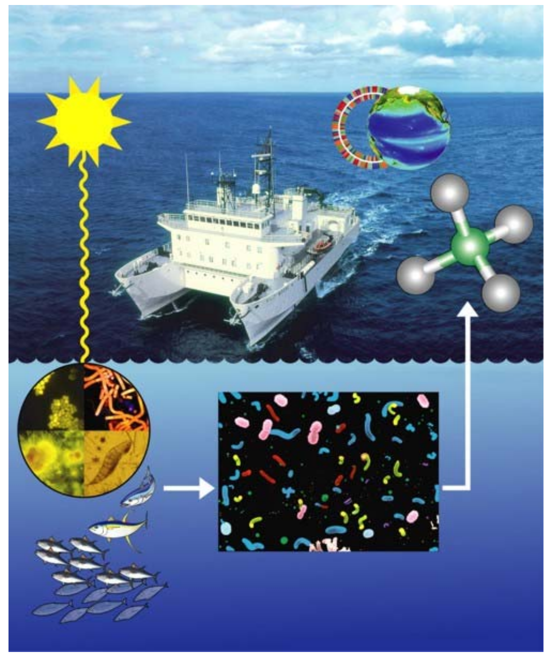
SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY

Press Release

Wednesday July 2, 2008

New Pathway for Methane Production in the Oceans

Honolulu, HI – A new pathway for methane production has been uncovered in the oceans, and this has a significant potential impact for the study of greenhouse gas production on our planet. The article, released in the prestigious journal Nature Geoscience, reveals that aerobic decomposition of an organic, phosphorus-containing compound, methylphosphonate, may be responsible for the supersaturation of methane in ocean surface waters.

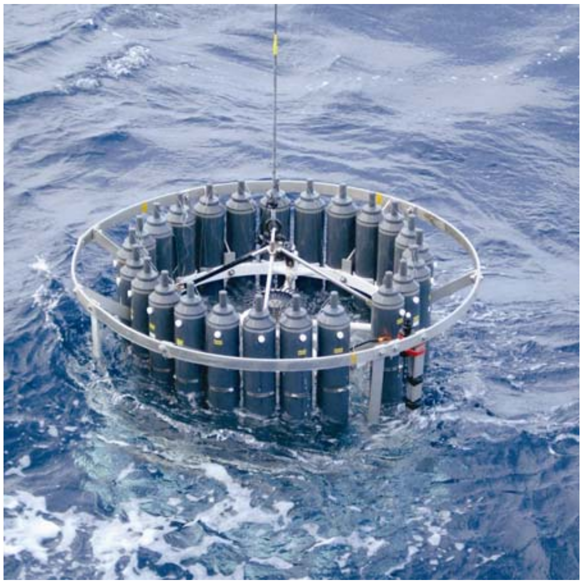


A conceptual view of the role of sunlight in producing methylphosphonate through food-web processes (circle), bacterial decomposition (square), producing the greenhouse gas methane CH4. The University of Hawaii Research Vessel Kilo Moana supported the field work in this study. Credit C-MORE/ SOEST

Methane is a more potent greenhouse gas than CO_2 on a per weight basis. Although the volume of methane in the atmosphere is considerably less than CO_2, methane is much more efficient at trapping the long wavelength radiation that keeps our planet habitable but is also responsible for enhanced greenhouse warming. Today, between 20-30% of the total radiative forcing of the atmosphere is due to methane. Terrestrial sources of methane production are well known and studied (including extraction from natural gas deposits and fermentation of organic matter), but those known sources did not account for the levels of methane observed in the atmosphere. David Karl, an Oceanographer in the School of Ocean and Earth Science and Technology at the University of Hawaii at Manoa and lead author of this paper, was interested in this "methane enigma" and why the surface ocean was loaded with methane, over and above levels found in the atmosphere. When looking at the literature, Karl found a possible solution to the enigma, in the compound methylphosphonates, a very unusual organic compound only discovered in the 1960s. In the laboratory, the aerobic growth of certain bacteria on methylphosphonate can lead to the production of methane, but until now this process of methylphosphonate degradation in the ocean had not been suggested as a possible pathway for the aerobic production of methane in the sea.

