The formation process of calsitic skeleton of deep-sea isidid octocorals inferred from crystal orientation

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Calsitic skeleton of Isidid octocorals is robust in the deep-sea and attract much interest from palaeoceanographer because they have potential for proxy records. For use of geochemical data of the isidid octocorals for palaeoceanographic research as a proxy, their formation process and vital effects require evaluation.

Isidid octocorals, which are cosmopolitan in distribution and occur to 4850 m in depth, have bamboo-like jointed axis consisting of elongated calcitic internodes with hollow structures in its center. These are joined by short nodes consisting of dark scleroprotains. The calcareous internode grows both vertically and horizontally and shows concentric growth layers in transverse section. To understand the formation process of their skeletons, previous studies have only focused the histology, cytology, and the observations with SEM. However, the hypotheses of the formation process are not consistent with each other.

The previous studies suggested a rejuvenation near the center part of the calcareous internode by using radiocarbon dating methods and the ^{210}Pb-based dating (Tracey et al., 2007; Farmer et al., 2015). The causes of the rejuvenation are considered (1) the changes of the age of water mass or (2) the secondary infilling of the hollow structure of internode. The analogous behavior of geochemical data was reported in the studies focused on the Mg/Ca of calcareous internode as a record for past ambient temperature. The reconstruction of past ambient temperature is considered to be difficult due to the anomalous increases of Mg/Ca near the center of internodes (e.g., Thresher et al., 2007, 2010; Flöter et al., 2019). On the other hand, the histological study of the precious red coral (*Corallium rubrum*) suggested that the formation of concentric layers of calcitic axial skeleton were secreted by skeletogenic epithelium on its outer surface (Grillo et al., 1993). Based on the histological study, the process of the infilling may not be suitable for isidid octocorals.

To ascertain whether the infilling of the center part of internodes occurs in the isidid octocorals, we analyze the crystal orientation of the calcitic internodes and the base with SEM/EBSD. The different formation processes are considered to makes different crystal structures. The isidid octocorals samples are collected by dredge during KH-10-7 and KH-19-1 from the Conrad Rise, Indian sector of the Southern Ocean.

The basal part of isidid octocorals represents the layered structure and the differences in their crystal orientation. These results support that the crystal orientation of calcitic skeletons varies depends on primary and secondary. The crystal orientation of internode shows a relatively uniform structure compare to the basal part. Both the horizontal and vertical data show that (1) the internodes are not composed of very fine grains rather than fiber crystals, (2) the *c-axis* directions of the calcitic internodes are approximately parallel to the vertical growth line, and (3) the crystal structure of the internodes is almost uniform. These results support that the formation of the calcitic internodes occurs only on the outermost part of internodes by the skeletogenic epithelium.

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