Vol. 92 No. 1 pp. 410–413 ACTA GEOLOGICA SINICA (English Edition) Feb. 2018

Research Advances

New Zircon U-Pb Age of Granodiorite in Chifeng at the Northern Margin of North China Craton and Constraints on Plate Tectonic Evolution

CHEN Jingsheng[1, 2], LI Bin[1, *], YANG Hao[2], LIU Miao[1], YANG Fan[1, 2], LI Wei[1], WANG Yan[1] and CUI Tianri[1]

1 *Shenyang Geological Survey Center of China Geological Survey, Shenyang 110034, Liaoning, China*
2 *College of Earth Sciences*, *Jilin University, Changchun 130061, Jilin, China*

Objective

The North China Craton (NCC) is one of the oldest cratons in the world. The accretionary belt at its northern margin has been the focus of scholars both at home and abroad (Zhu Junbing and Ren Jishun, 2017). In recent years, a series of Late Paleozoic–Mesozoic intrusions trending E–W have been discovered within the northern margin of the NCC, forming a magmatic belt. The study on the origin and tectonic setting of this magmatic belt not only has important significance for understanding the Late Paleozoic–Mesozoic tectonic evolution history of the northern margin of the NCC, but also can provide key constraints on the evolution of its surrounding Xing′an–Mongolia orogenic belt and the Paleo-Asian Ocean. At present, no Devonian to early stage of Early Carboniferous intrusion has been reported within the northern margin of the NCC. A large volume of granites is distributed in the Chifeng area, and the exsiting datas show that they are mostly emplaced from the Permian to Mesozoic (Cui Yuliang et al., 2017). Are there any earlier intrusions within this region? In order to solve the problem, this paper reports a newly discovered Early Carboniferous granodiorite in the Chifeng area, which will provide evidence on the Early Carboniferous tectonic evolution of the northern margin of the NCC.

Methods

Four samples for zircons dating in this work were collected from the Xiaxinjing and Zhuanshanzi plutons in eastern Chifeng. Zircon grains were extracted from whole-rock samples and handpicked at the Langfang Yuneng Mineral Separation Limited Company, Hebei Province, China. The cathodoluminescence (CL) images of zircons were completed at the electron microprobe Laboratory of the Institute of Geology and Geophysics, Chinese Academy of sciences. The LA-ICP-MS zircon U-Pb analysis was carried out at the Geologic Lab Center, China University of Geosciences (Beijing).

Results

In CL images, all samples display striped absorption and fine-scale oscillatory zoning. Zircons of the samples are short to long column. Most zircons have high Th/U ratios (>0.4), indicating a magmatic origin. Therefore, the LA-ICP-MS U-Pb zircon ages represent their magmatic crystallization ages.

The Th/U ratios of zircons from the sample PM205 range from 0.47 to 1.04. Twenty-four analyses of zircons were obtained from this sample. All the data points have small variation range and distribute in one group on the concordant line. Their weighted mean $^{206}Pb/^{238}U$ age is 354.3±1.1 Ma (MSDW=0.94), which is regarded as the magma crystallization age of this sample. The Th/U ratios of zircons from the sample D2710-1 range from 0.41 to 1.11. For this sample, twenty-five U-Pb analyses were obtained. All but two of the analyses data distribute in one group on or near the concordant line. Their weighted mean $^{206}Pb/^{238}U$ age is 351.1±1.7Ma (MSDW=0.67), which is regarded as the crystallization age of D2710-1. The Th/U ratios of zircons from the sample D2712-1 range from 0.53 to 1.55 except one inherited zircon (Th/U=0.13). Twenty-five analyses of zircons were obtained from this sample. Eleven of these data are inherited zircon, and the other 14 analyses data distribute in one group on the concordant line. Their weighted mean $^{206}Pb/^{238}U$ age is 355.3±3.1 Ma (MSDW=0.23), which is regarded as the crystallization age of this sample. The Th/U ratios of zircons from the sample D7274 range from 0.33 to 1.56. For this sample, twenty-five U-Pb analyses were obtained. Eight zircon data are eliminated in drawing concordia

