Impact of the earthworm *Lumbricus terrestris* on arsenic mobility and speciation in soil

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Earthworms can be found living in arsenic contaminated soil. Generally earthworm activity increases the mobility and bioavailability of contaminants [1]. Using soil collected from Devon Great Consols containing 1150 mg As kg^{-1} we have investigated how the secretion of earthworm mucus and the passage of soil through the earthworm gut impacts mobility and speciation of As.

Lumbricus terrestris were cultivated in the As-contaminated soil and the casts collected. Water soluble As increased from 1.6 mg kg^{-1} in the bulk soil to 18 mg kg^{-1} in the casts. Casts were then aged and this effect was still present 56 days after soil excretion. Analysis indicated that these changes were due to release of As(V) from soil particles during the digestion process as a result of increases in pH and increased concentrations of disolved organic carbon. No reduction of As(V) to As(III) was detected despite passage of the As through the anoxic rear-gut of the earthworm.

Solutions of earthworm mucus were produced by washing earthworms with deionised water. These solutions were then used as an extractant for the As-contaminated soil. At low mucus concentrations As extraction was reduced relative to deionised water due to formation of ternary complexes between the amino acids present in the mucus, As and surfaces of Fe oxyhydroxides. However, at higher mucus concentrations increased pH and dissolved organic carbon effects dominated resulting in increased extraction of As.

The mobilisation of As (and other elements) from contaminated soils in the environment by cast production and mucus secretion may allow for accelerated leaching or uptake into biota which is under-estimated in current risk assessments based on analysis using soils in the absence of soil biota.

[1] Sizmur & Hodson (2009) *Environ. Pollut.* **157**, 1981–1989.

Continental subduction, slab breakoff and eduction: End-member processes for UHP rock histories

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We conducted a set of numerical experiments to study the evolution of a subduction–collision system subject to spontaneous slab breakoff. The study takes into account complex rheological behaviour including plasticity, viscous creep and Peierls creep and mineralogical phase transformations including UHP melting. A limited number of contrasting geodynamic scenarios were observed that combine several previously suggested end-member tectonic processes such as continental subduction, multiple crustal stacking, oceanic slab delamination and breakoff, plate eduction, ductile crustal extrusions and buoyant partially molten trans-lithospheric plumes. In the explored parameter space, breakoff depth can range from 40 to 400 km with Peierls creep in the cold subducted mantle been a key mechanism for slab necking. We also found that melting of crustal materials at ultrahigh pressure metamorphic (UHPM) conditions can trigger the exhumation of high temperature-ultrahigh pressure metamorphic (HT-UHPM) rocks. In the model, the generation of temperatures high enough for anatexis during subduction is due to the continental crust and associated sediments coming into contact with hot asthenospheric mantle of the wedge at ultrahigh pressure conditions. The consequent enhanced buoyancy of the melt-bearing crustal and associated sedimentary materials drives the subsequent exhumation of the HT-UHPM rocks from mantle depths to mid-to-lower crustal levels. Exhumation occurs by a thermally induced slab-parallel ductile extrusion of melt-bearing crustal materials along the interface between the stagnant subducted slab and the mantle wedge. The up to 1000 C peak temperatures achieved in the experiments at UHPM conditions are the highest obtained so far in experiments using numerical models; they are similar to many natural HT-UHPM rocks. The sensitivity studies suggest that some other mechanisms proposed previously for the exhumation of UHPM rocks including multiple crustal stacking, plate eduction, trans-lithospheric crustal plumes and channel flow are mainly controlled by the oceanic slab age and length and by the incoming passive margin geometry. Indeed, all these exhumation processes typically result in colder P-T paths with the coldest (<500 C) peak temperatures been produced by the eduction-driven exhumation.