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Late Triassic climate change recorded by the oxygen isotopic composition of early diagenetic dolomite (Dolomites, Northern Italy)

Anna Breda (1), Nereo Preto (1), Jacopo Dal Corso (2), Christoph Spötl (3), Tomaso Bontognali (4,5)

(1) University of Padova, Department of Geosciences, Padova, Italy (anna.breda@unipd.it), (2) University of Leeds, School of Earth and Environment, Leeds, United Kingdom, (3) University of Innsbruck, Institute of Geology, Innsbruck, Austria, (4) ETH Zurich, Department of Earth Sciences, Zürich, Switzerland, (5) Space Exploration Institute, Neuchâtel, Switzerland

Carbonate marine sediments may precipitate in equilibrium with sea-water, but shallow-water carbonates are usually subject to intense and complex diagenesis, so that their depositional carbon (δ 13C) and oxygen (δ18O) stable isotope signature is frequently overprinted.
During the late Carnian (Late Triassic) in the Dolomites (Northeastern Italy), a mixed carbonate-siliciclastic succession (Travenanzes Fm.) was deposited in arid-semi arid supratidal mudflat, carbonate tidal flat and shallow subtidal environments. Upwards, this succession passes gradually into peritidal sedimentary cycles of the Dolomia Principale. Both formations consist of dolomite.
The δ 13C and δ18O of 155 dolomite samples from three stratigraphic sections encompassing the Travenanzes Fm. were analyzed. Four main dolomite types were identified on the base of sedimentological and petrographic observations: dolomite cement of fluvial sandstones, dolocrete nodules, aphanotopic dolostones of tidal ponds or supratidal playa-lakes, stromatolitic and bioclastic dolostones with marine fossils.
δ 13C values scatter widely from ca. -6‰ to +4‰ but each sedimentary facies shows characteristic values. This has been interpreted as differential early diagenesis (Preto et al., 2015), but it also suggests that this early diagenetic signature was not further modified during burial.
δ18O values vary within a narrow range from ca. 0‰ to +3‰ṫhese data are consistent with dolomite precipitation from Carnian sea-water (cf. Korte et al., 2005) and show a consistent ca. 3‰ positive temporal trend in all sections. The δ13C and δ18O data are uncorrelated (R2 < 0.001).
Primary precipitation of dolomite (or its precursor) may have occurred either in microbial mats within the first centimeters of supratidal sediment, similarly to the sabkhas on the coasts of the Persian Gulf, or directly from the water column in tidal ponds or supratidal playa-lakes intermittently isolated from the sea. This primary dolomite is however a volumetrically minor portion of the final dolomite rock. To explain the uniformity of δ18O values across facies, we propose that early diagenetic ripening to fine crystalline dolomite (< 10 μm) took place in the first few centimeters to meters of sediment, within a saline to mixed groundwater beneath the supratidal flat and in contact with seawater and the atmosphere. The average mean annual temperature of this groundwater was related to the average sea surface and mean annual air temperatures. Consequently, the δ18O values of fine crystalline dolomites likely recorded the local sea-surface temperature. In fact, the positive trend recorded by the three studied successions is consistent with a late Carnian drop in sea-surface temperatures recorded by δ18O data of conodont apatite (Trotter et al., 2015).
As the supratidal flat prograded onto lagoonal sediments, the ripening of dolomite in the near-surface groundwater affected all peritidal sediments and nearly occluded all pore space, impending further precipitation of late (burial) dolomite and preserving the early diagenetic δ18O signature.

Korte et al. (2005) Palaeogeography Palaeoclimatology Palaeoecology, 226, 287–306.
Preto et al. (2015) Sedimentology 62, 697-716.
Trotter et al. (2015) Earth and Planetary Science Letters 415 (2015) 165–174.