Recent seismic results from the Blake Ridge Hydrate Province: Implications for direct detection, gas injection, and methane escape

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A deeper understanding of marine methane hydrate systems requires progress on several key issues, including: (1) the global and local distribution and concentrations of hydrate and associated free gas, (2) the sites, rates, and mechanisms of interaction between the Earth's hydrate reservoir and the global carbon cycle, and (3) the dynamics of hydrate systems. Addressing these issues requires improved methods of remotely detecting and quantifying methane hydrate and gas using seismic reflection data. We present new seismic reflection data from the Blake Ridge hydrate province, offshore South Carolina, that yield new insights on both hydrate processes and seismic detection of hydrate.

The Blake Ridge is an excellent field laboratory to study hydrate processes, largely because the relatively simple tectonic setting and uniform lithologies provide a virtual *tabula rasa* against which seismic anomalies can be confidently interpreted in terms of gas and hydrate. A large array of background knowledge exists on the Blake Ridge, from numerous seismic, drilling, coring, and submersible studies. Sedimentary biological, and physical processes produce a wide array of methane flux environments within a relatively well-understood

We acquired long-offset (6000 m), high-resolution (6.25 m CMP spacing) seismic reflection data in Fall 2000 on the Blake Ridge in a project jointly sponsored by NSF and DOE. These data provide remarkably clear images of the entire hydrate and free gas zone, up to depths of 1000 mbsl. Examples of direct seismic detection of hydrate within the hydrate stability zone include (1) "bright spots" from layers of concentrated hydrate (up to 70% of porosity), (2) cross-cutting paleo-BSR reflections formed after erosional events, and (3) a lens of amplitude "blanking" that has been confirmed as a high-velocity layer that likely contains elevated concentrations of hydrate (~30% of porosity). The free gas zone on the Blake Ridge is surprisingly dynamic, with numerous chimneys through which gas can migrate hundreds of meters into the hydrate stability zone. Large quantities (0.6 Gt) of methane gas have apparently escaped through a large depression on the ridge crest that represents a large sediment wave field.