Research Advances

Detrital Zircon U-Pb Geochronology of the Triassic Sandstones from the Yanyuan Basin of Southwestern Sichuan, China

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Objective

The Yanyuan and Sichuan Basins, located at the southwestern margin of the Yangtze Block, are separated by the Kangdian Oldland. The provenance of the Upper Triassic sediments deposited in the Sichuan Basin has been extensively studied much based on detrital zircon U-Pb geochronology (Zhang et al, 2016; Zhu et al., 2017; Yan et al., 2019). However, the provenance of the Upper Triassic Boda Formation in the Yanyuan Basin still remains unresolved. In order to constrain the paleogeographic evolution of the western margin of the Yangtze Block during the Triassic, this work conducted detrital zircon dating on two Triassic sandstone samples collected from the Yanyuan Basin.

Methods

Two sandstone samples, collected from the Lower Triassic Qingtianbao Formation and Upper Triassic Boda Formation in the Yanyuan Basin, were selected for detrital zircon U-Pb analysis. Analysis was made by LA-ICP-MS using the facilities at the London Geochronology Centre, University College London, based on a New Wave NWR193 excimer laser ablation system and an Agilent 7700x quadrupole mass spectrometer. The laser was set to produce ~2.5 J/cm^2 energy density at 8 Hz repetition rate for 25 seconds. Data reduction was processed using the GLITTER software package.

Results

In total, 219 (including 196 concordant points) detrital zircons from two detrital samples were analyzed. The U-Pb data for each sample is presented in Appendix 1.

The sample YY02 (101°20′37.14″ E, 27°38′49.94″N) was collected from the Lower Triassic Qingtianbo Formation in the Yanyuan Basin. Among the 108 single zircon grains of the sample YY02, 91 zircon grains yield concordant ages ranging from ca. 226.3±2.77 Ma to 947.4±11.83 Ma, with 93% lying between 240 Ma and 280 Ma, showing a dominant mode at ~262 Ma (Fig. 1a). In contrast to the Lower Triassic sample, detrital zircon ages of the Middle Triassic sample from the Yanyuan Basin show a main peak at ~534 Ma, and three minor peaks at ~257 Ma, ~764 Ma and ~968 Ma, respectively (Zhu et al., 2017). Moreover, the detrital zircon ages of the Lower Triassic samples from the adjacent areas, with a prominent peak at ~810 Ma (Yan et al., 2019), are significantly different from those of the sample YY02.

The sample YY04 (101°18′52.25″ E, 27°23′52.11″N) was collected from the Upper Triassic Boda Formation in the Yanuan Basin. Among the 111 single zircon grains of the sample YY04, 105 zircon grains gave concordant ages ranging from ca. 265±3.51 Ma to 2425.3±18.31 Ma, with 92% lying between 760 Ma and 885 Ma, showing a dominant mode at ~792 Ma (Fig. 1b). The detrital zircon U-Pb age spectrum of the Boda Formation is significantly different from the overlying Donggualing Formation in the Yanyuan Basin. The Donggualing Formation gave multiple age peaks at ~210 Ma, ~271 Ma, ~431Ma, ~760 Ma, ~1860 Ma and 2400 Ma (Zhu et al., 2017), which is similar to the Upper Triassic samples from the Sichuan Basin (Zhang et al, 2016; Zhu et al., 2017; Yan et al., 2019).

Conclusion

The Triassic sandstones in the Yanyuan Basin record different detrital zircon geochronology signals. Integration of the published detrital zircon data from the Yanyuan Basin indicates that the most likely source area is the Kangdian Oldland during the Early-Middle Triassic and the early stage of Late Triassic time, whereas the sandstones that contain a more diverse range of zircon ages, sourced from the Songpan-Ganze terrane during the late stage of Late Triassic. This change reflects a major drainage adjustment in response to the closure of the Paleo -Tethys Ocean and significant shortening in the western margin of the Yangtze Block. In addition, the marked change in provenance (i.e., the initiate of foreland basin) of the Yanyuan Basin is later than that of Sichuan Basin during the Late Triassic, which reflects that the orogeny

