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GEOCHEMISTRY

Early Vendian Age of Multiple Gabbro–Granite Complexes of the Karalon–Mamakan Zone, Baikal–Muya Belt: New U–Pb Zircon Data

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The Karalon–Mamakan zone is situated in the eastern margin of the Baikal–Muya belt (Fig. 1a) and consists of the Mamakan and Karalon segments. Two multiple intrusive complexes, the Early Proterozoic Muya gabbrodiorite and Middle Proterozoic Vitim diorite–granite complexes, were distinguished by Salop [5] in the Karalon segment (Middle Vitim mountainous region) [5]. During subsequent works, mutually intersecting diorite and granitoid intrusions on the left bank of the middle Vitim River (Padora–Orlov interfluve) were combined into the multiphase Padora complex, while leucoplagiogranites with an age of 537 ± 9 Ma were identified as the Maloyakornyi Complex (Fig. 1b) [6]. Recent geochronological data showed that plagiogranites of the Tallaya (Muya plagiogranites [5]) gabbrodiorite–plagiogranite pluton in the Vitim–Tallaya–Padora interfluve have a U–Pb zircon age of 625 ± 14 Ma [4]; gabbroids of the Zaoblachnyi pyroxenite–gabbronorite pluton define a Sm–Nd isochron age of 612 ± 34 Ma [2]; and volcanic rocks of the Padra Group, which overlie plagiogranites and gabbroids with erosional unconformity, define an age of 590 ± 5 Ma [3]. In the legend for the Muya Group in GDP-200 sheets, the gabbro–diorite–plagiogranite plutons from the middle Vitim area were distinguished as the independent island-arc Tallaya Complex, the mapped volume of which exactly corresponds to that of the Muya Complex in the Karalon segment. Thus, available data indicate that a wide spectrum of the magmatic rocks of this segment of the Baikal–Muya belt was formed within a narrow range of the Early Vendian. To confirm this conclusion of regional importance, we carried out additional study of the gabbroids of the first intrusive phase of the Tallaya Complex, which account for up to 50 vol % of the Padora granites of controversial age on the left bank of the middle Vitim River and host gold–quartz bodies of the Karalon ore field.

The isotope dating was accomplished for typical low-Ti gabbroids of the Tallaya Complex, which was sampled from the coastal exposure of the Vitim River across the mouth of Verkhnii Orlov Creek (sample 2/02), and Padora granite, which was sampled from the prospecting borehole core within the Karalon ore field (sample S24) (Figs. 1b, 1c). The chemical compositions of the samples are shown in Table 1.

Zircons were extracted using the conventional heavy liquid technique. The chemical decomposition of zircons and extraction of U and Pb were performed using the modified Krogh technique [8]. Zircon in gabbroids is subhedral transparent prismatic with high birefringence and thin zoning. Zircon from granites forms subhedral and euhedral short-prismatic crystals of zircon habit and pink and red color due to inclusions of iron hydroxides. The crystals are homogenous with fragments of thin zoning and normal birefringence. The zircon morphology attests to the magmatic origin.

The U–Pb isotope data obtained are presented in Table 2 and Fig. 2. The gabbroids define an almost concordant age of 604 ± 7 Ma, while the Padora granites yield an age of 598 ± 4 Ma. Thus, all magmatic rocks of the Karalon segment, including the data obtained in this work, are nearly similar within the error limits and correspond to the Early Vendian.

In general, the age of multiphase intrusive magmatism of the Karalon segment can be constrained by the ages of host metavolcanic rocks of the Karalon sequence. Based on the U–Pb zircon dating, subvolcanic metarhyolites define an age of 663 ± 3 Ma for this sequence [4]. Rhyolites of the Padra Group, which unconformably overlie the gabbroids and granites, yield 590 ± 5 Ma [3]. The eclogite-like rocks of the

