On a Peculiar Shaped Concretionary Structure from the Stone Quarry of Mt. Mitakigamori in Haruno-cho, Agawa-gun. Kochi Prefecture, Shikoku, Japan

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On a Peculiar Shaped Concretionary Structure from the Stone Quarry of Mt. Mitakigamori in Haruno-cho, Agawa-gun, Kochi Prefecture, Shikoku, Japan

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Abstract

The peculiar-shaped concretionary structure from the Cretaceous Hayama Formation is described and discussed. It is considered valuable for interpretation of the upper and under surface of strata.

INTRODUCTION AND ACKNOWLEDGMENTS

Recently a peculiar shaped concretionary structure was presented to the writer for examination by a worker of the Kansai Saiseki Company at the stone quarry situated at the western side of Mt. Mitakigamori in Haruno-cho, Agawa-gun, Kochi Prefecture. This interesting specimen seems worthy of description and interpretation of its geological significance in the Upper Cretaceous Hayama Formation, a stratigraphical unit from where marine or plant fossils have not been discovered, and further, to date there has been found no positive evidence for determining the upper or lower deposition surface of the bedded, massive sandstone of the formation.

Under the circumstances just mentioned and mainly because the concretionary structure under consideration is seemingly different from the concretions or concretionary structures of sandstones so far as the writer has noticed from literature, its publication may be of interest to other workers and also contribute to our knowledge of such structures.

At this place the writer expresses his deep appreciation to Professor Kotora Hatai of the Institute of Geology and Paleontology, Tohoku University, for his continued encouragement and directing the present work. Thanks are due to Mr. Kimiji Kumagai for photographic work and Mrs. Kimiko Shibuya for typing the manuscript, both of the Institute of Geology and Paleontology, Tohoku University. Appreciation is expressed to the Kansai Saiseki Company for donating the concretionary specimen to the writer for study.

STRATIGRAPHIC POSITION OF THE CONCRETIONARY STRUCTURE

The specimen, as mentioned above, was found in the steeply dipping Upper Cretaceous Hayama Formation exposed at the stone quarry situated on the western side of Mt. Mitakigamori in Haruno-cho, Agawa-gun, Kochi Prefecture, Southwest Japan. At the mentioned locality the Hayama Formation is composed of bedded, massive, homogeneous sandstone from which no fossils have been found to date. At the quarry the strata dip at about 60°N with strike of N65°E (*see* Pl. 51, fig. 3), and the specimen under consideration was found in the same sandstone, but on the opposite side separated by a fault of almost N40°E trend and with southward dip of about 45° and strike of N85°E. Because no fossils have been found from the formation and since there had been known no positive

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evidence for determination of the upper or lower surfaces, the faulted sandstone remained unknown as to its true stratigraphic orientation.

The stratigraphic position of the Hayama Formation in the geologic column of Agawa-gun, Kochi Prefecture along the southern coastal area of Shikoku, is shown in Table 1.

Table 1. Stratigraphic position of the Hayama Formation distributed in Agawa-gun, Kochi Prefecture (after J. Katto, 1960).

	Formation name	Lithological Facies
Shimantogawa Group (Up. Cretaceous)	Susaki Formation	Shale and sandstone, red shale, schalstein, chert, limestone
	(Fault)	
	Hayama Formation	Thick bedded sandstone intercalated with thin shale, alternation of sandstone and shale
	(Fault)	
	Doganaro Formation	Shale rich alternation with sandstone, Torinosu type limestone
	(Butsuzo tectonic line)	

