Dynamics of the magma chamber beneath fast-spreading ridge: Implication from the crustal sequence in the northern Oman ophiolite

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We have proposed a segmentation structure of the crustal section based on regional geologic mapping of the northern Oman ophiolite (Adachi and Miyashita , 2003; Miyashita et al., 2003; Umino et al., 2003). That is, a large discontinuity possibly corresponding to the second to third order defined by Macdonald et al. (1991) locates at the Wadi Fizh area, while the center of segment at the Wadi Thuqbah area where is about 20 km south from the Wadi Fizh area.

We present new geological data obtained from the southern part of the Hilti block locating at the southern area of the Thuqbah area. The surveyed area covers from Wadi Suhayli to Wadi Ahin, through Wadi Hilti and Sudum. Gabbroic unit is continuously and widely exposed in this area with about 5 to 10 km width. Reuber (1991) found that some of gabbros show complicated structure as shown by crosscutting relation of layering. However, regional distribution of such complicated zone was not shown and the significance of the disturbed zone is not understood well so far.

The disturbed zone is defined by sudden steeping of igneous layering and by appearance of crosscutting relation of layering like as magmatic melange. These disturbed zones are found from whole area over 15 km long. We found that there are three disturbed zones in surveyed area and these three zones have common features: all disturbed zones appear from the uppermost stratigraphic position of layered gabbro unit (i.e. basal part of upper gabbro) then extend into more deeper stratigraphic position until about upper one third of the layered gabbro unit. The three disturbed zones trend NW-SE to NNW-SSE over several km with about a few hundreds m in width, resulting in echelon-like distribution. Since the general trends and distribution of the gabbroic unit are N-S to NNW-SSE, above echelon like distribution of the disturbed zones implies that they are oblique to the general structure, i.e. cutting the lithostratigraphy as mentioned above. Furthermore, leucocratic rocks (plagiogranite) and massive gabbro similar to the upper gabbro intrude frequently in and around the disturbed zones. Despite of the appearance of such disturbed zone, gabbroic unit is exposed continuously without any discontinuity. Therefore, we propose that these disturbed zones correspond to the third to fourth discontinuity in ocean ridge segmentation, which is characterized by a periodical occurrence of inflection of ridge axis.

On the other hand, the existence of the wehrlitic intrusions and layered gabbros intruded by the upper gabbro and sheeted dike complex in the southern part of surveyed area suggests that there exist two stages of ocean ridge magmatism in this area. The southern margin of the survey area is cut by a large fault, which displaces the ophiolite distribution about 10 km. This displacement may correspond to larger scale of the discontinuity (i.e., the second to third order discontinuity in the ridge segmentation). This assumption is in good agreement with the regional variation of bulk rock composition of the sheeted dike complex by which Miyashita et al. (2003) proposed that the southern margin of the Hilti block was a segment margin. If this ridge segment propagates southward, preexisting oceanic crustal section was disrupted and intruded by advancing ridge magmatism, as shown by the appearance of wehrlite blocks.

We conclude that 1) the southern margin of the Hilti block was probably a tip of propagating ridge axis (second to third order discontinuity), 2) wehrlite blocks are disrupted and intruded by the advancing ridge magmatism, 3) disturbed zones in the gabbro unit appearing as echelon like zones oblique to the main structure may correspond to smaller scale of discontinuity (third to fourth order) in ridge segmentation.