Research Advances

SHRIMP Zircon U–Pb Age of the Sidingheishan Mafic–Ultramafic Intrusion in the Southern Margin of the Central Asian Orogenic Belt, NW China and its Petrogenesis implication

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Objective

The Sidingheishan mafic-ultramafic intrusion is located in the eastern part of the North Tianshan Mountains. This work used zircon U-Pb age data, bulk rock major and trace elements, Sr-Nd-Pb isotope data to assess mantle source characteristics and crustal assimilation of the parental magma of the Sidingheishan intrusion. We have also discussed the tectonic evolution of the southern margin of the Central Asian Orogenic belt in the Late Paleozoic.

Methods

The zircon grains from olivine gabbro of the Sidingheishan intrusion (SDHS) at 42°3′4.3″ N and 96°13′ 52.2″ E were analyzed using a SHRIMP II at the Beijing SHRIMP Center, the Institute of Geology, Chinese Academy of Geological Sciences. The zircon grains from gabbro of the Sidingheishan intrusion (SDGB) at 42°2′ 53.3″N and 96°13′17.5″E were analyzed using a Neptune ICP-MS equipped with a New Wave UP 213 laser-ablation sampling system in the MRL Key Laboratory of Metallogeny and Mineral Assessment, Institute of Mineral Resources, Chinese Academy of Geological Sciences. Whole-rock major and trace elements were determined by XRF analysis and by acid digestion in steel-jacketed Teflon "bombs" followed by ICP-MS analysis, respectively at Chang'an University. Whole-rock Sr-Nd-Pb isotope analyses were determined at Northwest University, China. Rb-Sr and Sm-Nd isotopes were determined by MC-ICP-MS, with total procedural blanks of ~10 pg for Sm and Nd, and ~20 pg for Rb and Sr.

Results

The zircons from olivine gabbro samples (SDHS) have 40–263 ppm U, 22–310 ppm Th, 1.9–12.5 ppm radiogenic Pb, and Th/U ratios in a range 0.43–1.22 (Table 1). Eight zircon grains were selected from SDHS for analysis by SHRIMP. The determined mean age was 351.4±5.8 Ma (MSWD=1.18). A concordia plot for the analytical results is shown in Fig. 1a. The zircons in gabbro (SDGB) samples were analyzed by LA–ICP–MS. Table 1displays the U, Th and Pb contents, and Th/U ratios. The results yield a mean age of 359.2±6.4Ma (95% confidence,

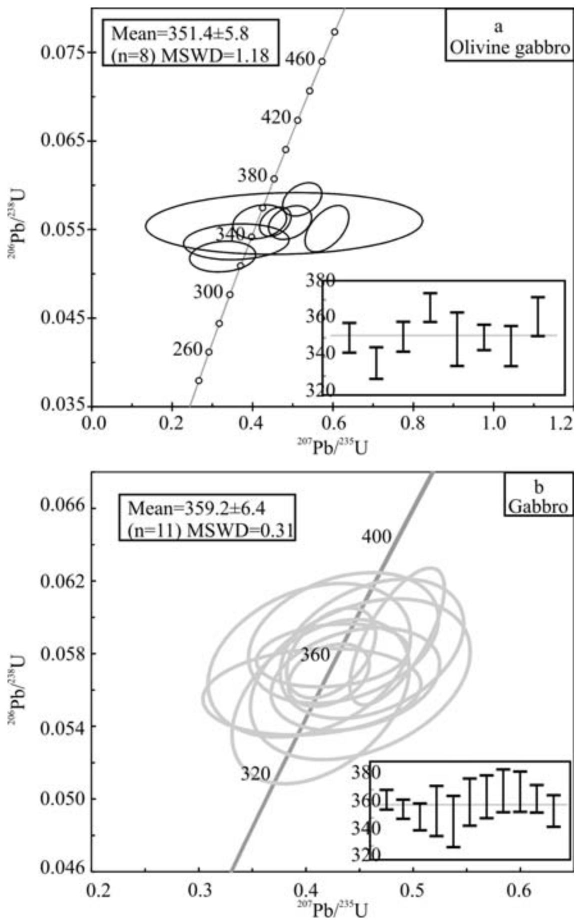

Fig. 1. $^{207}Pb/^{235}U$-$^{206}Pb/^{238}U$ concordia diagram of zircons separated from olivine gabbro (a) and gabbro (b) of the Sidingheishan intrusion.