"When people began measuring methane in the ocean, they found that methane concentrations varied with geographical location and with water depth", says Karl. "If methane was inert in the ocean, its concentration should be constant and nearly equal to the concentration in the atmosphere. What the scientists found was that methane was lower than expected in deep waters, implying net consumption by microbes. However the big surprise was that near surface concentrations were higher than in the overlying atmosphere which indicated a local production of methane in the sea. Because methane is produced only in regions devoid of oxygen and since the surface ocean contains high oxygen levels this was very perplexing."

Karl was able to combine a long term interest in methane, 20 years of ocean observing data at the Hawaii Ocean Timeseries site Station Aloha, and new technology that Massachusetts Institute of Technology co-author Edward DeLong and colleagues have developed to produce methane in aerobic marine environments. "I think this work nicely demonstrates the complementarity of different methods and approaches, which include oceanography, microbial ecology, and genomics techniques," says DeLong. "In the case of genomics, the growing databases of marine microbial genomic and metagenomic data have great potential to help us link which organisms, and which genes, are responsible for driving important nutrient and elemental cycles in the sea, like aerobic methane generation. With our colleagues at the Center for Microbial Oceanography: Research and Education (C-MORE, of which Karl is the Director, and DeLong the Co-Director), we plan next to learn how and when microbial communities turn on and off their methane production genes, in response



CTD (conductivity, temperature, depth) rosette being deployed to gather water samples at Station Aloha.
Credit: HOT/ SOEST

to the methane precursors, like methylphosphonate, in their natural environment. This should provide new insights about the 'who' and the 'how' of this newly discovered methane generating process in the sea."

Although the implications for global climate change are still being studied, the warming and further stratification of the ocean seem likely to affect marine methane production. "This is a newly recognized pathway of methane formation that needs to be incorporated into our thinking of global climate," says Karl. "Since our oceans cover ¾ of the planet, you just need to stimulate this pathway a little bit and you're going to create more methane. And one way you can tweak it is to stratify the oceans, which we know will happen. All of the climate models show that the ocean will become more nutrient limited over time."

Phil Taylor, Acting Head of the Ocean Section, Division of Ocean Sciences at the National Science Foundation (NSF) agrees. "This remarkable discovery about methane production where we thought there would be none is a harbinger of many new insights on the ocean's changing biogeochemical nature, and the intricate microbiological reasons for those changes."

Interest in this research crosses many specialties. Oceanographers will be excited because it offers a solution to the long standing methane paradox. Microbiologists will be excited because it shows an aerobic production pathway of methane, which goes against everything that is currently known about methane, and Climatologists will be interested because it's a potent greenhouse gas that we don't have constraints on, and this new pathway is very exciting.

"NSF funded C-MORE with the hope that its scientists would make new discoveries about the vast genomic diversity and complexity in the microbial world, and its impacts from cellular to global scales," says Matt Kane, Program Director for the NSF Division of Environmental Biology. "These findings are an example of the payoffs that come from an interdisciplinary and integrative approach to microbial oceanography."

This research was supported by the Gordon and Betty Moore Foundation and the National Science Foundation.

For Interviews contact:

David Karl, Professor, Department of Oceanography, School of Ocean and Earth Science and Technology, University of Hawaii, dkarl@hawaii.edu, (808) 956-8964 http://hahana.soest.hawaii.edu/lab/dkarl.html
Edward F. DeLong, Professor, Division of Biological Engineering and Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, delong@mit.edu (617)253-5271 http://cee.mit.edu/index.pl?id=7058

SOEST Media Contact: Tara Hicks Johnson, (808) 956-3151, hickst@hawaii.edu

Paper Information:

Aerobic production of methane in the sea
David M. Karl, Lucas Beversdorf, Karin M. Björkman, Matthew J. Church, Asuncion Martinez & Edward F. Delong
Nature Geoscience, Published online: 29 June 2008 | doi:10.1038/ngeo234
http://www.nature.com/ngeo/journal/v1/n7/abs/ngeo234.html
