Geophysical Baseline Characterization of Subsurface Gas Hydrates at MC118, Gulf of Mexico

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Methane hydrates are now widely known from the deepwater Gulf of Mexico. Analysis of industry 2-D and 3-D multichannel seismic reflection data from a hydrate-bearing region in the Mississippi Canyon protraction area (MC 118) provide the basis for investigation of the physical properties of gas hydrates concealed beneath the seafloor. These seismic data give a much deeper 3D view of the geologic setting of the site than previously attained and cross a one-kilometer diameter carbonate/hydrate mound. The subsurface structural, stratigraphic, thermal, and fluid flow architecture of MC 118, like that of many regions in the Gulf of Mexico, is dominated by the presence of salt, and the salt-related fault systems provide likely migration pathways for the thermogenic hydrocarbons.

Geophysical investigation of this industry dataset in conjunction with logs from a 1989 well drilled within the block is focused on quantification of the inferred subsurface hydrate deposits and involves: 1) derivation of elastic properties of hydrate-bearing sediments, 2) modeling of rock physics, and 3) calculation of hydrate saturation. Seismic inversion provides a quantitative map of elastic properties of hydrate-bearing sediments as well as an estimate of porosity volume. Subsequent rock physics modeling is executed by relating P-wave velocities extracted from the 3-D seismic volume to rock models of hydrate-bearing sediments and testing a range of rock models including: (1) hydrates grown at the grain contacts, (2) hydrates coating grains, (3) hydrates grown in the interior of the porous framework, (4) hydrates grown within the pore fluid, (5) hydrates uniformly distributed within the rock matrix like the ice layer in permafrost, and/or (6) hydrates grown as nodules, fracture filling veins. Once the appropriate model is decided, it will be used to derive velocity curves that illustrate changes in the hydrate concentrations that in turn will be used with the impedance volume to calculate a hydrate saturation volume. In addition, an amplitude variation with offset (AVO) analysis performed on seismic lines that cross the hydrate mound test the hypothesis that ‘bright spots” mapped in the subsurface may be interfaces separating gas hydrate deposits underlain by free gas.