

Characterisation of depleted uranium munitions residues by synchrotron X-ray microanalysis

D.E. CREAN^{1,2}, F.R. LIVENS², M.C. STENNETT¹,
D. GROLIMUND³, C.N. BORCA³ AND N.C. HYATT^{1*}

¹Department of Materials Science and Engineering, University of Sheffield, UK

(*correspondence: n.c.hyatt@sheffield.ac.uk)

²School of Chemistry, University of Manchester, UK

³Swiss Light Source, Paul Scherrer Institute, Villigen, Switzerland

The testing and use of depleted uranium (DU) munitions has resulted in the contamination of a number of sites worldwide. Interaction of DU munitions with armoured targets on impact produces particulate residues mainly composed of uranium oxides [1]. Although these residues are well characterised on formation, there is uncertainty surrounding their long term fate in the environment.

Using a complementary suite of synchrotron X-ray microanalyses, we have characterised a set of ~30 yr. environmentally aged DU particles recovered from soils at MOD Eskmeals, UK. Two areas of the site were sampled, an surface soil and a disposal pit for contaminated timbers.

Particles in surface soils had a distinctive spherical morphology and were composed of uranium oxides, U₃O₇ and U₃O₈. X-ray diffraction (μ -XRD) and X-ray absorption spectroscopy (μ -XAS) mapping were used to resolve distribution of these phases and corresponding U oxidation states, revealing distinct domains of each oxide. These data are consistent with DU particles as formed, and indicate that, at this site, primary morphology and U speciation are persistent in the environment.

In contrast, U in disposal pit soils was speciated mainly as U(VI) phosphate hydrate phases such as meta-ankoleite (K(UO₂)(PO₄)·3H₂O). A combination of X-ray fluorescence (μ -XRF), μ -XRD and μ -XANES mapping was used to resolve domains of U₃O₇, likely residual primary particles, surrounded by a widespread distribution of U(VI) phosphate hydrates, suggestive of a substantial alteration layer.

This study indicates that the environmental stability of DU munitions residues is highly variable and sensitive to deposition environments. Additionally, the utility of high spatial resolution synchrotron X-ray microprobe techniques to resolve micron-scale heterogeneity in U chemistry in complex environmental samples was demonstrated.

[1] Handley-Siduh, *et. al* (2010), *Sci. Total Environ.* **408**(23) 5690-700.

Platinum Stable Isotope Tracing of Earth's Accretion and Differentiation

JOHN B. CREECH^{1*}, JOEL A. BAKER²,
MONICA R. HANDLER¹, MARTIN SCHILLER³
AND MARTIN BIZZARRO³

¹School of Geography, Environment and Earth Sciences, Victoria University of Wellington, PO Box 600, Wellington 6140, New Zealand.

(*correspondence: john.creech@vuw.ac.nz)

²School of Environment, The University of Auckland, Private Bag 92019, Auckland, New Zealand

³Centre for Star and Planet Formation, Natural History Museum of Denmark, University of Copenhagen, DK-1350 Copenhagen, Denmark

The platinum group elements (PGEs; Ru, Rh, Pd, Os, Ir, Pt) are highly siderophile and strongly sequestered into metallic cores during planetary differentiation. However, PGE abundances in Earth's mantle are higher than predicted from low-pressure metal-silicate partitioning experiments. These relative excesses are reconciled in models by considering either late addition of chondritic material or very different physical conditions during core formation. The Pt stable isotope system represents a novel tool for investigating this problem.

Using recently developed methods for highly precise measurement of Pt stable isotopes by double-spike MC-ICPMS [1] and chemical separation of Pt from geological materials [2], we have characterised the Pt stable isotopic compositions of iron meteorites (as a proxy for Earth's core) and chondrites (as a proxy for the undifferentiated Earth as well as proposed late veneer material) and compare these with data for samples of Earth's mantle. Pt is concentrated in iron meteorites (ca. 3–40 ppm; [3]) compared with undifferentiated meteorites (ca. 0.7–5.0 ppm; [4]), and core formation is thus expected to produce a fractionation in Pt stable isotope ratios, particularly if changes in redox state are involved (Pt²⁺ versus Pt⁰). The composition of such materials are expected to be isotopically distinct from undifferentiated meteorites. By identifying these isotopic fingerprints in Earth's mantle, it should thus be possible to constrain the potential sources or processes responsible for the PGE distribution in Earth's mantle.

[1] Creech *et al.* (2013). *Journal of Analytical Atomic Spectrometry* (In press). [2] Creech *et al.* (in prep). [3] D'Orazio and Folco (2003). *Geostandards and Geoanalytical Research* **27**, 215-225. [4] Tagle and Berlin (2008). *Meteoritics & Planetary Science* **43**, 541-559.