Research Advances

First Report of Zircon U-Pb Chronology and Hf Isotope Evidence of the Heluositan Group Granulite in West Kunlun, Xinjiang

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Objective

As the uplift belt on the southern margin of the Tarim block, the Tiekelike block consists mainly of a set of Precambrian metamorphic rocks with granulite and gneisses. The Heluositan group-complex is the most ancient rock series in the area, and is a key area for studying the formation and evolution of the Precambrian basement of the Tarim craton. LA-ICP-MS zircon U-Pb dating and Hf isotopic analysis of granulite in this area provide new evidence for revealing the formation and evolution of the Precambrian basement in the Tarim Basin.

Methods

Zircon U-Pb isotopic dating was performed using the LA-ICP-MS in the State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences (Wuhan). The laser ablation system adopted the 193 mm Geolsa 2005 and the ICP-MS used the Agilent 7700a. Helium and argon were used to be the carrier gas and compensation gas, respectively, in order to adjust the sensitivity. The adopted laser diameter was 32 μm, and the period of analysis consists of blank signal (20 s) and analysis signal (35 s).

In situ Hf isotope ratio analysis of zircon by LA-MC-ICPMS was conducted using a Neptune Plus MC-ICP-MS (Thermo Fisher Scientific, Germany) in combination with a Geolas 2005 excimer ArF laser ablation system (Lambda Physik, Go¨ttingen, Germany) that was hosted at the State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences (Wuhan).

Results

In this work, a total of eight zircons were selected for peridotite pyroxene, and zircon age and Hf isotopes were all inherited from zircons in the core. The zircons inherited by the core have obvious oscillating zoning with an average Th/U of 0.61 (Appendix 1), and zircon REE maps show a typical magmatic. The $^{207}Pb/^{206}Pb$ weighted average age of 3145±22 Ma (MSWD=1.11) represents the age of formation of the Heluositan group-complex (Fig. 1a). The Lu-Hf isotopic analysis shows that the $^{176}Hf/^{177}Hf$ ratio was 0.28088–0.28099 with an average of 0.28094 (Appendix 2). The $\varepsilon_{Hf}(t)$ and T_{DM} were calculated from the above intersection point of 3185 Ma from 4.0 to 6.7 with an average of 5.4 and T_{DM2} of 3128–3238 Ma, with an average of 3199 Ma. The age of the second-stage model is consistent with the age of formation in the error range. The age $\varepsilon_{Hf}(t)$ shows that it basically lags behind the depleted mantle line (Fig. 1b), indicating that the host rocks of these core zircons are about 3199 Ma directly from the depleted mantle.

Conclusion

The Early Precambrian was an important period of the formation of the craton in the world and was extremely important for understanding the formation and crustal growth of the continent. The Middle Paleoproterozoic granulite series discovered in the Tikelike region on the southern margin of the Tarim Basin is Tarim craton one of the oldest rock formations ever discovered. The $^{207}Pb/^{206}Pb$ weighted average age of peridotite pyroxene zircon is 3145±22 Ma, corresponding to T_{DM2} 3128–3238Ma, with an average of 3199 Ma. At this time, the zircon age and two-stage Hf model age are close, which represents the age of crust source. In conclusion, the crustal growth event happened in middle Tarim at about 3199 Ma in the Tarim craton, corresponding to the 3.2 Ga crustal growth events in the world. This will provide new constraints on the evolution of the crust in the early continental China in northwestern China and even throughout China (Bontognali, 2013; Kranendonk, 2015; Wang Yuxi et al., 2017）.

