Impact of aeolian deposition on Mn cycling in soils

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Aeolian mass transport is a potentially critical, yet largely unrecognized, component of the manganese cycle. Mn is an essential micronutrient for plants and animals; however, high Mn exposure can lead to neurological disease in humans and forest decline in sensitive ecosystems. Furthermore, reactive Mn-compounds can affect organic matter breakdown, nutrient cycles, and heavy metal mobility. High Mn levels are observed in soils at the Susquehanna Shale Hills Observatory (SSHO), a forested watershed in central Pennsylvania, USA. The SSHO is a Critical Zone Observatory established to examine regolith evolution on shale. Using the mass transfer coefficient, $\tau_{Ti,Mn}$, to evaluate Mn mobility in the regolith, we find that surface soils are enriched relative to the parent shale ($\tau_{Ti,Mn}$ = 5.18 ± 4.9). Here, we present findings that Mn addition to SSHO soils is best explained by industrial-aged aeolian inputs and propose a mass balance model to quantify atmospheric deposition. Elevated Mn concentrations in foliage (4,600 ± 1,500 ppm), leaf litter (8,500 ± 1,000 ppm) and the organic horizon (16,400 ± 13,800 ppm) indicate active cycling by vegetation; therefore, biotic mixing is incorporated into the model in order to evaluate the role of biota in creating the observed addition profile. Additionally, x-ray absorption spectroscopy is used to characterize structural and redox changes in Mn-compounds through biogeochemical cycling.

Analysis of soils data from throughout the United States and Europe suggests patterns of Mn enrichment in surface soils coincident with industrial or population centers. The SSHO field study can provide a comprehensive analysis of biogeochemical Mn cycling and may have international relevance concerning the long-term effect of industrial Mn emissions on ecosystems.

Norway's first exploitation of oil? The processing of marine mammal blubber in slab-lined pits

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Analysis of lipids of archaeological interest from soils and sediments has focussed largely on anthropogenic markers of manuring and cess deposition. This presentation targets a specific archaeological feature known as the slab-lined pit. Some 700 of these pits have been recorded in northern Norway. Lipid analysis and bulk carbon and nitrogen isotope determinations have been performed on samples ('cemented organic residues', charcoal, sediment and fire-cracked rock) excavated from twelve slab-lined pits to test the premise that these features were used for the extraction of oil from the blubber of marine mammals, such as seal, porpoise and whale. A wide range of lipid compound classes was detected especially in the 'cemented organic residues'. The presence of long-chain mono- and diunsaturated fatty acids together with a wide range of oxidation and thermal alteration products of diagnostic unsaturated acids suggests that these features were used for oil extraction from marine tissues. Further information was provided by the presence of long-chain fatty acids associated with surviving triacylglycerols and the presence of cholesterol. A probable biomarker of microbiological activity impacting on the organic matter deposited in the pits was also identified. Bulk isotope analysis conducted on the 'cemented organic residues' is consistent with modern reference samples of blubber and oil from seal and whale. These data provide the first analytical evidence for the function of slab-lined pits in the archaeological record and confirm widespread exploitation of marine mammals for producing oil for heating, lighting and myriad other uses in the past.