Geochemistry of primitive glasses from the Volcanologists Massif (Far Western Aleutian Arc) obtained during SO201-KALMAR

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The Volcanologists Massif is located ca. 50 km north of Medny Island between Alpha and Bering FZ in the axial part of the Komandor Graben, the southernmost spreading center of the Komandorsky Basin (Baranov et al., 1991). Piip Volcano occupies the central part of the massif and considered to be the westernmost active volcano in the Aleutian Arc. Here we report first results of geochemical investigation of volcanic rocks obtained during R/V Sonne cruise SO201-KALMAR (Leg 2, 30.08.-08-10.2009). The goals of the study are development of a model of the geodynamic evolution of the Volcanologists Massif and Piip Seamount, and testing of petrogenetic models proposed for the origin of active volcanism in the Western Aleutian Arc.

Dredging at the Volcanologists Massif during SO201-KALMAR followed three previous sampling campaigns at this volcanic structure in 1985-1989 with Russian research vessels "Vulcanolog" and "Akademik Keldish" (summarized in Yogodzinski et al., 1994). The SO201-2 expedition focused primarily on detailed bathymetric mapping of the massif and dredging of

structural units of different ages within the volcanic complex (Fig. 1). The rocks obtained at 10 dredge stations ranged from aphyric to olivine-plagioclase-pyroxene-phyric basaltic and andesitic lavas and dacitic pumice. Our investigations have focused on major, trace element and isotope compositions of volcanic glasses from the dredged rocks, which represent magmatic melts quenched by contact with seawater. Several samples obtained by R/V Vulcanolog during Legs 26 and 35 were also included in this study.

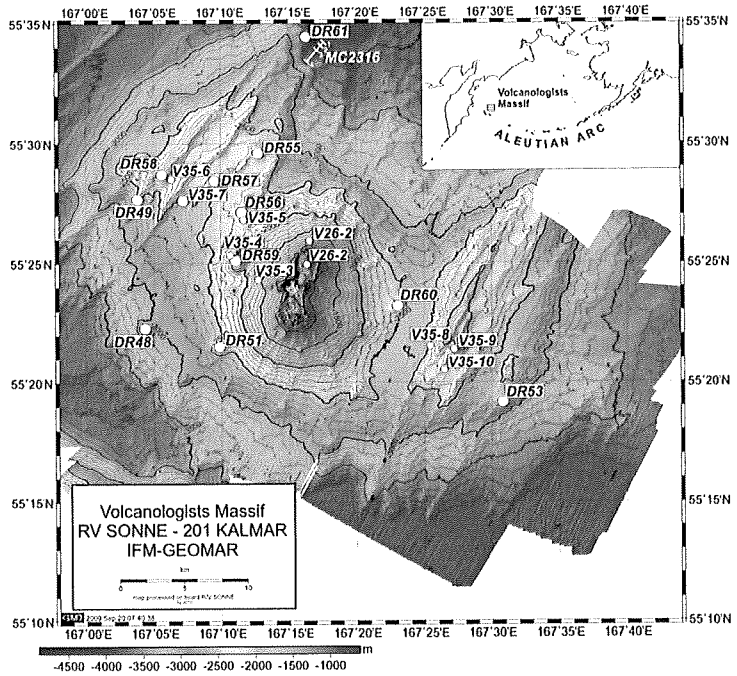

Fig. 1: Bathymetric map of the Volcanologists Massif and Piip Volcano. Large circles indicate dredge locations (DR) during SO201 KALMAR; small circles – locations of dredging by R/V Volcanologist during Leg 26 (V26) and Leg 35 (V35); a line with tick marks denotes a series of samples (MC2316 – 1 to 4) collected by submersible Mir (R/V Academik Keldish).

Based on dredge location, petrography and geochemistry we subdivided all studied samples into 3 groups. Group 1 is comprised of aphyric and rare olivine-plagioclase-phyric basalts and basaltic andesites dredged at the

greatest depths, possibly representing the oldest rocks in the massif (DR53, DR61, V35-10). These rocks correspond to the Komandor Series after Yogodzinski et al. (1994). Volcanic glasses from the Group 1 have moderately evolved (Mg#=0.50-0.52), low-K (K_2O=0.44-56 wt %), relatively rich in FeO (7.1-7.6 wt %) and TiO_2 (1.3-1.7 wt %) andesitic compositions (SiO_2=54-56 wt %). These glasses have the highest S content (140-450 ppm) and the lowest Cl (510-640 ppm) compared to the other groups. The glasses have relatively high HREE and Y concentrations similar to MORB-like lavas from the Gamma FZ in the Komandorsky Basin (Fig. 2). Concentrations of more incompatible elements are higher compared to the Komandorsky Basin basalt, and their fractionated pattern suggests small to moderate contribution from slab-derived fluid to their mantle source (Ba/La=6.0-8.8, Pb/Ce=0.07-0.10). The Group 1 glasses have relatively low $^{87}Sr/^{86}Sr$ (0.70256-0.70271), high $^{143}Nd/^{144}Nd$ (0.51318) and slightly elevated $^{206}Pb/^{204}Pb$ (18.07-18.11) compared to other samples.

