

FLUID ACTIVITY AND PARTIAL MELTING IN THE EVOLUTION OF UHP ROCK: EVIDENCES FROM ZIRCON U-Pb AGE AND Hf-O ISOTOPES

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In subduction- or collision-related metamorphism, fluid activity and partial melting occur at different stages and play key roles in many geological processes including metasomatism, crustal rheology, anatexis, resetting of isotopic clocks, transformation of mineral assemblages, and the creation and preservation of high-pressure (HP) and ultrahigh-pressure (UHP) rocks. The timing and features of fluid activity and partial melting, however, are quite difficult to constrain. In this study, in situ U–Pb geochronology, O and Hf isotopes in zircon have been done on a retrograde eclogite, a quartz vein and a leucosome vein enclosed in the eclogite and a country rock gneiss from the Xitieshan UHP terrane in the North Qaidam metamorphic belt, northwest China. Zircon from the quartz vein was dated at 438.0 ± 11 Ma and is consistent with the timing of peak UHP metamorphism in this region. This demonstrates that there was fluid activity during the peak UHP metamorphism. The homogeneous, bright in cathodoluminescence, zircon cores in the quartz vein contain O and Hf isotope compositions similar to the zircon in the eclogite, indicating that the zircon cores of quartz vein may be related to, or possibly derived from, the eclogite. In contrast, the oscillatory-zoned rims in the zircon crystals in the quartz vein have O and Hf isotope compositions consistent with the country rock gneiss sample. Most zircons from the leucosome vein have oscillatory zoning or wholly caliginous homogeneous in cathodoluminescence. The zircon U–Pb age of the leucosome vein is 419.6 ± 3.9 Ma, which can be regarded as the timing of extensive partial melting of the Xitieshan UHP rocks. The O and Hf isotope composition of the leucosome vein zircon is also consistent with the country rock gneiss. Therefore, the O and Hf isotopes in both the zircon rims of quartz vein and the zircons in leucosome vein are compatible with their origins from the surrounding felsic gneiss. The metamorphic zircon cores grew in the presence of fluids during the peak UHP metamorphism, whereas the younger zircon grew during partial melting of the surrounding gneiss during exhumation following granulite-facies metamorphism. This suggests that the fluid flow at the peak conditions might induce a low-degree of partial melting of the subducted slab and promote the initiation exhumation of the continental crust.

Tracing continental weathering using Li and Mg isotopes:

Insights from rivers draining the Columbia River Basalts

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Chemical weathering may have an important influence on continental crust evolution, as weathering of basalt removes Mg and can shift the crust composition towards more andesitic compositions, thus helping to solve the crustal composition paradox [e.g., 1]. We are exploring the use of soluble elements like lithium and magnesium, and their isotopes, to monitor chemical weathering of the continents. These elements are preferentially transferred to the rivers during weathering, coupled with large isotopic fractionations [e.g., 2], and therefore could be useful tracers of weathering processes. Here, we report chemical and isotopic analyses of small rivers and streams whose catchments lie entirely within the Columbia River Basalts in order to understand the processes associated with basalt weathering.

Soluble elements, such as Na, Mg and Ca are positively correlated with TDS (Total Dissolved Solids) in the rivers. The river water chemistry (e.g., Mg/Na vs. Ca/Na) reveals that more than 95% of the dissolved load comes from silicate weathering, consistent with the lithology of the catchments (basalt). There are large variations in the lithium isotopic composition of the river waters ($\delta^7\text{Li}$ varies from +9 to +30) and a negative correlation between $\delta^7\text{Li}$ and normalized Li concentration in the dissolved load, which likely marks the influence of two weathering regimes on river chemistry: incipient weathering (generating large isotopic fractionation, $\delta^7\text{Li}$ up to +30) vs. advanced weathering (with less significant isotopic fractionation, $\delta^7\text{Li}$ is around +10). This trend is opposite to that found in a previous study from rivers draining a multi-lithology basin [3]. Nonetheless, combined $\delta^7\text{Li}$ and normalized Li concentration may be a good tracer of weathering intensity. By contrast, the magnesium isotopic signature in river waters does not display an obvious difference between these two weathering regimes, which may be due to the influence of additional factors, such as different isotopic fractionation associated with various secondary mineral formation, as well as biological activity on the Mg isotope signatures. Nonetheless, river waters have isotopically light $\delta^{26}\text{Mg}$ (varying from -0.8 to -0.2) relative to the basalts (-0.2 \pm 0.1), consistent with equilibrium isotopic fractionation between water and regolith.

[1] Liu and Rudnick (2011) *Proceedings of National Academy of Sciences* **108**, 20873-20880. [2] Teng et al. (2010) *Earth and Planetary Science Letters* **300**, 63-71. [3] Millot et al. (2010) *Geochimica et Cosmochimica Acta* **74**, 3897-3912.