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GEOLOGY

First Sr–Nd Isotope Data on Granitoids of the Eastern and Coastal Taigonos Belts (Southern Part of the Taigonos Peninsula, Northeast Russia)

M. V. Luchitskaya[a] and K. N. Shatagin[b]

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The study of Nd and Sr isotopic compositions in granites provides insights into the possible composition and age of sources of granitic magmas, as well as the role of granitic magmatism in the evolution of the Earth's crust. In recent years, numerous Sm–Nd and Rb–Sr geochronological datings have been obtained for granitoids of the Okhotsk–Chukot and Eastern Sikhote Alin volcanic belts (see, for example, [2]). However, K–Ar and Rb–Sr isotope analyses have not been carried out for the elucidation of sources of granitic magmas in Northeast Russia. The present communication reports the first Sr–Nd isotope data on granites in the southern Taigonos Peninsula.

The Taigonos Peninsula is located in the western Koryak fold system. Its structures are discordant with structural patterns of the adjacent Verkhoyansk–Chukot and Koryak–Kamchatka fold zones. From north to south across the strike of structures, the Taigonos Peninsula can be divided into the Avekov, Central Taigonos, and Beregovoi tectonostratigraphic terranes (Fig. 1). The Avekov terrane is composed of Precambrian and Lower Paleozoic metamorphic rocks overlain by slightly deformed Upper Paleozoic cover [3, 4]. The Avekov terrane is separated from the Central Taigonos terrane by the Pylga shear zone. The Central Taigonos terrane is composed of volcanosedimentary complexes confined to structures of the Permian–Early Mesozoic Koni–Taigonos and Late Jurassic–Early Cretaceous Uda–Murgal island arcs [5]. Along the Southern Taigonos overthrust, the Central Taigonos terrane borders with the Beregovoi terrane. Tectonic sheets located along the Southern Taigonos overthrust fault contain Ordovician and Carboniferous rocks, ophiolites, and Upper Jurassic–Valanginian tuffaceous–terrigenous rocks [3]. The latter rocks are interpreted as fragments of a forearc basin of the Uda–Murgal arc. The older complexes, including accreted ophiolites, serve as a basement of the forearc. The Beregovoi terrane is characterized by an imbricate-overthrust structure of mainly southward vergence. This terrane is considered an accretionary prism formed in front of the Volgian–Neocomian Uda–Murgal volcanic arc [6].

Rocks of the Beregovoi terrane are intruded by plutons of the Coastal Taigonos belt composed of small gabbro–diorite and diorite–granodiorite bodies. The Eastern Taigonos pluton, 200 km long and 25 km wide, has a distinct linear sublatitudinal orientation. The pluton intrudes various rocks of both the Central Taigonos (the southern border) and the Coastal terranes (Fig. 1). The Eastern Taigonos pluton has Early Cretaceous age: 103.4 ± 0.5 Ma (^{40}Ar–^{39}Ar method [7]); 103.4 ± 1.7, 104.6 ± 1.0, and 97.0 ± 1.1 Ma (SHRIMP U–Pb zircon data [8]).

The ^{40}Ar/^{39}Ar dating yielded 103.1 ± 0.5 and 103.3 ± 0.3 Ma for granitoids of the Eastern Taigonos belt. Data for the Coastal Taigonos belt are 100.9 ± 0.6, 101.3 ± 0.5, 103.5 ± 1.9, and 101.1 ± 0.4 Ma. The SHRIMP U–Pb zircon datings for granitoids of the Coastal Taigonos and Eastern Taigonos belts indicate that the granitoids intruded during an approximately 10-Ma-long interval (from 106.5 ± 0.9 to 97.0 ± 1.1 Ma ago [8]).