* Corresponding author. E-mail: 5202268@qq.com

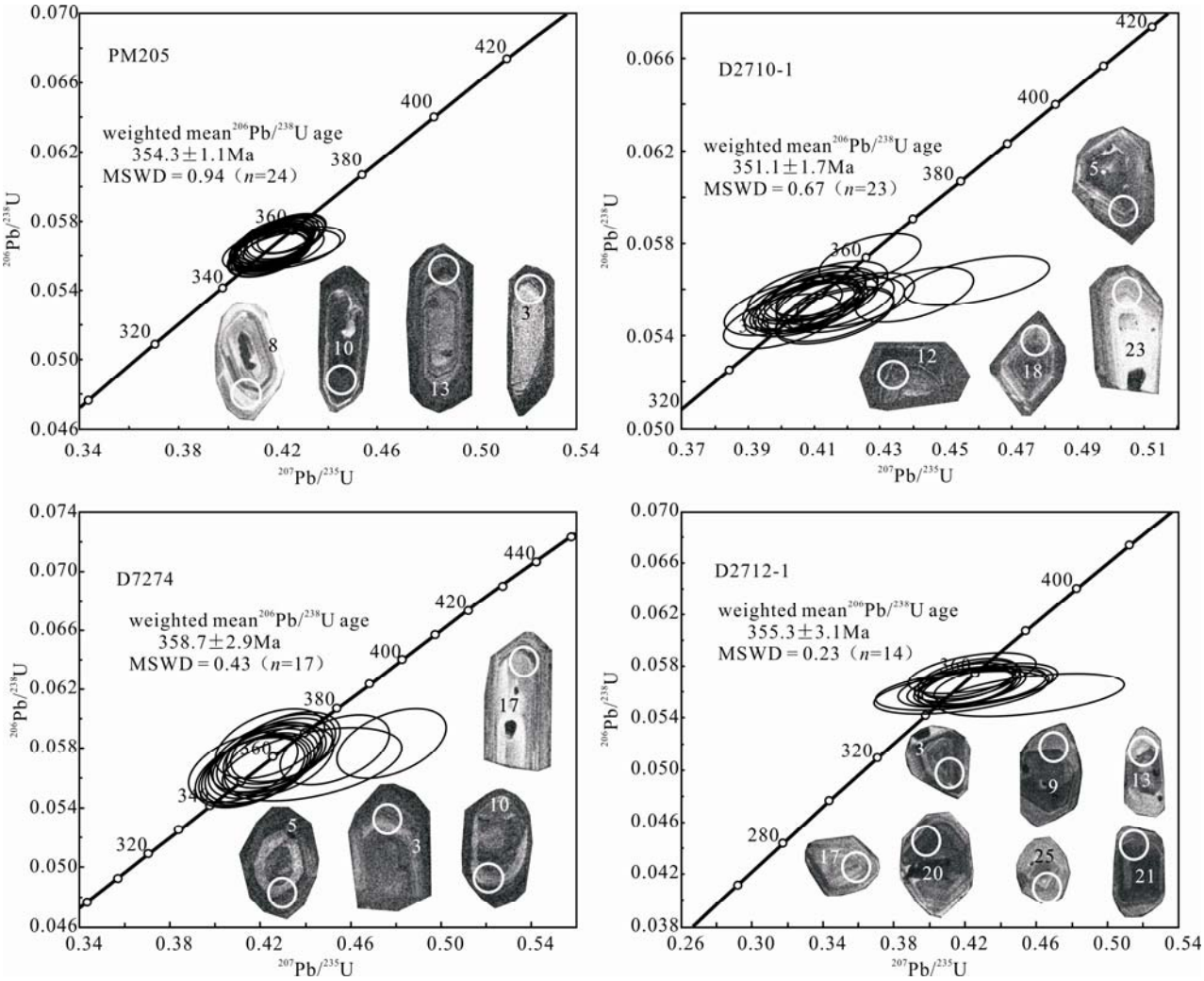

Fig. 1. U-Pb concordia diagrams of zircons from the granodiorites from the Yuanbaoshan and Zhuanshanzi area in eastern Chifeng.

diagram because of inherited age or high discordancy. The other 17 zircon analyses distribute in one group on or near the concordant line, with a weighted mean $^{206}Pb/^{238}U$ age of 358.7±2.9 Ma (MSDW=0.43), which is regarded as the crystallization age of D7274. The dating results of four granodiorite samples indicate they were emplaced in the Early Carboniferous with an age range of 351.1–358.7Ma.

