Mineralogical Constraints on Paleoenvironmental Changes During Formation of the Eplény Manganese Deposit, Bakony Mountains, Hungary

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The Early Jurassic Toarcian Anoxic Event (T-OAE) is associated with manganese mineralization that is economically important in some locations and is well known worldwide. In Hungary, there were two closely located important manganese deposits, with two operating mines at Úrkút (closed in 2016) and at Eplény (closed in 1975). At Eplény, during the active mining operations, 233 boreholes were drilled, but the cores are difficult to access and thus were not investigated for decades. This study is a modern mineralogical investigation of the Eplény Mn-deposit based on recently recovered archive drill core samples.

The Eplény deposit can be divided into a western and an eastern part. The western part contains iron-rich, siliceous, primary manganese ores that overlie lower Jurassic limestones that continuously evolved from the Triassic Dachstein-type platform carbonates. The elevated eastern part contains secondary manganese ores that were reworked during the Eocene. The western area can be further subdivided into two other parts. The larger one contains only manganese oxides, whereas the smaller one, which represents the deepest part of the Eplény basin, also contains manganese carbonates near the manganese oxides.

Contributing to a sample/data preservation campaign in the last three years, we had the unique opportunity to access the old drill core from the Úrkút manganese mine that held the samples from the Eplény deposit after its closing. During a period of three months, we archived more than 22,000 drill core samples from both deposits from which more than 200 samples were selected that were representative of the Eplény mining area and favorable for detailed investigations.

Stereo and polarized reflected light microscopy, X-ray microanalysis, Raman spectroscopy, micro X-ray diffraction, X-ray powder diffraction, optical emission and mass spectrometry, and X-ray fluorescence spectroscopy were applied to the selected samples. The main ore minerals (pyrolusite, todorokite, cryptomelane, hollandite, rhodochrosite, kutnohorite, and lithiophorite) and gangue minerals (quartz, calcite, feldspars, pyrite, gypsum, and clay minerals), their distribution, and their textural relations were described.

The textures of the primary manganese oxides in the western part are mainly botryoidal, stromatolite-like. The manganese carbonates in the deepest part of the deposit are always related to different fossils as manganese-bearing carbonate shells with varying Mn content, or as overgrown phases on fossils. The manganese content of these phases decreases upward in the Úrkút Manganese Formation (ÚMF). In the reworked eastern part of the investigated area, ores occur as vein-filling manganese oxides in limestone, and their textures show evidence of fluid flow during at least three different time periods.

In the deepest part of the deposit, which represents the most complete stratigraphic column, continuous changes were detected in the redox condition upwards from the bottom of the ÚMF. In the lower part, Mn^{4+} containing minerals are characteristic, but these are gradually replaced by Mn^{2+} minerals upwards, indicating the extension of the anoxic environment during the T-OAE. This observation is important for identification of the local geological environment, which essentially contributes to a better understanding of the processes that led to the economically viable Mn-accumulations in the Úrkút-Eplény area.