[a] *Geological Institute, Russian Academy of Sciences, Pyzhevskii per. 7, Moscow, 119017 Russia; e-mail: luchitskaya@ginras.ru*

[b] *Institute of Geology of Ore Deposits, Petrography, Mineralogy, and Geochemistry, Russian Academy of Sciences, Staromonetnyi per. 35, Moscow, 119017 Russia*

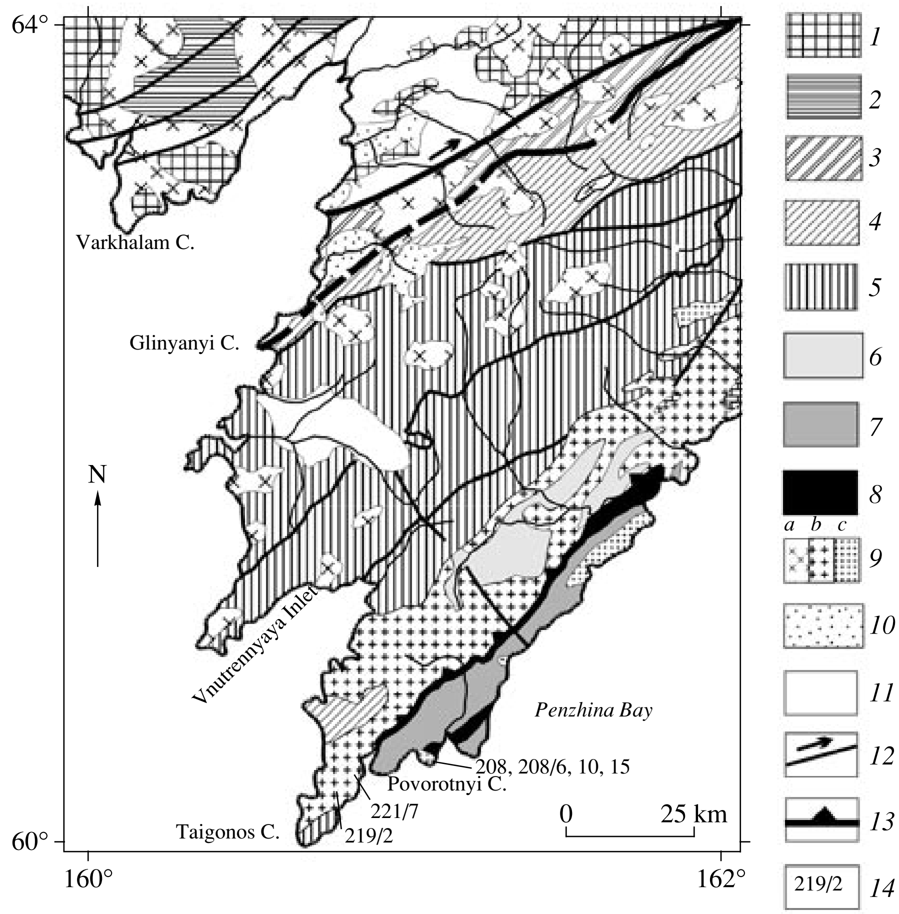

Fig. 1. Geological scheme of the Taigonos Peninsula (based on [6]). (*1, 2*) Azov terrane: (*1*) Precambrian rocks, (*2*) metamorphosed Paleozoic cover; (*3*) metamorphosed rocks of the Pylga suture zone; (*4–6*) Central Taigonos Peninsula: (*4*) Upper Paleozoic–Lower Mesozoic volcanogenic–terrigenous rocks, (*5*) Upper Jurassic–Lower Cretaceous volcanogenic–terrigenous rocks of the axial zone of the Uda–Murgal arc, (*6*) tuffaceous–terrigenous rocks and complexes of the basement of the Uda–Murgal forearc; (*7, 8*) Beregovoi terrane: (*7*) Triassic–Lower Cretaceous terrigenous, volcanogenic, and siliceous rocks of the accretionary structure, (*8*) ophiolites; (*9*) granitoids of belts: (*a*) Eastern Taigonos, (*b*) Coastal Taigonos, (*c*) Northern Taigonos; (*10*) Upper Cretaceous basalts of the Okhotsk–Chukot volcanogenic belt; (*11*) Neogene–Quaternary sediments; (*12*) faults (arrows show directions of dislocations); (*13*) Southern Taigonos overthrust; (*14*) sample numbers.

