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GEOLOGY

Age and Geochemistry of the Luchinsky Mafic–Ultramafic Pluton, the Southeastern Framework of the Siberian Craton

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Mafic–ultramafic plutons (Lukinda, Kengurak–Sergach, Mongol, Veselka, Nyukzha, Luchinsky, Il'deus, and others) are widespread in the Dzhugdzhur–Stanovoi Superterrane of the southeastern framework of the Siberian Craton separated by the Dzheltulak Suture Zone from the Selenga–Stanovoi Superterrane (Fig. 1).

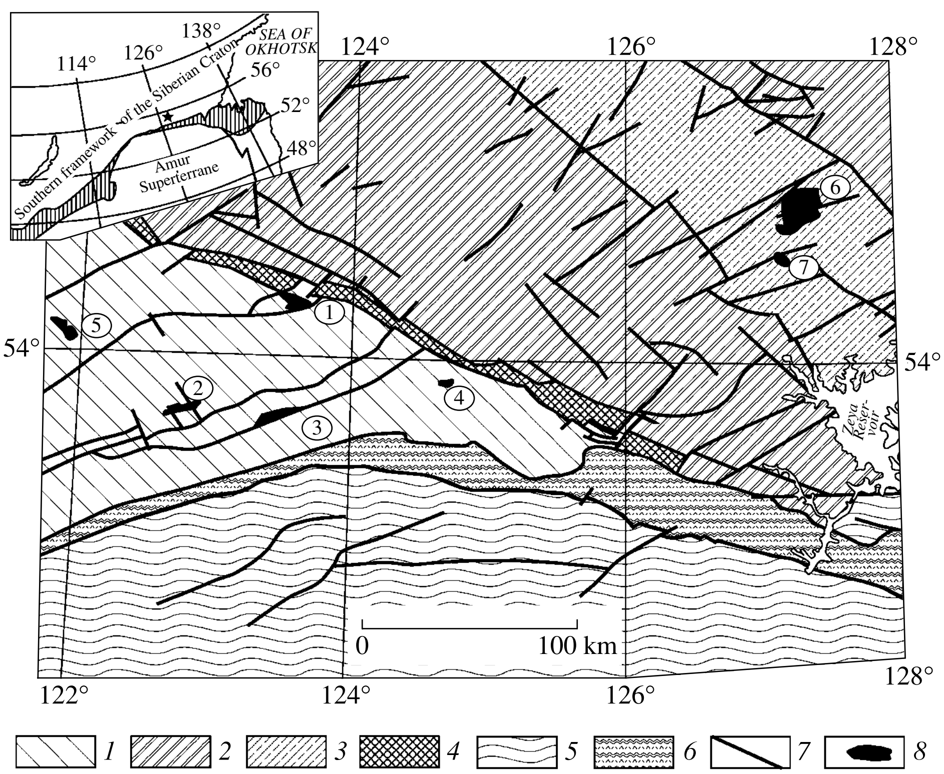

Fig. 1. Location of the mafic–ultramafic plutons in the southeastern framework of the Siberian Craton, after [1]. (*1–4*) Tectonic units of the southern and southeastern framework of the Siberian Craton: (*1*) Selenga–Stanovoi Superterrane, (*2, 3*) Dzhugdzhur–Stanovoi Superterrane: (*2*) Dambuka, Ilikan, and Larba blocks; (*3*) Bryanta Block; (*4*) Dzheltulak Suture Zone; (*5*) Kerulen–Argun–Mamyn Superterrane; (*6*) Mongol–Okhotsk Foldbelt; (*7*) faults; (*8*) mafic–ultramafic plutons (numerals in circles): (1) Lukinda; (2) Kengurak; (3) Mongol; (4) Veselka; (5) Nyukzha; (6) Luchinsky; (7) Il'deus. Location of the Luchinsky pluton in inset is marked by asterisk.

