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Research Advances

The Redefinition on Formation Time of the Lapeiquan Group in the Hongliugou Area, North Altyn: Constrains from New Detrital Zircon LA-ICP-MS U-Pb Ages

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Objective

The Early Paleozoic tectonic events such as oceanic subduction and collision-orogeny in the North Altyn have been extensively studied. The Lapeiquan Group, distributed in the Hongliugou ophiolite mélange belt (Fig. 1), was interpreted to form along with the Ordovician Caledonian tectonic events. Based on few evidence of macrofossils, the formation age of the Lapeiquan Group was the Late Ordovician, which remains controversial. This work reports initially the detrital zircon LA-ICP-MS U-Pb ages of the sandstone sample from this group, the youngest U-Pb ages enable us to redefine the formation age of the Lapeiquan Group, further provide new basic information for studies on Early Paleozoic tectonic evolution in the North Altyn.

Methods

Based on detailed geological field survey in the Hongliugou area, we selected fresh coarse sandstone samples from the Lapeiquan Group for subsequent zircon selection and U-Pb dating. Zircons were separated using standard heavy liquid, magnetic techniques and hand picking at the Langfang Regional Geological Survey Institute in Hebei Province, China. Cathodoluminescence images and LA-ICP-MS U-Pb dating of detrital zircons were both carried out at the State Key Laboratory of Lithospheric Evolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, China. U-Th-Pb isotopic ratios were calculated using the Glitter program. Data reduction was conducted using Isoplot.

Results

The Lapeiquan Group is generally divided into three segments from the bottom up based on the dominant lithology: volcanic-rock member, clastic-rock member and carbonate-rock member. The sandstone sample (sample No. HLG-03) used for U-Pb dating in this study was collected from the clastic-rock member in Qiashikansayi canal, Hongliugou area (Fig. 1). The sample HLG-03 is greywacke with matrix proportion >25%. Quartz grains yield 35% of the whole grains, while feldspars and lithic fragments yield proportions of 30% and 35%, respectively. Generally speaking, most grains are characterized by poor sorting and roundness, indicative of the immature nature and short transportation distance.

This sandstone sample yields 93 effective detrital zircon U-Pb ages in a wide range from 393 Ma to 2080 Ma (Fig. 1c), with 90% of Paleozoic ages among the whole data. As a whole, it yields a most evident peak age of 475 Ma with several Precambrian ages distributing sporadically. It's noteworthy that this sandstone sample includes 15 youngest U-Pb ages (discordance from −7% to 10%) between 393 Ma and 436 Ma with a peak age of 430 Ma (Fig. 1d), i.e., ages younger than Ordovician, which occupies 16% of the whole ages. The zircons yielding these young ages mostly present clear oscillatory zoning (Fig. 1e) and have wholly Th/U ratios of greater than 0.1, indicative of their magmatic origin.

Conclusions

The sandstone sample collected from the clastic-rock member of the Lapeiquan Group, North Altyn, yields a wide age ranging from 393 Ma to 2080 Ma with 15 young U-Pb ages between 393 Ma and 436 Ma, and CL images and Th/U ratios of the young zircons suggest their magmatic origin. Thus, the Lapeiquan Group must have formed after 393 Ma. In addition, it is inferred that the deposition time of the Lapeiquan Group is the Devonian or younger age but not the Late Ordovician.

