# EFFECTS OF SEAWATER MG$^{2+}$ AND CA$^{2+}$ CONCENTRATIONS ON SR, MG, AND S ELEMENTAL PARTITIONING IN SCLERACTINIAN CORALS

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## PROJECT OBJECTIVES

- To further our knowledge of the partitioning of trace and minor (B, S, Sr, Mg, and Ba) elements into coral carbonates in relation to the $Mg^{2+}/Ca^{2+}$ ratio of seawater.
- To investigate the influence that the $Mg^{2+}/Ca^{2+}$ ratio of seawater has upon growth rate.

## PROJECT RATIONALE

Approximately 30 years ago a theory was introduced which suggested that the oceans had undergone transitions between periods when aragonite was the primary calcium carbonate produced by shallow water calcareous organisms and precipitated inorganically from the oceans to times when it was low Mg-calcite (LMC) (Sandberg, 1983). The favored explanation for the alteration between so-called aragonite and calcite seas is that the Mg/Ca ratio of ocean water ($Mg/Ca_{sw}$) has varied through time (Hardie, 2003), although other work has suggested that the sulfate concentration of the ocean may be important (Bots et al., 2011). One of the supporting lines of evidence of the change in ocean chemistry has been obtained from the elemental analysis of scleractinian coral skeletons which have remained unaltered (Gothmann et al., 2015). Hence, it would be important to know if the distribution coefficients for various elements remain independent of the concentration of elements such as $Mg^{2+}$ and $Ca^{2+}$.

## SCOPE OF WORK

In order to test the assumption that distribution coefficient (D) values are independent of the changes in the major element chemistry of ocean water, we have grown corals in seawater where the $Mg^{2+}$ and $Ca^{2+}$ concentrations have been altered. Three phases of experiments have been completed. These include experiments in which the concentrations of Ca, Mg, and S were increased and decreased. The concentrations were changed to match relevant seawater $Mg^{2+}/Ca^{2+}$ ratios similar to those of the Triassic, Cretaceous, Eocene, and Miocene. Throughout the experiment the calcification rates of the corals were measured and the seawater chemistry monitored. At the termination of the experiment the coral skeletons were analyzed for a range of minor and trace elements. An example of preliminary data is shown in Figure 1 which reveals that the distribution coefficient for Sr ($D_{Sr}$) is dependent upon the $Ca^{2+}$ concentration of seawater. A final set of experiments will be carried out in 2017.

## SIGNIFICANCE

This work has implications for understanding the potential of coral carbonates to act as paleoenvironmental proxies of changes in seawater chemistry. In particular, the data shown in Figure 1 reveal that the application of a single $D_{Sr}$ value throughout periods during which seawater $Ca^{2+}$ concentration change may not be valid. These findings may also be applicable to non-biogenically produced carbonates. The finding of an increasing $D_{Sr}$ also provides key insights into the biomineralization processes in scleractinian corals.

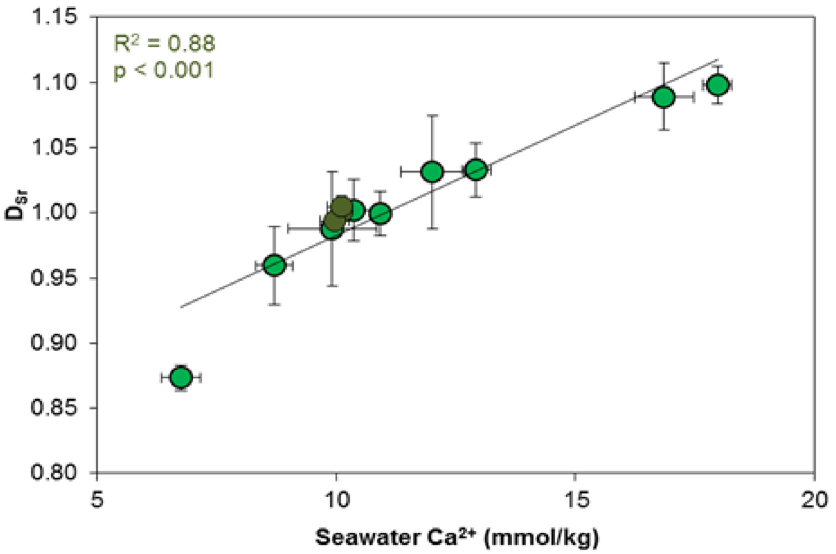

*Figure 1: Changes in the $D_{Sr}$ for corals as a function of the $Ca^{2+}$ concentration in the seawater. The grey symbols show data obtained during a second experiment. The results were obtained by both lowering and increasing $Ca^{2+}$ concentrations. These results imply that the application of a single $D_{Sr}$ value throughout time is not valid.*

## REFERENCES

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