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Reading #2

Hydrothermal vents and the origin of life

Authors: Martin et al. (2008)

Summary: This article addresses a very difficult question: what might the origin of life be? It begins by talking about the Organic Soup Model which supposes that organic compounds such as simple proteins were created due to reactions by lightning or that such molecules were delivered to earth during the period of heavy bombardment. This paper is more supportive of the theory that life began along hydrothermal vents in the young earth’s oceans and they discuss the chemistry produced at these vents in great detail. “Black Smokers” such as the Faulty Towers complex host diverse biological communities which, apart from bacteria, today host crabs, worms and clams (Google). Black smokers are located directly over magma chambers and have flow systems which allow allow the vent to maintain a very hot range of temperatures (200-400 C). They produce an effluent that is very acidic (pH 2-3) and are rich in transition metals. What is important to note about them is that they produce large amounts of magmatic CO2 and dissolved H2 gas as well as CH4, all of which are used in life processes.

The main point that this paper makes is that there was a recent discovery of a different type of hydrothermal vent - the Lost City vent. The reason why this is important is because the water of these types of vents do not come into direct contact with any magma chambers (although they remain heated by them) and as a result they contain almost no CO2, causing them to have a much higher pH of 8-9 than Black Smokers. It was found that a new type of methanogens are present here and that they can use certain organic compounds used in anaerobic methane oxidation (AMO) which has been found to occur at both hydrothermal sites as well as cold seep sites. Serpentinization to produce H2 also occurs here, and the paper notes that when sea-water mixes with warm, high-pH fluids, carbonate precipitation occurs.

What I liked: It was interesting to learn that AMO can occur in both hydrothermal sediments (Lost City vents) and methane seeps although their temperature ranges are vastly different. I know that for fossil methane seeps the d13C ratio is very low. I would imagine that it must be the same for Lost City sediments and I would love to learn more about fossil hydrothermal vents in the rock record. I also wonder if, like methane seeps, the presence of hydrothermal vents near the habitats of marine taxa (used as proxies for paleoclimate reconstruction) influences their d13 C ratio as well. I would also like to know what are other distinguishing characteristics of fossil vents.

I also thought it was interesting that this paper points out that this paper addresses alkalinity and its possible role in the origin of life because it isn’t an idea that I’ve come across before. The authors say that alkaline Hadean hydrothermal vents probably played an important part in the origin of free cells. They say that “the ability to harness a continuous and naturally existing proton gradient is older than the ability to generate a proton gradient specified by genes.” Although they say that this idea appears counter-intuitive, this makes a lot of sense to me because it seems that it would be better/easier to utilise something already existing.

What I disliked: To be honest, I really liked this paper and I don’t have much in terms of critique because I learned a lot and I like the details. My only critique would be that I think it’s a little too long for a paper, but on the other hand the authors walk through the chemistry step-by-step and the layout is more visually appealing than many other papers I’ve read. I didn’t understand a good part of the biological chemistry and I think that when I have more background I’ll better understand all of the ideas in this paper.