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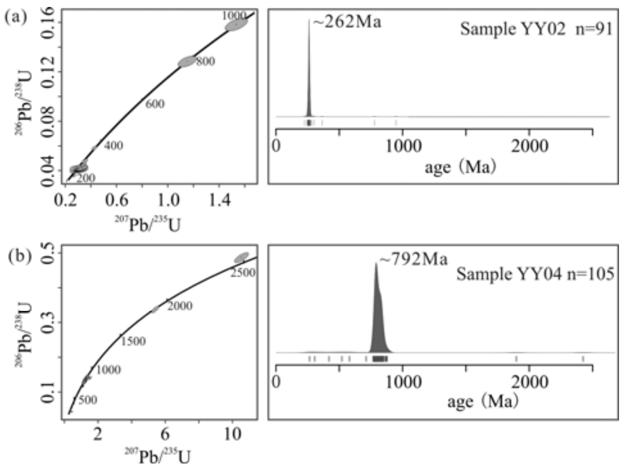

Fig. 1. Concordance plots and Kernel Density Estimation (KDE) plots of the detrital zircon U-Pb data for the sample YY02 (Lower Triassic Qingtianbao Formation) and the sample YY04 (Upper Triassic Boda Formation).

proceeded from north to south along the western margin of the Yangtze Block during the Late Triassic.

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Appendix 1 Detrital zircon U-Pb dating results of the selected samples in the Yanyuan Basin

