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Reconstructing geochemical conditions during dolomite formation in a Carnian coastal sabkha using 87Sr/86Sr isotopes - Travenanzes Formation, northern Italy

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The geochemical conditions that were conducive to primary dolomite formation in extremely shallow evaporitic environments along the Triassic Tethyan margin are still poorly understood. While the massive Triassic dolomites in the Austroalpine and South Alpine realm are largely affected by diagenetic or hydrothermal overprint, Preto et al. (2015) provide evidence of primary dolomite based on nano-crystal aggregates observed under the transmission electron microscope. These dolomites are intercalated in a 100-m-thick sequence of clay (Travenanzes Formation, Southern Alps), deposited on a semi-arid coastal plain in the Late Carnian (Tuvalian II). They may serve as a geochemical archive of evaporative brine composition at the time of dolomite formation.

Petrographic and field observations revealed that dolomites occur as three different types, (1) dm- to m-thick homogenous beds, (2) mm-scale laminated (stromatolitic) beds and (3) nodules associated with root traces and palaeosols. In all types, the dolomite is stoichiometrically and structurally well ordered. While the homogeneous dolomites occasionally show a peloidal structure, all types of dolomite are generally microcrystalline. Soft sediment deformation, or brittle deformation with mud infill indicates that the dolomitic sediment was largely unlithified at the time of deposition. We analysed the dolomites under the SEM in backscatter mode and observed largely anhedral structures with grain sizes in the μm-range. The laminated dolomites consist of mm- to cm-scale clay-dolomite alternations, whereby the dolomite often shows a spherulitic growth near the dolomite-clay interface, where further recrystallization was inhibited.

We measured strontium isotope ratios (87Sr/86Sr) as an indicator for the source of alkalinity driving dolomite precipitation. Our data are in a range between 0.707672 (homogenous dolomite) and 0.707976 (both 2σ: 4*10-5) (nodular dolomite) indicating a similar trend as in Triassic seawater during the Carnian (Korte et al., 2003). 87Sr/86Sr ratios of homogenous dolomite beds and peloidal grainstone plot near to the seawater curve indicating a formation of dolomite in a lagoonal or intertidal environment influenced by evaporating sea water. Synsedimentary deformation and reworking of some laminae may indicate tidal currents or storm events. Cuspate-upward deformed lamination most likely results from desiccation cracks. Laminated dolomites are slightly more radiogenic than the seawater curve, indicating an influence of continental groundwater as observed by Müller et al. (1990) in the landward parts of the modern Sabkha of Abu Dhabi. A bit more radiogenic values occur in the nodular dolomites associated with palaeosols and large amounts of clay. Presumably, these palaeosols formed at times of seawater lowstand when the supratidal flat was subject to more continental influence. At the same time, dolomites from the Germanic Keuper Basin (also Upper Triassic) are much more radiogenic and were clearly formed by continental groundwater as an ionic source. In conclusion, 87Sr/86Sr-ratios very well match the sedimentary conditions in a sabkha with seasonally humid episodes as suggested by the palaeoenvironmental reconstructions. This confirms that ancient primary dolomites can indeed serve as geochemical archives.

Korte et al. (2003) Geochimica et Cosmochimica Acta 67, 47-62.
Müller et al. (1999) Geology 18, 618-621.
Preto et al. (2015) Sedimentology 62, 697-716.