Discovery of an Active Submarine Mud Volcano Along the Nootka Fault West of Vancouver Island

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AB: Submarine mud volcanoes are a common feature in margin environments, but few of them have been documented in the Northeast Pacific. However, during a Hydrosweep bathymetric survey in July, 2001, and a follow-on sub-surface seismic survey in August two mud volcanoes were imaged along the Nootka Fault, 16-18 km west of Vancouver Island at a water depth of 2500 m. The southern volcano, called Maquinna, lies directly along the southern expression of the left lateral, strike slip Nootka Fault. It is 1.5 km across, has a breached caldera and two small summit craters, and it stands about 30 m above the seafloor. The base is bounded by a narrow moat, partially filled by Holocene sediments that are flat lying; older, underlying sediments show steep downwarping towards the sides of the volcano. Subsurface imaging shows a dramatic loss of reflectivity beneath the volcano mound, which may indicate significant mobilization of material. However, a very bright reflector is seen at about 400 m depth below the volcano. This reflector is too deep for stability of methane clathrate, and is interpreted as a zone of high fluid content. A CTD vertical cast above the summit of the volcano showed strong, co-registered thermal, particulate, and oxygen anomalies that extend 50 m up into the overlying water column. These data indicate that the volcano is actively venting warm hydrothermal fluids. The fluids are depleted in CO2, contain background concentrations of CH4, but show elevated H2 concentrations above ocean background water. Microscopic examination of the Nootka hydrothermal samples shows that they contain dense and morphologically diverse microbial communities in comparison to background seawater with cell densities of 106 cells/ml. Enrichment culturing indicates that these communities include both anaerobic and aerobic organisms, some of which are thermophilic with optimal growth temperatures in excess of 50 deg C. Some of these cultures can use methane oxidation as an energy source. Additional culturing experiments and analysis of preserved samples are underway to further characterize the microbes. To further understand the biogeochemical cycles at these sites, samples recently taken from piston cores and CTD casts in this region, are being surveyed for stable and radio carbon isotope signatures of CH4, dissolved inorganic carbon, organic carbon and phospholipid bacterial biomarkers. A second volcano lies ~ 8 km to the northwest of the Maquinna that has a less well defined seafloor expression. However, like Maquinna, seismic reflectivity is lost nearly completely beneath the mound, except for a very bright reflector at about 800 m depth. It is not yet known if this volcano is hydrothermally active. It is likely that high sediment accumulation and lateral tectonic compression associated with accretionary prism formation along the west coast of Vancouver Island support overpressuring of fluids at depth along the Nootka Fault zone, resulting in growth of the two volcanoes.

DE: 1050 Marine geochemistry (4835, 4850)
DE: 3000 MARINE GEOLOGY AND GEOPHYSICS
DE: 3025 Marine seismics (0935)
DE: 3045 Seafloor morphology and bottom photography
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