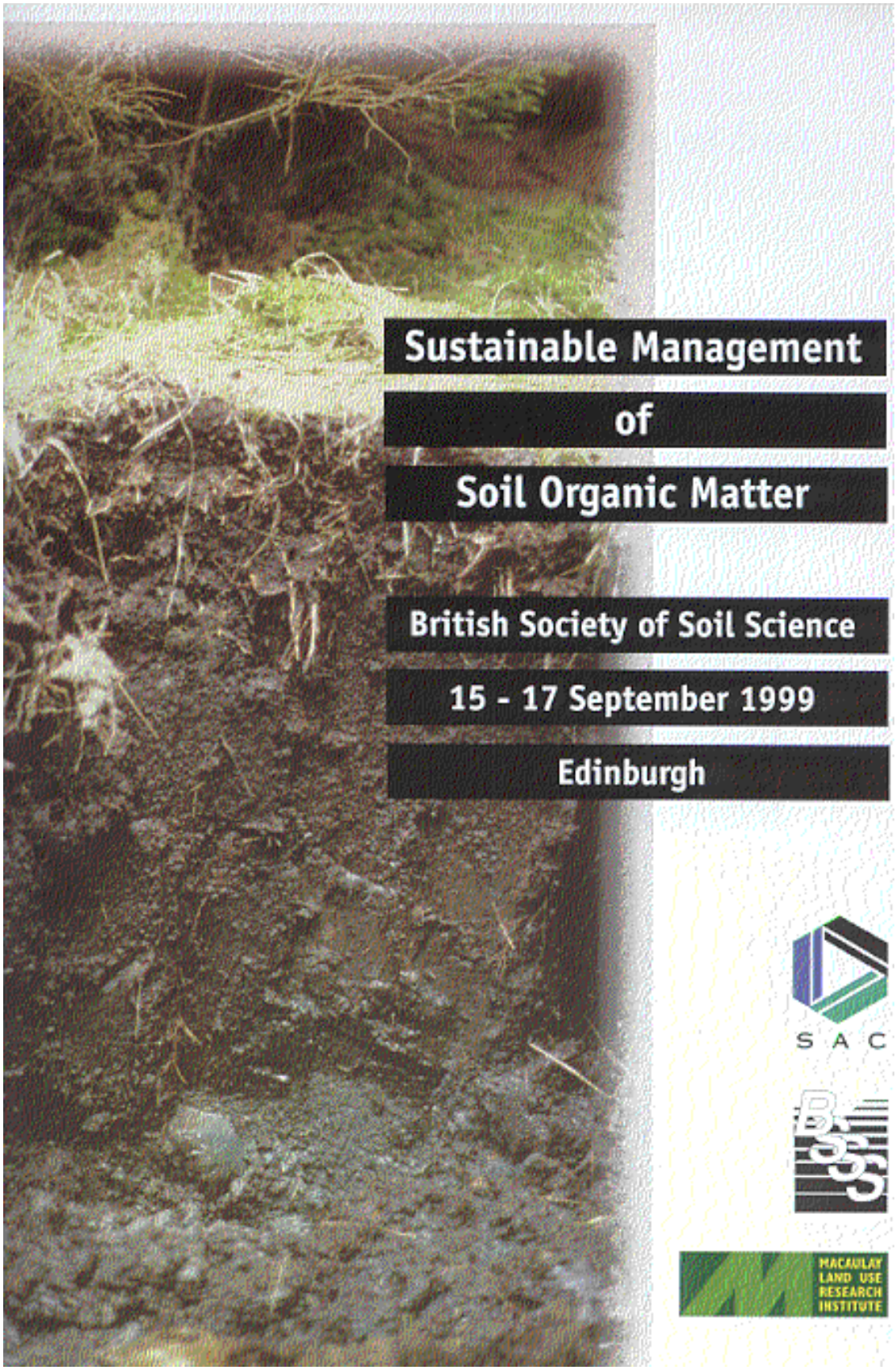

Sustainable Management of Soil Organic Matter

British Society of Soil Science

15 - 17 September 1999

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The use of centrifuge leaching tests for predicting the mobility of heavy metals

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Organic wastes can often cause heavy metal contamination. This almost always involves a multi-element contamination, where the competition of these metals is very important in understanding their mobility in the soil (Alloway, 1995). Nickel and Cu are among the most serious contaminants, while their mobility in real field conditions is still being addressed (McBride, 1995). The mobility of heavy metals depends not only on the metal competition but on the distribution of heavy metals between solid soil components and the soil solution, as well. This distribution can be expressed as K_d (high K_d means low metal mobility), and high K_d is expected in soils with high organic matter and/or clay content. Most researchers determined K_d by adsorption experiments or by leaching columns. However, both techniques bear significant disadvantages; adsorption tests overestimate sorption and are far from simulating realistic field conditions, while leaching columns are only suitable for high permeability (sandy) soils. In centrifuge leaching tests (CLT) any type of soil can be employed and they test metal sorption on the soil itself rather than in the soil suspension. Thus, in a clayey soil, the competition effect of Cu and Ni was tested by CLT. K_d was measured from both the breakthrough curves and the soil sorption. Competition between Cu and Ni was found to be a very significant mechanism for ruling the mobility of these metals in the soil environment. The mobility of Ni and Cu increased significantly when both were present in the leaching solution, compared with their mobility without any competition effects. As expected, Ni was more mobile than Cu. CLT can be a valuable tool for assessing and estimating the mobility of heavy metals especially in cases of multi-element contamination, such as sewage sludge application to land.

