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REE composition of submarine volcanic rocks in the southern Mariana Trough

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Rare earth element composition was analyzed for submarine volcanic rocks taken from the southern Mariana Trough to evaluate the characteristics of source magmas related to the rifting and spreading of southern end of the trough.

Mariana Trough is a back-arc basin formed in association with the subduction of Pacific Plate beneath Mariana ridge. The southern Mariana Trough is topographically high and flat compared with the middle and north region of the trough. In the studied area, at least three sets of back-arc spreading ridge, and presently active ridge is on the edge of the trough adjacent to the active arc volcanic chain. The active back-arc ridge is separated into three segments, and magma chamber was recognized beneath the boundary between northern two segments. Four rift zones are found on the southern end of the trough, and the most eastern one is presumed to be most active.

Rare-earth elements were analyzed using ICP-MS applied to combination of In-internal standard and standard addition methods. Analytical error was checked using JB-1a, and that of each element concentration was smaller than 5% except Tm and Lu, which were less than 7%.

Volcanic rocks obtained from the active back-arc ridge are basalt and andesite, of which SiO_2 concentration is 50-60%. CI-normalized REE composition patterns of those rocks are similar to that of N-MORB while La and Eu are slightly depleted. Fresh quenched glass layer without Mn coating was recovered from the southern end of active ridge, and the REE pattern of this rock is also similar to N-MORB. Chemical compositions of rocks from the ridge crest just above the magma chamber and the southern end are similar to each other, and the lowest SiO_2 and REEs concentrations among studied back-arc volcanic rocks indicate the most primitive composition of source magma of this area. All rocks except one from remnant ridges at the center of the trough give the REE patterns similar to that of N-MORB.

Volcanic rocks from submarine volcanoes on the four rift zones at the southern end of the trough are basalts, of which SiO_2 concentration is 48-51%. They give LREE-enriched REE patterns except one sample, which was taken from the easternmost zone. Among those rocks concentration of REEs decreases toward the east. The rocks taken from the three different seamounts on the easternmost rift zone, and the rocks from two seamounts give LREE-enriched arc like REE pattern, while, the other gives N-MORB like REE pattern. Normalized La/Sm ratio of the rocks from the rift zones can be plotted on the line having trend of about 4, and one of the endmember ratio is concordant with that of primitive back-arc volcanic rock. The La/Sm ratio becomes higher with increasing SiO_2 concentration, while negative Eu is not observed. Thus, the island-arc volcanic rocks of the studied area have the same source magma as the back-arc volcanic rocks, and the degree of addition of crustal material would be different to verify the chemical composition.

One volcanic rock taken from the easternmost rift zone has N-MORB like REE pattern and similar major chemical composition to the back-arc volcanic rock taken from the southern end of the active back-arc spreading ridge, indicating that spreading has already started at the easternmost rift zone, and probably, the southeastern end of the Mariana Trough is active back-arc volcanic zone.