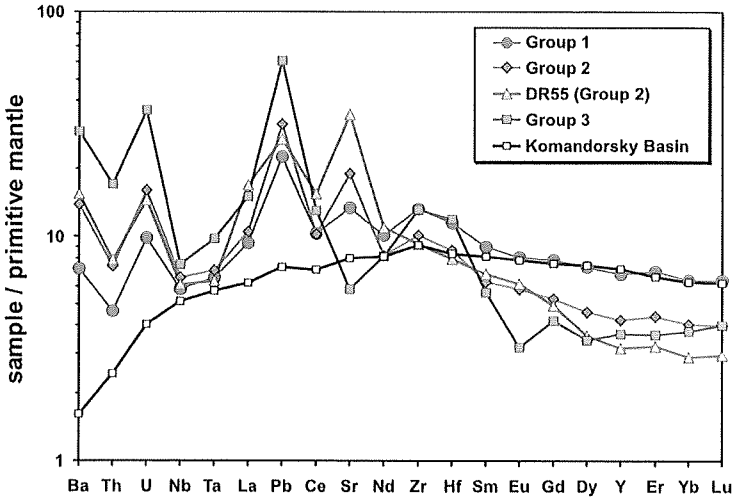

Fig. 2. Average trace element compositions of three groups of volcanic glasses from the Volcanologists Massif. Composition of Komandorsky Basin basalt from the Gamma FZ (SO201-2, DR118-1) is shown for reference.

Groups 2 and 3 correspond to the Piip Series after Yogodzinski et al. (1994). The Group 2 is comprised by olivine-pyroxene-plagioclase-phyric basaltic andesites and andesites dredged on both flanks of the Volcanologists Massif and from the foot of Piip volcano (DR48, DR51, DR55-60).

Quenched glasses of this group have primitive (Mg#=0.54-0.68) low- to middle-K (K_2O=0.45-0.96 wt %), relatively low-FeO (6.6-4.7 wt %) and low-TiO_2 (0.73-1.21 wt %) andesitic compositions. Compared to the Group 1, these glasses are remarkably depleted in S (30-150 ppm), all REE (except La and Ce), enriched in Cl (600-1030 ppm) and highly incompatible elements and have more pronounced subduction-related signature (e.g., Ba/La=9.2-18.3, Pb/Ce=0.09-0.16) (Fig. 2). The $^{87}Sr/^{86}Sr$ ratios (0.70264-0.70279) are similar, and $^{143}Nd/^{144}Nd$ (0.51313-0.51317) are lower compared to glasses of the Group 1. $^{206}Pb/^{204}Pb$ ratios (17.98-18.15) show greater variation but completely enclose Group 1. Among the Group 2 glasses, samples DR55 have specific compositions. They are enriched in Cl (1300 ppm), Sr (~740 ppm), LREE (La/Yb~8.5) and highly depleted in HREE. DR55 glasses have relatively low $^{87}Sr/^{86}Sr$ (0.70264) and $^{143}Nd/^{144}Nd$ (0.51313) compared to other Group 2 glasses and likely contain a large proportion of MORB-eclogite melt component (A-type adakite).

Glasses of the Group 3 have evolved (Mg#=0.28-0.46) middle-K (K_2O=1.66-1.81 wt %) dacite rhyolitic (SiO_2=70.4-74.3 wt %) compositions. The glasses occur at chilled margins of some andesitic lavas (DR59) and in dacitic pumice (DR60), which were dredged at the foot of the Piip Volcano and likely represent the youngest rocks in the massif. As indicated by negative Eu and Sr anomalies and flat HREE pattern of these glasses (Fig. 2), they originated by significant fractionation of plagioclase and amphibole from more primitive melts. These silicic glasses have the most pronounced slab-related signature (e.g., Ba/La=9.2-18.3, Pb/Ce=0.09-0.16) and also higher $^{87}Sr/^{86}Sr$ (0.70277-0.70284) and lower $^{143}Nd/^{144}Nd$ (0.51315-0.51316) compared to the other groups.

In summary, the compositions of volcanic glasses from the Volcanologists Massif suggest clear temporal evolution of the mantle sources from weakly modified in subduction zone (Group 1) to strongly modified (Groups 2 and 3). This transition can be explained if the distance from the volcano to the subducting plate has shortened and more slab-derived fluids and melts reached the source region of younger magmas. Possible tectonic models to explain geochemical evolution of the Volcanologists Massif are trench advance, migration of the massif closer to the trench and changes of slab dip.

References

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