Research Advances

New Discovery of ~2.65 Ga Tonalitic Gneiss in the Southern Jilin Province, China

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Objective

The North China Craton (NCC) is almost continuously widespread TTGs of 3.8–2.5 Ga, and the intrusive peak appears at ~2.53 Ga, indicating that the Neoarchean is the most important period of continental growth in the NCC (Wan Yusheng et al., 2017). Recently studies reveal that the TTGs were formed during ~2.7 Ga and 2.6–2.5 Ga in southern Jilin Province, NE of the NCC (Wang Chaoyang et al., 2017; Guo et al., 2017), whereas 2.7–2.6 Ga magmatism is scarce. In this paper, we first report the ~2.65 Ga tonalitic gneiss in the north of Baishan City. Combined with previous geological results, the newly discovered tonalitic gneiss together makes up a complete record of 2.7–2.5 Ga magmatism in southern Jilin Province, which has important significance for the early crustal evolution of the NCC.

Methods

Rock samples were collected from tonalitic gneiss near Shangqing Village (126°26′30″E, 42°02′20″N), north of Baishan City. Samples were crushed and zircons were separated at the Langfang Regional Geological Survey Institute in Hebei Province, China. The internal structure of zircons was revealed with the cathodoluminescence imaging. Zircon U-Pb isotopic dating was conducted by LA-ICP-MS at the Key Laboratory of Mineral Resources Evaluation in Northeast Asia, Ministry of Land and Resources, Jilin University, Changchun, China. Zircon in situ Lu-Hf isotope analysis was performed by LA-MC-ICP-MS at the Laboratory of Isotope Geology, Tianjin Institute of Geology and Mineral Resources, Tianjin, China. Whole-rock geochemical analyses were undertaken at ALS Chemex, Guangzhou, China.

Results

The Shangqing tonalitic gneiss is mainly composed of plagioclase (~60%), quartz (~25%), biotite (~10%), and hornblende (~5%). Zircons selected from it are euhedral to subhedral columnar ranging from 100 to 190 μm in diameter. They generally display oscillatory zoning, consistent with a magmatic origin, and some zircons developed dark structureless rims. Zircon U-Pb dating data can be obviously classified into three groups (Fig. 1). One group has Th/U ratios of 0.50–1.00 and with $^{207}Pb/^{206}Pb$ ages ranging from 2675–2616 Ma, which obtained a concordant age of 2645±4 Ma (MSWD=0.01), representing the crystallization age of the tonalite. One group has Th/U ratios of 0.69–0.78 and with $^{207}Pb/^{206}Pb$ ages of 2706–2698 Ma, which obtained a concordant age of 2700±13 Ma (MSWD=0.01), suggesting that they could be captured zircons. Besides, one analysis from the dark rim displays younger apparent $^{207}Pb/^{206}Pb$ age (2514±19 Ma) and lower Th/U ratios (0.43), representing later metamorphism or anatexis events. The tonalitic gneisses are rich in SiO_2, Al_2O_3, Na_2O and CaO, and they belong to metaluminous and medium-K calc-alkaline series. They are rich in LREEs and depleted in HREEs, HFSEs (Nb, Ta, Ti) and P. Moreover, the Shangqing tonalitic gneiss has positive $\varepsilon_{Hf}(t)$ values and old Hf model ages, indicating that the primary magma could be derived from partial melting of ancient basaltic materials.

Conclusions

Our new research on the Shangqing tonalitic gneisses is the first identified ~2.65 Ga granitic magmatism in southern Jilin Province, which is relatively rare in the NCC. Besides, some captured zircons with ~2.7 Ga concordant age indicate that this region probably has undergone early Neoarchean magmatism. Lu-Hf isotope analyses indicate that the magma was derived from partial melting of basaltic materials. This result contributes to the research on early crustal evolution of the NCC.

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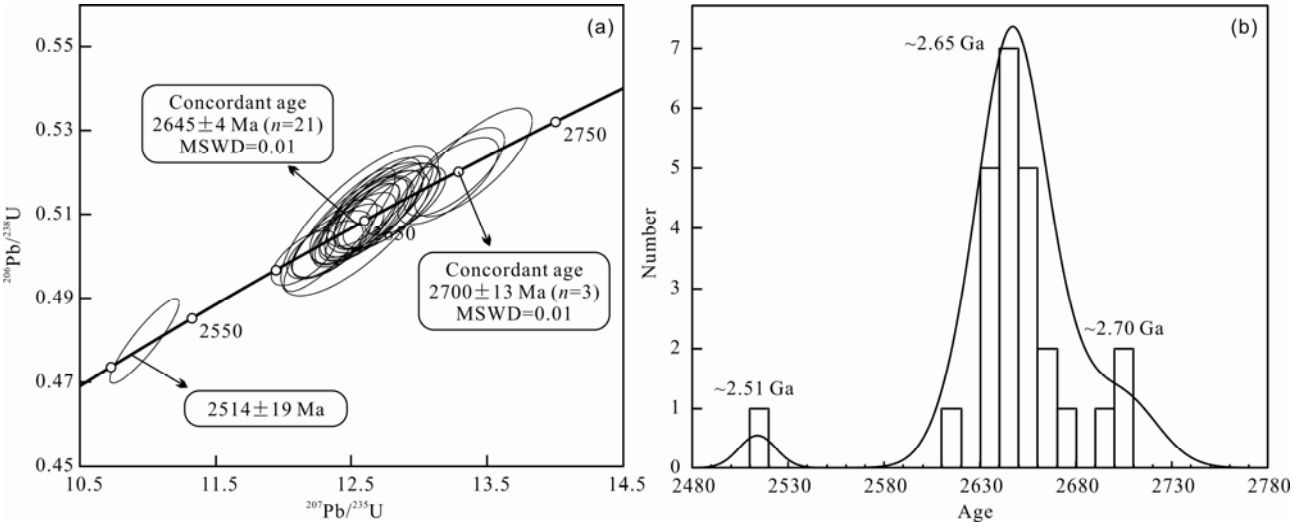

