

## Cerium isotope systematics of oceanic carbonatites

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Oceanic carbonatites have been reported only at the Cape Verde and Canary archipelagos, North Atlantic Ocean. Geochemical studies based on stable, radiogenic and noble gas isotopes have led to the general consensus that their parental magmas originate in the mantle. Two contrasted models, however, have been proposed for the origin of the carbon of their source: recycled marine carbonates via subduction [1, 2] vs. primordial carbon [3].

Marine carbonates [4] show REE patterns distinct from those assumed or measured for mantle and mantle-derived reservoirs (D<sup>77</sup>: [5]; Lower Mantle: [6]; DMM: [7]; MORB: [8]). Notably chondrite-normalized La/Ce and Sm/Nd ratios have inverse values. Consequently old recycled carbonates are likely to display  $\epsilon_{\text{Ce}} > 0$  ( $\epsilon_{\text{Ce}}$  is the  $^{138}\text{Ce}/^{142}\text{Ce}$  variation relative to the Bulk Earth  $\times 10000$ ) and  $\epsilon_{\text{Nd}} < 0$  ( $^{143}\text{Nd}/^{144}\text{Nd}$  variation relative to the Bulk Earth  $\times 10000$ ) with time, whereas mantle-related materials will show  $\epsilon_{\text{Ce}} \leq 0$  and  $\epsilon_{\text{Nd}} \geq 0$ . Thus coupled Ce and Nd isotope systematics appear to be a powerful tool to decipher between the two proposed origins for the carbon of oceanic carbonatites.

We have measured Ce and Nd data on carbonatites from the Cape Verde and Canaries archipelagos, together with basaltic samples from the same locations. We have also determined  $\epsilon_{\text{Ce}}$  and  $\epsilon_{\text{Nd}}$  values for Tamazert carbonatites (Marocco) as it has been proposed that the Cape Verde, Canary and Tamazert carbonatites share a common source [9]. Our first measurements on oceanic samples argue in favor of recycled marine carbonates in the source of oceanic carbonatites.

[1] Hoernle *et al.* (2002) *Cont. Mineral. Petrol.* **142**, 520-542. [2] Doucelance *et al.* (2010) *GCA* **74**, 7261-7282. [3] Mata *et al.* (2010) *EPSL* **291**, 70-83. [4] Plank & Langmuir (1998) *Chem. Geol.* **145**, 325-394. [5] Tolstikhin *et al.* (2006) *Chem. Geol.* **226**, 79-99. [6] Doucelance *et al.* (2003) *GCA* **67**, 3717-3733. [7] Workman & Hart (2005) *EPSL* **231**, 53-72. [8] Hofmann (1988) *EPSL* **90**, 297-314. [9] Bouabdellah *et al.* (2010) *J. Petrol.* **51**, 1655-1686.

## Dramatic seasonality of biogeochemical signatures in watersheds underlain by continuous and discontinuous permafrost

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High latitude watersheds experience two extreme seasons: 6-9 months of cold, snow covered winter and a warm, bright, summer. Between these seasons is the spring freshet, a dramatic two to three week period when up to three quarters of the yearly precipitation runs off. The summer to winter transition is far less remarkable as temperatures and light slowly decrease until winter arrives. The intense seasonality and transitions in Arctic rivers are associated with unique biogeochemical signatures, a landscape scale “view” of vegetation, soil, weathering, and water column processes.

Discerning sources or fluxes of compounds out of Arctic rivers is difficult in large rivers because they represent the combined effect of innumerable plot-scale melt water sources, each coming from different soil and vegetation types, each experiencing a slightly different melt timing and evolution, and each following its own timing. Work at Arctic sites typically means field work in remote locations with sparse ancillary data and this provides added challenges.

Spring melt is characterized by an ionic pulse of solutes, dissolved organic carbon and other nutrients (ammonium, phosphate and nitrate) leached by snow melt water from the surface organic mat of vegetation and near-surface soil. Summer and fall flows are comprised largely of shallow flow from a deepening seasonally thawed (“active”) layer. During late summer with an expanded active layer or at sites where permafrost is degrading these processes may be associated with an increasing mineral weathering signal into watersheds. The watershed biogeochemical response to precipitation in continuous and discontinuous terrains may also yield insight into subsurface permafrost geomorphological characteristics. Winter processes are the least studied or understood but overflow ice (“aufeis”) provides access to deep, old waters.

This presentation will focus on using water stable isotopes, major ion concentrations, and permafrost delineation to identify biogeochemical sources in watersheds draining continuous and discontinuous permafrost. Field sites represent permafrost terrains in Alaska from the North Slope to the Interior. Biogeochemical processes associated with scaling, meteorology, and climate warming will be discussed.