

Physical, chemical and biological behaviour of radioactive chlorine and iodine in soils

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Abstract. A series of laboratory-based soil column studies has been carried out to determine the comparative behaviour of the radioactive halogens ^{36}Cl and ^{125}I (as a surrogate for ^{129}I) in the soil-plant system. Physical migration of ^{36}Cl in the soil appears to be unretarded due to its presence predominantly in the chloride form. This lead to substantial accumulation of ^{36}Cl at the soil surface in a column experiment in which the net flux of water was upwards. Physical migration of ^{125}I in soils appears to be relatively rapid at low oxidation-reduction potentials, but is substantially retarded under more oxic soil conditions. This lead to accumulation of ^{125}I in the zone of transition between anoxic and oxic zones in the soil. Gel filtration chromatography confirmed that the predominant chemical forms of ^{36}Cl in the soil is the chloride anion. Conversely, ^{125}I showed a strong tendency to associate with both high and low molecular weight fractions of soil humic substances, though its attachment to the low molecular weight fraction appears to be more specific than to the high molecular weight fraction. Soil-plant transfer was measured for both ^{36}Cl and ^{125}I in rye grass swards in undisturbed soil columns. Biological assimilation of ^{36}Cl was particularly significant, with more than 50% of the total ^{36}Cl activity in the soil being taken up by the grass sward after three weeks' growth. Uptake of ^{125}I by grass swards was less spectacular, though still resulted in approximately 1% of the total soil ^{125}I activity being assimilated even though the standing biomass of the grass sward was low.

1. INTRODUCTION

The potential for the disposal of radioactive wastes in geological repositories presents a new challenge for radioecology. The timescale over which leakage from repositories and eventual emergence into the biosphere of radionuclides is likely to occur is so long (>1000 y) that only long-lived radionuclides have the potential to become significant environmental contaminants from this source. Furthermore, only those radionuclides with considerable mobility within the geosphere will emerge into the surface environment in significant quantities. The radioactive halogens ^{36}Cl and ^{129}I (300 thousand and 15.7 million year half lives, respectively) both possess a combination of long physical half life and a high degree of geospheric mobility, which dictates that their potential environmental impact as a result of radioactive waste disposal should be investigated thoroughly. We have conducted a series of experiments to determine the physical, chemical and biological behaviour of ^{36}Cl and ^{125}I (as a surrogate for ^{129}I) in both undisturbed and re-packed soil columns. The aim of this paper is to summarise some of the most important results from these experiments and to compare and contrast the behaviour of radioactive chlorine and iodine in the soil-plant system.

2. MATERIALS AND METHODS

2.1 Physical migration of ^{36}Cl and ^{125}I in soils

Homogeneous soil columns were constructed by packing a screened (1 cm mesh size) sandy loam into plastic tubes 50 cm long and 15 cm in diameter. Each packed column was placed in a reservoir containing water contaminated with either ^{36}Cl or ^{125}I at a target activity concentration of 20 kBq L⁻¹ (the initial chemical form was either chloride or iodide, respectively). This allowed the establishment of a water table at a height of 5 cm from the base of the column, i.e. at a depth of 45 cm from the soil surface. No additions of water were made to the soil surface. Consequently, when rye grass (*Lolium perenne* cv.

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