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Otavite from Montevecchio, Sardinia, Italy

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ABSTRACT

The rare mineral otavite $CdCO_3$ was found at the abandoned Pb-Zn mine of Montevecchio (SW Sardinia, Italy). Otavite occurs in the oxidised gossan, in association with aurichalcite. SEM imaging shows that otavite is composed of lenticular hollow structures containing aggregates of tiny rhombohedral crystals. Oxidation of primary Cd-bearing sulphides (sphalerite and greenockite) releases up to 24 ppm of Cd to drainage waters of the Montevecchio area. These waters are generally saturated with respect to otavite. Therefore, this mineral might play an important role in controlling Cd mobility in the environment.

KEYWORDS: otavite, Montevecchio Pb-Zn deposit, Sardinia, environmental geochemistry, phase equilibria.

Mr Domenico Preite, a mineral collector from Garbagnate (MI), recently brought to our attention a sample he had collected in the waste dump of the Minghetti stope at the abandoned Pb-Zn mine of Montevecchio (SW Sardinia). The Montevecchio-Gennamari-Ingurtosu mine system, once one of the largest in Italy and Europe, exploited quartz-sulphide veins emplaced within Ordovician metasediments near the contact with the Hercynian Arburese granitoid batholith. The sample consists of a small fragment of strongly oxidized gossan, where quartz grains are cemented by iron hydroxides, coated with a greenish-bluish and whitish patinae. Under the binocular, and by SEM observation, the greenish-bluish patina appears to consist of an aggregate of bladed elongated crystals, that X-ray powder diffraction indicates as aurichalcite (Fig. 1*a*), a copper-zinc carbonate long known at Montevecchio (cf. Binotto *et al.*, 1987-88). According to these latter authors, the platy habit of aurichalcite crystals is distinctive for Montevecchio, whereas it is uncommon elsewhere. The whitish patina is composed of lenticular shaped crystals (Fig. 1*b,c*). Their X-ray powder pattern shows the five strongest lines of otavite, the cadmium carbonate, with additional peaks of goethite. SEM/EDS determinations confirmed that the only major element detectable in the whitish crystals is Cd, plus traces of Zn and Pb (from contamination?). SEM imaging also shows that the lenticular 'crystals' are actually hollow and crustified structures, that contain aggregates of tiny rhombohedral crystals (Fig. 1*d*).

Otavite, first reported from Tsumeb near Otavi in Namibia (Palache *et al.*, 1951) is a quite rare mineral. For Sardinia, otavite is reported at the Pb-Zn San Giovanni mine near Iglesias (Vacca and Mura, 1992), but details of the occurrence and of identification techniques are not given; it is otherwise unknown elsewhere in Sardinia (P. Stara, personal communication, 1996). Its occurrence at Montevecchio may be of more significance than a simple mineralogical oddity. The Montevecchio-Gennamari-Ingurtosu mining complex is the subject of extensive studies aiming at the assessment of the environmental impact of the huge abandoned waste piles (cf. e.g. Fanfani, 1995). Primary ores contain appreciable Cd, that was long recovered as a by-product, mostly in the sphalerite lattice, but also in proper minerals such as greenockite (Binotto *et al.*, 1987-88). The oxidation of Cd-bearing sulphides releases Cd to the supergene environment, so that waters draining the area contain significant dissolved Cd (up to 24 ppm). Cadmium can be removed from the aqueous phase by incorporation in the lattice of carbonates such as calcite (Tesoriero and Pankow, 1996). Direct precipitation of $CdCO_3$ is also possible, under oxidizing, near-neutral to slightly basic pH conditions, from

