

## Cold seep carbonate and fossil assemblages from the Paleogene Taishu Group, Southwest Japan

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We found three limestones and one mudstone fossil assemblages from the upper most part of the lower formation of the Paleogene Taishu Group and examined the possibility cold seep chemosynthetic assemblages based on occurrence, fossil assemblages, sedimentary facies, petrography and geochemistry including carbon isotope ratio.

Kanoura limestones is about 2m thick and 10m wide intercalated in alternation of thin sandstone and mudstone, and composed mainly of black massive-limestone and bivalve-limestone with subnodular muddy limestone in the upper part. The boundary of black massive-limestone and bivalve-limestone is irregular. Limestones as well as bivalves are autochthonous because of the gradual change between limestone and underlying mudstone and bivalve occurrence. Around the limestone body, there are hyperpicnite sandstones, trace fossils (sand pipe), slump deposits and tidal deposits. These evidence indicates that the limestone are formed on a slope not distant from the coast. Bivalve-limestone is composed of crowded shells of *Calyptogena* sp. known as harboring chemoautotrophic symbionts, and calcite tube and micrite matrix. But the shell length is almost half compared with previously reported species in fossil records and recent species. Black massive-limestone displaying laminated structure is composed of calcite and black carbonaceous matrix, and rarely contain bivalves. In the underlying mudstone *Acharax johnsoni* and *Calyptogena* cf. *phaseoliformis* were found. These bivalves are known as harboring chemoautotrophic symbionts. The carbon isotope ratio of carbonate and bulk organic carbon (TOC) were -38 permil and -31~-54 permil, respectively indicating thermogenic origin for the limestone.

Nita limestone and Tanohama limestone are also characterized by crowded small *Calyptogena*, and carbon isotope ratio of TOC, -38 permil and -34 permil, suggesting thermogenic methane.

Fukisaki limestone is about 0.5m thick and 4m wide. Occurrence of *Acila* sp. from the underlying mudstone, associated slump structures and overlying slip surface indicate relatively large depth slope. The limestone is composed of dolomite in the lower part, and gray black limestone in the upper part, and the boundary of them is irregular. Fukisaki limestone rarely yield mega fossils, but there are crinoid fragments and pipe-like trace fossils suggesting benthic fauna. Fecal pellets are characteristic in calcareous concretions of 3-5 centimeters in diameter which are crowded just below the limestone. Dolomite part is composed of mostly dolomite which is possibly formed by sulfate reduction. Limestone is composed of brown and colorless calcite and black carbonaceous matrix. In the black matrix, aggregated oval structure less than 0.1mm in diameter suggesting microbiota community. The center of each cell is black carbonaceous core surrounded by calcareous rim. The carbon isotope ratio of TOC in limestone, -38 permil, indicates thermogenic methane origin. The carbon isotope ratio of dolomite, -29~-30 permil, and -28 permil of concretion, indicate that organism in the dolomite and concretion have methane origin.

At Nita, other than limestone, crowded Solemyidae assemblage was known in black mudstone (Aoki and Nishida, 1999). This assemblage, not accompanied by limestone, suggests less methane seep to precipitate carbonate.

These three types of fossil chemosynthetic assemblages were simultaneously developed in 20 km area in the sedimentary basin of the Taishu Group, such an occurrence has not yet been known elsewhere. Comparative study may improve the knowledge about the condition of the chemosynthetic fossil assemblages.