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Direct Detection of Methane Hydrates: Volume Estimates from Velocity Modeling

The ability to directly detect methane hydrate from seismic reflection data has been a subject of debate for some time. Hydrate provinces have long been identified on the presence of free gas below the methane hydrate stability zone and the prominent BSRs that mark the velocity contrast between hydrate bearing sediments and free gas bearing sediments. New imaging from the Blake Ridge clearly shows reflections resulting from increased concentrations of methane hydrate in discrete layers within the methane hydrate stability zone. The Blake Ridge, U.S. Atlantic margin, offers a unique natural laboratory for the study of methane hydrate processes. The uniform lithology and simple sedimentary structure of this passive margin setting indicate that many of the features visible in seismic profiles can be attributed to the effects of varying concentrations of methane hydrate or free methane gas in the porespace. Layers of increased methane hydrate concentrations, 20% of porespace, have been correlated from the ODP leg 164 well logs to horizons with small amplitude anomalies on prestack depth migrated seismic sections. Much larger amplitude anomalies have been modeled with waveform inversion and indicate hydrate occupation of well over 50% of the porespace. These elevated concentrations occur in discrete layers created by one of two mechanisms: the downward migration of the base of gas hydrate stability thus, creating elevated concentrations of hydrate along paleo-BSRs, or the upward migration of methane. Pathways for methane migration are chimneys, sediment wave bounding surfaces, and high-angle growth faults. Methane may migrate up any combination of these pathways and may in some cases reach the seafloor and enter the ocean/atmosphere system.