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# Spent Nuclear Fuel: OST&I Research Program

Presented to:  
**NWTRB Informal Information  
Exchange**

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# Office of Science and Technology and International (OST&I)

## Mission

“ Provide advanced science and technology to continually *enhance our understanding* of the repository system and to reduce the cost and schedule for the OCRWM mission.”

# Source Term Targeted Thrust of OST&I

## Integration

Research program is focused on the changing conditions over *time*, identifying the *critical processes* within each time interval, and with attention to the *radionuclides* that are the *major contributors to dose*

# Source Term Targeted Thrust

## Critical Processes

- Kinetics of waste form corrosion
- Formation of secondary, alteration phases
- Sorption/reduction on the surfaces of near-field materials
- Formation and mobility of colloids

# Source Term Targeted Thrust

## Radionuclides of Interest

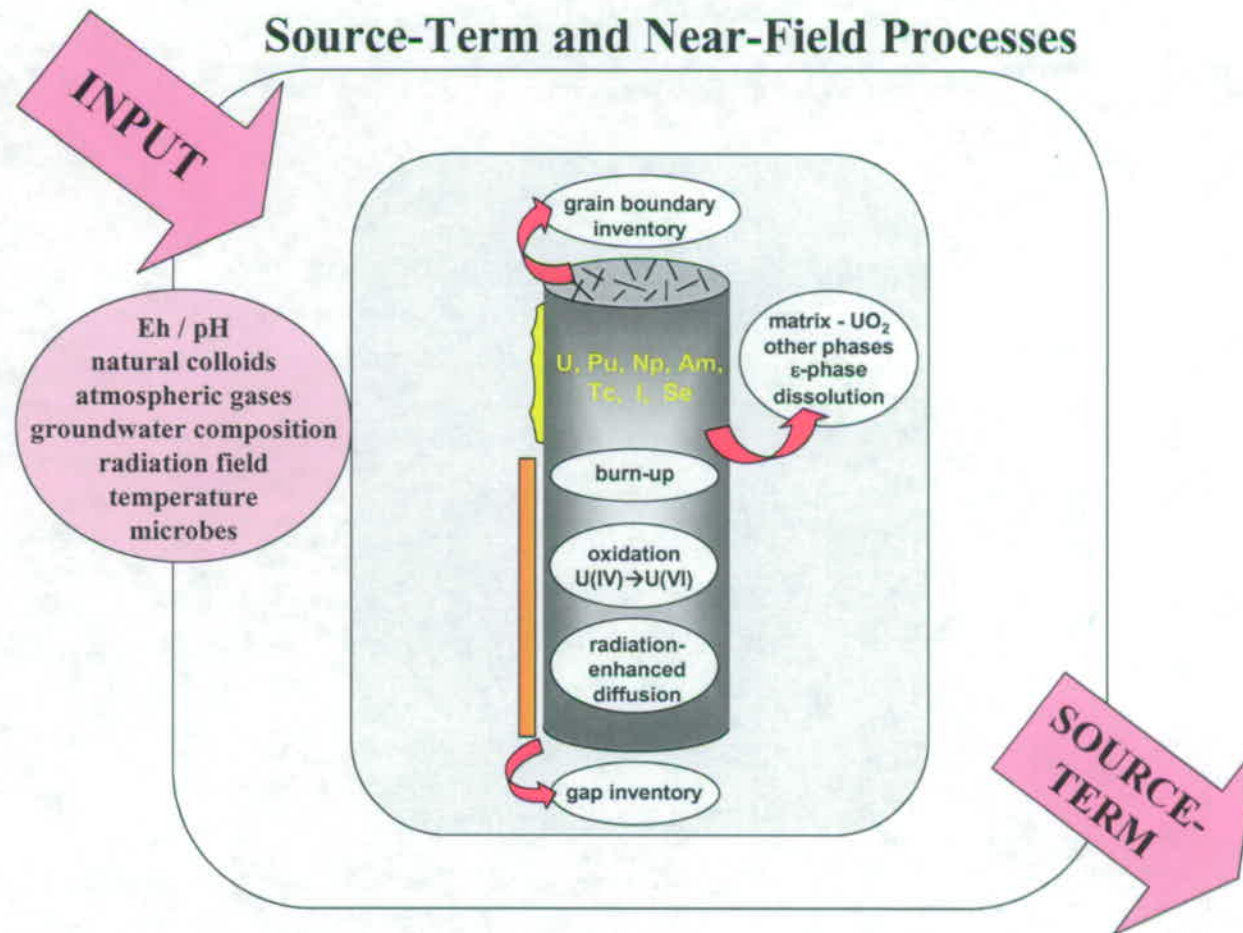
$^{238}\text{U}$ ,  $^{234}\text{U}$ ,  $^{233}\text{U}$ ,

