Recovering primary geochemistry from ancient aragonitic fossil corals

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Well preserved aragonitic fossil scleractinian corals are attractive targets for paleoenvironmental studies because the fact that they are unrecrystallized to calcite gives strong evidence that their original geochemical composition is preserved as well.

Here, we present results of a diagenetic study yielding ~60 well preserved fossil corals, ranging in age from recent through Triassic, that can be used to reconstruct paleochemical properties of the Mesozoic and Cenozoic oceans. Each specimen was exhaustively screened for diagenesis using tools including X-ray diffraction (XRD), Scanning Electron Microscopy, Cathodoluminesence (CL), clumped isotope thermometry, and $^{87}Sr/^{86}Sr$. Using Secondary Ion Mass Spectrometry (SIMS), we also measured the distribution of Mg and Sr in the skeleton as well as Mn and other trace elements sensitive to diagenesis.

We find that these ~60 specimens either completely retain their original mineralogy and geochemistry, or retain domains of original aragonite that are large enough for sampling. XRD analyses suggest that our samples are either completely or partially preserved as aragonite. Microscopy studies demonstrate that fossil coral crystal textures are similar to those found in modern corals. CL imaging either shows total absence of luminesence within coral skeletons or the presence of small domains of luminesence, further suggesting good preservation. Clumped isotopes measured on a subset of samples give temperatures ≤35°C for all but one specimen. Only 1 of 40 samples measured for $^{87}Sr/^{86}Sr$ gives an age incompatible with the stratigraphic age. SIMS measurements of trace elements in well preserved fossils show a general inverse relationship between Sr/Ca and Mg/Ca as in modern specimens [1]. Finally, even in partially altered specimens, microanalysis techniques allow one to avoid microscale zones of alteration and recover primary geochemistry.

[1] Gagnon *et al* (2007) *EPSL* **261**, 280-295.