Hydrology and Earth System Sciences, 1, 35–46 (1997) © EGS

Hydrology & Earth System Sciences

# Development of a Hydrogeological Model of the Borrowdale Volcanics at Sellafield

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## Abstract

**This work has arisen out of recent developments within the radioactive waste research programme managed by Her Majesty's Inspectorate of Pollution, UK (HMIP)*, to develop an integrated flow and transport model for the potential deep radioactive waste repository at Sellafield. One of the largest sources of uncertainty in model predictions, is the characterisation of the hydrogeological properties of the underlying strata, in particular, of the Borrowdale Volcanic Group (BVG) within which the repository is to be located. Analysis of the available borehole data (that released by the proponent company, Nirex, by December 1995) for the BVG formation has indicated a dual regime consisting of flow within faults and flow within the matrix (or an equivalent porous medium containing micro-fractures). Significant relationships between permeability, depth and the presence and orientation of faults have been identified; they account for a variation of up to 6 orders of magnitude in mean permeability measurements. This can be explained in part by the effect of the orientation of the current maximum principal stress directions within the BVG: however, it is likely that permeability is also dependent on the existence of fracture families, which cannot be effectively identified from the data currently available.**

**These analyses have enabled considerable insight to be gained into the dominant features of flow within the BVG. The conceptual hydrogeological model derived here will have a significant effect on the outcome and reliability of future radionuclide transport predictions in the Sellafield area.**

## Introduction

In the United Kingdom, disposal of radioactive waste requires an authorisation under the Radioactive Substances Act 1993, from the appropriate departments, which include, the regulator, Her Majesty's Inspectorate of Pollution, UK (HMIP). In order that HMIP make an informed assessment of the proposed site, a programme of work has been undertaken, since 1982, to develop, test and apply probabilistic methods to assess risks from underground disposal of radioactive waste (Thompson *et al.*, 1996). Within this programme, a synthetic site model was developed for the regional geological system centred on a hypothetical radioactive waste repository at Harwell, Oxfordshire, UK (Mackay 1993a). The synthetic site model is based on the integration of structural, lithological and hydrogeological models of the site, derived from the available measurement data. The application of this synthetic site model as a surrogate for a real site has shown its potential to provide important information about the behaviour and variability of the groundwater regime in the vicinity of the site to enable a site hydrogeological assessment (Mackay 1993b). The same modelling approach is being applied here for the Sellafield site which has been targeted by Nirex UK Ltd. as a potentlal location for a deep radioactive waste repository for disposal of solid low level and intermediate level radioactive wastes in the UK.

The risk assessment programme for Sellafield requires flow and transport modelling of both the regional and the detailed near-repository environment. This modelling is to be implemented within a stochastic framework to provide a methodology for examining the variability in the transport pathways for radionuclides from the site. One of the largest sources of model uncertainty is in the characterisation of the hydrogeological properties of the underlying strata, in particular, of the Borrowdale Volcanic Group (BVG) within which the repository is to be sited. Flow within the BVG occurs predominantly through a network of conducting faults and fractures.

* HMIP has now merged with the National Rivers Authority and the Waste Regulatory Authorities in England mand Wales to form the new National Environment Agency.