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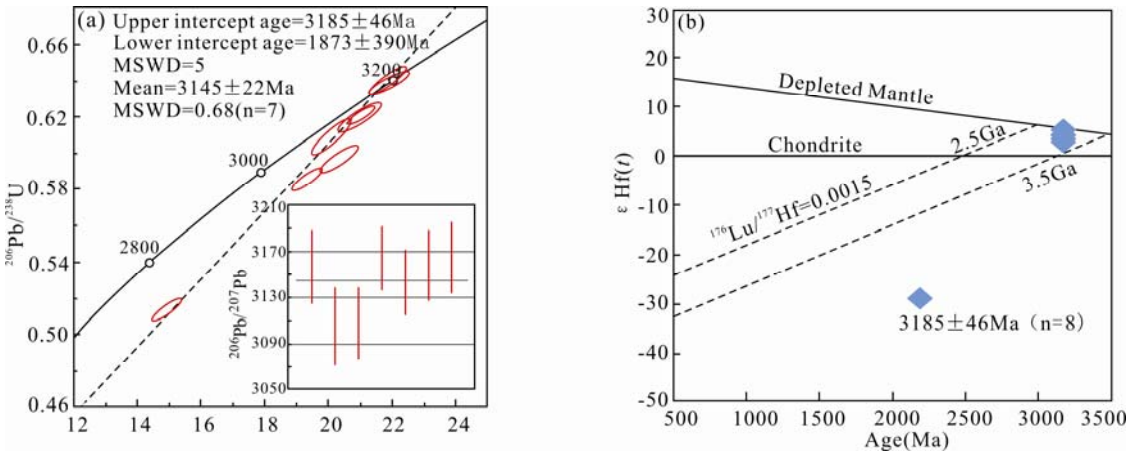

Fig. 1. Diagrams of zircon U-Pb age (a) and Hf isotope (b).

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Appendix 1 LA-ICP-MS U-Pb data of the Heluositan group-complex in west Kunlun, Xinjiang

Sample No.	Th/U	Isotopic ratio						Age (Ma)						Concordance
		$^{207}Pb/^{206}Pb$	1σ	$^{207}Pb/^{235}U$	1σ	$^{206}Pb/^{238}U$	1σ	$^{207}Pb/^{206}Pb$	1σ	$^{207}Pb/^{235}U$	1σ	$^{206}Pb/^{238}U$	1σ	
A0233-1	0.61	0.2457	0.0049	21.0191	0.4313	0.6197	0.0054	3157	32	3139	20	3109	21	99%
A0233-2	0.78	0.2378	0.0042	20.0839	0.4130	0.6095	0.0065	3105	34	3095	20	3068	26	99%
A0233-3	0.39	0.2095	0.0041	14.9176	0.3156	0.5140	0.0044	2902	32	2810	20	2674	19	95%
A0233-4	1.06	0.2383	0.0038	19.3473	0.3258	0.5860	0.0042	3108	31	3059	16	2973	17	97%
A0233-5	0.37	0.2468	0.0043	21.8135	0.3750	0.6391	0.0050	3165	27	3175	17	3185	20	99%
A0233-6	0.51	0.2436	0.0042	20.9266	0.3668	0.6200	0.0042	3144	28	3135	17	3110	17	99%
A0233-7	0.82	0.2459	0.0047	20.3155	0.3892	0.5968	0.0048	3158	30	3106	19	3017	19	97%
A0233-8	0.35	0.2469	0.0048	21.8400	0.4247	0.6382	0.0050	3165	31	3177	19	3182	20	99%
A0233-9	0.34	0.1460	0.0027	8.8004	0.1751	0.4343	0.0042	2299		2318	18	2325	19	99%
A0233-10	0.24	0.1247	0.0021	6.3568	0.1178	0.3672	0.0031	2024	30	2026	16	2016	15	99%
A0233-11	0.59	0.1487	0.0023	8.9043	0.1475	0.4315	0.0034	2331	26	2328	15	2312	15	99%
A0233-12	0.70	0.1496	0.0022	9.0027	0.1364	0.4336	0.0027	2343	26	2338	14	2322	12	99%
A0233-13	0.58	0.1515	0.0022	9.3338	0.1388	0.4441	0.0028	2363	24	2371	14	2369	13	99%
A0233-14	0.51	0.1480	0.0021	8.8421	0.1298	0.4309	0.0028	2324	24	2322	13	2310	13	99%
A0233-15	0.70	0.1484	0.0021	9.0002	0.1407	0.4367	0.0033	2328	25	2338	14	2336	15	99%
A0233-16	0.69	0.1496	0.0022	9.1427	0.1398	0.4405	0.0030	2343	25	2352	14	2353	13	99%

