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Research Advances

A ca. 2.2Ga Acidic Magmatic Event at the Northern Margin of the Yangtze Craton: Evidence from U-Pb Dating and Hf Isotope Analysis of Zircons from the Kongling Complex

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Objective

The Yangtze craton experienced Paleoproterozoic collisional orogeny at ca. 1.95–2.0 Ga and post-orogenic extensional events at ca. 1.85 Ga related to amalgamation of the Columbia (Nuna) supercontinent (Zhao and Cawood, 2012). A ca. 2.15 Ga suprasubduction zone ophiolitic mélange was recongized in the Archean-Paleoproterozoic Kongling Complex of the northern Yangtze craton (Han et al., 2017). However, the tectonic evolution in early Paleoproterozoic from 2.4 Ga to 2.2 Ga remains unclear. We report here the presence of a suite of Paleoproterozoic (2.2 Ga) granites in the Huangling dome, northern Yangtze craton, which may provide important insights into crustal growth processes in the craton prior to the assembly of Columbia.

Methods

The granite, which intruded into the ca. 2.9 Ga TTG gneiss, is exposed in the Taoyuan area of the northwest Huangling dome. Zircon grains from the granite were separated carefully by handpicking according to size, color, turbidity and shape. Prior to in situ U-Pb isotopic analyses, cathodoluminescence images of the zircons were obtained using a Qunanta 450 FEG scanning electron microscope connected to an Oxford SDD Inca X-Max 50 energy dispersive system and a Gantan Mono CL4+ CL system at the State Key Laboratory of Continental Dynamics (LCD), Northwest University. High spatial resolution, in situ U-Pb and Lu-Hf isotopic analyses of the zircon grains were also performed using the LA-ICP-MS and a Neptune Plus MC-ICP-MS in combination with a Geolas 2005 excimer ArF laser ablation system, respectively, at the LCD. Raw data were processed using the Glitter software. Concordia diagrams and weighted mean calculations were processed using the ISOPLOT program.

Results

Zircon grains from granite sample D51-7-2 are subhedral to euhedral in morphology, and commonly have a well-developed oscillatory zoning. Thorium (20–301 ppm) and U (21–181 ppm) concentrations yield moderate Th/U ratios (0.95–1.86) (Appendix 1), typical of an igneous origin. All 18 analyses yield apparent $^{207}Pb/^{206}Pb$ ages of 2181–2239 Ma with a weighted mean $^{207}Pb/^{206}Pb$ age of 2213±12 Ma (MSWD=0.34), which we interpret to be the emplacement age of the magmatic protolith (Fig. 1). Zircon Lu-Hf isotopic analysis shows that the granitoids have negative zircon $\varepsilon_{Hf}(t)$ values with an average of −7.27, and two-stage depleted mantle zircon Hf model ages (T_{DM2}) clustering around 2.8–3.2 Ga, indicative of the involvement of a significant Mesoarchean crustal

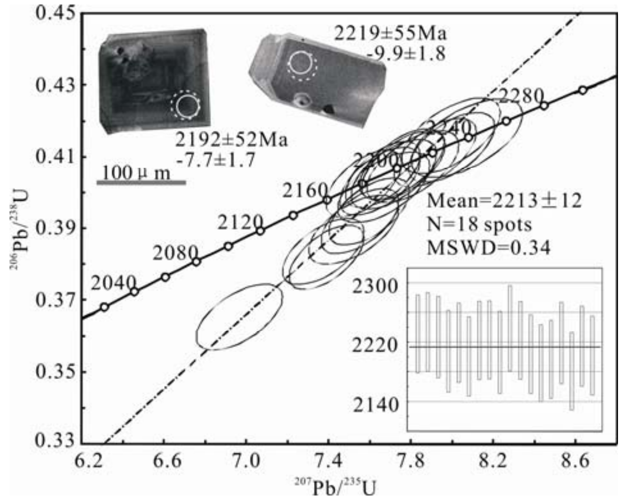

Fig. 1. Zircon U-Pb concordia diagrams from the granite sample.

