

Underpinning UK vitrified waste disposal in a geological facility

Research Group(s): MATES / Petrology / Geochemistry

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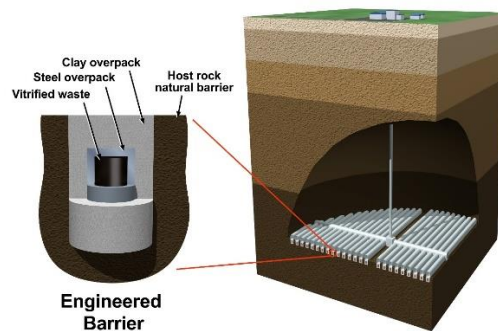
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Project keywords: radioactive waste; glass; geological disposal; sub-surface degradation; groundwater

Funder: [Nuclear Waste Services](#), through the [NWS Research Support Office](#)



Creating simulant radioactive waste glass in the laboratory, in preparation for groundwater leaching tests. Credit: Claire Corkhill



*Schematic showing how vitrified waste will be packaged prior to geological disposal. Credit: Thorpe, Corkhill et al. *Materials Degradation*, 5, 61 (2021)*

Project Background

In a geological disposal facility for radioactive waste, the release of radionuclides to the geosphere, over a period of 100,000s of years, will be controlled by the interaction of groundwater with the waste. Although vitrified radioactive waste is a highly durable material, it will slowly dissolve. This project aims to quantify the rate of vitrified waste degradation, using glasses produced in exactly the same way as real radioactive waste glass, but without the highly radioactive elements. These materials, known as magnox-glasses, are made on the vitrification test rig – a full-scale replica of the vitrification line at the Sellafield site.

We will make a “mini-geological disposal facility” in the laboratory, where borosilicate glass specimens will be placed in anoxic heated vessels containing groundwater simulants with / without the materials under consideration for containing the glass, e.g. stainless steel, carbon steel or copper. The rate of glass degradation will be directly measured, while the formation of corrosion layers – akin to rust – will be analysed to determine what drives degradation. The results of the project will be used to inform the best container materials for vitrified waste, as well as informing predictive models of the long-term safety of radioactive waste disposal.

Project Aims and Methods

This project aims to fill a key gap in the understanding of UK high level waste glass dissolution: understanding the dissolution of full-scale simulant magnox glass under conditions relevant to disposal. The key phases of work are as follows: (1) literature review; (2) acquisition and preparation of glass and container materials; (3) dissolution tests; (4) post-dissolution characterisation (e.g. SEM/EDX, XRD, TEM, Mossbauer spectroscopy, μ -XAS techniques).

Having obtained (or synthesised by standard glass melting techniques) simulant radioactive waste glass materials for study, a range of dissolution experiments will be performed to establish how groundwater composition and container material type will influence the rate at which radionuclides (or their surrogates) are leached into solution. The dissolution experiments will form a major part of the work and a series of different standard leaching protocols will be used, with development of alternative leaching protocols throughout the project as necessary. The amount of glass constituents leached into solution will be measured using ICP techniques (e.g. ICP-OES and ICP-MS), as well as ion chromatography, giving insight into the rate of glass dissolution. Post-dissolution characterisation using the laboratory and synchrotron facility techniques (e.g. at Diamond Light Source or National Synchrotron Light Source-II) detailed above, will enable an understanding of glass dissolution mechanisms. Both are important input for the safety case for radioactive waste disposal currently being formulated by the project sponsor, Nuclear Waste Services.

Candidate

This project would suit someone with a 1st or 2:1 Bachelor or Masters degree (or equivalent experience) in any of the following: geoscience, materials science, chemistry, chemical engineering, physics, environmental science or related subjects. You must be prepared to work independently and also as part of a research team, and not be afraid to get things wrong before they go right (that's how the best science works!). You will be interested in problem-solving, learning skills in solid-state and aqueous chemistry and keen to get hands-on in the laboratory, as well as having a keen eye for identifying trends in data. You will become an expert in wielding a pipette and will get to work on solving a real-life problem with near-term societal benefit.

Training

You will join a cohort of students funded by Nuclear Waste Services across the UK, all of whom are researching topics related to radioactive waste disposal, from social science-related aspects to geoscience and materials science. As part of this cohort, you will benefit from scientific training sessions (e.g. geochemical modelling software training) with your peers as well as public engagement and science communication training. It is anticipated that you will have the opportunity to use these skills talking to the communities currently part of the geological disposal facility voluntary siting process. You will attend an annual conference of the Nuclear Waste Services researchers, exposing you and your research to a range of future employers.

The project will be supervised by Professor Claire Corkhill, who is one of the UK's leading experts in radioactive waste disposal. She advises the UK Government on matters relating to nuclear waste, and is often found chatting about radioactive waste on the TV (e.g. as a lead contributor to the Channel 4 documentary, [Chernobyl: The New Evidence](#)) and radio.

Background reading and references

For an introduction to the topic of radioactive waste management, please see: Corkhill and Hyatt, Nuclear Waste Management, [IOP Publishing Ltd](#) (2018). For an overview of radioactive waste glass dissolution experiments, please see: Thorpe et al., Forty years of durability assessment of nuclear waste glass by standard methods. [npj Materials Degradation](#), 5, 61 (2021).

Useful links

[http://www.bristol.ac.uk/earthsciences/courses/postgraduate/Nuclear Waste Services](http://www.bristol.ac.uk/earthsciences/courses/postgraduate/Nuclear%20Waste%20Services)
[Nuclear Waste Services Research Support Office](#)

Eligibility

This project is restricted to British Nationals qualifying for UK home fee status.

Application deadline: 3rd May 2024 23.59 GMT

How to apply to the University of Bristol: <http://www.bristol.ac.uk/study/postgraduate/apply/>.

Please select PhD in Geology as the programme in the online application system.