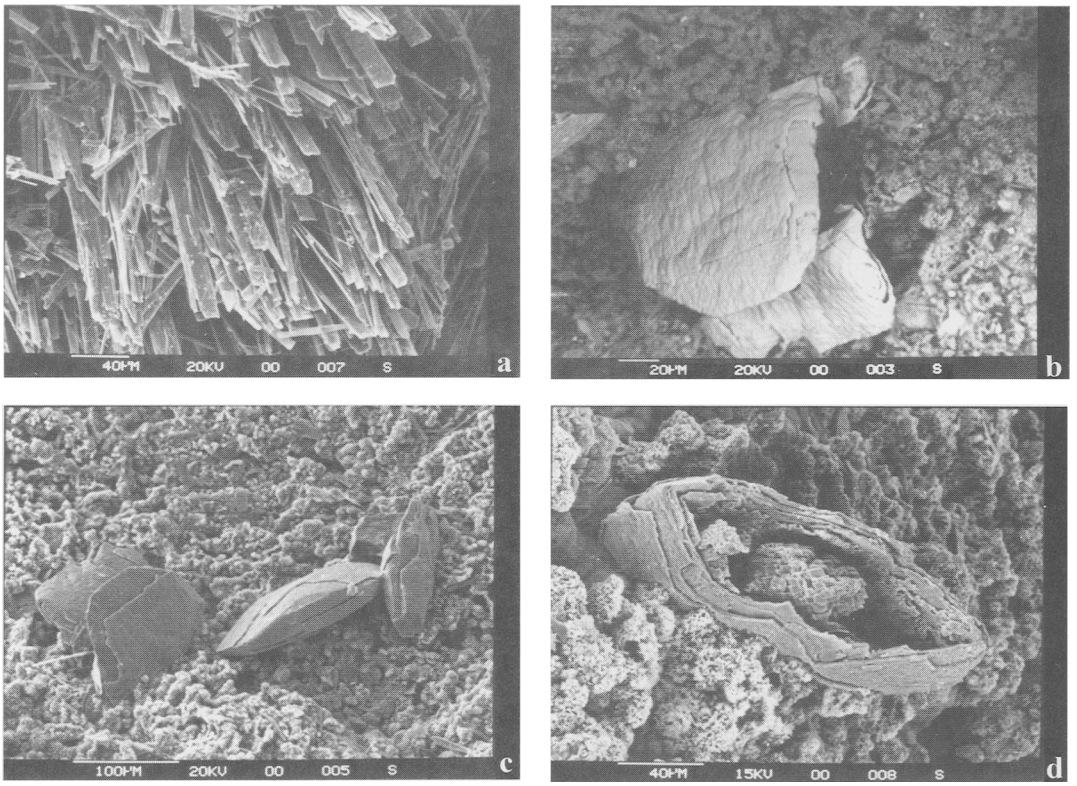

FIG. 1. SEM photomicrographs of Montevecchio minerals. (*a*) aurichalcite; (*b*), (*c*), (*d*) otavite.

surficial waters carrying unusually high concentrations of Cd (Salomons and Förstner, 1988). In surface waters at Montevecchio, activities of relevant dissolved species (calculated from the measured concentrations of Caboi *et al.*, 1996, by using the WATEQP code of Appelo and Postma, 1993) are typically the following: total S = 10^{-3}; $10^{-6.5}$ < Cd < 10^{-5}; 10^{-4} < total C < 10^{-3}; the most common values for Cd and total C fall in the range Cd = $10^{-6.5}$, total C = 10^{-3}, and Cd = 10^{-5}, total C = 10^{-4}. Hence, surface waters at Montevecchio are generally saturated with respect to otavite (Fig. 2). Whitish patinae are fairly common among the alteration products in the waste dumps in the area, and they are known to contain a variety of minerals (among them, hydrozincite would be especially common, Bertorino *et al.*, 1995). It is however possible that otavite is also present, and had gone unrecognized so far because of its inconspicuous appearance. Hence this mineral might play a role in controlling the release in the environment of Cd, an element of major concern for its high toxicity.

