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Influence of microorganisms in formation of authigenic pyrite associated with methane seeps

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Methane seeps are an important geological phenomenon in marine sediment, and methane-rich cold seeps are assumed to be the preferential outcrop of oil-gas and gas hydrate on the seafloor. Seafloor methane seeps represents a significant source of organic carbon in the ocean and atmosphere. The discharge of methane into the seafloor sediment known as cold seeps produces a unique microbial ecosystem and deposits of carbonates, Fe-sulfides with AOM in deep sea environments.

We are known that chemosynthetic communities that derive energy from H_2S and methane oxidation have developed at the sea floor. *Beggiatoa* spp, hydrogen sulfide-oxidizing organisms of tube worms, methane-utilizing clams (*Calyptogena*) and bivalves (*Acharax*) are distributed in the seep and vent sites in the world methane-seep settings. we do get some disarticulated shells of bivalves including Calyptogena sp., Acharax sp. with the carbonate in Jiulong methane reef of northern slope of South China Sea. In core GC10, we found some bacteria mats like *Beggiatoa* associated with pyrite tube which means high uprising hydrogen sulfide and methane areas at the sea floor.

Mineralogical analyses and iron and sulfur isotopes were applied to methane induced pyrite tube of core GC10 from northern continental slope of the South China Sea (SCS). Pyrite especially framboidal pyrite is very common in the sediments associated with methane seeps through AOM. SEM observations of pyrite tube indicate various aggregations in forms of framboid, authigenic, and colloidal pyrite. Many framboids in the tubes have outer crust that consists of secondary pyrite. High-resolution TEM image shows marcasite lamellae defects in the pyrite spherules. Nano graphitic carbon was observed to be closely associated with pyrite spherules. The occurrence of both marcasite and nano graphitic carbon suggest that the migration of methane from deep sediment. Meanwhile the pyrite δ^{34}S values range from -36.7‰ to -5.7‰ and pyrite δ^{56}Fe values range from -0.3‰ to -0.81‰ they both explained in terms of coupled Fe([U+2162]) and sulfate reduction during anaerobic oxidation of methane and bacterial sulfate reduction is a major pathway of the reduction of S and Fe.