Rapid weathering of arsenopyrite in agricultural soils

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Aerially distributed fine mineral waste particles (< 250 μm), the product of mining processes, are an important source of potentially toxic elements (PTEs) in the surface environment. However, there is a paucity of data on the short-term stability of PTE-rich particles in agricultural soils and the associated risk of producing contaminated crops when PTEs are released from mineral matrices.

This study aimed to determine whether sulphide ore minerals undergo geochemical alterations (i.e. oxidation-dissolution) at a rate that is relevant to crop growth (in the order of months – years). Arsenopyrite (FeAsS) was selected for this proof-of-concept experiment due to the toxicity of arsenic at low concentrations [1].

Two soils, contrasting in organic matter content and pH, were spiked with ground FeAsS (1, 600 μmol/kg As), sown with spring wheat (*Triticum aestivum)* and incubated under controlled conditions until the wheat ripened (90 days).

Following the incubation period, soluble (soil water extract) and exchangeable (0.1 mol/L phosphate buffer extract, pH 7.2) arsenic concentrations were significantly ($p<0.05$) higher in spiked soils, compared with controls. Low soluble arsenic concentrations suggested that less than 0.1% m/m of the mineral-bound arsenic had been released and remained present as soluble species. On the other hand, exchangeable As concentrations indicated that up to 9 % m/m (in acid soil, pH 4.5) of the mineral-bound arsenic had been released and loosely bound within the spiked acid soil matrix. The lower exchangeable concentrations extracted from the organic, neutral pH soil (0.5% m/m) were consistent with the reported FeAsS dissolution rate minima at pH 7-8 [2].

Short-term weathering of FeAsS did not yield dangerous arsenic concentrations (4.2-5.3 nmol/g) in edible plant tissues under the test conditions, based on cereal consumption rates [3]. However, this study provides evidence for significant arsenic release from arsenopyrite within an agriculturally relevant, short exposure period. Further experiments are underway, with the aim of determing the alteration rate of FeAsS and other related minerals in agricultural systems.

[1] World Health Organisation (1983) WHO Food Additive Report Series, Geneva. [2] Yu *et al*. (2007) ES&T **41**, 6460-6464. [3] European Food Standards Agency (2010) Concise European Food Consumption Database.

Ecosystem-level impact signals of groundwater borne continental nitrate transfer to the Ria Formosa lagoon by Submarine Groundwater Discharge (SGD) traced along the mixing gradient by a multi-indicator approach

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Recognition of the role played by SGD in the transfer of contaminants to near shore marine environments underscores the need for tools and approaches that will facilitate regional assessments of its environmental impact, including localization, spatial extent and magnitude as well as the provision of uninterrupted chains of evidence that effectively demonstrate links between polluted groundwater sources on land and ecosystem level effects in the coastal zone.

We present an uninterrupted chain of evidence linking groundwater pollution to coastal ecosystem function for a leaky coastal lagoon system. Here, for the first time, this causal link is demonstrated in its entirety for a single ecosystem. The approach used combines Earth observation techniques, hydrological mass balance approaches, conservative, radiogenic and stable isotope tracers, nutrient dynamics along the mixing line and finally, direct physiological indicators of primary producer assimilation of groundwater borne nutrients at the marine end member.