Use of Natural Analog Information by the Regulator: The U.S. Nuclear Regulatory Commission (NRC) Approach

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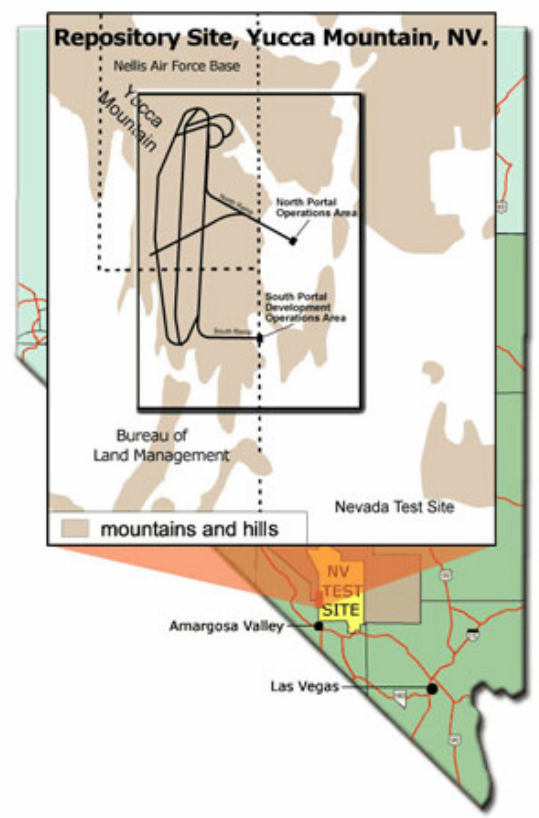
Use of Natural Analog Information by Regulators

- Dependent on particular nation's laws and regulations
- Function of the independent review capability of the regulator
- Dependent on the particular design and location
- Dependent on the availability of appropriate analogs

U.S. High-Level Radioactive Waste Program

- President recommended Yucca Mountain site in 2002
- Would contain commercial and defense spent nuclear fuel and other U.S. Department of Energy (DOE) high-level waste
- U.S. Nuclear Regulatory Commission (NRC) will review any license application DOE submits to build and operate
- DOE would build and operate, if approved



http://www.ocrwm.doe.gov/ym_repository/quick/index.shtml

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U.S. NRC Approach

- Natural analogs not addressed in pertinent U.S. high-level waste disposal laws
- Natural analogs are addressed in NRC regulations and in staff guidance for review of a license application
- NRC has developed an independent performance assessment review capability

Analog Information in NRC's Regulatory Framework

- Addressed in the disposal regulation
  - Code of Federal Regulations, Title 10, Part 63

    (10 CFR Part 63): Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada
- Addressed in staff guidance
  - Yucca Mountain Review Plan (YMRP), which provides guidance for NRC staff to review a license application

Natural Analogs in Disposal Regulation: 10 CFR Part 63

- No specific requirements regarding natural analogs
- Natural analog studies are mentioned as potential elements of supporting information for models assessing performance, e.g.,
  - 63.21(c)(15), describing the contents of the Safety Analysis Report: "Analyses and models that will be used to assess performance of the geologic repository must be supported by using an appropriate combination of such methods as field tests, in situ tests, laboratory tests that are representative of field conditions, monitoring data, and natural analog studies."
  - 63.114(g), requirements for performance assessment: "Provide the technical basis for models used in the performance assessment such as comparisons made with outputs of detailed process-level models and/or empirical observations (e.g., laboratory testing, field investigations, and natural analogs)."

Natural Analogs in NRC Staff Guidance

- Yucca Mountain Review Plan (YMRP) Rev 2; NUREG–1804
- Restricted to sections on postclosure performance assessment
- One type of information source that may be used
  - by DOE to support models and parameters, or
  - by NRC staff to evaluate DOE support for these models and parameters
- Scenario analysis and event probability, e.g.,
  - Review method on screening of features, events, and processes (FEPs) (§ 2.2.1.2.1.2): "Consider information from site and regional characterization, natural analog studies, and the repository design, during this evaluation."

Natural Analogs in NRC Staff Guidance (cont.)

- Model Abstractions: mentioned in all 14 sections, typically under data and model justification, data uncertainty, model uncertainty, and model support, e.g.,
  - Radionuclide Transport in the Unsaturated Zone

    (§ 2.2.1.3.7.3), Acceptance Criterion on Data Sufficiency: "Data…used in the total system performance assessment abstraction are based on appropriate techniques. These techniques may include laboratory experiments, site-specific field measurements, natural analog research, and process-level modeling studies."

