

# MINERALOGICAL NOTES

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## Rozenite and melanterite in lignitic layers from the Voras mountain, western Macedonia, Greece

SAMPLES of thin lignitic layers in which an interesting occurrence of rozenite and melanterite has been found were collected from the Poulovits area, 500 m from the Greek-Yugoslavia border. The area lies within the volcanics of the Voras mountain and is located 17 km NNW of Aridea, in western Macedonia. The volcanic rocks of this area, the Almopias volcanics, mainly of trachyandesitic composition, have been studied by Soldatos (1955), Mercier and Sauvage (1965), Marakis and Sideris (1973), Eleftheriades (1977), and Kolios *et al.* (1980). A series of volcanoclastic and sedimentary rocks overlain by tuffs and lavas occur in the area. Alternations of chert, pyroclastics, limestones, tuff and breccia either overlie a metamorphic basement, consisting of quartz-mica schists, calcitic schists and marbles or the volcanics themselves. In the Poulovits area, Chorianopoulou *et al.* (1984) have described lake sediments of siliceous limestones inter-

bedded with lignitic layers in which the rozenite and melanterite have been found.

This paper describes the new occurrence of rozenite and melanterite from the sulphide-rich lignitic layers.

**Rozenite-melanterite occurrence.** In the lignitic layers studied, microcrystalline massive sulphides, comprising pyrite and marcasite contaminated with organic compounds, have been observed. The sulphide-rich layers have a surface of loose material, yellow-brown in colour, consisting of gypsum, goethite and siderite. On these surface layers, white fibrous crystals of melanterite (fig. 1a), cotton like concretions of white rozenite (fig. 1b) and yellow spots of native sulphur are developed in places. *In situ* observations have shown that melanterite occurs in places where the rock is sufficiently wet (high humidity conditions), whereas rozenite occurs in places where the rock is nearly dry (low humidity conditions). Analogous phenomena have been described by Grunner and Hood (1971) in coal mine dumps, Perry County, Illinois, where the hydration state of  $\text{FeSO}_4$  is partially dependent in the relative humidity of the microenvironment. Cody and Biggs (1973) suggested that melanterite is formed by the hydration of rozenite at times of intense humidity in sandstones. Zodrow *et al.* (1979) summarize some alteration products of pyrite and their interrelationships in the Sydney coalfield (see Fig. 6, p. 68). They have observed a direct pyrite-rozenite link, which is based on apparently direct crystallization of rozenite on a block of pyrite shale. More recently Weise (1984) suggested that rozenite is formed by dehydration of melanterite in coal and xylites.

Chemical analyses of rozenite and melanterite from the Voras mountain, together with analyses from the literature, are given in Table I. The connection between pyrite, marcasite and the rozenite and melanterite studied is based mainly on XRD studies and field observations. Our rozenite and melanterite occurrences show a direct crystallization from pyrite and marcasite, since they have been observed as independent concretions coating as

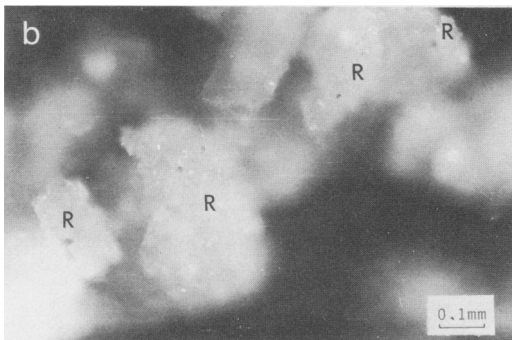
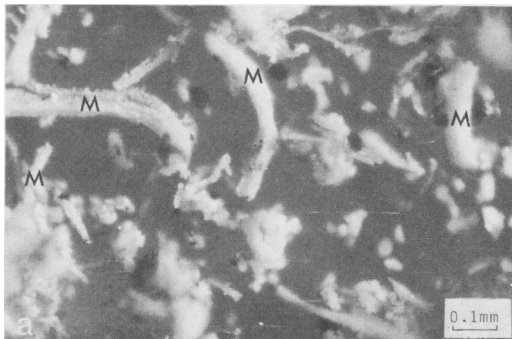


FIG. 1. Photomicrographs of (a) fibrous melanterite (M) and (b) rozenite (R) aggregates.

