Pore water analysis to determine conditions for recent dolomite formation in Lake Neusiedl, Austria

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The formation of dolomite $[CaMg(CO_3)2]$ is rarely observed in modern environments, probably due to its kinetic inhibition or extremely slow precipitation. Most sites of Holocene dolomite formation are coastal evaporative plains (sabkhas) or coastal ephemeral lakes, but dolomite is also observed to form in endorheic lakes. Lake Neusiedl, located at the Austrian-Hungarian border, is the largest evaporative lake in western Europe, and its sediment consists largely of authigenic Ca/Mg-carbonates, including poorly ordered dolomite (protodolomite). Only a few studies so far have addressed the formation of dolomite in Lake Neusiedl (e.g. Neuhuber et al., 2015), and it remains still unclear where in the sediment or at the surface the dolomite forms, from where ionic solutions originate, and how dolomite formation is influenced by microbial metabolic activity.

Here, we present first results of a porewater extraction and analysis combined with a sedimentary and mineralogical analysis of up to 60-cm-long sediment cores taken at Rust Bay, on the western side of the lake. Decreasing concentration of sulphate with depth and accumulation of sulphide indicates ongoing microbial sulphate reduction. Also increasing ammonium and DIC concentration of up to 0.5 and 20 mmol/l, respectively, indicate dissimilatory microbial activity in the sediment. Methane production is occurring in the presence of sulphate and is, thus, incompletely consumed by anaerobic methane oxidation. A slight decrease of pH with depth could be due to microbial activity, which would be expected based on the stoichiometry of the reactions involved. When calculating the saturation indices from the porewater data, it was observed that dolomite is most supersaturated, while calcite and aragonite are only slightly supersaturated, and supersaturation slightly decreases with depth. Under such conditions, Mg-calcite, within a certain range of Mg content, would be undersaturated. A decreasing supersaturation in the lake sediment, due to sulphate reducing microbial activity, would not support carbonate precipitation from the porewater.

X-ray diffraction showed the presence of calcite, magnesium-calcite and protodolomite, and downcore distribution of Mg/Ca ratios revealed no shift in the stoichiometries of the different carbonate phases. There is no clear trend in relative abundance of the different carbonate minerals, but rather abrupt changes occur. In particular, a decrease in Mg calcite occurs at ca. 30 cm depth, at the transition from homogenous mud to dark laminated mud, showing root structures. We interpret from this distribution that no ripening of metastable carbonate phases (disordered Mg-calcite) to ordered dolomite has occurred but that the change in composition is related to a change in chemical conditions in the past. The transition from laminated mud to homogeneous mud may have been related to a rise in lake level and, therefore, a change in ionic composition of the lake water. Extrapolating from the radiocarbon ages of Neuhuber et al. (2015), this lake level rise could have occurred several thousand years ago, and yet, carbonates do not show a ripening trend. In conclusion, ripening is either extremely slow, or the metastable phases are somehow stabilized under porewater conditions.

Neuhuber et al. (2015) Geophysical Research Abstracts 17, 15399.