Marine Gas Hydrates on the Northern Cascadia Margin

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On behalf of the N. Cascadia Marine Gas Hydrate Team, Including, Navy Research Laboratory, Univ. Toronto, Dalhousie Univ., Univ. B.C., Scripps Inst. Oceanography, Univ. Bremen Germany, Cambridge Univ. UK, & Participants on Ocean Drilling Program Leg 146

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On the northern Cascadia margin there have been extensive geophysical and geological studies, and Ocean Drilling Project (ODP) drilling that constrain the occurrence, distribution, and concentration of gas hydrate and underlying free gas beneath the continental slope. On this margin there is a large clastic accretionary sedimentary prism, the most common environment for high concentrations of marine gas hydrates. Most information on the gas hydrate has come from a wide range of seismic surveys, including multi-frequency surface seismic surveys, the NRL DTAGS deep towed seismic system, and ocean bottom seismographs. The data have allowed mapping the area of the characteristic bottom-simulating reflector (BSR), determining the depth distribution of hydrate and underlying free gas, and the geological controls of hydrate formation. BSRs are evident beneath about half of the mid-continental slope at a sub-bottom depth of about 250 m. Special seismic studies include BSR reflection coefficients, the frequency dependence of the BSR amplitude, BSR amplitude-versus-offset (AVO), and full waveform inversions. Additional information on hydrate concentration is provided by electrical resistivity profiling, and measurements of seafloor compliance. Heat flow surveys have mapped the thermal regime that controls the depth to which gas hydrate is stable. The seafloor expressions of focussed methane expulsion have been studied by piston core sampling and by the remotely operated submersible, ROPOS. Ocean Drilling Program Leg 146 drilled through the gas hydrate on the mid-continental slope and a reference hole in the adjacent deep sea Cascadia basin. Downhole geophysical logs and core analyses have constrained the concentrations of hydrate and free gas at the drill sites, and provided calibration of the regional geophysical data. In the region of the ODP site, there is a regional layer 50-100 m thick above BSR with concentration of disseminated hydrate in pore spaces that represent a very large amount of methane. In a few areas there are localized chimneys or channels especially well imaged by the DTAGS seismic data. They may contain a smaller total amount of methane but often have high concentration and massive hydrate. From both geophysical and borehole data the disseminated concentration is 20-30% of the pore space (10-15% of total volume), with an underlying 10-20 m layer of less than 1% free gas. The electrical data indicate that there may be significant hydrate concentrations where there are no BSRs. Over the chimney structures, coring has recovered massive gas hydrate, ROPOS submersible surveys show seafloor carbonates and cool vent organisms, and oceanographic data show a rising plume in the overlying ocean. These structures thus may focus upward fluid and methane transport. In an adjacent area several tonnes of massive gas hydrate were recovered from such a structure by a fishing dragger in experimental fishery.