Wednesday, April 28, 2004

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by ***Harry H. Roberts***
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Gas Hydrates in the Gulf of Mexico's Complex Geologic Setting: Future Energy Resource or Just Another Geohazard?

Complex geology of the northern Gulf of Mexico's continental slope makes identification of the gas hydrate stability zone difficult. Bottom simulating reflectors (BSRs) that mark the transition from solid gas hydrate above to free gas below are rarely identified on seismic profiles, but do occur in special cases. Both high-resolution acoustic data and 3D-seismic surface attribute images calibrated to ground-truth (manned submersible observations, sampling and piston coring) confirm that widespread fluid and gas expulsion at the seafloor is characteristic of the northern Gulf of Mexico continental slope. Gas hydrate at the seafloor and in the shallow subsurface is a product of the expulsion process.

A variety of seafloor features are associated with hydrocarbon venting from a leaky subsurface petroleum system. It is suggested that fluid flux rate determines the types of seafloor features, the occurrence of gas hydrate and chemosynthetic communities, and the degree of hydrocarbon biodegrdation. The rates of fluid venting are qualitatively defined as rapid, moderate and slow. Mud volcanoes and mud flows represent the rapid flux settings. These are mud-prone environments that host only limited and localized chemosynthetic communities and show little evidence of biodegradation. Heat flow is often associated with rapid fluid flux environments and retards the crystallization of gas hydrate. Residence time at these vent sites is so short that gas and oil may be relatively unaltered by bacterial oxidation. Moderate flux settings include gas hydrate mounds outcropping on the seafloor. Gas plumes representing the composite effect of many local seeps occur over areas where gas hydrates are exposed, suggesting that fault-supplied gas is consistently by-passing the seabed. This process provides a constant supply of gas for hydrate formation. These environments are characterized by the most diverse, dense, and widespread chemosynthetic communities. Finally, slow flux environments are mineral-prone and include areas where authigentic carbonates precipitate from hydrocarbons oxidized by bacteria. The carbonates occur as nodular masses in sediments, hardgrounds, slabs, and mound-like buildups. Very localized chemosynthetic communities and highly biodegraded hydrocarbons are associated with slow flux environments.

Over a sea level cycle (~100 kyr) gas hydrate stored in the continental margin decomposes as falling sea level approaches the glacial maximum. Many of the northern Gulf's slope failures at the shelf-to-slope transition probably are associated with hydrate decomposition. During rising to high sea level, the gas hydrate reservoir is quickly recharged because of the availability of abundant fluids as gases supplied by the northern Gulf's deep hydrocarbon-generating zones. ■

Biographical Sketch

Harry H. Roberts, Boyd Professor at LSU, has been a researcher at Coastal Studies Institute (CSI) and teacher in the Department of Oceanography and Coastal Sciences for over 34 years. He is a marine geologist-sedimentologist who has worked on both carbonate and siliciclastic depositional settings domestically and in foreign areas. For the last decade a large part of his research effort has been focused on developing a better understanding of the impacts of fluid and gas expulsion on the surficial geology and biology of the Gulf's continental slope. Gas hydrates are products of the expulsion process in some settings and therefore have been a focal point of the study. Manned submersibles, in situ experiments, 3D seismic surface attribute data, and high-resolution acoustic data have all played parts in these studies. Harry also continues work on the Mississippi River delta system and has recently developed a research program around the collection of high resolution geophysical data (side-scan sonar, chirp sonar, bathymetry) and various types of cores (vibracores, box cores, piston cores) to help better understand details of the sedimentary architecture that may be related to Louisiana's substantial land loss problem.