Characterization and source identification of gas bubbles observed at Mississippi Canyon Block 20 (MC20) in the Gulf of Mexico

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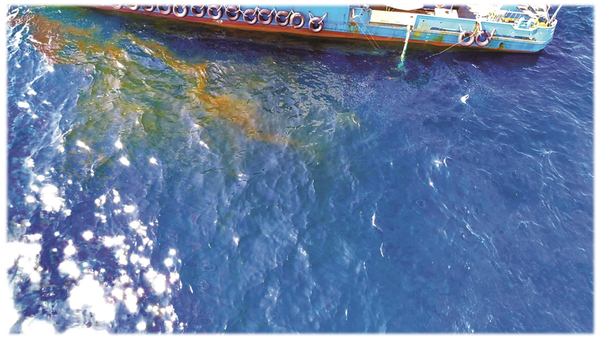
Abstract

An oil sheen and gas bubbles have been observed to be continuously released from the seabed in MC20 several kilometers offshore of Louisiana. Gas, oil, sediment, and water samples were collected by scientists and technical staff through a collaborative effort by BSEE, NOAA, and TDI-Brooks International aboard the R/V Brooks McCall in early September 2018. The hydrocarbons were extracted and then analyzed via gas chromatography (GC) and isotope ratio mass spectrometry (IRMS) at B&B Laboratories in College Station, Texas. The concentrations and carbon isotopic ratios of the light hydrocarbon gases were determined to discern if the gas originated from a thermogenic release or is biogenic and was produced by microbes.



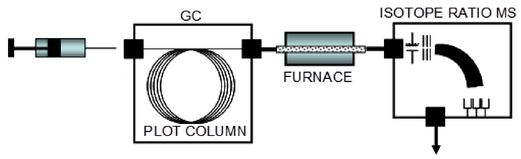
Introduction

The concentrations and isotopic ratios of light hydrocarbon gases (methane, ethene, ethane, propene, propane, iso-butane, n-butane, neo-pentane, iso-pentane, and n-pentane) are used to determine the origin of gas samples collected in surface geochemical exploration (SGE) studies for the purpose of seep hunting, but may also be used for forensic applications as well; these data are entered into a number of models that have been developed by geochemists to determine source and if any chemical alterations have occurred such as mixing, biodegradation, and/or fractionation.

Materials & Methods

Gas samples were collected in the field and stored in foil bags. To quantify C_1-C_5 hydrocarbons, samples were injected with a gas-tight syringe into a HP 5890 GC configured with a porous layer open tubular (PLOT) capillary column, thermal conductivity detector (TCD), and flame ionization detector (FID).

The carbon isotopic ratios were determined by injecting the sample into a similarly configured HP 5890 GC coupled to a MTI Corporation Tube Furnace and a Compact Science Systems IRMS. The hydrocarbon gases were quantitatively combusted to CO_2 using a cupric oxide catalyst heated to 980^{o}C in order to be detected by the IRMS.



Results

The three gas samples collected from a location exhibiting visible gas bubbles were analyzed by GC/FID and determined to be of similar hydrocarbon composition:

~93-95% methane
~4-6% C_2/C_3 alkanes
~1% C_4/C_5 alkanes

These data are plotted in **Figures 1 and 2** in concert with hundreds of SGE gas samples acquired from around the world by TDI-Brooks.

The methane carbon isotopic ratios of these three samples were approximately -57‰ VPDB (parts per thousand on the Vienna Pee Dee Belemnite Scale) and exhibited a $C_1/(C_2+C_3)$ ratio of <25 as shown on the Bernard Plot in **Figure 3**.

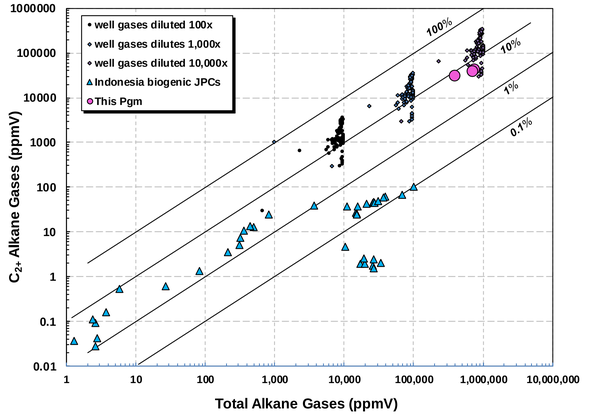


Figure 1. Gas Wetness Plot of samples distinguished by source

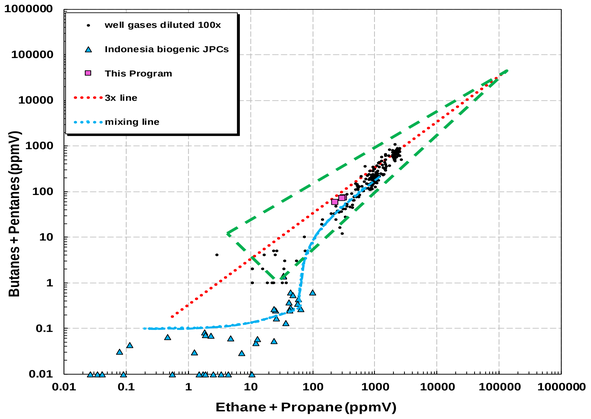


Figure 2. Triangle Plot of samples distinguished by source

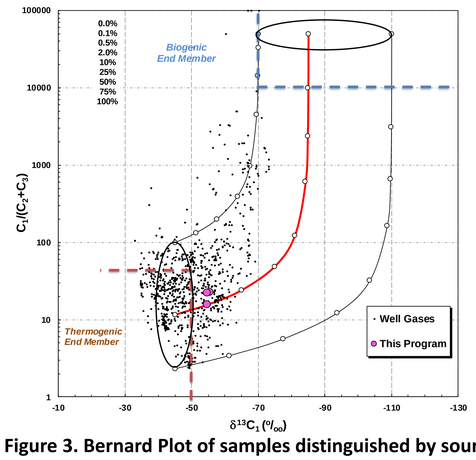


Figure 3. Bernard Plot of samples distinguished by source

Conclusions

Based on the methodology and historical gas data acquired from surface geochemical exploration (SGE) studies conducted by TDI-Brooks International, these three gases are of similar molecular and isotopic composition and most likely originate from the same thermogenic source.

These gases are “wet” due to elevated concentrations of C_2-C_5 alkane gases and are almost exclusively thermogenic. Biogenic gases typically contain some C_2-C_3 alkanes and alkenes, but contain very little to no C_4-C_5 gases.

The carbon isotopic ratios of methane in these samples are heavy (less negative) and are consistent with thermogenic well gases.

References

Bernard, B. *Light Hydrocarbons in Marine Sediments*, Technical Report 78-5-T, Texas A&M Press, 144p., College Station, Texas, USA, 1978.

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