The Khibiny complex (NW Russia) – An example of mixed-source hydrocarbons in plutonic rocks

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It is well known that plutonic complexes can host high concentrations of hydrocarbon-bearing fluids [1]. The hydrocarbons may be abiogenic, either sourced from the mantle or the result of late to post magmatic synthesis [2 and references therein]. Alternatively, they could be biogenic and transported by fluid movement into the plutons from the surrounding host rocks (e.g. [3, 4]). However, to date there have been no reports of mixed-source hydrocarbons in igneous rocks. To document such mixing it is necessary to analyse samples along a traverse from pluton core to rim as has been done in this study.

In the core-near rocks of the Khibiny complex an abiogenic mantle origin of the hydrocarbons is indicated by primary methane-dominant fluid inclusions, melt inclusions that contain a methane-rich gas phase and an isotopic composition of CH_4 ($\delta^{13}C$=-5.4‰) typical of mantle derived carbon. By contrast hydrocarbons in the outer parts of the pluton have a biogenic signature characterised by high carbon contents (0.2 wt %), high CH_4 levels (up to 100 cm³/kg STP) and low $\delta^{13}C$ values (-22.4‰). Incorporation of organic material into the pluton rim occurred either through convective fluid flow during emplacement or through post cooling percolation of meteoric waters and/or host rock related fluids along fracture systems.

This mixing phenomenon demonstrates the importance of appreciating sample locations when interpreting gas phase evolution in plutonic rocks.

[1] Schutter (2003) *Geol Soc. Spec. Pub.* **214**, 7-33. [2] Beeskow *et al.* (2006) *Lithos* **91**, 1-18. [3] Parnell (1988) *Mar. Pet. Geol.* **5**, 385–396. [4] Dutkiewicz (2004) *Org. Geochem.* **35**, 937-957.

Adsorption and reduction of U(VI) in soil from Dounreay, UK

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Microbially mediated removal of U(VI) from solution via reduction to insoluble U(IV) oxides is well known, but the fate of U(VI) already associated with solid surfaces is less clear. Here we describe results from oxic adsorption and anaerobic microcosm experiments to examine the fate of uranium(VI) during microbially mediated bioreduction. The microcosms contain soil representative of the UKAEA site at Dounreay [1]. In oxic adsorption experiments, uptake of 50 µmol l^{-1} U(VI) was rapid and complete from artificial groundwater and in experiments with groundwater amended with 0.2 mmol l^{-1} ethylenediaminetetraacetic acid (EDTA) a complexing ligand used in nuclear fuel cycle operations. By contrast, uptake was slower in systems amended with 10 mmol l^{-1} bicarbonate. XAS experiments confirmed that uranium was adsorbed to soil as U(VI) in all three groundwater systems. After anaerobic incubation for 120 days and the development of microbially mediated Fe(III)- and SO_4^{2-}- reducing conditions, soil associated uranium was present as U(IV) in all three systems. Further investigation of unamended groundwater systems indicated that complete U(VI) reduction required advanced iron- and sulfate- reducing conditions and an active microbial population. Microbial community analysis of soils incubated under anoxic conditions for 120 days revealed the predominance of close relatives of *Geobacter* and *Clostridium* species which are known to facilitate U(VI) reduction. Overall, efficient U(VI) removal from solution by adsorption and subsequent microbially mediated reduction of soil-associated U(VI) occurs even in the presence of potential complexing agents.

[1] Begg *et al.* (2007) *Sci. Total Environ.* **373**, 297-304.