Paleoecology of serpulid worm tubes in the Late Cretaceous Sada Limestone seep deposits in southwestern Shikoku, Japan

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The Sada Limestone consists of a group of seep carbonate deposits enclosed in the Late Cretaceous slope mudstone facies of the Northern Shimanto Belt, Shikoku, SW Japan. The seep deposits are characterized by mass occurrence of large-sized chemosynthetic thyasirid bivalves and serpulid worm tubes, but the taxonomy and paleoecology of the worm tubes has not yet been fully examined. We report tube shell characters, lithology of the surrounding sediments, and the detail mode of fossil mass occurrences.

The tube fossils are slightly curved with circular cross section, 2.11 to 8.00 mm in diameter, over 10 cm in length, often attached to each other. The outer surface is ornamented with straight or corrugated growth lines and perpendicular ridges. The attached part forms a widened base with single thick keel or three keels. The tubes lumen contains few to numerous irregularly spaced septae, concave in cross section. The tube wall is moderately thick, and consists of a thin inner layer and a thick outer layer with chevron growth pattern, which suggests the worm tube to be assigned to serpulids. The inner layers are composed of two organic(?) sheets binding carbonaceous fill. The septae also have similar structure to inner layers, but sometimes form multiple stacking, between which elliptical pellets were often sealed. The inner layers and septae were under flexible deformation and delamination during calcification in early diagenesis. Such delamination has been often confirmed in other tubes having organic walls in several seep deposits.

The tubes occur in muddy micrite, sometimes mixed with thyasirid fossils, but the exclusive mass occurrence of tubes is lithorogically characterized with rich sparitic fabrics enclosing abundant undeformed pelloids. The $\delta^{13}C$ values of the micritic matrices are not so depleted (-10 to -15 ‰). The mass of tubes forms beds and mounds, over 1 m thick, composed of well-preserved tubes standing vertically to beddings in matrix-supported condition. Such autochthonous tube concentration directly covers turbiditic sandy layers rich in shell fragments, indicating that abundant serpulids simultaneously settled by attaching to shell fragments or coarse clastics just after the physical disturbance. Top of the mass occurrences is often truncated by sandy flow deposits, which broke and pushed down upper parts of the tube individuals. Thin sandy layers also sometimes abut tube-cluster mounds, which maybe formed slight topographic rises.

On the basis of the mode of fossil occurrence noted above, the Sada serpulids were opportunistic and semi-infaunal sessiles, forming colonial mounds in seep site. Abundant pellets sealing between the septae suggest the possession of digestive system, and suspension feeding maybe on high production of chemosynthetic seep ecosystem.

Keywords: chemosynthesis, cold seep, worm tube, Serpulidae, Shimanto Belt

