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Research Advances

U-Pb Ages of the Late Early Cretaceous Magmatic Rocks in the Zhalantun Area of Inner Mongolia

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Objective

A great deal of early-to-mid Early Cretaceous magmatic activities have been recorded in the Zhalantun area of Inner Mongolia, while the late Early to Late Cretaceous magmatic rocks have been barely reported (Guo et al., 2018; Zhang Xiangxin et al., 2017). At present, only a few Late Cretaceous magmatic activities were reported in the Arongqi area, such as volcanic rocks of the Gushanzhen Formation. However, the Gushanzhen Formation lacks accurate isotopic age, and contemporaneous intrusive rocks has not been reported yet. In this work, we collected the volcanic rocks from the Gushanzhen Formation and contemporaneous intrusive rocks in the Zhanlantun and nearby, and aim to figure out the formation ages of volcanic rocks of the Gushanzhen Formation and accompanied intrusive rocks by analyzing zircon U-Pb isotopes (Fig. 1).

Methods

Based on regional geological survey, a rhyolite, a syenogranite and a granite porphyry were collected from the Zhanlantun area and were chosen to analyze for zircon in-situ U-Pb dating. Zircon separation and cathodoluminescence (CL) images were finished by Langfang Yuheng Mineral and Rock Technical Service Limited Company. Zircon U-Pb dating was determined at the National Geological Laboratory of the Chinese Academy of Geological Sciences and Ocean Lithosphere and Mantle Dynamics Lab, Institute of Oceanology, Chinese Academy of Sciences.

Results

CL images reveal that almost zircons from the rhyolite, syenogranites and granite porphyry yield high Th/U ratios (>0.4) and exhibit evident oscillatory zones, implying that the analyzed zircons have a magmatic origin.

The sample TW12 is a medium-fine grained syenogranite and was collected from the Guangming Village of Zhalantun area (122.59°E, 47.98°N). A total of twenty-five analyses were carried out and gave Th/U ratios of 0.49–1.70 (Appendix 1). Due to Pb loss, two analyses are far away from the concordia curve. The remained twenty-three analyses fall on the concordia curve (Fig. 1) and yield a weighted mean $^{206}Pb/^{238}U$ age of 110.6±1.0 Ma (MSWD=0.6), representing the magmatic age of syenogranite. The sample TW16 is a granite porphyry and was collected from the Xiaoxigou (122.65° E, 47.84° N). A total of twenty-five spots were analyzed and yielded Th/U ratios of 0.41–1.58. Twenty-three analyzed spots fall on or close to the concordia curve (Fig. 1) and yield a weighted mean $^{206}Pb/^{238}U$ age of 112.7 ±1.0 Ma (MSWD=1.5), indicative of the magmatic age of granite porphyry. The sample GSZ01 is a rhyolite and was selected from the Gushanzhen Formation in the Dahewan town (123.15°E, 47.86°N). A total of twenty-five spots were determined and have Th/U ratios of 0.59–2.94. Other than five analyses falling away from the concordia curve, the remained twenty analyses plot on or close to the concordia curve (Fig. 1) and yield a weighted mean $^{206}Pb/^{238}U$ age of 113.6±1.4 Ma (MSWD=0.5), which refers to the magmatic age of rhyolite. Collectively, a syenogranite, a granite porphyry and a rhyolite were formed at the end of the Early Cretaceous.

Conclusions

As discussed above, the zircon U-Pb dating results reveal that a syenogranite, a granite porphyry and a rhyolite were crystallized at 110.6±1.0 Ma, 112.7±1.0 Ma and 113.6±1.4 Ma, respectively. Therefore, the late Early Cretaceous magmatic activities are recognized in the Zhalantun area, eastern Great Khingan. Furthermore, the exact zircon U–Pb age for volcanic rocks from the Gushanzhen Formation in the Zhantanlun area is first reported in this study, which certifies that the Gushanzhen Formation was formed in the late Early Cretaceous era, instead of the Late Cretaceous era. The late Early Cretaceous intrusive rocks are first recognized in the Zhalantun area, Eastern Great Khingan, which is significant for studying the Mesozoic intrusive magmatic activities and probing the Mesozoic mineralization in the eastern Great Khingan.

