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Transport parameter estimation in hydro-geological media

Thomas Migliore[1,2], **Didier Auroux**[3] **and Jacques Blum**[2]

[1]Agence Nationale pour la gestion des Déchets Radioactifs (A.N.D.R.A)

[2] Laboratoire Jean-Alexandre Dieudonné - UMR CNRS 6621, Université de Nice Sophia-Antipolis

[3] Institut de Mathématiques de Toulouse - UMR 5219, Université Paul Sabatier Toulouse 3

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Abstract. *The nuclear waste storage in deep level requires to make simulations of the radionucleide transport in underground in order to determine the impact of a possible propagation of radioelements. To achieve this, we need to know the physical parameters of the different geological layers. Those parameters (porosity and diffusion) are not directly accessible by measurements, hence we have to solve an inverse problem to recover them. The idea is to inject chemical tracers in the ground and to measure the evolution of their concentration over several years. Then, the resolution of the inverse problem permits to determine these parameters and the geologic configuration which is compatible with the observations. This inverse problem is formulated as a least square minimization problem in which we minimize the misfit between observations and the corresponding quantities calculated by the model for a given set of parameters.*

In this work, we use for the direct problem the simulation code TRACES (Transport of RadioACtive Elements in Subsurface) developed by Fluid and Solid Mechanics Institute (IMFS) in Strasbourg and by ANDRA. This program, written in FORTRAN 90, simulates the flow and the reactive transport in saturated porous media. TRACES has been integrated in the ALLIANCES rig developed by ANDRA in partnership with CEA and EDF.

The aim of this paper is to estimate the transport coefficients, which are the diffusion coefficients with anisotropy and the porosity coefficient, from concentration measurements. The data consist of the concentration measurements collected in the injection room throughout the experience, as well as the measurements at the final time obtained by core drilling. The objective will be to apply these results to the DIR experiment – Diffusion of Inert and Reactive tracers – which belongs to the multidisciplinary research program started by ANDRA to study the possibility of the nuclear waste storage in the Callovo-Oxfordien clays formation at the Meuse/Haute Marne site at 500 m depth.

The particularity of this work is to use the zonation technics in two dimensions or in three dimensions (in the axisymmetric case) which consists in considerating the media as a set of homogeneous zones, for which the coefficients will be estimated. To achieve this, we develop the adjoint code of the diffusion-convection code TRACES by automatic differentiation with the software TAPENADE from INRIA Sophia-Antipolis.