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U-Pb dating and clumped isotopes constraints on massive-dolomite formation environments

MICHAL BEN-ISRAEL[1], URI RYB[1], ROBERT HOLDER[2] AND ANDREW KYLANDER-CLARK[3]

[1]Hebrew University of Jerusalem
[2]University of Michigan
[3]UC Santa Barbara

Presenting Author: michal.benisrael@mail.huji.ac.il

The ‘Dolomite Problem’ is a long-standing and fundamental question in sedimentology. At the heart of this puzzle, the abundance of dolomite in the pre-Cenozoic sedimentary record stands in contrast to its paucity in Cenozoic strata and modern marine depositional environments. The lower dolomite content in Cenozoic and modern carbonate sediments has been attributed to a kinetic barrier, preventing the formation of dolomite from unevaporated seawater at Earth-surface temperature. Possible solutions for the ‘dolomite problem’ require the crossing of the kinetic barrier in either (1) pervasive shallow, warm, and saline carbonate depositional environment in the Pre-Cenozoic; or (2) deep-burial diagenetic environments. This latter hypothesis predicts that dolomite formation ages will be significantly younger than their hosting strata's depositional age.

Here, we test this prediction using U-Pb isotope measurements in a suite of massive Paleozoic dolomite samples collected from the Colorado Plateau (southwestern US). These samples have been previously analyzed for oxygen and clumped isotope compositions that are suggested to reflect dolomite formation driven by km scale circulation of seawater in burial temperatures ranging from 40 to 150°C. Plotted on a Tara-Wasserburg composition-space, calculated U-Pb ages are generally younger than their depositional ages by 40-350 Myr and have intercept $^{207}Pb/^{206}Pb$ initial values of ~0.5-1.0, relatively lower than the expected value if these minerals have remained a closed system since deposition. These results suggest that the U-Pb system has been reset long after sedimentation, likely in association with dolomitization or re-crystallization. The 10^7-10^8 yr difference between the stratigraphic strictly depositional age and the dolomite's diagenetic age is consistent with the formation of massive dolomites over prolonged periods of deep burial.