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Orogenic Garnet Peridotite - Tools to Reconstruct Paleo-geodynamic Settings of Continental Collision Zones

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Orogenic garnet peridotites (metamorphic rocks containing the characteristic HP garnet-olivine mineral assemblage) exposed in ancient orogenic belts may contain quantitative data regarding formation of subcontinental/ subcratonic lithosphere, evolution of a lithospheric mantle wedge, incorporation of garnet peridotite into subducted continental crust, subsequent (ultra-)high pressure metamorphism during ongoing continental subduction and final exhumation back to subcrustal levels. Allowing a more systematic way to investigate such variables in nature we propose here a simplified conceptual model that can be used to classify orogenic garnet peridotites. In addition to the "classic" mantle wedge- versus subduction zone garnet peridotites, the model subdivides mantle wedge garnet peridotites into four subtypes, called type A, B, C and D, equivalent to young/hot/dynamic- versus cold/old/static mantle in thick or thin garnet-olivine bearing mantle wedges.

We have chosen three well studied orogenic belts in Scandinavia (Scandinavian Caledonides) and China (Sulu-Dabie and North Qaidam orogen) to illustrate the applicability of the model. For garnet peridotites of the Scandinavian Caledonides, our conceptual model seems to fit well with geological observations and petrological, mineral-chemical and isotope characteristics of the orogenic garnet peridotites. Different types of mantle wedge garnet peridotite can be recognized when garnet peridotites of the WGR (type A =old, cold, thick, depleted mantle wedge- and/or subduction zone garnet peridotite) are compared to those in the Seve-, Lindås- and Tromsø Nappes (type C=old, cold, thin, depleted mantle overprinted by subduction zone garnet peridotite). Similar investigations on Chinese orogenic garnet peridotites appear to be more complicated except for the crustal origin of the Bixiling and Maowu subduction zone garnet peridotites in Dabieshan. Published models concerning the origin and evolution of the Zhimafang garnet peridotite in the Sulu terrane have two contrasting interpretations, 1) Type A=Old, cold, depleted (subcratonic) lithospheric mantle and 2) type B or D= hot, fertile, young upwelling asthenosphere. Recent evidence points towards the idea that the Xugou garnet peridotite also originates from the subcratonic lithospheric mantle underneath the Sino-Korean Craton (type A). There are also three contrasting interpretations for the origin of the Lüliangshan garnet peridotite in the North Qaidam orogenic belt: 1) type D = thin, hot, young & dynamic (Alaska type magmatic cumulate), 2) subduction zone type = serpentinised cumulates formed by dehydration of serpentinites during the subduction process and 3) type A = Archean fragments underneath a subcratonic lithosphere. It is clear from the results presented that our model is able to classify all garnet peridotites but in the case of the Chinese occurrences more detailed work is still needed before the final subtype of the model can be identified.

Assuming universal applicability of our model we conclude that the most important discriminative parameters in our model are: 1) The mean bulk temperature (T) that is operative in the mantle wedge at the onset of continental collision/subduction and 2) the thickness (P) of the lithosphere underneath the overriding plate during collisional. Finally it needs to be emphasized that also the age of melting, as well as the depth at which melting takes place (LP versus HP) are important parameters to be determined in garnet peridotites.

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