

**U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT**

**NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING**

**SUBJECT: SOURCE TERM FOR THE PNL
TOTAL SYSTEM PERFORMANCE
ASSESSMENT**

PRESENTER: DAVID W. ENGEL

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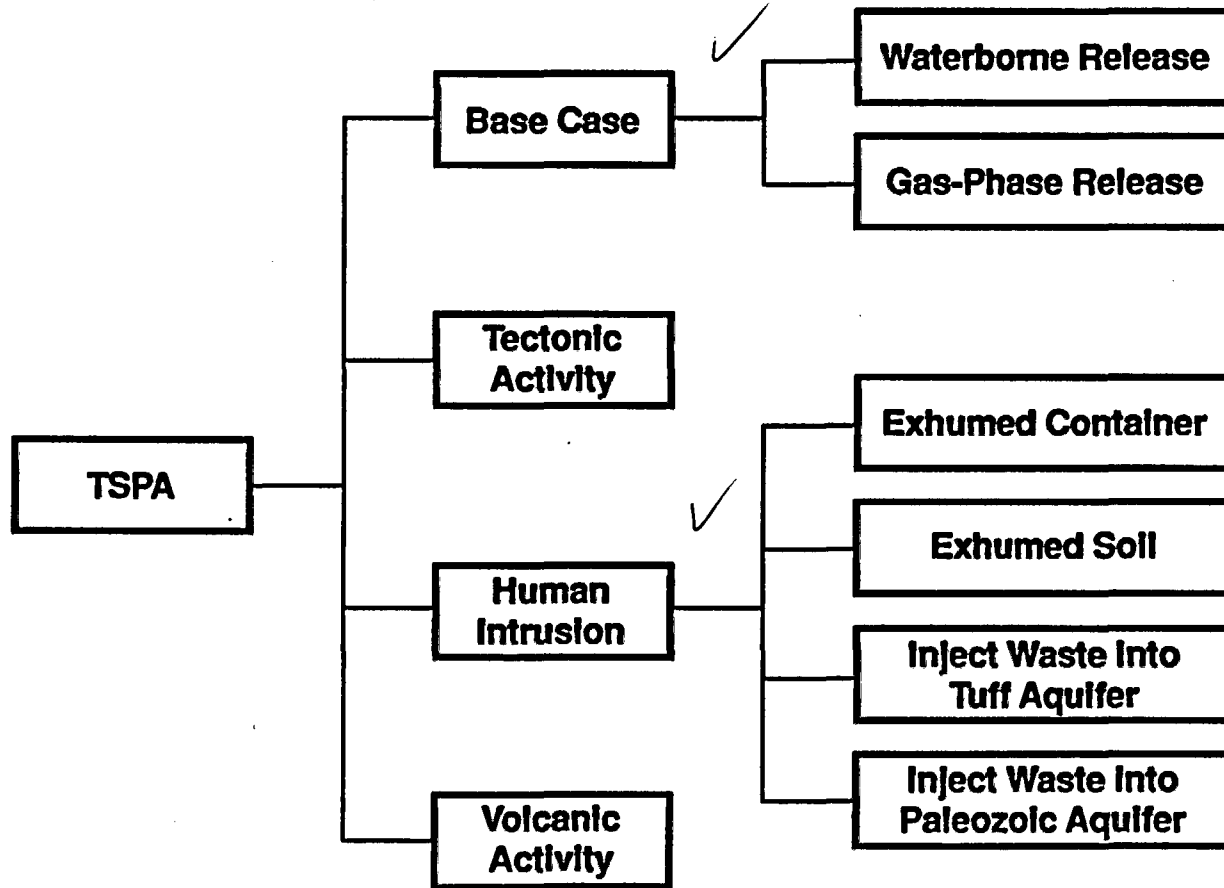
**PRESENTER'S
TELEPHONE NUMBER: (509) 375-2307**

**PLAZA SUITE HOTEL • LAS VEGAS, NEVADA
OCTOBER 14 - 16, 1992**

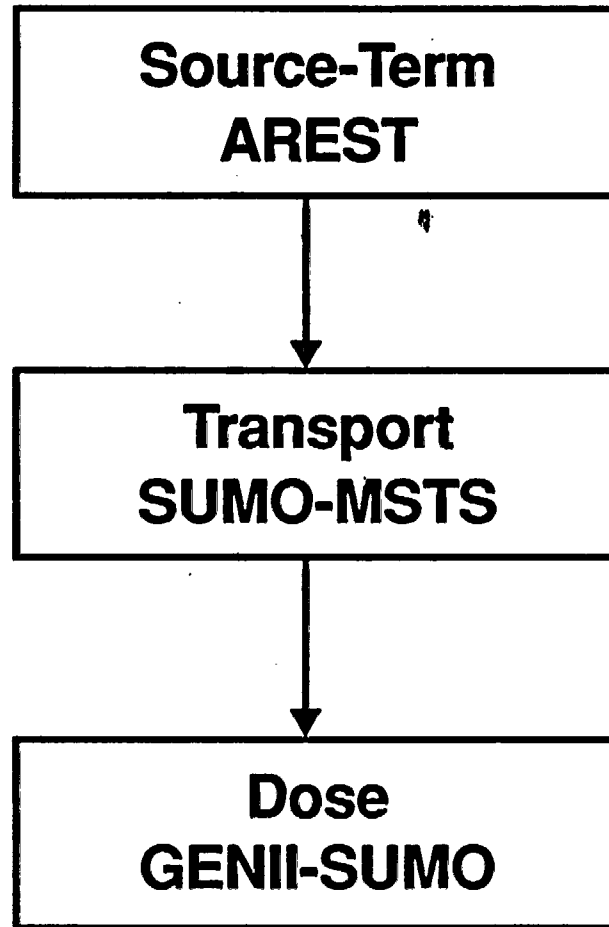
Presentation Topics

- **Description of the Total Systems Performance Assessment (TSPA)**
- **Description of models**
- **EBS results**
- **Thermal effects**
- **Conclusions**

Scenarios Modeled



Total System Performance Assessment Data Flow



Source-Term Specific Cases

Human Intrusion

- Tuff aquifer
- Paleozoic aquifer

Base case

- Spent fuel and glass (SRL-202)
 - 0.01, 0.05, 0.5 mm/yr infiltration rate
 - Diffusion-controlled

Gaseous release

- No infiltration
- 0.01 mm/yr infiltration
 - Early failures ~ U(300, 2000)
 - Late failures ~ U(2000, 5000)