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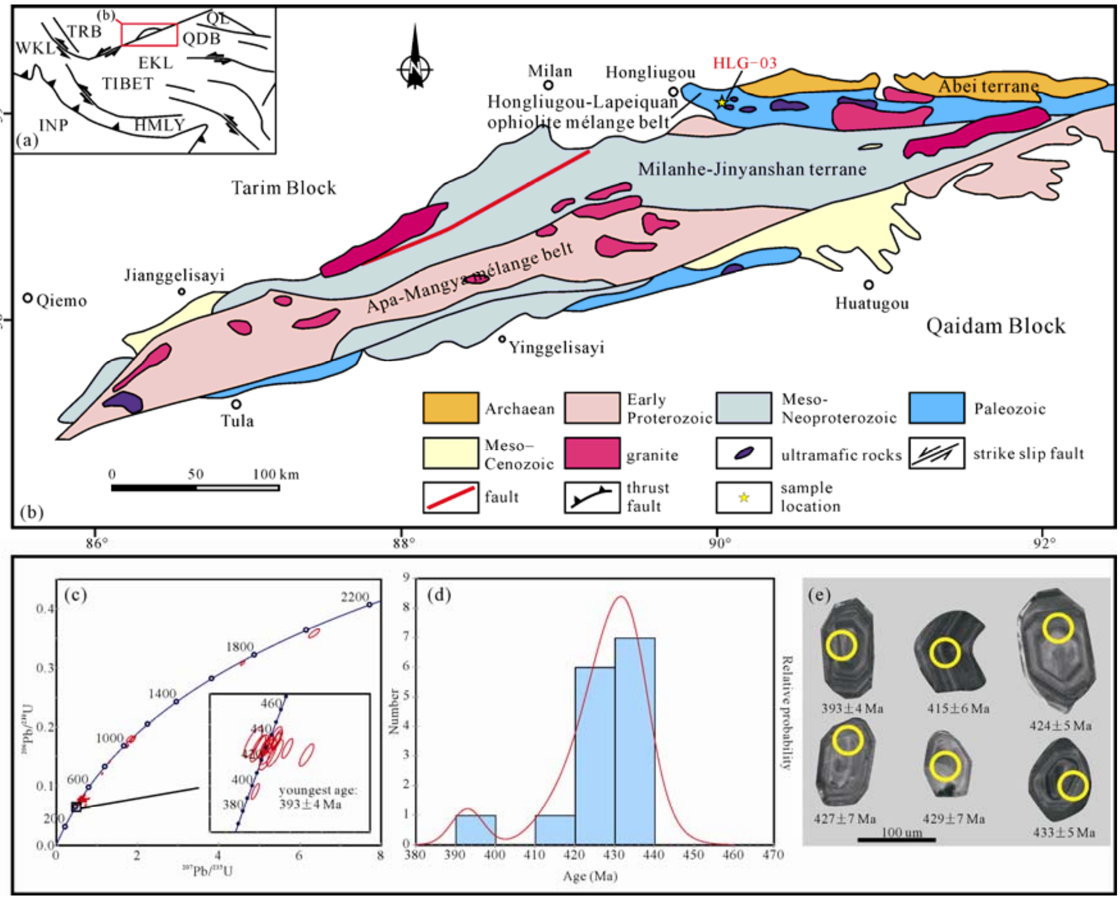

Fig. 1. (a) Generalized geological map of western China; (b) simplified geological map of the Altyn orogenic belt, showing the location of sample in this study; (c) concordia diagrams (one for whole age data, another for the ages younger than 440 Ma) of zircon U-Pb for the sandstone sample; (d-e) age spectra and cathodoluminescence images of the young zircons (younger than 440 Ma) from the sandstone sample, respectively.

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Appendix 1 Detrital zircon U-Pb dating result of the studied samples in the Lapeiquan Group

Sample No.	$^{232}Th/^{238}U$	Isotope ratios						Apparent ages (Ma)					
		$^{207}Pb/^{206}Pb$		$^{207}Pb/^{235}U$		$^{206}Pb/^{238}U$		$^{207}Pb/^{206}Pb$		$^{207}Pb/^{235}U$		$^{206}Pb/^{238}U$	
1	0.19	0.0581	0.0012	0.6259	0.0114	0.0782	0.0009	533	20	494	7	485	6
2	0.16	0.0676	0.0010	0.7221	0.0100	0.0775	0.0008	732	43	525	7	479	5
3	0.22	0.0552	0.0010	0.5985	0.0098	0.0786	0.0009	421	18	476	6	488	5
4	0.16	0.0574	0.0013	0.6114	0.0129	0.0773	0.0010	507	25	484	8	480	6
5	0.57	0.0598	0.0011	0.6712	0.0107	0.0814	0.0009	596	17	521	7	505	5
6	0.15	0.0567	0.0016	0.5753	0.0146	0.0735	0.0011	481	31	461	9	457	6
7	0.15	0.0571	0.0009	0.5991	0.0086	0.0761	0.0008	494	15	477	5	473	5
8	0.16	0.0580	0.0011	0.6129	0.0101	0.0766	0.0009	531	18	485	6	476	5
9	0.13	0.0584	0.0010	0.6023	0.0092	0.0748	0.0008	546	16	479	6	465	5
10	0.12	0.0512	0.0014	0.5476	0.0142	0.0776	0.0011	250	34	443	9	482	7
11	0.16	0.0572	0.0018	0.5517	0.0158	0.0700	0.0011	498	36	446	10	436	7
12	0.11	0.0678	0.0009	1.3126	0.0148	0.1404	0.0014	863	10	851	6	847	8
13	0.20	0.0557	0.0012	0.5333	0.0105	0.0695	0.0009	438	23	434	7	433	5
14	0.20	0.0592	0.0011	0.5945	0.0096	0.0729	0.0008	573	18	474	6	453	5
15	0.33	0.0576	0.0018	0.6395	0.0180	0.0806	0.0013	513	35	502	11	500	8
16	0.20	0.0555	0.0009	0.5774	0.0083	0.0755	0.0008	433	16	463	5	469	5
17	0.13	0.0602	0.0009	0.6350	0.0086	0.0765	0.0008	612	14	499	5	475	5
18	0.26	0.0678	0.0009	1.1309	0.0129	0.1211	0.0012	861	11	768	6	737	7
19	0.23	0.0563	0.0020	0.5989	0.0193	0.0772	0.0013	463	41	477	12	479	8
20	0.16	0.0541	0.0016	0.5316	0.0140	0.0713	0.0010	374	34	433	9	444	6
21	0.19	0.1287	0.0020	6.3544	0.0922	0.3582	0.0049	2080	11	2026	13	1974	23

