U-Th-Pb geochronology of meta-carbonatites and meta-alkaline rocks

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U-Pb and Th-Pb ages of zircons from eight meta-carbonatite and four meta-alkaline rock samples provide evidence for three distinct episodes of carbonatite and alkaline magmatism in the southern Canadian Cordillera spanning a period of ~460 Ma. The earliest (Neoproterozoic) event occurred at ~800-700 Ma and coincides with the postulated initial break-up of Rodinia. The second, previously undocumented, event of carbonatitic magmatism is constrained to the Late Cambrian to Early Ordovician at ~500-490 Ma and corresponds to a period of extensional tectonics that affected the western continental margin of North America from the Canadian Cordillera to the southwestern United States. The youngest and most prevalent period of alkaline igneous activity occurred in Late Devonian to Early Carboniferous times at ~360-340 Ma and also resulted from extensional tectonics. In addition, different episodes of amphibolites facies metamorphism subsequently affected the igneous rocks between ~170-50 Ma.

The magmatic emplacement ages, as well as the time of subsequent metamorphism, were further confirmed and constrained by U-Th-Pb dating of the accessory minerals baddeleyite, titanite, monazite, allanite, pyrochlore, and apatite (Figure 1).

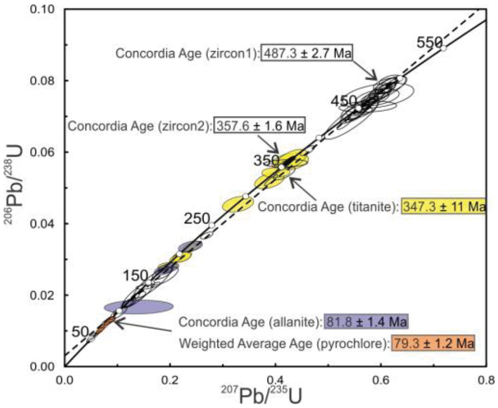

Figure 1: Concordia diagram of zircon, titanite, allanite and pyrochlore analyses from a meta-carbonatite sample (HwCr-001) defining a linear array with upper and lower intercepts of 436 and 71 Ma. However, this 'simple' linear array obscures the complex behavior of different isotope systems in the accessory phases and the complex geological history that led to the above pattern.

In combination, these datasets put new constraints on the timing of carbonatite and alkaline igneous activity and the evolution of (ancestral) North America's western continental margin from Neoproterozoic to Carboniferous times, and elucidate the applicability of different geochronometers and their sensitivity to amphibolites facies metamorphism in this set of unusual high-alkaline rocks.

Lithium isotopes systematics in Geothermal systems

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Assessing the origin and behaviour of lithium and the distribution of Li isotopes in geothermal systems is of major importance in order to increase our knowledge of the lithium cycling in the Earth's crust. Lithium is a fluid-mobile element and due to the large relative mass difference between its two stable isotopes, it is subject to significant low and high temperature mass fractionation which provides key information on the nature of water/rock interaction processes. The main objective of the present work is to constrain the behaviour of Li and its isotopes in geothermal systems both for geothermal water samples representing deep circulation in the crust and by using an experimental approach.

The behaviour of Li and its isotopes (δ^7Li) have been characterized in geothermal systems located in volcanic island arc areas: Guadeloupe, Martinique islands [1] and in New Zealand [2]. Moreover, one particularly important aspect of this work was to establish the nature, extent and mechanism of Li isotope fractionation as a function of temperature during water/rock interaction.
And, we also report results of Li isotope exchange experiments during seawater/basalt interaction (from 25 to 250°C). These results confirm that Li isotopic exchange is strongly temperature dependent, and demonstrate the importance of Li isotopic fractionation during the formation of Li-bearing secondary minerals and allow us to determine the following empirical relationship between isotopic fractionation and temperature: $\Delta_{\text{solution - solid}} = 7847 / T - 8.093$.

This work shows that the fractionation of Li isotopes is dependent upon the extent of water/rock interaction in terms of intensity (i.e. temperature that control primary mineral dissolution and secondary mineral formation in geothermal systems). Altogether, this study highlights that the use of Li isotopic systematics is a powerful tool for characterizing the origin of geothermal waters as well as the nature of their reservoir rocks.

[1] Millot *et al.* (2010) *Geochim. Cosmochim. Acta* **74**, 1852-1871.
[2] Millot *et al.* (2012) *Applied Geochem.* doi:10.1016/j.apgeochem.2011.12.015