$^{239}\text{Pu}$ ,  $^{237}\text{Np}$ ,  $^{241}\text{Am}$ ,

$^{226}\text{Ra}$ ,  $^{129}\text{I}$ ,  $^{99}\text{Tc}$ ,  $^{79}\text{Se}$ , and  $^{36}\text{Cl}$

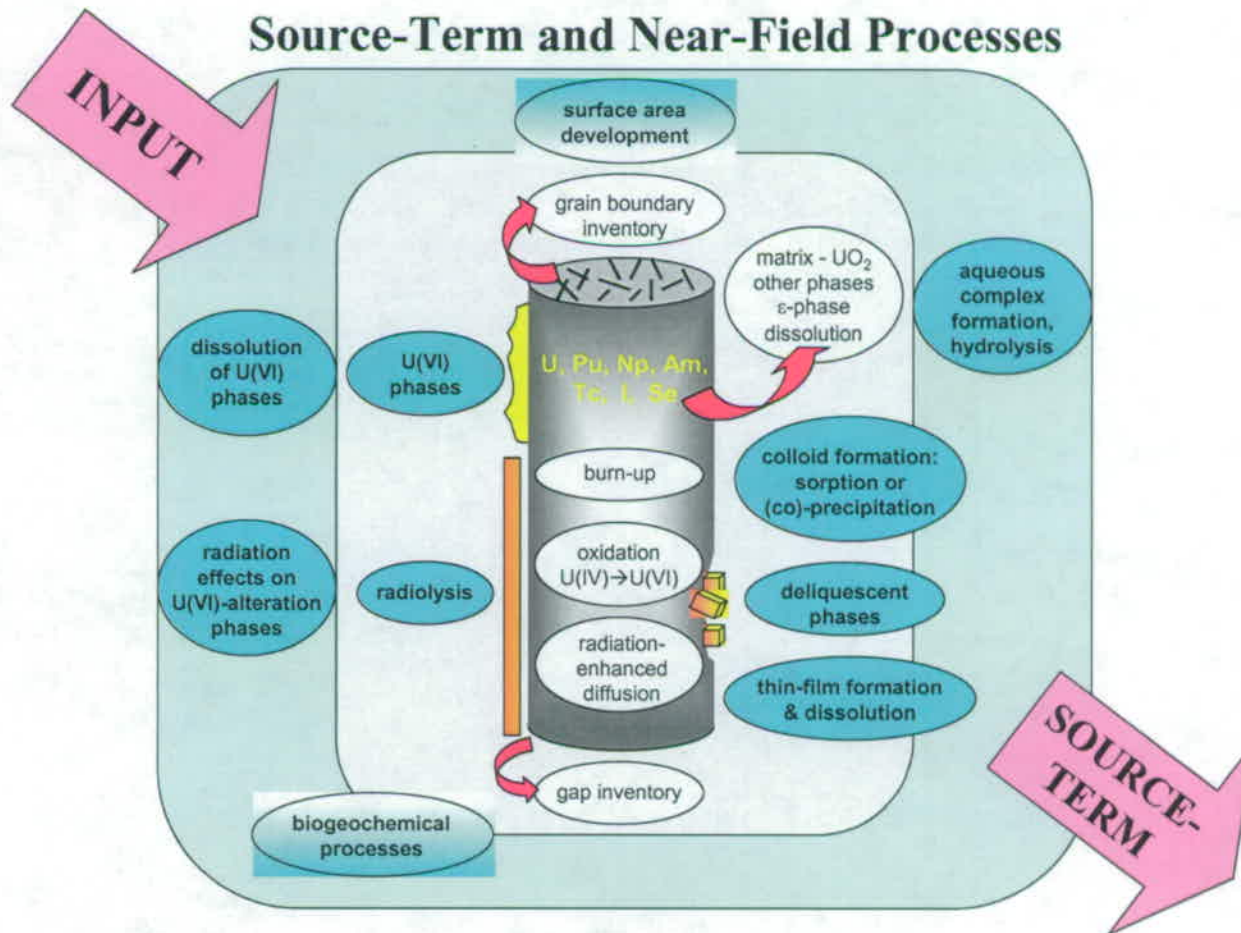
# Source Term Targeted Thrust

(prior to breach of waste package)