Appendix 2 Hf data of the Heluositan group-complex in west Kunlun, Xinjiang

Sample No.	$^{176}Hf/^{177}Hf$	1σ	$^{176}Lu/^{177}Hf$	1σ	$^{176}Yb/^{177}Hf$	1σ	Hf	Yb	Lu	Age (Ma)	$\varepsilon_{Hf}(0)$	1σ	$\varepsilon_{Hf}(t)$	1σ	T_{DM1}	T_{DM2}	F (Lu/Hf)
A0233-1-1	0.28090	0.00001	0.00053	0.00000	0.01209	0.00008	11138	225	44	3157	-66.1	0.7	4.1	0.9	3220	3245	-0.98
A0233-1-2	0.28097	0.00001	0.00112	0.00002	0.02527	0.00036	11413	482	96	3105	-63.6	0.7	4.1	0.9	3175	3203	-0.97
A0233-1-3	0.28089	0.00001	0.00050	0.00000	0.01186	0.00010	10248	201	38	2905	-66.4	0.7	-2.0	0.8	3231	3366	-0.98
A0233-1-4	0.28099	0.00002	0.00100	0.00002	0.02285	0.00042	11002	425	84	3108	-63.1	0.8	4.9	0.9	3147	3163	-0.97
A0233-1-5	0.28088	0.00001	0.00052	0.00001	0.01153	0.00022	10847	205	42	3165	-66.9	0.7	3.5	0.9	3249	3284	-0.98
A0233-1-6	0.28096	0.00002	0.00097	0.00003	0.02255	0.00079	10623	408	79	3144	-64.1	0.9	4.8	1.1	3181	3196	-0.97
A0233-1-7	0.28097	0.00002	0.00084	0.00002	0.02142	0.00042	9856	345	61	3158	-63.6	0.7	5.9	0.9	3152	3150	-0.97
A0233-1-8	0.28095	0.00001	0.00102	0.00004	0.02369	0.00109	9978	376	74	3165	-64.3	0.7	5.0	0.9	3195	3207	-0.97
A0233-1-9	0.28119	0.00001	0.00035	0.00001	0.00856	0.00011	13051	183	34	2299	-56.1	0.7	-5.2	0.8	2831	3054	-0.99
A0233-1-10	0.28125	0.00002	0.00041	0.00000	0.00982	0.00006	12652	205	38	2024	-53.8	0.7	-9.2	0.9	2748	3050	-0.99
A0233-1-11	0.28121	0.00001	0.00043	0.00000	0.01137	0.00009	10109	193	33	2331	-55.3	0.7	-3.8	0.8	2805	3002	-0.99
A0233-1-12	0.28124	0.00001	0.00052	0.00000	0.01465	0.00014	8671	209	34	2343	-54.2	0.7	-2.6	0.9	2772	2949	-0.98
A0233-1-13	0.28130	0.00001	0.00121	0.00002	0.03277	0.00063	9215	496	82	2363	-52.0	0.7	-0.9	0.9	2733	2876	-0.96
A0233-1-14	0.28125	0.00002	0.00075	0.00000	0.02004	0.00007	9470	316	53	2324	-53.7	0.7	-2.8	0.9	2767	2945	-0.98
A0233-1-15	0.28122	0.00002	0.00080	0.00000	0.02150	0.00015	8197	296	50	2328	-54.8	0.8	-3.9	0.9	2813	3008	-0.98
A0233-1-16	0.28125	0.00001	0.00071	0.00001	0.01880	0.00037	9480	302	51	2343	-54.0	0.7	-2.6	0.8	2775	2950	-0.98