

Geochemical characteristics of the volcanic rocks from the active spreading ridge in the southern Mariana Trough

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During the research cruise by R/V Kairei, KR03-13, held from the November to December, 2004, the rocks and sediments were dredged from nine sites in the southernmost part of the Mariana Trough from 12 degree 45 minute N, 143 degree 30 minute E to 13 degree 15 minute N, 143 degree 45 minute E; the seven sites were on the presently active spreading ridge axis and two on the off-axis seamounts, at one of which the active black smoker fluids were found in the October, 2003 (Utsumi et al., 2003). In this report, the obtained samples and chemical compositions of the volcanic rock are described in relation to the characteristics of the local volcanism.

Black smoker chimney blocks were obtained from the one site located on an off-axis seamount, white smoker and manganese chimneys from two sites located on the ridge crest of the spreading axis. No black smoker chimneys were obtained from the spreading ridge area. Combining with the results of deep-tow characterization (Ishibashi et al., this volume), presently active black smoker fluids cannot be expected along the ridge crest, and only white and clear smoker fluids precipitating silica, iron-oxyhydroxide and manganese oxide would be present there. That is, ambient seawater widely penetrates into the shallower crust in that area to mix with the high temperature black smoker fluid.

Topographic feature of the ridge crest of this area implies that the spreading ridge can be divided into two segment at about 13 degree 05 minute N; active southern segment, where the crest is 2900-2800m depths from the sea surface and the northern segment where the crest becomes deeper toward the north below 2900m. Calcareous deep-sediment was dredged with white smoker and manganese chimney blocks and no volcanic rocks from the northernmost site at about 13°15 minute N on the ridge crest, implying that the local volcanism is quiet at the present.

Volcanic rocks having fresh quenched glass rim were obtained from the six sites on the ridge crest and two on the off-axis seamounts. Based on the analytical results of chemical composition, most of those rocks have basaltic to andesitic composition ($\text{SiO}_2 = 52\text{-}59\%$). It is notable that the rocks from the southern seamount located on the off-axis (12 degree 54 minute N, 143 degree 38 minute E) are dacite giving 68% SiO_2 . The Fe_2O_3^* and MgO content range within 14 and 6 and 5 and 0.2 %, respectively, corresponding to SiO_2 from 53 to 68 %.

Minor chemical compositions of all studied rocks are characterized by the enrichment of K, Rb and Ba relative to N-MORB. REE patterns of those rocks are different from the typical MORB and BABB (back arc basin basalt), which enrich heavier REE than the lighter ones relative to chondrite. The studied rocks slightly enrich the light REE compared with MORB and typical BABB. Especially, the enrichment of light REE is obvious in the dacite from the one of off-axis seamount. The characteristics of major and trace elements are explained by the differentiation of the source magmas which have originally the same chemical compositions.

The black smoker chimney blocks taken from the northern off-axis seamount, where active black smoker fluid was venting, was mainly composed of pyrite. Chalcopyrite, one of the major minerals in typical black smoker chimneys associating with high temperature hydrothermal fluid on the mid oceanic ridge volcanism, was not observed in the studied chimneys. Thus, the redox condition of the reaction zone and the hydrothermal solution must be low compared with those at typical mid oceanic ridges.

The observations described here imply that the magma chambers are small and that the magmas of studied area obtained the chemical characteristics affected by the overlying crust of the Mariana Island Arc.