

Research Advances

New Zircon U-Pb Ages for the Volcano-sedimentary Strata in Yamu, Tibet and their Geological Significance



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Objective

The Gangdese porphyry Cu deposits (PCDs) are currently the most academically and economically significant in the Lhasa terrane. Except for the giant Xiongcu PCD, which were formed in the Jurassic, almost all the others were formed in the Miocene (e.g. Qulong, Jiamia). Previous studies have shown that these Miocene PCDs have a close spatial and genetic relationship with Jurassic magmatic arcs (Hou et al., 2015). The Xiongcu deposit is located in the Jurassic volcano-sedimentary strata, previously identified as the Early Cretaceous Bima

Formation in the 1: 250,000 geological map of Lazi County. It is worth noting that the map shows that the Bima Formation is also widespread in northern Yamu Township, near which the large Miocene Zhunuo PCD was developed (Huang et al., 2017) (Fig. 1a). In order to accurately determine the age of formation of the volcano-sedimentary strata exposed in Yamu and further verify whether the Zhunuo deposit is genetically linked to the Jurassic arc, we first carried out systematic zircon U-Pb dating for the strata on the basis of a detailed routine geological survey. This study can provide fundamental information for further research.

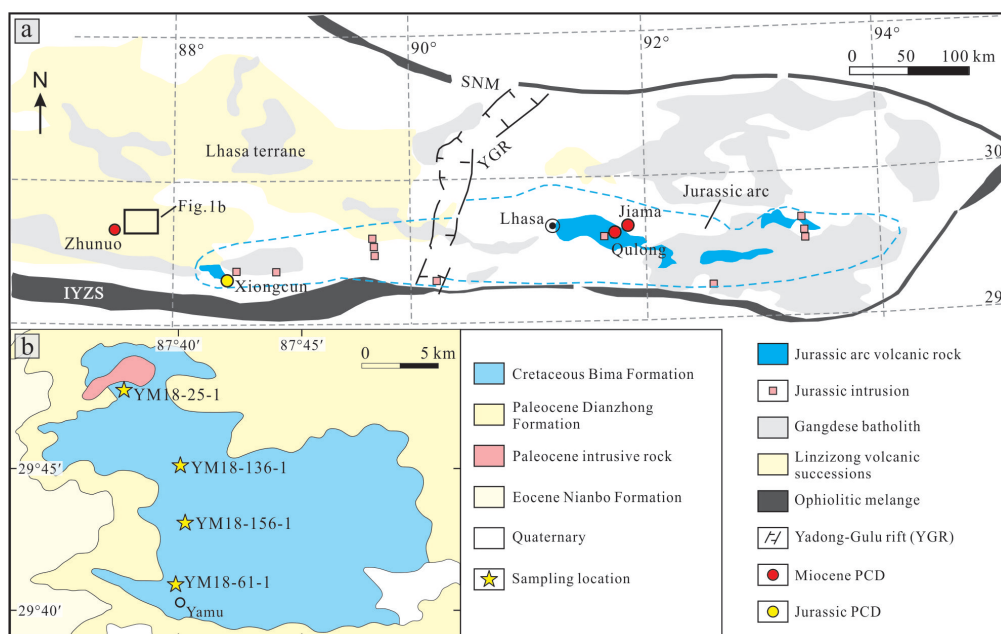


Fig. 1. (a) Geological sketch of the southeastern Lhasa terrane, showing distribution of Jurassic arc and representative porphyry Cu deposits (modified from Hou et al., 2015); (b) regional geological map of the Yamu area (modified from the 1: 250,000 geological map of Lazi County).

IYZS = Indus-Yarlung Zangbo suture; SNM = Shiquanhe-Nam Tso mélange.

