THE BREITENAU SPARRY MAGNESITE DEPOSIT (STYRIA, AUSTRIA), A PALEOZOIC MAGNESITE MINERALIZATION IN THE GRAZ PALEOZOIC OF THE EASTERN ALPS

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Abstract: The strata-bound Breitenau sparry magnesite deposit in the Graz Paleozoic lies embedded within a black shale facies occurring within an Upper Silurian silicate rock series which is characterized by a pronounced deficiency of carbonate sediments. The magnesite deposit is overprinted by diagenetic and post-diagenetic processes. Both the Upper Silurian rock series and its embedded magnesite deposit have been subjected to exactly the same succession of tectonic events and weak (low-grade) regional metamorphism.

Key words: Eastern Alps, Graz Paleozoic, magnesite, Paleozoic formation.

The Breitenau sparry magnesite deposit in the NE Graz Paleozoic (Styria, Austria) with its estimated total content of 50 million tons of magnesite constitutes the largest sparry magnesite deposit within the Eastern Alps and is situated at the northern slope of the Hochlantsch, strata-bound within the weak metamorphic overprinted “Laufnitzdorf Group”. This rock series represents formations of Upper Silurian to Upper Devonian age. The wall rock series of the magnesite deposit can be attributed to Upper Silurian formations. Very strikingly, the silicate rock series containing the strata-bound magnesite deposit is characterized by a pronounced deficiency of carbonate rocks such as limestone and dolomite. In contrast, the neighboring series exhibit considerable amounts of carbonate rocks, namely the “Kalkschieferfolge” (Lower Devonian to Upper Devonian) and in particular the “Hochlantsch Group” forming the tectonically highest unit and containing the up to 800 m thick Hochlantsch limestone, but are both characterized by a complete absence of magnesite.

The sparry magnesite of the Breitenau belongs to a strata-bound set of magnesite deposits which can be followed up by magnesite outcrops and deposits over a distance of several kilometers within the “Laufnitzdorf Group”. The magnesite ore body of the Breitenau deposit strikes around E - W, dipping around 25° to S, shows a thickness of up to 200 m

and can be followed over a distance of 1.7 to 2 km from a height of 800 m (open pit) above sea level to a depth of 200 m (underground mining) above sea level. In the subjacent part the magnesite body is accompanied by a fine-grained sedimentary dolomite of Upper Silurian age and showing a sharp boundary. The underlying bed of the magnesite body constitutes a carboniferous phyllitic schist, while the hanging wall is formed by metatuffite and carbon-rich phyllitic schist, the latter containing lydite. The magnesite deposit is partly strong tectonized, disturbed and thus exhibits numerous faults and displacements.

Magnesite (sparry magnesite, average contents: 2.69 wt.-% FeO, 0.295 wt.-% MnO, 0.34 wt.-% SiO_2, 71.7 or 17.8 ppm Sr, respectively < 2 - 1651 ppm Sr) occurs more or less as a monomineralic mineral constituent in the Breitenau deposit and often can be observed in relatively large crystals and crystal aggregates which can be up to several cm in length. Several types of magnesite occur, frequently such as white or light gray to dark gray or in places even black sparry magnesite. Extremely characteristic for the Breitenau deposit are banded magnesite and “magnesite suns”, while pignolitic magnesite is insignificant.

The lamination of the banded magnesite is of primary nature and has its origin in original, rhythmic successions or sequences and alternations of white pure and impure, dark to mostly gray, partially bituminous and in places also pyrite and/or argillaceous material containing carbonate layers of the original sediment. During late diagenesis, within the pure carbonate layers magnesite shows unhindered recrystallization and crystal growth and thus is often present in larger grain sizes, while magnesite within the impure carbonate layers exhibits impeded recrystallization and hindered, suppressed crystal growth. Dark layers or bands and lamina of magnesite in places are etched, broken or even completely dissolved. Although the magnesite is later finally overprinted by a weak (low-grade) regional metamorphism, primary textures are preserved. As a peculiarity banded magnesite exhibits load casts and thus reveals that originally unconsolidated, plastic, rhythmic alternations and sequences of magnesite were present, in which individual magnesite layers collapsed and impressed into underlying magnesite layers.

