Geologists Provide New Evidence for Reason Behind Rise of Life in Cambrian Period

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Geologists have uncovered evidence in the oil fields of Oman that explains how Earth could suddenly have changed 540 million years ago to favor the evolution of the single-celled life forms to the multicellular forms we know today.

Reporting in the December 7 issue of the journal *Nature*, researchers from MIT, the California Institute of Technology, and Indiana University show that there was a sudden change in the oxygenation of the world's oceans at the time just before the "Cambrian explosion," one of the most significant adaptative radiations in the history of life. With a increased availability of oxygen, the team speculates, single-celled life forms that had dominated the planet for the previous three billion years were able to evolve into the diverse metazoan phyla that still characterize life on Earth.

"The presence of oxygen on Earth is the best indicator of life," says coauthor John Grotzinger, the Fletcher Jones Professor of Geology at Caltech and an authority on sedimentary geology. "But it wasn't always that way. The history of oxygen begins about two and a half billion years ago and occurs in a series of steps. The last step is the subject of this paper."

The key insight was derived when Grotzinger's student Dave Fike, who is lead author of the paper, analyzed core samples and drillings taken at a depth of about three kilometers from oil wells in Oman, which are known to have the oldest commercially viable oil on the planet. The

results of carbon and sulfur isotopic analyses from the material led the team to the conclusion that the oceanic conditions that laid down the deposits originally in Oman were quite different from conditions of today.

"You need a very different ocean for these conditions to exist--more like the Black Sea of today, with an upper oxidized layer and lower reduced layer with very little oxygen," says Grotzinger. "The ocean today is pretty well oxidized at all layers, but the ocean before the Cambrian period must have been very different."

When organic matter falls into an ocean that doesn't stir, it becomes deprived of sufficient oxygen and cannot survive as multicellular forms. For this reason, with a limited amount of oxygen, life continued in its single-celled form for the first three billion years.

But about 550 million years ago, according to the team's geologic evidence, the deep oxygen began mixing its contents with the shallow ocean, resulting for the first time in a fully oxidized deep ocean.

Characterizing the study as paleoceanography, Grotzinger says the evidence is persuasive because it is so clearly evident in the rock record. Geologists have long believed that the rise of oxygen was a key element involved in the Cambrian radiation, so this discovery really helps solidify that hypothesis.

The oxygen trigger helps account for how life 500 million years ago could have gone from its single-celled existence to the emergence just 10 to 15 million years later of all the metazoan phyla we know today. In short, an abrupt increase in the availability of oxygen may have led to the diversity and complexity of life.

Fike is a graduate student at MIT who is currently in residence at

Caltech to work with his professor, Grotzinger, who himself came to Caltech from MIT last year. The other authors of the paper are Lisa Pratt of Indiana University and Roger Summons of MIT.

Source: Caltech