The anatectic effect on the zircon Hf isotope composition of migmatites and associated granites

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Zircon Hf isotope composition is widely used to trace the growth and evolution of continental crust. However, it is still controversial whether the Hf isotope composition of magmatic zircons can faithfully reflect that of their sources, especially for S-type granites. To provide an insight into this issue, we revisited published zircon Lu-Hf isotope data for well-studied migmatites and associated granites in the Sulu orogen and the Cathaysian terrane. The results show greatly elevated $^{176}Hf/^{177}Hf$ ratios (by more than 10ε units) for newly grown domains compared to relict domains. This difference indicates considerable contributions from non-zircon Hf to partial melts during crustal anatexis and subsequent magmatism. Furthermore, this more radiogenic Hf isotope signature was not erased during later magmatic process. The budget of Hf isotopes in source rocks with respect to mineral Lu/Hf ratios suggests the involvement of Hf-bearing major minerals in anatectic reactions by dissolving Hf-bearing major minerals into the anatectic melts. The significant Hf isotope variations in some anatectic and magmatic zircon domains from the migmatites and granites suggest not only the source heterogeneity but also the variable non-zircon Hf contributions. As such, the Hf isotope compositions of anatectic and magmatic zircons are substantially dictated by the mass balance between the non-zircon Hf from the anatectic reactions and the zircon-Hf from the dissolution of protolith zircons into the anatectic melts. They are primarily controlled by P-T conditions and mechanism of crustal anatexis, and the magmatic processes during melt evolution. The present study highlights the important contribution of non-zircon Hf to the anatectic and magmatic zircon domains. In this regard, the greatly elevated $^{176}Hf/^{177}Hf$ ratios for newly grown zircon domains in the migmatites and granites cannot reflect the Hf isotope compositions of their source rocks. Such a deviation must be kept in mind when linking relatively depleted Hf isotope compositions to the nature of source rocks in petrogenetic interpretation and to the growth of continental crust. The contribution of non-zircon Hf can also better account for the variable Hf isotope compositions often shown by zircons from S-type granites.