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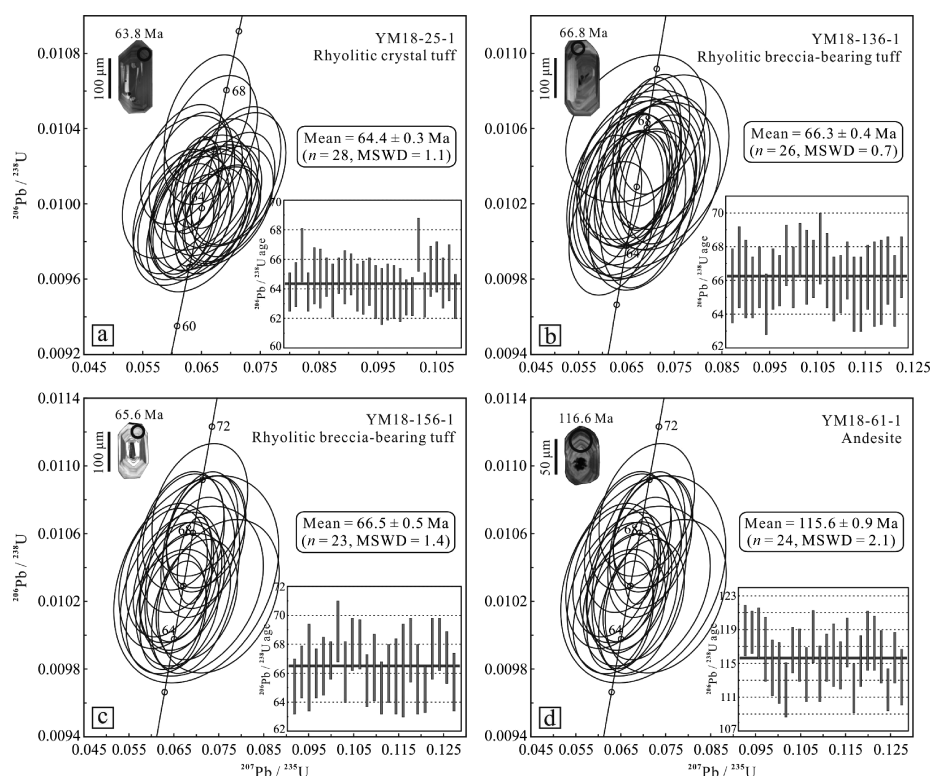


Fig. 2. Cathodoluminescence (CL) images for representative zircon grains and zircon U-Pb concordia and weighted average diagrams for the volcano-sedimentary strata exposed in Yamu.

Methods

LA-ICPMS zircon U-Pb dating was conducted at the Mineral and Fluid Inclusion Microanalysis Lab, Institute of Geology, Chinese Academy of Geological Sciences, Beijing. The NWR193UC laser ablation system (Elemental Scientific Lasers, USA) was equipped with a Coherent Excistar 200 excimer laser and a two-volume ablation cell. The laser ablation system was coupled to an Agilent 7900 ICPMS (Agilent, USA). Zircon 91500 was used as an external standard to correct for U-Th-Pb isotope fractionation effects and yielded a weighted mean $^{206}\text{Pb}/^{238}\text{U}$ age of 1061.5 ± 3.7 Ma.

Results

According to our field survey, the lithologies of the volcano-sedimentary strata exposed in Yamu are mainly rhyolitic-andesitic pyroclastic rocks with minor interlayers of lava, along with small amounts of phyllites, silicified sandstones and silicalites dipping to the NW in the central part of the study area. In this area, four samples were selected for zircon U-Pb dating, the lithologies of which were rhyolitic crystal tuff, rhyolitic breccia-bearing tuff, rhyolitic breccia-bearing tuff and andesite, respectively, from north to south. Zircon grains from these samples are transparent, colorless to light brown, showing euhedral to subhedral oscillatory zoning in CL images. These grains have relatively high Th/U ratios (0.4–3.0; Appendix 1), indicative of an igneous origin. Therefore, the U-Pb ages are interpreted as the crystallization ages of

the host rocks. The four samples from north to south yielded mean $^{206}\text{Pb}/^{238}\text{U}$ ages of 64.4 ± 0.3 Ma, 66.3 ± 0.4 Ma, 66.5 ± 0.5 Ma and 115.6 ± 0.9 Ma, respectively, with corresponding concordia U-Pb ages of 64.3 ± 0.3 Ma, 66.3 ± 0.4 Ma, 66.5 ± 0.4 Ma and 115.7 ± 0.8 Ma (Fig. 2).

