ANALYSIS OF DISSOLVED SILICATE AND METALS IN GLASS SEA SPONGE HABITATS.

DOMI LAM
EAES 2537: ENVIRONMENTAL SCIENCE, DOUGLAS COLLEGE

ABSTRACT

The purpose of the research is monitoring the health of Marine ecosystems in Howe Sound through analysis of Sea water and glass sea sponge reefs.

INTRODUCTION

Glass sea sponges are of significant benefit to humans, other living species, and the environment. For example, they filter a large amount of water, accumulate the heavy metal in the ocean and contribute to nutrient cycles (Cebrian et al. 2007). Glass sea sponge grows up slowly and becomes larger with time. However, Global Warming and changes in ocean water condition are affecting this species. There are factors that influence the growth of Glass Sea sponges such as dissolved silicate (dSi), acidification, and temperature. This research focuses on analyzing the dissolved silicate and metals (Cu, Pb, Zn, and Hg) in sea water where Glass Sea sponges live, specifically the Howe Sound Biosphere region, by using UV-VIS and atomic absorption spectrophotometry. Figure 1 below shows a reef of glass sea sponges in Howe Sound Biosphere region.

Figure 1: Glass sponge reef in Howe Sound area by Adam Taylor (mlssbc.com)

SAMPLE COLLECTION

Samples are collected directly from the ocean and delivered to the laboratory of Douglas College to analyze. Water is collected in the surface water and deep-sea water. Water sampling from the deep ocean was done by a scuba diver from "MLSS", a non- profit charitable group. The samples were stored in a plastic bottle and cooled out of sunlight. The location of sample collection is in Howe Sound area, a designated UNESCO Biosphere, where the glass sea sponge reef is located (see Figure 2).

