Paper Number: 1771

Hard and fast or soft and slow: rates of crustal reworking and orogenesis in the North Atlantic Region

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Zircon U-Pb age and Hf isotopic patterns have become the tool of choice to address questions not only on magma source but also crustal evolution. The latter use of time-Hf data relies on the distinctive conservative nature of the Hf isotopic system in which, after an initial fractionation event, this signature is assumed to be only modified through predictable ingrowth of radiogenic Hf dependent on the reservoirs Lu/Hf ratio. However, it has become evident that many magmatic events require new mantle addition as the thermal impetus for melting of pre-existing crust. In this situation rather than simply reflecting reworking, the isotopic signature indicates a mixing process. Such difference in process can to some extent be diagnosed via the slope of the apparent Hf evolution array. Hf-time trends also carry within them a, albeit cryptic, record of the geodynamic setting as different tectonic configurations recycle and add new crust at different rates. As an example of the difference in Hf apparent evolution slopes we present Hf-time compilations from three geographically distinct components of the North Atlantic Region and use this to assist in understanding their evolution during the past 1200 million years.

The εHf/Ma trajectory of the Sveconorwegian Orogen corresponds to a $^{176}Lu/^{177}Hf$ ratio of 0.012, which implies that crustal growth was driven primarily by reworking of pre-existing crust with little input from depleted mantle, nor from older, more evolved crustal reservoirs. The Valhalla Orogen reveals a similar comparatively shallow εHf/Ma path. In stark contrast to these patterns is the steep εHf/Ma trajectory of the Grenville Orogen that requires a mixing process involving a depleted component along with crust of at least ~1.8 Ga apparent age. The degree of reworking required to produce the εHf/Ma trend of the Grenville Orogen is consistent with a

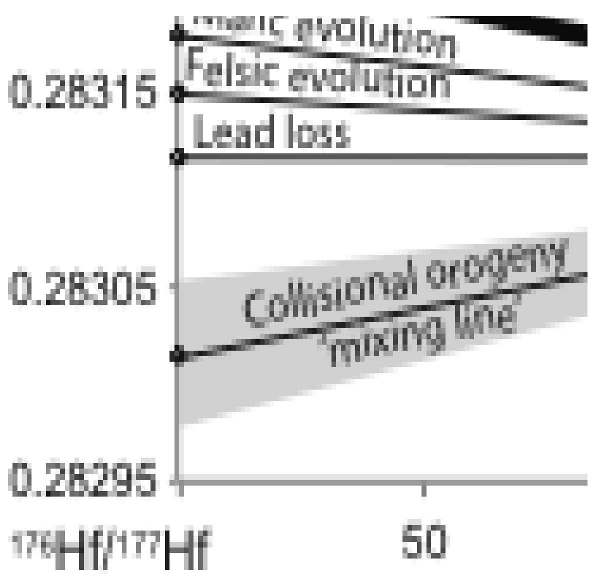

Figure 1: εHf (A.) and $^{176}Hf/^{177}Hf$ (B.) trajectories expected for crustal evolution of various compositions, lead-loss, and crustal mixing during a collisional orogeny.

collisional orogeny whereas both Sveconorwegian and Valhalla Orogens are consistent with an accretionary margin.