Research Advances

New Zircon U-Pb Age of Granodiorite from the Shayikenbulake Be Deposit in Altay, Xinjiang and its Significance

LI Qiang*, YANG Fuquan and YANG Chengdong

Key Laboratory of Metallogeny and Mineral Assessment, Ministry of Land and Resources, Institute of Mineral Resources, Chinese Academy of Geological Sciences, Beijing 100037, China

Objective

Intrusive rocks are widely distributed in Altay, Xinjiang, and appear in every structural belt. The rocks are mainly granite (Song Peng et al., 2017), which formed from 523 Ma to 202 Ma and can be divided into five periods: 479–421 Ma, 410–370 Ma, 368–313 Ma, 300–252 Ma and 247–202 Ma. However, intrusive rocks earlier than the Ordovician are rarely found. The small-scale low-grade metamorphic granite intruded in the Kanasi Group is the oldest intrusion reported up to now, which is the only one formed in the Early Cambrian (523±19 Ma, Liu Yuan et al., 2013). Few Cambrian intrusions limit the study of early magmatic-tectonic evolution in Altay. Medium-fine-grained granodiorite is exposed widely in the Shayikenbulake deposit of Central Altay, and occurs as batholith. It formed in the Early Cambrian indicated by U-Pb dating, and is an ideal intrusion for studying Cambrian magmatic-tectonic events in Altay.

Method

The medium-fine-grained granodiorite sample (SYKAGE-1; 47°32′02″N, 89°35′12″E) for zircon U-Pb dating has a massive structure and medium-fine-grained palimpsest granitic texture, with grey color. The sample separation and zircon selection are accomplished in the Laboratory of Hebei Institute of Regional Geology and Mineral Resources Survey. Zircon sample mount and cathodoluminescence (CL) imaging were undertaken at the Beijing Geoanalysis Co., Ltd. Zircons U-Pb dating was undertaken at the Analytikjena Plasma Quant MS Elite ICP-MS in Beijing Createch Testing Technology Co., Ltd. Helium was applied as a carrier gas. Argon was used as the make-up gas and mixed with the carrier gas via a T-connector before entering the ICP. Each analysis incorporated a background acquisition of approximately 15 s (gas blank) followed by 45 s data acquisition from the sample. Zircon GJ1 was used as external standard for U-Pb dating, and was analyzed twice every 5–10 analyses. Time-dependent drifts of U-Th-Pb isotopic ratios were corrected using a linear interpolation (with time) according to the variations of GJ1. Concordia diagrams and weighted mean calculations were made using Isoplot.

Results

Zircons from the medium-fine-grained granodiorite are transparent or translucent with an adamantine luster. The majority of zircons are euhedral-subhedral, long prismatic and bipyramidal in shape and have a prolate axis length of 75–159 μm, with length/width ratios of between 1.5:1 and 3:1. CL images reveal well-developed oscillatory zoning for most zircons. The concentrations of Th and U within 20 zircons are 31.00–758.52 ppm, and 93.39–2044.53 ppm (Appendix 1), yielding Th/U ratios greater than 0.1 (0.11–0.78) except of spot 20, indicative of a magmatic origin. Twelve zircons yielded a consistently narrow range of $^{206}Pb/^{238}U$ ages (524.4–533.6Ma), defining a weighted mean age of 531±6.3 Ma (MSWD=0.1). In the concordia diagram, the 12 data plot along or slightly away from the concordia (Fig. 1). Given this result, we consider 531±6.3 Ma to represent the timing of crystallization of the granodiorite. The other eight zircons gave $^{206}Pb/^{238}U$ ages of 738.1–989.5 Ma, and showed well-developed oscillatory zoning in CL images, indicative of remnant magmatic zircons that were inherited or captured from older unites.

Conclusion

Both the medium-fine-grained granodiorite in Shayikenbulake deposit and the metamorphic granite intruded in the Kanasi Group formed in the Early Cambrian, while the former has a larger scale and is the oldest published intrusion in Altlay now, indicative of magmatic activity in the Early Cambrian. Discovery of

* Corresponding author. E-mail: liqiangcags@163.com

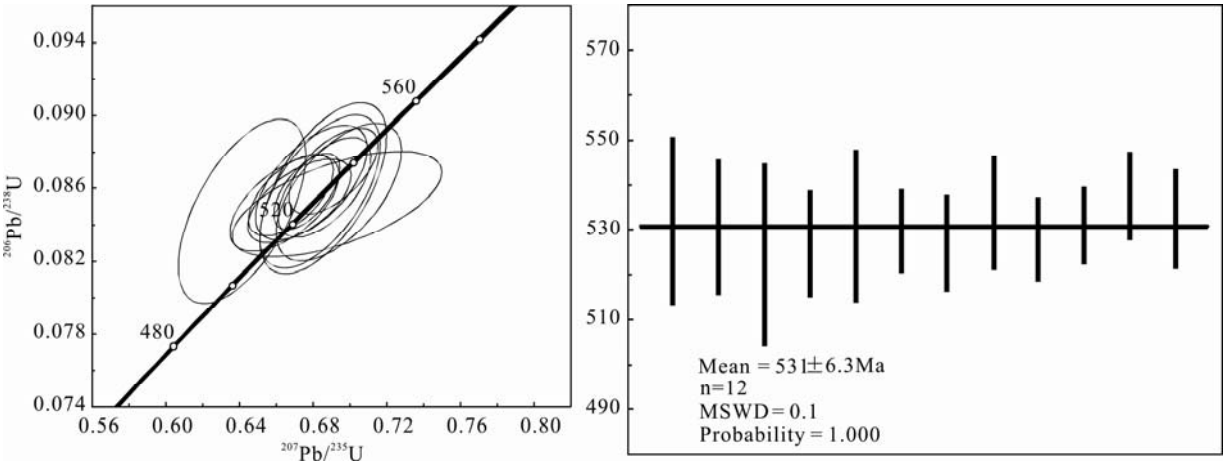

Fig. 1. Zircon LA-ICP-MS U-Pb concordia diagrams of medium-fine-grained granodiorite from Shayikenbulake deposit.