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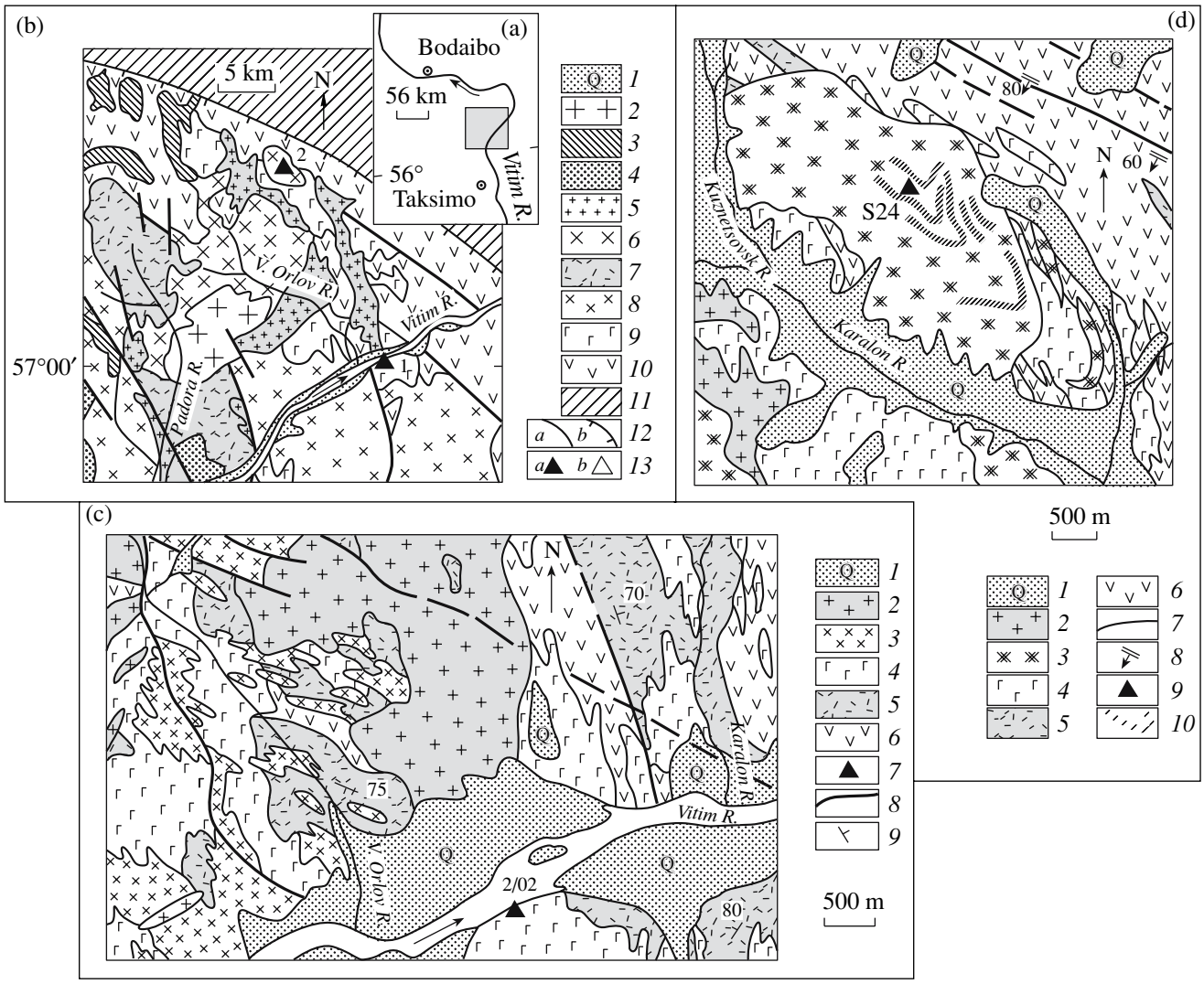

Fig. 1. Schematic geological structure of the northeastern Karalon segment, the Karalon–Mamakan zone. (a) Position of the study area. (b) Geological structure of the Vitim–Padora–Verkhnii Orlov interfluve: (*1*) Quaternary sediments of the Vitim valley; (*2*) Middle–Late Carboniferous granitoids; (*3*) Middle Paleozoic intrusive complexes (Biram'in, Maloyakornyi); (*4*) Vendian–Early Cambrian Padrokan terrigenous formation of the Mamakan Group; (*5–9*) Vendian rocks: (*5, 6*) Vitim (Padora) intrusive complex: (*5*) granite porphyry; (*6*) diorites, granites; (*7*) Padra Group; (*8, 9*) Tallaya Complex: (*8*) diorites and plagiogranites; (*9*) gabbro and gabbrodiorites; (*10, 11*) Late Riphean rocks: (*10*) Karalon volcanogenic sequence; (*11*) Delyun–Uran Group of the Baikal–Patom belt; (*12*) (*a*) faults, (*b*) Syul'ban thrust; (*13*) (a) sampling locality for the present study: (1) gabbro, (2) granites, (b) diorites after [4]. (c) Geological scheme of the sampling area of the gabbroids of the Tallaya Complex. (*1*) Quaternary sediments; (*2*) granite porphyries of the Vitim (Padora) complex; (*3*) diorites and plagiogranites of the Tallaya Complex; (*4*) gabbroids and gabbrodiorites; (*5, 6*) Karalon sequence: (*5*) felsic metavolcanic rocks; (*6*) mafic metavolcanics and greenschist tuffs; (*7*) locality of geochronological sampling of gabbro (2/02); (*8*) faults; (*9*) dip and strike. (d) Geological scheme of the sampling area of granites of the Padora Complex in the upper reaches of the Karalon River: (*1*) Quaternary sediments, (*2*) granite porphyries of the Vitim (Padora) complex; (*3*) plagiogranites and granites of the Padora Complex; (*4*) gabbroids of the Tallaya Complex; (*5, 6*) Karalon sequence: (*5*) felsic metavolcanic rocks; (*6*) mafic metavolcanic rocks and greenschist tuffs; (*7*) dip and strike; (*8*) faults; (*9*) sampling locality (S24); (*10*) quartz veins.

