Mobility of Metals in Soil as a Result of Earthworm Activity

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Introduction

Earthworms play a major role in translating surface material into deeper soil horizons. Metals are enriched in the fecal pellets used to line the worm burrows. These burrows serve as conduits for water flow from the soil surface to greater depths. Metal bioavailability and the rate of transport into groundwater will be enhanced if metals are converted to a more soluble form after passage through the worm gut.

This research reports the preliminary results of a micro-x-ray absorption near edge structure (micro-XANES) analysis of iron and manganese in both worm fecal pellets and in the surrounding soil matrix.

Methods

Dr. Protz supplied the cross section of the worm burrow. The sample was taken from a plot of silt loam soil that, as part of an extensive study, had sewage sludge applied to it from 1973-1980. [1,2] The plot was located at the University of Guelph's Elora experimental farm.

The sample was taken as an intact soil block, within 50 cm of the soil surface, then impregnated with 3-hydroxylbutylmethylmethacrylate and hardened. Sections 50 µm thick were cut, mounted on glass slides and polished.[3]

Micro-XANES were done at the 20-ID-B beamline (PNC-CAT) of the Advanced Photon Source (APS), located at Argonne National Laboratory. A pair of Kirkpatrick-Baez mirrors were used to focus the monochromatic x-ray beam to a spot size of 1.5 µm at the sample. A 13-element Ge detector was used to monitor the fluorescence x-ray yield at the Fe and Mn K-edges.

Results and Discussion

A picture of the worm burrow is shown in Fig. 1. The dark ring around the burrow is made of worm fecal secretions. The burrow and fecal material together are approximately 1 cm accross.

Figure 2 shows the Fe K-edge XANES spectra taken from a point within the fecal material and from a point in the surrounding soil matrix. The two spectra are essentially the same indicating that there is no change in the chemical species of Fe on passing through the gut of the worm.

Figure 3 shows the Mn K-edge spectra taken at the same points as the Fe spectra.

Unlike the Fe spectra the Mn K-edge shows a significant difference between the two sites. This suggests that the Mn containing species in the soil matrix is changed by passing through the worm gut.

Conclusions

In this study we found that not only do earthworms move material through the soil, but they can also change the chemical species of the material moved. Further studies are needed to determine the mechanism of the observed changes and whether or not they are beneficial, or can be made beneficial, to soil remediation projects.

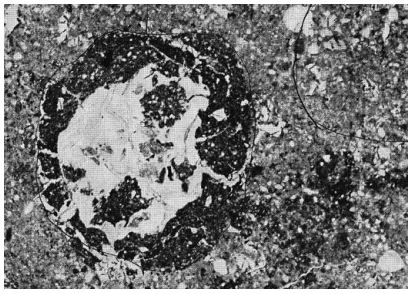

FIG 1. Picture of the studied worm burrow.

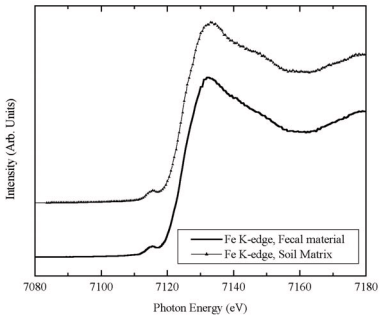

FIG 2. Fe K-edge micro-XANES spectra. The spectra have been shifted for clarity.

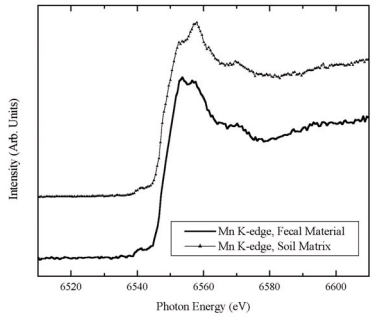

FIG 3. Mn K-edge micro-XANES spectra. The spectra have been shifted for clarity.

Acknowledgments

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