Geringer, Annika[1]; Grasemann, Bernhard[2]; Weber, Leopold[3]; Melcher, Frank[4]; Schuster, Ralf[1]

Polyphase deformation of the Graz Paleozoic recorded in the Pb-, Zn-, Ba- and Ag-bearing Arzberg deposit

[1]GeoSphere Austria, Neulinggasse 38, 1030 Wien, Österreich;
[2]Institut für Geologie, Universität Wien, Josef-Holaubek Platz 2, 1090 Wien, Österreich;
[3]Gentzgasse 129/2/45, 1180 Wien, Österreich;
[4]Lehrstuhl für Geologie und Lagerstättenlehre, Montanuniversität Leoben, Peter-Tunner Straße 5, 8700 Leoben, Österreich;
annika.geringer@geosphere.at

The Arzberg mine in Styria (Austria) reveals a long history of mining for silver, lead and zinc with a first documentation as early as 1242. Arzberg is one of the biggest occurrences of Pb-, Zn-, Ba- and Ag-bearing SEDEX (sedimentary exhalative) deposits situated in the Schöckel nappe of the Graz Paleozoic (Drauzug-Gurktal nappe system, Austroalpine Unit). The stratiform mineralization is dominated by galena, sphalerite, barite, pyrite and pyrrhotite and accompanied by chalcopyrite, arsenopyrite, fahlore, pyrargyrite, tetradymite, cobaltite, ullmannite, breithauptite, electrum and others. The mineralization is hosted by the upper Silurian to Lower Devonian Schönberg Formation (Arzberg Schichten), which consists of polyphase deformed, greenschist facies metasediments and metavolcanics. This represents an euxinic shelf sequence grading from siliciclastic to carbonatic sedimentation with minor basic tuffogeneous intercalations. It is overlain by the thick carbonate sequence of the Schöckel Formation.

The Arzberg mine is situated a few hundred meters below the SE dipping boundary of the Schönberg and Schöckel Formation. Competence contrasts cause more intense deformation and tectonic slicing along the boundary, whereas the internal deformation within the Schönberg Formation is simpler. In the mine the macroscopically visible deformation is polyphase and three stages can be recognised: (1) The first deformation event occurred during greenschist facies metamorphism and was associated with ductile shearing towards SE. This process led to the development of metamorphic layering, mylonites and phyllonites, as well as the formation of isoclinal folds with fold axes roughly parallel to the shear direction. Within this shearing process, multiple fluid pulses contributed to the creation of syn-shearing veins, which exhibit rotation and stretching to varying degrees confirming the SE-directed kinematics. The subsequent (2) deformation phase resulted in the formation of SE-vergent folds, superimposed upon the pre-existing mylonitic to phyllonitic foliation. The rocks exposed in the area of the Raabstollen may represent the upper limb of a SE-verging antiform, with a hinge area located at both the entrance and the end of the Raabstollen. All of these preceding ductile structures have been overprinted by a (3) phase of ductile/brittle faulting, along with hydrofracturing, and EW-extension accommodated by normal faults with clay gouges.

The ore mineralizations are primarily concentrated within two up to several decimetre-thick layers roughly parallel to the main foliation, which are structurally separated by approximately 30 m. The lower ore horizon is dominated by Fe-Pb-Zn-Cu-sulfides, whereas the upper ore horizon by barite along with magnetite and galena. Two major E-dipping faults displace the ore horizons, where an offset about several tens of meters is presumed. These two major E-dipping faults and numerous smaller faults with centimetre to meter offsets suggest a major component of WE-extension during the deformation phase 3, which is consistent with the lateral extrusion of central parts of the Eastern Alps towards the Pannonian Basin in the E.

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