Human Intrusion Analysis

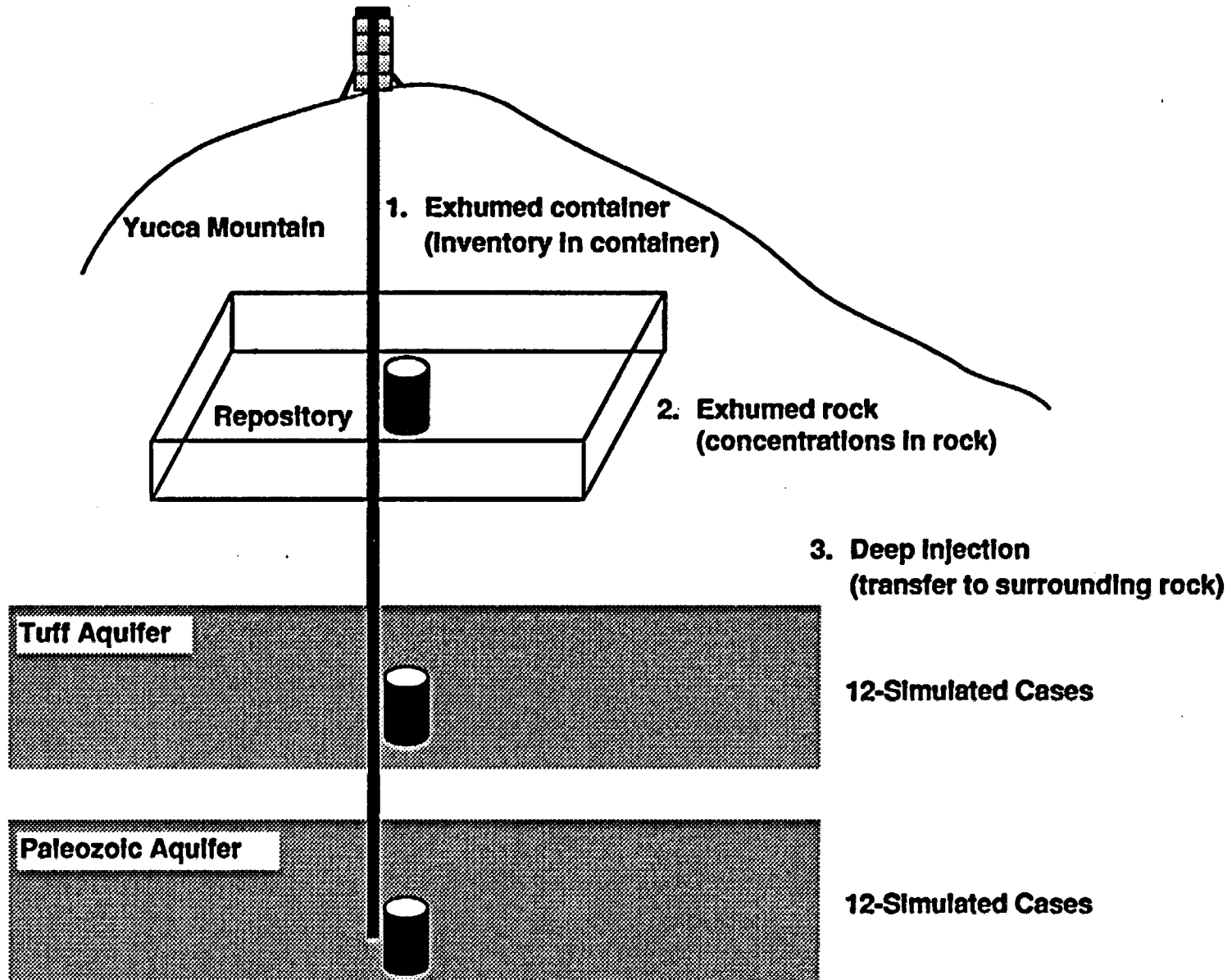
Assumptions

- **Single container displaced to aquifer**
 - Tuff
 - Carbonate (Paleozoic)
- **Wet-drip/Flow-through release model**
- **Wet-continuous release model**

Uncertainties

- **Drilling times ~ log uniform (10^2 , 10^4)**
- **Groundwater velocity**
 - Hydraulic head ~ uniform
 - Conductivity ~ spatial log normal

Human Intrusion Scenarios



Base Case Analysis

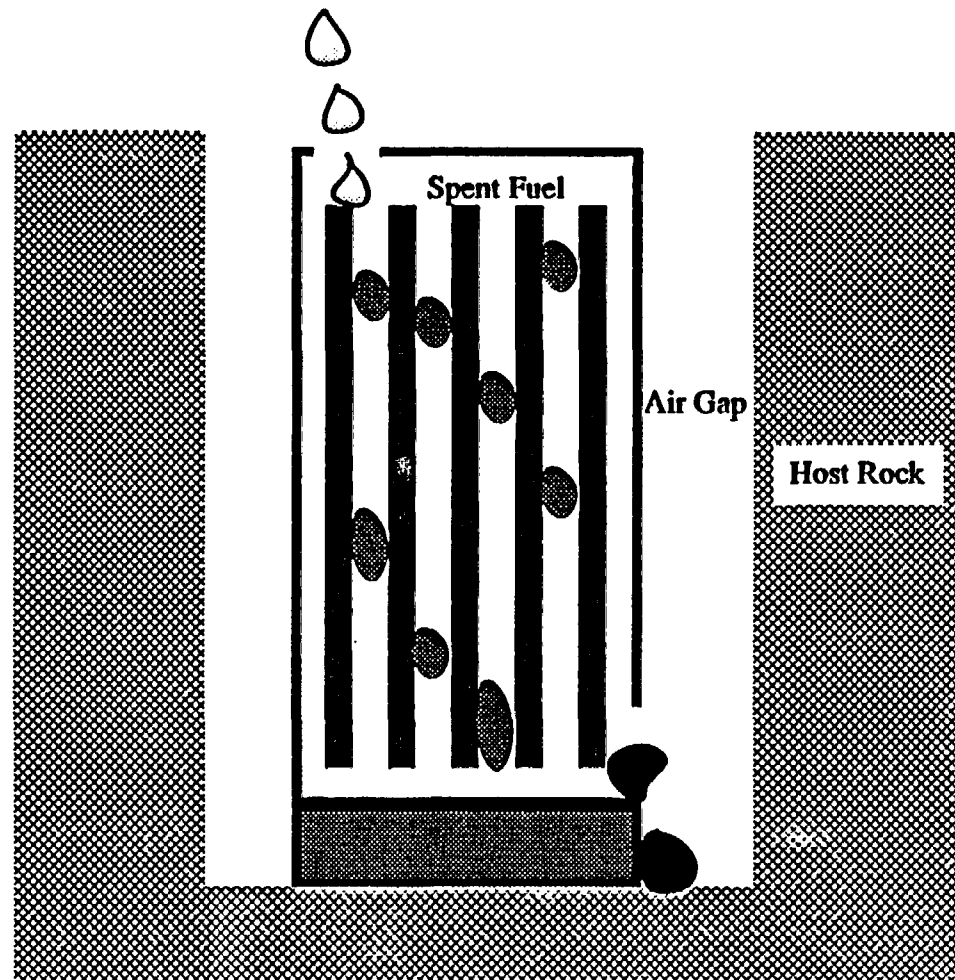
Assumptions

- **Gaseous release (C-14)**
 - Impulse release of gas at failure
 - Slow water-release (flow-through model)
- **Waterborne release**
 - Wet-drip/flow-through
 - Wet-continuous
 - Assumed cladding not a barrier

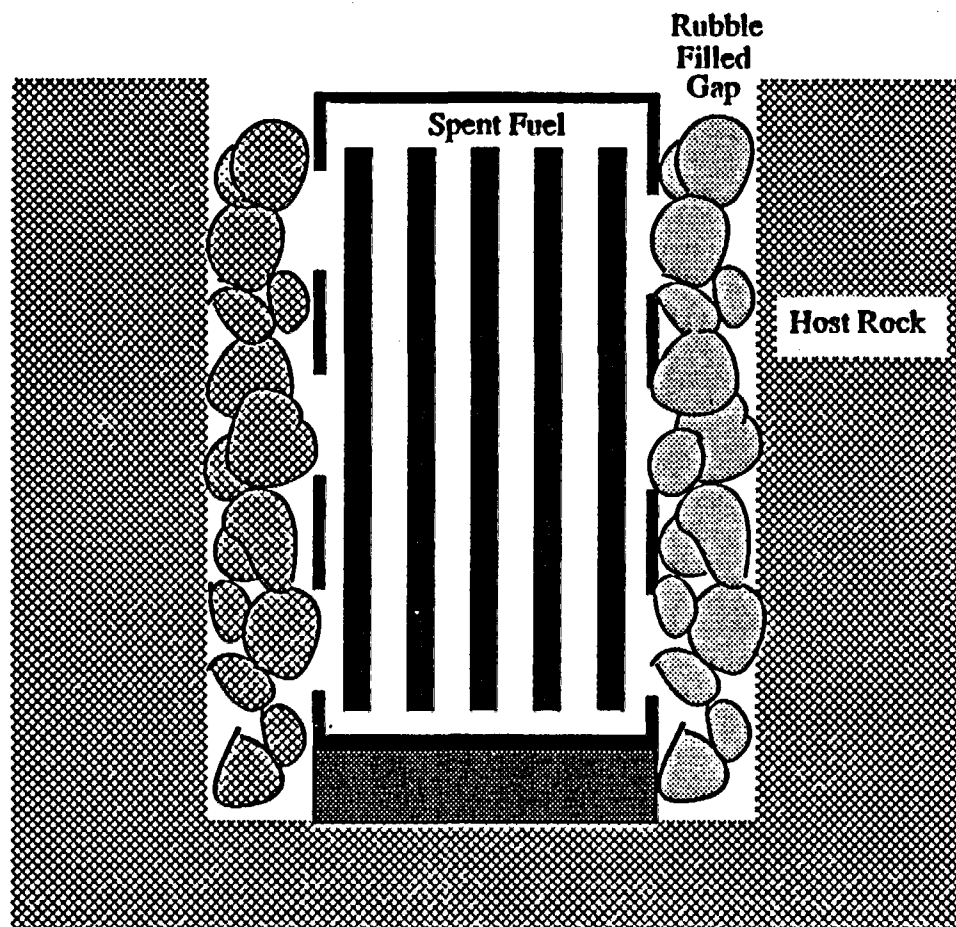
Uncertainties

- **Failure times ~ U(2000, 5000)**
- **Temperature**
- **Boundary conditions**
 - Surface solubility
 - Glass reaction control

