Acquisition of trace metal nutrients from Olivine by Shewanella oneidensis

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Introduction

Olivine is a potential nutrient source for bacteria because it contains Iron (Fe) and other trace metals and is abundant. However, we do not know if microbes, like Shewanella, can utilize nutrients present within olivine. In this research, we performed culture experiments with Shewanella and olivine in order to assess if olivine can sustain microbial life.

- Can Shewanella live off olivine?
- Does Shewanella affect olivine dissolution rates?

Methods

Olivine Experiment
- 3 replicates of 4 experiments in sterile bottles with 0.5 grams of olivine, media (Cassimino Acids of pH 7) and our bacteria (Shewanella) as well as a sterile control.
- Experiment 1: Only Iron (Fe)
- Experiment 2: Only Manganese (Mn)
- Experiment 3: All Metals
- Experiment 4: No Metals
- Experiment 5: Sterile Control
- Daily sampling of 5ml for Optical Density at 600nm with spectrophotometer and MP-DES analysis of Mg, Fe, and Si by standard addition.

Metal Addition Experiments
- 2 replicates of 7 experiments in sterile bottles with media (Cassimino Acids of pH 7) and our bacteria (Shewanella) as well as a sterile control.
- Metal addition to determine which metals were necessary for growth.

Results

Figure 1: Schematic of the reactor design used in the experiments.

Olivine Experiment
- In every experiment olivine can sustain bacterial growth.
- The experiment with no metals added was able to grow as well as the experiments with added metals.

Metal Addition Experiment
- Shewanella does not necessarily need Cobalt, Copper or Zinc as a nutrient source.
- All other metals or non-metals have a constant growth.
- A major decrease in bacterial growth when the experiment did not have Iron (Fe) or Manganese (Mn).
- Shewanella needs Iron and Manganese in order to live which is what olivine contains.

Figure 2: Optical Density of Shewanella with metals overtime.

Figure 3: Optical Density of Shewanella growth with Olivine.

Figure 4 and 5: Dissolution rates of Silicon and Magnesium in olivine experiment.

Conclusions

- Olivine could become a major nutrient source for microbial life, as it contains Iron and Manganese.
- Whether there are metals added or there aren’t metals added olivine was able to increase the growth of shewanella.
- Shewanella shows that other metals aren’t necessary for its growth.
- Mn and Fe required for growth; Co, Zn and Cu not required for growth.
- Shewanella utilizes Mg from olivine but not Si.
- Shewanella does not affect olivine dissolution rates.

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