Natural Analogs in NRC Staff Guidance (cont.)

- Item 20 in Appendix B, Acceptance Review Checklist:
  - "An explanation of measures used to support models for performance assessments. These models should be supported using an appropriate combination of methods such as field tests, in situ tests, laboratory tests representative of field conditions, monitoring data, and natural analog studies.
    - ❑Accept for Review
    - ❑Accept, but Request for Additional Information Prepared
    - ❑Reject, Inadequate to Support Detailed Review"

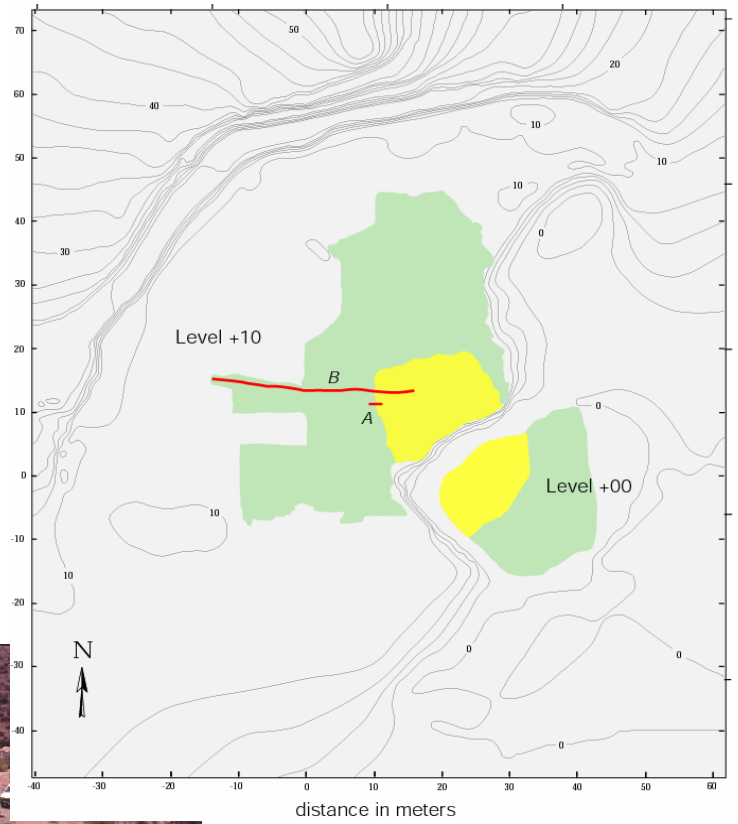
NRC Performance Assessment Review Capability

- Why?
  - To improve staff understanding of features, events, and processes that may be relevant to high-level waste disposal at Yucca Mountain
  - To assist in a risk-informed review of a potential license application
- What?
  - Independent studies of analogs
  - Independent performance assessment code Total-system Performance Assessment (TPA)

Peña Blanca—as a Geochemical Analog

- Uranium alteration mineralogy
- Fracture radionuclide transport
- Recent mobility (<10^6 years), based on uranium decay-series disequilibrium
- Basis for two optional source term models in TPA
  - Nopal I mass balance
  - Schoepite solubility