North Muya block have a Sm–Nd age of 653 ± 21 Ma [7], while enderbites of the Boguchan Granulite Complex on the northern bank of Lake Baikal have a U–Pb age of 617 ± 5 Ma [1]. These ages are close to the age of the Early Vendian magmatic complexes, which indicates that the multiphase magmatism could be coeval with high-temperature metamorphism at the deep crustal sections of the Baikal–Muya belt. This fact, in turn, can indicate that the multiphase magmatism of the Karalon segment was related to collisional paleodynamic settings.

New data suggest that the Early Vendian in the evolution of the Baikal–Muya belt is characterized by

Table 1. Chemical composition of the studied samples

Ordinal no.	Complex	Rock	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	LOI	Total
2/02*	Tallaya	Gabbro	47.9	1.39	17.1	9.79	0.164	7.45	10.7	2.39	1.02	0.185	1.66	99.7
S24	Padora	Granite	74.8	0.34	12.01	2.4	0.13	0.05	0.985	3.71	4.58	0.05	1.05	100.01

Note: Fe_2O_3 is total iron.

Table 2. U–Pb isotope data on zircon

Ordinal no.	Fraction size, μm	Sample weight, mg	Content μg/g		$\frac{^{206}Pb}{^{204}Pb}$	$\frac{^{207}Pb}{^{206}Pb}$	$\frac{^{208}Pb}{^{206}Pb}$	$\frac{^{207}Pb}{^{235}U}$
			Pb	U				
1	≤100	1.58	15.49	135	3240	0.06006	0.28	0.81616
2	100–150	1.29	22.86	200	4022	0.06001	0.279	0.81267
3	≥150	1.35	23.09	202.4	4486	0.06008	0.2739	0.81633
4	60–85	0.95	112	1193	1690	0.0598	0.1674	0.707798
5	85–100	0.86	104	1098	1542	0.05987	0.1667	0.7126
6	60–100*	2.35	115	1239	2393	0.05987	0.1631	0.71452

Ordinal no.	Fraction size, μm	$\frac{^{206}Pb}{^{238}U}$	$\frac{^{232}Th}{^{238}U}$	*Rho*	Age, Ma			α-dose
					$\frac{^{206}Pb}{^{238}U}$	$\frac{^{207}Pb}{^{235}U}$	$\frac{^{207}Pb}{^{208}Pb}$	
1	≤100	0.098553	0.9067	0.79	605.9	605.9	605.8 ± 2.0	0.34
2	100–150	0.098213	0.9035	0.64	603.9	604	604.1 ± 3.4	0.5
3	≥150	0.098555	0.887	0.93	605.9	606	606.5 ± 1.0	0.5
4	60–85	0.085872	0.5419	0.99	531.1	543.5	596.2 ± 1.0	
5	85–100	0.08633	0.5396	0.93	533.8	546.6	598.8 ± 1.0	
6	60–100	0.086555	0.528	0.95	535.1	547.4	599.0 ± 0.9	

Note: (1–3) Sample 2/02, (4–6) sample S24. Isotope analysis was made on a multichannel Finnigan MAT-261 mass-spectrometer. Experimental data were processed with PbDAT and Isoplot programs.

*IF 2h.

large-scale magmatism, which was completed by folding 590 Ma ago. New data also confirm that the listwaenite–beresite complex of gold-bearing metasomatites and the commercial gold–quartz mineralization of the Karalon–Tallaya ore cluster are younger than the Early Vendian.

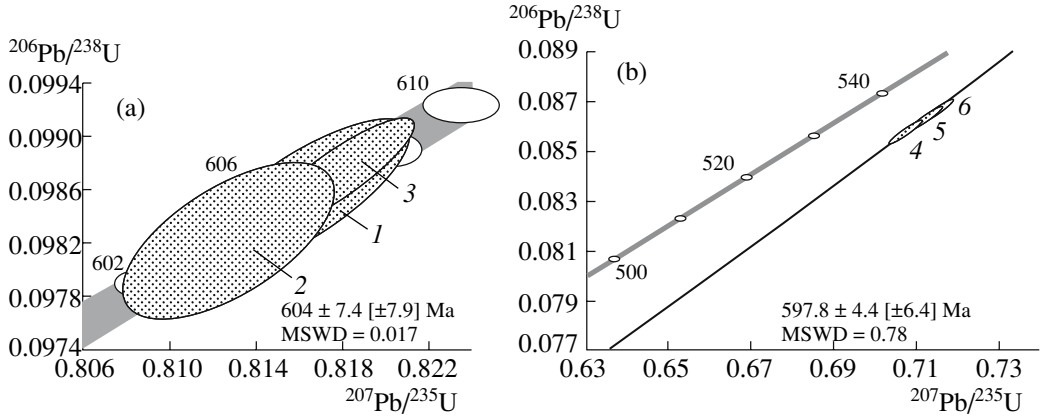

Fig. 2. Concordia diagram for (a) gabbroids of the Tallaya Complex and (b) granites of the Padora Complex. (*1–6*) Ordinal numbers are as in Table 2.

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