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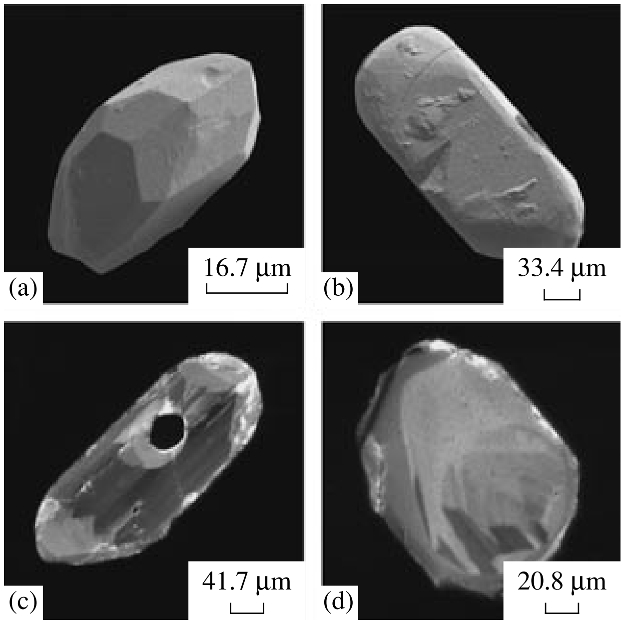

Fig. 2. Photomicrographs of zircon from gabbronorite of the Luchinsky pluton (sample I-352): (a, b) secondary electron images, SEM ABT 55; (c, d) cathodoluminescent images, SEM CamScan.

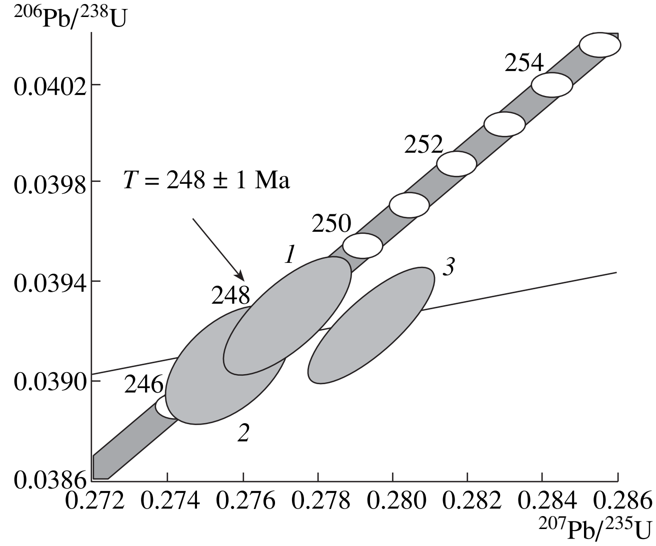

Fig. 3. Diagram with concordia for zircons from gabbronorite of the Luchinsky pluton (sample I-352). Point numbers correspond to the ordinal numbers in the table.

These plutons were traditionally referred to as Early Precambrian [1, 2]. However, new data on a much younger age of many igneous complexes in the southern framework of the North Asian Craton have been obtained recently [3–5]. In this regard, the necessity arose to specify the chronological position of mafic–ultramafic complexes in the geological history of the region.

In this communication, we report the results of geochronological (U–Pb zircon age) and geochemical investigations of the Luchinsky dunite–troctolite–gabbro pluton located in the Bryanta Block of the Dzhugdzhur–Stanovoi Superterrane (Fig. 1). The country rocks are composed of amphibole–plagioclase, biotite–amphibole–plagioclase, and amphibole–two-pyroxene–plagioclase crystalline schists and biotite–amphibole gneisses of the Stanovoi Complex. In plan view, this pluton is an oval 21 × 12 km^2 NE-elongated body. Three layered series are recognized within this pluton: (1) lower series (dunite and peridotite); (2) middle series (troctolites alternating with olivine gabbro, gabbro, and pyroxenite); and (3) upper series (olivine gabbro with sporadic troctolite and gabbronorite units). The vein complex comprises coarse-grained troctolite, pyroxenite, and gabbro.

The characteristic geochemical trend of these series is characterized by enrichment in SiO_2, Al_2O_3, and CaO at virtually constant concentrations of TiO_2 and FeO* and decreasing MgO content. The REE patterns are only slightly fractionated ($(La/Yb)_n$ = 1.6–3.8) and distinguished by a distinct positive Eu anomaly (Eu/Eu* = 1.7–2.9). The total REE content increases from the lower to the upper series.