Nopal I Deposit
Location Map
Nevada
Utah
California
Arizona
N. Mexico
Texas
Yucca Mountain
Nopal I
Study Area
San Antonio
Chihuahua
Mexico
Mexico City
N
0 250 500
Kilometers
TERTIARY VOLCANIC ROCKS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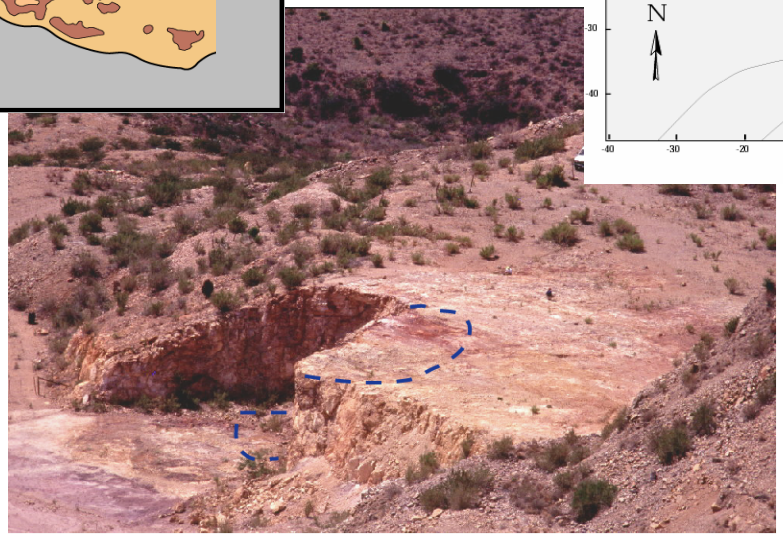
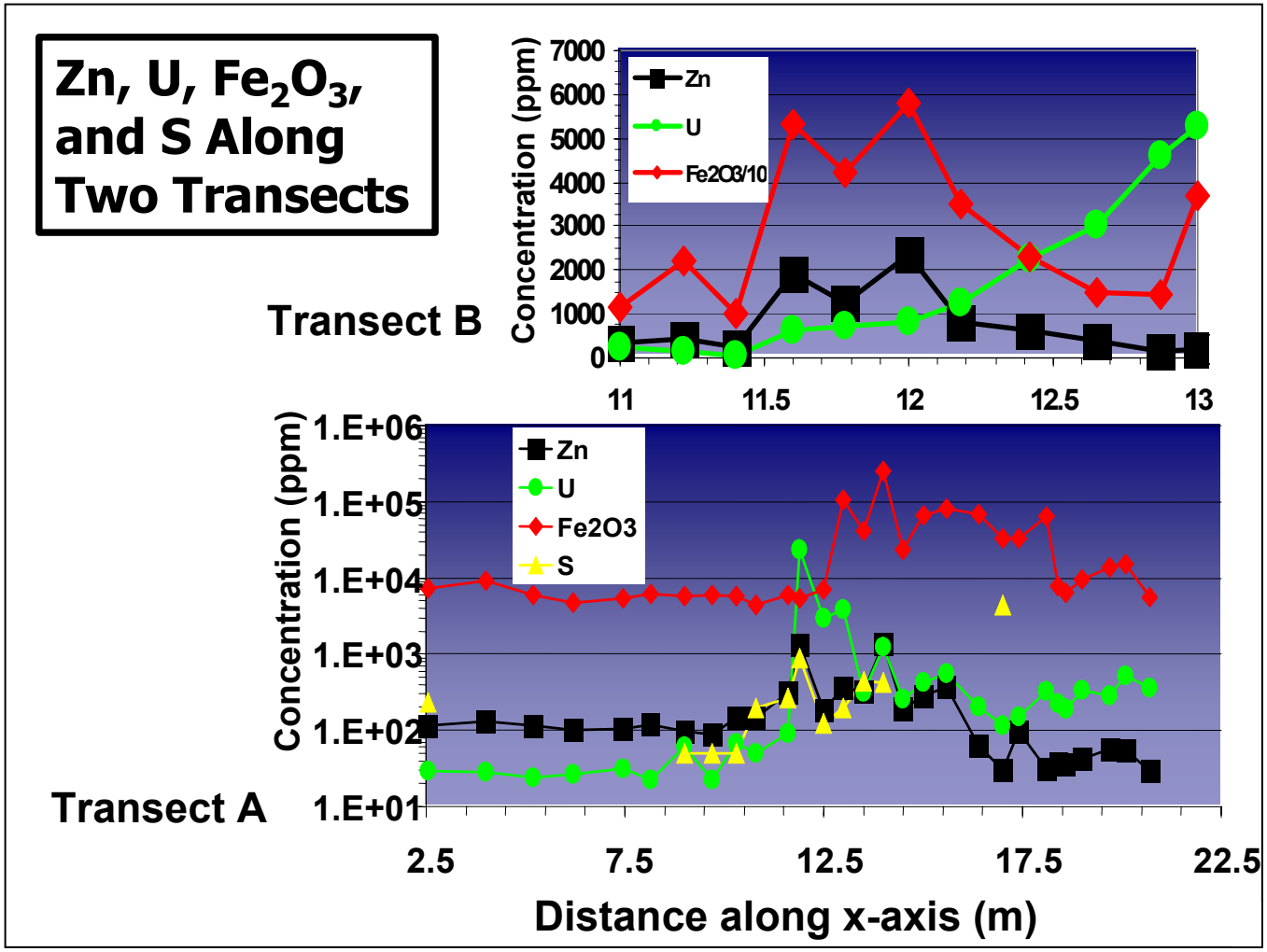


