

Correlating Aging and Durability of Ancient Glasses to Predicted Long-Term Performance of Vitrified Waste

PARTNERS



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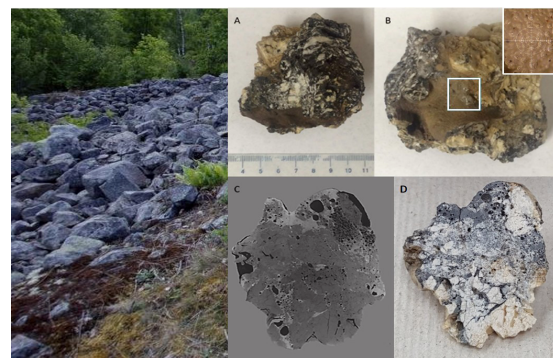
Pacific Northwest National Laboratory (PNNL), Washington State University (WSU), National Institute of Standards and Technology (NIST) and Smithsonian Institute's Museum Conservation Institute

Technical Summary

The two main goals of this project are to: (i) determine the long term durability of Broborg hillfort glass to support disposal of low-activity waste (LAW) glass in the Hanford Integrated Disposal Facility (IDF); and (ii) provide further insight into the anthropological and archaeological interpretation of the Broborg site. This includes determining the ancient glass melting technology used so that synthetic glass of the same composition can be generated and used in short-term accelerated aging test methods or the development of alternative tests to support IDF disposal requirements. Analysis of Broborg samples acquired from a private collection has allowed for the development of sample handling protocols, material preparation procedures, and analytical methodologies or approaches which will be used on future samples excavated from the site. These historical artifacts have been analyzed using non-destructive x-ray computed tomography (XCT) to select areas for sectioning, micro x-ray diffraction (μ XRD) to find amorphous glassy areas, micro x-ray fluorescence (μ XRF) to determine glass chemistry and electron microscopy to analyze alteration layers on the glass surface. Characterization of these alteration layers provides a unique insight into natural processes that drive glass corrosion over thousands of years, including the role of microorganisms. Taken along with information from the literature, these data have informed planning for the upcoming Broborg excavation.

Path Forward

- The international hillfort program plans to acquire "fresh" samples from the Broborg site to add to the growing analytical information and to address programmatic objectives.
- Multiple, sub-terrain glass-rich samples will be obtained with existing alteration layers. Soil/water/rock samples will provide insight into the geochemistry and hydrology impacts of corrosion. In addition, the role of microorganisms in glass corrosion will be investigated.



Vitrified samples from Broborg hillfort analyzed by x-ray computed tomography.

Key Accomplishments

- Broborg samples have been acquired from a private collection and shipped to PNNL to develop sample handling protocols, material preparation procedures, and analytical methodologies or approaches.
- Samples have been analyzed by the International team using a range of techniques to determine the internal structure of vitrified sections, the chemical composition of the glass, and the mineralogy of the rocks used in the glass melting process.
- Results from these analyses have formed the basis for publications in three refereed, peer-reviewed journal articles and presentations at three international conferences.

Key Benefits

- The effectiveness of glass aging tests will be validated if synthetic glass subjected to accelerated aging methods matches the condition of ancient glass from Broborg. More accurate aging tests could lead to improved waste loadings without compromising the long-term integrity of the glass, thereby reducing the clean-up mission life at Hanford.