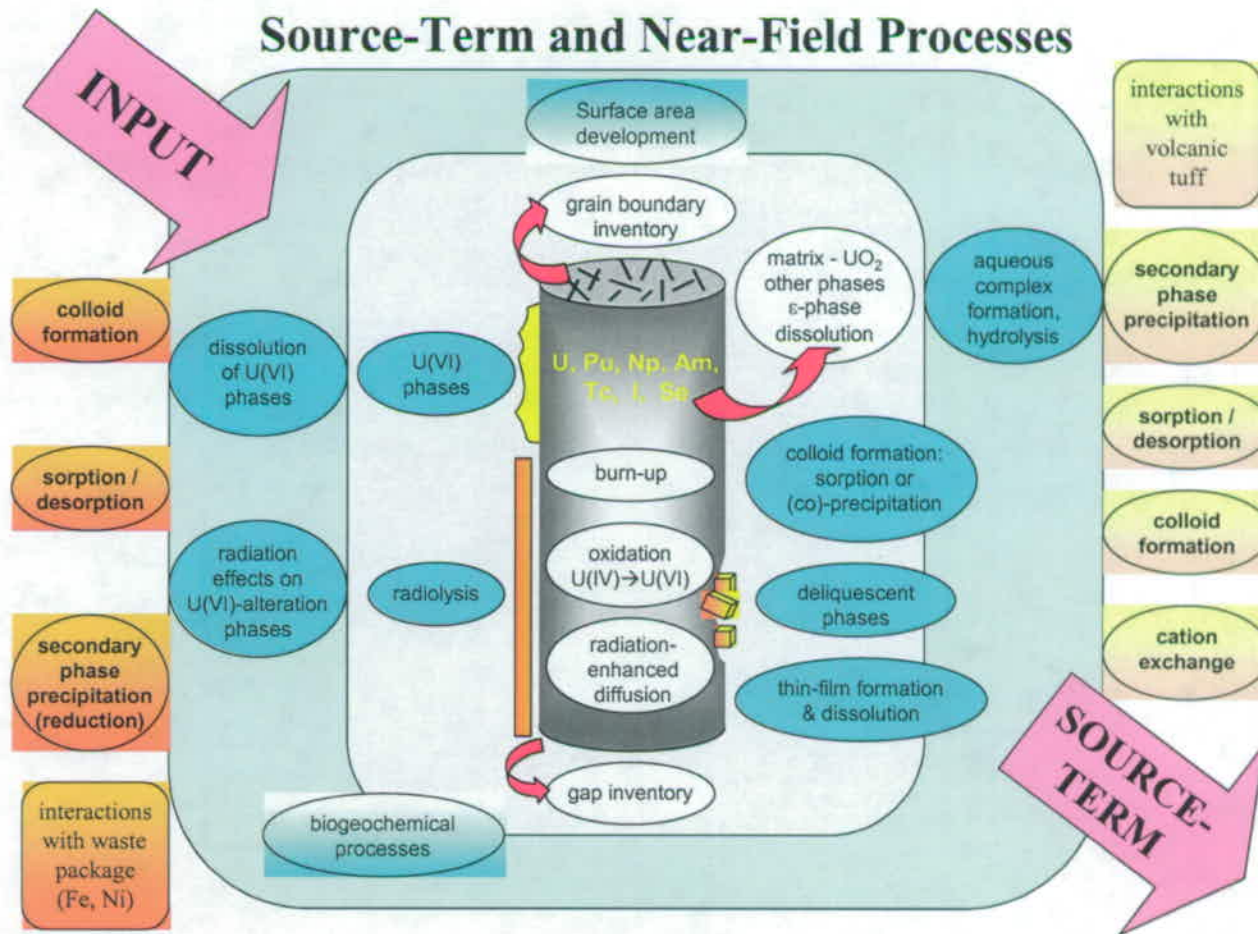
# Source Term Targeted Thrust

(early waste package failure)



