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Cold-water coral skeleton fluid inclusion water isotopes, environmental and calcification impacts

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Here we present fluid inclusion hydrogen and oxygen isotope compositions for Holocene and last glacial cold-water skeletons from Angola and Iceland. It was recently demonstrated that skeleton fluid water yields contrasting results with different techniques such as cavity ringdown spectroscopy (CRDS) and isotope ratio mass spectrometry (IRMS) [1]. Moreover, according to de Graaf and coworkers [1] internal water in biogenic carbonates express an open system for the interaction with hydration water in the skeletons finely dispersed organic matrix. Furthermore, crushing may release internal water from the coral skeletons with strong kinetic isotope fractionation dependent on the exposure temperature, preheating time, and the overall chosen extraction temperature. Altogether, bulk crushing techniques have been thought to produce unreliable fluid isotope ratios with respect for (palaeo-)environmental or microbiological studies. Here, we confirm massive kinetic isotope fractionation when crushing coral skeletons at temperatures of 120°C and using a CRDS continuous water vapor background analyzer. The temperature was set to recover free inclusion water. When coral fragments are, however, glass encapsulated the released water amount as well as its isotopic signature are far more reproducible and span a much smaller range of values largely independent of analytical parameters. A strong hydrogen isotope fractionation characterizes the extracted water (dD of -55‰ to -70‰). Oxygen isotope fractionation is low in our samples from Angola and Iceland yielding 0 to 3 ‰ (N=5). One sample from Angola shows a significantly enriched isotope composition with $d^{18}O$ of 7‰. Consequently, our new CRDS method yields a small range of isotopic composition in expected ranges from the dehydration of the calcifying fluid. The H-O isotope slope is approximately 4. Therefore, we suggest that analytical artefacts have been massively reduced and that skeleton fluid water possibly yield information on environmental and calcifying processes.

[1] de Graaf et al. Analytical artefacts preclude reliable isotope ratio measurement of internal water in coral skeletons, GGR, 46, 563-577, 2022