Mg-C isotopes trace carbon recycling in continental subduction zone

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Crustal subduction at convergent plate margins plays a key role in global carbon recycling. Although much attention has been paid to deep carbon recycling in oceanic subduction zones, our understanding of the carbon cycle process is far from completion. What is more, there is less and even no attention has been paid to deep carbon recycling in continental subduction zones.

In this study, we report for the first time the Mg-C isotopic compositions of postcollisional igneous mafic rocks from a collisional orogen. Our results indicate that the mafic igneous rocks from the Hong'an and Dabie orogens in China show systematic differences in their Mg-C isotope compositions. The mafic rocks in the Hong'an orogen generally exhibit low δ^{26}Mg values of -0.77 to -0.24 ‰ but high δ^{13}C values of -4.8 to -1.8 ‰. In addition, they also display OIB-like trace element distribution patterns and depleted radiogenic Sr-Nd-Hf isotope compositions. These features suggest the recycling of the precedingly subducted carbonated oceanic crust into their mantle. In contrast, the mafic rocks in the Dabie orogeny display high δ^{26}Mg values of -0.23 to -0.18 % but low δ^{13}C values of -17.3 to -4.1 %, as well as arc-like trace element distribution patterns and enriched radiogenic Sr-Nd-Hf isotope compositions, suggesting the recycling of supracrustal carbon in subsequently subducted continental crust. Model calculations for the δ^{26}Mg versus and δ^{13}C, $(^{87}Sr/^{86}Sr)_i$, $\varepsilon_{Nd}(t)$ and $\varepsilon_{Hf}(t)$ values for the studied postcollisional mafic igneous from the Hong'an and Dabie orogens also confirm that they can be explained by the source mixing of the mantle peridotite with the subducted carbonated oceanic crust and continental crust, respectively.

Thus, these Mg-C isotope compositions, together with the other geochemical variables, indicate different origins of crustal carbon were carried into the mantle by the oceanic crust at first during the oceanic subduction and subsequently by the continental crust during the continental collision. This provides new insights into the deep carbon recycling at convergent plate margins.