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Nováčekite and metanováčekite from Cornwall

NOVÁČEKITE, $\text{Mg}(\text{UO}_2)_2(\text{AsO}_4)_2 \cdot 12\text{H}_2\text{O}$, is isomorphous with saléeite, $\text{Mg}(\text{UO}_2)_2(\text{PO}_4)_2 \cdot 10\text{H}_2\text{O}$, its phosphate analogue. A number of incompletely characterised members of the saléeite–nováčekite series have been found in Cornwall (Ryback and Tandy, 1992), principally from Wheal Edward, St. Just. End-member nováčekite has now been confirmed on specimens found *in situ* on the footwall of a backfilled stope in disused mine workings at West Wheal Owles, St. Just (Grid. Ref. SW 362329). Identification was by energy dispersive X-ray (EDX) analysis and X-ray powder diffraction (NHM X-ray film number 8865F). Semi-quantitative EDX analysis gave $\text{P}_2\text{O}_5 < 0.3\%$ (below the detection limit). Small amounts of both Cu and Ca have been reported in analyses of nováčekite from Germany (Fron del 1951, 1958; Walenta, 1964). No Ca was detected in Wheal Owles nováčekite, but a little Cu was observed in most analyses ($\text{CuO} \leq 1\%$). XRD analysis showed that the lower hydrate, metanováčekite $\text{Mg}(\text{UO}_2)_2(\text{AsO}_4)_2 \cdot 4\text{--}8\text{H}_2\text{O}$, was also present, mixed with the nováčekite.

Walenta (1964) described three hydration states for nováčekite which he termed nováčekite I, nováčekite II and metanováčekite containing $12\text{H}_2\text{O}$, $10\text{H}_2\text{O}$ and $8\text{H}_2\text{O}$ respectively. Nováčekite I is unstable at room temperature and loses part of its water to form nováčekite II. In warm or dry conditions dehydration continues to produce the metahydrate. The process is reversible, and one day in a cold, damp atmosphere is sufficient to rehydrate metanováčekite to nováčekite II. Conditions within Wheal Owles are cool and damp, and other minerals found at this location that exhibit more than one state of hydration, such as zeunerite and tyuyamunite, occur as the higher hydrates (N. J. Elton and J. J. Hooper, in prep.). It is probable that the metanováčekite formed by dehydration of a higher hydrate subsequent to collection.

At Wheal Owles, nováčekite forms botryoidal crusts of interlocking plates and scales with an open 'egg-box' structure. Some individual crystals form euhedral plates, strongly flattened on [001] with a pseudo-hexagonal outline composed of forms {100}, {010} and {110}. Most of the crystals show fairly equal development of the prism faces, although some are elongated on [110] with unequal development of {100} and {010}. Modifying pyramidal forms are not discernible. Many of the crystals show subparallel growth and these habits are very similar to those described by Walenta (1964) from Anton Mine, Schiltach, Germany. Individual crystals are typically 10–20 μm across; some reach about 0.1 mm. The crusts are bright greenish-yellow, grading to almost white around the edges and exhibit vivid yellowish-green fluorescence under long-wave UV light. Both Fron del (1951) and Walenta (1964) described the fluorescence of nováčekite from Germany as weak or dull green and rather variable, but independent of hydration state. The weak fluorescence of German nováčekite contrasts with the bright fluorescence of the Wheal Owles nováčekite and the observation by Stern and Annel (1954) of bright lemon-yellow fluorescence in end-member nováčekite from Valencia County, New Mexico. Evidently fluorescence is a variable property and of no value in distinguishing nováčekite from saléeite. Walenta (1958) ascribed the fluorescence to a small amount of Ca in substitution for Mg, but later work with synthesised nováčekite proved this view incorrect (Walenta, 1964).

Nováčekite was first described from Schneeberg, Germany (Fron del, 1951) where it occurred in the oxidised zone of uraninite veins containing arsenides of Ni, Co and Fe. The resultant supergene assemblage included nováčekite and other arsenates of U together with arsenates of other metals including Ca, Co, Ni, Fe and Bi. The nováčekite described by Fron del (1951) is nováčekite II of Walenta (1964). The

highest hydrate has been recorded from Schmiedestollen tips, Wittichen; Anton mine, Schiltach and Michael mine, Lahr in the Black Forest region of Germany (Walenta, 1964). Nováčekite occurred as a coating on sandstone in Valencia County, New Mexico (Stern and Annell, 1954) and is also reported from Mexico, Brazil and Oklahoma, USA (Roberts *et al.*, 1990).

Recently, nováčekite has been identified on specimens collected in 1984 from Needle's Eye Dalbeattie, Kirkcudbrightshire, Scotland (Livingstone, 1993). Mineralisation at Needle's Eye occurs within dolomite-rich fissure veins in hornfels (Miller and Taylor, 1966). A complex suite of supergene minerals is found at this locality and the mineralisation is similar to that at Schneeberg and Wittichen (Braithwaite and Knight, 1990).

Wheal Owles primarily worked hydrothermal fissure veins for copper and tin; in the small section of workings presently accessible, hypogene mineralisation consists of predominantly Cu, Fe, As and Zn sulphides, with some uraninite. Nováčekite lined a small vug in quartz-sulphide veinstone containing chalcopyrite, arsenopyrite and sphalerite with a little biotite-type mica. The inner surface of the cavity was composed of altered quartzose-limonite to a depth of several mm and the nováčekite occurred on the surface of this oxidised layer. Nováčekite is not intimately associated with any other supergene mineral at Wheal Owles, although zeunerite (a common associate in other occurrences) occurs nearby. The wall rock is mafic hornfels, decomposition of which would readily provide the necessary Mg for the formation of nováčekite.

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