
# Waste Containment in permafrost

## 11A - Mining geotechnics, reclamation, contaminant behavior and nuclear waste safety in a changing climate

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There are an increasing number of mining projects being developed in regions where continuous permafrost is present. With the development of such mining projects, numerous unique engineering and environmental challenges follow. With respect to geotechnical engineering, mining operations have several critical infrastructures such as tailings dams, tailings, and waste rock storage facilities, which must be designed, operated and reclaimed to ensure optimal mine waste management and minimize environmental risks. The closure of mine waste storage facilities often requires the design and construction of engineered covers which aim to maintain the mine wastes physically and chemically stable.

Such geotechnical infrastructures constructed in continuous permafrost environments require time to freeze-back and reach thermal equilibrium with the natural ground. The aggradation of permafrost conditions within the mine wastes as well as tailings dams and cover systems have the overall beneficial effect of improving their physical stability, reducing water seepage and reducing the potential for the generation and transport of contaminants into the receiving environment. In this context, climate change represents the largest source of uncertainty with respect to the long-term geo-environmental behavior and performance of mine waste storage facilities and their reclamation strategies.

Cryogenic processes also play a crucial role in the safety assessments of long-term nuclear waste repositories and the transport of other contaminants. Within the timespan for which a safe enclosure of the waste must be ensured, which depending on the regulations, could be more than one million years, numerous climate cooling and warming cycles must be considered. The presence, aggradation, and degradation of permafrost and ice sheets can exert extensive pressure gradients and changes in pathways that impact the transport of radionuclides and other contaminants from the geosphere into the biosphere. Present-day permafrost regions currently serve as analogues for repository sites in a future cold climate, where processes that influence the migration of contaminants can be studied. Numerical modeling approaches of freezing and thawing of soil and rocks are constantly being improved, as the interplay between different processes and parameters becomes better understood.

**Keywords**: Engineered Covers, Tailings Storage Facilities, Waste Rock Piles, Mining Geotechnical Engineering, Nuclear Waste, Cryo-Hydrogeology, Climate Transition, Permafrost Transition

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## 12B - Contaminant behavior and nuclear waste safety in transitional climates

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In this session, we invite studies on any cold region processes that may impact contaminant transport, including but not limited to the context of long-term safety of nuclear waste repositories. We welcome contributions from numerical modeling, laboratory, field experiments, case studies and assessments in areas including (1) contaminant pathways between glacial, subglacial, and periglacial groundwater systems and surface systems; (2) impact of climatic transitions on contaminant transport; (3) links to ecological systems and biogeochemical transport processes; (4) effects of freezing and thawing of porous and fractured media (e.g. volume changes, cryosuction); (5) fault zone hydrogeology and the role of permafrost formation and thaw; (6) talik forming under freezing and thawing conditions.

**Keywords:** Nuclear Waste, Cryo-hydrogeology, Climate transition, Permafrost transition

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