

Distribution and internal structure of the nodules occurring in Shimanto sedimentary rocks, Muroto Peninsula, Shikoku

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Nodules are known to occur within the alternate layers of sand and mud stones in Muroto Peninsula, Shikoku. Those nodules apparently have been formed within the deep-sea sediment of the trench, the timing and the details of their formation, however, is not known. This report describes the occurrence of the nodules within the alternate layers of sand and mud. The occurrence and the cross-sectional observation of the nodules both support that the nodules are trace fossils and they formed within compacted layers of mud underneath the surface of the sea floor.

Spatial distribution and occurrence of the nodules were observed within an outcrop of alternate layers of sand and mud. The alternate layers were straight, with no evidence of large deformation associating the accretion. The thickness of the mud stone layer and the sand stone layer was approximately 10 cm and 2 cm, respectively. The size of the nodules was around 3 to 5 cm (radius). Nodules occurred in many different layers. Most nodules were found in groups within the same mud layer, located at a certain depth from the surface of the mud. Sand layers sometimes showed upward curvature above the nodules, indicating that the nodules formed before the compaction terminated.

Occurrence of the nodules and the relation between their mother rocks were described. Larger part of the nodules showed no clear boundary between the mother rocks. Nodules occurring in the layers with evidence of large deformation often showed boundary with certain thickness.

Observation of the cross-section of the nodules revealed that the materials within the nodules were not very much different from the materials in the mother mud stone. Calcite crystals occurred in the nodules but the areal fraction of calcite was comparable in and out of the nodules (5 to 10 %). Some of the nodules showed radial pattern of dark and light part, with slightly larger amount of calcite in the lighter part. Microveins of calcite were often found within the nodules and in the mud stone layers. Many of the nodules showed pyrite grains (<500 micrometer) with rounded triangular and quadrangular shape scattered within. These pyrite grains tended to occur near the calcitic microveins. Pyrite grains with framboidal structure (<10 micrometer) were also found in the nodules.

The sectional structure of the nodules of Tertiary Muroto Peninsula has been compared to that of the nodules that have just been growing on the deep sea floor of Japan sea. The modern nodules were rimmed with large (~4mm) calcite crystals. None of the Muroto nodules had such rim.

The occurrence, together with the cross-sectional observation of the nodules, indicate that the nodules in Muroto Peninsula did not form near the surface of the sea floor, but formed within layers of mud which had compacted to some extent. Radial pattern of dark and light part was found within the cross-section of the nodules. No evidence of concentric growth pattern was found. It is not likely that the nodules started growing on some small biotic core and gradually grew larger. The concretion of sediments seems to have started within a fixed space from the very start.

Keywords: nodule, Shimanto belt, mudstone layer, pyrite, trace fossil