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Natural Fluid Seepage in the Deepwater Gulf of Mexico: Petroleum Systems, Environment, and Ecology

The northern Gulf of Mexico offers a setting in which to study the relationships between hydrocarbons, fluid migration, and biological communities supported by hydrocarbon seepage. Compared with other basins, background hydrocarbon concentrations are high across much of the slope. This poses particular challenges to petroleum exploration and environmental management concerns as both require distinguishing macro-seeps from the high backgound.

Rapid Neogene and Quaternary sedimentation and shallow, mobile salt generate faults and fracture complexes which extend to the sea bed from depth. These offer avenues for hydrocarbons to migrate to the seabed from the thermogenic realm, intermediate reservoirs, and the shallower realm of gas hydrate stability. Seepage rates, as well as hydrocarbon and water chemistry are therefore variable throughout the region. Hydrocarbon enrichment and sulfate reduction support significant chemosynthetic communities.

We recognize three broad habits of hydrocarbon-bearing sediments. Background sediments are generally associated with an undisturbed seabed, contain hydrocarbons dominated by plant waxes and ‘detrital’ thermogenic components with a strong modern overprint and support a heterotrophic fauna. True hydrocarbon seeps are associated with faults/fractures to seabed, are dominated by large UCM, variable alkane yields, biomarker suites typical of subsurface oils and develop ‘lush’ chemosynthetic communities. Brine seeps are also associated with faults/fractures and contain elevated UCM, unbiodegraded n-alkanes, and biomarkers derived from low and high temperature processes; they tend to develop reduced chemosynthetic communities. Unlike those of true hydrocarbon seeps, the presence and character of hydrocarbons associated with brine seeps have not been found to be useful in petroleum exploration.