Geophysical Research Abstracts
Vol. 15, EGU2013-7420, 2013
EGU General Assembly 2013

In situ ^{40}Ar/^{39}Ar dating of zoned and recrystallized phengite in metasomatized high-pressure rocks

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In situ ^{40}Ar/^{39}Ar dating provides spatial resolution that is critical to understand the temporal information in ^{40}Ar/^{39}Ar dates of metasomatized and partially recrystallized rocks as these dates can be combined with petrologic and geochemical information about the rock's history. Here, we evaluate the effects of deformation and fluid flux on ^{40}Ar/^{39}Ar dates by investigating a structural profile with strain- and recrystallization gradient across a major crustal shear zone that separates two tectonometamorphic units in the Sesia-Lanzo Zone (Western Alps).

Weakly deformed, eclogite-facies samples contain phengites that show significant major element compositional differences between pristine cores and overprinted rims. In contrast, samples from the blueschist-facies shear zone contain fine-grained, mylonitic phengite. To test the hypothesis that increasing deformation and fluid flux promote Ar transmissivity, we compare *in situ* ^{40}Ar/^{39}Ar data and geochemical tracers of fluid flow (B, Li, δ^{11}B) of relict areas with overprinted areas and mylonitized phengites. Lithium (Li) and boron (B) concentrations and B isotopic data show that retrograde fluid influx increases from weakly deformed samples towards highly deformed mylonites. Samples from within the shear zone have the lowest B concentrations and the highest δ^{11}B values, suggesting equilibration with an external fluid with high δ^{11}B.

Apparent ^{40}Ar/^{39}Ar laser spot age data were evaluated on isochron and inverse isochron diagrams to evaluate the initial ^{40}Ar/^{36}Ar ratios and the significance of the dates. Phengite cores from weakly deformed eclogitic micaschists yield statistically valid ages of about 80±3 Ma that are interpreted as crystallization ages during eclogite-facies conditions. In contrast, samples that show an intense deformational overprint associated with mylonitisation yield bimodal apparent ages: Poorly defined ages around 80-90 Ma for large mica clasts that are surrounded by the foliation and a well-defined age of 65±3 Ma for the mylonitic mica. The latter age can be associated with high fluid flux in the shear zone an gives the age of fluid-rock interaction, which caused phengite recrystallization. Overprinted phengite rims in weakly deformed samples give ages of about 75±6 Ma, overlapping with the core ages but also showing a tendency to somewhat younger ages. These can be interpreted to either reflect incomplete isotopic resetting during limited fluid influx or a distinct metasomatic event after the eclogite-facies equilibration.

In summary, fluid-induced resetting of Ar isotopes in phengitic mica is controlled by mylonitic deformation and associated fluid flux during exhumation and juxtaposition of two tectonometamorphic segments in the Sesia-Lanzo zone. Our study demonstrates that high spatial resolution is critical to fully understand the temporal information in ^{40}Ar/^{39}Ar dates of metasomatized rocks and underlines the importance of metasomatic processes for geochronology.