Hydrogen Isotopic Composition of Methane

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Introduction

The δD or hydrogen isotopic composition of methane yields important information regarding methane production and oxidation. We are determining this for landfill and wetland studies. Stable hydrogen isotopes can be combined with stable carbon isotopes and used to distinguish sources of CH_4 including bacterial formation, thermogenic formation and biomass burning as well as to determine the effect of microbial oxidation in lake and wetland and landfill environments.

Experimental

We are using the DELTA XP Finnigan MAT isotope ration mass spectrometer for these studies. We determined D/H of CH_4 on a Finnigan MAT delta +XP using a Trace GC with a poroplot column and the reduction column set at 1450°C.

Results and Discussion

The δD of CH_4, ranged widely in this study (-315‰ to -420‰), and differed by study region and bubble type. The δD of Siberian CH_4 of point sources and hotspots (-392 ± 8‰, n=40) was δD-depleted compared to Alaskan hotspots (-351 ± 5‰, n=7) (t-value = 12.7_{45}, $p<0.0001$). δD_{CH4} was more depleted in thermokarst ponds situated on yedoma (-388‰ to -402‰) compared to man-made sandy ponds sitting on bedrock (-360‰ to -381‰). δD_{CH4} of interior Alaska thermokarst lakes (-340‰ to -355‰) was more depleted than that of the more northern tundra lakes that lacked intensive thermokarst (-321‰ to -339‰). Ice koshkas were enriched by 46‰ in Siberia and 24‰ in Alaska relative to the fresh point-source counterparts in both regions (Siberia -346 ± 13‰, n=4; Alaska -328 ± 5‰, n=22).

Conclusions

Isotopic separations between the δD of environmental water and CH_4 in high latitude wetlands was described by Chanton *et al.* (2006) based on the fractionation of deuterium during methanogenesis ($\delta D_{CH4}= 1.55\ \delta D_{H2O} – 145.4$, $r^2 = 0.69$ in Alaskan samples). Assuming a similar evaporative enrichment between δD_{H2O} of precipitation and δD_{H2O} of lake water in interior Alaska to that of Siberia (~2‰), and using the equation of Chanton *et al.* (2006), we would expect δD_{CH4} of -397‰ in Siberian lakes. This expected value was indeed close to the observed mean δD_{CH4} values for background (-380 ± 13 ‰, n=3), point-source (-384 ± 6 ‰, n=10) and hotspot (-394 ± 4 ‰, n=32) ebullition. Particularly low δD_{CH4} values in hotspot bubbles from Tube Dispenser Lake, a deep lake undergoing active thermokarst erosion, were on the order of -416 ± 4 ‰, n=2, suggesting possibly that hotspot CH_4 emitted from these thermokarst lakes was produced in an environment with a different water source than modern lake water.

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References

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