Research Advances

Latest Zircon U-Pb Age of the Baiyingaolao Formation Volcanic Rocks in the Keyihe Area of North-Central Da Hinggan Mountains

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Objective

Mesozoic volcanic rocks are mainly distributed in the Da Hinggan Mountains. The Baiyingaolao Formation is the main stratum in this area and has been considered to be formed in the Late Jurassic. Many scholars have researched these Mesozoic volcanic rocks in this area, which have been much debatable (Zhang Xiangxin et al., 2017). A series of studies focusing on the Baiyingaolao Formation volcanic rocks in the middle-south section of Da Hinggan Mountains and the middle-west section of Mongolia indicate that they are mostly aged from 123 Ma to 140 Ma (Gou Jun et al., 2010; Tan Haoyuan et al., 2017), which were formed in the Early Cretaceous. Adequate age evidence is still needed to support this perspective in the northern Da Hinggan Mountains. This paper first published two sets of zircon U-Pb ages for the Baiyingaolao Formation volcanic rocks in the northern Da Hinggan Mountains, which will provide basis for the division of the age of the Baiyingaolao Formation.

Methods

Two rhyolite samples of the Baiyingaolao Formation were collected in the Keyihe area of the northern Da Hinggan Mountains. The sample T-06 (50°39′12″N, 122° 23′35″E) was collected 5 km northwest of Keyihe Town, and the sample T-10 (50°36′48″N, 122°11′10″E) was collected 25 km southwest of Keyihe Town.

Sample dating was conducted by the LA-ICP-MS zircon U-Pb dating method. The zircons in the samples were hand-picked at the laboratory of the Institute of Geological Survey in Hebei Province. Sample target preparing, cathodoluminescence, transmitted light, reflected light and U-Pb dating were completed at the Institute of Mineral Resources, Chinese Academy of Geological Sciences. The instruments used were the Finnigan Neptune type MC-ICP -MS and the Newwave UP 213 UV Laser Ablation System. This work used isoplot 3.0 to draw the U-Pb harmonic diagram, and the age error is 1σ.

Results

Twenty zircon points in the rhyolite sample T-06 and 16 zircon points in the sample T-10 in the Keyihe area of the northern Da Hinggan Mountains were tested for U-Pb dating. The results are shown in Appendix 1. Zircon cathodoluminescence images of the two rhyolite samples suggest that the zircons are generally 30 to 70 μm, semi-autonomous, and have many complex structures such as annulus and sector structures. The 20 zircon Th/U ratios for the sample T-06 range from 0.9 to 2.43, indicative of their magmatic origin. The $^{206}Pb/^{238}U$ age is mainly divided into two age ranges, the first (16 zircons points) ranging from 109.32 to 117.84 Ma with a weighted mean age of 111.68±0.94 Ma and MSWD of 2.6, and the second (four zircon points) ranging from 124.10 to 126.43 Ma with a weighted mean age of 125.60±0.3 Ma and MSWD of 5.6. The zircon Th/U ratios for the sample T-10 is 0.63 to 1.52, implying their magmatic origin. The results of 16 zircon U-Pb ages in the sample are relatively consistent. The $^{206}Pb/^{238}U$ age ranges from 126.49 to 128.46 Ma with a weighted mean age of 127.17±0.53 Ma and MSWD of 0.17 (Fig. 1). According to the results of the two sets of dating samples, the age of the Baiyingaolao Formation in the Keyihe area of the northern Daxinganling Range lies between 111.68±0.94Ma and 127.17±0.53Ma.

Conclusion

The dating shows that the weighted mean age of the two

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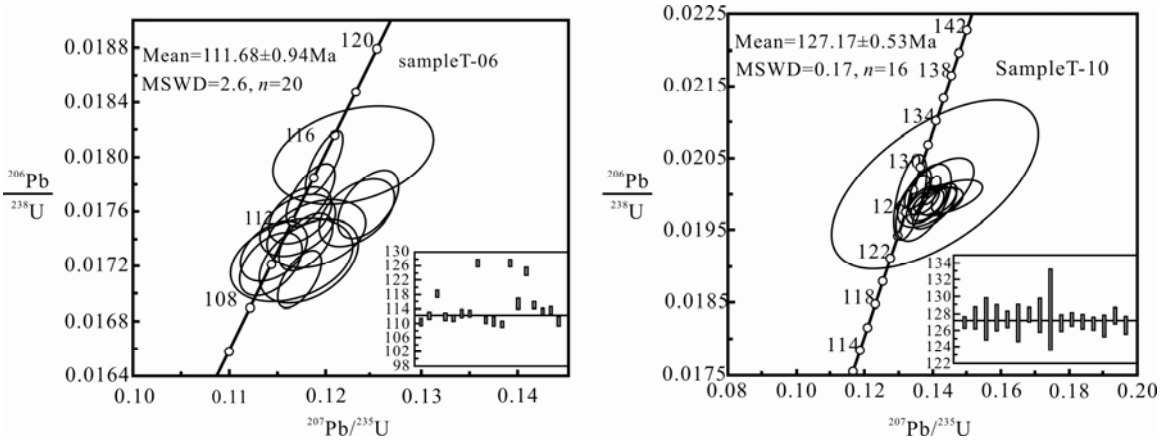

Fig. 1. Zircon U-Pb concordia diagrams of the Baiyingaolao rhyolites.

rhyolite samples in the Keyihe area of northern Da Hinggan Mountains ranges from 111.68±0.94 Ma to 127.17±0.53 Ma. This work further confirms that the Baiyingaolao Formation in this area was formed in the Early Cretaceous, not the Late Jurassic. The age results of this test are slightly later than that of the middle-west section of Mongolia (123 Ma to 140 Ma). Comprehensive comparison indicates that the formation time of this formation is different in the region. The formation age of the strata in this area becomes younger from the west to the east, which is related to the relative position of the Mongol-Okhotsk orogenic belt. The farther the strata are from the orogenic belt, the latter the formation time of the stratum is. The relatively early formation time of the Baiyingaolao Formation in the mountain belt confirms the gradual closure of the Mongol-Okhotsk suture zone from west to east.