THE USE OF CENTRIFUGE LEACHING TESTS FOR PREDICTING HEAVY METAL AVAILABILITY

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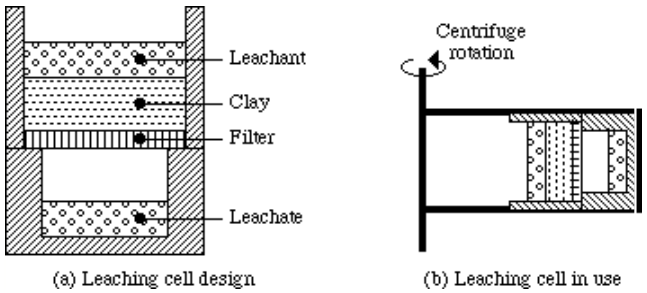
INTRODUCTION

Organic wastes can often cause heavy metal contamination. This is almost always a multi-element effect, where the competition of metals, *e.g.* Cu and Ni is very important in understanding their mobility in the soil. Metal mobility can be expressed with the distribution coefficient, K_d (high K_d means low metal mobility). K_d can be measured with Centrifuge Leaching Tests (CLTs), a technique which overcomes the disadvantages of adsorption experiments.

MATERIALS AND METHODS

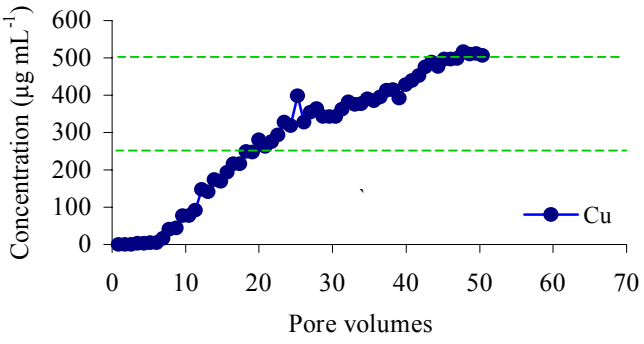
Figure 1: ***Centrifuge leaching cell.***



In a compacted layer of clayey soil (London Clay) K_d was measured from the breakthrough curves of leaching cells (Fig.1) using three nitrate solutions of the metals. The first was 500 μg mL^{-1} Cu, the second 500 μg mL^{-1} Ni and the third 500 μg mL^{-1} Cu and 500 μg mL^{-1} Ni. The centrifuge was running at 5,300 gravities (equal to 4,700 rpm).

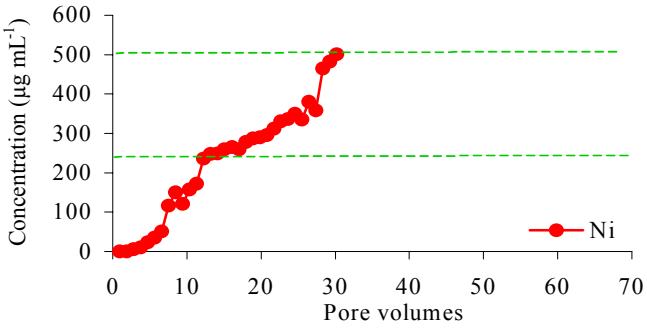
RESULTS AND DISCUSSION

Figure 2: ***Breakthrough curve for Cu.***



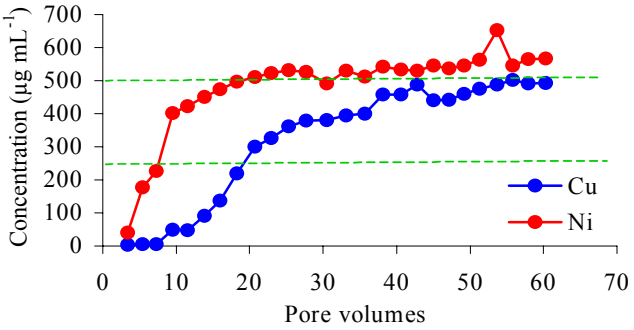
The number of pore volumes for the leachate concentration to rise to half of the leachant concentration (in this test, 250 μg mL^{-1}) is a measure of mobility of the metals, and is approximately equal to the retardation factor. For Cu, 20 pore volumes were required (Fig. 2), while for Ni 15 pore volumes were required (Fig. 3) to reach the level of 250 μg mL^{-1}.

Figure 3: ***Breakthrough curve for Ni.***



This suggests that Cu was sorbed onto the soil more strongly than Ni. When both metals were present in the leaching solution, the mobility of Cu did not change, but Ni mobility increased radically (Fig. 4).

Figure 4: ***Competitive breakthrough curves for Cu and Ni.***



Copper needed 20 pore volumes as before, while Ni only needed half of the pore volumes when in competition with Cu. Copper seems to be sorbing preferentially onto soil surfaces, excluding Ni from sorption sites previously available to it. Competition, therefore, can increase markedly the mobility of the less preferred heavy metal.

CONCLUSIONS

CLTs can be a valuable tool for estimating the mobility of heavy metals especially in cases of multi-element contamination, such as sewage sludge application to land.

Acknowledgements
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