Cold-seep carbonate and chemosynthetic assemblages from the Paleogene Taishu Grop, in the Tsushima Islands, Nagasaki Prefecture

Takashi Ninomiya[1]; Yuichiro Miyata[2]; Sho Taniguchi[3]; Shoichi Shimoyama[4]; Hiroki Matsuda[5]; Toshiro Yamanaka[6]; Takahiro Aoki[7]; Tamio Nishida[8]

[1] Dept. Earth and Planet. Sci., Kyushu Univ.; [2] Dept. Sci., Yamaguchi Univ.; [3] Earth and Planetary Science, Kyushu Univ.; [4] Earth and Planetary Sci., Kyushu Univ; [5] Dept. Earth Sci., Grad. Sch. Sci. Tech., Kumamoto Univ.; [6] Fac. Sci., Okayama Univ.; [7] Shinwa Tecno Co. Ltd.; [8] Calture and Education, Saga Univ.

Cold-seep carbonate and fossil chemosynthetic assemblages were found from the lower part of the middle formation of the Paleogene Taishu Group, namely (1) Kanoura Limestone, (2) Nita Limestone, (3) Tanohama Limestone, (4) Fukisaki Limestone and (5) Nita Mudstone. Occurrence, sedimentary facies, molluscan fossil assemblages, carbon and sulfur stable isotope ratios revealed that three types of cold seep chemosynthetic assemblages were established simultaneously at time of the basin deepening (ca. 46Ma) synchronized with onset of the Japan-Sea opening.

Kanoura Limestone (Loc.1) 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 muddy part in the uppermost. Sedimentary facies indicate that the Kanoura limestone is formed on a slope near from the coast. *Calyptogena* sp. known as harboring chemoautotrophic symbionts is dense in the bivalve-limestone. But the shell length is almost half compared with previously reported species. Black massive-limestone displaying laminated structure is composed of calcite and black carbonaceous matrix.

In the underlying mudstone, *Acharax johnsoni*, *Adipicola* sp. A, *Adipicola* sp. B, *Calyptogena*? sp. and *Acharax johnsoni* were found. Occurence of *Adipicola* fossils are similar with modern *Adipicola crypta* and *Adipicola pacifica*. These bivalves are known as harboring chemoautotrophic sulfur oxidation type symbionts on attached modern whale-fall. Carbon stable isotope ratios of carbonate as -33.1 to -39.7 per mil and of bulk organic carbon -31.0 to -54.0 per mil indicate that the Kanoura limestone originate cold seep include methane and methane oxidation. Sulfur stable isotope ratio of pyrite in limestone were +5.8 to +14.8 per mil, indicating sulfate reduction with methane oxidation.

Nita limestone (Loc.2) and Tanohama limestone (Loc.3) also show similar occurrence of small *Calyptogena*, lithology, and isotope ratio indicating that sulfate reduction prevailed with methane oxidation.

Fukisaki limestone (Loc.4) is about 0.5m thick and 4m wide. Occurrence *Acila* sp. in the underlying mudstone, associated slump zone overlying shallow-water HCS sandstone indicate the deepening of the basin.

The carbonate rock is composed of dolomite in the lower part, and limestone in the upper part, with irregular boundary due to bioturbation indicating activity of the benthic fauna. The limestone yield a few small *Bathymodiolus* sp.. Fecal pellets are characteristic in calcareous concretions of 3-5 centimeters in diameter which are crowded just below the limestone. Limestone is composed of brown and colorless calcite and micrite. In the micrite, aggregated oval structure less than 0.1mm in diameter is suggestive of microbiota. The center of each cell is micrite core surrounded by calcite rim.

The carbon stable isotope ratio in limestone of carbonate and bulk organic carbon were each -39.8 per mil and -37.6 per mil. Limestone carbon stable isotope ratio indicate that limestone formed methane oxidation originated cold seep include. In dolomite, carbon stable isotope ratio of organic carbon and carbonate were -29.9 per mil and -6.3 per mil, respectively. Dolomite originated cold seep shows heavy carbon isotope ratio, but the reason remains uncertain. Sulfur stable isotope ratio of pyrite in limestone were -11.4 to -16.4 per mil. These values indicate that sulfate reduction occurred with methane oxidation.

At Nita (Loc.5), other than limestone, crowded *Acharax* sp. assemblage was known in black mudstone (Aoki and Nishida, 1999). Bulk organic carbon stable isotope ratio is not different from the common organic carbon. But the sulfur stable isotope ratio of pyrite in mudstone was -2.5 per mil. This value indicates that *Acharax* sp. assemblage depended on hydrogen sulfide originated methane cold seep.