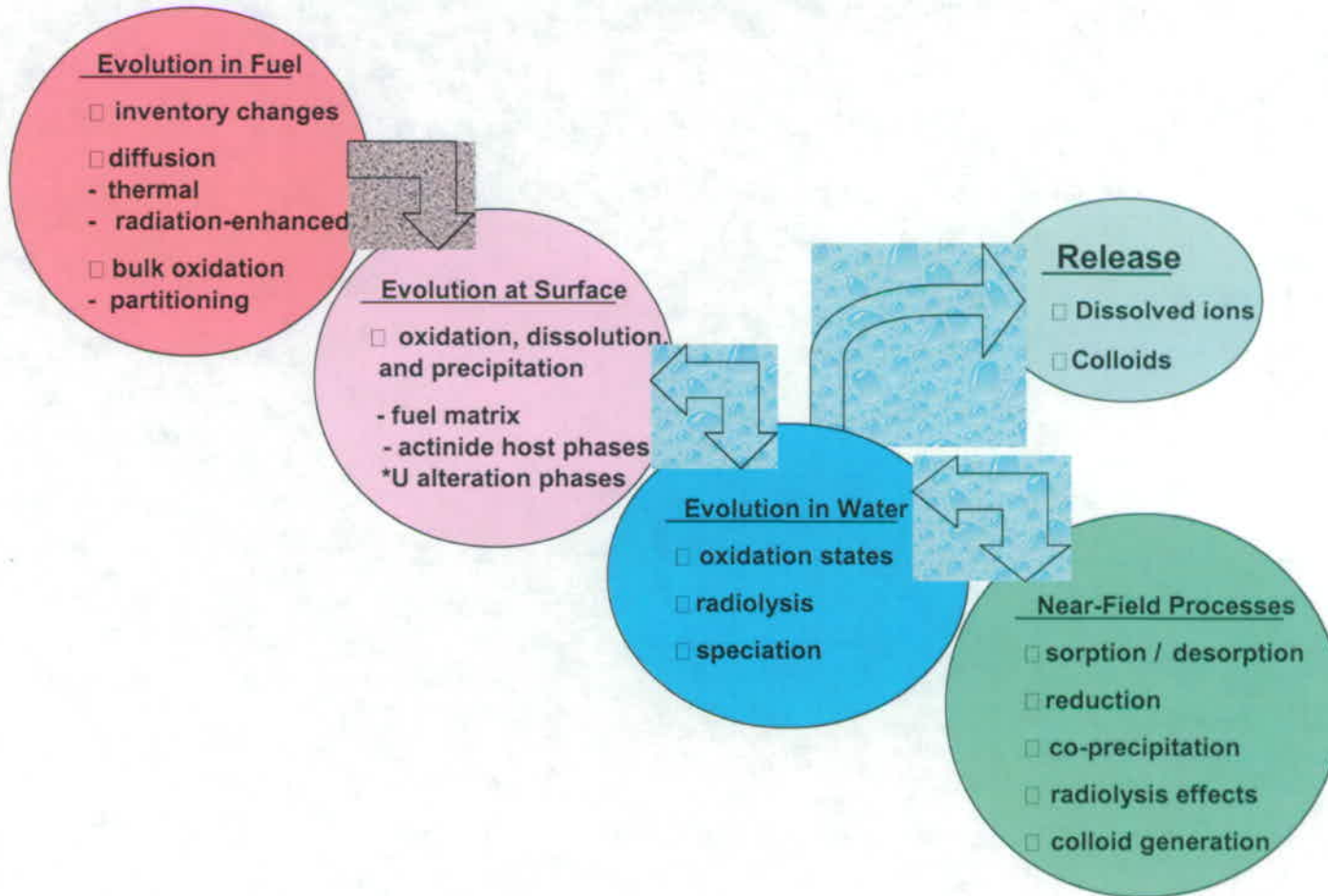
# Source Term Targeted Thrust

(waste package failure at longer times)



