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A Global Assessment of Geologically-Sourced Methane Seepage

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Methane is the most abundant organic compound in the Earth's atmosphere, where it acts as a greenhouse gas and thus has implications for global climate change. The total annual net input of methane to the atmosphere has been constrained by others to about 540 Tg (teragrams = 10^{12} g of methane). Sources of methane to the atmosphere are varied with the methane containing both modern (with ^{14}C) and ancient (without ^{14}C) carbon, but the current atmospheric methane budget does not take into account geologically-sourced methane seepage.

Thus a workshop was organized to address the issue of the missing, geologically-sourced carbon in the current global inventory of sources of atmospheric methane. The eighteen participants addressed the hypothesis that naturally occurring methane seeps contribute a significant amount of methane, containing much geologically-sourced carbon, to the atmosphere. Natural gas seepage rates have previously been ignored in inventories of atmospheric methane sources. However, natural gas seeps, commonly occurring with natural oil seeps, are found in both terrestrial and marine settings. These seeps range from microseepages (often considered in geochemical prospecting for petroleum) to macroseepages (so clearly evident in the Santa Barbara Channel, offshore from southern California). Also ignored have been the natural exhalations of methane from exposed outcrops, particularly petroleum source rocks and coal beds. The workshop, informally named the Gaia's Breath Working Group, addressed issues of natural gas seep occurrence, measurements of rates of methane emission from seeps on local scales, estimates of rates of methane emission from seeps on a global scale, and methods for improved assessment of methane seepage rates.

The Working Group concluded that the contribution of geologically-sourced methane to the atmospheric organic carbon cycle is significant and should be included in any global inventory of atmospheric methane. As a first approximation, the observed global rate of methane emission at the seabed was estimated to be about 50 Tg/yr resulting in an atmospheric emission rate of about 30 Tg/yr. A theoretical estimate, based on the total reservoir of methane available for seepage over geologic time, steady-state conditions, and a half-life of methane in the system of 10^8 years, resulted in similar rates of methane emission of 30 Tg/yr at the seabed and 10 Tg/yr to the atmosphere. These first approximation rates are strongly influenced by methane oxidation which plays a critical role in limiting the amount of methane available to the ocean-atmosphere system. Knowledge of methane emissions from terrestrial sources (volcanoes, rock outcrops, coal beds) is minimal, but the rate of methane emission from these sources is believed to be less than from the oceans.