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component in the primary magmas for the granites.

Conclusions

This study report here, for the first time, evidence of a 2.2 Ga granites in the northern Yangtze Block, which could be the source of the 2.2–2.1Ga inherited zircons from the sedimentary rocks in the nucleus of the Yangtze craton. The presence of 2.2Ga granites, together with the ~2.2 Ga arc-related gabbroic dikes (Lu Shansong et al., 2017), may provides important geological constraints for the occurrence of the early Paleoproterozoic subduction-collision. Comparison of magmatic events, as well as contemporary Kongling metasedimentary sequences, in the Yangtze Block with contemporaneous global events can helps to further constrain possible paleogeographic configurations.

Acknowledgements

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Appendix 1 Zircon LA-ICP-MS U-Pb geochronological data for the granite sample in the Yangtze Block

Sample No.	Th	U	Th/U	$^{207}Pb/^{206}Pb$		$^{207}Pb/^{235}U$		$^{206}Pb/^{238}U$		$^{207}Pb/^{206}Pb$		$^{207}Pb/^{235}U$		$^{206}Pb/^{238}U$	
	ppm	ppm		Ratio	±1σ	Ratio	±1σ	Ratio	±1σ	Age	±1σ	Age	±1σ	Age	±1σ
01	284	159	1.79	0.1403	0.0043	7.3910	0.1201	0.3819	0.0059	2231	52	2160	15	2085	28
02	103	75	1.37	0.1406	0.0044	7.9999	0.1382	0.4128	0.0065	2234	53	2231	16	2228	30
03	123	82	1.51	0.1400	0.0045	7.5238	0.1447	0.3898	0.0064	2227	55	2176	17	2122	30
04	30	28	1.05	0.1385	0.0045	7.6685	0.1486	0.4016	0.0066	2208	55	2193	17	2177	30
05	41	43	0.95	0.1394	0.0044	7.3727	0.1305	0.3836	0.0061	2220	54	2158	16	2093	28
06	87	67	1.31	0.1379	0.0043	7.7583	0.1366	0.4080	0.0065	2201	54	2203	16	2206	30
07	248	133	1.86	0.1396	0.0044	7.5994	0.1300	0.3947	0.0062	2223	53	2185	15	2145	29
08	268	152	1.76	0.1397	0.0043	7.5541	0.1254	0.3922	0.0061	2224	53	2179	15	2133	28
09	33	30	1.10	0.1384	0.0045	6.9681	0.1384	0.3653	0.0061	2207	56	2107	18	2007	29
10	20	21	0.95	0.1410	0.0048	8.0730	0.1790	0.4153	0.0073	2239	58	2239	20	2239	33
11	73	59	1.24	0.1397	0.0043	7.9185	0.1317	0.4112	0.0064	2223	52	2222	15	2221	29
12	41	43	0.97	0.1382	0.0043	7.7672	0.1341	0.4077	0.0064	2204	53	2204	16	2205	29
13	301	181	1.66	0.1372	0.0042	7.6665	0.1201	0.4052	0.0062	2192	52	2193	14	2193	28
14	81	67	1.21	0.1376	0.0043	7.6532	0.1289	0.4033	0.0063	2197	53	2191	15	2184	29
15	36	37	0.98	0.1394	0.0045	7.9957	0.1581	0.4161	0.0069	2219	55	2231	18	2243	31
16	139	95	1.45	0.1363	0.0042	7.5712	0.1224	0.4027	0.0062	2181	52	2182	14	2181	28
17	47	39	1.20	0.1390	0.0044	7.8094	0.1469	0.4073	0.0066	2215	54	2209	17	2203	30
18	79	57	1.40	0.1380	0.0043	7.7159	0.1379	0.4054	0.0065	2202	53	2199	16	2194	30