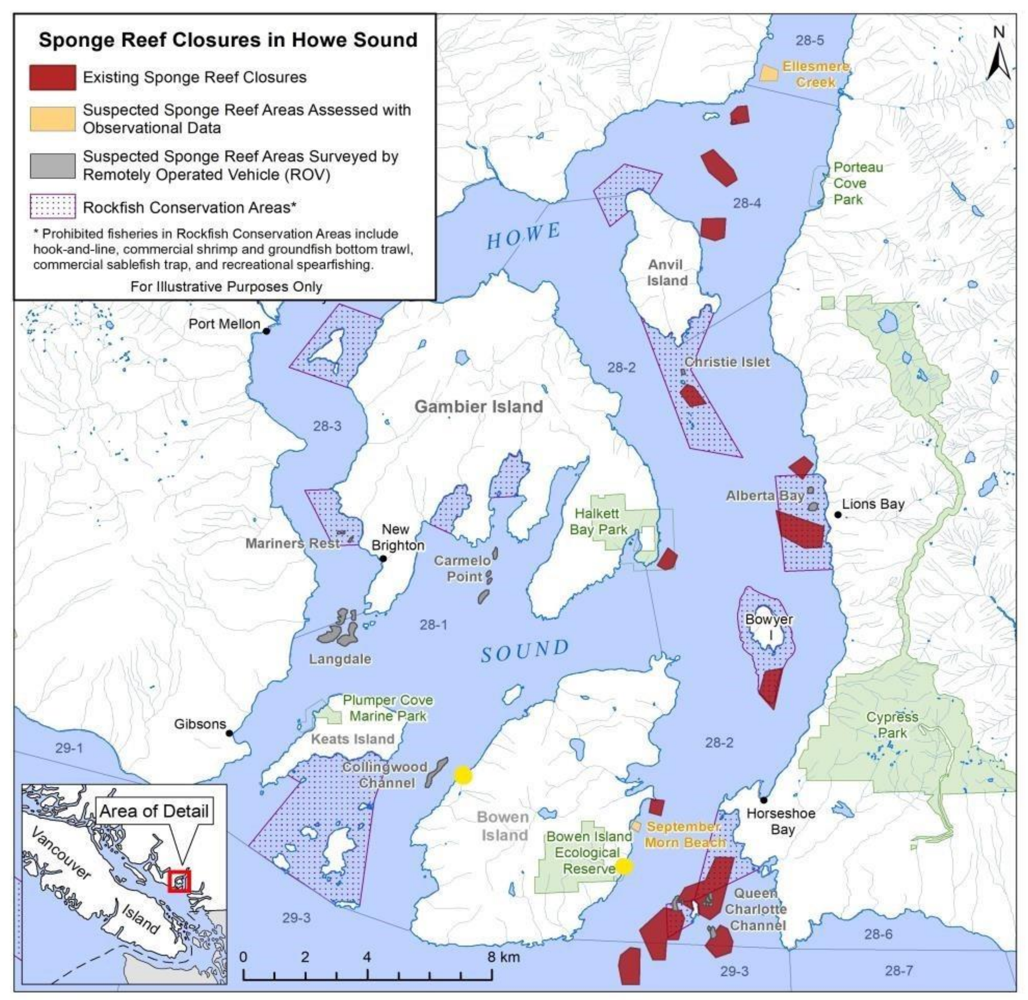

Figure 2: Sample sites are 2 yellow dots in the West and the East of Bowen Island.

The sea water sample locations to date are:

- September Morn Beach, Bowen Island (East side of Bowen Island), BC (49°22'12.3"N 123°19'56.6"W)
- Mount Gardner Government, Bowen Island (West side of Bowen Island), BC (49°23'28''N 123°24'00''W)
- Further samples will be collected in areas near Gambier Island and Squamish.

The purpose of collecting samples in this area is to compare the relationship between dissolved silicate and metals in sponge habitats, and to provide essential information of sponge living environment when we compare this area with general seawater where there are no sponge reefs. The concentration of analytes may also be an indicator of glass sponge health.

CHEMICAL REACTIONS

The sea water reacts with molybdate under conditions which produce the Silicomolybdate, Phosphomolybdate, and Arsenomolybdate. A reducing agent, which includes metol and oxalic acid, is used to diminish the Silicomolibdate compound and at the same time decompose any given side-products phosphomolybdate and arsenomolybdate. So, the solution will form the blue color and reduce the interference from phosphate and arsenate (Strickland et al. 1972). The absorption of final solution is determined at l= 810 nm in 1 cm cells.

Silicic acid reacts with water to form a hydrate:

$$H_2SiO_3 + 3H_2O \longrightarrow H_8SiO_6$$

Figure 6: Standard solution with blue color from highest concentration of Silicate (left) to lowest concentration of Silicate (right)

Silicomolybdic acid is formed when hydrated silicic acid reacts with molybdate

$$H_8SiO_6 + 12(NH_4)_2MoO_4 + 12H_2SO_4 \longrightarrow H_8[Si(Mo_2O_7)_6] + 12(NH_4)2SO_4 + 12H_2O$$

This siliconmolybdic acid is then reduced by Metol $(C_7H_{10}NO)_2SO_4$ to an intensely colored blue complex which absorbs light at wavelength 810 nm, as shown in Figure 6.

METHODOLOGY

The method to analyze the dissolved Silicate in sea water is the absorption of light. The equipment used is Perkin Elmer, precisely Lambda 25 UV- Vis double- Beam spectrophotometer (see Figure 3). A double beam spectrophotometer splits light into two beams: one passes through sample, and another one passes through the blank. At the detector, the irradiances of the sample (P) and reference (Po) beam are determined in quick succession and used to calculate transmittance and absorbance.

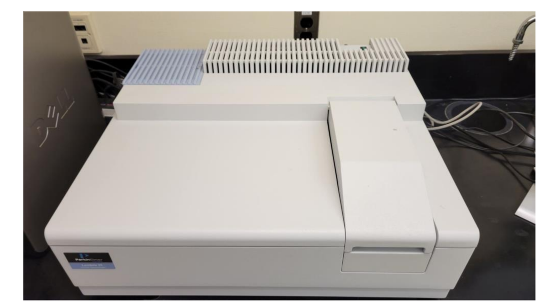

Figure 3: Outside of Lambda 25 UV- Vis double- beam spectrophotometer.

