IODINE DYNAMICS
IN THE TERRESTRIAL ENVIRONMENT

HANNAH E. BOWLEY MChem (hons.), MSc.

Thesis submitted to the University of Nottingham
for the degree of doctor of philosophy

JULY 2013
ABSTRACT

The aim of this work was to investigate the effect of soil properties on soil iodine dynamics and uptake to plants. Soil and vegetation samples were collected from across eastern Northern Ireland (NI) to form the basis of most experimental work; samples from the Rothamsted Park Grass archive were used to investigate the role of changing soil chemistry through time and due to selected fertiliser applications; and iodine dynamics in humic acid (HA) were studied to improve understanding of the role of organic matter in soils. Input of iodine in rainfall was considered in the context of samples from both locations, and the additional influences of coastal proximity, soil type and underlying geology were reviewed for the NI samples. Total iodine analysis was carried out using extraction with TMAH and quantification by ICP-MS; aqueous iodine speciation was determined using HPLC and SEC coupled with ICP-MS.

The most important iodine inputs to both soil and vegetation were found to be directly from the sea in coastally-exposed locations, and from rainfall in other cases. Soil organic matter (measured as soil organic carbon, SOC) was determined to be involved in both retaining a portion of recalcitrant iodine in soil and HA, and in promoting sorption of both iodide and iodate in highly organic soils. Metal oxides (Fe, Mn and Al) were found to be important in rapid sorption of iodate to soils with SOC ≤ 38 %, and there was an indication that they may be involved in promoting the reaction of iodide with organic matter.

Replenishment of a transient phyto-available pool was essential for provision of iodine to vegetation. The availability of recently added iodine (as $^{129}$IO$_3^-$) in the pot experiment was controlled by its sorption onto the solid phase, and near-constant input from irrigation water was the major source of vegetation iodine in most cases. Rainfall was shown to be important in controlling vegetation iodine concentrations in field situations. In soils collected from very coastally-exposed locations, the soil iodine concentration was extremely high and therefore a greater proportion of labile native iodine was available for uptake; irrigation sources were much less important.

This work improves understanding of soil iodine dynamics and the important factors controlling iodine speciation and availability to plants. Results can be used to inform practices regarding provision of iodine to crops for both humans and grazing animals.