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GEOLOGY

Age of the Shanuch Copper–Nickel Deposit in Kamchatka

V. A. Stepanov and Yu. P. Trukhin

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Copper–nickel deposits associated with hornblende-rich basic [1] or norite–cortlandite [2] minor intrusions and dikes are widespread at the eastern margin of the Asian continent. They are generally confined to carbonaceous metaschists or gneisses of median crystalline massifs or swells in the Precambrian basement of fold belts. According to [1–3], the age of the copper–nickel mineralization in this region ranges from Proterozoic to Late Cretaceous.

In Kamchatka, copper–nickel mineralization is confined to the Kamchatka median crystalline massif (KMCM) [2, 4]. According to A.A. Kremenetskii, Yu.P. Trukhin, et al. (2003), the crystalline massif includes the Shanuch and Dukuk ore nodes with copper–nickel mineralization developed at the northern and southern parts of the KMCM, respectively.

The best-studied Shanuch copper–nickel deposit is composed of massive, brecciated, stringer, and disseminated bodies of chalcopyrite–pentlandite–pyrrhotite ores. The orebodies are confined to steep dike-shaped intrusions of amphibole gabbro, amphibole–biotite diorites, and quartz diorites [5]. They are located among Paleozoic (?) gneissic granites and graphite-containing crystalline schists of the Proterozoic Kamchatka Group.

The age of the Ni-bearing intrusions in Kamchatka is a debatable issue. For example, based on the K–Ar dating of ore-bearing intrusions (54–96 Ma), the authors of the overview of the geology and mineral resources of Kamchatka [4] assign the copper–nickel mineralization to the Late Cretaceous–Early Paleogene. However, based on the same K–Ar dating method, Shcheka and Chubarov [2] demonstrated that the age of the Ni-bearing intrusions in the KMCM ranges from 220 to 80 Ma, i.e., from the Late Triassic to the Late Cretaceous. Baikov et al. [6] obtained an older age (presumably, Late Paleozoic) for the copper–nickel mineralization in Kamchatka. According to the later work of Poletaev [7], the absolute age of nickel-bearing intrusions in Central Kamchatka varies from the Jurassic to the Oligocene, but the crystalline massif could have formed in the Early Cretaceous.

Table 1. Chemical composition of intrusive rocks at the Shanuch deposit

Ord. no.	Sample no.	Rock	Wt %												
			SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	SO_3	L.O.I.	Total
1	SSh-2	Gabbrodiorite	53.55	0.428	8.92	2.8	7.21	0.137	19.12	1.42	0.1	1.10	0.076	0.64	3.85	98.61
2	SSh-5	Meladiorite	59.91	0.405	14.78	0.39	5.06	0.08	10.63	4.13	2.46	0.322	0.129	0.066	1.44	99.80
3	SSh-7	Diorite	58.71	1.01	20.08	0.89	3.79	0.06	2.84	5.82	3.54	1.86	0.294	0.037	0.90	99.81
4	ShA-3	Pegmatoid diorite	56.24	0.98	19.18	7.33	3.38	0.15	2.90	5.92	3.39	1.89	0.55	0.01	1.59	99.51
5	ShA-5	Pegmatoid gabbrodiorite	53.53	1.52	11.54	3.94	6.75	0.13	8.84	6.65	1.55	2.00	0.13	0.10	2.28	98.96

Note: Samples ShA-3 and ShA-5 were taken by V.A. Stepanov; samples SSh-2, SSh-5, and SSh-7, by O.B. Selyangin.

