

## Revisiting land to ocean fluxes

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A large number of diverse observations reveal that substantial lithogenic material dissolution occurs at the land-ocean interface, a key area targeted by the GEOTRACES international program ([www.geotraces.org](http://www.geotraces.org)).

1) The compositions and distribution of numerous elemental tracers and isotopic systems including Co, <sup>143</sup>Nd/ <sup>144</sup>Nd, <sup>232</sup>Th/<sup>230</sup>Th, <sup>30</sup>Si/<sup>28</sup>Si, <sup>56</sup>Fe/<sup>54</sup>Fe in the oceans can only be accurately interpreted by taking account of a substantial input to seawater from lithogenic material from the continental shelf or margins [1].

2) Closed-system laboratory experiments show that a significant fraction of river transported material dissolves into seawater over the time scale of days to months, releasing elements and isotopes to the fluid [2].

3) A recent study demonstrated that particulate material dissolution is the dominant source of Sr to the waters the Borgarfjörður (Iceland) estuary (Jones *et al.*, in prep).

These observations suggest that from 0.5 and 10% of the mass contained in river transported particulate material is released to seawater during the first days to months following its arriving to the oceans. As the total particulate material flux to the world's oceans exceeds the corresponding dissolved load flux by as much as a factor of 30, particulate dissolution at the continental margins may be the dominant source of many of the elements present in the oceans [3].

To assess the significance of particulate dissolution on ocean chemistry, we have estimated the total global flux to seawater of a suite of elements originating from riverine transported particulate material by taking account of the average composition and mineralogy of continental and volcanic sourced particulates, together with the published dissolution rates for these minerals, measured surface areas of representative particulate materials, and mineral saturation indexes computed using PHREEQC. Results indicate that particulate material dissolution is a significant contributor to the global flux of major elements (e.g. Si, Ca, and Sr) to the oceans, and can dominate the fluxes of some critical trace elements and nutrients.

[1] Arsouze *et al.*, Biogeo., 2009; Fripiat *et al.*, Mar Chem. 2011; Radic *et al.*, EPSL, 2011; Bown *et al.*, Biogeo., 2013.

[2] Jones *et al.*, GCA, 2011; EPSL 2012; Pierce *et al.*, EPSL, 2013; Oelkers *et al.*, C.R. Geoscience, 2012. [3] Jeandel *et al.*, EOS, 2011.

## Magmatic processes beneath Furnas volcano, São Miguel, Azores

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Furnas, São Miguel, Azores is an oceanic-island caldera volcano characterised by mafic to silicic, metaluminous to peralkaline magmas, and a range of eruption styles that imply significant variation in pre- and syn-eruptive processes. Here, we investigate these processes and provide insights into the magma plumbing system of Furnas by targeting selected units within the volcano's stratigraphy. These include the products of two older caldera-forming events, namely the Povoação Ignimbrite (PI) (30,000 <sup>14</sup>C y B.P.) and an ignimbrite interpreted to represent the second caldera-forming eruption (~12,000 <sup>14</sup>C y B.P.), as well as the younger, sub-plinian eruptions (< ~5,000 <sup>14</sup>C y B.P.) of the Upper Furnas Group (UFG), Furnas A-J.

The UFG spans a compositional range from metaluminous to mildly peralkaline trachyte, with agpaite indices (AI) between 0.73 and 1.13. Mineralogical assemblages of the UFG include alkali-feldspar, clinopyroxene, Ti-magnetite ± biotite, ilmenite and apatite, though phenocryst contents are typically low (< 5 vol.%). Ba and Sr concentrations are 5-115 and 2-51 ppm, respectively, whilst Nb and Zr contents are 177-303 and 1010-1498 ppm, respectively. A pronounced negative Eu anomaly (Eu/Eu\* = 0.15) is present in all UFG samples. Rare cognate syenite nodules are present in Furnas J, comprising alkali-feldspar, clinopyroxene, amphibole, Fe-Ti oxides and apatite. The PI is trachytic and metaluminous (AI = 0.95-0.98), with no Eu anomaly. The mineral assemblage is similar to the UFG, but Ba and Sr contents are significantly higher (287-308 and 85-88 ppm, respectively), whilst Nb and Zr are notably lower (133-140 and 810-860 ppm, respectively) than in the UFG.

We discuss the geochemical variation of silicic magmatism at Furnas, and highlight the role of plagioclase and alkali-feldspar fractionation, alongside formation of a syenitic mush zone, in the derivation and shallow crustal evolution of Furnas magmas, as well as the temporal development of oceanic island, peralkaline magma systems.