Biogeochemical Investigations of Microbial Biomarkers in an Active Estuarine Pockmark Field, Penobscot Bay, Maine

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Penobscot Bay contains eight large concentrations of pockmarks. Nearly 6000 individual pockmarks have been mapped by sidescan sonar. Previous investigations have shown that the pore fluid contains water, methane and carbon dioxide. The absence of higher-order hydrocarbons suggests a bacterial origin for methane. High-grade metamorphic and igneous bedrock underlying the Quaternary sediments virtually preclude thermogenic sources.

In order to elucidate the origin of the methane, an extensive research program is underway. Seismic and sidescan sonar imagery were used to support the collection of fifty-six vibracores within and near pockmark concentrations. The combined dataset suggests several possible origins for the organic-rich sediments used for methane generation: 1) Paleo-lacustrine: paleo-lakes formed on the subaerially exposed portion of the inner continental shelf persevered through transgression; 2) Paleo-palustrine: wetlands formed in environments similar to paleo-lakes; 3) Detrital organics: organic matter washed into the basin from terrestrial sources.

To determine the source material, a biogeochemical study of one core is underway. This study will utilize total lipid extraction techniques to isolate known biomarkers for microbes that generate or utilize methane including dinosterol, crocetane, pentamethylicosane, and others. Specific biomarkers can indicate the biological pathway used in methanogenesis and provide information about the environment of deposition. For example, acetate fermentation is dominant in freshwater environments (paleo-lacustrine/palustrine) while CO_2 reduction is dominant in marine environments (paleo-palustrine/detrital organics).

An understanding of methanogenesis in Penobscot Bay will clarify the evolution of this and other gas-rich estuaries, and assist in the quantification of the global methane flux.