Conclusions

A suite of granodiorite has been identified in the Yuanbaoshan and Zhuanshanzi area in eastern Chifeng at northern margin of NCC. The dating results of four granodiorite samples are 354.3±1.1 Ma, 351.1±1.7 Ma, 355.3±3.1 Ma and 358.7±2.9 Ma, respectively, indicating that their crystallization age is the Early Carboniferous. This is the first discovery of early stage of Early Carboniferous intrusion in the northern margin of the NCC. The identification of the granodiorite fills the gap of the early stage of Early Carboniferous tectonic evolution of the northern margin of the NCC.

Acknowledgments

This study is financially supported by the China Geological Survey (grants No. DD20160048-05, 12120113053400 and 12120114055501).

References

Cui Yuliang, Qu Hongjie, Chen Yingfu, Wang Sen, Meng Xianfeng, Song Dianlan, Zhang Wenyong and Wang Huan, 2017. The age of the original Silurian Badangshan Formation and its ductile deformation in the northern margin of North China Craton: new evidence from zircon SHRIMP U-Pb ages. *Acta Geologica Sinica* (English Edition), 91(6): 2330–2332.

Zhu Junbing and Ren Jishun, 2017. Carboniferous-Permian stratigraphy and sedimentary environment of southeastern Inner Mongolia, China: constraints on final closure of the Paleo-Asian Ocean. *Acta Geologica Sinica* (English Edition), 91(3): 832–856.

Appendix 1 LA-ICP-MS U-Pb data of zircons from the granodiorite in the Chifeng area

