

Research Advances

SHRIMP Zircon U-Pb Ages of the Manketouebo Formation in the Southern Manzhouli Area, Northeast China



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Objective

The Great Xing'an Range is located in the eastern Central Asian Orogenic Belt and contains a Mesozoic volcanic belt that crops out over an area of 100,000 km², dominating the Mesozoic stratigraphy of the Great Xing'an Range. Numerous studies have examined the Late Mesozoic volcanic rocks of the Great Xing'an Range over the past years. The Mesozoic volcanic rocks in the southern Manzhouli area were subdivided into Tamulangou, Manketouebo, Manitu, Baiyingaolao, Meiletu and Damoguaihe formations from bottom to top. The Manketouebo Formation lies between the trachyandesite of the underlying Tamulangou Formation and andesite of the overlying Manitu Formation. Zircon U-Pb ages for trachyandesite and andesite are 164.8 Ma and 160.2 Ma, respectively. The rhyolite lavas and ignimbrites of the Baiyingaolao Formation erupted around 137 Ma and the basaltic andesite of the Meiletu Formation has zircon U-Pb age of 130.6 Ma.

The Manketouebo Formation is mainly composed of rhyolite, volcanoclastic rock and rhyolitic tuff. The rhyolite is porphyritic with quartz, K-feldspar and plagioclase as the dominant phenocrysts. Biotite occurs sporadically. The rhyolitic tuff has similar composition to the rhyolitic lavas with the debris crystals of quartz, plagioclase and perthite. Here, we report new zircon U-Pb dating of the rhyolitic tuff and rhyolite within the Manketouebo Formation in the southern Manzhouli area, with the aim to constrain the timing of the Manketouebo Formation.

Methods

Zircons were separated from the rhyolitic tuff (sample No. D8323-1) and rhyolite (sample No. D1308-2) by conventional heavy liquid and magnetic techniques and were further purified by handpicking under a binocular microscope at the Langfang Regional Geological Survey in Hebei Province, China. Zircon U-Pb dating was performed using the Sensitive High-Resolution Ion

Microprobe (SHRIMP II) with a spot size of 30 μm at the Beijing Ion Probe Centre of the Chinese Academy of Geological Sciences. Testing conditions and data processing procedures are similar to those described by Liu et al. (2006). The measured ²⁰⁶Pb/²³⁸U ratios were used for inter-element fractionation corrections with the TEMORA zircon standards (417 Ma; ²⁰⁶Pb/²³⁸U=0.06683). The SL13 zircon standard (572 Ma; 238 ppm U) was used for calibration of U, Th and Pb contents. Common lead correction was performed using ²⁰⁴Pb, with a single testing error of 1σ and a ²⁰⁶Pb/²³⁸U weighted average age error of 2σ. The standard sample was measured after every nine points, in order to ensure the reliability of the measured results and then to monitor the stability of the instrument. The weighted mean U-Pb age and concordia plots were carried out using the ISOPLOT 3.0 program.

Results

The CL imaging of these zircons is prismatic, colorless, transparent, and 100–200 μm long, combined with their high Th/U ratios (0.75–2.35), which indicates that these euhedral and subhedral zircons are magmatic, suggesting that the U-Pb ages obtained for these samples represent the time of formation. The results of SHRIMP U-Pb zircon dating are listed in Appendix 1 and shown in concordia diagrams (Fig. 1). A total of 13 grains provided a weighted mean ²⁰⁶Pb/²³⁸U age of 160.26±0.71 Ma (1σ) (95% confidence interval) for the rhyolitic tuff. Rhyolite yielded weighted mean ²⁰⁶Pb/²³⁸U ages of 157.30±1.30 Ma (MSWD=0.079) (95% confidence interval).

Conclusions

The rhyolitic tuff and rhyolite from the Manketouebo Formation was dated by the SHRIMP U-Pb method at 157 and 160 Ma, suggesting that the volcanic rocks were formed during the Late Jurassic. Furthermore, in combination with other study (Gou et al., 2013), the Mesozoic volcanism in the southern Manzhouli area occurred in two stages: an early one in the Middle to Later