Table I. Chemical analyses of rozenite and melanterite from the Voras mountain, together with analyses from the literature

	1	2	3	4
H <sub>2</sub> O	32.22	32.17	32.98	44.36
SO <sub>3</sub>	35.93	35.74	36.29	29.23
FeO	31.72	32.09	31.13	26.88
MgO	-	-	0.97	-
Mn	-	-	0.06	-
Total	99.87	100.00	101.43	100.47

1. Rozenite (this study).
2. Rozenite after melanterite dehyd. (after Weise, 1984).
3. Rozenite (after Weise, 1984).
4. Melanterite (this study).

efflorescences these pre-existing minerals. No direct conversion of rozenite to melanterite and vice-versa has been observed. The stability field of rozenite and melanterite at room temperature as a function of relative humidity is given by Ehlers and Stiles (1965). They have demonstrated that rozenite is the stable phase for humidity conditions less than 70–80%, whereas melanterite is stable at higher values. These experimental results are in agreement with our *in situ* observations.

Thus, both minerals were probably formed by alteration of pyrite and marcasite, while their independent existence could be interpreted as initial formation in places of different humidity.

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- Weddell Sea (at 4434–5008 m) (Bannister and Hey, 1936). The mineral occurred as well-formed colourless, tetragonal, bipyramidal crystals, spacegroup  $I4/m$ ,  $a = 12.40$  and  $c = 7.37$  Å. The crystals were uniaxial (+),  $\omega = 1.523$ . The mineral has since been observed in other environments as documented by Mandarino and Witt (1983). The most commonly reported occurrences of weddellite are in the bottom sediments of aqueous environments.
- Weddellite has now been found in the sediments on Cape Herschel, Ellesmere Island, Northwest Territories. The mineral occurred in trace amounts in black sand lenses of stream sediments and in a raised beach deposit. The stream sands were covered by 3–10 cm of water while the sands on the raised beach were on dry land. Both deposits were made up of subrounded grains and pebbles reworked from glacial debris, but only the sand-sized fraction was examined.
- A fine coating of dust on the beach samples was removed, then all the samples were separated into heavy and light fractions. The weddellite occurred in the heavy fraction with garnet, amphibole, biotite, magnetite, ilmenite, pyroxene, hematite, chlorite, dolomite, and aragonite, attached to unknown grains. In the light fraction, it occurred as discrete grains associated with quartz, feldspars and calcite.
- Weddellite from Cape Herschel was colourless to orange-brown, and transparent to opaque, with a dull lustre. The grains were subrounded, porous, polycrystalline aggregates ranging from 0.3–0.4 mm, and crumbled easily as a result of weathering. Under the scanning electron microscope the most porous grain charged up, resulting in a poor image with a few poorly resolved shapes which may have been highly weathered crystals of weddellite. The more compact grains were more clearly resolved. These grains were almost completely massive, with a few poorly defined grain boundaries indicating a finely crystalline nature.
- X-ray powder diffraction data for weddellite was obtained using a 114.6 mm Gandolfi camera with Cu-K $\alpha$  radiation, then refined by the least-squares method using the cell parameters reported by Marlowe (1970). The refined values were found to be:  $a = 12.385(5)$  and  $c = 7.365(3)$  Å. These cell parameters are compared with the results of other workers in Table I.

**KEYWORDS:** rozenite, melanterite, lignite, Voras mountain, Greece.

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### Weddellite: a new occurrence

WEDDELLITE, a calcium oxalate hydrate,  $\text{CaC}_2\text{O}_4 \cdot (2+x)\text{H}_2\text{O}$ , was first found in bottom sediments of the

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