Acta Geologica Sinica (English Edition), 2019, 93(4): 1154–1155

Research Advances

New Zircon U-Pb Dating of the Tuanliangzi Formation in South Lancangjiang Zone, Western Yunnan: Implications for the Tethyan Evolution of the Simao Block

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Citation: Zhao et al., 2019. New Zircon U-Pb Dating of the Tuanliangzi Formation in South Lancangjiang Zone, Western Yunnan: Implications for the Tethyan Evolution of the Simao Block. Acta Geologica Sinica (English Edition), 93(4): 1154–1155. DOI: 10.1111/1755-6724.13846

Objective

The Lincang area has witnessed complex history of the Proto-Paleo Tethyan evolution. Much attention has been paid on the Lincang granite batholith and Changning–Menglian suture, but the properties of the Lancangjiang tectonic belt and the boundary of the Simao block still remain highly controversial. The Tuanliangzi Formation widely distributed in the southern Lancangjiang tectonic belt was previously considered to be the Proterozoic basement rock of the western margin of the Simao Basin. The Tuanliangzi Formation is mainly composed of metasedimentary rocks. As is known, zircons in metasedimentary rocks have a variety of origins, including detrital zircons of protoliths and later metamorphic zircons, which may be its disadvantage on dating for stratum when compared with coeval interbedded volcanic rocks. Unfortunately, previous studies have focused on the metasedimentary rocks, ignored the determination of meta-volcanic rocks, which has restricted the accurate understanding of its formation time and tectonic affinity. Recently, a suit of andesitic tuffs in the Upper Tuanliangzi Formation were discovered for the first time, which provides an excellent way for determining its upper depositional time and exploring its tectonic significance. This study carried out systematic studies on its field geology, petrography and geochronology, with the purpose to date the time of the Tuanliangzi Formation. This new discovery is of great significance for understanding the tectonic evolution of the Sanjiang Tethyan tectonic zone, especially the Simao block.

Methods

Uranium-lead isotopic data were determined from magmatic zircons in andesitic stuff (sample Pz_1t-1TW), which were sampled from the Tuanliangzi Formation in the Pincun area (23°43′09"N, 100°22′19"E). Sample preparation and analysis were conducted at the State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences, Wuhan. An Agilent 7500a ICPMS instrument was used to acquire ion-signal intensities. The analytical procedures used for the U-Pb dating were described in detail by Liu et al. (2010). Data were processed by ICPMSDataCal. Concordia diagrams and weighted mean calculations were made by Isoplot/Ex_ver3. The U-Pb isotopic data are presented in Appendix 1.

Results

The rocks show blastoporphyritic texture with phenocrysts of plagioclase (5–10vol%) and amphibole (5vol%), while the matrix has tuffaceous texture. The petrography study shows that the primary rock is andesitic tuff. The studied zircons are euhedral columnar crystals and very limpid without inclusions. They have typical oscillatory zoning (Fig. 1a), and have high concentrations of Th and U with high Th/U ratios (0.31–1.09), indicative of a magmatic origin (Appendix 1). The analyzed zircons yield $^{206}Pb/^{238}U$ ages ranging from 285 to 299 Ma with a concordant age of 292.4±7.3 Ma (MSWD=0.22), which is identical to the weighted mean age of 291.1±1.8 Ma (MSWD=1.8, Fig. 1). Thus, the best estimate for the crystallization age of the andesitic tuff in Tuanliangzi Formation may be ca. 291 Ma, namely the Early Permian.

Conclusions

The andesitic tuffs in Tuanliangzi Formation were identified for the first time, and the formation age is the Early Permian. This new breakthrough not only accurately defines the sedimentary time limit of the upper Tuanliangzi Formation, but also indicates that the Tuanliangzi Formation was most probably the product related to the evolution of the southern Lancangjiang Paleo-Tethyan Ocean, but not the ancient basement rocks as previously considered. Besides, this previously unidentified Early Permian magmatism occurred in the South Lancangjiang tectonic belt, which suggests that the western boundary of the Simao block was an active

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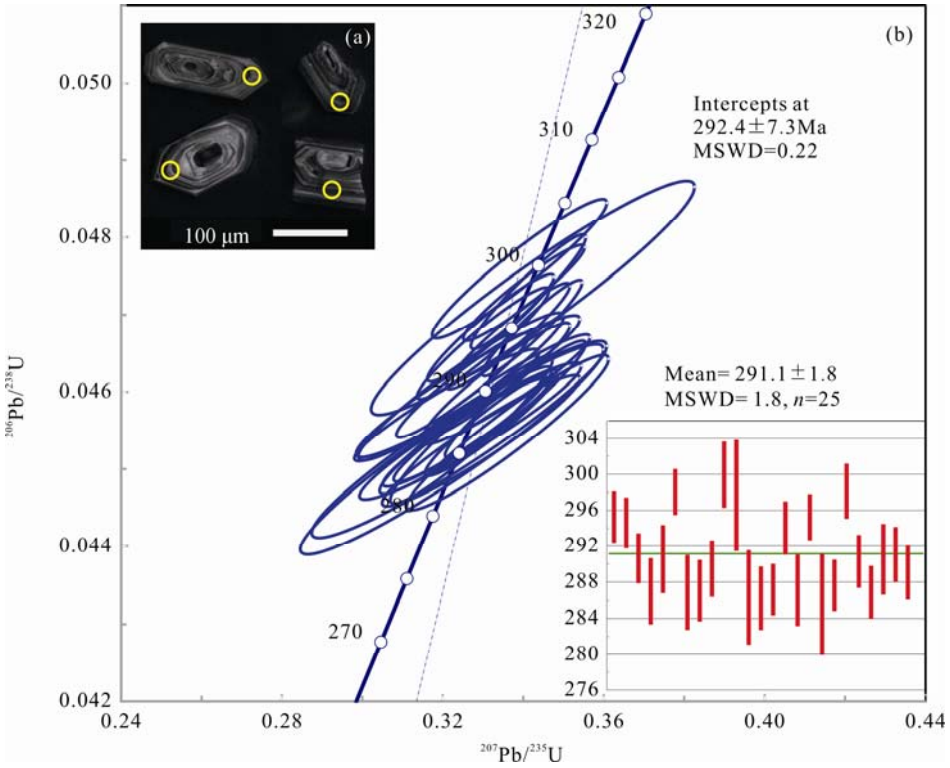

