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Hydrothermal Vents and the Origin of Life

**Article Summary**

Like the previous paper, this article begins with a question. The authors of this paper are concerned with possible answers to the question, “what is the origin of life?” Specifically, this article evaluates the suitability of undersea hydrothermal vents as staging areas for the development of the organic chemistry necessary for metabolic reactions. The article begins by introducing the prevailing hypothesis about how life originated: the “organic soup” hypothesis. This hypothesis suggests that mixtures of organic compounds could create prebiotic metabolisms capable of self-replication. This is followed by an introduction to the two types of hydrothermal vent: the “black smoker” chimneys and the “off-axis” vents with which the paper is primarily concerned. The article continues by explaining why the discovery of a new hydrothermal vent system, dubbed the Lost City hydrothermal field (LCHF) is intriguing for researchers studying the origin of life. The Lost City is host to a wide variety of chemotrophic bacteria, many of which are methanotrophs. This is significant to the researchers because primordial life may have produced ATP by reducing carbon dioxide to methane, a process they call anaerobic methane oxidation (AMO). There are many clues at the LCHF that indicate that the bacteria and archaea that call the place home are theoretically capable of AMO, and may even be performing AMO now. The authors cite increased concentrations of smaller hydrocarbons around the LCHF, and the presence of acetate and formate in the same area, as evidence that pre-biological chemical reactions are very possible in a hydrothermal vent system. Furthermore, the pH gradient that accompanies undersea hydrothermal vents in the LCHF also provide conditions that are favorable for the development of primitive genetic material. The authors conclude by positing that, because hydrothermal vent systems like the LCHF have existed for as long as there has been water on Earth, it is well worth considering that places like the Lost City were the cradle of life on this planet.

**Things I liked about this paper**

This article provides much in the way of supporting information, and is not short on academic sources. There are several ‘boxes’, which segregate tangentially important information from the body of the paper. These, combined with footnotes detailing particularly esoteric concepts, keeps the main argument flowing while still presenting all necessary information in an organized manner. Several times the authors clarify that their paper does not invalidate other hypotheses surrounding the origin of life, and that its purpose is a call to action for more research of the LCHF and other systems like it. This is important, because this is a somewhat controversial topic, and current evidence is too scant to rule out much of anything.

**Things I didn’t like about this paper**

This paper is very, very dense. This density makes it hard to follow, and obscures the overall argument somewhat. The problem is that there is so much information that the authors need to convey, and so little space in which to convey it, that critical explanatory information is occasionally crammed into very awkward sentences. The boxes were a great idea; I would have liked to see even more of them, perhaps one to clarify the significance of AMO.

**Evaluate the graphs and figures (if any)**

This paper has three figures and one table. Figure 1 is a helpful map of the location of undersea hydrothermal systems, which serves to suggest the existence of more sites like the LCHF. Figure 2 is a collage of photographs of “black smokers”, Lost City vents, and research equipment; the middle diagram is helpful for illustrating the temperature and chemistry surrounding a vent, but the other photographs really seem to me to be distractions. Table 1 compares the different aerobic and anaerobic metabolic reactions and their energy yields. This is essential information presented clearly. The final figure is a diagram of the various metabolic reactions used to reduce carbon dioxide to methane; this is also very helpful for illustrating how chemistry becomes biology. Overall the figures were average: they presented necessary information in an understandable format.