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Table 1 Concentrations of U, Th and Pb, and U–Pb isotopes of zircon from the Sidingheishan intrusion

Sample	U (ppm)	Th (ppm)	Pb (ppm)	Th/U	$^{207}Pb/^{235}U$	1σ	$^{206}Pb/^{238}U$	1σ	$^{207}Pb/^{206}Pb$	1σ	$t_{206/238}$ (Ma)	1σ
Sidingheishan Olivine gabbro, SHRIMP												
SDHS-1	87	53	4.15	0.63	0.493	7.2	0.0558	2.2	0.0642	6.8	349.9	7.7
SDHS-2	72	33	3.39	0.48	0.36	24	0.0536	2.5	0.049	24	336.7	8.1
SDHS-3	58	26	2.79	0.47	0.418	11	0.0559	2.3	0.0543	10	350.5	7.7
SDHS-4	60	28	2.98	0.49	0.524	6.1	0.0584	2.1	0.065	5.7	365.9	7.5
SDHS-5	54	23	2.67	0.43	0.48	47	0.0557	4.1	0.062	47	349	14
SDHS-6	263	310	12.5	1.22	0.457	5.7	0.0559	2	0.0593	5.3	350.5	6.7
SDHS-7	40	22	1.9	0.56	0.585	6.2	0.0551	3.1	0.0771	5.3	346	11
SDHS-8	61	41	3.1	0.69	0.34	32	0.0576	2.9	0.042	32	361	10
Sidingheishan Gabbro, LA-ICP-MS												
SDGB-1	118	126	8	1.06	0.424678	0.046692	0.057903	0.001142	0.053639	0.006239	362.9	7
SDGB-2	292	220	19	0.75	0.421340	0.024891	0.056814	0.001131	0.053486	0.003107	356.2	7
SDGB-3	147	79	9	0.53	0.405656	0.067092	0.055902	0.001570	0.053641	0.009770	350.7	10
SDGB-4	65	58	4	0.89	0.450773	0.067658	0.056592	0.002921	0.060175	0.007953	354.9	18
SDGB-5	95	74	6	0.78	0.413758	0.054555	0.055360	0.002983	0.058851	0.008580	347.3	18
SDGB-6	89	64	6	0.72	0.403181	0.062351	0.057638	0.002789	0.053429	0.009551	361.2	17
SDGB-7	150	63	9	0.42	0.461578	0.056515	0.058267	0.002531	0.060785	0.008430	365.1	15
SDGB-8	410	177	25	0.43	0.485046	0.029057	0.058946	0.002487	0.060120	0.004161	369.2	15
SDGB-9	247	126	16	0.51	0.435113	0.058437	0.058865	0.002374	0.053604	0.007556	368.7	14
SDGB-10	340	154	21	0.45	0.423479	0.027419	0.058037	0.001635	0.052707	0.003221	363.7	10
SDGB-11	267	191	17	0.71	0.446163	0.051925	0.056594	0.001863	0.055931	0.006162	354.9	11

MSWD=0.31, n=11) for SDGB. The concordia plots for the analytical results are shown in Fig. 1b.

The Sidingheishan samples show low values of total REE, slight enrichments in light REE relative to heavy REE and positive Eu anomalies. All of the Sidingheishan samples show enrichment in Th, Sm and depletion in Nb, Ta, Zr and Hf. All the Sidingheishan samples show narrow variations of initial $^{87}Sr/^{86}Sr$ ratios (0.7035 to 0.7042) and positive $\varepsilon_{Nd(t)}$ values (6.70 to 9.64). The calculated initial $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$ and $^{208}Pb/^{204}Pb$ ratios are in the ranges of 17.23–17.91, 15.45–15.54 and 37.54–38.09, respectively.

Conclusions

The Sidingheishan intrusion was formed in Late Devonian–Early Carboniferous and produced by flush melting of the asthenosphere, related to subduction of the slab break–off material.

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