Tracing magma mixing in the origin of granite by *in situ* Hf and Nd isotope analysis

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Zircon, apatite and titanite are common accessory minerals and contain high Hf, Sr and Nd concentrations. Thus, they are suitable for *in situ* U-Pb dating and Sr, Nd and Hf isotopic analysis by SIMS and LA-(MC-)ICPMS, which are useful tracers to constrain sources and petrogenetic processes of granites.

The Fangshan pluton, one of the typical Early Cretaceous intrusions in the eastern North China Craton, consists mainly of quartz diorite at the outside and granodiorite at the centre. Granodiorite contains abundant mafic microgranular enclaves, which mostly range from angular to oval in shape and from diorite to quartz diorite in composition. The enclaves have igneous textures, identical to those of mafic enclaves found around the world, shows mingling/mixing between mafic and felsic magmas. Zircons from quartz diorite, granodiorite and enclaves show ages of 132.3±2.8Ma, 132.3±1.8Ma and 134.0±2.4Ma respectively, which means that the time of crystallization of the diorite and granodiorite and its enclaves was identical.

In situ MC-ICPMS analysis show that the zircons in enclaves have $^{176}Hf/^{177}Hf$ isotopic ratios of 0.282080-0.282255, distinct from those in the host granodiorites (0.281980~0.282180). The εNd values of apatites and titanites in the enclaves are -12.8~-16.8 and -15.2~-16.8, also distinct from those (-17.0~-19.5 for apatite and -16.3~-19.7 for titanite) of the host granites, indicating that the magmas parental to enclaves and their host granodiorites were derived from different sources. Minerals from the quartz diorites have similar isotopic compositions to those of enclaves. Of these, two distinct components involved in the origin of granitoid and its mafic enclaves were not revealed by previous whole rock geochemical and Nd and Sr isotopic studies. Our results show that combined *in situ* zircon Hf, apatite Sr and Nd and titanite Nd isotopic analysis can be a powerful geochemical tracer with the potential to provide unique petrogenetic information.

Geochemistry characters of platinum-group elements in the Huangshandong Ni–Cu sulfide deposit, East Tianshan, China

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The East Tianshan orogenic belt is one of the most important Ni-Cu ore belts in China, and Huangshandong, one of the large-size Ni-Cu sulfide deposits in this belt, is a multiple intrusion and composed of hornblende gabbro, olivine gabbro, lherzolite and diorite. The concentration of platinum-group element (PGE) in ores and rocks is very low. The average concentration of PGE in rocks is 2 ppb, lower than primitive mantle (23.5ppb) [1], and 86ppb in ores which increase with sulfide content increase. On the basis of 100% sulfide recalculated, the concentration of the total PGE in ores is between 89.62 ppb and 365.27 ppb, and the average is 186 ppb. Rock and ore samples have similar mantle-normalized PGE patterns. Diagrams of Ni /Cu verses Pd /Ir and petrochemistry reveal that the initial magma of Huangshandong is basaltic magma, which should be undepleted in PGE. Compared with continental tholeiite, the parental magma is visibly depleted PGE, possibly related to the sulfide segregation of initial magma in deep crust. The lower Pd/Ir ratio(4.22-17.24 ppb, 8.49 ppb in average) in ores show that there little has later hydrothermal alteration in the mineralized process[2]. The sulfur isotope (the$\delta^{34}S$ ratio from -0.79 to 2.775 ‰) indicate that the sulfur source from crust is poor. In addition, the Re-Os isotope combining with petrology show that the fractionation of olivine and chromite and crustal contaminated are likely the main factor leading sulfur saturation and segregation in deep crust.

[1] McDonough and Sun (1995) *Chem Geol* **120**, 223–253.
[2] Keays (1995) *Lithos* **34**, 1-18.