Antarctic Science Bursary

Lucie Cassarino awarded in 2019

Project title: Investigation of silicon isotopes fractionation from shallow benthic sponges

Overview of the work undertaken

With this project I wanted to answer the following questions: 1) Is silicon (Si) isotopic fractionation controlled genetically in benthic sponges? 2) Do environmental changes impact the Si isotopic fractionation of benthic sponges? Also, as part of this project, I measured for the first time the Si isotopic signature (δ^{30}Si) and fractionation of shallow benthic siliceous sponges.

To respond to questions 1 and 2, the project had first to analyse the Si isotopic signature of 263 sponge specimens and the dissolved silicon of the seawater in which the sponges grew. To do so, and to train myself for future student supervision, I appointed a summer student. First, seawater dissolved silicon was measure with the molybdate-blue method (Strickland and Parsons, 1968). Prior to the instrumental analysis of Si isotopes, the pre-concentration of Si from seawater, in a clean laboratory, was done using the Mg-induced co-precipitation (MAGIC) method following Karl and Tien (1992), which has been modified by Reynolds et al., (2006), which takes four days to do. The sponge samples required cleaning prior to Si isotopic analysis. Firstly, we had to remove all the organic matter with consecutive hydrogen peroxide (H_2O_2) and Milli-Q rinses at 85˚C. The pre-cleaned spicules (skeletal feature made of silica) were then cleaned with concentrated nitric acid and rinsed with Milli-Q. This procedure follows Hendry and Robinson, 2012, and takes a week to do. In two months, Harry Norman (my summer student) and I managed to clean and prepare 168 sponges for isotopic analysis. Before the isotopic analysis, all samples, seawaters, sponges, and standards were purified by cation exchange chromatography. Si isotopic analyses were carried out on the Multi-Collector Inductive-coupled-Plasma Mass-Spectrometer (MC-ICP-MS) at the Bristol Isotope Group facilities. Unfortunately, I was not able to measure all the samples, only 64 specimens have been analysed due to machine time requirement. In addition to the isotopic analysis, we did some scanning electron microscope (SEM) images of some specific and random samples. Samples were selected depending on their Si fractionation factor values, which represent the differences between the δ^{30}Si of the sponge spicule and the δ^{30}Si of the seawater (equation 1):

Δ^{30}Si sponge = δ^{30}Si sponge - δ^{30}Si seawater (1)

The fractionation factor value was compared to the existing calibration curve from Hendry and Robinson, 2012, with the addition of Cassarino et al., 2018. Four samples showing a value falling off the calibration and two following the calibration were selected for imaging by SEM.

Results

Figure 1 shows the Si isotopic fractionation factor (Δ^{30}Si sponge) of the 64 new specimens and the previous Δ^{30}Si sponge published for deep-sea sponges. First the Δ^{30}Si sponge of the shallow benthic sponges are in accordance with the preferential uptake of the light Si isotopes resulting in a negative Δ^{30}Si.

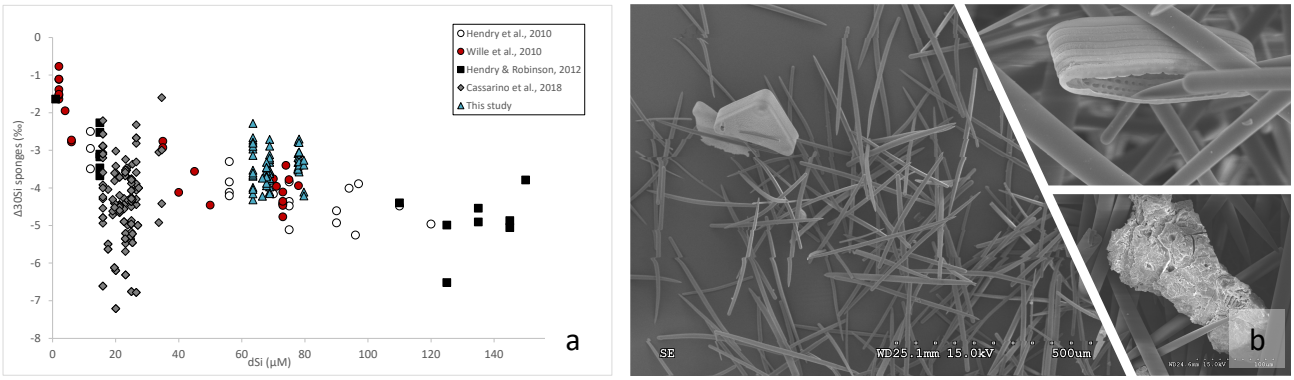

Figure 1: a) Si isotopic fractionation factors of shallow benthic sponges and previous published data plotted against ambient dissolved silicon concentrations (dSi). b) SEM images of diatoms and other material within the sponge spicules.

The SEM imaging revealed the presence of diatoms (siliceous phytoplankton) and likely detrital material inside the spicules of the six sponge specimens (Figure 2). These observations are in accordance with the location of the samples. Sponges have been sampled at about 20m water depth along the West Antarctic Peninsula coastline. The area is characterised by diatoms blooms and many glaciers and streams are present along the peninsula.

From these results and in particular the SEM images we would like to bring to future coastal sponge isotopic analysis' attention to the possible contamination from detrital material and/or diatoms for example. It is important to be careful with the cleaning of specimens as detritus such as diatoms could shift the sponge apparent isotopic composition and thus the calculated fractionation factor. These observations are more likely concerning coastal shallow sponges as they live within the productive zone and/or detrital export areas. Furthermore, some genus such as *Haliclona* uses detrital material to build their skeletal features which add to the importance of specimen identification. Our results show that environmental changes, here dissolved silicon concentration, is not the only factor controlling the $\Delta^{30}Si$ as is has been suggested by pioneer studies, but it seems to be in accordance with the more recent studies expressing a potential link with species and/or genetic control.

<u>Next steps</u>

After the Si isotopic analysis, I was aiming to visit Joana Xavier in Portugal to discuss the results and learn more about sponge physiology and genetic control. Unfortunately, the visit was not possible before some planned field work in early 2020. The project has been on hold since my return from field work due to the COVID-19 pandemic. The next steps are to evaluate the correlation between species specimen with their $\Delta^{30}Si$ and to publish the results. The data will be published in a form of a report, which will be an addition of data available to the scientific community.