Isotope investigations were performed for four tonalite and diorite samples from the outer contact of the Coastal Taigonos belt and for three granodiorite and two-mica granite samples from the Eastern Taigonos pluton (Fig. 1, Table 1). Together with data on other Cretaceous granitoids of the Pacific region, the isotope results are plotted in the Sr–Nd diagram (Fig. 2).

In general, all the studied granitoids have high positive $\varepsilon_{Nd}(T)$ values and relatively low $(^{87}Sr/^{86}Sr)_0$ values. Relative to the data on other Cretaceous granitoids of the Pacific region shown in the Sr–Nd diagram (Fig. 2), the Taigonos granitoids have the most primitive (mantle-type) isotope characteristics.

Granitoids of the Coastal Taigonos and Eastern Taigonos plutons reveal certain differences. For example, the Coastal Taigonos granitoids have higher $(^{87}Sr/^{86}Sr)_0$ values, relatively lower $\varepsilon_{Nd}(T)$ values, and significantly higher $^{147}Sm/^{144}Nd$ values. In the Sr–Nd isotope plot, data points of the studied samples make up two clusters. Data points of the Eastern Taigonos pluton are confined to the so-called “mantle correlation” band, while granitoids of the Coastal Taigonos massif are shifted to the right side from this band.

Isotopic discrepancies recorded for the granitoids suggest their origin from two different sources.

High $(^{87}Sr/^{86}Sr)_0$ values and the calc-alkaline affinity of the Coastal Taigonos granitoids indicate their genetic relation with suprasubduction processes. The high $^{147}Sm/^{144}Nd$ value can be related to the formation of granitic melts during the differentiation of calc-alkaline magmas produced by melting of the mantle wedge substance. The high $(^{87}Sr/^{86}Sr)_0$ ratio suggests that Sr in the calc-alkaline magma source was derived from the hydrothermally altered oceanic crust in the course of its dehydration [13].

Results of the Rb–Sr and Sm–Nd isotope analyses of granitoid bulk samples from the southern Taigonos Peninsula

Sample no.	Rb	Sr	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$	$(^{87}Sr/^{86}Sr)_0$	Sm	Nd	$^{147}Sm/^{144}Nd$	$^{143}Nd/^{144}Nd$	$\varepsilon_{Nd}(T)$
	μg/g					μg/g				
Coastal Taigonos Peninsula										
208/6	40.8	227	0.5193	0.705975	0.70523	4.06	16.5	0.1488	0.512830	4.36
208/10	33.8	207	0.4724	0.705238	0.70456	3.33	13.0	0.1553	0.512838	4.44
208	28.6	176	0.4714	0.705187	0.70451	4.44	16.7	0.1610	0.512811	3.84
208/15	52.9	61	2.5090	0.708289	0.70469	1.62	9.79	0.0998	0.512817	4.74
Eastern Taigonos Peninsula										
223/1	42.3	624	0.1963	0.703839	0.70355	2.00	9.69	0.1244	0.512907	6.20
219/2	60.2	399	0.4368	0.704693	0.70405	2.73	13.6	0.1211	0.512832	4.78
221/7	99.3	99.3	2.8950	0.708100	0.70386	1.70	9.78	0.1049	0.512888	6.09

