# Integrating Pb isotopic composition of feldspar with Hf isotope systematics of zircon to constrain granite sources

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The integration of Pb isotope data from feldspars and Hf isotope data from zircons that crystallized in the same granitic rock has the potential to determine the timing and nature of its crustal source more rigorously than using only Pb or Hf isotope data alone. Hf model ages of zircon grains can be calculated to constrain the timing of melt extraction from depleted mantle, yet the results depend critically on the $^{176}Lu/^{177}Hf$ assumed for this calculation. The measured $^{176}Lu/^{177}Hf$ of a zircon grain can be quite different than the Lu/Hf of the parent magma due to preferential partitioning of Hf into the zircon crystal, resulting in low Lu/Hf. Therefore, the Lu/Hf of the crustal source of the analyzed zircon must be assumed in order to calculate a Hf model age, if only Hf isotope data are available. However, Pb isotope data from feldspar can independently constrain the timing of crustal source separation from depleted mantle, and thus the Lu/Hf can be determined uniquely. The derived Lu/Hf can then be used to characterize the nature of the crustal source based on the positive correlation between Lu/Hf and $SiO_2$ (wt.%) for various rock types.

To demonstrate the Hf-Pb combined technique, we present LA-MC-ICP-MS analyses of Pb isotope compositions of igneous feldspars and Hf isotope compositions of magmatic zircon grains from 3 different granodiorite samples from the surface of the southern edge of the Flemish Cap, an offshore basement high in the North Atlantic, collected by the Canadian scientific vessel CCGS Hudson. LA-ICP-MS U-Pb zircon geochronology revealed the granodiorite samples have different ages: 2711±13 Ma (2s), 1869±15 Ma (2s), and 304.7±3.5 Ma (2s), with zircon $\varepsilon_{Hf}$ ranging from (-0.1 to -2.8), (-14.1 to -20.1), and (+1.1 to -5.1), respectively. Pb isotope compositions from all 3 granodiorite samples plot slightly above upper mantle values, trending towards a high-$\mu$ source such as upper crust. The Pb isotope compositions of the feldspar is used to determine the time of source separation from the depleted mantle. This 'model age' is then used along with the Hf isotope compositions of zircon grains to back-calculate the Lu/Hf of the crustal source, thereby characterizing the nature of the extracted crust.