Spot No.	Content (ppm)			Th/U	Isotopic composition				Age (Ma)			
	Pb	Th	U		$^{207}Pb/^{235}U$		$^{206}Pb/^{238}U$		$^{207}Pb/^{235}U$	1σ	$^{206}Pb/^{238}U$	1σ
PM205-01	25	352	348	1.01	0.41574	0.01076	0.05631	0.00088	353	8	353	5
PM205-02	26	349	365	0.96	0.42047	0.01107	0.05687	0.00090	356	8	357	5
PM205-03	17	200	244	0.82	0.41754	0.01159	0.05640	0.00091	354	8	354	6
PM205-04	18	249	255	0.98	0.41897	0.01272	0.05656	0.00091	355	9	355	6
PM205-05	12	113	185	0.61	0.41522	0.01208	0.05623	0.00093	353	9	353	6
PM205-06	30	296	458	0.65	0.41820	0.01677	0.05630	0.00102	355	12	353	6
PM205-07	14	157	199	0.79	0.42099	0.01310	0.05686	0.00096	357	9	357	6
PM205-08	23	261	348	0.75	0.41674	0.01272	0.05615	0.00092	354	9	352	6
PM205-09	8	84	123	0.68	0.41882	0.01490	0.05657	0.00098	355	11	355	6
PM205-10	14	147	204	0.72	0.41689	0.01206	0.05629	0.00092	354	9	353	6
PM205-11	17	206	242	0.85	0.42825	0.01348	0.05624	0.00091	362	10	353	6
PM205-12	9	73	136	0.54	0.42106	0.01481	0.05700	0.00097	357	11	357	6
PM205-13	10	109	150	0.72	0.41921	0.01309	0.05680	0.00094	355	9	356	6
PM205-14	22	229	335	0.68	0.42028	0.01018	0.05684	0.00089	356	7	356	5
PM205-15	16	196	223	0.88	0.42097	0.01177	0.05690	0.00092	357	8	357	6
PM205-16	21	304	292	1.04	0.41491	0.01046	0.05623	0.00089	352	8	353	5
PM205-17	18	202	270	0.75	0.41256	0.01078	0.05585	0.00089	351	8	350	5
PM205-18	15	140	231	0.61	0.41376	0.01116	0.05594	0.00090	352	8	351	5
PM205-19	18	221	268	0.83	0.43146	0.01267	0.05653	0.00090	364	9	354	5
PM205-20	24	349	339	1.03	0.41211	0.01026	0.05590	0.00088	350	7	351	5
PM205-21	19	170	290	0.59	0.42414	0.01221	0.05728	0.00090	359	9	359	5
PM205-22	29	175	370	0.47	0.42370	0.01005	0.05723	0.00089	359	7	359	5
PM205-23	19	192	281	0.68	0.41883	0.01090	0.05664	0.00090	355	8	355	5
PM205-24	16	154	249	0.62	0.41424	0.01071	0.05602	0.00090	352	8	351	5
D2710-01	26	344	377	0.91	0.42675	0.01030	0.05731	0.00073	361	7	359	4
D2710-02	36	283	603	0.47	0.41678	0.01186	0.05491	0.00072	354	8	345	4
D2710-03	37	406	578	0.7	0.41766	0.00992	0.05611	0.00071	354	7	352	4
D2710-04	27	399	402	0.99	0.40055	0.01184	0.05460	0.00072	342	9	343	4
D2710-05	73	834	1115	0.75	0.41071	0.00828	0.05560	0.00069	349	6	349	4
D2710-06	12	173	185	0.94	0.40235	0.01292	0.05518	0.00074	343	9	346	5
D2710-07	22	223	358	0.62	0.42352	0.01141	0.05559	0.00072	359	8	349	4
D2710-08	57	549	897	0.61	0.41918	0.00897	0.05608	0.00070	355	6	352	4
D2710-09	13	102	212	0.48	0.45911	0.01465	0.05637	0.00074	384	10	354	5
D2710-10	44	429	705	0.61	0.42363	0.00916	0.05542	0.00069	359	7	348	4
D2710-11	24	205	386	0.53	0.41924	0.01019	0.05550	0.00071	356	7	348	4
D2710-12	34	351	540	0.65	0.41228	0.00942	0.05586	0.00070	351	7	350	4
D2710-13	35	246	581	0.42	0.40397	0.00928	0.05576	0.00071	345	7	350	4
D2710-14	44	692	623	1.11	0.40709	0.00934	0.05517	0.00070	347	7	346	4
D2710-15	62	746	942	0.79	0.40307	0.00871	0.05568	0.00070	344	6	349	4
D2710-16	56	793	826	0.96	0.40747	0.00876	0.05556	0.00070	347	6	349	4
D2710-17	49	462	795	0.58	0.40230	0.00869	0.05501	0.00069	343	6	345	4
D2710-18	32	469	463	1.01	0.41457	0.00981	0.05585	0.00071	352	7	350	4
D2710-19	78	922	1197	0.77	0.40760	0.00866	0.05587	0.00070	347	6	350	4
D2710-20*	81	1172	1229	0.95	0.51462	0.01079	0.05610	0.00070	422	7	352	4
D2710-21	25	340	378	0.9	0.40663	0.01019	0.05564	0.00071	346	7	349	4
D2710-22	26	237	432	0.55	0.40542	0.00978	0.05507	0.00070	346	7	346	4
D2710-23	37	394	588	0.67	0.41206	0.00978	0.05593	0.00071	350	7	351	4
D2710-24*	17	249	233	1.07	0.47974	0.01554	0.05922	0.00080	398	11	371	5
D2710-25	40	522	584	0.89	0.44040	0.01240	0.05575	0.00073	371	9	350	4
D2712-1-01*	348	92	701	0.13	10.1891	0.25852	0.45644	0.00674	2452	23	2424	30
D2712-1-02	15	274	201	1.36	0.42430	0.02386	0.05742	0.00106	359	17	360	6
D2712-1-03	20	309	278	1.11	0.41666	0.02281	0.05629	0.00099	354	16	353	6
D2712-1-04	16	184	235	0.78	0.43767	0.02315	0.05662	0.00095	369	16	355	6
D2712-1-05	21	253	310	0.82	0.42629	0.01801	0.05662	0.00091	361	13	355	6
D2712-1-06*	26	390	342	1.14	0.46618	0.04062	0.05578	0.00106	389	28	350	6
D2712-1-07*	13	125	170	0.74	0.45790	0.05464	0.05359	0.00122	383	38	337	7
D2712-1-08*	13	195	178	1.09	0.54077	0.02517	0.05999	0.00105	439	17	376	6
D2712-1-09	16	196	246	0.8	0.41815	0.02034	0.05628	0.00093	355	15	353	6
D2712-1-10	23	244	319	0.76	0.47371	0.02066	0.06263	0.00106	394	14	392	6
D2712-1-11	23	218	354	0.61	0.42548	0.01715	0.05709	0.00092	360	12	358	6
D2712-1-12*	34	167	218	0.77	0.66490	0.14997	0.04460	0.00149	518	91	281	9
D2712-1-13	47	887	570	1.55	0.41997	0.01397	0.05688	0.00089	356	10	357	5
D2712-1-14	11	88	167	0.53	0.41816	0.03265	0.05597	0.00117	355	23	351	7
D2712-1-15	50	886	646	1.37	0.42118	0.01467	0.05700	0.00089	357	10	357	5
D2712-1-16*	13	215	146	1.47	0.81568	0.04059	0.06177	0.00121	606	23	386	7
D2712-1-17	8	74	128	0.58	0.41937	0.03294	0.05622	0.00120	356	24	353	7
D2712-1-18*	17	145	146	0.99	0.50635	0.08250	0.05557	0.00124	416	56	349	8
D2712-1-19*	29	455	348	1.31	0.50585	0.04377	0.05630	0.00105	416	30	353	6
D2712-1-20	12	142	182	0.78	0.42142	0.01849	0.05720	0.00096	357	13	359	6
D2712-1-21	16	209	229	0.92	0.41713	0.01942	0.05642	0.00096	354	14	354	6
D2712-1-22*	10	143	151	0.95	0.54403	0.03415	0.05684	0.00119	441	22	356	7
D2712-1-23*	20	191	201	0.95	0.83251	0.08765	0.06071	0.00149	615	49	380	9

