Distinguishing metamorphic growth from recrystallization of zircon in eclogite-facies metamorphic rocks

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A combined study of petrography, trace elements, U-Pb and Lu-Hf isotopes were carried out for zircons from UHP eclogite-facie rocks in the Dabie-Sulu orogenic belt, China. The results provide a new insight into metamorphic zirconology, with further classification of metamorphic zircon into five subtypes. In doing so, metamorphic growth means new precipitation from aqueous fluid or hydrous melt, whereas metamorphic recrystallization is subdivided into three mechanisms of solid-state transformation, replacement alteration and dissolution reprecipitation depending on the involvement extent of metamorphic fluid/melt. The different subtypes of metamorphic zircon have their characteristic apparent $^{206}Pb/^{238}U$ ages, trace element compositions, Th/U ratios, $^{176}Lu/^{177}Hf$ and $^{176}Hf/^{177}Hf$ isotope ratios.

Metamorphically grown zircon has concordant U-Pb ages of metamorphism, high contents of U, low Th/U and $^{176}Lu/^{177}Hf$ ratios, and elevated Hf isotope ratios. Furthermore, metamorphic growth from the aqueous fluid has lower contents of REE, Th and HFSE than that from the hydrous melt. For the purpose of dating given metamorphic events, it is necessary to date the metamorphic growth in different stage of subduction-zone metamorphism.

Metamorphic recrystallization results in varying degrees of reworking on protolith zircon, depending on the activity of metamorphic fluid during metamorphism. Solid-state recrystallization leads to the lowest degrees of reworking on internal textures and U-Pb isotopes in the protolith zircon. As a result, its initial Hf isotopes and trace elements keep unchanged, consistent with the lack of fluid action during the metamorphism. In contrast, dissolution recrystallization causes the highest degrees of reworking due to the action of metamorphic fluid/melt. The resultant zircons exhibit very weak cathodoluminescence, spongy or porous texture, and nearly concordant U-Pb ages. Their trace elements show consistent enrichment of REE, Th, U and HFSE (Nb, Ta and Hf) relative to the protolith zircon, indicating that a supercritical fluid may be present at peak UHP conditions. Replacement recrystallization results in intermediate degrees of reworking, with the modified zircons displaying weakly zoned or unzoned texture, and discordant U-Pb ages. While the maximum U-Pb ages for recrystallized zircons are close to protolith ages, the minimum U-Pb ages for them are close to time of metamorphic event.

Permian basalts and mafic-ultramafic intrusions in the Northeastern of Tarim Plate (NW China): Insights into a large igneous province

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Permian igneous rocks are widely distributed in the northeastern of Tarim plate, China. The magmatism is represented by Bijiashan igneous rocks in Beishan rift (NE Tarim plate). The basalts in Bijiashan area have SiO_2 (49.86~51.91%) and total alkalis (Na_2O+K_2O=3.51~4.54%) belonging to tholeiitic series, and with higher TiO_2 (2.35%~3.81%) and FeO^T (11.77%~15.42%). The basalts display $\varepsilon Nd(t)$ values (+ 5.21) and the initial $^{87}Sr/^{86}Sr$ value of 0.70443. The rocks have chondrite-normalized REE patterns enriched in LREE and depleted in HREE, indicating that the primary magma were derived from OIB-mantle source by small degrees of partial melting.

In contrast, the mafic-ultramafic intrusions in Bijiashan area have lower TiO_2 (0.07~0.32%), lower total alkalis (Na_2O+K_2O=0.46~1.80%), lower REE ($3.7\sim32.8\times10^{-6}$) and most incompatible elements, and the ε_{Nd} (t) values is + 5.75. These indicate that their magmatic source belongs to depleted lithospheric mantle by partial melting at spinel stable depths.

The basalts and mafic-ultramafic intrusions are closely associated in spatially and temporally, indicating that they may represent Tarim large igneous province.

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