SRNL is a DOE National Laboratory
operated by Savannah River Nuclear Solutions.

We put science to work.™

# Innovations

## from Savannah River National Laboratory

U.S. DEPARTMENT OF ENERGY • SAVANNAH RIVER SITE • AIKEN • SC

srnl.doe.gov

## Impact

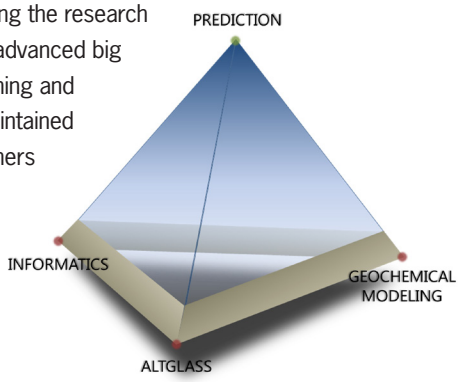
Savannah River National Laboratory is using informatics techniques coupled with the Accelerated Leaching and Testing of GLASS (ALTGLASS) database to advance transformational, cross-cutting concepts into the research of nuclear waste glass corrosion.

- The ALTGLASS database is being employed by scientists and engineers to strengthen existing and formulate new models of glass corrosion phenomena that are being applied to the performance assessment calculations for long-term disposal repositories.
- Since its inception, ALTGLASS has highlighted the utility of centralized databases focused on material property aspects of nuclear waste management – several efforts are underway to develop similar databases for information like thermodynamic data related to glass corrosion.

**srnl.doe.gov**

# Accelerating high-level waste glass corrosion research with big data

Savannah River National Laboratory (SRNL) is accelerating the research of nuclear high-level waste (HLW) glass corrosion using advanced big data techniques available through the Accelerated Leaching and Testing of GLASS (ALTGLASS) database. Developed, maintained and distributed by SRNL, ALTGLASS gives HLW researchers access to chemical durability data for hundreds of glass compositions, allowing scientists to use an "informatics approach" to analyze existing and new experimental data contained in the database to advance glass corrosion science.




## The Challenge

As HLW glass comes into contact with an aqueous solution (laboratory solutions, groundwater, brine, etc.), radionuclides contained in the glass will be released into the surroundings. The rate of release depends on many factors including glass composition, environment, and temperature. Once exposed to an aqueous solution, the initial alteration of the glass waste form will occur rapidly in what is known as Stage I corrosion. As the concentration of glass constituents builds up in the solution and an alteration layer forms on the glass surface, the rate of radionuclide release slows into Stage II corrosion, which can last for years, centuries, or millennia. However, in laboratory experiments some glass compositions in Stage II have demonstrated a resumption of rapid alteration known as Stage III corrosion.

## Innovative Solutions

Understanding the mechanisms responsible for the Stage II to Stage III transition is an important step in designing durable waste glass compositions and repository performance assessments. SRNL recently began pioneering a novel approach to glass corrosion research:

- Developed new conceptual model combining geochemistry and data regression to link glass alteration products to corrosion behavior.
- Indicated corrosion-produced alteration layer chemistry is intimately tied to Stage II → Stage III transition.
- Demonstrated utility of big data techniques applied to ALTGLASS and similar databases.

Savannah River National Laboratory®
OPERATED BY SAVANNAH RIVER NUCLEAR SOLUTIONS

Savannah River NUCLEAR SOLUTIONS℠
FLUOR • NEWPORT NEWS NUCLEAR • HONEYWELL

U.S. Department of Energy Office of Environmental Management multi-program national laboratory.

Innovations from Savannah River National Laboratory

The research was presented in two recent publications in the International Journal of Applied Glass Science and represents a potential paradigm shift in the way researchers think about HLW corrosion and applications of ALTGLASS.

## Future research directions:

With the support of U.S. Department of Energy's Office of Environmental Management, SRNL has advanced the knowledge of long-term glass corrosion mechanisms through the development of ALTGLASS. This one-of-a-kind database gives researchers from around the world access to thousands of experimental data points on HLW and LAW glass corrosion.

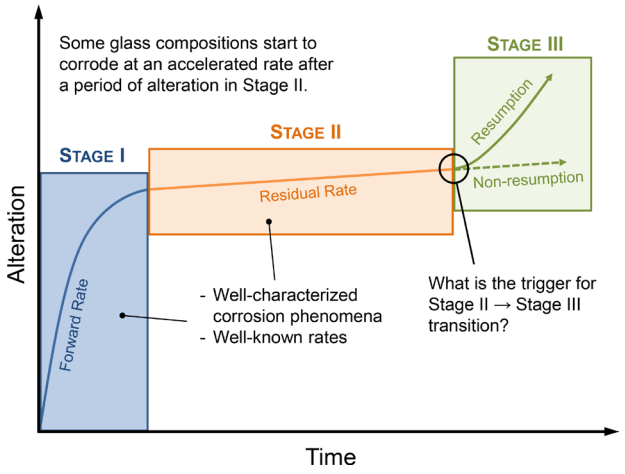
To allow a broader application of theory to real-world nuclear waste problems, future efforts will focus on:

- Updating ALTGLASS with additional test results.
- Testing new conceptual models by combining informatics, geochemistry, and glass science.
- Determining efficacy of glass corrosion byproducts (e.g., zeolites or clays) for sequestering radionuclides.
- Continuing collaborative efforts with researchers in academia, DOE National Laboratories, and international partners.

## ALTGLASS Facts:

- Data given in ALTGLASS:
  - *Concentration analyses for: Silicon, Boron, Calcium, Lithium, Sodium, Potassium, Aluminum, Iron, Molybdenum, Magnesium, Titanium, Zinc, and Zirconium.*
    - *Glass Type (HLW or LAW)*
    - *Test vessel type (Teflon or stainless steel)*
    - *Test duration (days)*
    - *Geometric surface area (SA) of initial glass product (m2)*
    - *Surface area-to-volume ratio (SA/V)(m-1)*
    - *SA/V*time (days/m)*
    - *Density (g/cm3)*
    - *Glass starting mass (g)*
    - *Glass particle size (mesh)*
    - *Leachant volume (L)*
    - *Type of leachant (water, brine, etc.)*
    - *Test temperature (°C)*
    - *Final pH of leachant solution*
    - *Secondary mineral phases formed during corrosion (mineral type, name)*
    - *Analytical method used to identify/study secondary mineral phases*
    - *Glass composition (wt.%)*

- The first version of ALTLGASS was released in 2013.
- Four versions have been released (Versions 1.0, 2.0, 2.1, 3.0).
- Version 3.0 is the first to contain data shared from international partners (National Nuclear Laboratory – United Kingdom).
- Contains Product Consistency Test (PCT) data for different glass compositions.
- PCT durations range from several hours to multiple decades.
- Led to publication of four documents (3 journal articles and 1 technical report).
- Highlighted in several presentations at the Nuclear Waste Technical Review Board.
- Being used by researchers at Argonne National Laboratory to develop a conservative model for Stage III corrosion in performance assessment.




## Partners in Success

**National Laboratories**
Savannah River National Laboratory
Argonne National Laboratory
Pacific Northwest National Laboratory

**Department of Energy**
Office of Environmental Management

**Universities**
Clemson University
University of South Carolina
Pennsylvania State University
Vitreous State Laboratory – Catholic University

**Commercial Partners**
National Nuclear Laboratory – United Kingdom



SEPTEMBER 2018 13CC00015_IS025