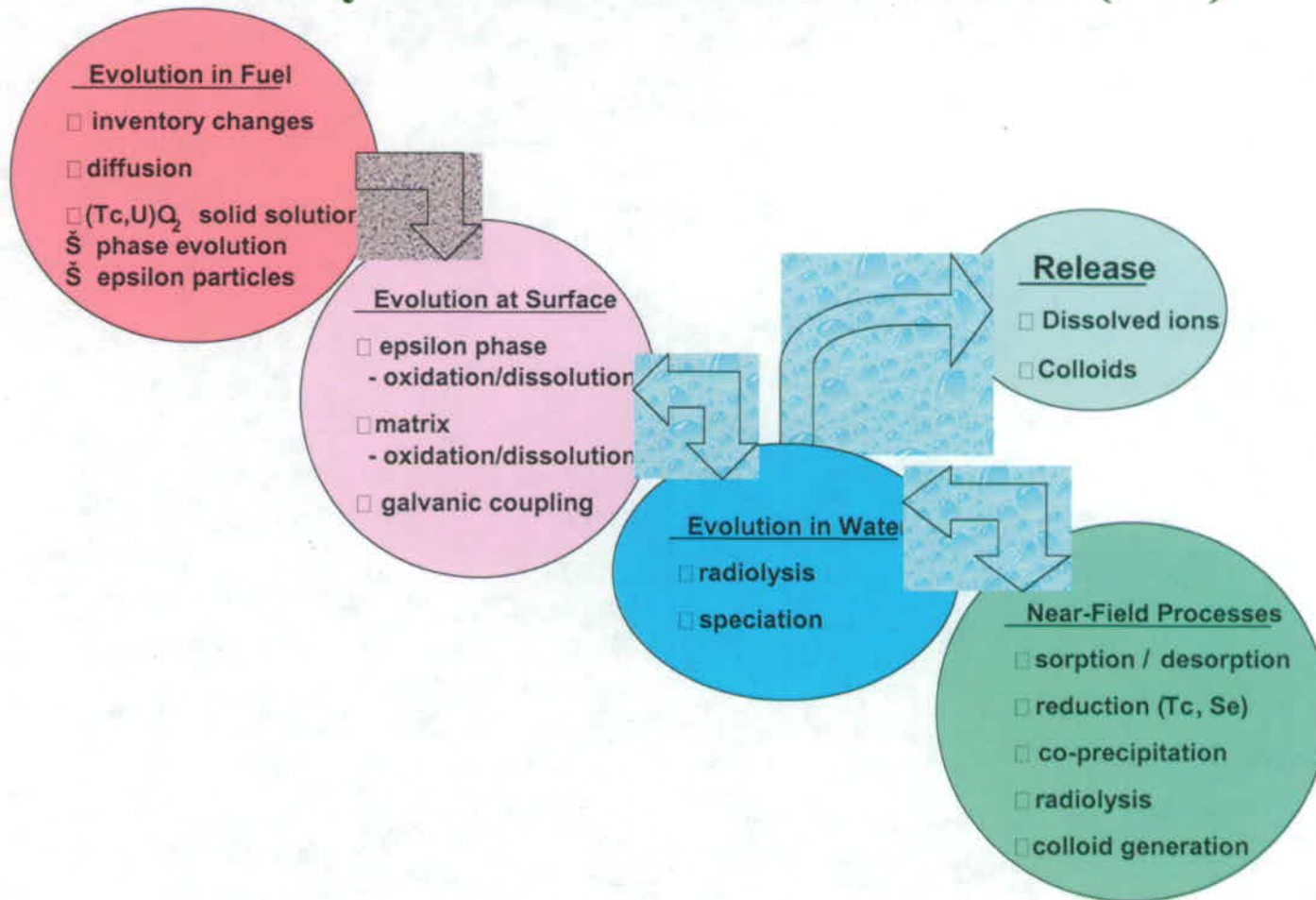
# Source Term Targeted Thrust

## Pathway to Release for Actinides ( $^{237}\text{Np}$ , $^{239}\text{Pu}$ , $^{241}\text{Am}$ )



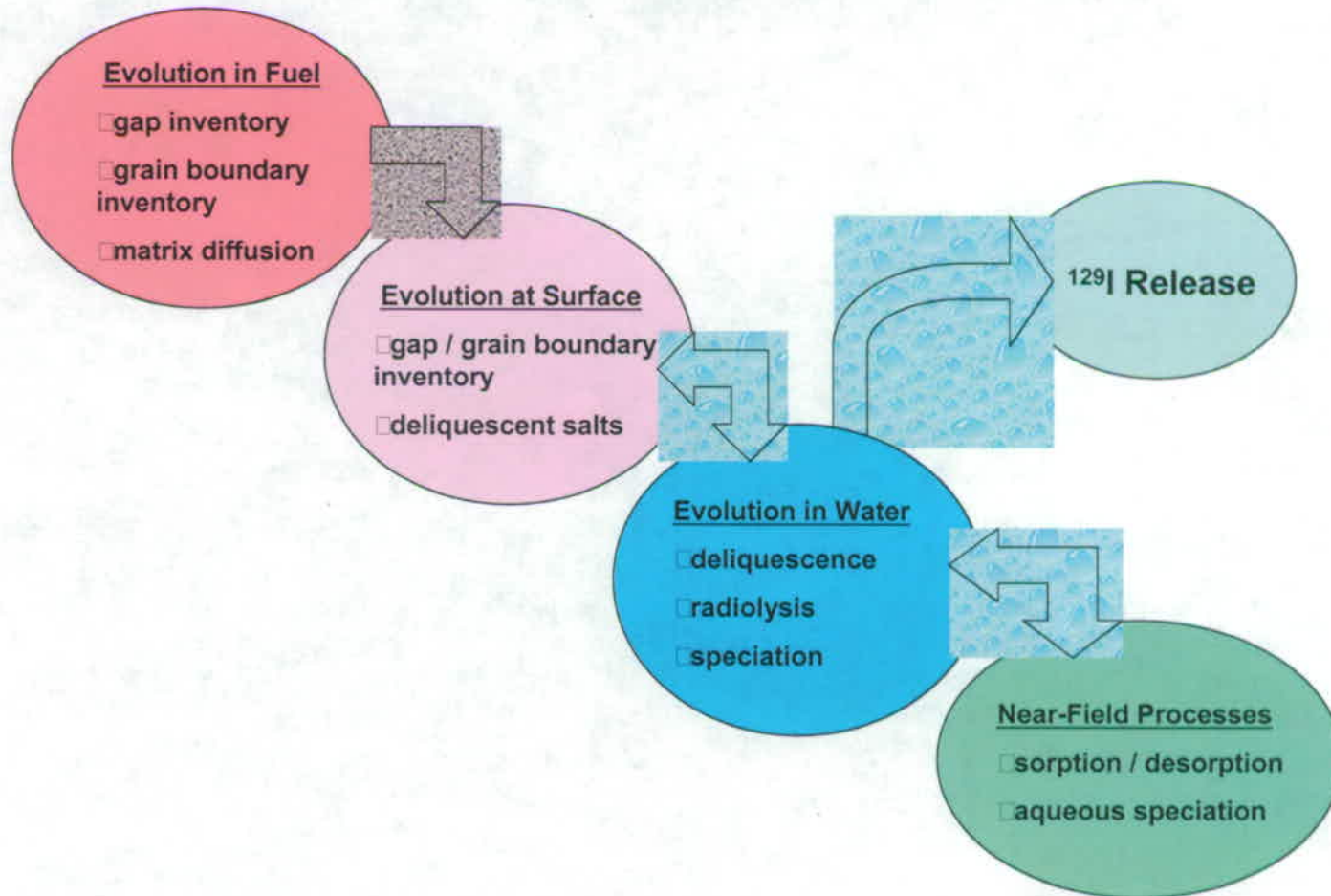
# Source Term Targeted Thrust

## Pathway to Release for Fission Products ( $^{99}\text{Tc}$ )



# Source Term Targeted Thrust

## Pathway to Release for Fission Products ( $^{129}\text{I}$ )



# Source Term Targeted Thrust

## Integration

- Time
- Critical Processes
- Radionuclide Inventories
- Pathways to Radionuclide Release

# Source Term Targeted Thrust

## Research Areas

- **Objective - enhance the understanding of the release mechanisms of key radionuclides from spent nuclear fuel (SNF) and explore technical enhancements**
- **Engineered materials and radionuclide sequestration**
  - **Corrosion effects on chemistry and radionuclide release processes**
- **Secondary alteration phases**
  - **Effects of environment on the formation, evolution, and radionuclide incorporation**
- **Matrix dissolution**
  - **Oxidation and dissolution of SNF and evolution of surface conditions**

