on Dùn Mingulay and Rudha Liath trend approximately north-south consistent with the regional pattern of Tertiary dykes in this part of the Hebridean igneous province and that on Guarsay Beg follows a crush belt. The texture of the dykes is subophitic and they consist of labradorite (An₅₈), titanaugite, olivine, and opaque iron ores. Major element, trace element, normative, and modal data for the Dùn Mingulay dyke are given in table I. These data are recorded so that they can be used in studies of igneous activity in a wider context.

The number of the analysed specimen refers to the rock catalogue of the Hunterian Museum, University of Glasgow, and the information follows from the Glasgow University Exploration Society Expedition to Mingulay (Robertson *et al.*, 1964).

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