Inter- and intra-shell clumped isotope variability in sea-urchin calcite: Investigating "vital effects" in Echinoidea

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The stable oxygen isotope composition of marine carbonate is widely used to reconstruct paleoenvironmental conditions. While the stable oxygen isotope composition of some taxa faithfully reflects both the temperature and the $\delta^{18}O$ seawater, many show specific discrepancies known as "vital effects". The carbonate clumped isotope thermometer is a paleotemperature proxy based on the thermodynamically dependent "clumping" of ^{13}C-^{18}O bonds within the carbonate crystal lattice. It enables reconstruction of carbonate formation temperature independent of the $\delta^{18}O$ of the parent fluid. The first biogenic calibrations of the clumped isotope thermometer appear free of vital effects. Recent work however highlights subtle yet unexplained differences in the clumped isotope composition of some groups.

Echinoderms exhibit strong vital effects in $\delta^{18}O$ and $\delta^{13}C$. The echinoidea are therefore an ideal target to examine vital effects in the clumped isotope composition of biogenic calcite. Here, we present the first measurement of echinoderm calcite, and the first assessment of variability in the clumped isotope composition of echinoids.

We measured the clumped isotope composition (Δ_{47}), $\delta^{18}O$ and $\delta^{13}C$ of two echinoids, three marine gastropods and a bivalve mollusk from modern beach deposits of Bali, Indonesia. The only regular echinoid measured shows a significant offset from expected Δ_{47} values, interpreted as evidence of a "vital effect" such as that observed in surface corals. This is in contrast to a sand dollar measured, which exhibited a Δ_{47} within error of local sea surface temperature.

Further focusing on the Echinoidea, we present data on the inter-skeletal variability in the clumped isotopic composition of three echinoid species. By understanding of the correlation between vital effects in $\delta^{18}O$ and $\delta^{13}C$ and the clumped isotopic composition of echinoid calcite we look to constrain the causes of vital effects observed in oxygen and carbon isotopes as a result of invertebrate biomineralization