DESCRIPTION OF THE CONCRETIONARY STRUCTURE

The concretionary structure is elongate, measuring more than 40 cm because both terminal parts are missing and part of the intermediate part has been lost. So far as the preserved parts are concerned the concretionary structure seems to lessen in width towards both ends, the maximum width as preserved is about 10 cm in maximum and the thickness of the crescent-shaped (profile) is about 2.5 cm in maximum. The convex side of the concretionary specimen is coated with a thin covering of dark to light brownish graphitic to clayey sediment, whereas the main part of the specimen consists of medium grained sandstone in which occur sporadic coarse to angular grains of chert, sandstone and greenstone. The angular grains measure about 3 mm in maximum diameter. The sandstone is light brown to grayish white. The flat surface of the specimen shows more coarse grains than the convex side. The coarse grains are all sporadic in distribution and few in number. The polished cross-section of the specimen reveals that the longer axis of the coarse grains are all parallel with the flat surface, and occupy the lower half of the specimen. No coarse grains are found near to the convex surface where fine to medium grained sands predominate. Slight imbrication of the grains is noticed near to the convex side and also near to the flat surface, which points to that some current action existed during deposition of the sands filling the cast. Further, judging from the orientation of the grains, both large and small, it is noticed that a rough approximation can be recognized of layered structure, and this also points to the action of subsequent sedimentation due to transportation agencies, such as due to current action. Thus from the evidence noticed from the orientation of the grains and their approximate layering in the polished section, it can be inferred that agencies necessary for their formation existed, and if in a tunnel like cast, then the agencies must be attributed to aqueous processes.

The flat surface is parallel with the bedding plane whereas the convex side seems to be the stratigraphically upper surface.

INTERPRETATION OF THE CONCRETIONARY STRUCTURE

The concretionary peculiar shaped structure which developed parallel to the bedding plane and preserves graphitic clayey material on its concave side and a flat coarse grained

undersurface, may represent a true concretion subsequently modified by tectonism, or a structure of mechanical origin. If of the former, the problem arises as to how such a peculiar shaped concretion can developed, with one surface convex and the other flat. If of mechanical origin the problem arises as to how such a form can develope. In the following explanations are given to the two possibilities in origin.

Concerning the shape of the concretionary structure, two explanations are necessary; first the convex side may be the undersurface and second, the convex side may be the upper surface, and for this reason two explanations should be given before the final interpretation. If the convex side is taken to be the upper surface and the flat side the lower, then it is necessary that there be some kind of a cast in which the mould can be made, or in other words the peculiar shaped concretionary structure. Such cast can develope in several ways in the Hayama Sandstone of marine origin, probably of neritic deposition. Such structure as can develop in neritic conditions as cross-bedding, current or wave ripples, bottom scouring, wash-outs, lenticular conglomerates or lentils, fossils of neritic origin, or other structures have not been observed in the sandstone of the Hayama Formation. Thus the cast cannot be ascribed to any of the structures just mentioned. From lacking such features the cast in which the mould or concretionary structure was made is sought for in another kind of structure.

The cast in which the present elongated, crescent-shaped in profile, concretionary structure was made is thought to have been as described in the following.

After deposition of the Hayama Formation and probably during diagenesis it is inferred that ground water may have penetrated the sandstone by tunnelling process, thereby constructing a tunnel that was subsequently compressed after being secondarily filled by sandy sediments partially consolidated. By compression of the tunnel-filled secondarily deposited sandy sediments, the shape was transformed from roughly circular to more or less crescent shape, and the terminal parts of the mould although somewhat of irregular shape may have graded laterally into the formation body. The process just mentioned is further upheld by that the coarse grained sediments occupy the lower or flat part of the specimen whereas the finer grained sediments the upper part, as would be expected, the former being due to traction and the latter to suspension. The sporadic distribution of the coarse grains may also be explained by the transportation by traction agencies. If such is possible and can be accepted then it follows that the convex side is the upper and the flat side the lower. However, with regard to the graphitic or clayey sediment covering the convex side of the specimen, it should be said that this may be due to subsequent forces acting longitudinally.

Another explanation to the peculiar shaped concretionary structure is as follows. In this explanation it is assumed that the sandstone embedding the structure is overturned, thus the convex side represents the lower surface whereas the flat surface the upper side, stratigraphically. Thus to make a structure with convex lower side and flat upper side, the next explanation may be possible.

During deposition or immediately thereafter the surface of the depositing or deposited sandstone may have been subjected to erosive agencies such as stream or current erosion by which small troughs, elongated by scouring by which long but shallow wash-outs were produced, elongation of marine pot-holes produced by eddy currents resulting in narrow shallow troughs with rounded bottoms, troughs of ripples or rills, small troughs constructed on the lee side of some kind of obstacle on the bottom such as of saturated drift woods, or troughs with rounded bottoms and of short length produced by marine agencies. After the construction of some kind of trough as mentioned above, it is probable that marine sands were transported to be deposited in the excavated sea bottom, whereby the lower part would be convex in form and the upper with flat surface. In such a way the

concretionary structure under consideration could have been produced.

