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Research Advances

A New Discovery of Cretaceous (~125 Ma) Migmatite in Liaodong Peninsula, North China Craton

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Objective

The North China Craton (NCC), especially its eastern region, had experienced extensive lithospheric thinning during the Mesozoic (Zhu et al., 2011). The Liaodong Peninsula is an important constituent of the eastern NCC, and has recorded intensive lithospheric thinning-related magmatism and extensional deformation (e.g., metamorphic core complex; Zheng et al., 2018). Previous studies reveal that the activity of lithospheric thinning and cratonic destruction reached the peak at ~125 Ma (Zhu et al., 2011). However, none of related Cretaceous metamorphic ages from Liaodong Peninsula have been reported yet. For the first time, we report a ~125 Ma anatectic age of a migmatite outcrop from the Shendianzi Village in Dandong City, eastern Liaoning Province, China (GPS location: 40° 10′ 33″ N, 123° 51′ 48″ E). Combining with previous studies, we suggest that this ~125 Ma migmatite resulted from partial melting related to the lithospheric thinning of the NCC during the Cretaceous.

Methods

Zircons were extracted by conventional magnetic and density separation techniques and were further hand-picked under a binocular microscope, mounted in epoxy resin, and polished to approximately half-thickness. Cathodoluminescence (CL) imaging was undertaken by the Nanjing Hongchuang GeoAnalysis, Nanjing, China. The zircon U-Pb analysis was performed using laser-ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) housed at the Yanduzhongshi Geological Analysis Laboratories, Beijing, China.

Results

The migmatite outcrop mainly consists of melanosomes (i.e., biotite felsic gneisses) and leucosomes. The dating sample SDZ-N1 was collected from biotite felsic gneiss, which is grey or dark-grey in color, and has a granular lamellar crystalloblastic texture and foliated structure defined by a preferred alignment of biotite. Minerals of biotite felsic gneisses include quartz (60%), plagioclase (25%), and biotite (10%), with accessory minerals (5%), including apatite, zircon, and monazite. All these minerals are generally <1 mm in size. Furthermore, granitic leucosomes are widely distributed as irregular lenses, thin layers, and dykes in the host biotite felsic gneisses.

The zircons from the sample SDZ-N1 are subround or round, and commonly show a core-rim structure in CL images (Fig. 1). Zircon cores have variable structures, including pronounced concentric oscillatory zoning or blurred irregular banding and zoning, which are indicative of detrital zircons. By contrast, the rims show planar zoning or no zoning indicative of a metamorphic origin. A total of seven rims and 20 cores have been analyzed, and

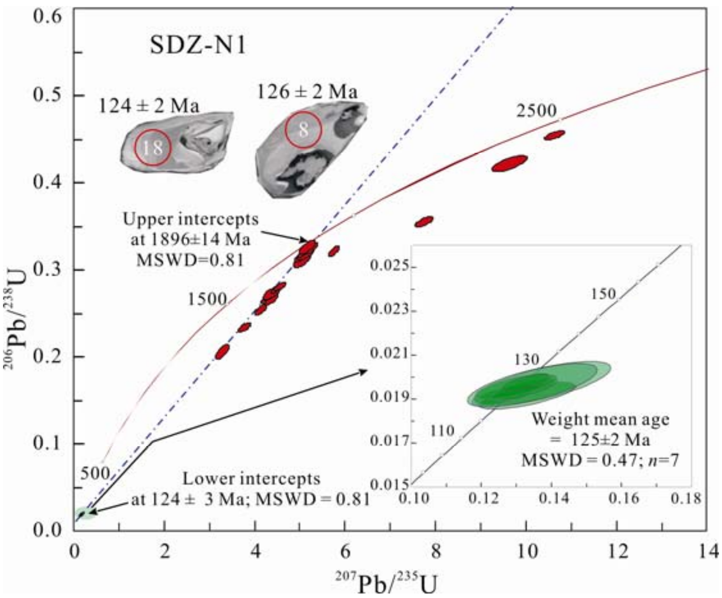

Fig. 1. Zircon U-Pb concordia diagram for the biotite felsic gneiss (SDZ-N1).

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the results are listed in Appendix 1. These seven rim analyses yield $^{206}Pb/^{238}U$ ages between 126 and 122 Ma with a weighted mean age of 125±2 Ma (MSWD=0.47; Fig. 1). The Th/U ratios of these seven zircon rims are <0.1 (0.01–0.05) (Appendix 1), indicating that ~125 Ma is the timing of metamorphism. A total of 20 analyses on zircon cores yield variable $^{207}Pb/^{206}Pb$ ages ranging from 2537 to 1857 Ma, with Th/U ratios ranging in 0.07–1.24 (Appendix 1). These data of zircon cores show a dominant age group of 1921–1857 Ma (15 analyses) with a peak at 1875 Ma.

Conclusions

Geochronological and geochemical studies indicate that the protolith of the SDZ anatectic gneiss was sedimentary rock and suffered anatexis at ~125 Ma. Traditionally, anatexis was thought to be related to high-amphibolite to granulite facies metamorphism in an orogen (Brown, 2001). However, no such Jurassic-Cretaceous metamorphic rocks have been found in the eastern NCC. Additionally, the migmatites reported in this study are locally cropped out within the ductile shear zone and near the Mesozoic granites. Therefore, the ~125 Ma anatexis might be generated under a locally high stress and temperature environment, which was caused by the activity of the Mesozoic ductile shear zone and magmatism in the southeastern Liaodong Peninsula.

