Quaternary Volcanism and Origin of the Kurile Basin (Sea of Okhotsk)

I.A. Tararin[1], R. Werner[2] and E.P. Lelikov[3]

[1] *Far East Geological Institute, Russian Academy of Sciences, Vladivostok 690022, Russia, E-mail: igortararin@yahoo.com*

[2] *GEOMAR, Department of Volcanology and Petrology, Wischhfstr, 1-3, D-24148, Kiel, Germany, E-mail: rwerner@geomar.de*

[3] *Pacific Institute of Oceanology named in honour of V.I. Il'ichev, Russian Academy of Sciences, Vladivostok 690041, Russia, E-mail: pacific@online.marine.su*

The Kurile Basin is a marginal basin located at the convergent plate boundary between the pacific plate and the Asian continent. It has a triangular shape, extends about 1100 km in W-E direction and bordered by the Academy of Sciences Rise on the north and by the Kurile Island Arc on the south. The width of the basin is ca. 200 km near Shiashkotan Island. The average depth is about 3000 m.

Geophysical data show that the crust thickness of the Kurile Basin varies from 10 km on the south to 14 km on the north. The crust thickness and P-wave velocity of the basin similar to that of typical oceanic crust although it has a higher thickness (Bogdanov, 1988; Neprochnov et al., 1999). As whole, magnetic anomalies strike parallel to the long axis of the basin, W-E striking linear anomalies occurs at its axial zone. The basin has intensive Bouguer gravity anomalies similar to those of the backarc basins of the marginal seas and is characterized by high heat flow with average values 99± 29 mWm^2 (Bogdanov, 1988). Data of the geological setting of the basin are only available for the upper section of the sedimentary strata. The basement is poorly known.

The age of the Kurile Basin has not been determined certainly, but identical average heat flow and basement depths in both Japan and Kurile Basins suppose Tamaki (1988) a simultaneous opening of the two basins in the Late Oligocene to Middle Miocene. High heat flow and presence of sparse diapiric bathymetric highs suppose very recent volcanic and tectonic activity of the basin-taking place.

Therefore one of the objective of the KOMEX Russian-Germany dredging Program was to obtain representative geological and geochemical data on the rocks from the bathymetric highs protruding the sedimentary strata of the Kurile Basin. We carried most of the dredging program out on the submarine volcanic edifice in the eastern part of the basin where a few small fragments of basaltic andesite have been sampled for first time during RV 'Akademik Nesmeyanov' cruise 27. During RV 'Akademik Lavrentyev' cruise 28 (1997) and RV 'Marshal Gelovany' cruise 1 (1998) we recovered 9 dredges four of which yielded bedrock's from 3000-2400 m water depth.

The submarine volcano is made up of highly porphyritic (up to 20-30%), vesicular in appearance (up to 20% vol. vesicles) basalt, basaltic andesite and subordinate plagiobasalt. In basalt, the phenocrysts are plagioclase, clinopyroxene, olivine, and amphibole. Basaltic andesite is characterized by the appearance of orthopyroxene and minor olivine phenocrysts. Plagioclase phenocryst in basalt is generally superimposed on a decrease in An content from core (An_{93-72}) to rim (An_{60-65}) and contains numerous glass inclusions. Clinopyroxene having composition of predominantly Ca-rich augite with some diopside or salite is secondary to plagioclase as major phase and the most common groundmass pyroxene. Olivine phenocrysts range in composition from Fo_{89} to Fo_{76}. Olivine tends to disappear in the rocks with $SiO_2 > 54\%$ where it is replaced by orthopyroxene En_{69-73}. Brown-green amphibole phenocrysts are typical both for basalt and more evolved basaltic andesite and represented by magnesian hastingsite or rare tschermakitic and pargasitic hornblende. Phenocrysts of Fe-Ti-oxides are magnetite and titanomagnetite. Groundmass is mainly composed of glass with the numerous microlites of the same minerals, which also occur as phenocryst phase.

The rocks have geochemical features typical for high-K and high-Al island-arc volcanic. They are enriched in LILE and depleted in Zr, Ti, Nb and Y. The REE patterns are characterized by enrichment of LREE that similar to those of island-arc lava from the submarine volcanoes of rear-arc zone of the Kurile Island Arc.

Petrological and geochemical analyses of dredged rocks indicate that this seamount shows some special features. The high vesicularity of the rocks as well as low sulfur concentrations in matrix glass (<400 ppm) compared to high sulfur contents of melt inclusion in phenocrysts (>2000 ppm) indicate volcanic activity in shallow water (<ca. 500 m) or subaerial conditions. Considering the available age data of the volcano (K-Ar age: 0.9 and 1.6 Ma; Tararin et al., 2000) and recent position of its crest in ca. 2200 m b.s.l., our data may imply extremely high subsidence rates for the eastern part of the Kurile Basin. The Sm-Nd-Pb isotope ratios of the most samples from the seamount fall into the range of the Kurile island arc volcanoes with $^{87}Sr/^{86}Sr$ = 0.70287–0.70342; $^{143}Nd/^{144}Nd$ = 0.51303–0.51308; $^{206}Pb/^{204}Pb$ = 18.38–18.40; $^{207}Pb/^{204}Pb$ = 15.48–15.51; $^{208}Pb/^{204}Pb$ = 38.06–38.19. Isotopic data are very homogeneous and indicate a MORB-like source for these magmas in the mantle wedge. Some basalt, however, differ significantly in isotopic composition (higher $^{87}Sr/^{86}Sr$, lower $^{143}Nd/^{144}Nd$, varying Pb isotope ratios). These data could point to a sediment component in the melts or, probably, to crustal contamination. The latter would be in agreement with the model proposing a continental crustal basement for the eastern part of the Kurile Basin (Tararin et al., 2000). The available petrological data are consistent with the origin of the island-arc magmas by interaction of a primary basaltic melt and continental crust.