Element Distribution in Nopal I Ore Body



Leslie & Pickett, 2006 Annual Meeting, Geological Society of America

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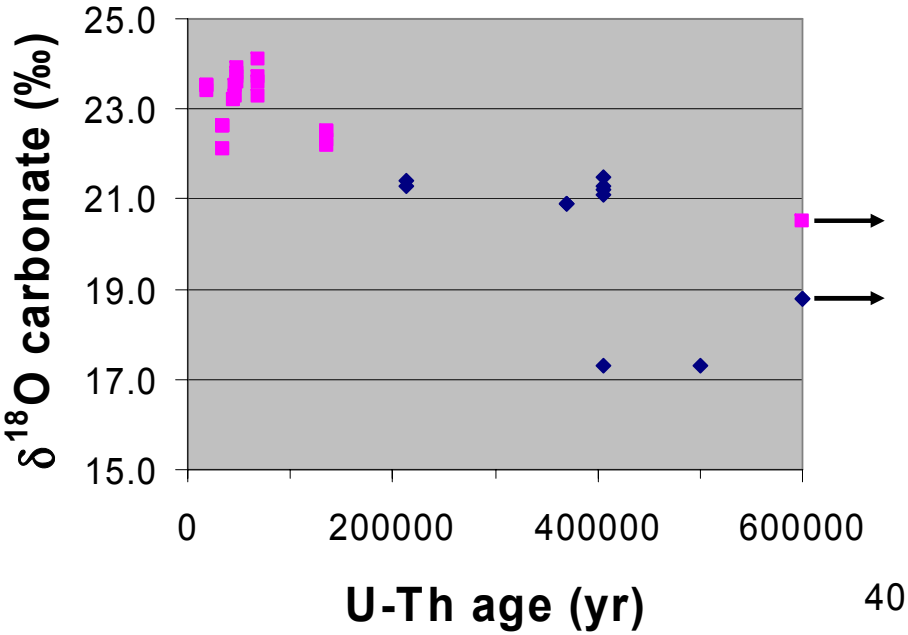
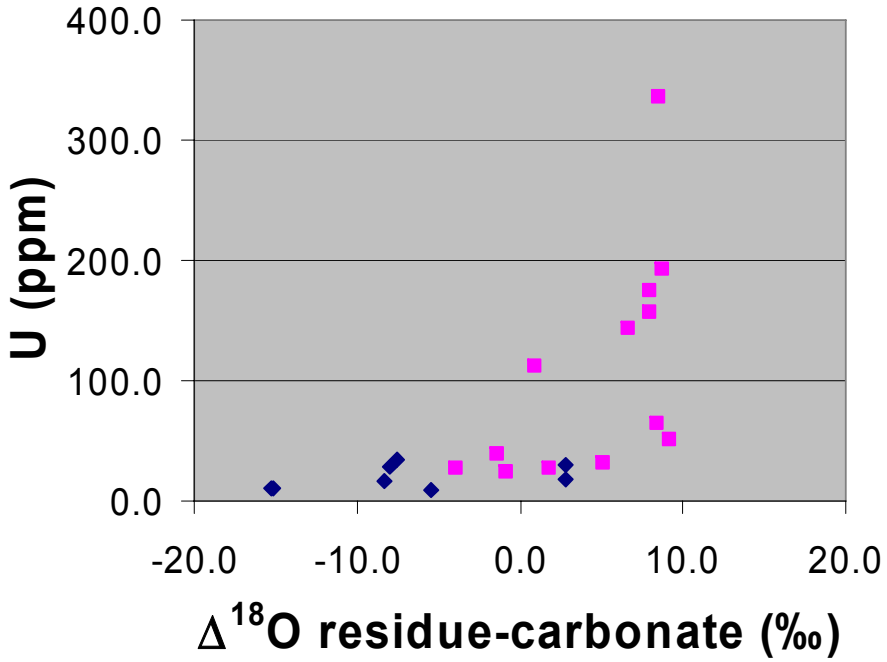


- U-rich caliches (squares) and U-poor calcites (diamonds) around Nopal I
- Suggests recent, low-temperature deposition of U-rich authigenic carbonate and silicate



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Other NRC Natural Analog Activities

- Igneous Activity: e.g., active basaltic eruptions for tephra dispersal processes
- Container Life: e.g., experimental and literature study of josephinite—natural iron-nickel alloy (55-75 percent Ni), analog to Alloy 22
- Unsaturated Flow: Bishop Tuff, California (analog silicic tuff, e.g., infiltration, fracture- and fault-related permeability effects)
- Seismicity: Bishop Tuff (normal fault system development)
- Akrotiri: Metal transport in tuff

Summary

- No specific U.S. regulatory requirements for natural analogs
- YMRP suggests natural analogs as one component of support for models and parameters
- Natural analog information potentially relevant to a license application for high-level waste disposal at Yucca Mountain may be subject to analysis and evaluation during license review
- NRC uses analog studies to prepare for a risk-informed review of many aspects of a potential license application for a Yucca Mountain repository

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