Conclusions

Three samples yielded zircon U-Pb ages of 64.3–66.5 Ma, indicating that the majority of the volcano-sedimentary strata exposed at Yamu probably belong to the Paleocene Dianzhong Formation, as with its surrounding rocks (Fig. 1b). The Early Cretaceous Bima Formation has only a small exposure in southern Yamu (~116 Ma). No Jurassic stratum has been identified in this area. In conjunction with previous studies, there is currently no evidence that the Miocene Zhunuo PCD is genetically linked with the strata exposed in Yamu, the potential relationship between them requires more information in order for it to be constrained.

Acknowledgements

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Appendix 1 Zircon LA-ICPMS U-Pb data for the volcano-sedimentary strata in Yamu

Sample spot	Th (ppm)	U (ppm)	Th/U	²⁰⁷ Pb/ ²³⁵ U		²⁰⁶ Pb/ ²³⁸ U		²⁰⁷ Pb/ ²³⁵ U		²⁰⁶ Pb/ ²³⁸ U	
				Ratio	1σ	Ratio	1σ	Age (Ma)	1σ	Age (Ma)	1σ
YM18-25-1-01	639	344	1.9	0.0683	0.0053	0.00994	0.00021	66.6	5.0	63.8	1.3
YM18-25-1-02	591	295	2.0	0.0667	0.0064	0.01002	0.00024	65.0	6.1	64.3	1.5
YM18-25-1-03	275	216	1.3	0.0666	0.0065	0.01034	0.00028	65.4	6.3	66.3	1.8
YM18-25-1-04	1054	463	2.3	0.0686	0.0053	0.00995	0.00021	67.0	5.0	63.8	1.3
YM18-25-1-05	270	204	1.3	0.0708	0.0070	0.01013	0.00029	68.7	6.6	64.9	1.9
YM18-25-1-06	188	176	1.1	0.0611	0.0078	0.01009	0.00031	59.2	7.4	64.7	2.0
YM18-25-1-07	1550	1544	1.0	0.0638	0.0034	0.01010	0.00021	62.7	3.2	64.8	1.3
YM18-25-1-08	399	263	1.5	0.0607	0.0060	0.00996	0.00027	59.3	5.7	63.9	1.8
YM18-25-1-09	1459	1057	1.4	0.0644	0.0034	0.01011	0.00019	63.2	3.2	64.9	1.2
YM18-25-1-10	293	209	1.4	0.0676	0.0059	0.01011	0.00028	66.6	5.7	64.8	1.8
YM18-25-1-11	1366	1265	1.1	0.0668	0.0042	0.01014	0.00022	65.4	4.0	65.0	1.4
YM18-25-1-12	165	213	0.8	0.0689	0.0068	0.00999	0.00026	66.9	6.4	64.1	1.6
YM18-25-1-13	303	200	1.5	0.0657	0.0078	0.00999	0.00028	63.6	7.4	64.1	1.8
YM18-25-1-14	877	292	3.0	0.0652	0.0068	0.01006	0.00025	64.1	6.6	64.5	1.6
YM18-25-1-15	298	204	1.5	0.0645	0.0069	0.00995	0.00028	63.4	6.7	63.8	1.8