Although there are two ways of explaining the development of the concretionary structure with one side convex and the other flat, the problem is which of the two are to be retained, and what caused the muddy or graphitic substance on the convex side. Also to be considered is that minute cracks or fissures are developed exceeding well on the flat surface, but none on the convex side. The cracks are wide at the upper flat surface, but their width decreases toward the convex side nearby where evidence of such structures are totally absent. This shows that the cracks are directed towards the flat surface and that the agencies that caused them was stress from the convex side. Another feature to be considered is the development of a thin yet distinct covering of dark colored clayey material resembling graphite and may be taken as graphitic material on the outer surface of the convex side of the concretionary structure. This thin covering is thought to be due to lateral movement after full consolidation of the concretionary structure, probably at a time during diagenesis or thereafter. This thin layer is thought to indicate either lateral or some degree of obliqueness of stress movement.

GEOLOGICAL SIGNIFICANCE OF THE CONCRETIONARY STRUCTURE

From the features mentioned in the foregoing lines it is evident that the concretionary structure under consideration was made by secondary processes, is not a concretion in the sense of the term although concretionary in form, that the convex side is stratigraphically the lower and the flat surface the depositional upper part of the specimen, and since the specimen was found with the convex side facing upward, the Hayama Sandstone is thought to be overturned.

From the features mentioned it can be considered that the present specimen is significant in being a tool for interpretating the upper or lower surface of the sedimentary stratigraphic unit, to point to or at least suggest the neritic environment of its development, stress following its development at a time after diagenesis, and also of being subjected to tectonism of probably reverse movement, and this is why the concretionary structure can not be neglected in the role of stratigraphy.

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The name of *Spiroraphe concentrica* described as a new species by Katto (1964, p. 54, pl. 7, fig. 2) from the Naharigawa Formation (Eocene) of the sea coast of Kannoura, Toyo-cho, Aki-gun on the eastern side of Kochi Prefecture, is preoccupied by *Spiroraphe concentrica* (AZPEITIA, 1933). For this reason the Kannoura specimen is distinguished from *S. concentrica* of AZPEITIA in the broader and thicker threads that are more widely spaced, therefore for this specimen the new subspecific name of *toyoensis* is proposed.

Explanation of Plate

Plate 51

Fig. 1. View of the upper or flat surface of a piece of the peculiar shaped concretionary structure showing the outward directed cracks. Natural size. Locality-Mt. Mitakigamori stone quarry.

Fig. 2. View of the concretionary structure. Note that certain parts are missing, yet the general elongate structure narrowing vaguely towards both ends is recognizable. Graphitic material is seen on the surface. 2/3 natural size. Locality-Mt. Mitakigamori stone quarry.

Fig. 3. General view of the stone quarry of Mt. Mitakigamori, Haruno-cho, Agawa-gun, Kochi Prefecture. Note the steeply dipping sandstone (light) with intercalated shale (dark) layers. Locality-Mt. Mitakigamori, Haruno-cho, Agawa-gun, Kochi Prefecture.

Fig. 4. Polished cross-section of part of the concretionary structure showing the distribution of the fine and coarse grains. Note their orientation. Natural size. Locality-Mt. Mitakigamori stone quarry.


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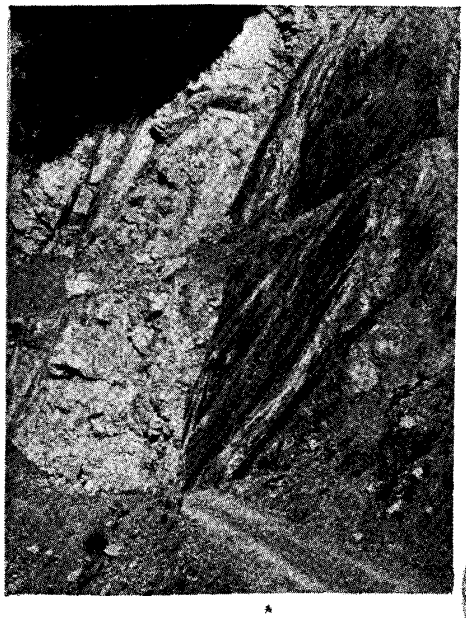
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