Fig. 1. Cathodoluminescence images (a) and U-Pb concordia diagram (b) for zircons from the sample.

continent margin in the Early Permian and has been in the system of Paleo-Tethyan subduction. Overall, this study provides important research object and useful data for the research on the tectonic evolution of the Sanjiang Tethyan domain and the sedimentary history and tectonic affinity of the western margin of Simao Basin during the Paleo-Tethyan orogeny.

Acknowledgments

This study was financially supported by China Geological Survey (grants No. 121201010000150007-24 and DD20160107-03), the National Nature Science Foundation of China (grant No. 41602049), and the China Postdoctoral Science Foundation (grant No. 2015M582529).

Appendix 1 LA-ICP-MS zircon U-Pb data for the andesite in the Tuanliangzi Formation

Spots	Contents		Ratios	Isotopic ratios						Isotopic ages (Ma)					
	Th	U	Th/U	$^{207}Pb/^{206}Pb$	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
1	368	813	0.45	0.0518	0.0024	0.3391	0.0144	0.0476	0.0006	276	104	296	11	300	4
2	450	1397	0.32	0.0523	0.0015	0.3413	0.0094	0.0473	0.0005	298	65	298	7	298	3
3	597	1332	0.45	0.0520	0.0015	0.3402	0.0100	0.0473	0.0004	287	69	297	8	298	3
4	301	482	0.62	0.0526	0.0041	0.3424	0.0266	0.0472	0.0010	309	176	299	20	297	6
5	529	1041	0.51	0.0517	0.0017	0.3319	0.0104	0.0468	0.0005	333	74	291	8	295	3
6	1185	2193	0.54	0.0529	0.0013	0.3422	0.0082	0.0468	0.0004	324	21	299	6	295	3
7	1014	1084	0.94	0.0524	0.0016	0.3362	0.0101	0.0467	0.0005	302	69	294	8	294	3
8	396	1073	0.37	0.0514	0.0018	0.3300	0.0108	0.0466	0.0005	257	84	290	8	294	3
9	880	990	0.89	0.0528	0.0020	0.3335	0.0120	0.0462	0.0005	320	89	292	9	291	3
10	623	1051	0.59	0.0512	0.0017	0.3250	0.0109	0.0461	0.0004	250	76	286	8	290	3
11	256	371	0.69	0.0518	0.0031	0.3263	0.0184	0.0461	0.0006	280	105	287	14	290	4
12	552	863	0.64	0.0513	0.0028	0.3245	0.0169	0.0461	0.0006	254	124	285	13	290	4
13	668	828	0.81	0.0527	0.0022	0.3356	0.0138	0.0460	0.0005	317	93	294	11	290	3
14	832	877	0.95	0.0535	0.0019	0.3381	0.0116	0.0459	0.0005	350	50	296	9	289	3
15	604	1495	0.40	0.0506	0.0025	0.3210	0.0152	0.0458	0.0005	233	113	283	12	289	3
16	272	868	0.31	0.0529	0.0018	0.3322	0.0110	0.0456	0.0005	328	106	291	8	287	3
17	787	1015	0.78	0.0520	0.0020	0.3267	0.0125	0.0455	0.0005	283	91	287	10	287	3
18	542	657	0.83	0.0523	0.0022	0.3271	0.0133	0.0455	0.0006	298	96	287	10	287	4
19	337	791	0.43	0.0520	0.0023	0.3257	0.0141	0.0455	0.0005	287	99	286	11	287	3
20	240	361	0.66	0.0527	0.0030	0.3269	0.0182	0.0455	0.0006	322	125	287	14	287	4
21	1578	1447	1.09	0.0519	0.0023	0.3259	0.0137	0.0455	0.0005	283	100	286	10	287	3
22	317	654	0.48	0.0540	0.0028	0.3361	0.0166	0.0455	0.0007	372	119	294	13	287	4
23	130	224	0.58	0.0529	0.0042	0.3241	0.0242	0.0454	0.0008	324	147	285	19	286	5
24	307	485	0.63	0.0527	0.0026	0.3295	0.0163	0.0454	0.0006	317	108	289	12	286	3
25	435	924	0.47	0.0523	0.0045	0.3223	0.0249	0.0453	0.0009	298	193	284	19	285	6