



Distinguishing trace levels of migrating thermogenic gas from local biogenic gas in seabed sediments

Bernie B. Bernard and James M. Brooks
TDI-Brooks International, Inc.

Summary

We have historically considered interstitial concentrations less than 100 ppmV total alkane gases in seabed sediments as background. The predominant light hydrocarbon is methane, as has been the case in essentially all marine sediments (seabed to 15 m below) we have analyzed. We have found interstitial methane to exist at higher than 0.7 ppmV concentrations in 100,000+ sediment samples we have acquired from the seabed of the world ocean. The presence in seabed sediments of elevated levels of C₂+ alkane gases has historically served as a prospecting indicator of migrating thermally-sourced gas (also called "wet" gas), as conventional wisdom holds that ethane, propane, the butanes and the pentanes are not locally produced and sustained at more than a few ppmV in the first several meters of sediment. Whereas these gases greater than background may indeed be indicators of migrating thermogenic gas, such samples must be further qualified before any valid conclusions may be drawn, because microbially-produced gas can also cause a similar near-surface anomaly. Along with intense methanogenesis, high rates of anaerobic microbial activity perhaps coupled with diagenetic degradation of olefins to alkanes, produces gas compositions that exhibit remarkably high levels of C₂+ alkane gases that would conventionally and historically be interpreted as thermogenic. A gas wetness plot illustrates that some core samples plot in the same range as expected for thermogenic wet gases, but many plot in the low-wetness range of the biogenic gases. This occurrence is almost certainly due to mixing with, and dilution by, biogenic gases.

Very few seabed sediment gases are strictly thermogenic in source due to the ubiquitous nature of locally generated biogenic gas in seabed sediments. However, because thermogenic wet gas contains much higher concentrations of the C₂+ alkanes including the butanes and pentanes, even a trace of thermogenic gas mixed or diluted with a large fraction of biogenic gas can allow the detection of that trace component. Presented here is a screening plot that attempts to account for the nuances and complexities of natural processes encountered in marine sediments. Competing processes include local light hydrocarbon gas production, consumption, migration, alteration, fractionation, and especially mixing, down through the sulfate reducing zone and into the zone of intense methanogenesis. This gas-source screening tool compares the sum of the ethane and propane concentrations to the sum of the iso-butane, n-butane, iso-pentane, neopentane, and n-pentane concentrations. This plot often carries more interpretive weight than even the carbon isotopic ratios of each gas component. We developed this tool by comparing the interstitial gas concentrations measured in all of our recent seabed geochemistry surveys as well as our well-gas databases, while looking for trends that involved as many analytical parameters as possible. We noticed a distinctive and consistent trend of thousands of well

gases as well as interstitial gas data independently confirmed as thermogenic seepage. Well gases and sediments with components of migrated thermogenic gas tend to preserve a distinct trend ratio among the C2-C5 alkane elements whereas sediments with high-level biogenic gases display an array of different and scattered patterns. The observed distribution ratio among the thermogenic C2-C5 alkane gases in nature is also supported by a recently developed thermocatalytic-cracking predictive model for gas compositions as a function of maturity.