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The Effect of Microbial Biomass in Soil on Adsorption of Radio Cesium

Medical Science

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ABSTRACT

The purpose of this paper was to determine the effect of microbial biomass in sorption and migration of radio cesium in soil by batch experiments. The conceptual approach to elucidating the micro organisms was the measurement of radio cesium adsorption in clay soil after soil samples had been held under conditions which were known to alter the amount and/or the activity of microbial biomass. The number of microorganisms in clay soil were reduced by biocidal treatment or increased by addition of nutrient sources. 137Cs++ adsorption by pretreatment soil was measured, relative to untreated soil samples, in aqueous suspensions containing 10-8 mole per liter cesium by estimating the radio cesium after eight days of incubation. A reduction of biomass drastically decreased adsorption. When the concentration of radio cesium in the suspension was increased, there was a closing correlation between soil biomass and adsorption. Radio cesium sorption might be affected by activity and survival of microorganisms. Adsorption was lowered clearly by anaerobic conditions during the incubation period of eight days. However, radio cesium migration in water saturated soil columns was influenced by quantity of available microorganism due to anaerobic conditions in the system according to relationship between radio cesium adsorption and biomass microorganisms.

Introduction:

Radio nuclides such as radio caesium compounds are widely emitted in power explosion; thus, its risk from deposits on ground is inevitably increased (1). The amount of radioactive elements (2), the degree of mixing of radioactive materials (3) and the rate of absorption (4), and selective absorption by the plants (5) influence the absorption of radioactive materials by the soil. In addition to numerous organic, mineral materials (6), soil is characterized by its inventory of microorganisms (fungi, bacteria) (7) Many other factors such as concentration of these ions between phases, the cation exchange capacity of the soil as well as its clay content, chemical composition, grain size distribution, calcite, iron oxide content, and organic coatings are influenced in distribution radio caesium between soil/water phases (8). Most of the liberated radio caesium is eventually reached the soil and its behaviour and fate in this environmental compartment requires special attention. Strong specific sorption of radio caesium is depended on the moisture substances. Rapid sorption to wet substances is believed to significantly reduce the rates. Soil microbial processes contribute substantially to the budgets of atmospheric trace gases (9). The water contains precipitated particulate, resulting in a strong affinity for anionic species. Radio caesium deposition on soil is a significant pathway for the transport of ^{137}Cs. This analysis suggests that the pH sensitivity of soil solution and potassium concentration is not required for radio cesium adsorption on organic matter (10). The most agricultural soils contain 0.2-1.2 mg dry matter per gram of soil as microbial cells. The soil micro organisms are responsible for the degradation of all plants residues and many inorganic soil components (11). The data were useful for estimating the amount of radio caesium on the soil during the course of work. The objective of the work is to determine influence of the soil microbial biomass on absorption the concentration of radio caesium ^{137}Cs deposited on soil and the subsequent levels over a period of time.

Method and material:

Clay soil from agricultural fields in the vicinity of Aberdeen in Scotland of England was used in this investigation. They were collected from the upper 20 cm and were sieved (<2mm) before applying. The soil adsorption of radio cesium by clay soil was proposed by an alternative batch approach in which somewhat more realistic soil conditions are maintained. In particular, this approach allows for determination of radio cesium values under realistic soil moisture contents and in a system in which time-dependent processes. Radio cesium values were measured in the soil and the solution.

For the experiment, 10 g dry weight of biomass manipulated soil samples and untreated control samples were suspended in 100 ml Erlenmeyer flasks with 20 ml distilled water which contained 63 kBq of radio cesium corresponding to 0.1 ng Cs^{++}. The flask was closed by cotton wool plugs after shaking (140 rpm) for 8 days at 22 C, the solid and livid phases were separated by filtration and radioactivity determined by gamma spectroscopy of aliquots of filtered and filtrate the reseals soil. All experiments were carried out in triplicate.

The effect of the soil microbial biomass on radio cesium adsorption was investigated in experiments in which the inventories of microorganisms had been increased or reduced. A proliferation of organisms was achieved by addition of carbon source together with nitrogen and phosphors source, giving a C: N: P ratio of 20:1:0.5. On the basis of this result, appropriate amounts of glucose KNO_3 and K_2HPO_4 were chosen to increase the biomass by about 30, 70, and 100%. The nutrients were applied as a solution to the bulk soil and were incubated for 10 days at 22 C in plastic bags sealed with cotton plugs.

A drastic reduction of biomass was accompanied by fumigation of soils with alcohol-free chloroform in closed desiccators as described by Jenkinson and Powlson (12). After removal of fumigant 24 h later; the soil were kept for a further 10 days at 22 C in plastic bags with cotton wool plugs.

Results

The data obtained for radio cesium are presented and indicate that soil moisture content, particularly in conjunction with soil redox potential (through water-logging of the soil), has a marked effect on measured radio cesium values. The results indicate the advantages and potential usefulness of the batch approach in assessing the environmental behavior of radioactive, and other, soil contaminants. The data indicate that radio cesium values are highly influenced by the quantity of microorganisms. Fumigation reduced the biomass of soil and radio cesium also decreased for the untreated soil. A difference in clay soil was also observed when microbial biomass was increased. In clay soil the proliferation of biomass also increased the radio cesium value.

Discussion:

The enzymatic oxidation of radio cesium and subsequence of organic radio cesium compounds are great importance for migration of Cs-137 in the environment. The addition of organic matter to reference clay minerals causes to decrease of up to an order of magnitude in the distribution of radio cesium (13). The experiments provide some evidence of the direct involvement of biomass in the adsorption behavior of radiocesium. However, different microbial biomass may be part of the reason for differences in metabolism, It affects nitrogen on uptake by soil; decrease of production with decreasing temperature; or different rates and modes of NO and N2O production in soil samples and under different conditions (9).

A researcher conducted similar batch experiments with different soils suspended in an aqueous solution of radio cesium (14). He found a generally fast and high adsorption of radio nuclide but a fraction of the radio nuclide was converted to other compounds. No adsorption occurred with autoclave soils. A major decrease in adsorption was found after application of anaerobic condition to the soil suspensions. The behavior of samples was explained by poorly mummified character of the organic matter. The effect of temperature on the distribution of radio cesium has been utilized in order to evaluate the changes in the standard thermodynamic parameters. The results indicated that Cs^{++} ions could be efficiently removed using a special ions composite in the given pH range from aqueous solutions. Therefore, uptake of radio cesium is affected to varying degrees by the presence of some diverse ions (15).

Additional proof of the involvement of micro organisms comes from experiments involving biomass proliferation by addition of a glucose based nutrient solution. It can be expected that manipulation of the adsorption soil will not change any of the other soil constructions responsible for adsorption. Adsorption depended directly on biomass levels especially at higher radio cesium concentration. Therefore, the changes in the root uptake are depended on the resulting situation from changes in some type of ions values in the soil solution (16).

Experiments indicated a potential increase in ammonium ions concentrations leads to an increase in the radio cesium root uptake. Some occurrences affect on experiments. High initial K+ concentration in the soil showed that, K+ concentration decreased below a threshold value and lead to an increase in radio cesium transfer after adding high water solution to mass of soil. Experiments show survival of microorganisms is diminished by temperature above 25 C and air-drying of soil.

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