EFFECT OF SOME MINERALS AND DISSOLVED ORGANIC CARBON ON THE BEHAVIOUR OF SOME HEAVY METALS IN SOILS

By

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B.Sc. (Microbiology and Chemistry), Ain Shams University, 2002

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ABSTRACT

Ashraf Latif Iskander Botrous: Effect of Some Minerals and Dissolved Organic Carbon on the Behaviour of Some Heavy Metals in Soils. Unpublished M.Sc. Thesis, Department of Soil, Faculty of Agriculture, Ain Shams University, 2010.

In this study the effect of natural minerals such as zeolite and bentonite and the dissolved organic carbon on the behavior of heavy metals (Zn, Mn and Ni) in two different soil samples (sand and clay soils) were carried out. The main results can be summarized as follows:

1- Adsorption and desorption experiment:

The studied minerals zeolite and bentonite showed considerable variations in Zn, Mn and Ni sorption properties and DTPA extractability. Bentonite has the highest ability for Mn and Ni sorption, while zeolite has the highest ability for Zn sorption. Zeolite retains a relatively high percentage of the sorbed Zn against the extraction by DTPA. Zinc, manganese and nickel sorption data were described by a Freundlich and Langmuir adsorption model. The results showed that Langmuir constants for Zn, Mn and Ni sorption [maximum adsorption (b mmol kg^{-1})] have been in the following decreasing order: Bentonite Mn > Bentonite Ni > Zeolite Mn > Bentonite Zn > Zeolite Ni > Zeolite Zn. While the [binding strength values (k in mmol l^{-1})] was in the order: Zeolite Mn > Zeolite Zn > Zeolite Ni > Bentonite Mn > Bentonite Zn > Bentonite Ni. The results suggest that natural zeolite and bentonite minerals have a high potential for Zn, Mn and Ni retention. The availability of the retained Zn, Mn and Ni was higher for Zn compared with Mn and Ni, and zeolite seems to have the highest ability for Zn sorption and extractability by DTPA. Bentonite has intermediate characteristics for Zn, Mn and Ni sorption.

2- Incubation experiment:

Data of the incubation showed that there are gradual increasing in the concentration of studied heavy metal in all fractions by increasing the rates of metals loading on zeolite and bentonite and as a results of incubation times. This increasing for the concentration of heavy metals (Zn, Mn and Ni) under study not only in the means of rates of doses of zeolite and bentonite but also in the means of incubating times. In the control clay soil, the background Zn, Mn and Ni in each fraction were generally in the order carbonate > Fe–Mn oxides > organic matter > exchangeable > water soluble fraction. While in the untreated sand soil, the background Zn, Mn and Ni in each fraction were generally in the order Fe–Mn oxides > exchangeable > carbonate > organic matter > water soluble. It was observed that after the period of incubation, metals in exchangeable fraction were predominant in all treatments of both soils with some exception. Moreover the increases in the other fractions were also observed. It may indicated that a fast process of metal distribution among the fractions occurred during the first 2-days incubation. The redistribution process from 2-weeks to 4-weeks is much slower comparing with that in 2-days. At the end of 4-weeks incubation, the percentages of Zn, Mn and Ni in exchangeable fraction were still very high. This observation was possibly due to the slow transformation of metals from loosely bound fractions such as exchangeable fraction to strongly bound.

3- Column experiment:

Addition of the natural mineral loaded by Zn, Mn and Ni to surface of the soil resulted in a marked increase in the amount of total Zn, Mn and Ni in both soil**.** The increases corresponding, in general, to the concentrations of metals loaded in the clay mineral. For the rate of natural clay mineral (0.4%) were chosen for application, total amounts

were presented (mg/kg soil) as a function of soil depth. Maximum total concentrations of metals were found in the surface layer of soil (0-5 cm) for all metal ions. Data revealed that the amounts of Zn and Mn extracted by DTPA solution were generally decreased with increasing soil depth this in case of Zn and Mn. While Ni has a different pattern where it decreases by depth then increased in the last segment of column especially in case of sandy soil. Mobility of heavy metals were followed the order Mn > Zn > Ni.

Key words:

Heavy metal, Zeolite, Bentonite, and Dissolved Organic Carbon (D.O.C).

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I. INTRODUCTION

There is growing concern that the heavy metal contents of soil are increasing as the result of industrial, mining, agricultural and domestic activities. Although certain heavy metals, such as manganese and zinc, are essential for plant growth as micronutrients, they are toxic at higher levels, as are metals such as nickel.

Interactions of heavy metals (Zn, Mn and Ni) with phyllosilicate mineral such as bentonite or tectosilicate such as zeolite are important in the chemical speciation and fate of these metals in soils and other ecosystems. The processes that decrease the activity and extractability of these metals retained by above natural minerals are believed to be important in the availability of these metals added to soils and in the remediation of soils contaminated with these metals.

So understanding the sorption process by natural zeolite and bentonite are necessary for efffictive utilization of these minerals. It can be used in the soil as a trap for heavy metals and as nutrient adsorbents and consequently as slow releases to plant. The fate and transport of metal ions in the environment are generally controlled by sorption reactions. Adsorption and desorption are a major process responsible for accumulation of heavy metals. Therefore the study of adsorption processes is of utmost importance for the understanding of how heavy metals are transferred from a liquid mobile phase to the surface of a solid phase and vise versa.

Also the migration of heavy metals could be enhanced by their complexation with some fractions of the organic matter. In addition to humic-like substances, compost extract by water produces a water-soluble organic matter known as dissolved organic carbon (DOC), which can pass through a 0.45 μm filter. This DOC has a low molecular weight and is a mixture of polymeric materials containing a number of polar and non-polar sites.