REE distribution between zircon and orthopyroxene in granulites as a link between petrology and geochronology

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Zircon has been the most versatile tool for high temperature geochronology for many decades. New trace element tools are now developed to use it also as thermometer and link it to pressure and temperature evolution of metamorphic rocks. The main focus in studies on the distribution of rare earth elements (REE) has been on garnet and zircon; with an ongoing debate about which distribution patterns constitute equilibrium under different metamorphic conditions in granulites, eclogites and migmatites. There is little data available for REE exchange with other minerals in high grade metamorphic assemblages.

We present in-situ ion microprobe data on coexisting zircon-orthopyroxene (opx) pairs from garnet-free high temperature leucosomes (tonalitic composition) as well as both garnet-absent and garnet-bearing granulites of granitic composition. The samples are from the high-temperature low-pressure granulites of Rogaland (SW Norway) and the UHT medium pressure granulites from the Brasilia fold belt.

All investigated rocks without garnet yield similar patterns for orthopyroxene, with low abundances of L-MREE (La to Eu) between 0.1 to 1x chondritic values, small negative Eu anomalies and steeply increasing M-HREE to ca. 50x chondrite for Yb. Zircon in the orthopyroxene-bearing leucosome and garnet-absent granulites have steep REE patterns, including a steep rise in HREE (at variable absolute values) with Yb/Gd of 10-20. The relatively flat HREE zircon-orthopyroxene distribution patterns (10-30 for Gd to Lu) are quite similar to patterns obtained from UHT leucosomes and granulites for zircon-garnet pairs (own studies and other authors). It can be concluded that when present in equilibrium with zircon in high temperature rocks, orthopyroxene is a sink for MREE and HREE not to be overlooked. It has similarly steep REE patterns, but much lower abundances than garnet. The impact on HREE abundances in zircon is thus diminished and the HREE pattern of zircon in equilibrium is steep.

As a result, we caution against overinterpretation of REE patterns from detrital zircon, i.e invoking granulite conditions for source rocks based only on flat or decreasing HREE patterns.

PGE distributions in Mesoarchean chromitites and mafic-ultramafic rocks in the Singhbhum Craton (India): Evidence for presence of a subchondritic source mantle domain

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In the Singhbhum Craton of India the layered ultramafic bodies with chromite deposits occur within the Archean greenstone sequences of Iron Ore Group mainly in the Nuasahi, Sukinda and Jojohatu areas. In many places these ultramafic bodies are closely associated with gabbroic intrusions. The massive chromitites of seams from the Nuasahi area are enriched in total platinum group element (PGE) concentrations (∑PGE=142 to 549 ppb) compared to host peridotitic (∑PGE=7 to 26 ppb) and adjacent gabbroic rocks (∑PGE=3 to 116 ppb). The PGE compositions for peridotitic rocks are near chondritic with strong Ir-depletion with a general positive slope (Pd/Ir = 3 to 10). The PGE compositions of chromitites are superchondritic with strong Pt depletion coupled with Ru enrichments. Gabbroic rocks have strong subchondritic IPGE compositions and show distinct PPGE fractionated trend with strong positive slope. The geochemical distributions of the PGEs in chromitites and silicate lithounits bear directly on the two problems (1) why PGEs fractionate and (2) why are they enriched in chromitites. The strong depletion of Ir and relative enrichments of PPGE in ultramafic suite along with high PGE concentrations in chromitites are genetically related to crystallization from a boninitic parental magma in a suprasubduction zone setting in Archean. However, it is difficult to explain the strong fractionation between IPGEs (Os/Ir and Ru/Ir) in the peridotitic rocks by the existing models. The strong subchondritic Ir pattern is perhaps related to the presence of a subchondritic source mantle domain beneath the Singhbhum Craton. The notion of the presence of a subchondritic source domain within the upper mantle beneath the Singhbhum Craton is also supported by the recent Os isotopic studies of these rocks.