Dolomite of the dolomites: a role in the genesis of Alpine MVT deposits?

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Mississippi-Valley Type (MVT) Pb-Zn ore deposits are potential targets for critical raw materials such as Ge and Ga, essential for the green transition. Four major MVT deposits are located around the Periadriatic lineament: Raibl and Salafossa in the Southern Alps (Italy), and Bleiberg (Austria) and Mežica (Slovenia) in the Drau Range. All these deposits are hosted in Ladinian-Carnian dolomite, show nearly identical parageneses, and formed at temperatures compatible with reflux circulation during the growth of a carbonate platform under arid climate (e.g., Manning and Emsbo 2018).

Dolomite units in the Dolomites UNESCO World Heritage Site, and the broader Southern and Northern Calcareous Alps, are divided into two main series. The lower >1000 m-thick Anisian to lower Carnian (ca. 242-234 Ma) dolomites are massive, coarse crystalline and replaced limestones. They host MVT deposits and remain severely understudied. Overlying them are 200-2000 m of late Carnian to Rhaetian (ca. 230-200 Ma) layered dolomites, the "Hauptdolomit", more finely crystalline and rich in fossils and sedimentary features, which formed in wide carbonate platforms and coastal sabkhas under arid climate.

Our working hypothesis is that the lower dolomites resulted from reflux dolomitization, i.e., replacement of limestones by dense, Mg-rich brines formed in the late Triassic on evaporitic carbonate platforms-sabkhas of the Hauptdolomit. Brines percolated downward through the sedimentary column, reached temperatures sufficient to leach metals at depths of 2-3 km in the crust, and later precipitated Pb and Zn in MVT deposits under favorable physicochemical conditions.

This project aims to investigate the entire dolomitization system, from precipitation of sedimentary dolomite of the Hauptdolomit to Mg-rich brine generation and metal precipitation. We will sample dolomite at different stratigraphic levels in the Dolomites area and near and within the MVT deposits. Petrographic, mineralogical, and geochemical characterization will include optical and cathodoluminescence microscopy on thin sections, XRD, SEM-EDX, ICP-MS, and stable isotope analyses.

We will also apply advanced microstructural and isotopic approaches, including clumped isotope thermometry ($\Delta 47$), to constrain mechanisms, temperatures, and fluid evolution during the reflux, burial, and hydrothermal stages. Sulfur isotope analyses will constrain fluid sources and redox conditions related to mineralization; trace element and REE-Y geochemistry will fingerprint fluid-rock interaction processes. Microstructural analyses (XRD, SEM, TEM, Raman) will assess recrystallization stages and dolomite ordering. Integration of isotopic and geochemical data will lead to a quantitative model of fluid evolution and dolomitization linked to ore genesis.

The project will be carried out in collaboration with carbonate isotope and dolomitization specialists of the University of Granada, Spain.

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