YM18-25-1-16	266	224	1.2	0.0646	0.0073	0.00990	0.00030	62.7	6.9	63.5	1.9
YM18-25-1-17	170	209	0.8	0.0650	0.0070	0.00995	0.00029	63.1	6.7	63.8	1.9
YM18-25-1-18	368	249	1.5	0.0619	0.0063	0.00994	0.00028	61.1	6.1	63.8	1.8
YM18-25-1-19	319	222	1.4	0.0620	0.0070	0.00991	0.00028	60.2	6.7	63.6	1.8
YM18-25-1-20	1932	1516	1.3	0.0638	0.0027	0.00989	0.00018	62.7	2.6	63.4	1.2
YM18-25-1-21	950	442	2.1	0.0642	0.0049	0.00990	0.00021	62.8	4.7	63.5	1.3
YM18-25-1-22	270	294	0.9	0.0660	0.0060	0.01045	0.00028	64.3	5.7	67.0	1.8
YM18-25-1-23	662	351	1.9	0.0625	0.0047	0.00992	0.00024	61.2	4.5	63.6	1.5
YM18-25-1-24	614	330	1.9	0.0632	0.0058	0.01017	0.00026	62.4	5.7	65.2	1.7
YM18-25-1-25	324	235	1.4	0.0620	0.0060	0.01021	0.00026	61.0	5.8	65.5	1.7
YM18-25-1-26	388	265	1.5	0.0704	0.0058	0.01005	0.00027	68.5	5.4	64.4	1.7
YM18-25-1-27	281	349	0.8	0.0708	0.0063	0.01015	0.00030	68.8	5.9	65.1	1.9
YM18-25-1-28	574	370	1.6	0.0666	0.0050	0.00991	0.00023	65.0	4.7	63.5	1.5
YM18-136-1-01	85	129	0.7	0.0648	0.0090	0.01025	0.00035	62.3	8.4	65.7	2.2
YM18-136-1-02	115	119	1.0	0.0730	0.0110	0.01042	0.00038	71.0	10.0	66.8	2.4
YM18-136-1-03	69	83	0.8	0.0700	0.0120	0.01030	0.00036	67.0	11.0	66.1	2.3
YM18-136-1-04	145	179	0.8	0.0650	0.0073	0.01023	0.00029	63.1	7.0	65.6	1.8
YM18-136-1-05	167	218	0.8	0.0665	0.0066	0.01032	0.00029	64.7	6.3	66.2	1.8
YM18-136-1-06	209	188	1.1	0.0619	0.0073	0.01007	0.00029	60.2	6.9	64.6	1.8
YM18-136-1-07	258	201	1.3	0.0709	0.0072	0.01030	0.00028	68.7	6.8	66.1	1.8
YM18-136-1-08	758	835	0.9	0.0685	0.0041	0.01030	0.00023	67.1	3.9	66.0	1.5
YM18-136-1-09	225	309	0.7	0.0693	0.0058	0.01053	0.00028	67.5	5.5	67.5	1.8
YM18-136-1-10	217	274	0.8	0.0725	0.0065	0.01033	0.00028	70.3	6.1	66.2	1.8
YM18-136-1-11	209	318	0.7	0.0709	0.0060	0.01057	0.00026	69.7	5.8	67.8	1.6
YM18-136-1-12	119	141	0.8	0.0676	0.0073	0.01041	0.00035	66.3	7.1	66.8	2.2
YM18-136-1-13	213	250	0.9	0.0695	0.0065	0.01040	0.00027	68.2	6.3	66.7	1.7
YM18-136-1-14	82	91	0.9	0.0670	0.0120	0.01060	0.00032	64.0	11.0	67.9	2.1
