Petrological and geochemical characteristics of volcanic and ultramafic rocks from the Southwest Indian ridge (34E-40E)

Hiroshi Sato[1]; Ryoko Senda[2]; Kentaro Nakamura[3]; Shiki Machida[4]; Natsuki Neo[5]; Tomoaki Morishita[6]; Hidenori Kumagai[7]

[1] School Business Administration, Senshu Univ.; [2] IFREE, JAMSTEC; [3] FRCER, Univ. of Tokyo; [4] ORI, Univ.Tokyo; [5] none; [6] FSO, Kanazawa Univ.; [7] JAMSTEC

Basalts from western part of the Southwest Indian ridge (SWIR) show several different geochemical signatures even under the same spreading rate (full spreading ca 15 mm/yr). This indicates the differences of source mantle conditions (compositions, temperature, etc) beneath the western SWIR. It is already reported that basalts with normal mid-ocean ridge basalt (N-MORB) composition, hotspot signature, and DUPAL signature occur from very close segments along SWIR (e.g., Le Roex et al., 1989; Mahoney et al., 1992; Janney et al., 2005).

Eight dredge operations were performed along SWIR during KH07-4 Leg 2, and volcanic and ultramafic rocks were recovered from six dredge hauls. According to previous reports, basalts from segment west to the Prince Edward fracture zone (˜35E) show N-MORB-like composition, those between the Prince Edward and Eric Simpson fracture zones (35-39E) are affected by Marion hotspot, and those east to the Eric Simpson fracture zone (39˜E) have DUPAL signature.

One dredge (KH07-4D07) located in N-MORB segment yielded slightly altered aphyric basalt. Na8 (Na2O contents at MgO=8 wt% after Klein and Langmuir, 1989) is approximately 2.5. Trace element compositions analyzed with XRF are similar to N-MORB (Sun and McDonough, 1989) and previous results.

Two dredges located in hotspot-affected segment yielded small pieces of glass (KH07-4D01) and highly plagioclase porphyric basalts (KH07-4D02). Na8 of KH07-4D01 basalt glass ranges from 2.6 to 2.8, suggesting that degree of melting beneath this segment is slightly lower than N-MORB segment if source mantle has homogeneous compositions. Trace element compositions were analyzed with LA-ICP-MS at Kanazawa University, they are similar to previous results. Chondrite-normalized rare-earth elements (REE) compositions of KH07-4D01 basalt glass show flat pattern from light REE to heavy REE, although values previously reported are more LREE enriched. Multielements compositions are slightly poor in LILE.

Two dredges located in DUPAL segment yielded highly plagioclase porphyric basalts (KH07-4D04) and slightly altered aphyric basalts (KH07-4D06). Na8 values for basalts from KH07-4D4 ranges 2.6 to 2.7, whereas those from KH07-4D6 is approximately 1.9. This lowest Na8 value suggests that degree of melting beneath this segment is highest in this area if source mantle has homogeneous compositions.

Conglomerates including pieces of ultramafic clast were recovered from structural high with in the Prince Edward fracture zone (KH07-4D8). Ultramafic clasts up to 5 cm in size are included in sand-size matrix. The clasts are highly serpentinized, and primary minerals are contained approximately 30 vol% (olivine less than 2 vol%, Opx 12 vol%, Cpx 11 vol%, spinel 1.3 vol%). Based on modal compositions of these minerals, original lithology is estimated as lherzolite. Mg# of olivine is approximately 0.92 (N=9). Mg# and Cr# of spinel are 0.68 and 0.33, respectively. Cr# of spinel indicates relatively lower degree of melting.

Based on Na8, basalts from N-MORB segment resulted in higher degree of melting than those from hotspot-affected and DUPAL segments if source mantle composition beneath the SWIR is homogeneous. However, also pointed out by Le Roex et al. (1989), basalts from DUPAL segment have high Ba/Nb ratio than those from another segments. Furthermore, compositions of another trace element indicate that the source mantle has heterogeneous compositions beneath western SWIR.

Only differences of source mantle compositions probably can't explain the differences of basalt compositions, because basalts from the same segment (DUPAL segment: KH07-4D4 and KH07-4D6) have different compositions both major and trace elements. Therefore, conditions of melting (temperature, pressure, or degree of melting) are still important factor to determine the basalt compositions.