Gabbroic rocks of the middle and the upper series are depleted in Nb (0.1–3.7 ppm), Ta (0.01–0.24 ppm), Hf (0.3–1.1 ppm), and Zr (10–45 ppm). At the same time, they are enriched in Rb (up to 17 ppm) and Ba (up to 380 ppm) relative to the primitive mantle. The Ba, K, and Sr contents are much higher, whereas Th, U, Ta, Hf, Zr, and Tb contents are much lower than in the primitive mantle. This feature may indicate the contribution of a lithospheric component to the magma source.

Gabbronorite from the upper layered series was chosen for U–Pb dating of zircon (sample I-352). The accessory zircon in this sample is represented by transparent colorless subhedral (prismatic and oval) crystals and crystal fragments (Fig. 2). The rough internal zoning and sectorial structure is typical of zircon crystals (Fig. 2). The size of zircon grains varies from 50 to 300 μm (elongation coefficient 1.0–2.5).

The U–Pb isotopic study was performed for three zircon charges selected from size fractions >150 and >100 μm. Zircon of two charges underwent acid treatment (table, nos. 2 and 3) [11]. As can be seen from Fig. 3, untreated zircon and the residual zircon grains left after acid treatment for 3 h are characterized by the concordant age of 248 ± 1 Ma (MSWD = 0.2, probability 0.7). Zircon treated with acid for a longer time has a somewhat older $^{207}Pb/^{206}Pb$ age likely testifying to the presence of an insignificant ancient component. The lower intercept with discordia calculated for all three zircon fractions corresponds to the age of 248 ± 1 Ma (MSWD = 1.7). The morphology of zircon crystals testifies to their magmatic origin. Hence, the concordant age of 248 ± 1 Ma may be accepted as the most accurate estimate of the timing of the Luchinsky dunite–troctolite–gabbro pluton.

Results of the U–Pb isotopic study of zircons from gabbronorite of the Luchinsky pluton (sample I-352)

No.	Size fraction, μm and its characteristic	Charge, mg	Content, ppm		Isotope ratios		
			Pb	U	$^{206}Pb/^{204}Pb$	$^{207}Pb/^{206}Pb^{(a)}$	$^{208}Pb/^{206}Pb^{(a)}$
1	>150, >100	4.02	0.82	1.70	896	0.0512 ± 1	0.3124 ± 1
2	>150, ac. tr., 3 h	–	U/Pb* = 21.7		2151	0.0512 ± 1	0.2980 ± 1
3	>100, ac. tr., 3.5 h	–	U/Pb* = 21.0		974	0.0517 ± 1	0.2896 ± 1

No.	Size fraction, μm and its characteristic	Isotope ratios		*Rho*	Age, Ma		
		$^{207}Pb/^{235}U$	$^{206}Pb/^{238}U$		$^{207}Pb/^{235}U$	$^{206}Pb/^{238}U$	$^{207}Pb/^{206}Pb$
1	>150, >100	0.2772 ± 11	0.0393 ± 1	0.74	248 ± 1	248 ± 1	250 ± 6
2	>150, ac. tr., 3 h	0.2756 ± 8	0.0391 ± 1	0.52	247 ± 1	247 ± 1	248 ± 6
3	>100, ac. tr., 3.5 h	0.2794 ± 6	0.0392 ± 1	0.81	250 ± 1	248 ± 1	271 ± 2

Note: (a) Isotope ratios corrected for procedure blank and common lead; (ac. tr.) zircon residue after acid treatment; (*) unspecified charges. Error values correspond to the last significant decimal digit. Zircon was separated with heavy liquids using the standard technique. Decomposition of zircon and chemical separation of Pb and U was performed following the modified Krogh method [6]. The procedure blank during the study was no higher than 20 pg Pb. The Pb and U isotopic compositions were determined on a Finnigan MAT 261 mass spectrometer in the static regime or with an electronic multiplier (coefficient of discrimination for Pb is 0.32 ± ± 0.11 amu). The experimental data were processed using PbDAT and ISOPLOT programs [7, 8]. The universally accepted uranium decay constants [9] were used. Correction for common lead was introduced in consistence with modeling values [10]. All uncertainties are given at 2σ level.

The obtained estimate allows us to outline the Early Mesozoic stage of mafic–ultramafic magmatism in the geological history of the Dzhugdzhur–Stanovoi Superterrane. This stage is correlated with mafic–ultramafic magmatism at the Siberian Craton dated at 250 Ma [12, 13] and related to the Siberian superplume.

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