Extremely characteristic for the Breitenau deposit are “magnesite suns” (“Magnesit-Sonnen”), disclosing and documenting magnesite crystallization (partly of considerable grain size and length) within large open cavities. Dark gray to nearly black, mostly already lithified, or else in places likewise still plastic layers of fine-grained magnesite, accompanied by traces or small amounts of carboniferous matter and pyrite, constitute the substratum which often shows etching and, as a result of late diagenetic cementation over-

growth of light gray magnesite on a large scale, primary radial growth fabrics (magnesite crystals several cm, up to nearly 10 cm in length, cement generation I). This light gray magnesite cement generation I contains traces of carboniferous matter as a coloring pigment and is itself followed and overgrown by white magnesite in large scale primary radial growth fabrics (magnesite crystals likewise several cm in length, cement generation II) growing further into the open cavity. In places, this magnesite cement generation II itself can be followed and overgrown by large dolomite crystals ("Roßzahndolomit" – "horse tooth dolomite", cement generation III), finally forming the residual cavity fillings.

Distinctly tectonic stress has partly affected the magnesite and as a consequence in places even thicker magnesite breccias can be found. Hence, magnesite can reveal considerable postcrystalline deformation and cataclasis and even recrystallization.

Dolomite occurs as a minor or accessory constituent, while further accessory constituents, locally also minor constituents, are quartz and chlorite (clinochlore), and occasionally calcite can be found as an accessory constituent. From the mineral paragenetic point of view talc could be expected in this magnesite deposit, but is completely lacking. Carboniferous matter and pyrite form minor to accessory constituents, along with which the former also can appear somewhat more abundantly and also can be found forming "graphite mirrors" upon dislocation plans and slickensides. Locally sphalerite, chalcopyrite and rutile can be found as accessory constituents. From the mineralogical point of view, local evidence for magnetite is of interest. On the one hand magnetite exhibits pseudomorphs after older hematite ("mushketovite"), which is completely replaced. On the other hand magnetite itself is replaced by younger hematite ("martite"). Young formations are accessory barite and sphalerite upon joints, as well as cinnabar and millerite.

Likewise, the Breitenau magnesite deposit demonstrates very clearly that the trace element analysis of the rare-earth elements (REE) allows no reliable statements concerning the genesis of the magnesite. The REE content (Σ REE without Y) of the Breitenau magnesite varies between 1.515 ppm and 125.889 ppm, with an average of 20.621 ppm, and normally magnesite exhibits a negative Eu anomaly. Furthermore, a weak negative or positive Ce anomaly can be developed. In general, dark to black magnesite shows higher REE contents, whereas white magnesite is characterized by very low REE contents (e. g., banded magnesite). Conspicuously, magnesite very strikingly, in its "suns" and cavity fillings, also reveals a distinct to drastic decrease in the REE content from the dark gray to nearly black fine-grained magnesite substratum to its late-diagenetic cementation overgrowth of light gray magnesite (cement generation I) and then upon that white mag-

nesite (cement generation II), both in large scale primary radial growth fabrics, in places followed and overgrown by large dolomite crystals ("Roßzahndolomit" – "horse tooth dolomite", cement generation III) as final, residual cavity fillings. In addition, the REE distribution patterns of magnesite disclose that they are caused by foreign material and inclusions within the respective magnesite (samples), thus portraying the REE distribution patterns of this foreign material and inclusions. In contrast to this the secondary, mobilized, young magnesite which replaces the Upper Silurian dolomite is distinguished by REE distribution patterns similar to those of the replaced dolomite.

Valid conclusions concerning the genesis of the Breitenau magnesite deposit can be drawn from the geological findings. Distinguishing for this magnesite deposit is its strata-bound occurrence within an Upper Silurian silicate rock series which is characterized by a pronounced deficiency of carbonate sediments. The Breitenau magnesite deposit lies embedded within a black-shale facies, is overprinted by diagenetic and post-diagenetic processes and reveals a connection between subsidence and volcanic influences connected with this geological processes with regard to the effect of formation of saliniferous solutions. A feeding of epigenetic hydrothermal or metamorphogenic-hydrothermal solutions causing magnesite metasomatism does not apply for the Breitenau sparry magnesite. The Breitenau magnesite deposit exhibits exactly the same tectonic stress as well as exactly the same (several) tectonic deformation processes and weak (low-grade) regional metamorphism, as does the surrounding "Laufnitzdorf Group" in which the strata-bound Breitenau magnesite deposit lies embedded. In conclusion, the Upper Silurian Breitenau magnesite deposit has passed through the entire tectonic and metamorphic geological development of the "Laufnitzdorf Group". The Breitenau deposit within the Upper Silurian of the Graz Paleozoic represents an only low-grade regionally metamorphically overprinted sparry magnesite deposit of the Radenthein (Carinthia) type.