Acknowledgements

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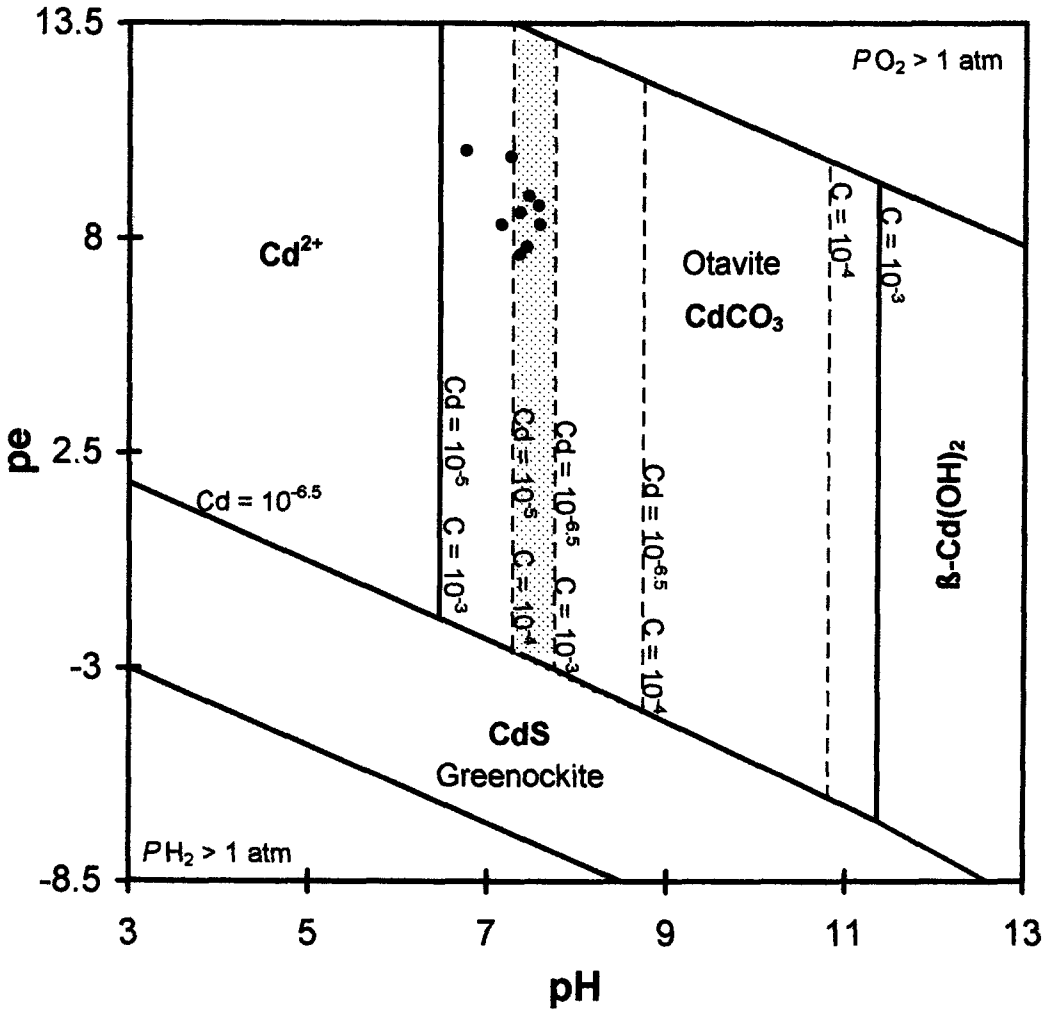

FIG. 2. pe–pH diagram showing the stability fields of phases in the system Cd–C–S–O–H. The diagram was constructed at 25°C, 1 atm, activity of total dissolved S species = 10^{-3}, by using the thermodynamic data of Stipp *et al.* (1993) and Stumm and Morgan (1996). The solid circles represent the pe and pH values measured in surface waters at Montevecchio; the shaded field encompasses the most typical range of Cd and total C activities in those waters (see text).

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