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Along-axis variations of ultramafic-mafic intrusions in the northern Oman ophiolite

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The Oman ophiolite contains ubiquitous ultramafic-mafic intrusions (called as ”wehrlite” intrusions). There are three different ideas for the genesis of these intrusions; 1) off-axis magmatism (Jousselin and Nicolas, 2000), 2) oceanic thrusting during V2 volcanism (Koepke et al., 2009), 3) mantle remelting due to mantle diapir in the sub-ocean ridge (Clenet et al., 2009). Although Jousselin and Nicolas (2000) claimed genesis of ocean ridge, Koepke et al. (2009) insisted island arc setting for the genesis of ”wehrlite” intrusions. On the other hand, Adachi and Miyashita (2003) showed that there are two different types of ultramafic-mafic intrusions, common ubiquitous intrusions (genesis of ocean ridge; Geotimes unit) and plutonic equivalents of island arc magmatism (Alley unit). Ridge segment structure in the northern Oman ophiolite is shown by Miyashita et al. (2003) and Umino et al. (2003): Wadi Fizh area is northern margin, Wadi Thuqbah area is center, Wadi Hilti area is intermediate and Wadi Ahin area is southern margin of the second order ridge segment. We describe petrological features of the ultramafic-mafic intrusions and discuss with along-axis variations and these genesis.

Recently we have found a huge ultramafic-mafic intrusion (Barghah complex ; 10x2km) from the northern part of Salahi (Hilti) block (Wadi Barghah). The layering and foliation of the host layered gabbro are dragged by this intrusion to result an apparent anticline structure around the Barghah complex. This complex is mainly composed of Cpx (clinopyroxene) dunite, Cpx-Pl (plagioclase) dunite, wehrlite, Pl wehrlite and Cpx mela troctolite. The Moho transition zone of Wadi Barghah area is mainly composed of dunite, Pl dunite, Cpx-Pl dunite and Ol mela gabbro, and attains about 200m thick, indicating that this area corresponds to the ridge segment center.

”Wehrlite” intrusions at the Wadi Fizh area (segment margin) about a few tens to hundred m width, are mainly composed of Hbl (hornblende) mela Ol gabbro, Hbl mela troctolite and Hbl mela Ol gabbronorite. These rocks are characterized by abundant brown Hbl and Opx (orthopyroxene).

Fo contents of olivine and Cpx Mg# from Barghah complex ranges from 85 to 91, and 0.89 to 0.94. These compositions are primitive as similar to those of the Moho transition zone (Ol Fo=86˜92,Cpx Mg#=0.88˜0.93) in this area. Ti and Na contents of Cpx show wide compositional ranges, though the Cpx Mg# ranges are narrow, suggesting a melt-mantle reaction. These compositional features of Cpx are different from the differentiation trend of MORB. Cr# and TiO2 contents of Cr spinels ranges from 0.45 to 0.62, and 0.19 to 2.41 wt%, respectively, similar to MORB spinels and distinct from those of island arc magmatism (Alley unit).

Fo contents of olivine and Cpx Mg# from Wadi Fizh area ranges from 80 to 86, and 0.85 to 0.88. Apparently these compositions are considerably evolved than those of the Barghah complex. Cr# and TiO2 contents of Cr spinels ranges from 0.51 to 0.69, and 0.48 to 2.90 wt%, respectively, similar to MORB spinels and distinct from those of island arc magmatism (Alley unit).

Abundant appearance of Hbl and Opx indicates that the melts of Fizh ”wehrlite” are rich in H2O. The origin of H2O may be ascribed to the penetration of sea water along the fracture at the ridge segment margin. On the other hand, ultramafic-mafic intrusions of Wadi Barghah are free from igneous amphiboles and have less evolved features, similar to the Moho transition zone in terms of lithology and mineral composition. This complex is rooted the Moho transition zone and intruded diapirically. Thus, ultramafic-mafic intrusions show signficant variations due to the location in the ridge segment.

Keywords: Oman ophiolite, wehrlite intrusion, ridge segmentation