Large thickness of the sedimentary cover (ca. 3–4.5 km), almost completely marking the basement structure, insignificant amount of the basement rocks, determine controversial opinions on the origin of the Kurile Basin. One research considers the basin as a relic block of the oceanic plate or as a zone of downwarping of the edge of the Okhotsk continental plate. However, the opinions prevail, according to which the Kurile Basin is a newly forming back-arc basin formed: a) with spreading, caused by subduction of Pacific plate under Kurile Islands (Bogdanov, 1988), b) with continental rifting, crystal thinning and break-up of continental crust, coeval with the sinistral NE strike-slip motion (Utkin, 1984), c) with continental rifting and coeval clockwise rotation that create a pull-apart basin (Baranov et al., 1995). At the present stage researches without data of deep-sea drilling any of these hypotheses cannot be considered reasonable.

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Late Palaeozoic Brachiopod Faunas of the South Kitakami Region, NE Japan: Counter Evidence for the South Kitakami Microcontinent Hypothesis

Jun-ichi Tazawa

Department of Geology, Faculty of Science, Niigata University, Niigata 950-2181, Japan

In 1982, Saito and Hashimoto expressed the opinion that the South Kitakami Belt is a microcontinent, which originated and migrated from the Pacifica, and accreted to the present position in the Jurassic time. This hypothesis has been accepted and developed by many subsequent authors (e.g., Taira and Tashiro, 1987; Maruyama et al., 1989; Ichikawa, 1990; Ehiro and Kanisawa, 1999). However, Late Palaeozoic (Devonian to Permian) brachiopod evidence indicates that the South Kitakami Belt was born near the Sino-Korean block, and occupied the northern or eastern margin during the Late Palaeozoic times.

A Middle Devonian (Eifelian) brachiopod fauna from the upper part of the Nakazato Formation in the Hikoroichi area, South Kitakami Belt, contains 22 species assigned to 22 genera. Among the brachiopods of the Nakazato fauna, the following 8 species have been found also from the top of the Yikewusu Formation (Upper Eifelian) in the Zhusilenghaierhan region, western Inner Mongolia (Chen and Tazawa, in press): *Levenea wotuoshanensis* Zhang, *Malurostrophia sugiyamai* Chen and Tazawa, *Leptostrophia gracila* Zhang, *Leptaena anlogaeformis* Biernat, *Planatrypa japonica* (Sugiyama), *Kayseria lens* (Phillips), *Kymatothyris vandercammeni* (Minato and Kato) and *Hysterolites uniplicatus* Zhang.

Lower Carboniferous (Tournaisian-Lower Visean) brachiopod fauna of the South Kitakami region contains *Marginatia, Syringothyris* and *Rotaia* (Tazawa, 1996). It is noteworthy that the genus *Rotaia* is an important element of the Tournaisian to early Visean brachiopod fauna of the North China Province (Yang, 1983), which covers the Tienshan-Inner Mongolia-Jilin region, and is characterized by the presence of *Marginatia-Syringothyris-Rotaia* assemblage.

Middle Permian brachiopod fauna of the South Kitakami region contains both of the Boreal (including bipolar or anti-tropical ones) and the Tethyan elements. The Boreal elements are *Derbyia, Waagenites, Yakovlevia, Megousia, Kochiproductus, Waagenoconcha, Cancrinella, Stenoscisma, Neospirifer* and *Spiriferella*. The Tethyan elements are *Rhipidomella, Meekella, Geyerella, Orthothetina, Edriosteges, Capillomesolobus, Spinomarginifera, Transennatia, Tyloplecta, Compressoproductus, Permundaria, Urushtenoidea, Richthofenia, Leptodus, Permianella* and *Laterispina*. The Boreal-Tethyan mixed brachiopod faunas, like that of the South Kitakami region, are distributed in the Inner Mongolian-Japanese Transitional Zone (Tazawa, 1991), which include Inner Mongolia, Northeast China, South Primorye, the Hida Gaien Belt (central Japan) and South Kitakami Belt, all placed at the northern to eastern margin of the Sino-Korean block in the Middle Permian time.

The South Kitakami Microcontinent hypothesis requires the assumption that this microcontinent was situsted in the equatorial region of the Tethyan-Panthalassan Sea together with many seamounts covered by carbonate sediments in the Permian and Triassic. However, the above data on Late palaeozoic brachiopod faunas of the South Kitakami Belt suggest that the South Kitakami region was situated on the northern or eastern margin of the Sino-Korean block throughout Devonian to Permian times.

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