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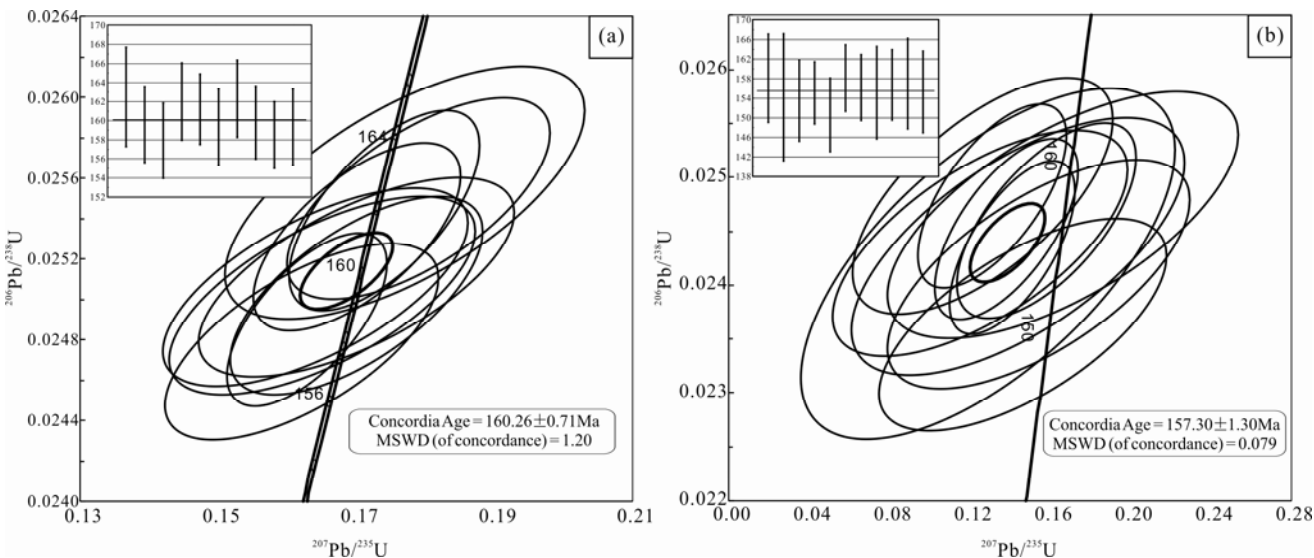


Fig. 1. Zircon U-Pb concordia diagrams and age histograms for rhyolitic tuff (a) and rhyolite (b) from the Manketouebo Formation in the southern Manzhouli area.

Jurassic (165–157 Ma) and a later one during the Early Cretaceous (137–130 Ma).

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Appendix 1 SHRIMP U-Pb zircon data for rhyolitic tuff and rhyolite from the Manketouebo Formation in the southern Manzhouli area

Spot	$^{206}\text{Pb}_c$ (%)	U (ppm)	Th (ppm)	$^{232}\text{Th}/^{238}\text{U}$	$^{206}\text{Pb}^*$ (ppm)	$^{207}\text{Pb}^*/^{235}\text{U}$	1σ (%)	$^{207}\text{Pb}^*/^{235}\text{U}$	1σ (%)	$^{206}\text{Pb}^*/^{238}\text{U}$	1σ (%)	$^{206}\text{Pb}/^{238}\text{U}$ Age (Ma)
D8323-1.1	3.53	44	79	1.84	0.977	0.037	42	0.126	42	0.02483	3.6	158.1
D8323-2.1	8.31	19	26	1.43	0.424	0.039	59	0.129	59	0.0242	5.5	154.2
D8323-3.1	4.67	41	76	1.93	0.881	0.046	40	0.154	40	0.0241	3.6	153.5
D8323-4.1	1.49	199	451	2.35	4.22	0.0421	17	0.141	18	0.02435	2.7	155.1
D8323-7.1	5.31	171	322	1.94	3.67	0.045	40	0.146	40	0.02363	3.4	150.6
D8323-8.1	2.78	154	312	2.10	3.37	0.0382	23	0.131	23	0.02483	2.8	158.1
D8323-10.1	2.50	147	258	1.82	3.17	0.0408	21	0.138	21	0.02452	2.8	156.2
D8323-11.1	5.05	45	50	1.15	0.988	0.043	47	0.144	47	0.02436	4	155.1
D8323-12.1	2.81	111	176	1.64	2.41	0.047	23	0.158	23	0.0246	3	156.7
D8323-13.1	3.92	50	96	2.01	1.09	0.049	42	0.166	43	0.02465	3.8	157
D8323-14.1	3.77	93	137	1.52	2.03	0.037	48	0.125	48	0.02439	3.5	155.3
D1308-1.1	1.92	153	296	2	3.41	0.0502	12	0.177	12	0.02553	2	162.5
D1308-4.1	1.25	573	940	1.69	12.5	0.0474	11	0.164	11	0.02506	1.6	159.6
D1308-5.1	2.31	787	1363	1.79	17.2	0.0473	10	0.162	10	0.02479	1.6	157.9
D1308-7.1	0.61	228	172	0.78	5.02	0.0495	6.3	0.174	6.5	0.02544	1.6	162
D1308-8.1	1.35	680	992	1.51	15	0.0487	7.1	0.17	7.2	0.02531	1.5	161.2
D1308-9.1	0.84	432	574	1.37	9.37	0.0494	8.7	0.17	8.8	0.02502	1.6	159.3
D1308-10.1	1.21	314	323	1.06	6.96	0.0509	8.5	0.179	8.7	0.0255	1.6	162.3
D1308-11.1	1.76	420	681	1.68	9.22	0.049	11	0.17	11	0.02511	1.6	159.8
D1308-12.1	1.35	843	634	0.78	18.3	0.0474	5.6	0.1628	5.8	0.0249	1.4	158.5
D1308-13.1	1.44	317	427	1.39	6.91	0.0477	11	0.165	11	0.02502	1.6	159.3