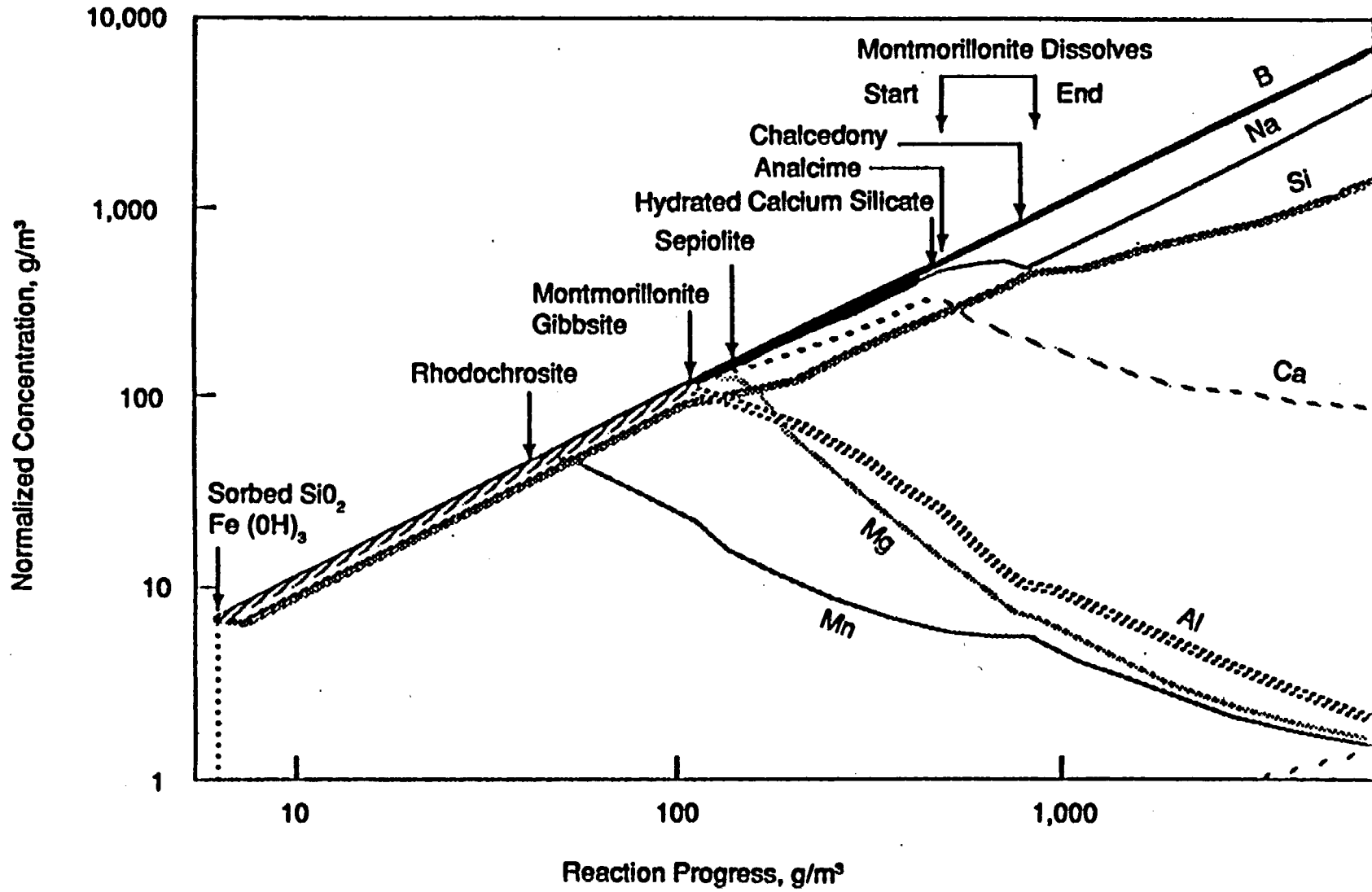
Flow-Through Mode



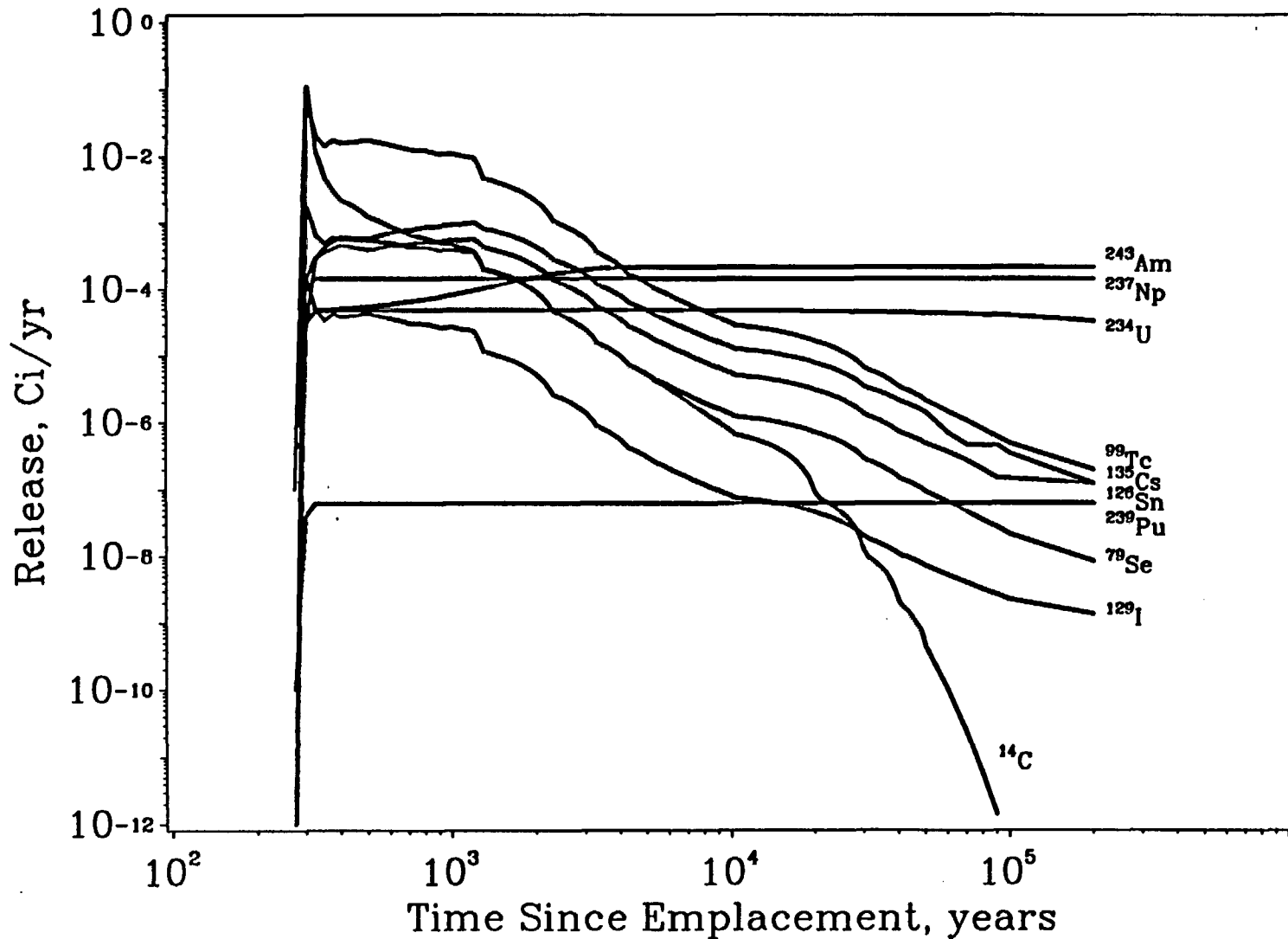
Wet-Continuous Mode



Glass Dissolution Model

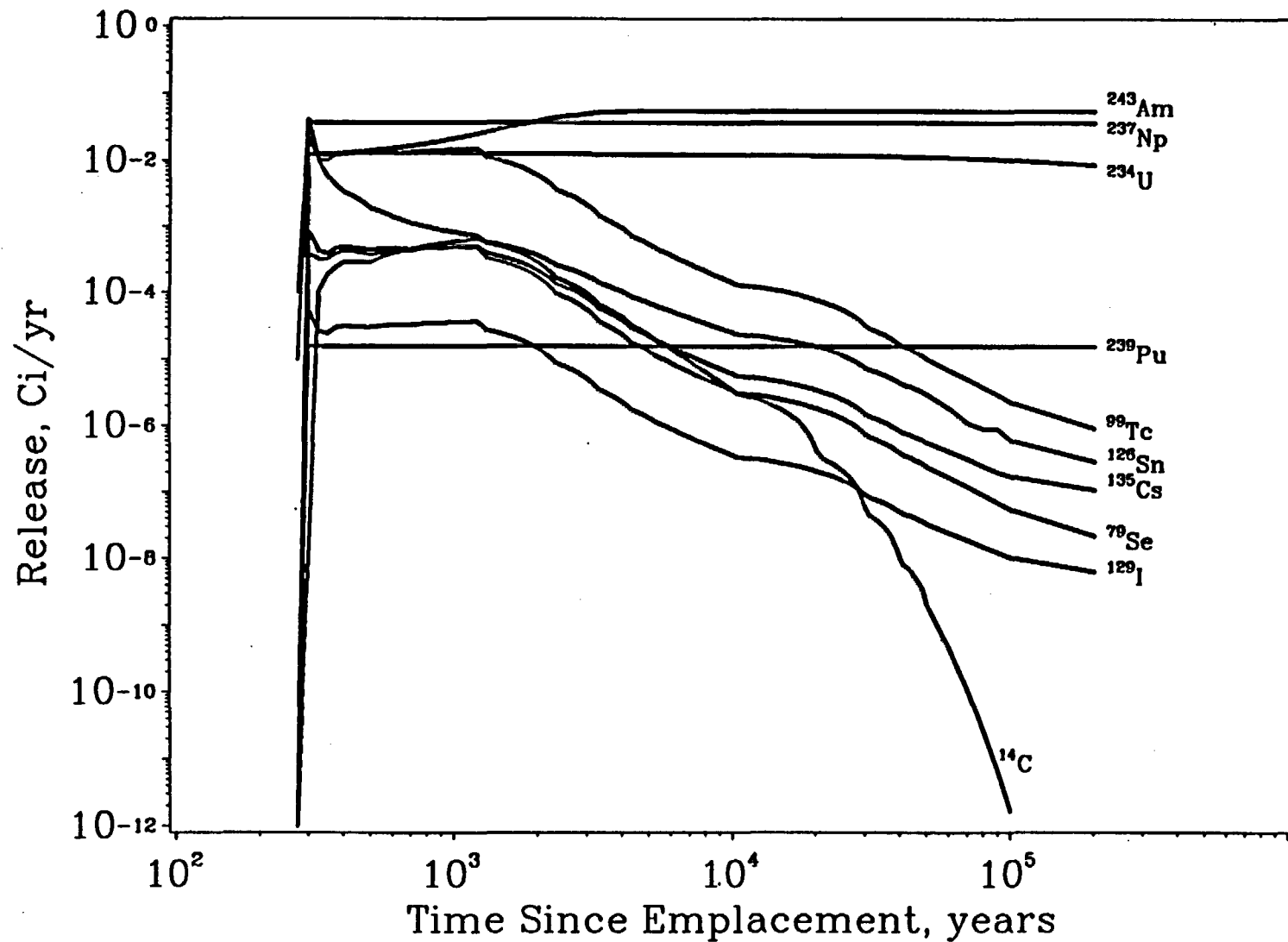


Human Intrusion Analysis, Spent Fuel, Tuff Aquifer (Case 12)