YM18-136-1-15	82	128	0.6	0.0680	0.0110	0.01039	0.00034	65.0	10.0	66.6	2.2
YM18-136-1-16	179	253	0.7	0.0606	0.0062	0.01021	0.00029	59.1	5.9	65.5	1.9
YM18-136-1-17	240	332	0.7	0.0655	0.0059	0.01025	0.00027	63.9	5.6	65.8	1.7
YM18-136-1-18	824	437	1.9	0.0691	0.0052	0.01039	0.00027	67.4	4.9	66.6	1.7
YM18-136-1-19	174	195	0.9	0.0685	0.0073	0.01017	0.00034	66.4	6.9	65.2	2.2
YM18-136-1-20	100	124	0.8	0.0682	0.0091	0.01017	0.00035	65.7	8.5	65.2	2.2
YM18-136-1-21	143	172	0.8	0.0653	0.0072	0.01033	0.00029	64.2	6.9	66.2	1.9
YM18-136-1-22	119	98	1.2	0.0660	0.0110	0.01027	0.00039	63.0	10.0	65.8	2.5
YM18-136-1-23	71	97	0.7	0.0680	0.0110	0.01028	0.00039	65.0	10.0	65.9	2.5
YM18-136-1-24	163	149	1.1	0.0657	0.0087	0.01039	0.00031	63.3	8.1	66.6	2.0
YM18-136-1-25	165	160	1.0	0.0658	0.0075	0.01020	0.00032	63.8	7.0	65.4	2.1
YM18-136-1-26	280	181	1.5	0.0725	0.0082	0.01042	0.00029	70.8	7.8	66.8	1.8
YM18-156-1-01	125	152	0.8	0.0101	0.0003	0.04730	0.0062	64.3	8.3	65.1	1.9
YM18-156-1-02	169	171	1.0	0.0103	0.0003	0.04710	0.0058	63.4	7.3	66.1	1.8
YM18-156-1-03	613	585	1.0	0.0104	0.0005	0.04930	0.0065	67.6	8.1	66.4	3.0
YM18-156-1-04	312	269	1.2	0.0103	0.0003	0.04740	0.0044	64.5	5.6	66.0	1.7
YM18-156-1-05	263	157	1.7	0.0104	0.0003	0.04590	0.0056	62.3	7.2	66.5	2.0
YM18-156-1-06	982	1267	0.8	0.0104	0.0002	0.04840	0.0023	68.2	3.0	66.9	1.3
YM18-156-1-07	227	216	1.1	0.0107	0.0003	0.04630	0.0057	68.4	8.1	68.9	2.1
YM18-156-1-08	194	180	1.1	0.0103	0.0003	0.04760	0.0055	64.4	7.0	66.1	2.1
YM18-156-1-09	220	183	1.2	0.0106	0.0003	0.04630	0.0053	64.9	7.0	68.0	1.8
YM18-156-1-10	272	212	1.3	0.0106	0.0003	0.04960	0.0051	69.8	6.8	68.0	1.7
YM18-156-1-11	147	204	0.7	0.0102	0.0003	0.04960	0.0052	67.8	7.0	65.5	1.8
YM18-156-1-12	105	145	0.7	0.0104	0.0004	0.04570	0.0065	61.1	8.2	66.4	2.3
YM18-156-1-13	214	247	0.9	0.0101	0.0003	0.04560	0.0042	63.1	5.7	65.0	1.8
YM18-156-1-14	143	169	0.8	0.0103	0.0003	0.04630	0.0055	64.7	7.3	66.0	2.0
YM18-156-1-15	110	82	1.3	0.0103	0.0004	0.04950	0.0095	66.0	12.0	65.8	2.6
YM18-156-1-16	45	58	0.8	0.0103	0.0005	0.05200	0.0120	68.0	15.0	66.2	3.2

