AAPG HEDBERG CONFERENCE
"*Near-Surface Hydrocarbon Migration: Mechanisms and Seepage Rates*
SEPTEMBER 16-19, 2001, VANCOUVER, BC, CANADA

Increase in Methane Input to the Atmosphere from Hydrocarbon Seeps on the World's Continental Shelves During Lowered Sea Level

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Present day seepage from hydrocarbon reservoirs beneath the world's continental margins discharge oil and natural gas into the ocean and atmosphere and contribute to the global methane budget. On the northern shelf of the Santa Barbara Channel, California the Coal Oil Point seep field discharges about 100,000 m^3 of gas and 100 bbl of oil per day. The hydrocarbons seep from faulted anticlines in the Monterey and Sisquoc Formations. The gas includes 40 metric tons of methane emitted to the atmosphere each day. We have determined that an equal amount of methane dissolves in the water column as hydrocarbon gas bubbles travel 50 to 70 meters to the ocean surface. The dissolved methane is advected away from the seeps by currents and dissipates throughout the waters of the Southern California Bight. Ultimately this dissolved methane is oxidized by microbes in the ocean or escapes to the atmosphere. The relative amounts due to these processes are unknown, but we assume that a significant proportion of the dissolved methane is lost in the ocean to oxidation. During lowering sea level of glacial periods these seeps and others like them around the world became exposed to the atmosphere. Furthermore, deeper gas seeps on the upper continental slope became covered with less water. The result of the sea level fall was more methane input directly to the atmosphere instead of dissolving in the ocean and oxidizing.

The greenhouse effect of the added methane input to the atmosphere serves as a negative feedback to other factors driving a drop in global temperatures. The methane added to the atmosphere from exposed seeps could be double the amount now estimated to result from marine seeps - to 20 - 100 trillion grams (Tg) per year. This proposed source of methane helps mitigate problems associated with calling upon wetlands as a major source of methane during lowered sea level of the Last Glacial Maximum and other glacial periods. Wetlands today are the main source of non-cultural methane (110 Tg/yr) to the global budget (170 Tg/r) but geologic evidence suggests that less extensive wetlands existed prior to the Holocene. Wetland sources were likely much less significant in Pleistocene compared to warmer Holocene time. Dryer climate, lowered sea level and lowered water tables probably reduced wetland areas in glacial compared to interglacial times.

Prior to the Holocene another source is needed to explain the finding in ice cores of atmospheric methane concentrations in glacial times that are 50% the concentrations of interglacial times. Significant methane sources during the Last Glacial Maximum and other glacial periods are likely exposed marine gas seeps, onshore gas seeps, methane release from continental shelf sediments, termites, remnant wetlands, fires – and possibly methane from the conversion of gas hydrates. The implication is that without a major wetland source the glacial period methane sources were largely thermogenic and ^{14}C depleted. This proposal can be tested by isotopic studies of air bubbles in ice cores.