Apparent crustal growth due to disequilibration of the Lu-Hf isotope system during crustal melting

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The combined U-Pb-Hf analysis of zircon is a powerful, widely-used tool for studying the evolution of the continental crust though time. It allows for estimates of the proportions of new, primitive crust relative to the recycled, older continental crust for separate time slices from the Hadean through to the present.

While the general concept appears clear and straight forward, individual data sets generally need careful evaluation before interpretation. Various issues have an important influence on the isotopic data, such as the complexity of natural zircon grains, demanding careful spot selection and high spatial resolution during isotope analyses. Other analytical problems are the possible disturbance of the U-Pb system and the substantial interference correction during Hf isotope analyses.

This study will discuss the possibility that many crustal melts do not reflect the isotopic composition of their source. Most granitic rocks contain inherited zircon in their zircon population commonly preserved as cores overgrown by newly crystallized rims. The Hf isotope composition of the rims usually represents that of the magma, which is either a mixture between mantle magma and crustal components or of pure crustal origin. Even in the latter case, the $^{176}Hf/^{177}Hf$ of the melt, as reflected by the zircon rim composition, will be more radiogenic than that of their average crustal source, as unradiogenic Hf is stored in the inherited cores. The effect will increase with the percentage of inherited, non-dissolved zircon and with the time since last isotope equilibration of the crustal source. This is because new ^{176}Hf formed from Lu-decay usually readily enters the melt, as Lu is incorporated in phases other than zircon that are reactants in the melting process, while only a fraction of the Hf stored in zircon will be dissolved. Assuming a time span of 0.5-1.0 Ga since the last isotopic equilibration and that 40-60% of zircon from the source dissolve in the melt, the Hf isotope composition of the melt will be about 3-11 εHf(t) (t= time of melting) units lower than that of the source. Using 4 different examples from the recent literature, inherited zircon cores have at time of granite generation a mean εHf(t) of -3±3, -13±20, -22±19, and -21±20, which is in average about 6-20 εHf units lower than that of their magmatic rims. This correlates well with the mean age of the cores, which are about 0.46 to 1.5 Ga older than that of their rims. Notably is also that the overall isotopic variation of the inherited cores is about 5-40times higher than that in the magmatic rims (e.g., ±0.5, SD).

As a consequence, estimation of the average crustal residence time (e.g. T_{DM} ages) based on the composition of the magmatic zircon will be too young and will thus overestimate the contribution of juvenile magmas to the system. Although granite magmas probably do not fully equilibrate with their sources, the data imply that crustal melting stimulates isotopic and chemical homogenisation of the crust.

Protracted tectonometamophic history at the base of an orogenic channel in the southeastern Canadian Cordillera

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We tested the recently proposed model of channel flow[1] by mapping key outcrops in the northern Monashee Mountains of the southeastern Canadian Cordillera. The structural and metamorphic continuity of this area constitute the main challenges for this controversial model. Our fieldwork revealed the existence of a major SE-striking, reverse-sense shear zone, named Hellroar Creek Shear Zone (HCSZ). It is characterized by a large volume (>60%) of highly sheared leucogranite and leucosome, whereas leucogranite in its footwall, although locally as abundant, forms a heterogeneous mesh of highly discordant intrusions. The HCSZ separates a low-strain domain with preserved stratigraphic polarity and dominated by SW- to W-verging structures in its footwall, from a high-strain domain with rocks recording complete transposition by top-to-the-NNE to top-to-the-E shearing in its hanging wall.

One migmatitic pelitic schist, one prekinematic, and one synkinematic leucogranite dykes from the hanging wall of the HCSZ, as well as one postkinematic leucogranite dykes from its immediate footwall were dated for U-(Th)-Pb monazite and zircon geochronology. Collectively, the near continuous record of monazite and zircon growth from 104 to 57 Ma in these samples indicates an exceptionally long tectonometamorphic history for this reverse-sense shear zone.

The presence of a major shear zone with a protracted history of ductile deformation in an area previously mapped as continuous supports the channel flow model. In addition, the timeframe of shearing coincides with the timing of flow derived from the pattern of younger cooling ages recorded from the front to the rear of the proposed channel.[1] The HCSZ is thus interpreted as the base of a channel flow system that was active for >40 Myr in the Late Cretaceous.

[1] Gervais & Brown (2011) *Lithosphere* **3**, 55-75.