Geochmical evidence for recycling of the Paleo-Tethyan oceanic crust into the mantle source of syn-collisional mafic igneous rocks in China

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Crustal subduction generally develops from oceanic to continental slabs, with the disappearance of previously subducting paleo-oceanic crust in collisional orogens. However, it is difficult to identify the geochemical evidence of the subducted paleo-oceanic crust due to the modification of collisonal orogeny. This difficulty is overcome by a combined study of whole-rock major and trace elements, radiogenic Sr-Nd-Hf and stable O isotopes in syn-collisional mafic igneous igneous from the southeastern margin of the North China Block (NCB), which was underthrusted by the Paleo-Tethyan oceanic slab in the Late Paleozoic and then by the South China Block (SCB) in the Early Mesozoic. Zircon U-Pb dating yields concordant ages of 247-244 Ma for magma emplacement, coeval with the initial collision between the NCB and SCB. The rocks generally exhibit OIB-like trace element distribution patterns, markedly different from arc-like patterns for common ones in continental margins. In addition, these rocks show intermediate $(^{87}Sr/^{86}Sr)_i$ ratios of 0.7057 to 0.7091, weakly negative $\varepsilon_{Nd}(t)$ values of -1.2 to -3.8, and $\varepsilon_{Hf}(t)$ values of -1.3 to -3.2. These features indicate that their mantle source contains recycled crustal materials. The Triassic syn-magmatic zircons show variable Hf-O isotope compositions, indicating that the crustal materials were composed of both altered oeanic basalt and terrigenous sediment. These mafic igneous rocks of Triassic have high Fe/Mn and Zn/Fe ratios, suggesting that their mantle source would be a kind of ultramafic pyroxenites. Thus, the pyroxenite was generated by metasomatic reaction of the mantle wedge peridotite with felsic melts derived from the subducting Paleo-Tethyan oceanic crust at postarc depths, where rutile in the subducting oceanic crust became broken down to cause the enrichment of Nb and Ta in the felsic melts. Such melts are diffferent from those produced by partial melting of the subducting oceanic crust at subarc depths, which are depleted in Nb and Ta. Therefore, rutile is a critical mineral to the composition of subducition zone fluids. As such, the depth of slab subduction is a key to the stability of this mineral during the crust-mantle interaction in the Paleo-Tethyan oceanic subduciton channel.