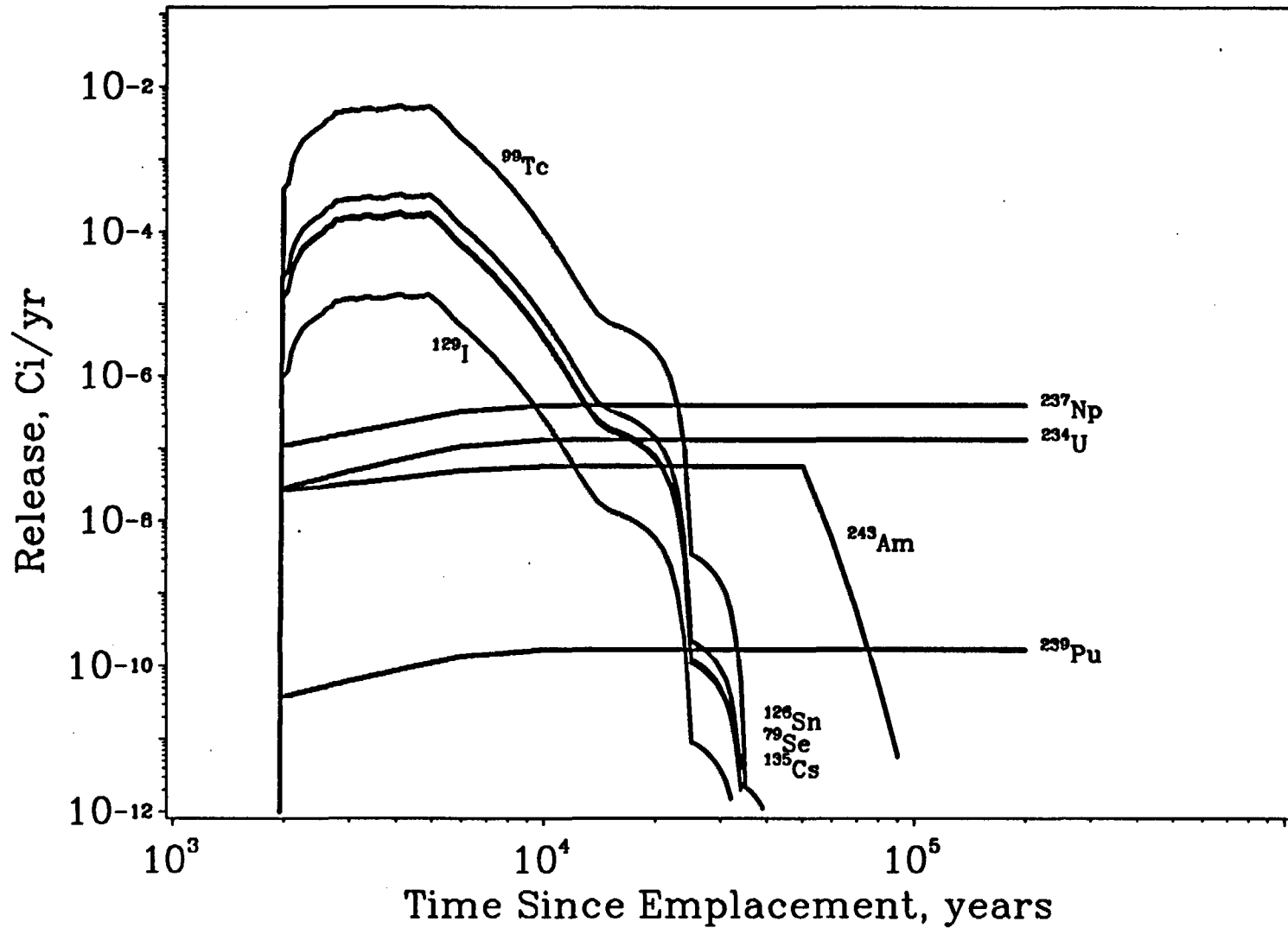


*Solubilities
of what?*

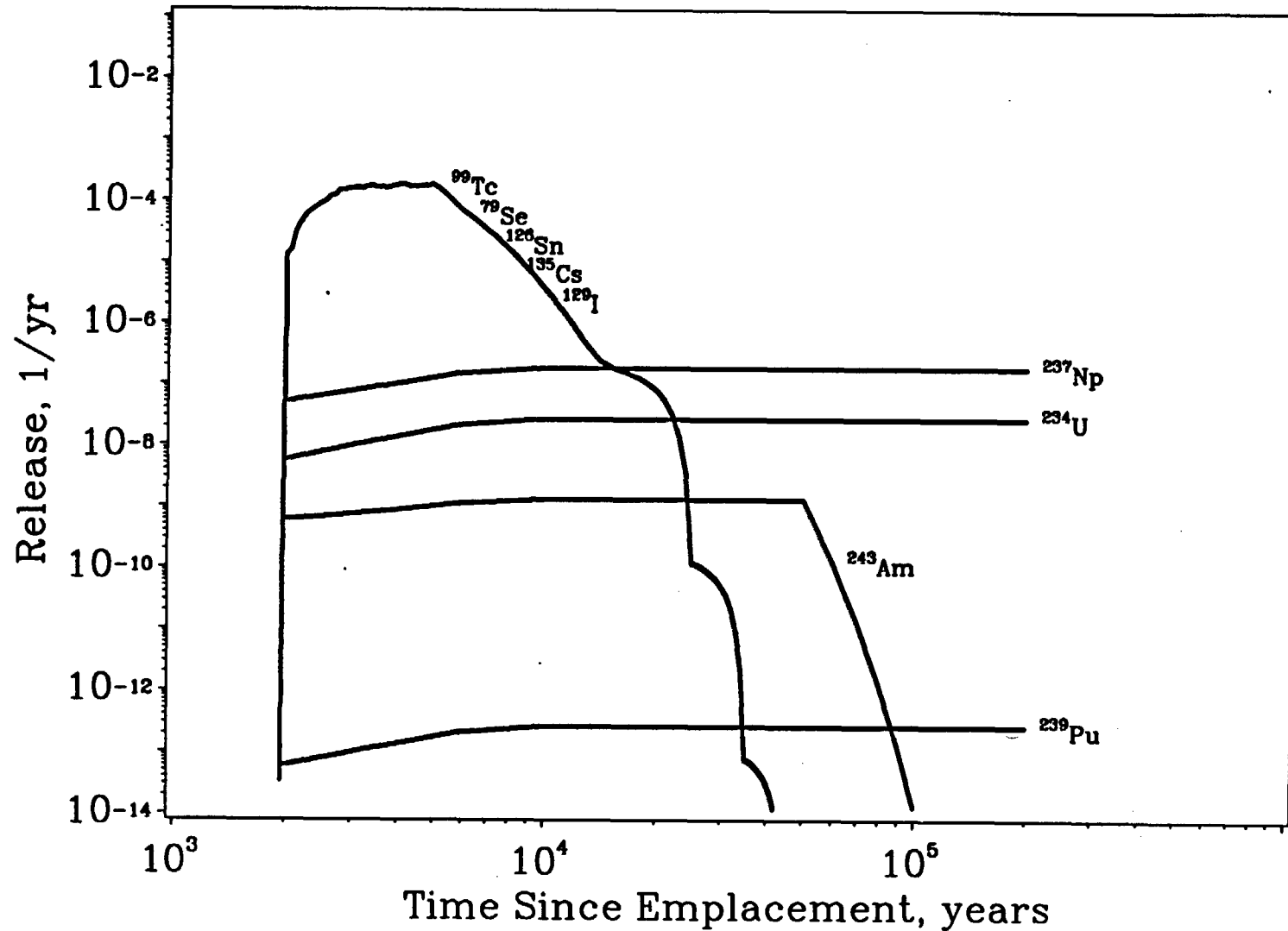
Human Intrusion Analysis, Spent Fuel, Paleozoic Aquifer (Case 12)



