

## Remediation of metal, arsenic and phenanthrene contaminated soil using charcoal and iron filings

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In soils with mixed contamination, degradation of organic pollutants is limited by toxicity caused by metals and as such are difficult to remediate. Non-activated charcoals made from low cost source materials have been developed that can remove 200000 mg/kg metal cations. Given that charcoals are stable in the environment, these charcoals provide low cost, long term remediation solutions for metal immobilisation in soil. For arsenic contamination, iron amendments are a common treatment. In this study, highly metal sorbent charcoals have been used in combination with iron filings to immobilise both metal and arsenic toxicity, enabling the degradation of organic contaminants (phenanthrene) to take place. Treatments with 1% w/w charcoal alone or in combination with 5% w/w iron filings effectively enabled phenanthrene degradation and restored plant growth by reducing leachable metals. Charcoal had no effect on leachable arsenic levels, but iron filings used alone or in combination with charcoal significantly reduced arsenic leaching and uptake into plant material. While treatment with iron filings alone reduced both arsenic and metal leaching, enabling phenanthrene degradation to take place, plant growth was not restored possibly due to changes in soil texture and increased iron availability.

## Origin of Siberian flood basalts

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We report compositions and formation conditions of parental melts for early stage of Siberian Flood Basalts (SFB) based on the compositions of host olivines and melt inclusions from picrites of Gudchihinskaya unit, Norilsk region [1]. High precision analysis of olivine phenocrysts [2] reveals much too high Ni and far too low Mn in their compositions to be equilibrium with peridotite mantle source. Using approach of [2,3] we found that the mantle source of early SFB was olivine free pyroxenite formed by reaction between recycled crust and peridotite. Trace element and radiogenic isotope composition of parental melts argue for old depleted oceanic crust as the original recycled component. Reconstructed parental melts contain 11-14 wt. % MgO, 48-49 wt.% SiO<sub>2</sub>, 9-10 wt.% CaO and 650-900 ppm Ni. They have likely formed by melting of pyroxenite at depth of 150-180 km under thick Siberian platform in a mantle plume with potential temperature 1500-1600°C similar to the Hawaiian plume [4]. SFB primary melts formed at temperatures lower than dry peridotite solidus by 50-100°C [1]. This explains lack of peridotitic component in the Gudchinskaya SFB primary melts source.

Gudchinskaya SFB parental melts were depleted in S (200-500 ppm) but enriched in Cu and PGEs due to the lack of residual sulfide in their pyroxenitic restite. This feature likely played a crucial role in building their ore forming potential.

Parental and evolved melts were unusually enriched in Cl (350 to 2000 ppm), containing significantly more Cl than typical OIB and Decan flood basalts [1,5]. This Cl partly came from the mantle source but mostly was inherited by magmas from Cl rich sediments shallow in the Siberian continental crust. Our data suggest that SFB may have produced more than 4 Tt (10<sup>12</sup> tons) of HCl emission to the atmosphere. Possibly this was significant contribution to the cause of the Permian-Triassic mass extinction.

[1] Sobolev *et al.* (2009) *Petrology* **17** (3), 1-37. [2] Sobolev *et al.* (2007) *Science* **316**, 412-417. [3] Sobolev *et al.* (2008) *Science* **321**, 536. [4] Sobolev *et al.* (2005) *Nature* **434**, 590-597. [5] Self *et al.* (2008) *Science* **319**, 1654-1657.