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# Fluid transport in Ordinary Portland Cement (CEMI) and slag cement (CEMIII) waste forms from in situ Positron Emission Tomography (PET)

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Radioactive waste poses a serious challenge. Solidifying this waste in cementitious matrices is a common strategy to immobilize radionuclides. Cement is also used in barriers separating waste repositories from the environment. The cement's ability to retain radionuclides and radionuclide-containing fluids are key for successful long-term storage. However, in-situ observation and direct measurements of transport processes in cementitious waste forms are challenging.

Positron Emission Tomography (PET) is a non-destructive method for measuring the 3D distribution in time of positron-emitting radionuclides in an opaque, porous media. We tested the compatibility of potential radiotracers for obtaining quantitative data on short-term (fluid uptake) and long-term (diffusion) transport processes in cement pastes over different time scales and developed a procedure for applying PET for monitoring these processes in cementitious matrices. Finally, we used PET to observe and measure fluid transport and radionuclide diffusion in Ordinary Portland Cement (CEMI) and Slag cement (CEMIII) pastes, representing cementitious waste forms.

Here, we will present our method and quantitative data from short-term and long-term transport experiments in CEMI and CEMIII pastes. We will discuss the physical principles of PET measurement, its capabilities and limitations, and the consideration for selecting a radiotracer. We will show that $^{124}I$ and $^{22}Na$ are suitable for measuring, respectively, fast and slow transport processes. Finally, we will show, based on in situ measurements, that radionuclide transport in CEMIII waste forms is retarded compared with CEMI waste forms.