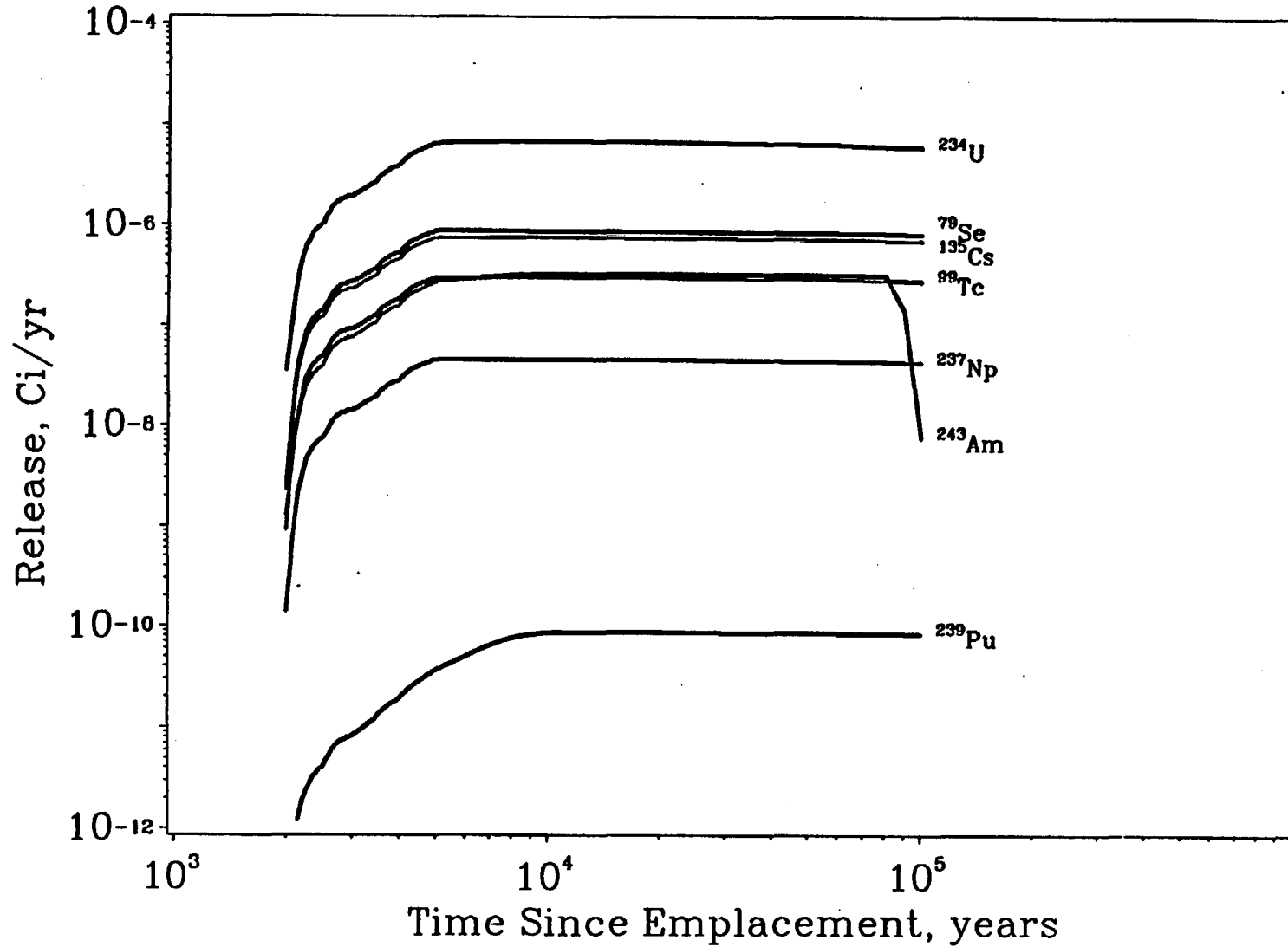
Base Case, Spent Fuel, 0.5 mm/yr.



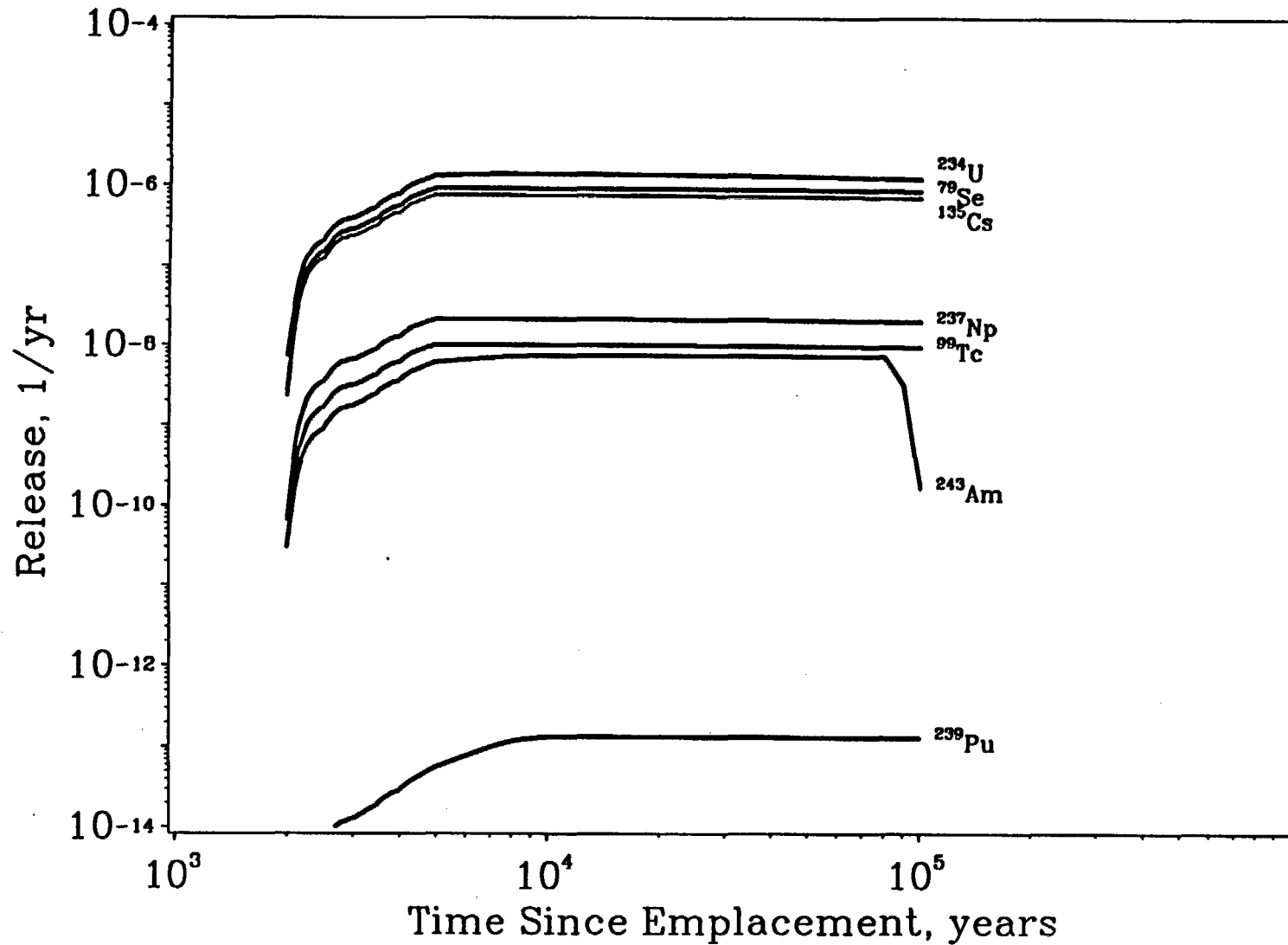
Base Case, Spent Fuel, 0.5 mm/yr.



