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Petrographic analysis of Triassic lacustrine dolomites from the Germanic Basin

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It is still argued if the large amounts of dolomite [$CaMg(CO_3)2$] in the geological record formed early, in evaporative environments or if they are a late diagenetic overprint. Based on preserved nanocrystalline structures Preto et al. (2015) conclude that dolomites from the Travenanzes Formation may have formed as a primary precipitate. This would be consistent with observations from modern lake environments suggesting primary dolomite formation in Deep Springs Lake in California (Meister et al., 2011). Further petrographic and analytical characterization of ancient dolomites is necessary to validate such a primary pathway of dolomite formation.

We studied dolomite beds intercalated in a clay-rich sequence from the Arnstadt Formation (Germany) to reconstruct the depositional conditions and processes conducive to primary dolomite formation in a playa-lake/perennial-lake system in the Germanic Basin during the Norian. This system is ideally suited to test the hypothesis of primary dolomite formation as the Germanic Basin has experienced relatively little burial overprint and dolomites are constrained to lacustrine, partially evaporative conditions (Reinhard and Ricken, 2000).

Dolomite samples have been collected within the stratigraphic context in several measured sections in Thuringia and Lower Saxony. Mineralogical analysis by X-ray diffraction showed stoichiometrically ordered dolomite and no other carbonate phase. Thin sections analysed under the light microscope mostly exhibit graded lamination and reworked mudclasts embedded in a dolomicrite matrix. This indicates reworking and slumping of largely unlithified fine-grained carbonate mud, suggesting precipitation directly from oversaturated brine. Some dolomites show a densely packed peloidal structure, where the peloids are deformed due to compaction and thus were still partially unlithified at the time of deposition. The microfacies of the dolomites generally indicates a shallow evaporative environment, independent of the position in the stratigraphic section. Oxygen isotope values ranging between -5.21 and -0.36‰ VPDB only indicate a small isotopic influence of meteoric water. This suggests that dolomites form as a results of episodically evaporative conditions. Carbon isotope values in the range of -4.28 to 1.39 ‰ VPDB indicate a small contribution of remineralized organic carbon, probably due to early diagenetic lithification of primary dolomite mud. In conclusion, sedimentary structures and isotopic compositions are consistent with a primary precipitation of the dolomite in a large playa lake in the Germanic Basin during the Norian.

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Preto, N. et al. (2015) Sedimentology 62, 697-716.

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