Emplacement and Solidification processes of off-axial large submarine lava field: Petrology of V3 flow of Oman Ophiolite

*Ryo Otsuka[1], Yuki Kusano[2], Kyoko Kanayama[3], Susumu Umino[4]

1.Earth Science Course School of Natural System, College of Science and Engineering, Kanazawa University, 2.Geological Survey of Japan, 3.San'in Kaigan Global Geopark Promotion Office, Natural Green Resources Division, Tottori Prefectural Government, 4.Department of Earth Sciences, Kanazawa University

Large submarine lava with thicknesses >100 m and volumes exceeding a few cubic kilometers are not uncommon volcanic constructs of mid-ocean ridges and around Hawaii Islands, yet details of the physical processes of emplacement of these large lava flows are poorly understood. The V3 Volcanics of the Oman Ophiolite extruded at 90 Ma far off the paleospreading axis as thick lava flows with an areal extent of >11 km by 1.5 km and the maximum thickness >270 m, yielding an estimated volume of several cubic kilometers. The V3 flow was fed by a thick feeder dike in the SW of the flow field and buried off-axial fault-bounded basins. V3 flows consist of massive core sandwiched between columnar jointed lava crusts. V3 flow is divided into the Upper and the Lower flow by the presence of pillow lava with interstitial mudstone. Unlike the Lower flow with massive cores, the Upper flow comprises piled up flow lobes showing dome-like structures with thicknesses varying from 2 m to 20 m. The Upper flow consists at least of seventeen flow lobes along a transect at 6 km from the feeder dike.

Low-T hydrothermal alteration and weathering affected LILE compositions of the V3 flow. However, strong positive correlations among incompatible HFSEs and REEs, and relatively good correlations with Zr show that these elements were less mobile and preserve primary characteristics. V3 flow comprises trachybasalt to basaltic trachyandesite dolerite with intermediate trace element characteristics between OIB and E-type MORB. Whole-rock major and trace element variations through a stratigraphic transect at 8.7 km from the feeder dike show fractional crystallization of augite, plagioclase and magnetite. By contrast, other samples of V3 flow show highly scattered whole-rock compositions, which may be explained by internal mixing of variably differentiated magmas.

Yb of the basal crust show increases downflow to ~4.5 km, then decreases to 6 km, high value at 7 km from the feeder dike and decreases further downflow. Because the basal crust is the quenched lava that came to rest first at that place, samples farther away from the feeder were extruded and emplaced later in the eruptive event. The downflow variations show extrusion of differentiated lava in the middle stage of the eruption and less differentiated lava in early and late stages.

The Lower flow was initially emplaced as a thin sheet of lava, and was inflated to become a thick sheet lava as lava was injected into the core of the flow. Meanwhile, the lava was mainly cooled from above and solidified downward. Yb stratigraphic variation shows decreases from the basal crust to the core at 26 m in stratigraphic height, then increases to the upper crust at 83 m in height and then decreases to the top of the Lower flow at 136 m in height. The Yb concentrations of 2.07 μg/g in the core are comparable to those of the later flows frozen in the proximal basal crust. It is consistent with the model where the core was formed by the lastly supplied and solidified lava. Besides the lava at height 259 m, the variation in Yb concentration from 145 m in height to the top of the Upper flow are correlatable to the temporal variation of the extruded lava, consistent with interpretation that the Upper flow formed by welded flows which were emplaced one on top of the other.

N-MORB normalized primitive V3 trace element patterns show LREE enrichment in spite of similar HREE abundances to N-MORB. Geochemical partial melting model of depleted MORB mantle indicates that the

primitive V3 trace element compositions can be reproduced by the mixing of melts formed by 0.2 wt% partial melting of garnet lherzolite and 1.5 wt% to 3.0 wt% partial melting of spinel lherzolite.

Keywords: Oman Ophiolite, large submarine lava flow, chemical variation, Emplacement processes , partial melting, magma genesis