Sample No.	Isotope ratio						Age (Ma)								Discordance
	$^{207}Pb/^{235}U$	1σ	$^{206}Pb/^{238}U$	1σ	$^{207}Pb/^{206}Pb$	1σ	$^{207}Pb/^{235}U$	1σ	$^{207}Pb/^{206}Pb$	1σ	$^{206}Pb/^{238}U$	1σ	preferred age	1σ	
YY02_001	0.31063	0.00544	0.0428	0.00053	0.05266	0.00091	274.7	4.22	314	38.68	270.2	3.3	270.2	3.3	1.67
YY02_002	0.34309	0.00735	0.04485	6.00E−04	0.0555	0.0012	299.5	5.55	432.3	47.01	282.8	3.69	282.8	3.69	5.91
YY02_003	0.30298	0.00548	0.04152	0.00052	0.05295	0.00095	268.7	4.27	326.7	39.96	262.2	3.23	262.2	3.23	2.48
YY02_004	0.28923	0.01235	0.04145	0.00075	0.05062	0.00224	258	9.73	223.7	99.18	261.8	4.65	261.8	4.65	−1.45
YY02_005	0.28932	0.00714	0.04124	0.00057	0.0509	0.00128	258	5.63	236.2	56.96	260.5	3.55	260.5	3.55	−0.96
YY02_006	0.29775	0.00501	0.04104	0.00051	0.05264	0.00087	264.6	3.92	313.2	36.94	259.3	3.14	259.3	3.14	2.04
YY02_007	0.32585	0.01815	0.04246	0.00094	0.05568	0.00323	286.4	13.9	439.5	124.51	268.1	5.8	268.1	5.8	6.83
YY02_008	0.27012	0.00465	0.03573	0.00044	0.05486	0.00093	242.8	3.71	406.4	37.11	226.3	2.77	226.3	2.77	7.29
YY02_009	0.28946	0.00476	0.04136	0.00051	0.05078	0.00081	258.1	3.75	231.1	36.58	261.2	3.14	261.2	3.14	−1.19
YY02_010	0.29629	0.00975	0.0403	0.00064	0.05334	0.00181	263.5	7.64	343.2	75.1	254.7	3.98	254.7	3.98	3.46
YY02_011	0.29581	0.00668	0.04181	0.00056	0.05134	0.00117	263.1	5.23	256	51.61	264	3.48	264	3.48	−0.34
YY02_012	0.30237	0.00637	0.04167	0.00055	0.05265	0.00112	268.2	4.96	313.6	47.39	263.2	3.4	263.2	3.4	1.90
YY02_015	0.3083	0.00608	0.04067	0.00053	0.055	0.00108	272.9	4.72	412.4	43.19	257	3.26	257	3.26	6.19
YY02_016	0.32983	0.01777	0.04112	0.00089	0.0582	0.00327	289.4	13.57	536.8	118.97	259.8	5.51	259.8	5.51	11.39
YY02_017	0.30667	0.0055	0.04168	0.00052	0.05339	0.00095	271.6	4.28	345.1	39.59	263.2	3.24	263.2	3.24	3.19
YY02_018	0.2907	0.00449	0.04128	5.00E−04	0.0511	0.00076	259.1	3.53	245.3	33.87	260.7	3.09	260.7	3.09	−0.61
YY02_019	0.3034	0.00691	0.04197	0.00057	0.05246	0.00121	269.1	5.38	305.3	51.58	265	3.51	265	3.51	1.55
YY02_020	0.28	0.00591	0.03859	0.00051	0.05264	0.00112	250.7	4.69	313.4	47.55	244.1	3.16	244.1	3.16	2.70
YY02_021	0.27391	0.01124	0.03973	0.00071	0.05003	0.00213	245.8	8.96	196.3	96.03	251.1	4.39	251.1	4.39	−2.11
YY02_022	0.27563	0.00509	0.03942	5.00E−04	0.05073	0.00093	247.2	4.05	228.8	41.68	249.2	3.09	249.2	3.09	−0.80
YY02_023	0.27093	0.01262	0.04187	0.00078	0.04695	0.00226	243.4	10.08	46.5	111.44	264.4	4.81	264.4	4.81	−7.94
YY02_024	0.28834	0.00637	0.04079	0.00055	0.05129	0.00115	257.3	5.02	254	50.56	257.7	3.38	257.7	3.38	−0.16
YY02_025	0.29011	0.00453	0.04191	0.00051	0.05023	0.00076	258.6	3.57	205.6	34.58	264.6	3.14	264.6	3.14	−2.27
YY02_026	0.28155	0.00505	0.04004	5.00E−04	0.05102	9.00E−04	251.9	4	241.9	40.29	253.1	3.11	253.1	3.11	−0.47
YY02_027	0.3047	0.00734	0.04121	0.00057	0.05364	0.00132	270.1	5.72	356	54.54	260.3	3.54	260.3	3.54	3.76
YY02_028	0.29106	0.00602	0.04115	0.00054	0.05132	0.00107	259.4	4.74	255.3	47.04	260	3.33	260	3.33	−0.23
YY02_029	0.3015	0.01233	0.04212	0.00074	0.05194	0.0022	267.6	9.62	282.6	93.87	266	4.59	266	4.59	0.60
YY02_030	0.28719	0.00586	0.04168	0.00054	0.05	0.00102	256.3	4.63	195	46.83	263.2	3.35	263.2	3.35	−2.62
YY02_031	0.3122	0.01477	0.04199	0.00084	0.05395	0.00266	275.9	11.43	369	106.87	265.1	5.21	265.1	5.21	4.07
YY02_032	0.28916	0.00571	0.04104	0.00053	0.05112	0.00101	257.9	4.5	246.4	44.77	259.3	3.27	259.3	3.27	−0.54
YY02_033	0.29668	0.00462	0.04227	0.00051	0.05093	0.00076	263.8	3.62	237.7	34.23	266.9	3.17	266.9	3.17	−1.16
YY02_035	0.28003	0.00958	0.04165	0.00066	0.04879	0.00172	250.7	7.6	137.7	80.7	263	4.08	263	4.08	−4.68
YY02_036	0.29985	0.00935	0.04205	0.00065	0.05174	0.00166	266.3	7.31	273.9	71.94	265.5	4.02	265.5	4.02	0.30
YY02_037	0.29814	0.00557	0.04037	0.00051	0.05358	0.00099	264.9	4.36	353.4	41.47	255.1	3.18	255.1	3.18	3.84
YY02_038	0.29108	0.00481	0.04054	5.00E−04	0.0521	0.00084	259.4	3.79	289.8	36.38	256.2	3.09	256.2	3.09	1.25
YY02_039	0.32197	0.00871	0.04197	0.00062	0.05567	0.00155	283.4	6.69	438.8	60.4	265	3.8	265	3.8	6.94
YY02_040	0.31077	0.00833	0.04228	0.00061	0.05334	0.00146	274.8	6.45	343.1	61.01	266.9	3.79	266.9	3.79	2.96
YY02_041	0.29487	0.00663	0.04154	0.00056	0.0515	0.00117	262.4	5.2	263.2	51.34	262.4	3.46	262.4	3.46	0.00
YY02_042	0.30895	0.01673	0.04069	0.00087	0.05509	0.0031	273.4	12.98	415.7	120.72	257.1	5.39	257.1	5.39	6.34
YY02_043	0.29772	0.00485	0.04284	0.00052	0.05043	8.00E−04	264.6	3.79	214.8	36.19	270.4	3.24	270.4	3.24	−2.14
YY02_044	0.28755	0.00771	0.04262	0.00061	0.04896	0.00134	256.6	6.08	145.7	62.92	269	3.75	269	3.75	−4.61