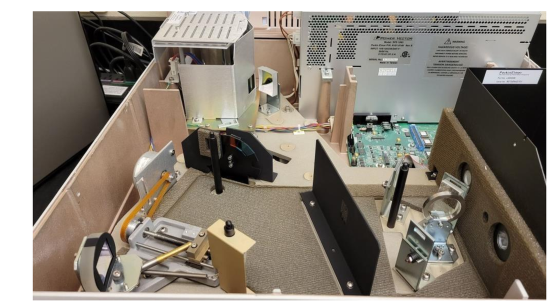

Figure 4: Inside of Lambda 25 UV- Vis double- beam spectrophotometer.

The method to analyze heavy metal in sea water is using Flame Atomic absorption spectrometry. The method is based on ground state metals absorbing light at a specific wavelength (see Figure 5).

The relationship between absorbance and concentration of dissolved silicate and heavy metals in sea water is described by Beer's law equation:

$$A = \varepsilon bc \quad (1)$$

(A is absorbance, ε molar absorptivity constant, b is length of sample cell, and c is molar concentration)

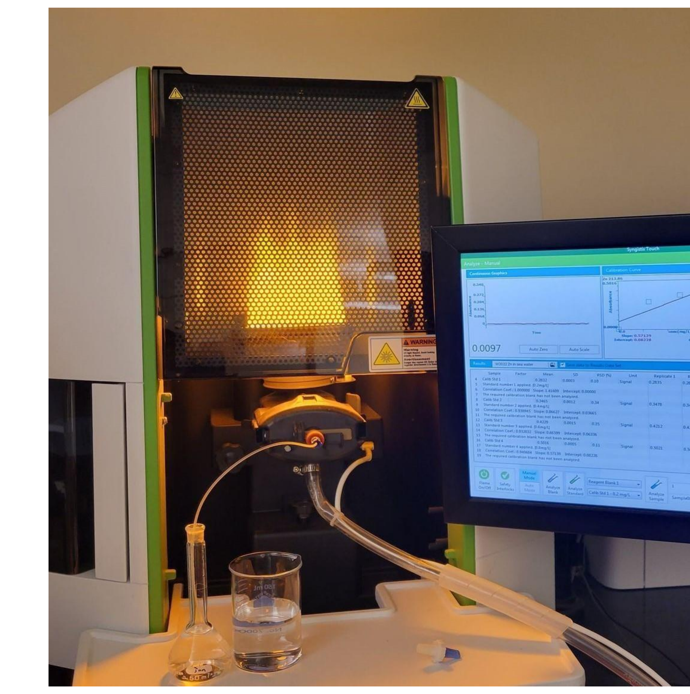

Figure 5: The color of atomic absorption flame fire is changed to yellow due to the sea water containing sodium.

RESULTS

Standard	Volume diluted(mL)	diluted M (microM)	M sample(microM)	M (ppm)	Absorbance
0	0	0	0	0	0
1	1	5.000	2.500	0.07021	0.03070
2	2	10.00	5.000	0.1404	0.08380
3	3	25.00	12.50	0.3511	0.2883
4	4	50.00	25.00	0.7021	0.6104
5	5	100.0	50.00	1.4043	1.0275
sample 1	25	Concentration of dSi sample 1 (ppm)	Concentration of dSi sample 1 in diluted solution (ppm)	Average absorbance of sample 1	0.9129
					0.9155
		2.406	1.203	0.9136	0.9123
Sample 2	25	Concentration of dSi sample 2 (ppm)	Concentration of dSi sample 2 in diluted solution (ppm)	Average absorbance of sample 2	0.6254
					0.6259
		1.645	0.8225	0.6259	0.6265

Table 1: Data table of concentration and absorbance of silicate of standard solution and sea water sample. The standard solutions with a concentration of 0.00μ , 2.50μM , 5.00μM , 12.5μM ,25.0μM ,50μM .

