Natural Hydrocarbon Seeps: toward understanding a complex natural system

Abstract-20108: Spatial and Temporal Variability of Hydrocarbon Seepage, Offshore Gulf of Mexico, Regional and Local Variations As Defined by Natural Seeps

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In 1967 the Gulf Oil Company initiated a program to develop technology for locating seeps in the marine environment. By 1974 a fairly sophisticated system had been developed and installed on Gulf's seismic vessel, the R/V Hollis Hedberg. This system, operated by Gulf from 1974 to 1983 was used to collect an extensive "sniffer" geochemical database in the Gulf of Mexico that contains over 191, 000 dissolved gas analyses. A detailed evaluation of this database made with respect to discoveries made after the geochemical data was recorded showed that the data was 88 % effective in finding new commercial production. This technology not only has the ability to predict whether a block has hydrocarbon potential, but also whether it is more likely to produce oil or gas, a very important economic factor in the evaluation of offshore blocks.

This marine "sniffer" database extends from Florida to the Mexican border, covering the entire Texas and Louisiana offshore shelf. Active seepage anomalies demonstrate the actual extent and variability of oil and gas seeps, defining both the spatial extent and vertical variability of hydrocarbon plumes as they rise from the seafloor sediments. Spatial and temporal changes are quite distinctive when comparing natural versus anthropogenic seeps, which are almost exclusively related to leaking well casing and/or pipelines. This marine database allows the full complexity of dissolved hydrocarbons associated with deep marine seepages from natural and anthropogenic sources to be illustrated by numerous examples that demonstrate the variability of dissolved hydrocarbon concentrations in seawater.

This hydrocarbon seepage database provides the most extensive and complete coverage of the entire Gulf of Mexico shelf that has ever been collected. Dissolved gas measurements have been made at the surface (hull inlet) and at two depths (mid-tow, 450 feet) and (deep-tow, 600 feet), allowing both vertical and temporal measurements on regional and localized grids that cover a vast expanse of the offshore Gulf of Mexico. Examples shown will demonstrate the spatial, vertical and temporal variability of natural and anthropogenic seepages. An understanding of this natural seepage complexity is essential when trying to compare and determine the potential source of new, or continuing seepage that might be associated with an abandoned well, such as the Macondo well.

[figure1]

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Abstract-20288: Complexity of Biologically Generated Gases with Associated Hydrocarbon Seepage

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Numerous examples from actual exploration and environmental surveys illustrate the actual spatial variability imposed by geological heterogeneity in natural sediments on biologically generated gases associated with hydrocarbon seepage. Horizontal and vertical sediment heterogeneity forces hydrocarbon seepage to very selectively channel towards more permeable pathways, creating the need for very close spacing (feet to 10's of feet) to correctly image the actual seepage patterns between biological gases and their sources. Biological gases, in particular methane and carbon dioxide are created from anaerobic and aerobic environmental conditions that occur in very close proximity to the individual hydrocarbon contact points that provide the organic material required for their generation. Numerous examples will illustrate the spatial complexity of methane and carbon dioxide from a wide variety of hydrocarbon sources.

Anaerobic methane is generated in extremely large concentrations in direct association with subsurface petroleum products and has been shown to provide an accurate indicator for mapping the distribution of phase separated hydrocarbon products. Carbon dioxide patterns are much more complex due to the fact that carbon dioxide generation varies significantly, depending upon both the proximity to source and oxygen availability, in addition to the fact that it can from under both aerobic and anaerobic conditions. While methane forms anomalies directly associated with the source, carbon dioxide can form both direct and halo type patterns that require much higher sampling density for delineation.