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FROM THE DEEP OCEAN TO THE ESTUARIES

What the geographical distribution of marine iron-oxidizing bacteria throughout South Carolinas coasts could mean for the iron cycle

Iron is an important element necessary for all life on earth; organisms require it to grow and develop. With the reliance of almost all living things on iron, understanding how organisms get this iron, and in which forms that they are able to utilize it has become a hot topic.

New research is aimed at better understanding the biogeochemical cycles of iron in the ocean, where it is limited, present only in extremely small concentrations. This iron in the ocean is present in two forms Fe(II), which is dissolved in the water, and Fe(III), which is not dissolved in the water and forms solids instead. Because Fe(II) is dissolved in the water, it is the form of iron that is available for most organisms to utilize. It is known that Fe(II) enters the ocean via iron rich rivers, or from iron rich dust that is blown across the oceans from the deserts of the world. Upon entering the ocean, Fe(II) can be removed as it is taken up by biological life or as it precipitates out into Fe(III). The discovery of one organism, however, has the potential to change the way that we thought iron cycled through the ocean. This organism is Zetaproteobacteria.

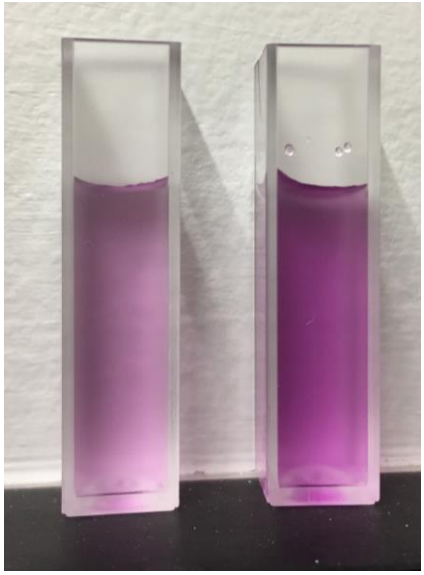
First identified at hydrothermal vents, Zetaproteobacteria are bacteria that use Fe(II) in the ocean to create energy for themselves, oxidizing it into Fe(III), otherwise known as rust, and releasing it as waste. They are special because they are the first and only known marine iron oxidizing bacteria. Through their transformation of Fe(II) to Fe(III), Zetaproteobacteria may play an important role in the iron cycle as a source of iron removal.

Lauren Rodgers, an intern at the Fort Johnson REU Internship program at the College of Charleston, along with her mentor, Dr. Heather Fullerton, are conducting research to determine current levels of iron in the sediments around Charleston to determine if they would be a good habitat for these Zetaproteobacteria. As Lauren's mentor, Dr. Heather Fullerton, states, "Zetaproteobacteria have been found in coastal regions very similar to Charleston that have lower iron concentrations, so they should also be found here."

In order to carry out this experiment, they identified muddy, easily accessible sites at different salinities along the tidal rivers around Charleston and sampled the mud at different depths. In order to measure these iron concentrations, Lauren conducted a ferrozine assay in which the samples turn varying shades of purple depending on how much Fe(II) is present in the sample. The resulting iron concentrations were then compared with salinity readings from each site to identify a possible correlation.

They found that there was no correlation between the concentration of iron and the salinity of the water that the sediment was exposed to. With iron not being dependent on the salinity, it could be affected by other factors, such as Zetaproteobacteria. The levels of Fe(II) that were found in the sediments were also fairly high, ranging from 250 µM up to 400 µM. For comparison, the Fe(II) concentrations in other regions that Zetaproteobacteria inhabited ranged from 40 µM to 1000 µM. The Fe(II) concentrations in the sediments around Charleston are well within this range, meaning that they could be a good habitat for Zetaproteobacteria.

If Zetaproteobacteria are found in the sediments around Charleston, it could have many implications. The first implication is that they could be affecting the local iron cycle around Charleston through their transformations of Fe(II). Zetaproteobacteria have also been shown to be able to live on solid metal and use the Fe(II) present in it, enhancing the metal's rate of rusting. If they are found in Charleston, they could be speeding up the rusting of ships or even metal pipes. Lastly, their presence in Charleston would add evidence to their potential worldwide distribution.



Left: Transferring mud sample into collection tubes (pc: Heather Fullerton)
Right: Solutions for ferrozine assay; the darker the shade of purple the greater the concentration of iron in the solution (pc: Lauren Rodgers)

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