Acknowledgment

This research was supported by the Natural Science Foundation of Heilongjiang Province, China (grant No. QC2017035).

References

Gou Jun, Sun Deyou, Zhao Zhonghua, Ren Yunsheng, Zhang Xueyuan, Fu Changliang, Wang Xi and Wei Hongyan, 2010. Zircon LA-ICPMS U-Pb dating and petrogenesis of rhyolites in Baiyingaolao Formation from the southern Manzhouli, Inner-Mongolia. *Acta Petrologica Sinica*, 26(1): 333–344 (in Chinese with English abstract).

Tan Haoyuan,He Zhonghua, Chen Fei,Du Yuedan and Ren Zihui, 2017. Zircon U-Pb ages and geochemical characteristics of volcanic rocks in Baiyingaolao Formation of Suolun area within central Da Hinggan Mountains and their tectonic implications. *Geological Bulletin of China,* 36(5): 893–908 (in Chinese with English abstract).

Zhang Xiangxin, Sun Zhen and Gao Yongfeng, 2017. Zircon U-Pb geochronology and geochemistry of the Early Cretaceous volcanic rocks from the Manitu Formation in the Hongol area, northeastern Inner Mongolia. *Acta Geologica Sinica* (English Edition), 91(4): 1286–1304.

Appendix 1 Ziron isotopic analyses for Baiyingaolao rhyolites

Analysis spots	Th	U	Th/U	$^{207}Pb/^{206}Pb$	$^{207}Pb/^{235}U$	$^{206}Pb/^{238}U$	Analysis spots	Th	U	Th/U	$^{207}Pb/^{206}Pb$	$^{207}Pb/^{235}U$	$^{206}Pb/^{238}U$
	ppm	ppm		Age(Ma)	Age(Ma)	Age(Ma)		ppm	ppm		Age(Ma)	Age(Ma)	Age(Ma)
T-06-1	165.63	74.24	2.23	116.76	109.96	110.04	T-06-19	125.95	139.3	0.9	124.16	113.74	113.23
T-06-2	86.38	49.51	1.74	142.68	112.51	111.81	T-06-20	23.86	23.19	1.03	211.19	113.53	110.16
T-06-3	93.29	62.47	1.49	187.12	120.68	117.84	T-10-1	180.87	182.65	0.99	164.9	128.97	126.96
T-06-4	38.94	41.2	0.95	1168.52	181.21	113.59	T-10-2	135.61	100.62	1.35	153.79	128.77	127.44
T-06-5	41.58	22.66	1.84	187.12	114.25	111.44	T-10-3	52.93	52.43	1.01	131.57	127.23	127.31
T-06-6	122.33	84.36	1.45	161.2	113.27	111.05	T-10-4	159.17	105.01	1.52	176.01	130.1	127.48
T-06-7	97.1	60.82	1.6	242.66	118.06	112.39	T-10-5	103.93	86.41	1.2	322.28	137.55	127.31
T-06-8	109.72	45.08	2.43	124.16	112.72	112.29	T-10-6	55.62	44.42	1.25	213.04	130.92	126.86
T-06-9	286.68	132.4	2.17	264.88	133.84	126.43	T-10-7	140.02	93.4	1.5	233.4	132.81	127.9
T-06-10	380.52	183.84	2.07	1887.97	297.96	125.6	T-10-8	31.16	25.26	1.23	255.62	134.04	127.77
T-06-11	65.74	38.18	1.72	109.35	110.23	110.62	T-10-9	17.8	15.5	1.15	231.55	133.72	128.46
T-06-12	18.8	17.16	1.1	168.6	111.93	110.22	T-10-10	61.78	43.62	1.42	231.55	132.21	126.87
T-06-13	196.24	142.12	1.38	183.42	112.66	109.32	T-10-11	80.13	57	1.41	294.51	136.09	127.28
T-06-14	179.03	86.36	2.07	168.6	127.94	126.28	T-10-12	83.87	55.29	1.52	211.19	130.91	127.03
T-06-15	18.71	14.72	1.27	172.31	117.75	115.06	T-10-13	49.54	78.7	0.63	255.62	133.01	126.83
T-06-16	69.41	36.81	1.89	142.68	124.71	124.1	T-10-14	41.81	39.78	1.05	264.88	133.46	126.49
T-06-17	430.81	211.03	2.04	124.16	114.97	114.69	T-10-15	77.99	66.06	1.18	166.75	129.18	127.79
T-06-18	180.77	106.14	1.7	255.62	119.17	112.8	T-10-16	44.68	51.29	0.87	264.88	133.71	126.57