Research Geotechnological Center, Far East Division, Russian Academy of Sciences, Severo-Vostochnoe sh. 30, Petropavlovsk-Kamchatski, 683002 Russia; e-mail: vitstepanov@yandex.ru

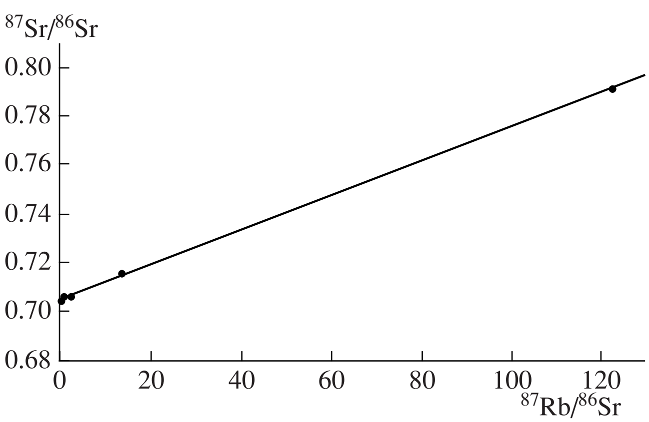
Table 2. Results of determination of the absolute age by the Rb–Sr method

Ord. nos.	Sample	Rock	Mineral	Rb (ppm)	Sr (ppm)	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$
1	SSh-2	Gabbrodiorite	Amphibole	35.49	93.23	1.10	0.7062 ± 0.0012
2	SSh-5	Meladiorite	Biotite, amphibole	19.09	123.8	0.4456	0.7052 ± 0.0013
3	SSh-7	Diorite	Biotite	171.3	218.1	2.269	0.7065 ± 0.0010
4	ShA-3	Pegmatoid diorite	Biotite	334.4	69.50	13.92	0.7159 ± 0.0010
5	ShA-5	Pegmatoid gabbrodiorite	Amphibole, biotite	515.6	12.20	123.2	0.7909 ± 0.0010

Note: Isochron parameters: nos. 2, 3, 5, t = 49.16 ± 0.29 Ma, JR = 0.7049 ± 0.0015, MSWD = 0.016; nos. 1–5, t = 49.2 ± 2.7 Ma, JR = 0.7053 ± 0.0010, MSWD = 33 (P.B. Lebedev, analyst).

In order to refine the age of nickel-bearing intrusions in the Shanuch deposit, we carried out Rb–Sr dating of a pluton in orebody 1 of this deposit. The pluton is composed of rocks of the Dukuk Complex. We took five samples of unaltered amphibole diorites, meladiorites, gabbrodiorites, pegmatoid gabbrodiorites, and pegmatoid diorites from the pluton surface. Examination of thin sections confirmed the absence of secondary alterations in the chosen samples. Table 1 presents their chemical compositions. After crushing the samples up to fraction 0.5–1 mm, we separated amphibole and biotite monofractions or biotite–amphibole intergrowths as proxies with the highest K content.

The Rb–Sr dating was carried out at the Center of Isotope Investigations of the Karpinskii All-Russia Research Institute of Geology (St. Petersburg). The contents of Rb and Sr were determined with a Triton thermoionization spectrometer (Germany). The results obtained are presented in Table 2 and the figure. Analysis of five samples yielded the following isochron parameters: t = 49.2 ± 2.7 Ma, JR = 0.7053 ± 0.0010, MSWD = 33. The isochron based on three samples yielded the following parameters (Table 2): t = 49.16 ± 0.29 Ma, JR = 0.7049 ± 0.0015, MSWD = 0.016. Both isochrons indicate the Eocene age of magmatism (49.16–49.2 Ma) with an insignificant standard deviation. The low primary ratio of the Sr isotope (0.7049 and 0.7053) testifies to the mantle source of the magma.



Isochron of the absolute age of the Ni-bearing gabbrodiorite intrusion at the Shanuch deposit.

The results obtained demonstrate the Eocene age of the Shanuch copper–nickel deposit, which is associated with minor intrusions and dikes of hornblende-rich basic and ultrabasic rocks. Together with datings of the analogous mineralization in the Amur region [3], our data refine significantly the timing of nickel-bearing basic–ultrabasic formations in the Russian Far East and indicate that the Ni-bearing massifs were formed at the Mesozoic–Cenozoic stage of the geological evolution of the region.

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