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# An experimental approach to reactive transport in geomaterials: GeoPET

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Detailed understanding of reactive transport in geomaterials of chemical species, including radionuclides, is required for the utilization of the subsoil, e.g. for designing ore production by in-situ leaching, or for radioactive waste disposal. To complement the well-established conventional approach, i.e. computer model simulations based upon bulk material parameters and geochemical data bases, we apply process tomography with positron emission tomography (GeoPET) for direct observation and parameterization of the reactive transport processes. This enables to consider heterogeneity as pervasive feature of processes in complex media. One example is localized flow meandering along fractures, where preferential flow may jeopardize leaching efficiency. On the other hand, fissure networks through otherwise tight material could provide fast transport pathways through geological barriers.
Our workflow consist of
1. production of appropriate PET-nuclides and labelling,
2. transport experiment on samples of drill core size with the labelled species,
3. recording of PET-data (list-mode-files) during the course of tracer propagation,
4. computation of PET-frames with appropriate frame rate and correction for material effects,
5. parameterization of the spatiotemporal data set with the target parameters effective volume distribution and velocity distribution.
The choice of PET-nuclides is broader than in common biomedical PET applications, because longevity and toxicity of the tracers are inconsiderable, but spatial resolution and efficient corrections for attenuation and scatter require attention. The development of the GeoPET method during the past decade is described in Kulenkampff et al. (2016).
As illustration, we present an example from ore leaching, where the leaching solution is flown through an artificial fracture. During leaching we experimentally determined the macroscopic flow field with GeoPET. With these hydrodynamic data we are able to establish a realistic and light-weight reactive transport model which can directly serve for efficient design of leaching.
The procedure is one good example for the benefit of radiotracers for unravelling complex processes by non-destructive molecular imaging. We strongly suggest utilizing this distinguished tool, in particular for .parameterization and upscaling of heterogeneous reactive transport models.

Kulenkampff, J., Gründig, M., Zakhnini, A., Lippmann-Pipke, J. 2016. Geoscientific process monitoring with positron emission tomography (GeoPET), Solid Earth, 7, 1217-1231, 10.5194/se-7-1217-2016.

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