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Combined Lu-Hf and Sm-Nd garnet-geochronology of lower crustal metapelites from the Val Strona section, Ivrea Zone

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The Ivrea Zone (IZ) is an unique example for studying geological processes in the lower and middle continental crust. Along the Val Strona (N-Italy) a nearly complete lower crustal cross-section is exposed, comprising a continuous assemblage of granulite to amphibolite facies rocks. Therefore, this section is a model example to study metamorphic processes along an increasing temperature gradient.
In order to gain new insight into the metamorphic evolution of the IZ, two metapelites covering amphibolite-facies (Kinzigite, samples E12 and E29) and granulite-facies metamorphism (Stronalite, sample E32) were investigated in terms of their petrology, geochemistry, and combined Lu-Hf and Sm-Nd garnet geochronology. Additionally, representative garnets were also investigated via EMP and LA-ICP-MS, determining their distribution patterns of major and some trace elements (REE, HFSE).
The Lu-Hf ages obtained for the granulite facies stronalite (263 $\pm$ 0,5 Ma; MSWD 0,9) is about 15 Myrs younger than the Lu-Hf ages obtained for the kinzigites (278 $\pm$ 3 Ma; MSWD 2.3, and 279.7 $\pm$ 0,9 Ma; MSWD: 0,31). The Sm-Nd ages obtained for the stronalite sample (230 $\pm$ 4,3 Ma; MSWD: 1,6) and one kinzigite sample (214 $\pm$ 33 Ma; MSWD 0.22) are younger than the Lu-Hf ages. In regard to reconstruct the metamorphic history of the IZ, it is important to reveal if the Lu-Hf ages represent garnet growth or cooling.
Although electron-microprobe data for 2+ elements (e.g. Mn) in the garnets show no typical prograde zoning patterns, LA-ICP-MS analyses revealed bell-shaped Lu concentration profiles of all three samples, indicating that the Lu-Hf ages most likely reflect garnet growth. In contrast, LA-ICP-MS profiles of Sm and Nd lack any prograde zonation. Hence, the Sm-Nd ages likely represent cooling ages and may thus indicate retrograde diffusion-controlled re-equilibration processes.
It is a long discussed question whether or not the mafic intrusions at about 290 Ma provide the heat for granulite grade metamorphism (Barboza et al. 1999). The presented Lu-Hf data are the first report on ages of metamorphic minerals apart from zircon and monazite. If the young ages of 279 Ma – 263 Ma document garnet growth, this argues for a major thermal influence of the mafic intrusions on the thermal evolution of the kinzigite formation in the Val Strona. Similar ages were also reported for zircon overgrowth zones (Vavra et al. 1996).The Sm-Nd geochronology results combined with major and trace element analyses suggest that diffusive element redistribution of these elements may have been triggered by enhanced later stage fluid activity. Furthermore, somewhat younger Lu-Hf ages obtained for nearby granulite-facies metabasites (Schuengel et al. 2012, this volume), support an underplating model as accounting for the lithological association found in the IZ.
REFERENCES:
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