Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.34829

Oxygen and Mg isotope composition of amorphous calcium carbonate-derived $CaCO_3$ minerals as a function of temperature and time

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Amorphous Calcium Carbonate (ACC) is a common constituent of the hard parts of biominerals that occurs as a transient precursor phase that eventually transform to crystalline $CaCO_3$ minerals. These hard parts in organisms such as foraminifera, corals and brachiopods are routinely used as proxies of the environmental conditions that occurred at the time of their growth. Yet to date only little is known about the fate of trace metal concentration and isotope composition during crystallization of ACC although ACC-derived biominerals comprise an important tool for environmental reconstruction. Recently Mavromatis et al. (2026) conducted ACC transformation experiments where an initially metal free ACC phase was allowed to transform to crystalline $CaCO_3$ polymorphs in a solution containing B, Li, Mg and Na. These experiments conducted at 5, 25 and 40ºC over a period of 90 days showed that solid-fluid elemental and ^{13}C exchange occurred after ACC crystallization and continued till the end of the runs. Here we expanded the work in the same set of samples and we analyzed the $\delta^{18}O$ and $\delta^{26}Mg$ in selected reactive fluids and solids in order to assess how two isotopic systems commonly utilized in carbonate paleoarchives behave during ACC crystallization and aging. The obtained results suggest that $\delta^{18}O$ and $\delta^{26}Mg$ values exhibit temporal variations however they do not obtain oxygen and/or magnesium carbonate-fluid isotope equilibrium values during the duration of the experimental runs. This observation comes in contrast to the results of Mavromatis et al. (2017) and Dietzel et al. (2020) who showed rapid attainment of near equilibrium values in ACC-derived Mg-calcites. Note here that in the latter studies formation of ACC and its transformation to crystalline solid occurred in the same solution, in contrast to this study where ACC crystallization took place in a solution different to what used initially to form ACC. These results highlight the role of fluid availability and composition on the preservation of the isotopic composition of ACC-derived carbonate minerals.

References: Mavromatis et al. (2017) EPSL 464, 227-236; Dietzel et al. (2020) GCA 276, 258-273; Mavromatis et al. (2026) ChemGeol 123303.