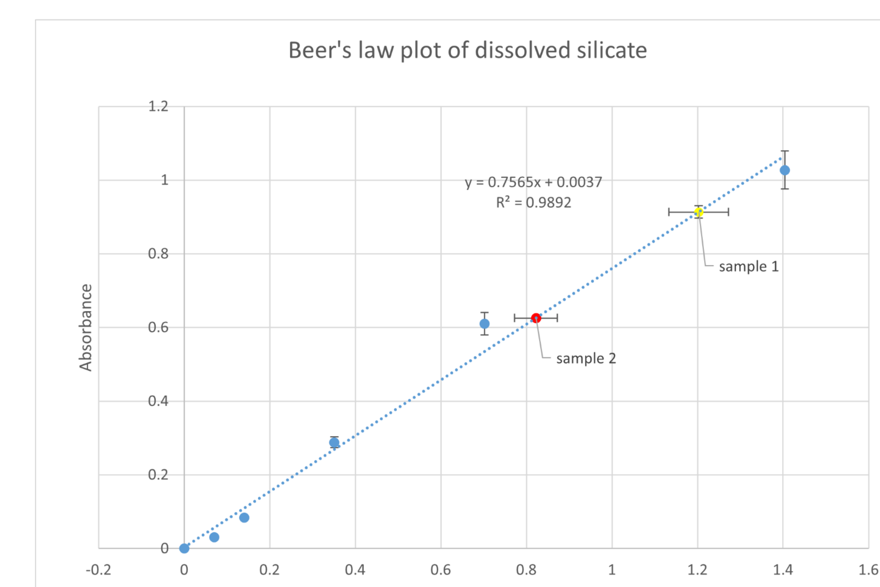

Figure 7: Beer's law graph shows the linear relationship between concentrations and absorbances of silicate solution.

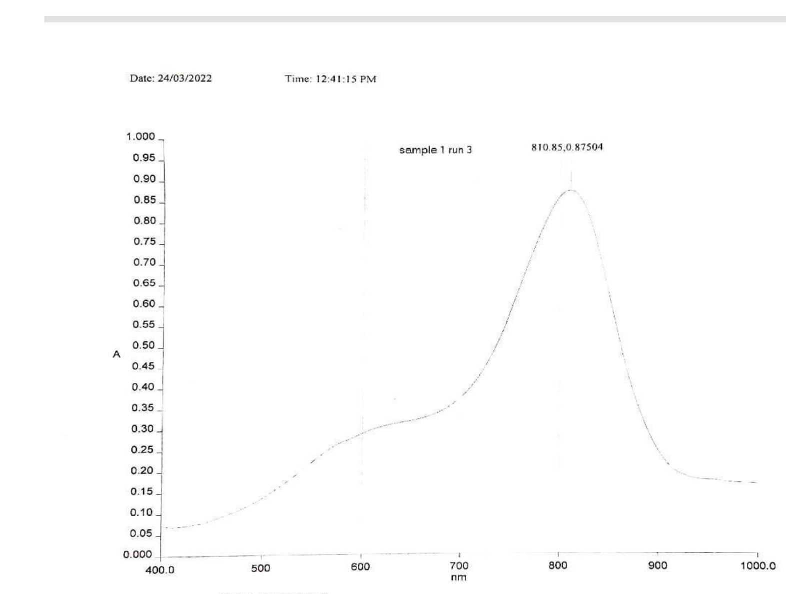

Figure 8: The maximum absorbance of Silicate solution shows up when the wavelength is at 810nm

DISCUSSION AND CONCLUSION

From the data we collected, a graph of concentration versus absorbance is made, and given the information of A = εbc (ε= 0.7565). Therefore, the concentration of dissolved silicate in sample 1 is 2.41 ± 0.07 ppm and in sample 2 is 1.65 ± 0.05 ppm by using the data of absorbance vs concentration to do calculations.