Fig. 1. Zircon U-Pb concordia diagram (a) and age histogram diagram (b) for the Shangqing tonalitic gneiss.

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Appendix 1 LA–ICP–MS zircon U-Pb isotopic dating data for the Shangqing tonalitic gneiss in the north of Baishan City, Jilin Province

Sample No.	Th (ppm)	U (ppm)	Th/U Ratio	$^{207}Pb/^{206}Pb$ Ratio	1σ	$^{207}Pb/^{235}U$ Ratio	1σ	$^{206}Pb/^{238}U$ Ratio	1σ	$^{207}Pb/^{206}Pb$ Age(Ma)	1σ	$^{207}Pb/^{235}U$ Age(Ma)	1σ	$^{206}Pb/^{238}U$ Age(Ma)	1σ
1	30	43	0.68	0.17854	0.00316	12.46973	0.21999	0.50534	0.00587	2639	29	2640	17	2637	25
2	47	47	1.00	0.17611	0.00296	12.14924	0.19585	0.49965	0.00534	2616	28	2616	15	2612	23
3	26	40	0.65	0.17975	0.00363	12.62138	0.26097	0.50917	0.00763	2650	33	2652	20	2653	33
4	84	197	0.43	0.16560	0.00235	10.97491	0.20847	0.47991	0.00822	2514	19	2521	18	2527	36
5	24	37	0.67	0.17836	0.00368	12.30558	0.23053	0.50150	0.00563	2639	34	2628	18	2620	24
6	30	41	0.72	0.17797	0.00313	12.35229	0.24100	0.50298	0.00646	2635	30	2632	18	2627	28
7	26	31	0.82	0.17835	0.00341	12.37643	0.25530	0.50430	0.00771	2639	32	2633	19	2632	33
10	14	22	0.63	0.18024	0.00389	12.69631	0.30855	0.51063	0.00803	2655	35	2657	23	2659	34
12	31	43	0.72	0.18244	0.00316	12.89626	0.24450	0.51320	0.00666	2675	29	2672	18	2670	28
13	73	75	0.97	0.17823	0.00361	12.41264	0.33570	0.50635	0.01197	2637	34	2636	25	2641	51
15	34	37	0.91	0.17967	0.00576	12.55995	0.47358	0.50849	0.01457	2650	53	2647	36	2650	62
16	28	37	0.75	0.18568	0.00402	13.21270	0.30421	0.51796	0.00844	2706	36	2695	22	2691	36
17	29	35	0.82	0.17975	0.00360	12.54370	0.25574	0.50768	0.00793	2650	33	2646	19	2647	34
18	27	38	0.72	0.17892	0.00362	12.57550	0.31311	0.50873	0.00854	2643	34	2648	23	2651	37
19	31	45	0.68	0.17947	0.00314	12.54753	0.22707	0.50746	0.00634	2648	28	2646	17	2646	27
20	50	64	0.78	0.17964	0.00271	12.58036	0.22223	0.50817	0.00743	2650	26	2649	17	2649	32
21	30	44	0.69	0.18590	0.00403	13.40012	0.35280	0.52236	0.01053	2706	36	2708	25	2709	45
22	24	31	0.78	0.18501	0.00435	13.25858	0.30253	0.52013	0.00861	2698	39	2698	22	2700	37
23	31	45	0.69	0.18080	0.00352	12.79679	0.29323	0.51208	0.00820	2660	32	2665	22	2666	35
24	31	62	0.50	0.18000	0.00314	12.71199	0.25624	0.51116	0.00756	2653	30	2659	19	2662	32
25	23	33	0.71	0.18081	0.00427	12.76028	0.31703	0.51192	0.00840	2660	39	2662	23	2665	36
26	31	45	0.70	0.17934	0.00356	12.64710	0.31676	0.51062	0.00960	2647	33	2654	24	2659	41
27	40	56	0.72	0.17919	0.00377	12.66550	0.28224	0.51293	0.00863	2645	35	2655	21	2669	37
28	35	44	0.80	0.18010	0.00382	12.73447	0.29838	0.51274	0.00909	2654	35	2660	22	2668	39
30	35	42	0.83	0.17893	0.00354	12.56415	0.28673	0.50815	0.00875	2643	33	2648	22	2649	37