Gas hydrates on the oregon continental margin: recent results and plans for ODP drilling

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Abstract

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Gas hydrates and free gas, as indicated by the seismic proxy known as the BSR, are widespread on the Oregon continental margin. A number of geological, geochemical and geophysical studies have been conducted here in the past several years in preparation for deep drilling during Leg 204 of the Ocean Drilling Program, scheduled for summer 2002. In this presentation, we first present an overview of the seafloor morphology and reflectivity. We then discuss recent results from samples and measurements made at the seafloor. Finally, we discuss the subsurface plumbing as determined from a recent 3-D seismic survey and objectives of the planned drilling.

Hydrate Ridge, known as Second Ridge prior to discovery in 1996 of abundant massive methane hydrate at the seafloor, is a 15-km-long northeast-trending accretionary ridge 80 km west of Newport, OR, that was formed by subduction of the Juan de Fuca plate beneath North America. The northern summit of the ridge is covered by a carapace of authigenic carbonate whereas the southern summit is mostly covered by sediment, with the exception of a single spectacular carbonate pinnacle on the SW flank (Clague et al., 2001; Torres et al., 1999, Johnson and Goldfinger, in prep). This has been interpreted to indicate that the northern summit is at a more mature stage in the evolution of a hydrate-bearing accretionary ridge (Trehu et al., 1999), a model that is being upheld by U/Th dates on recovered carbonate samples (Teichert at al., 2001).

Bubbling vents have been observed at the summits of both northern and southern Hydrate Ridge. These vents, observed directly by submersible and ROV and indirectly by acoustic backscatter, dominate the flux of methane from the seafloor (Torres et al., in press). The presence and persistence of methane bubbles in the water column at temperatures and pressures at which hydrate should be stable indicate both rapid flux and armoring of bubbles by hydrate. The bubbles are dissolved in the ocean at ~500 m depth, indicating that this is not a major mechanism for transporting methane from the seafloor to the atmosphere.

In 1996, 50 kg of massive hydrate were recovered by a TV-guided grab sampler from the summit of southern Hydrate Ridge (Suess et al. 1999, 2001). These hydrates show a wide range of texture and density (Suess et al., 2002), but all are considerably less dense than water and must be held on the seafloor by the weight and shear strength of surrounding sediment. It is likely that large pieces of seafloor occasionally break off and float to the sea surface, where the hydrate will dissociate, adding methane to the atmosphere. This may occur spontaneously or in response to earthquakes.

3-D seismic data reveal the subsurface plumbing system feeding the vents (Trehu and Bangs, 2001; Trehu et al., 2002). Preliminary analysis of the data suggests that diffuse fluid flow in

highly fractured sediments of the accretionary complex is focused along unconformities and other stratigraphic boundaries when these sediments are capped by impermeable slope basin sediments. Two particular flow systems have been identified beneath south Hydrate Ridge, one of which appears to be the primary system feeding the bubbling vents and massive hydrates at the seafloor. The seismic data also suggest that the region of extensive massive hydrate extends to a sub-seafloor depth of 30 m.

During Leg 204, we will test our interpretations of the seismic data, determine the physical properties of in situ hydrate-bearing sediments, calibrate additional high resolution geophysical techniques, sample and quantify the microbiological processes associated with subsurface methane and other chemical gradients, and test hypothesized geologic proxies for past and present hydrate occurrence. Those data should help us build a comprehensive model for predicting the distribution and concentration of hydrate in tectonically active accretionary complexes that will lead to a better assessment of the resource potential and hazards of hydrates in this environment.

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