Continued Appendix 1

Sample spot	Th (ppm)	U (ppm)	Th/U	²⁰⁷ Pb/ ²³⁵ U		²⁰⁶ Pb/ ²³⁸ U		²⁰⁷ Pb/ ²³⁵ U		²⁰⁶ Pb/ ²³⁸ U	
				Ratio	1σ	Ratio	1σ	Age (Ma)	1σ	Age (Ma)	1σ
YM18-156-1-17	150	140	1.1	0.0106	0.0003	0.04560	0.0057	64.5	7.5	67.6	2.2
YM18-156-1-18	105	103	1.0	0.0102	0.0004	0.05310	0.0077	71.5	9.8	65.6	2.4
YM18-156-1-19	304	419	0.7	0.0101	0.0003	0.04790	0.0038	64.7	4.7	64.9	1.6
YM18-156-1-20	133	184	0.7	0.0106	0.0003	0.05220	0.0059	69.4	7.1	67.7	2.1
YM18-156-1-21	485	287	1.7	0.0106	0.0003	0.04930	0.0046	69.2	6.1	68.0	1.8
YM18-156-1-22	216	251	0.9	0.0105	0.0003	0.04890	0.0048	68.2	6.3	67.1	1.8
YM18-156-1-23	147	142	1.0	0.0102	0.0003	0.04970	0.0065	64.6	8.0	65.4	2.0
YM18-61-1-01	115	113	1.0	0.1290	0.0130	0.01861	0.00047	123.0	12.0	118.9	3.0
YM18-61-1-02	699	1246	0.6	0.1225	0.0049	0.01859	0.00039	117.1	4.4	118.7	2.5
YM18-61-1-03	93	135	0.7	0.1260	0.0130	0.01857	0.00047	118.0	11.0	118.6	3.0
YM18-61-1-04	58	69	0.8	0.1240	0.0170	0.01828	0.00059	116.0	15.0	116.7	3.8
YM18-61-1-05	135	139	1.0	0.1250	0.0150	0.01792	0.00051	119.0	14.0	114.5	3.3
YM18-61-1-06	51	80	0.6	0.1110	0.0160	0.01783	0.00058	103.0	14.0	113.9	3.6
YM18-61-1-07	102	172	0.6	0.1220	0.0120	0.01751	0.00050	115.0	11.0	111.9	3.2
YM18-61-1-08	169	232	0.7	0.1265	0.0097	0.01825	0.00043	120.7	9.0	116.6	2.7
YM18-61-1-09	99	137	0.7	0.1290	0.0110	0.01816	0.00048	121.3	9.9	116.0	3.1
YM18-61-1-10	94	126	0.7	0.1200	0.0120	0.01780	0.00051	112.0	11.0	113.7	3.2
YM18-61-1-11	69	110	0.6	0.1150	0.0120	0.01852	0.00049	108.0	11.0	118.2	3.1
YM18-61-1-12	68	96	0.7	0.1220	0.0140	0.01781	0.00053	114.0	12.0	113.8	3.3
YM18-61-1-13	126	147	0.9	0.1200	0.0120	0.01811	0.00044	114.0	11.0	115.7	2.8
YM18-61-1-14	48	86	0.6	0.1190	0.0150	0.01817	0.00058	111.0	13.0	116.0	3.7
YM18-61-1-15	171	167	1.0	0.1150	0.0110	0.01797	0.00044	108.5	9.8	114.8	2.8
YM18-61-1-16	220	191	1.2	0.1290	0.0120	0.01840	0.00046	121.0	11.0	117.5	2.9
YM18-61-1-17	113	156	0.7	0.1300	0.0120	0.01754	0.00046	122.0	11.0	112.1	2.9
YM18-61-1-18	234	231	1.0	0.1161	0.0092	0.01805	0.00047	110.3	8.3	115.3	3.0
YM18-61-1-19	99	136	0.7	0.1210	0.0120	0.01843	0.00055	116.0	11.0	117.7	3.5
YM18-61-1-20	104	130	0.8	0.1270	0.0130	0.01839	0.0005	120.0	12.0	117.4	3.2
YM18-61-1-21	55	130	0.4	0.1200	0.0120	0.01814	0.00049	114.0	11.0	115.8	3.1
YM18-61-1-22	453	310	1.5	0.1170	0.0079	0.01751	0.00039	111.5	7.2	111.9	2.5
YM18-61-1-23	117	132	0.9	0.1120	0.0110	0.01811	0.00048	107.0	11.0	115.7	3.0
YM18-61-1-24	86	122	0.7	0.1150	0.0120	0.01775	0.00053	108.0	11.0	113.4	3.3