

## No role for discrete, depleted high $^3\text{He}/^4\text{He}$ mantle

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Recently, several studies have shown an apparent link between high  $^3\text{He}/^4\text{He}$  and depleted mantle (Stuart *et al.*, 2003; Class and Goldstein 2005) which is inconsistent with prevailing orthodoxy where high  $^3\text{He}/^4\text{He}$  reflects a lack of mantle degassing and depletion. Here we present 28 new  $^3\text{He}/^4\text{He}$  analyses from Tertiary picrites of Baffin Island and West Greenland and have identified 21 samples with  $^3\text{He}/^4\text{He} > 35R_a$  (the highest value observed in recently erupted basalt). Whole rock  $^{143}\text{Nd}/^{144}\text{Nd}$  for these samples show a significant peak at depleted values (mean of 0.513024), as observed in an earlier study (Stuart *et al.*, 2003), but an interesting feature of the new data is the scatter in  $^{143}\text{Nd}/^{144}\text{Nd}$  down to 0.512876, a value which although not chondritic is certainly less depleted than that observed by Stuart *et al.*, (2003). It is important to establish the effects of crustal contamination that would act to lower both  $^3\text{He}/^4\text{He}$  and  $^{143}\text{Nd}/^{144}\text{Nd}$ . Whole rock Pb isotope data show significant variations which are consistent with incorporation of unradiogenic Pb of crustal origin but critically there is no relationship between Pb and Nd isotopes. Thus, if crustal contamination is the cause of Pb isotope variation, it was not responsible for the range in  $^{143}\text{Nd}/^{144}\text{Nd}$ . In addition, major and trace element compositions of olivine hosted melt inclusions allow us to compare melt inclusion compositions from olivines of various sizes, that record different stages of magma evolution, to provide better resolution on the effects, if any, and timing of potential crustal contamination. We conclude that variations in  $^{143}\text{Nd}/^{144}\text{Nd}$  are likely to derive from heterogeneity in the mantle sources tapped by the Baffin Island and West Greenland picrites and that these new data do not support the concept of a discrete depleted-high  $^3\text{He}/^4\text{He}$  end-member in the mantle.

### References

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## What controls iron isotope fractionation in an acid mining pile?

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This study explores the potential use of Fe isotope analysis in long-term risk assessment of acid mine drainage generating mining piles. Balci *et al.* (2006) have demonstrated the enrichment of heavy Fe isotopes in Fe oxidation products with respect to  $\text{Fe(II)}_{\text{aq}}$  during growth of *Acidithiobacillus ferrooxidans* in batch culture-experiments. They argued that inorganic equilibrium fractionation between  $\text{Fe(III)}_{\text{aq}}$  and  $\text{Fe(II)}_{\text{aq}}$  is the controlling reaction as described earlier by Welch *et al.* (2003). These authors have shown that in equilibrium the isotopic difference is  $\Delta^{56}\text{Fe}_{\text{Fe(III)-Fe(II)}} \sim 2.9 \text{ ‰}$ . Here, we present Fe isotope ratios measured on sequentially leached tailings material sampled from a 25 m drill core into an active pile at Selebi-Phikwe, Botswana, and of an additional analog column bio-leaching experiment in the laboratory. Throughout the drill core, reactive solid  $\text{Fe(III)}$  is enriched in the heavy isotopes (average  $\delta^{56}\text{Fe} = -0.15 \text{ ‰}$ ) with respect to pyrrhotite (average  $\delta^{56}\text{Fe} = -0.40 \text{ ‰}$ ). This is in general agreement with the batch experiments of Balci *et al.* (2006). The fraction of exchangeable and soluble Fe shows very low  $\delta^{56}\text{Fe}$  values down to  $-2.4 \text{ ‰}$ . Such extreme values can only occur in a small residual pool after the majority of dissolved Fe has been removed by precipitation. Our results can best be explained if the total reaction is broken down as follows. Fe dissolved from pyrrhotite is partitioned by microbial  $\text{Fe(II)}$ -oxidation into a mixed  $\text{Fe(III)}_{\text{aq}}$  and  $\text{Fe(II)}_{\text{aq}}$  pool which quickly equilibrates isotopically. Precipitation of solid  $\text{Fe(III)}$  occurs with perhaps additional fractionation from the  $\text{Fe(III)}_{\text{aq}}$  in the mix. Our data suggest that the mixed reservoir initially consisted mostly of  $\text{Fe(III)}_{\text{aq}}$  whose  $\delta^{56}\text{Fe}$  would be close to the initial pyrrhotite. The strongly fractionated residual derives from the remaining small pool of  $\text{Fe(II)}_{\text{aq}}$ . However, low  $\delta^{56}\text{Fe}$  values cannot be sustained unless resupply of unfractionated, freshly dissolved Fe from pyrrhotite is sluggish. Although showing complex results, the bio-leaching experiments appear to confirm that the ratio of  $\text{Fe(II)}_{\text{aq}}$  to  $\text{Fe(III)}_{\text{aq}}$  in the fluid, and thus the overall metal sulfide oxidation activity in the pile, is the main factor that controls the isotopic composition of soluble Fe.

### References

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