Plastic deformation enhanced diffusion mass transfer and metamorphic transformation in shear zones developed in deep continental subduction channel

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The effect of deformation on metamorphism and that of metamorphic reaction on strain softening and localization in shear zones in crust are well documented. But the interplay of the two processes in deep continent subduction channel is poorly explored. Understanding of the interaction of the two in the subduction regime is essential for understanding deformation behavior and HP-UHP metamorphism of continental crusts in deep subduction zones. Study of rocks from an undeformed pyroxene-bearing granite block and strain-localized shear zones in the block in an HP-UHP ductile shear complex at Yangkou, Sulu UHP metamorphic belt, China reveals that the undeformed granite has preserved granitic texture and primary mineral assemblage of hypersthene, augite, plagioclase, K-feldspar, quartz and biotite. UHP metamorphic transformation is limited to coronas, 10-20 microns wide at grain boundaries between plagioclase, hypersthene and biotite. In mylonite from the shear zones most of the primary minerals are sheared into thin mono- or poly-mineralic bands that are transformed to UHP phases except augite that stands as porphyroclasts in a mylonitic matrix. Hypersthene and biotite disappear instead fine grained omphacite, garnet and garnet-rutile bands occur. Plagioclase is transformed into poly-mineralic bands composed of fine-grained garnet, kyanite, zoisite and albite (retrograd). Augite porphyroclasts often have pressure shadows with rutile precipitation. Deformation conditions estimated using the syn-deformation phases, garnet-omphacite-kyanite-phengite-quartz/coesite, are ca 550-600°C and a minimum pressure 2.5 GPa. This study suggests that metamorphic phase transformation in the undeformed granite is slow and limited to grain boundaries due to lack of fluid activity and slow diffusion rate within and between minerals. In the shear zones dynamic recrystallization-accommodated dislocation creep results in significant grain size reduction of the primary minerals, which increases reaction surface area and enhanced metamorphic transformation. Fluid released by biotite leads to diffusion mass transfer that greatly accelerates the metamorphic process.

Chemical architecture of the Dabie orogen: constraints from zircon Hf and whole-rock Sr-Nd isotopes in Mesozoic magmatic rocks

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Zircon Hf and whole-rock Sr-Nd isotope compositions were determined for Mesozoic mafic-felsic intrusions in the Dabie orogen, east-central China. The results provide not only insights into their petrogeneses, but also constraints on chemical architecture of the continental collision orogen prior to the Early Cretaceous magmatism. Zircon Hf isotope analyses show negative $\varepsilon_{Hf}(t)$ values of -26.3±0.6 to -7.0±0.5 for pyroxenite and gabbro, with Hf model ages of 1097±19 Ma and 1749±20 to 1837±22 Ma relative to the depleted mantle. Granitoids also have negative $\varepsilon_{Hf}(t)$ values of -31.6±0.5 to -16.9±0.9, with crust Hf model ages of 2251±55 to 3162±28 Ma. Both the mafic and felsic magmatic rocks have high initial $^{87}Sr/^{86}Sr$ raios of 0.7065 to 0.7084 and very low $\varepsilon_{Nd}(t)$ values of -21.7 to -11.7. The zircon Hf model ages of the pyroxenite and gabbro are respectively consistent with two major events of crust-mantle differentiation at late Mesoproterozoic (~1.16 Ga) and middle Paleoproterozoic (~1.92 Ga) as recorded in zircon Hf isotopes of the Dabie UHP metaigneous rocks. This suggests that remelting of subcontinental lithospheric mantle formed at the two episodes is responsible for the Mesozoic mafic rocks. The granitoids have the crust Hf model ages as old as 3.16 Ga, which cannot be only formed by reworking of the Dabie UHP metaigneous rocks, but requires involvement of ancient Archean crust. Thus, there may source mixing in which one endmember resembles the North Dabie gneiss with middel Paleoproterozoic Hf model ages (~1.9 Ga) and the other endmember is like the Kongling gneiss with Archean Hf model ages (~3.5 Ga). Therefore, the Mesozoic magmatic rocks in the Dabie orogen were formed by remelting of subducted continental lithosphere in the northern edge of the South China Block. Combined the present and previous studies, the Dabie orogen would have a three-layer crustal structure prior to the Early Cretaceous magmatism: Central Dabie in the upper with dominately young Hf model ages of late Mesoproterozoic (~1.16 Ga), North Dabie in the middle with dominately Hf model ages of middel Paleoproterozoic (~1.92 Ga), and the source region of the Early Cretaceous magmas in the lower with both middel Paleoproterozoic (~1.92 Ga) and Archean (~3.5 Ga) Hf model ages.