Appendix 1 Continued

Spot No.	Content (ppm)			Th/U	Isotopic composition				Age (Ma)			
	Pb	Th	U		$^{207}Pb/^{235}U$		$^{206}Pb/^{238}U$		$^{207}Pb/^{235}U$	1σ	$^{206}Pb/^{238}U$	1σ
D2712-1-24*	16	209	184	1.13	0.83296	0.06666	0.05903	0.00128	615	37	370	8
D2712-1-25	15	192	215	0.89	0.42029	0.01906	0.05674	0.00096	356	14	356	6
D7274-01*	112	94	253	0.37	4.80470	0.10326	0.30645	0.00491	1786	18	1723	24
D7274-02	77	451	1079	0.42	0.45318	0.01005	0.05781	0.00093	380	7	362	6
D7274-03	70	412	1081	0.38	0.42455	0.00960	0.05738	0.00093	359	7	360	6
D7274-04	58	292	713	0.41	0.41778	0.00951	0.05649	0.00091	354	7	354	6
D7274-05	45	225	543	0.41	0.42150	0.00993	0.05695	0.00093	357	7	357	6
D7274-06	101	715	1680	0.43	0.41822	0.00941	0.05647	0.00091	355	7	354	6
D7274-07*	102	90	212	0.43	5.73748	0.12582	0.34679	0.00560	1937	19	1919	27
D7274-08*	74	155	373	0.42	2.70238	0.06021	0.18952	0.00307	1329	17	1119	17
D7274-09	11	234	150	1.56	0.44275	0.01640	0.05690	0.00101	372	12	357	6
D7274-10	85	496	1432	0.35	0.42384	0.00993	0.05739	0.00094	359	7	360	6
D7274-11	24	189	389	0.48	0.41825	0.01107	0.05650	0.00095	355	8	354	6
D7274-12*	245	163	374	0.44	5.00940	0.11135	0.30946	0.00500	1821	19	1738	25
D7274-13	30	225	500	0.45	0.41723	0.01070	0.05647	0.00093	354	8	354	6
D7274-14	80	874	1217	0.72	0.42833	0.01011	0.05774	0.00094	362	7	362	6
D7274-15	48	436	743	0.59	0.48257	0.01172	0.05845	0.00097	400	8	366	6
D7274-16*	123	191	307	0.62	3.46932	0.07870	0.23533	0.00383	1520	18	1362	20
D7274-17	88	610	1460	0.42	0.42435	0.00991	0.05830	0.00095	359	7	365	6
D7274-18	89	449	1191	0.38	0.41958	0.00987	0.05675	0.00093	356	7	356	6
D7274-19	74	534	1254	0.43	0.42802	0.01033	0.05711	0.00094	362	7	358	6
D7274-20*	47	297	653	0.46	0.52031	0.01813	0.06812	0.00112	425	12	425	7
D7274-21	71	520	1024	0.51	0.41298	0.00995	0.05682	0.00094	351	7	356	6
D7274-22	104	565	1726	0.33	0.43056	0.01031	0.05798	0.00095	364	7	363	6
D7274-23*	117	886	1793	0.49	0.57966	0.02268	0.05801	0.00099	464	15	364	6
D7274-24*	86	747	1270	0.59	0.43899	0.01071	0.06139	0.00101	370	8	384	6
D7274-25	45	393	716	0.55	0.42578	0.01104	0.05748	0.00096	360	8	360	6

*Representing the abandoned points when calculating weighted average age because of discordance.