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Methane gas emanation from an active carbonate mound in Santa Monica Basin, offshore Southern California

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An isolated mud volcano on the seafloor of Santa Monica Basin, offshore Southern California, was explored in 2005 during 3 dives using MBARI's ROV $Tiburon$. This $\sim$30 m high by 400 m wide feature was originally identified on a USGS-collected seismic-reflection profile and lies within a NNW-SSE trending zone of active transpressional strike-slip faulting. A short piston core taken in 2003 on the flanks of the mound recovered gas hydrate at approximately 2 m below the seafloor and living clams, including Vesicomya, were obtained from the core top (Normark et al., 2003).

Mid-water sonar targets, visually confirmed to be gas bubbles, were observed at 500 m water depth during the initial ROV descent. This plume of bubbles was followed to the mound crest where continuous streams of gas bubbles were emanating from two vents into the water column at a water depth of 802 m. The uppermost 5 meters of the mound crest is composed of an extensive authigenic carbonate pavement and is largely sediment bare. ROV observation and sonar showed that the mound is ovoid in shape with the long axis parallel to the regional fault system. Its profile is not symmetrical perpendicular to the fault; its ENE side appears to be one continuous pavement, whereas, the WSW side is offset downward and has a sediment pond at an intermediate level. Where sediment occurs on the flanks of the mound, the seafloor is covered with extensive communities of chemosynthetic clams, predominately $Vesicomya\ elongata$. However, hard layers were encountered at shallow depths below the sediment surface (10-100 cm) indicating that layers of authigenic carbonate also extend beneath these areas as well thus preventing corer penetration. Analyses of pore water extracted from ROV-collected push cores from sediment covering the mound indicate rapid sulfate

depletion in these sediments and suggest that anaerobic oxidation of methane is active and stimulating extensive carbonate cementation. Sediments draping the mound and surrounding seafloor contain extensive amounts of DDT indicating that these sediments have accumulated here recently. These observations further suggest that this mound is still in the process of formation.

Gas-hydrate grew when gas bubble streams were trapped under an inverted gas-sampling funnel. This gas is primarily methane (99.22%; δ^{13}C = -70.8‰ PDB) with trace amounts of ethane (0.0029%) and carbon dioxide (0.093%). Gas bubbles were released when the sediment veneer was disturbed indicating bubble saturation occurs just beneath the sediment surface. δ^{13}C values for methane extracted from the pore water in sediment cores collected away from the vent sites were distinctly more ^{13}C-depleted [δ^{13}C = -86.0±8.6‰ (PDB), n=27] than the methane bubbles emanating from the two vents. Curiously, while this mound is basically adjacent to the onshore Los Angeles Basin, which is one of the best-known Cenozoic basins along the California coast for its prolific oil production, the methane emanating from the mound crest mound appears to be microbial in origin, based on the conventional interpretation of the C_1/C_2 (34,000) and δ^{13}C values.