CLUMPED ISOTOPIC VARIATIONS IN MODERN CARBONATE SEDIMENTS

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PROJECT OBJECTIVES

- Determine the relationship between Δ_{47} and temperature for a range of different carbonate allochems.
- Analyze a wide range of bulk carbonate sediments in order to ascertain the extent of deviation from their expected temperature of formation.

PROJECT RATIONALE

The variation of multiply substituted "clumped" isotopologues in calcium-carbonate, measured as the Δ_{47} of CO_2, has been found to be a precise and reliable indicator of formation temperature (Ghosh et al., 2006). The use of this technique has a major advantage over the most common paleothermometers because it does not require any knowledge of the original solution from which the carbonate was precipitated. This is because the multiple substitution of isotopes into a molecule is strongly dependent on temperature and is not reliant upon the oxygen or carbon composition within the solution. The use of clumped isotopes as a paleothermometer opens up a new realm of possibilities in the variety and age of samples that can be measured and will aid in any project that has been hindered by a lack of knowledge of the isotopic composition of the precipitating solution. A further advantage is that once the temperature has been determined, it will be possible utilizing the $\delta^{18}O$ value of the carbonate to calculate the $\delta^{18}O$ value of the fluid involved in precipitation or diagenesis.

Although the original calibration involved several different types of carbonate materials, raising the hope that there was one universal calibration which could be applied to all carbonate materials, this hope has been dashed over the past 10 years as it has become obvious that many different carbonates fractionate the Δ_{47} differently. For example, corals give temperatures which are much lower than expected (Saenger et al., 2012), while echinoderms give higher than expected temperatures (Davies and John, 2018). As the sediments contributing to the sedimentary record are usually composed of a range of different allochems it will be important to calibrate different type of Modern sediments to see how faithfully the bulk compositions track the Modern temperatures.

SCOPE OF WORK

We propose to analyze the (i) Δ_{47} value of a range of carbonate allochems from environments with well constrained temperatures, these will include different green calcareous algae (*Halimeda* sp., *Penicillus* sp., *Acetabularia* sp.), red calcareous algae, molluscs, echinoderms, and benthic foraminifera, ooids, peloids, and mud components (bottom sediment and whiting materials), (ii) a range of different bulk sediments from the Bahamas, Florida, Belize,

Maldives, and the Persian Gulf. In addition to measurements of the Δ_{47} values, we will characterize the mineralogy of the samples as well as other bulk geochemical parameters ($\delta^{13}C$, $\delta^{18}O$, and trace element geochemistry). As a start we will build on the work of Atasoy (2014) who analyzed the Δ_{47} values in samples collected during a survey of the stable isotopic composition of bulk surface sediments from the Bahamas (Swart et al., 2009). This will be supplemented by samples in hand from a survey of sediments from the Maldives (Swart et al., 2019), Belize(Gischler and Lomando, 1999) and Florida. We will also collect new samples this year during a cruise to the eastern portion of Great Bahama Bank.

SIGNIFICANCE

Many applications of the clumped isotope method have already utilized bulk samples from throughout the Phanerozoic. The basic assumption in all of these studies is that the bulk sediments reflect the original depositional temperature. The proposed work outlined is important as it will confirm whether such interpretations are correct.

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