this period of granite is of great significance for the study of the tectonic evolution of Altay. It's a consistent view that Altay was in subduction environment in the Early–Middle Devonian. However, the beginning of the subducion is not well limited. According to a zircon Pb-Pb age (505 Ma) for a felsic lava, Windley et al. (2002) suggested that a continental arc was built on the southern margin of the central Altay terrane. The medium-fine-grained granodiorite in this paper formed in the Early Cambrian (531Ma), and its geochemistry data (unpublished) show characteristics of arc granite, suggesting the Early Cambrian tectonic setting of Central Altay could be a passive continental margin. This achievement presents important new clue to tectonic evolution of Altay.

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Appendix 1 Zircon LA-ICP-MSU-Pb isotopic data for the medium-fine-grained granodiorite from Shayikenbulake deposit

Spot	Concentration (ppm)			Isotope ratios						Apparent ages (Ma)					
	Pb	U	Th	$^{206}Pb/^{238}U$	1σ	$^{207}Pb/^{206}Pb$	1σ	$^{207}Pb/^{235}U$	1σ	$^{206}Pb/^{238}U$	1σ	$^{207}Pb/^{206}Pb$	1σ	$^{207}Pb/^{235}U$	1σ
1	51.64	306.93	38.19	0.162812	0.003910	0.068234	0.001100	1.536512	0.039620	972.4	21.7	875.9	33.3	945.1	15.9
2	16.53	178.33	55.95	0.085990	0.003090	0.058318	0.002340	0.685255	0.022979	531.8	18.3	542.6	88.9	529.9	13.8
3	14.40	139.41	109.04	0.085779	0.002491	0.058781	0.001810	0.693440	0.022468	530.5	14.8	566.7	66.7	534.9	13.5
4	88.87	894.70	632.20	0.084748	0.003339	0.055293	0.001655	0.641143	0.022808	524.4	19.8	433.4	66.7	503.0	14.1
5	63.62	364.65	96.53	0.165899	0.003878	0.069901	0.001557	1.599931	0.042564	989.5	21.4	925.6	46.3	970.2	16.6
6	8.85	93.39	47.08	0.085137	0.001916	0.058707	0.002748	0.692722	0.037472	526.7	11.4	566.7	101.8	534.4	22.5
7	77.77	867.39	271.07	0.085817	0.002779	0.057694	0.000987	0.683301	0.021660	530.8	16.5	516.7	37.0	528.8	13.1
8	27.73	307.56	112.82	0.085626	0.001473	0.056542	0.001381	0.667908	0.014954	529.6	8.7	472.3	53.7	519.4	9.1
9	22.17	236.39	120.22	0.085168	0.001734	0.056545	0.001602	0.664345	0.019594	526.9	10.3	472.3	95.4	517.3	12.0
10	130.36	1565.20	160.16	0.086302	0.002072	0.056761	0.000908	0.678932	0.019928	533.6	12.3	483.4	30.6	526.1	12.1
11	30.06	185.31	130.05	0.140827	0.002827	0.066527	0.001482	1.295054	0.033804	849.3	16.0	833.3	50.9	843.5	15.0
12	30.90	360.87	73.49	0.085300	0.001517	0.056937	0.001236	0.672598	0.018586	527.7	9.0	500.0	80.5	522.3	11.3
13	52.28	313.30	64.69	0.163570	0.002785	0.071309	0.001307	1.610697	0.030986	976.6	15.4	966.4	37.8	974.4	12.1
14	113.71	607.51	408.09	0.163004	0.002810	0.068859	0.000873	1.552798	0.029830	973.4	15.6	894.4	21.3	951.6	11.9
15	110.65	808.65	303.07	0.129307	0.002907	0.065947	0.000977	1.176963	0.025784	783.9	16.6	805.6	31.5	789.9	12.0
16	184.39	2044.53	758.52	0.085815	0.001380	0.057024	0.000868	0.676277	0.011891	530.7	8.2	500.0	33.3	524.5	7.2
17	93.91	525.80	253.64	0.163168	0.003255	0.071330	0.001265	1.609073	0.040274	974.4	18.0	968.5	39.8	973.7	15.7
18	39.53	427.90	177.87	0.086952	0.001563	0.057483	0.001035	0.690804	0.016147	537.5	9.3	509.3	36.1	533.3	9.7
19	102.72	1165.38	330.47	0.086068	0.001812	0.057616	0.000742	0.685930	0.016593	532.2	10.8	516.7	27.8	530.4	10.0
20	55.83	464.19	31.00	0.121304	0.002221	0.065614	0.001020	1.098474	0.021204	738.1	12.8	794.4	33.3	752.6	10.3