Continued Appendix 1

Sample No.	$^{232}Th/^{238}U$	Isotope ratios						Apparent ages (Ma)					
		$^{207}Pb/^{206}Pb$		$^{207}Pb/^{235}U$		$^{206}Pb/^{238}U$		$^{207}Pb/^{206}Pb$		$^{207}Pb/^{235}U$		$^{206}Pb/^{238}U$	
22	0.21	0.0573	0.0013	0.6119	0.0126	0.0775	0.0010	503	24	485	8	481	6
23	0.21	0.0528	0.0018	0.5010	0.0158	0.0689	0.0011	319	42	412	11	429	7
24	0.20	0.0706	0.0012	0.7535	0.0117	0.0775	0.0009	744	51	526	9	477	5
25	0.15	0.0581	0.0013	0.5601	0.0112	0.0700	0.0009	533	23	452	7	436	5
26	0.15	0.0585	0.0009	0.5791	0.0080	0.0718	0.0007	549	14	464	5	447	4
27	0.10	0.0731	0.0011	0.7370	0.0098	0.0732	0.0008	724	44	497	7	450	4
28	0.13	0.0580	0.0010	0.5580	0.0082	0.0699	0.0007	528	16	450	5	435	4
29	0.14	0.0606	0.0013	0.5938	0.0111	0.0711	0.0009	626	21	473	7	443	5
30	0.14	0.0575	0.0009	0.5706	0.0084	0.0719	0.0008	512	16	458	5	448	5
31	0.14	0.0595	0.0011	0.6027	0.0098	0.0735	0.0008	585	18	479	6	457	5
32	0.11	0.0574	0.0009	0.5784	0.0084	0.0731	0.0008	506	15	463	5	455	5
33	0.14	0.0561	0.0012	0.5542	0.0106	0.0717	0.0009	455	23	448	7	446	5
34	0.05	0.0760	0.0010	1.7584	0.0214	0.1678	0.0017	1022	34	1004	8	996	9
35	0.12	0.0563	0.0012	0.5604	0.0107	0.0722	0.0009	465	22	452	7	449	5
36	0.17	0.0549	0.0013	0.5208	0.0110	0.0689	0.0009	407	26	426	7	429	5
37	0.10	0.1084	0.0009	4.5969	0.0313	0.3077	0.0027	1729	21	1727	6	1724	13
38	0.17	0.0567	0.0013	0.5613	0.0117	0.0718	0.0009	481	25	452	8	447	5
39	0.10	0.0559	0.0011	0.5578	0.0100	0.0724	0.0008	449	21	450	7	450	5
40	0.24	0.0545	0.0014	0.6038	0.0140	0.0803	0.0011	393	29	480	9	498	6
41	0.23	0.0600	0.0011	0.6972	0.0115	0.0843	0.0010	602	18	537	7	522	6
42	0.47	0.0628	0.0007	1.1613	0.0106	0.1342	0.0012	701	9	783	5	812	7
43	0.29	0.0548	0.0008	0.6092	0.0082	0.0807	0.0008	402	14	483	5	500	5
44	0.20	0.0565	0.0011	0.5559	0.0100	0.0714	0.0008	472	21	449	6	444	5
45	0.35	0.0561	0.0011	0.5998	0.0112	0.0776	0.0009	456	22	477	7	482	5
46	0.20	0.0586	0.0010	0.6477	0.0102	0.0802	0.0009	552	17	507	6	497	5
47	0.27	0.0529	0.0013	0.5947	0.0136	0.0816	0.0011	323	29	474	9	506	6
48	0.28	0.0573	0.0013	0.6184	0.0125	0.0784	0.0010	502	24	489	8	486	6
49	0.23	0.0567	0.0009	0.5980	0.0088	0.0765	0.0008	481	16	476	6	475	5
50	0.25	0.0640	0.0015	0.6862	0.0141	0.0779	0.0010	740	23	531	8	483	6
51	0.21	0.0578	0.0009	0.5963	0.0079	0.0749	0.0007	521	14	475	5	466	4
52	0.22	0.0569	0.0010	0.6048	0.0094	0.0771	0.0008	488	17	480	6	479	5
53	0.23	0.0566	0.0015	0.5842	0.0139	0.0749	0.0010	475	29	467	9	466	6
54	0.17	0.0636	0.0011	0.6629	0.0101	0.0756	0.0008	728	16	516	6	470	5
55	0.10	0.0559	0.0009	0.5966	0.0088	0.0774	0.0008	448	16	475	6	481	5
56	0.20	0.0621	0.0011	0.6584	0.0101	0.0769	0.0008	472	53	474	8	474	5