# Source Term Targeted Thrust

## Present Research Areas

- Sequestration of radionuclides (SNL, ANL, PNNL)
- Impact of secondary alteration phases of SNF on mobility of Np and Pu (Notre Dame)
- Deliquescence and decay heat effects on source term (ANL)
- Dissolution mechanisms and rates (PNNL)
- Chemistry and coordination structure of radionuclides (ANL)
- Corrosion of SNF: The long-term assessment (University of Michigan)

# Source Term Targeted Thrust

## Solicitation for Proposals 2005

- **Secondary alteration phases and radionuclide release**
  - **stability and thermochemistry**
  - **solubility**
  - **energetics of radionuclide incorporation**
  - **structural studies**
  - **sorption/desorption mechanisms**
  - **kinetics of precipitation and dissolution**
- **International source term programs for collaboration on understanding release of key radionuclides**

# Solicitation Awards

- **Mitigation of the Release of  $^{129}\text{I}$  from Spent Nuclear Fuel via Uptake by Uranyl Alteration Phases** (Thomas E. Albrecht-Schmitt, Auburn University)
- **An In-Situ Spectroelectrochemical Study of Np Redox, Dissolution and Precipitation Behavior at the Corroding CSNF / Alteration Phase Interface** (Artem Guelis, Argonne National Laboratory)
- **Np-Incorporation into the U6+-alteration phases of spent nuclear fuel and Np-sorption onto oxide phases** (Udo Becker, University of Michigan)
- **Surface Charge and Radionuclide Adsorption Characteristics of U(IV/VI) and metal corrosion oxides at 25-150°C under Repository Chemical Environments** (David J. Wesolowski, Oak Ridge National Laboratory)
- **Direct Determination of the Thermodynamic Properties of Uranyl Minerals Important for the Performance of the Geological Repository at Yucca Mountain** (Jeremy B. Fein, University of Notre Dame)
- **A Model for Radionuclide Release From Spent Commercial Nuclear Fuel** (Carl I. Steefel, Lawrence Berkeley National Laboratory)
- **Actinide Adsorption to U(VI) Silicates** (S. B. Clark, Washington State University)
- **Natural Sequestration of Radionuclides in Volcanic Tuff And Secondary Phases** (J. P. Icenhower, Pacific Northwest National Laboratory)