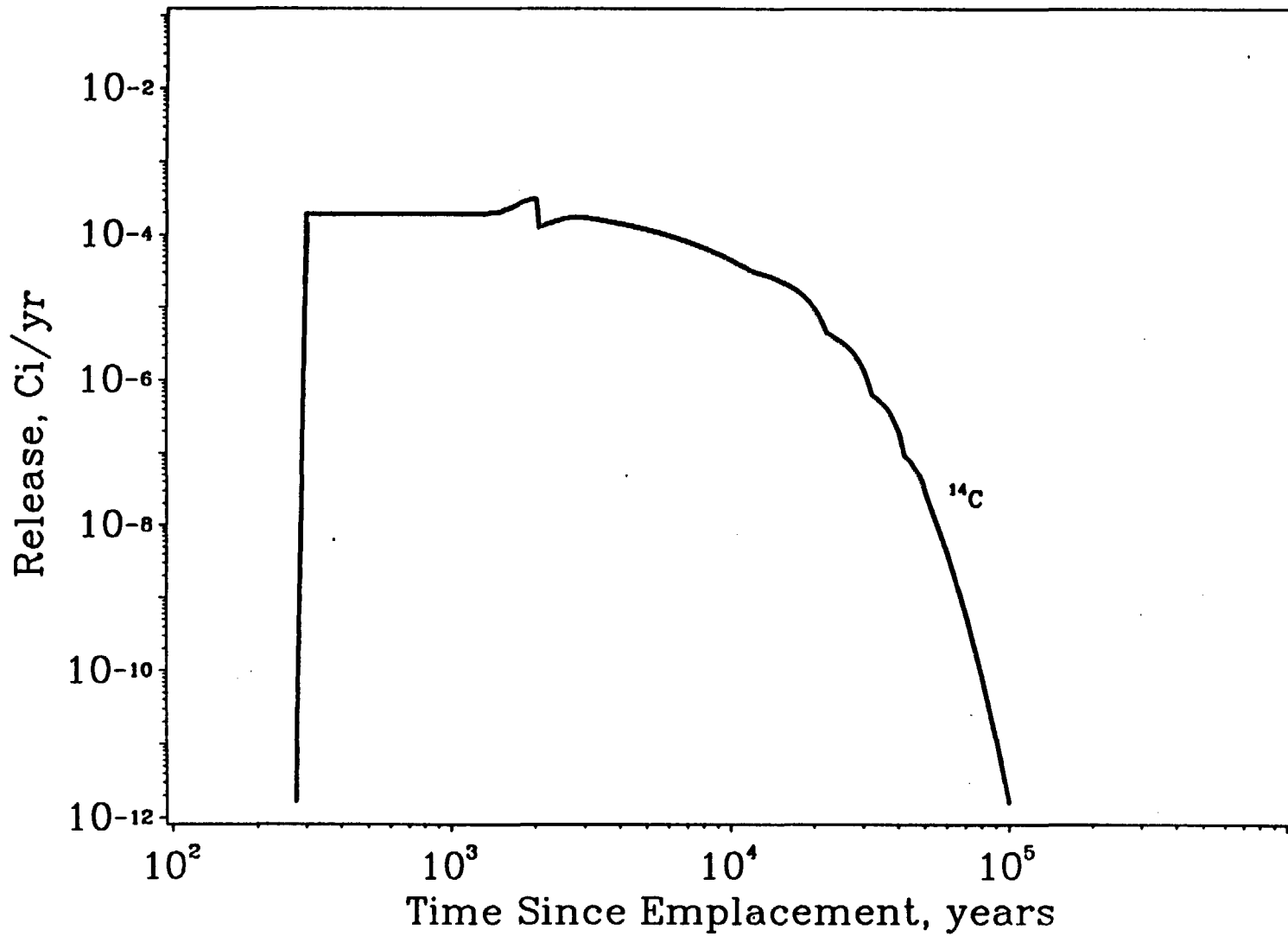
Base Case, Glass, 0.5 mm/yr.



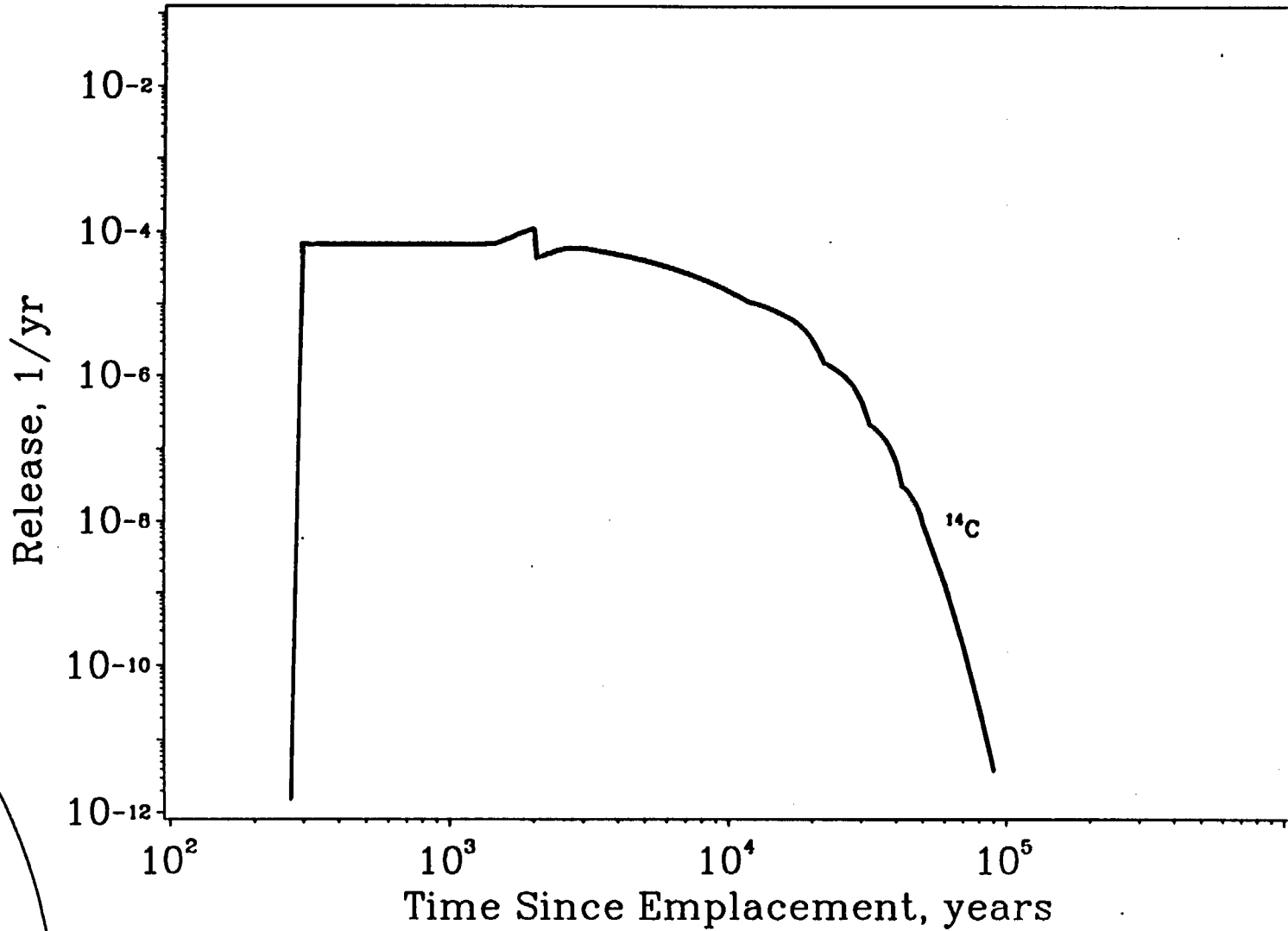
Base Case, Glass, 0.5 mm/yr.