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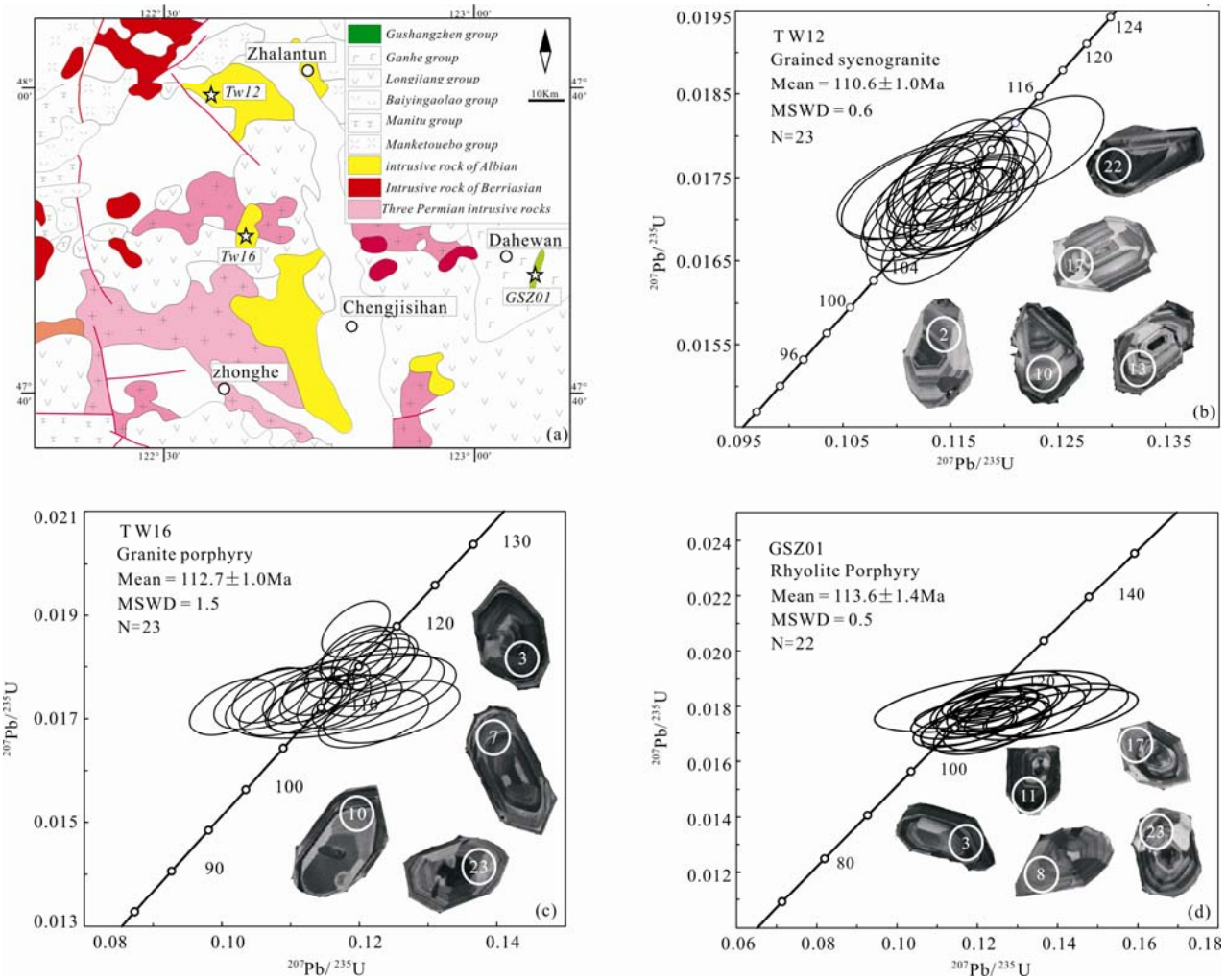

Fig. 1. U-Pb harmonic diagram of igneous rocks at the end of the Early Cretaceous in Zhalantun.

113054100, 121201207000171401 and 1212011220435).

