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Preface: Subglacial erosional landforms and their relevance for the long-term safety of a radioactive waste repository

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1 Long-term safety of radioactive waste repositories

Deep geological repositories are generally agreed to be the best way to dispose of radioactive waste and to isolate it from the biosphere. The long-term safety of such radioactive waste repositories has to be assessed for very long periods (up to 1 million years), implying that the impact of potential future cold stages and glaciations on the geological barrier of a repository needs to be considered. In glaciated regions, erosion beneath glaciers and ice sheets can mobilise and redistribute substantial amounts of rock and sediment. Subglacial erosional landforms such as overdeepened basins and tunnel valleys may attain depths of more than 500 m. Such deep erosion is within the depth range considered for repositories and could seriously affect the integrity of the geological barrier of a radioactive waste repository during future glaciations.

To address the topic of subglacial erosion and its relevance for the long-term safety of radioactive waste repositories, to bring the community together, and to assess the state of knowledge, a 2 d workshop was organised by the BGR (Bundesanstalt für Geowissenschaften und Rohstoffe – Federal Institute for Geosciences and Natural Resources) and BGE (Bundesgesellschaft für Endlagerung mbH – Federal Company for Radioactive Waste Disposal) in December 2021. The workshop attracted almost 200 participants from research institutes, universities, industry and the wider public. Although the workshop was held online, the combination of lectures, virtual posters and discussions provided an opportunity for interaction and exchange between the participants.

2 Contents of this special issue

This special issue presents a collection of studies on various aspects of subglacial erosion and its treatment with regard to site selection and the long-term safety of radioactive waste repositories.

Cohen et al. (2023) present the results of high-resolution ice-flow simulations of the Rhine glacier during the last glaciation. By estimating the location of subglacial drainage routes and linking these locations to zones of erosion, the model helps to explain the locations of overdeepened valleys in the northern foreland of the Alps.

Breuer et al. (2023) present a new overview map of the maximum depth of Pleistocene tunnel valleys in northern Germany. To assess the potential for future tunnel-valley formation, depth zones are mapped which may serve as a basis for defining a spatially variable additional depth to the minimum depth of a repository required by German legislation.

Müller et al. (2023) explain the role and execution of representative preliminary safety assessments in the site selection process for high-level radioactive waste in Germany. The example of tunnel-valley formation is used to demonstrate how possible future evolutions of potential disposal sites are

developed from the understanding of past evolutions to minimise the consequences of error as far as possible.

Gegg and Preusser (2023) compare overdeepened valleys in the foreland of the Alps to tunnel valleys in northern central Europe. Their comparison highlights that foreland overdeepenings and tunnel valleys are connected to different types of ice masses but share many characteristics. The understanding of the formation and infilling of these features would benefit from more intense exchange and discussion between the respective scientific communities.

Lohrberg et al. (2022) mapped and updated Pleistocene tunnel valleys in the south-eastern North Sea based on seismic data. While marine seismic data are effective tools to understand tunnel-valley formation and filling, dense grids of seismic profiles are necessary to map the complex tunnel-valley networks and infills.

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