Base Case, Spent Fuel, 0.05 mm/yr.



Base Case, Spent Fuel, 0.05 mm/yr.



attraction
rate 10⁻³/year
↓
10⁵ years
all waste
dissolves

Thermal Effects

Objective

- **Evaluate effects of higher thermal loading on radionuclide release**
- **Resaturation time**
- **Temperature-dependent solubility**
- **Glass dissolution**

Thermal Effects

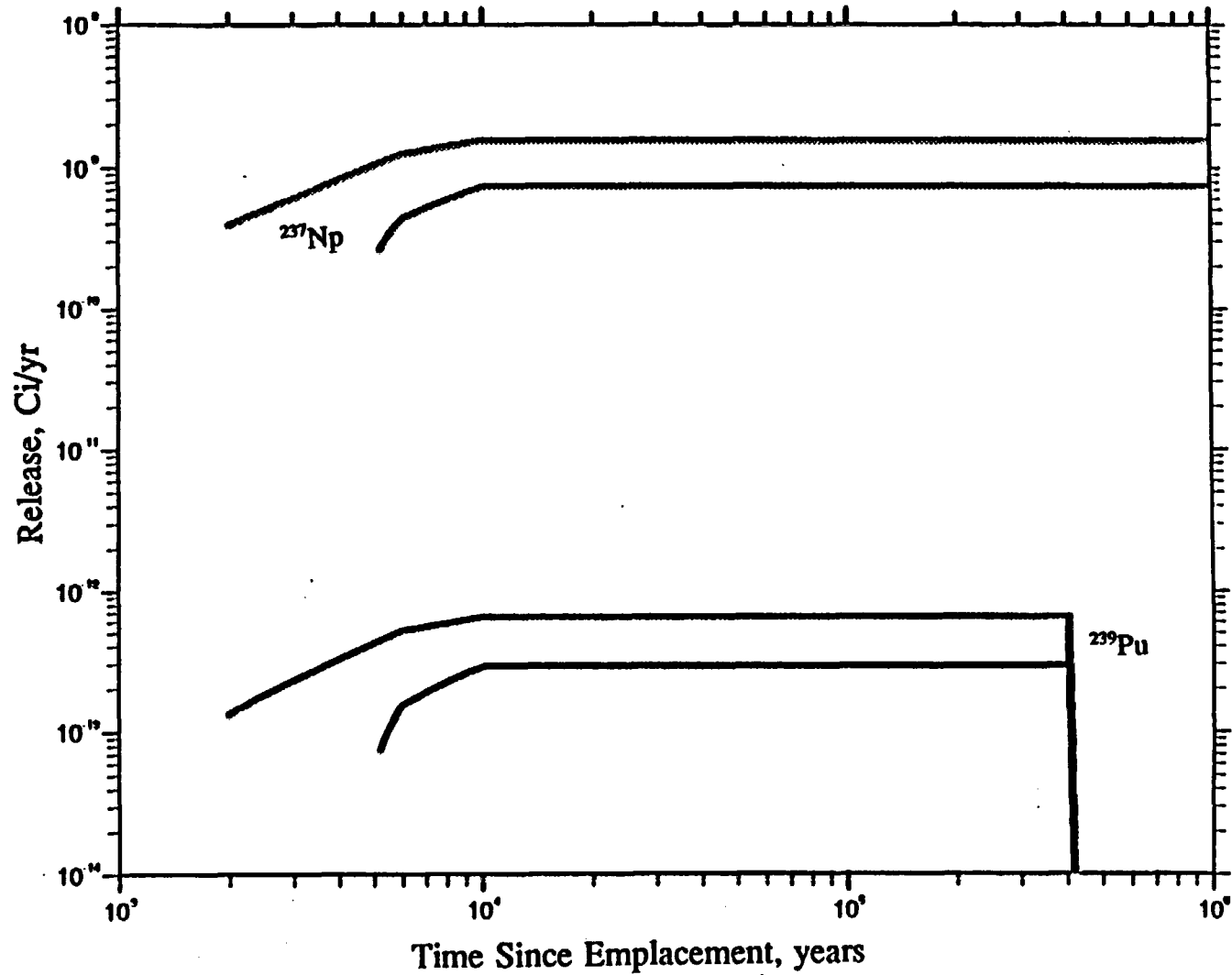
Cases studied

- **Increased temperature**
- **Spent fuel**
 - **Solubility-limited**
 - **Alteration-rate limited**
- **Glass-groundwater coupled reaction**
 - **Fission products**
 - **Actinides**

