

Developing a Paleo-proxy of Submarine Groundwater Discharge

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What were the primary questions you were trying to address with this research? (Or, if more appropriate, was there a hypothesis or theory that you were trying to prove or disprove?)

Submarine groundwater discharge is the flow of water from land to the sea, but unlike rivers, this flow occurs underground. This flow is not easy to quantify given its diffuse and heterogeneous nature. Thus, while we are beginning to appreciate the spatial variability groundwater discharge displays, we have a very limited understanding of temporal variability on the scale of months, to years and beyond. Our research goal was to find a proxy for past groundwater flow into the ocean.

What have you discovered or learned that you didn't know before you started this work?

To link groundwater flow to the ocean to a signal in a coral skeleton, we first had to establish that groundwater acquires a certain chemical fingerprint (in this case a unique barium to calcium ratio) that is distinct from seawater chemistry. We then had to show that this fingerprint was reflected in the coral skeleton as they grew. In several coral samples, we observed a high degree of seasonal and interannual variability that appears to be related to the amount of precipitation in the region, which we think is tightly linked to groundwater discharge at the coast.

What is the significance of your findings for others working in this field of inquiry and for the broader scientific community?

We have demonstrated that barium is a good tracer of groundwater discharge that is also readily taken up consistently by corals. Thus, with some knowledge about both coral growth rates and water residence times, the coral barium signal can inform the barium loading via groundwater to the ocean.

What is the significance of this research for society?

Human civilization cannot exist without easy access to abundant fresh water. The Mayan empire rose and fell according to this edict. Submarine groundwater discharge is the least constrained, but most anthropogenically impacted components of the water cycle. Further impacts are

anticipated as human populations demand more groundwater resources and climate change impacts rainfall patterns. Understanding how groundwater flowed to the ocean in the past allows us to make forecasts about the present and future.

What were the greatest challenges and difficulties?

Conducting research primarily outside of the United States presents a unique set of challenges, especially when it is shore-based. We collaborated with local scientists in Mexico for assistance with everything from importing equipment to finding field sites. This collaboration insured the success of the project.

When and where was this investigation conducted? (For instance, did you conduct new field research, or was this a new analysis of existing data?)

The groundwater data was collected over several years from the Yucatan Peninsula, Mexico. We did experiments with corals in aquaria at the Bermuda Institute of Oceanography to quantitatively demonstrate coral incorporation of barium. Regarding coral cores, these were already drilled for another project, which allowed us to devote more resources to modern day proxy validation.

What were the key tools or instruments you used to conduct this research?

We do our chemical analysis on a mass spectrometer here at WHOI. To know how old the corals are, we looked at density banding, similar to tree rings, using WHOI's CT scanner facility.

Is this research part of a larger project or program?

No.

What are your next steps?

We will continue to seek funding for this project despite two unsuccessful attempts at NSF.

Have you published findings or web pages related to this research? Please provide a citation, reprint, and web link (when available).

Note: Martin Burch and Lonny Lippsett are preparing both an Oceanus article and video slide show on this work, which should be available soon.

Please provide photographs, illustrations, tables/charts, and web links that can help illustrate your research.