To date we can conclude the following: There is a connection between the dissolved silicate in sea water and population of Glass Sea sponge. Glass Sea sponge population in the East side of Bowen Island (where sample 1 is collected) is much more than the population of glass sea sponge in the West side of Bowen Island (where sample 2 is located), which is shown in figure 2. The results are the higher concentration of dissolved Silicate, the more Glass Sea sponge in the area. This is expected since glass sea sponges require silicate to build their skeletons. Therefore, the concentration of dissolved silicate is one indicator of the presence of healthy glass sea sponge reefs in the areas, and we have successfully been able to monitor this .

CONTINUING OUR WORK

We plan to expand this research by the end of summer. The next step is to focus on analyzing the concentration of metals (Zn, Cu, Pb and Hg) by using Flame Atomic absorption spectrometry. Figure 9 shows the plot of Beer's law of concentration and absorbance of Zinc in general, for our standards.

We are going to run at least four to six samples of sea water to compare the heavy metal between the regions of Glass Sea sponge and regions without Glass Sea sponge to monitor the change in heavy metal concentration and the presence of Glass Sea Sponge in the area.

Furthermore, we are about to measure the concentration of metal accumulation in glass sea sponge tissue.

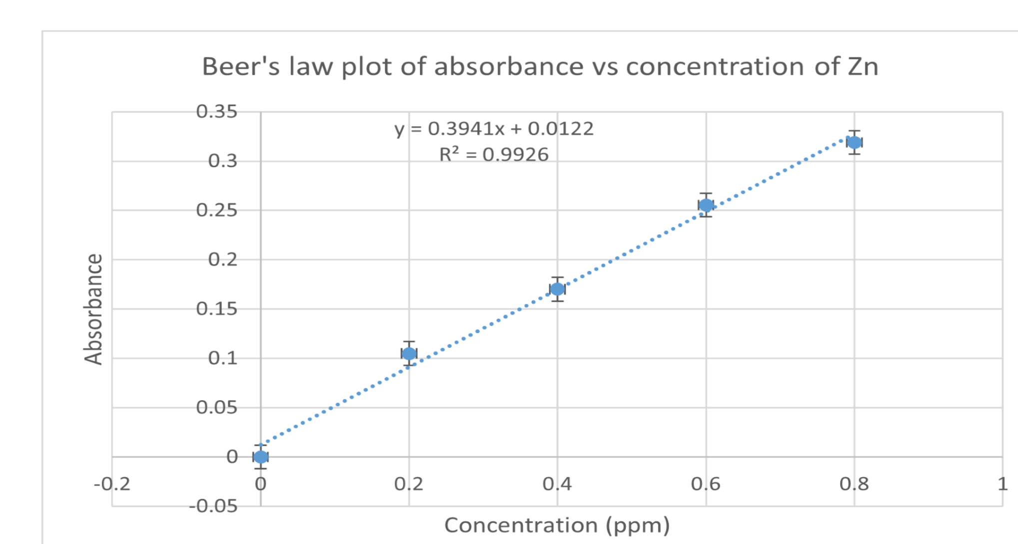

Figure 9: Beer's law graph shows the linear relationship between concentration and absorbance of Zin C by using Flame Atomic Absorption spectrometry

REFERENCES

- Cebra, E., Uriz, M., & Turon, X. (2007). *Sponges as biomonitor of heavy metals in spatial and temporal surveys in northwestern Mediterranean: multispecies comparison. Environmental Toxicology and chemistry, 26(11), 2430-2439.* https://setac.onlinelibrary.wiley.com/doi/epdf/10.1897/07-292.1
- Strickland, J. & Parson, T. (1972). *A practical handbook of sea water analysis* (Second edition). Fisheries research board of Canada (1972).

ACKNOWLEDGEMENTS

I would like to send great thanks to Dr Brenda Addison- Jones for her continuous supervision throughout this research project. Her time contributed to guiding me and supporting me is valuable.