Geophysical Research Abstracts, Vol. 9, 02754, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-02754

Observation of transport processes in soils and rocks with Positron Emission Tomography

J. Kulenkampff (1), M. Richter (1), M. Gründig (1), A. Seese (2)

(1) Institute for Interdisciplinary Isotope Research, Leipzig, Germany, (2) Clinic of Nuclear Medicine, University of Leipzig, Germany

Migration of any substance through soils and rocks includes advection, hydrodynamic dispersion, diffusion, sorption, and chemical reactions, which all are varying in space and time. A most effective observation method for these processes is Positron Emission Tomography (PET), which enables to determine the 3D-spatial distribution of positron-emitting tracers quantitatively. The required number of tracer atoms is small, compared to the requirement of other tomographic methods, like MRT or ERT, and thus the modification of the fluid composition usually is negligible. The majority of processes in the geosphere is slow; therefore the use of radionuclides with decay times in the order of days (for example ^{124}I: 4.18 days, ^{58}Co: 70.78 days, ^{22}Na: 2.6 years) is more appropriate than common medical tracers (^{18}F: 1.83 hours). Time-resolved PET-measurements during injection and transport of fluids that are marked with an appropriate tracer then yield the spatiotemporal variation of concentration with an intermediate spatial resolution. The resolution limit is determined by the decay length of a positron of 1-2 mm, depending on its energy and the material density, and can be achieved with small animal PET scanners or a specially designed GeoPET. Therefore, the sensitivity of PET for events on the atomic scale is effectively transformed to a macroscopical scale, showing preferential flow paths, anisotropical transport behaviour, and diffusive spreading of concentration fronts. PET is therefore an excellent means for deriving transport parameters and their spatial distribution, as well as for experimental tests of modelling results. In the past five years a number of PET experiments have been conducted in Leipzig on soil columns and barrier rocks. The practicability and benefits of the method for process observation could be clearly demonstrated, and data sets which can be used for the calibration of model codes are available.