Magmatic processes in the roof zone of magma chambers in the Oman ophiolite

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We studied along-axis variations of the roof zone of magma chamber of the Oman ophiolite, northern Oman Mountains. On the basis of field observations, the roof zone is composed of doleritic gabbro, pegmatitic gabbro, isotropic gabbro, and laminated gabbro in descending order. Mingling of mafic and felsic magmas is observed at segment boundaries.

Plagioclase is strongly zoned in the doleritic gabbro than in the isotropic gabbro, and the pegmatitic gabbro appears between these two gabbros. These facts suggest that the doleritic and isotropic gabbros were formed under the roof and the floor of the melt lens, respectively.

Sinton and Detrick (1992) proposed that the magma chambers beneath fast spreading ridges are capped with thin melt lenses and underlain by crystal mush on the basis of tomographic study. However, layered gabbro expected to be formed in the middle and lower magma chambers, have not been discovered from the mid-ocean ridges, and the structures of and magmatic processes within the magma chambers are not well understood. The Oman Ophiolite, the largest one in the world, is noticed as an analog of the fast spreading ridge which the original structures are observed on the ground.

The roof zone of the magma chamber is regarded as a thermal boundary between the convective magma in the chamber and the hydrothermal circuit in the sheeted dyke complex, and it is envisaged having a extreme thermal gradient (~5C/m) (Nicolas and Boudier, 1991). In the Oman Ophiolite, MacLeod and Rothery (1992) proposed that the foliated gabbro, which is observed in the roof zone, recorded magma flow fossilized as it ascended into the base of the sheeted dyke complex. Nicolas and Boudier (1991) attributed the foliation in the gabbro to viscous flows along the cooling walls of the magma chamber.

Thus, the problem on the origin of the foliated gabbro has not been settled yet, and very few is known on the structural variations of the roof zone along axis. The object of this study is to describe along-axis variations of textures and structures, and to elucidate the magmatic processes within the roof zone of the magma chamber in the northern Oman Ophiolite.

In Wadi Fizh, dykes intrude into the layered gabbro and xenoliths of layered gabbro are found in the gabbro. The moho transition zone is thickest in Wadi ath Thuqbah about 1 km south. Sheeted dykes are more differentiated from Wadi Thuqbah toward Wadi Fizh. On these grounds, Miyashita (1999) proposed that the tip of a propagating rift existed in Wadi Fizh, and the locus of magma supply is in Wadi ath Thuqbah. We have studied the roof zone in this segment and present along-axis variation of the structure of the roof zone in the Oman magma chamber.

In Wadi ath Thuqbah, the center of magma supply, the roof zone consists of doleritic gabbro composed of plagioclase laths embedded in ophitic to subophitic clinopyroxene, pegmatitic gabbro, isotropic gabbro with abundant phenocrysts of clinopyroxene, and laminated gabbro, in descending order. Fabric of the laminated gabbro is concordant with the dolerite dykes above, although it is cut by some dykes.

In Wadi Sudum where are away from the center of the magma supply, doleritic dykes and sills of felsic cumulates are frequently observed in the host of doleritic gabbro. The felsic cumulates have xenoliths of doleritic gabbro and large dendrites of clinopyroxene. Further upstream, the sheeted dykes grade downward into pegmatitic gabbro through isotropic gabbro to laminated gabbro within 60 m thick. As we go downward from the base of sheeted dykes, the abundance of dykes in the host gabbro decreases.

In the northern and southern segment boundaries at Wadis Zab n and Hilti, mingling of felsic and mafic magmas are observed. The mafic rocks form pillow-like blobs, which are assimilated by the felsic magma, changing into spotted margins from outward.

All the observations show that the roof zone is generally composed of doleritic gabbro, pegmatitic gabbro, isotropic gabbro, and laminated gabbro in descending order.

Near the segment boundaries, felsic magma pocket is likely to be formed, due to lower magma supply, where mafic magma occasionally supplied, causing mingling of both magmas.

Strong zoning of plagioclase in the doleritic gabbro suggest large undercooling compared to the isotropic gabbro. In addition, the pegmatitic gabbro, which is the final product of crystallization differentiation, appears between these two gabbros. These facts suggest that the doleritic the isotropic gabbros were formed under the roof and on the floor of the melt lens, respectively.