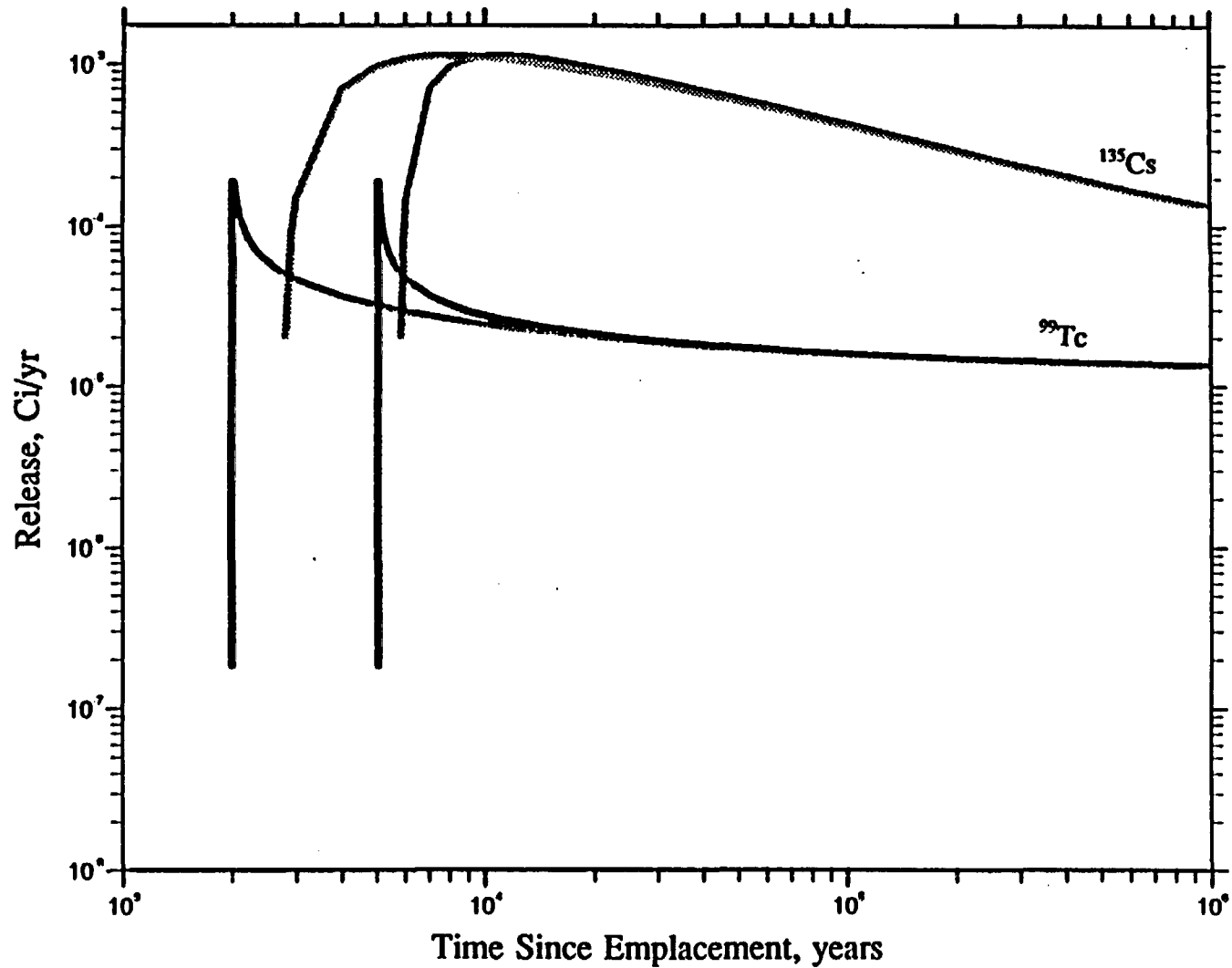
Thermal Profiles Increased Temperature



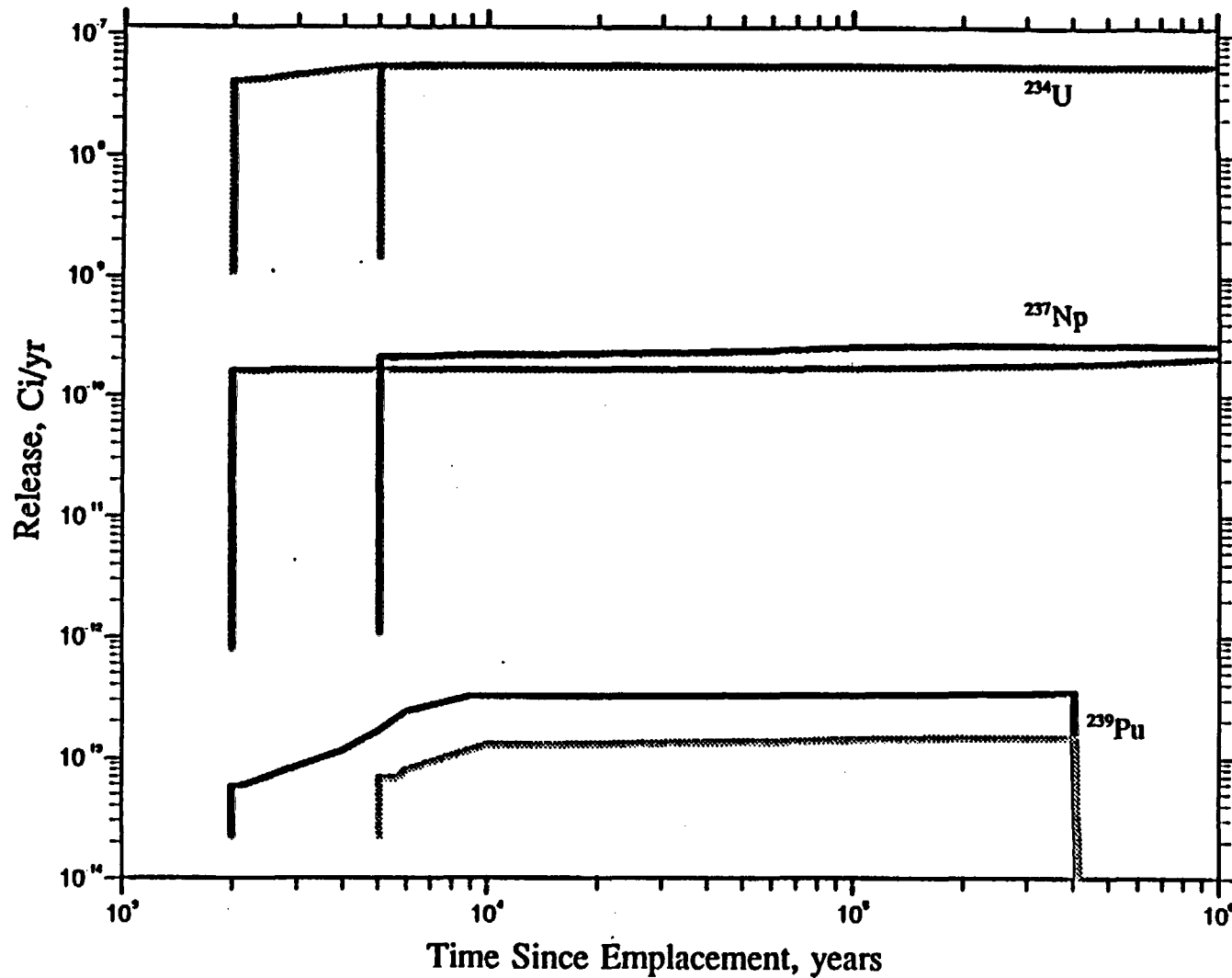
Thermal Effects, Spent Fuel, Solubility-Limited Nuclides



Thermal Effects, Spent Fuel, Alteration-Rate Limited Nuclides

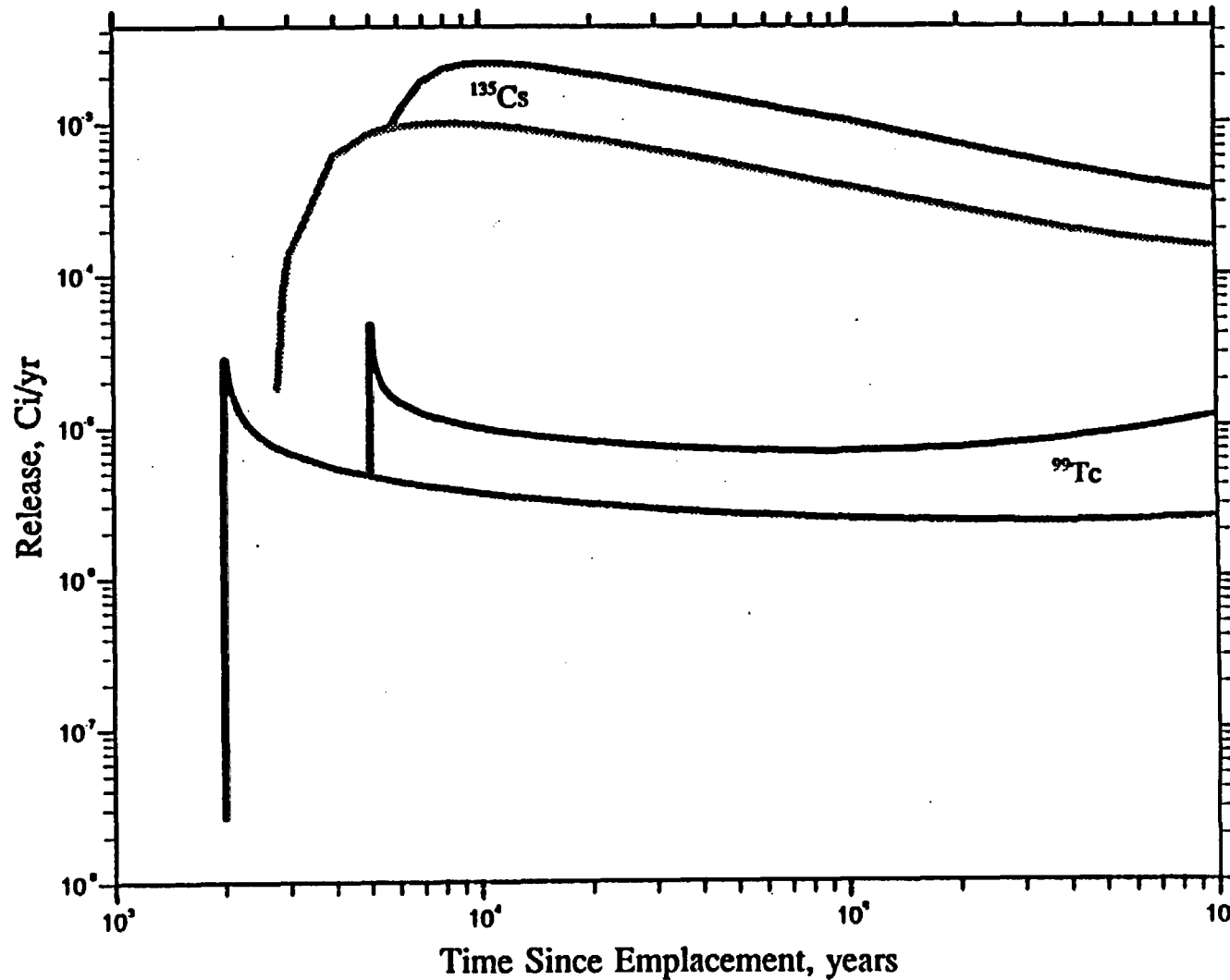


Thermal Effects, Glass Dissolution Model, Solubility-Limited Nuclides



transport included

Thermal Effects, Glass Dissolution Model, Alteration-Rate Limited Nuclides



Conclusions

- **Some cases exceeded NRC (10 CFR 60) release criteria**
- **Need for more detailed modeling**
 - **Coupled-reactive transport model**
- **Higher thermal loading**
 - **Delays transport time for ALL cases**
 - **Lowers release rates for some cases**
(Solubility-limited model)
 - **No change in release rates for some cases**
(Alteration-limited model)
 - **Higher release rates for some cases**
(Glass dissolution model)