VADOSE - A NEW PROJECT TO INVESTIGATE SPATIAL VARIATION OF DOSE RATES IN SOILS AND SEDIMENTS

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Determination of dose rates from naturally occurring radioactive materials (NORMs) is key to establishing their locations, concentrations and the effects on the environment of the ionising radiation they emit. These effects are applied directly in the luminescence dating of archaeomaterials and their contexts: luminescence dating can contribute to this field.

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Background

Natural materials generally contain heterogeneously distributed mixtures of radionuclides and absorbers of different types, producing complex mixed attenuated radiation fields. Radiometric and geochemical measurements of activity and concentration are conducted under specific experimental conditions using samples and geometries of defined scales. Transfer functions must be applied to assess radionuclide distributions, dose rates and /or implications for different conditions, scales and/or applications.

Aims

Established methodologies need to be reassessed experimentally, taking account of advances in instrumentation, understanding of radiation transport processes and computational capacity. The principal aim of VADOSE is to develop improved recipes for the simple, rapid and accurate prediction of dose rates at different scales in soils and sediments, through detailed experimental investigation and Monte Carlo modelling. The implications of this understanding and the information gathered for its development will be assessed in the context of methodologies in environmental dosimetry, and the significance of radiological and geochemical baselines.

Methods

VADOSE is an integrated and intensive dosimetric study combining instrumental and computational techniques. Radiologically contrasting environmental settings are being examined in terms of spatial variability of dose rate and differences in the radioactivity of subsamples of different grain size-fractions. Samples will be of well sorted sediments of dune sand and silt, and soils developed on granitic, limestone, siltstone and uraniferous dolerite lithologies. In situ radiometric measurements are being made by NaI gamma spectrometry, and luminescence enclosure dosimetry. Mineralogy and major and trace element composition including radionuclides will be determined for bulk samples and different grain size fractions, using SEM, XRD, XRF, INAA and HPGe spectrometry, to evaluate radioactivities and radiation absorption characteristics. The experimental determinations will be used, with granulometric distributions, to calibrate radiation transport models of the alpha, beta and gamma radiation environments in the soils and sediments using MCNPX and proprietary codes.

Preliminary work has included review of water retention characteristics in a wide range of soil/sediment and rock/artefact samples, the establishment of high resolution gamma spectrometry measurements of non-neutron-activated samples in the GeoLuC group, for uraniferous samples from the study region (see e.g. Trindade et al.), and the modelling and testing of source geometries for the calibration of environmental dosimeters.

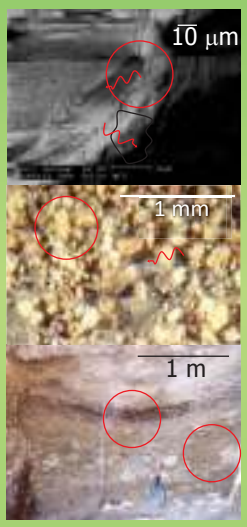
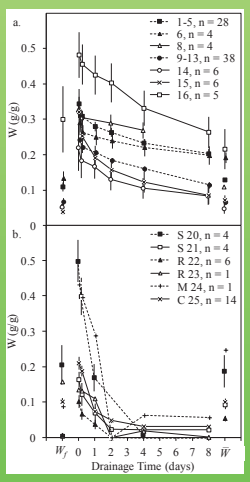
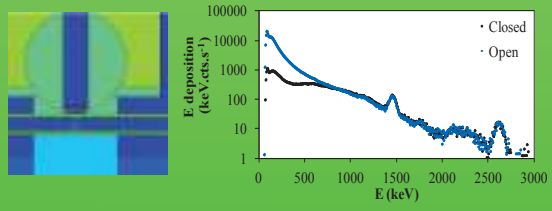


Illustration of some materials and spatial scales of interest for alpha, beta and gamma radiation



Water retention characteristics for 121 luminescence dating samples of different textures and mineralogies. a. samples measured in tubes. b. samples measured in/on sieve mesh: Soil, Rock, Mortar, Ceramic/heated clay.



Detail of elements of a Riso automatic irradiator being used for modelling with MCNPX. Measured photon spectra in front of the reader with source open and closed (lower).

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