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Roger Sassen[1], Alexei V. Milkov[2], Debra A. DeFreitas[1], Stephen T. Sweet[1] (1) Texas A & M University, College Station, TX (2) Texas A&M University, College Station, TX

Molecular and Isotopic Properties of High Flux Gas Seeps, Northwestern Gulf of Mexico

Study of the molecular distributions and carbon isotopic properties of methane from 160 high flux seep sites across the Gulf of Mexico from the outer shelf to the lower slope reveals new insight to the complex origin of gas at the sea floor. Each site represents the intersection of a major migration conduit from the deep subsurface to the sea floor related to salt or faults. Sites were selected to minimize bias from known gas and oil fields. Mean concentration of methane is 99,407 ppm. Means of ethane (1,837 ppm), iso-butane (825 ppm), and normal butane (607 ppm) are anomalous. To provide perspective, typical Gulf sediment has methane < 10 ppm and higher hydrocarbons may be in low abundance or below detection limits. The mean carbon isotopic composition (per mil, PDB standard) of methane is -74.0, whereas the range is from -30.1 to -116.6. The occurrence of isotopically heavy methane probably represents bacterially oxidized thermogenic methane, but the occurrence of extremely light methane implies that carbon is recycled through bacterial hydrocarbon oxidation and reduction of carbon dioxide in natural bioreactors. Molecular and isotopic properties of gas suggest that nearly all high-flux gas seeps across the Gulf are a mixture of bacterial and thermogenic hydrocarbons. Contrary to previous generalizations, much bacterial methane may originate from several kilometers depth. The carbon isotopic threshold between bacterial and thermogenic methane often cannot be defined because considerable overlap exists and bacterial alteration is common.