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Appendix 1 LA-ICP-MS U-Pb isotopic age data for the late Early Cretaceous igneous rocks in the Zhalantun area

Sample No.	Th/U	Isotopic composition				Age(Ma)			
		$^{207}Pb/^{235}U$		$^{206}Pb/^{238}U$		$^{207}Pb/^{235}U$		$^{206}Pb/^{238}U$	
TW12-01	0.85	0.11326	0.00307	0.01674	0.00034	108.9	2.80	107.0	2.19
TW12-02*	0.49	3.80723	0.07698	0.22798	0.00455	1594.3	16.26	1323.9	23.88
TW12-03	1.00	0.11384	0.00275	0.01709	0.00035	109.5	2.51	109.3	2.20
TW12-04	0.76	0.11149	0.00284	0.01691	0.00035	107.3	2.59	108.1	2.19
TW12-05	0.84	0.11162	0.00312	0.01715	0.00035	107.4	2.85	109.6	2.24
TW12-06	1.20	0.11288	0.00292	0.01716	0.00035	108.6	2.67	109.7	2.23
TW12-07	0.79	0.11132	0.00425	0.01732	0.00037	107.2	3.89	110.7	2.37
TW12-08	0.96	0.1232	0.004	0.0179	0.00038	118.0	3.61	114.4	2.40
TW12-09	1.03	0.11594	0.00309	0.0171	0.00035	111.4	2.81	109.3	2.23
TW12-10	0.79	0.11629	0.00368	0.01718	0.00036	111.7	3.34	109.8	2.29
TW12-11*	0.97	0.20257	0.00585	0.01713	0.00036	187.3	4.94	109.5	2.30
TW12-12	0.57	0.11532	0.00313	0.01765	0.00036	110.8	2.85	112.8	2.30
TW12-13	0.61	0.11661	0.00355	0.01721	0.00036	112.0	3.23	110.0	2.29
TW12-14	0.86	0.11952	0.00314	0.01778	0.00036	114.6	2.84	113.6	2.31
TW12-15	1.70	0.11258	0.00389	0.01706	0.00037	108.3	3.55	109.0	2.33
TW12-16	0.78	0.11628	0.00316	0.01744	0.00036	111.7	2.87	111.4	2.28
TW12-17	0.82	0.11547	0.00486	0.0174	0.00039	111.0	4.43	111.2	2.47
TW12-18	0.58	0.11546	0.0038	0.01707	0.00036	111.0	3.46	109.1	2.31
TW12-19	1.08	0.11383	0.00275	0.01747	0.00035	109.5	2.50	111.6	2.25
TW12-20	1.00	0.11506	0.00385	0.01749	0.00037	110.6	3.51	111.8	2.34
TW12-21	0.87	0.11762	0.00303	0.01767	0.00036	112.9	2.75	112.9	2.29
TW12-22	1.39	0.11643	0.00321	0.01741	0.00036	111.8	2.92	111.3	2.27
TW12-23	0.79	0.11478	0.00377	0.01745	0.00037	110.3	3.43	111.5	2.35
TW12-24	1.06	0.11613	0.00464	0.01721	0.00038	111.6	4.22	110.0	2.41
TW12-25	0.93	0.11444	0.00657	0.01742	0.00043	110.0	5.99	111.3	2.71
TW16-01	0.61	0.11964	0.00432	0.01732	0.00035	114.7	3.92	110.7	2.21
TW16-02	0.57	0.12242	0.00402	0.0181	0.00036	117.3	3.64	115.6	2.26
TW16-03	0.61	0.11633	0.00355	0.01733	0.00034	111.7	3.23	110.7	2.14
TW16-04	0.71	0.12084	0.00321	0.01818	0.00035	115.8	2.91	116.1	2.20
TW16-05	0.56	0.11511	0.0058	0.01728	0.00038	110.6	5.29	110.4	2.42
TW16-06	0.99	0.11952	0.00336	0.01827	0.00035	114.6	3.04	116.7	2.23
TW16-07	0.67	0.12256	0.00522	0.01781	0.00038	117.4	4.72	113.8	2.40
TW16-08	1.58	0.12316	0.00321	0.01804	0.00034	117.9	2.90	115.2	2.18
TW16-09	0.42	0.1152	0.00418	0.0176	0.00035	110.7	3.81	112.5	2.25
TW16-10	0.56	0.11003	0.00494	0.01722	0.00037	106.0	4.52	110.1	2.35
TW16-11	0.56	0.10156	0.00413	0.01722	0.00036	98.2	3.81	110.0	2.27
