Optimised investigation of radioactively contaminated land

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The United Kingdom played a leading role in the development of nuclear power, and currently about 1/6 of the country's electricity is generated by nuclear reactors. Most reactors are expected to reach the end of their operational lives within the next decade, and the Nuclear Decommmissioning Authority is responsible for nineteen sites that require some level of decommissioning[2]. As a result of this history, areas of potentially radioactively contaminated land (and the concrete floor slabs of buildings) are known to exist at sites such as Sellafield and Dounreay. It is therefore important to devise efficient methods for the characterisation of land areas for radionuclide content.

Regulatory requirements imply a need for the identification of both hotspots of activity and estimation of mean activities over averaging areas. Surveys undertaken using *in situ* and *ex situ* measurement techniques at Dounreay suggest that activity concentrations of the radionuclide Cs-137 in soils show considerable small-scale heterogeneity, and often exist in small volumes compared to the volumes of soil being measured. There is therefore likely to be some pay-off between the use of in situ measurements, which have the advantages of remote detection capabilities, up to 100% site coverage and lower cost, and ex situ methods where laboratory measurements are made from excavated samples. Laboratory measurements currently have greater credibility, due partly to uncertainties in the geometry of in situ detection methods, and they are also unaffected by the depths of excavated hotspots of activity. Conversly, In situ methods are liable to underestimate buried activity due to attenuation of radiation by overlying material. However, they are much more likely to locate small activity hotspots where these are randomly located on or near the ground surface, and which are liable to be missed by measurements of widely-spaced, excavated soil samples.

Field experiments at Dounreay and desk experiments using detection modelling software (ISOCS) have suggested the following:

a) *In situ* methods at high coverage (~100%) are the optimal approach to locating activity hotspots in radioactively contaminated land, where this activity is

at or near the ground surface;

b) Careful interpretation of *in situ* measurements is required to characterise activity concentrations of averaging areas, to avoid potential large biases between *in situ* and *ex situ* methods.

c) Coverage of more than 100% of the measured area by in situ methods may be optimal where the objective is to locate small "hot" particles. This is because of the reduced signal obtained as their distance from the detector increases, with a corresponding increase in difficulty of separating this signal from background radiation levels.

Work is ongoing to develop techniques which will enable optimisation of the measurement uncertainty, and numbers of samples, for both types of measurement.

References

[1]http://www.niauk.org/industry-issues.html

[2]http://www.nda.gov.uk/sites/financials/

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