

TECTONIC CONTROLS ON GAS HYDRATE STABILITY IN AN ACTIVE MARGIN SETTING, HYDRATE RIDGE, CASCADIA ACCRETIONARY PRISM

[JOHNSON, Joel E.](#)¹, GOLDFINGER, Chris¹, NELSON, C. Hans², and TREHU, Anne M.¹, (1) College of Oceanic & Atmospheric Sciences, Oregon State Univ, 104 Ocean Administration Building, Corvallis, OR 97331, jjohnson@coas.oregonstate.edu, (2) Department of Oceanography, Texas A & M Univ, 3146 TAMU, College Station, TX 77843

The gas hydrate system at Hydrate Ridge exists within a dynamic tectonic setting near the deformation front of the Cascadia accretionary prism. The shallow structures of the ridge and surrounding region, as interpreted on seismic reflection profiles, reflect a history of deformation driven by accretion, folding and faulting. The distribution and spacing of fold axes and faults across the region implies clockwise rotation of Hydrate Ridge within a dextral shear couple, which is superimposed on E-W compressive structures. This complex tectonic response is driven by oblique subduction of the Juan de Fuca plate and results in expulsion of methane-rich fluids from the deeper portion of the prism to the seafloor, where the methane reacts with seawater to precipitate carbonate. The surface distribution of these cold-seep carbonates, as imaged with SeaMarc 30 deep towed sidescan sonar, suggests that the fluid flow pathways are focused along structures. These pathways can effectively act as sites of gas hydrate destabilization within the sedimentary section by delivering warm fluids to the base of the hydrate stability zone and inducing melting. This process may be controlled by the frequency of contraction and dilation of the structures. Another important mechanism for near surface gas hydrate destabilization on Hydrate Ridge is delamination of the ridge by submarine landslides. The oversteepened western flank of Hydrate Ridge is highly dissected by small submarine canyons and failure scars. This erosional evidence suggests sedimentation in the basin downslope of Hydrate Ridge is punctuated by submarine landslides derived from the ridge. Good evidence for a recurrent record of these events exists in rock kasten core AT8408-10RKC. This core contains 11 graded sand to silt beds, separated by hemipelagic mud. These sediments represent post-accretion slope-basin fill and we interpret the graded beds as the distal facies of submarine landslides derived from the ridge. A recurrent regional tectonic signal that may serve as the trigger for these landslides is subduction zone earthquakes, which are well documented in both offshore and onshore stratigraphic records. Future coring in the basin coupled with radiocarbon dating might determine which, if any, of the submarine landslides were triggered by subduction zone earthquakes.

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