Combined with previous studies, we proposed that the ~125 Ma anatexis in the southeastern margin of Liaodong Peninsula was related to biotite dehydration melting under locally high stress-temperature and water-rich fluid environments, which was resulted from the lithospheric thinning of the NCC. This study may also indicate that the eastern China not only experienced intensive magmatism and extensional deformation in the Cretaceous, but also may record obvious anatexis.

Acknowledgments

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Appendix 1 LA-ICP-MS U-Pb data of zircons from the migmatite (SDZ-N1)

Spot	U (ppm)	Th (ppm)	Th/U	Isotopic ratios						Age (Ma)					
				$^{207}Pb/^{206}Pb$	1σ	$^{207}Pb/^{235}U$	1σ	$^{206}Pb/^{238}U$	1σ	$^{207}Pb/^{206}Pb$	1σ	$^{207}Pb/^{235}U$	1σ	$^{206}Pb/^{238}U$	1σ
Zircon rims															
9	410.53	6.43	0.02	0.0502	0.0031	0.1331	0.0091	0.0192	0.0004	204	144	127	8	122	3
10	361.84	5.28	0.01	0.0481	0.0025	0.1268	0.0064	0.0192	0.0003	103	122	121	6	123	2
18	433.91	21.53	0.05	0.0491	0.0022	0.1324	0.0063	0.0195	0.0003	154	105	126	6	124	2
23	315.07	3.15	0.01	0.0481	0.0029	0.1299	0.0076	0.0196	0.0004	102	141	124	7	125	2
6	357.73	5.40	0.02	0.0498	0.0039	0.1346	0.0122	0.0197	0.0007	185	181	128	11	125	4
1	109.23	0.53	0.01	0.0548	0.0060	0.1374	0.0129	0.0197	0.0007	406	246	131	12	126	4
8	967.05	22.70	0.02	0.0485	0.0015	0.1327	0.0044	0.0198	0.0002	125	73	127	4	126	2
Zircon cores															
2	400.29	214.45	0.54	0.1152	0.0024	3.2547	0.1009	0.2066	0.0054	1884	37	1470	24	1211	29
22	831.93	22.65	0.03	0.1145	0.0013	3.7536	0.0876	0.2355	0.0034	1872	20	1583	19	1363	18
14	372.57	48.59	0.13	0.1167	0.0020	4.1118	0.0818	0.2554	0.0037	1907	31	1657	16	1466	19
28	352.21	22.99	0.07	0.1151	0.0021	4.2664	0.0961	0.2672	0.0033	1882	33	1687	19	1527	17
12	1028.65	75.37	0.07	0.1177	0.0017	4.3595	0.0915	0.2682	0.0047	1921	25	1705	17	1532	24
26	463.72	34.29	0.07	0.1149	0.0029	4.3206	0.0977	0.2720	0.0036	1878	45	1697	19	1551	18
31	179.17	84.20	0.47	0.1145	0.0026	4.3552	0.1215	0.2746	0.0050	1873	41	1704	23	1564	25
11	567.92	41.64	0.07	0.1147	0.0014	4.4072	0.0491	0.2783	0.0026	1875	21	1714	9	1583	13
16	368.63	47.44	0.13	0.1166	0.0022	4.5356	0.0864	0.2825	0.0033	1904	34	1738	16	1604	16
7	451.98	51.62	0.11	0.1161	0.0033	5.0432	0.1337	0.3143	0.0066	1897	52	1827	22	1762	32
4	325.67	54.09	0.17	0.1141	0.0012	4.9877	0.0795	0.3161	0.0037	1866	20	1817	13	1771	18
24	177.79	136.34	0.77	0.1147	0.0019	5.0979	0.1244	0.3201	0.0045	1876	30	1836	21	1790	22
5	474.04	193.95	0.41	0.1135	0.0013	5.0173	0.0601	0.3207	0.0036	1857	21	1822	10	1793	17
3	175.54	59.99	0.34	0.1284	0.0014	5.7280	0.0772	0.3227	0.0036	2077	19	1936	12	1803	18
15	301.24	51.47	0.17	0.1149	0.0018	5.2011	0.1115	0.3262	0.0041	1878	28	1853	18	1820	20
27	524.46	197.25	0.38	0.1136	0.0016	5.1409	0.1155	0.3269	0.0050	1857	26	1843	19	1823	24
30	534.13	377.07	0.71	0.1559	0.0025	7.7108	0.1291	0.3568	0.0036	2411	28	2198	15	1967	17
25	733.89	209.24	0.29	0.1632	0.0017	9.5022	0.1300	0.4199	0.0032	2489	17	2388	13	2260	14
21	256.78	213.05	0.83	0.1626	0.0023	9.6137	0.2527	0.4234	0.0062	2483	24	2398	24	2276	28
19	232.12	287.34	1.24	0.1679	0.0017	10.6043	0.1473	0.4559	0.0037	2537	17	2489	13	2421	17