TW16-12	0.80	0.11341	0.00329	0.01745	0.00034	109.1	3.00	111.5	2.13
TW16-13	1.01	0.10707	0.00367	0.01745	0.00035	103.3	3.37	111.5	2.21
TW16-14	0.62	0.11274	0.00398	0.01725	0.00035	108.5	3.64	110.3	2.20
TW16-15*	0.66	0.15998	0.00809	0.01816	0.00043	150.7	7.08	116.0	2.70
TW16-16	0.70	0.11949	0.00327	0.01873	0.00036	114.6	2.96	119.6	2.27
TW16-17*	0.52	0.19418	0.0065	0.01823	0.00037	180.2	5.52	116.5	2.37
TW16-18	0.60	0.1234	0.0059	0.01763	0.00039	118.1	5.34	112.7	2.44
TW16-19	0.53	0.11731	0.01108	0.01743	0.00054	112.6	10.07	111.4	3.40
TW16-20	0.88	0.12205	0.00529	0.01699	0.00037	116.9	4.79	108.6	2.32
TW16-21	0.63	0.12077	0.0043	0.01821	0.00037	115.8	3.89	116.3	2.33
TW16-22	0.77	0.1247	0.00656	0.01713	0.0004	119.3	5.93	109.5	2.51
TW16-23	0.43	0.11259	0.00439	0.01745	0.00036	108.3	4.01	111.5	2.27
TW16-24	0.55	0.10716	0.00549	0.01738	0.00039	103.4	5.03	111.1	2.45
TW16-25	0.43	0.11841	0.00421	0.01794	0.00036	113.6	3.82	114.6	2.28
GSZ01-01*	0.88	0.17747	0.01215	0.01693	0.00082	165.9	10.48	108.2	5.19
GSZ01-02	1.25	0.13457	0.00812	0.01780	0.00059	128.2	7.27	113.8	3.77
GSZ01-03	1.03	0.12158	0.01030	0.01734	0.00065	116.5	9.32	110.9	4.11
GSZ01-04	2.94	0.12100	0.00649	0.01814	0.00036	116.0	5.88	115.9	2.26
GSZ01-05*	0.82	0.16940	0.01828	0.01941	0.00083	158.9	15.87	124.0	5.24
GSZ01-06	0.62	0.12485	0.00697	0.01802	0.00040	119.5	6.29	115.2	2.55
GSZ01-07	1.14	0.11658	0.00828	0.01722	0.00048	112.0	7.53	110.1	3.02
GSZ01-08	1.18	0.11981	0.00652	0.01751	0.00044	114.9	5.91	111.9	2.77
GSZ01-09	1.07	0.11789	0.00796	0.01723	0.00044	113.2	7.23	110.1	2.81
GSZ01-10	1.22	0.12374	0.00741	0.01805	0.00037	118.5	6.69	115.3	2.37
GSZ01-11	1.24	0.11852	0.00934	0.01778	0.00038	113.7	8.48	113.6	2.42
GSZ01-12	1.00	0.12069	0.01137	0.01766	0.00057	115.7	10.30	112.8	3.60
GSZ01-13	0.72	0.14078	0.01272	0.01774	0.00057	133.7	11.32	113.3	3.62
GSZ01-14	1.05	0.12679	0.00947	0.01791	0.00055	121.2	8.54	114.4	3.48
GSZ01-15	0.59	0.12756	0.00832	0.01798	0.00053	121.9	7.50	114.9	3.35
GSZ01-16	0.87	0.12630	0.01099	0.01811	0.00076	120.8	9.91	115.7	4.83
GSZ01-17*	0.74	0.15990	0.00994	0.01831	0.00056	150.6	8.70	116.9	3.52
GSZ01-18	0.84	0.12261	0.00611	0.01810	0.00035	117.4	5.52	115.6	2.22
GSZ01-19*	1.06	0.19419	0.01363	0.01768	0.00073	180.2	11.59	112.9	4.63
GSZ01-20	0.69	0.13720	0.01349	0.01778	0.00067	130.5	12.05	113.6	4.27
GSZ01-21	0.72	0.12365	0.01930	0.01815	0.00074	118.4	17.44	116.0	4.67
GSZ01-22*	0.99	0.14952	0.01904	0.01993	0.00119	141.5	16.82	127.2	7.54
GSZ01-23	1.06	0.12500	0.00893	0.01731	0.00062	119.6	8.06	110.7	3.90
GSZ01-24	1.25	0.12831	0.01319	0.01808	0.00069	122.6	11.87	115.5	4.36
GSZ01-25	1.01	0.12265	0.00892	0.01711	0.00057	117.5	8.07	109.4	3.63

*refers to discordant age and is precluded in the weighted mean age calculations.