57	0.12	0.0581	0.0010	0.5743	0.0088	0.0717	0.0008	535	17	461	6	446	5
58	0.14	0.0655	0.0010	0.6665	0.0086	0.0738	0.0007	516	45	465	7	454	4
59	0.19	0.0564	0.0012	0.5975	0.0113	0.0768	0.0009	469	22	476	7	477	6
60	0.18	0.0774	0.0018	0.7244	0.0150	0.0679	0.0010	663	76	455	12	415	6
61	0.14	0.0642	0.0013	0.6084	0.0114	0.0688	0.0009	413	65	422	9	424	5
62	0.11	0.0570	0.0009	0.5761	0.0079	0.0733	0.0007	493	15	462	5	456	4
63	0.15	0.0561	0.0011	0.5772	0.0098	0.0747	0.0008	456	19	463	6	464	5
64	0.22	0.0561	0.0010	0.6001	0.0094	0.0777	0.0008	455	17	477	6	482	5
65	0.20	0.0740	0.0011	0.8023	0.0104	0.0787	0.0008	693	48	520	8	481	5
66	0.13	0.0583	0.0010	0.6038	0.0094	0.0751	0.0008	542	17	480	6	467	5
67	0.17	0.0570	0.0017	0.5650	0.0154	0.0719	0.0011	491	34	455	10	448	7
68	0.15	0.0554	0.0014	0.5838	0.0130	0.0765	0.0010	426	27	467	8	475	6
69	0.11	0.0758	0.0022	1.8754	0.0505	0.1795	0.0032	1090	27	1072	18	1064	17
70	0.30	0.0579	0.0017	0.6014	0.0157	0.0753	0.0011	526	32	478	10	468	7
71	0.12	0.0538	0.0014	0.5355	0.0125	0.0723	0.0010	361	29	435	8	450	6
72	0.11	0.0609	0.0011	0.5284	0.0083	0.0629	0.0007	636	17	431	6	393	4
73	0.19	0.0585	0.0014	0.5983	0.0134	0.0743	0.0010	547	26	476	8	462	6
74	0.24	0.0695	0.0017	0.7083	0.0157	0.0739	0.0011	427	88	448	13	452	6
75	0.10	0.0618	0.0012	0.6687	0.0116	0.0785	0.0009	667	19	520	7	487	5
76	0.28	0.0558	0.0013	0.5877	0.0126	0.0765	0.0010	443	26	469	8	475	6
77	0.17	0.0552	0.0014	0.5779	0.0133	0.0760	0.0010	418	28	463	9	472	6
78	0.04	0.0560	0.0009	0.6288	0.0094	0.0814	0.0009	454	16	495	6	505	5
79	0.13	0.0583	0.0011	0.6235	0.0108	0.0776	0.0009	542	19	492	7	481	5
80	0.19	0.0572	0.0013	0.5793	0.0115	0.0734	0.0009	500	23	464	7	457	5
81	0.12	0.0732	0.0022	1.8126	0.0505	0.1798	0.0033	1018	29	1050	18	1066	18
82	0.13	0.0577	0.0013	0.5980	0.0121	0.0753	0.0009	516	24	476	8	468	6
83	0.15	0.0564	0.0020	0.5746	0.0184	0.0739	0.0013	469	41	461	12	460	8
84	0.16	0.0506	0.0022	0.4858	0.0194	0.0697	0.0013	221	57	402	13	434	8
85	0.08	0.0568	0.0021	0.5318	0.0184	0.0680	0.0013	482	44	433	12	424	8
86	0.08	0.0589	0.0020	0.5543	0.0168	0.0683	0.0011	422	86	424	12	424	7
87	0.11	0.0565	0.0019	0.5341	0.0164	0.0686	0.0011	474	39	435	11	427	7
88	0.19	0.0631	0.0009	0.6286	0.0084	0.0723	0.0007	711	13	495	5	450	4
89	0.18	0.0574	0.0010	0.5664	0.0090	0.0716	0.0008	508	18	456	6	445	5
90	0.09	0.0535	0.0016	0.5099	0.0143	0.0691	0.0010	352	37	418	10	431	6
91	0.37	0.0558	0.0012	0.5324	0.0102	0.0692	0.0008	444	22	433	7	431	5
92	0.31	0.0631	0.0011	0.6553	0.0106	0.0754	0.0008	711	17	512	6	469	5
93	0.13	0.0764	0.0019	1.8753	0.0436	0.1780	0.0028	1106	23	1072	15	1056	15