



## Isotopic composition of sulfate accumulations, Northern Calcareous Alps, Austria

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The Eastern Alps are characterised by the presence of three main tectonic units, such as the Lower, Middle and Upper Austroalpine, which overlie the Penninicum (Tollmann, 1977). The Upper Austroalpine unit consists of the Northern Calcareous Alps (NCA) overlying the Greywacke zone and corresponding to the Graz Paleozoic, Murau Paleozoic and the Gurktal Nappe. Evaporitic rocks are lacking in the later ones. The Northern Calcareous Alps are a detached fold and thrust belt. The sedimentation started in the Late Carboniferous or Early Permian, the age of the youngest sediments being Eocene. The NCA are divided into the Bajuvaric, Tirolic and Juvavic nappe complexes. The evaporitic Haselgebirge Formation occurs in connection with the Juvavic nappe complex at the base of the Tirolic units (Leitner et al., 2013). The Haselgebirge Formation consists mainly of salt, shales, gypsum and anhydrite and includes the oldest sediments of the NCA. The age of the Haselgebirge Formation, established by using spores and geochronological data, is Permian to Lower Triassic. For the Northern Calcareous Alps, the mineralogy of sulphate accumulations consists mainly of gypsum and anhydrite and subordonates of carbonates. The carbonates as magnesite, dolomite and calcite can be found either as singular crystals or as small accumulations within the hosting gypsum. Sulfides (sphalerite, galena, pyrite), sulfarsenides (enargite, baumhauerite) and native sulphur enrichments are known from several deposits (Kirchner, 1987; Postl, 1990).

The investigated samples were selected from various gypsum and halite rich deposits of the Northern Calcareous Alps. A total of over 20 samples were investigated, and both oxygen and sulfur isotopic composition were determined for anhydrite, gyps, polyhalite, blödite and langbeinite. The sulfur isotopic values vary between 10.1 to 14 ‰ (CDT), with three values higher than 14 ‰. The Oxygen isotopic values show a range from 9 to 23 ‰ (SMOW). The sulfur isotopic composition of 14 sulfides as galena, sphalerite, pyrite and native sulfure were determined as well, with values ranging between -17.5 and 2.8 ‰ (CDT).

For the investigated sulfates, the  $[U+F064]$  sulfur isotopic values show generally low values, which are characteristic for the late Permian. The broad distribution of sulfide values point toward bacterial reduction, fact also reflected by some higher  $[U+F064]$  isotopic values of sulfates. The  $[U+F064]$  oxygen values show a larger scatter from 9 to 23‰ which is even larger than that found for the Zechstein anhydrites of northern Germany, north-eastern Italian Alps or western Poland. The associated carbonates, as calcite, dolomite and magnesite are in disequilibrium with the sulfates indicating rather primary marine isotopic signature than re-equilibration with the sulfates at higher temperatures.

### References

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