Note: Concentrations of elements and values of $^{87}Sr/^{86}Sr$ ratios (uncertainty better than ±1%, 2σ) and $^{147}Sm/^{144}Nd$ (uncertainty better than ±0.5%, 2σ) were determined by the isotope dilution method. The uncertainty of the $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ values does not exceed ±0.002%, 2σ. During the process of data gathering, the $^{87}Sr/^{86}Sr$ value in the SRM-987 standard was 0.710259 ± 19 (2σ) and the $^{143}Nd/^{144}Nd$ value in the Nd_2O_3 (IGEM RAN Laboratory) standard was 0.512404 ± 12 (2σ), which matches the La Jolla value (0.511857). Average values and uncertainties related to standards are given for 34 and 24 measurements, respectively. The primary Sr isotopic composition and $\varepsilon_{Nd}(T)$ value are calculated for the age of 102 Ma based on the following CHUR parameters: $^{147}Sm/^{144}Nd = 0.1967$ and $^{143}Nd/^{144}Nd = 0.512638$.

Granitoids of the Eastern Taigonos pluton are enriched in Sr (400–600 μg/g in the Coastal Taigonos granitoids) relative to Nd. The Rb/Sr ratio is generally moderate or low (Table 1). Higher Sr/Nd values for some granitoids of the Eastern Taigonos pluton are comparable with those for adakites, the petrogenetic model of which differs from the model for calc-alkaline rocks [14, 15].

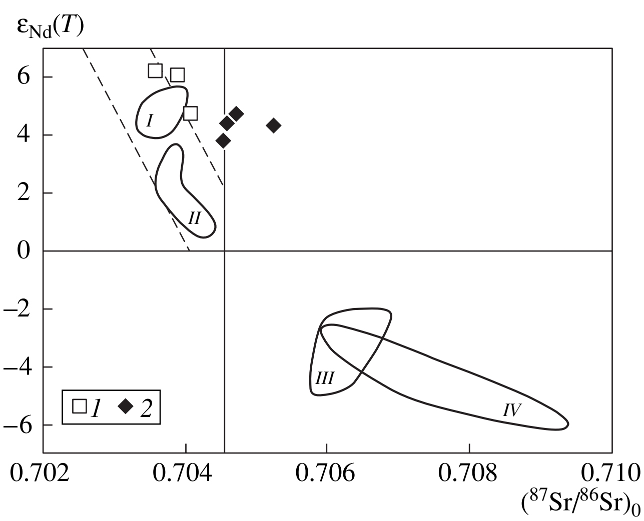

Fig. 2. $^{87}Sr/^{86}Sr)_0$–$\varepsilon_{Nd}(T)$ plot for granitoids of the Coastal and Eastern Taigonos belts. (*1*) Eastern Taigonos pluton; (*2*) Coastal Taigonos pluton; fields with numbers outline the isotope data on Cretaceous granites of the Pacific region: (*I*) Illapel massif, Coastal batholith, Chile [9], (*II*) batholith of northern Patagonia, Chile [10], (*III*) Sonora massif, northeastern Mexico [11], (*IV*) Kassair massif, British Columbia, Canada [12]. Dotted lines show the mantle correlation band.

The initial Sr and Nd isotopic compositions of the Taigonos granitoids show minor variations within the outlined rock groups. In the Sr–Nd isotope plot (Fig. 2), discrepancies between the most differentiated rocks (samples 208/15 and 221/7 from the Coastal Taigonos and Eastern Taigonos plutons, respectively) do not exceed the discrepancies between the major granitoid varieties of plutons. Therefore, we can affirm that the ancient (pre-Riphean) crustal substance was absent both in the granitoid melt source and at the pluton evolution depth. However, one cannot rule out the influence of the Paleozoic continental crust. The effect of this influence cannot be as high as during the interaction between melts with mantle-type isotope signatures and the pre-Riphean continental crust, because the discrepancies in their isotope characteristics are not so significant.

Thus, we can draw the following conclusions.

(1) Granitoids of the Coastal Taigonos and Eastern Taigonos massifs have two different sources of primary melt. Both sources were dominated by the mantle substance.

(2) Pre-Riphean material of the continental crust was not involved in the formation of the Taigonos gran-

itoids. Hence, pre-Riphean rocks were absent in the peninsula basement.

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