Lucky find off Galapagos

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During an expedition off the South American coast, an international team of ocean scientists discovered that the gases ethane and propane are widespread, and are being produced by microorganisms in deeply buried sediments.

Prof. Kai-Uwe Hinrichs (Research Center Ocean Margins, University of Bremen), co-author Prof. John Hayes (Woods Hole Oceanographic Institution), and colleagues report new findings on the production of energy-laden gases in a paper in this week's online edition of the renowned *Proceedings of the National Academy of Sciences of the U.S.A.* (PNAS). The findings suggest that microbes in the deeply buried, vast ecosystem below the seafloor carry out hitherto unrecognized processes, which are highly relevant to both our understanding of global element cycles and the metabolic abilities of Earth's microbial biosphere.

"In a way, the finding was coincidental," Hinrichs states. Onboard the research drilling vessel JOIDES Resolution, the geochemist, now at the University of Bremen but then at Woods Hole Oceanographic Institution (WHOI), analyzed the gases in sediments buried up to 400 meters in the Equatorial Pacific off Peru. "We were swamped with samples: in nearly a thousand samples of up to 40 million-year-old sediment, we analyzed the gas content." Despite work shifts of up to 14 hours, the shipboard scientists soon had a backlog of unanalyzed samples, which turned out to be lucky. "When we later looked at the samples, we noticed that concentrations of ethane and propane were suspiciously high," Hinrichs adds. Soon the scientists realized that these gases were not artifacts or contaminants, but that they must have slowly escaped from the sediment.

The researchers began to wonder how to account for the presence of these gases. Normally, ethane and propane are known as typical products of fossil fuel generation at elevated temperatures and pressure, without direct involvement of microbes. In the PNAS article, the team argues that microbes played a key role in the formation of these hydrocarbons.

"Sediments contain organic material (the fossil remnant of oceanic plants and animals)," Hinrichs explains. "This material, a key ingredient in the carbon cycle, is the major food used by the deep biosphere. During its decomposition by microbes, acetate--the ionic form of acetic acid--is formed. We think that bacteria use hydrogen to convert acetate into ethane. Addition of inorganic carbon and hydrogen provides a route to propane."

In support of their hypothesis for a biological origin of the gases, the researchers point to several clues: "First, the sampling locations are remote from reservoirs of oil and natural gas, so that this source can be eliminated," Hinrichs says. "Moreover, the abundance of stable isotopes of carbon are markedly different from those in gases formed at high temperature," adds co-author John Hayes, a geochemist at Woods Hole Oceanographic Institution (WHOI).

Co-author Wolfgang Bach, geochemist and professor at the Bremer Research Center points out, "We also were able to demonstrate that under the conditions prevailing at depth, these processes could yield just enough energy for growth of bacterial communities."

The paper leads to several new questions that will be addressed in future work. In a current PhD project in the Organic Geochemistry Group at the Research Center Ocean Margins, experiments are being conducted to locate the sedimentary sites where the gases are hidden. "Interlayer spaces of clay minerals are the best candidates right now," Hinrichs says. Other experiments are currently being designed to find out more about

how the gases are being formed. He adds, "One important goal right now is to study these processes under controlled conditions in the lab to verify or refine the proposed mechanism." Hinrichs knows that it may not be easy to simulate processes from the deep biosphere, but the geochemist hopes to identify and replicate the conditions needed to stimulate the microbes to produce a lot of these energy carriers.

Source: Integrated Ocean Drilling Program Management International