Paleozoic-Mesozoic dolomitization of the Colorado Plateau by deep circulation of sea-water

URI RYB[1*] AND JOHN M. EILER[1]

[1] California Institute of Techonology, 1200 E California Blvd Pasadena, CA 91125 (*correspondence: uriryb@caltech.edu)

Sediments deposited on carbonate platforms commonly undergo diagenesis, modifying the composition and fabric of resulting rocks. These processes can take place over a wide range of burial temperatures, and in the presence of diverse marine, fresh or formation waters. Here, we combine bulk and clumped isotope measurements of Paleozoic marine carbonate units from the Colorado Plateau (southwestern N. America) to constrain both temperatures of diagenesis and compositions of the diagenetic waters. We find that dolomitization of this section was driven by deep circulation of relatively unmodified seawater; one implication of this finding is that the altered rock record can be used to constrain past seawater compositions.

The dolomite samples we examined have $\delta^{18}O$ values of 2 to -12‰ (VPDB), and exhibit a positive correlation with Δ_{47} values of 0.458-0.647‰, (absolute reference frame). This trend is interpreted to result from dolomitization at temperatures from 41 to 146°C that correspond to Paleozoic to Late Mesozoic burial conditions. The calculated $\delta^{18}O$ composition of dolomite-forming water is consistent with that of Cenozoic seawater (±1‰ VSMOW) and basinal brines (1-8‰ VSMOW); the continuous trend in $\delta^{18}O_{water}$ vs. temperature suggests the deep-seated brines evolved by progressive reaction of seawater. The least evolved waters in this system were similar in $\delta^{18}O$ to Cenozoic seawater; we suggest this ocean was approximately -1‰ (VSMOW) during dolomitization that occurred between the Paleozoic and Late Mesozoic.

Calcite dominated samples from related units have $\delta^{18}O$ values of -4 to -16‰ (VPDB) and Δ_{47} values of 0.688-0.414‰, implying apparent temperatures of 27-191°C. There is no correlation between $\delta^{18}O$ and Δ_{47}, and $\delta^{18}O$ values of some samples are not consistent with temperature dependent fractionation between calcite and the water $\delta^{18}O$ values implied by dolomite compositions. We attribute some of these inconsistencies to diagenesis in the presence of isotopically depleted water, and suggest that meteoric water contributed to the diagenetic fluids that altered those samples. We attribute other such inconsistencies to a decrease of Δ_{47} values through solid-state isotopic reordering at elevated burial temperatures.