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# Association among active seafloor deformation, mound formation, and gas hydrate growth and accumulation within the seafloor of the Santa Monica Basin, offshore California

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**Abstract**

Seafloor blister-like mounds, methane migration and gas hydrate formation were investigated through detailed seafloor surveys in Santa Monica Basin, offshore of Los Angeles, California. Two distinct deep-water (≥800 m water depth) topographic mounds were surveyed using an autonomous underwater vehicle (carrying a multibeam sonar and a chirp sub-bottom profiler) and one of these was explored with the remotely operated vehicle *Tiburon*. The mounds are >10 m high and >100 m wide dome-shaped bathymetric features. These mounds protrude from crests of broad anticlines (~20 m high and 1 to 3 km long) formed within latest Quaternary-aged seafloor sediment associated with compression between lateral offsets in regional faults. No allochthonous sediments were observed on the mounds, except slumped material off the steep slopes of the mounds. Continuous streams of methane gas bubbles emanate from the crest of the northeastern mound, and extensive methane-derived authigenic carbonate pavements and chemosynthetic communities mantle the mound surface. The large local vertical displacements needed to produce these mounds suggests a corresponding net mass accumulation has occurred within the immediate subsurface. Formation and accumulation of pure gas hydrate lenses in the subsurface is proposed as a mechanism to blister the seafloor and form these mounds.


*Keywords:* gas hydrate; chemosynthetic communities; mounds; gas vent; methane; mud volcano; diaper; pingo

## 1. Introduction

Discrete dome-shaped bathymetric features that have been described as diapirs or mud volcanoes within the Santa Monica Basin, offshore southern California are known to contain gas hydrate at shallow depths (Normark and Piper, 1998; Normark et al., 2003; Hein et al., 2006). The seafloor surrounding one mound was explored with a remotely operated vehicle (ROV), characterized with geochemical measurements, and imaged with high-resolution seafloor-mapping surveys. The role that gas hydrate formation and regional faulting plays in the formation of these features is considered here.

Venting of methane and other hydrocarbon gases through seafloor sediment stimulates profound changes to the local environment. These changes are focused near the seafloor where mixing occurs between the rising gas and the overlying oxygenated and sulfate-bearing seawater. Anaerobic oxidation of methane (AOM) supports communities of chemosynthetic organisms (Sibuet and Olu, 1998), and induces rapid diagenetic changes within near-seafloor sediments (e.g., Paull et al., 1992; Greinert et al., 2000; Peckmann et al., 2001; Roberts, 2001). The most obvious manifestation of this early diagenesis is the formation of authigenic minerals, primarily methane-derived carbonates. Such carbonates are identified on the basis of their $^{13}$C-depleted cements and distinctive textures.

Gas hydrate may also form within seafloor sediments beneath deep-sea gas vents (generally >520 m water depths) where there is an adequate concentration of low molecular weight gas, usually methane (Sloan, 1998). The formation of gas hydrate within seafloor sediments where there is continued supply of methane is believed to exert a significant influence on

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