U.S. Department of Energy
Office of Civilian Radioactive Waste Management

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Summary of Key Results for the Peña Blanca Natural Analogue

Presented to:
Appendix 7 Meeting on Peña Blanca Natural Analogue Studies

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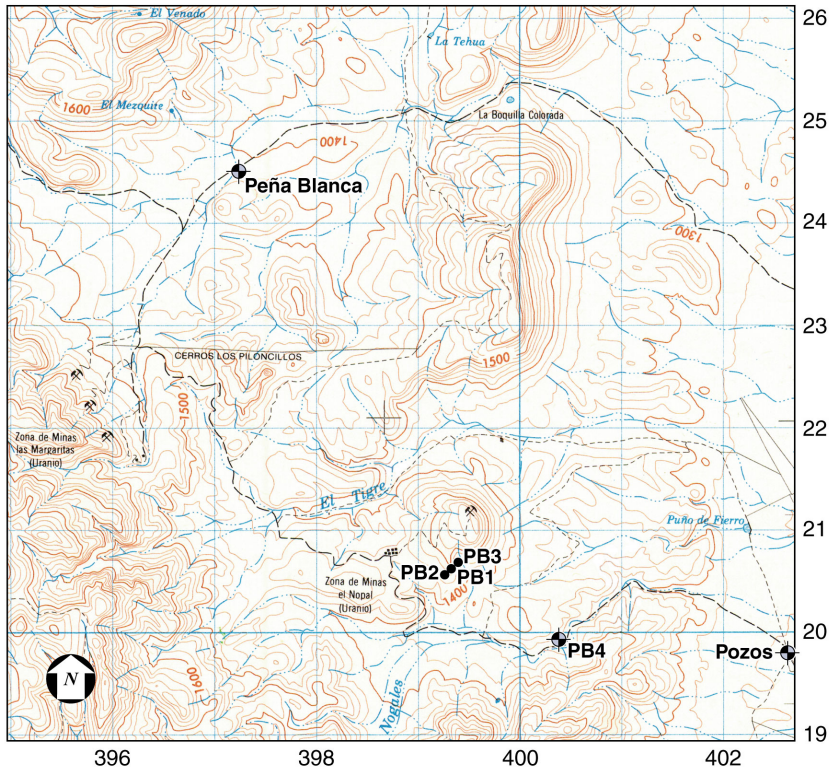
February 16, 2006
Las Vegas, Nevada

Presentation Outline

- 1999-2003 DOE activities at Peña Blanca
  - Water sampling and analysis
  - Drilling at Peña Blanca
  - Update of Natural Analogue Synthesis Report
- DOE Office of Science & Technology and International (OST&I) project at Peña Blanca (2004-present)
  - Development of Technical Work Plan document
  - Integrated field, laboratory, and modeling study
  - Special session at 2005 Geological Society of America meeting
- Key work tasks – FY06

1999-2003 DOE Activities

- **Water sampling of regional wells and adit**
  - **Examine U decay series mobility from water analyses**
  - **Determine U concentrations in regional aquifer**
- **Drilling of three wells at Nopal I deposit**
  - **One cored well (PB-1)**
  - **Two rotary-drilled wells (PB-2, PB-3)**

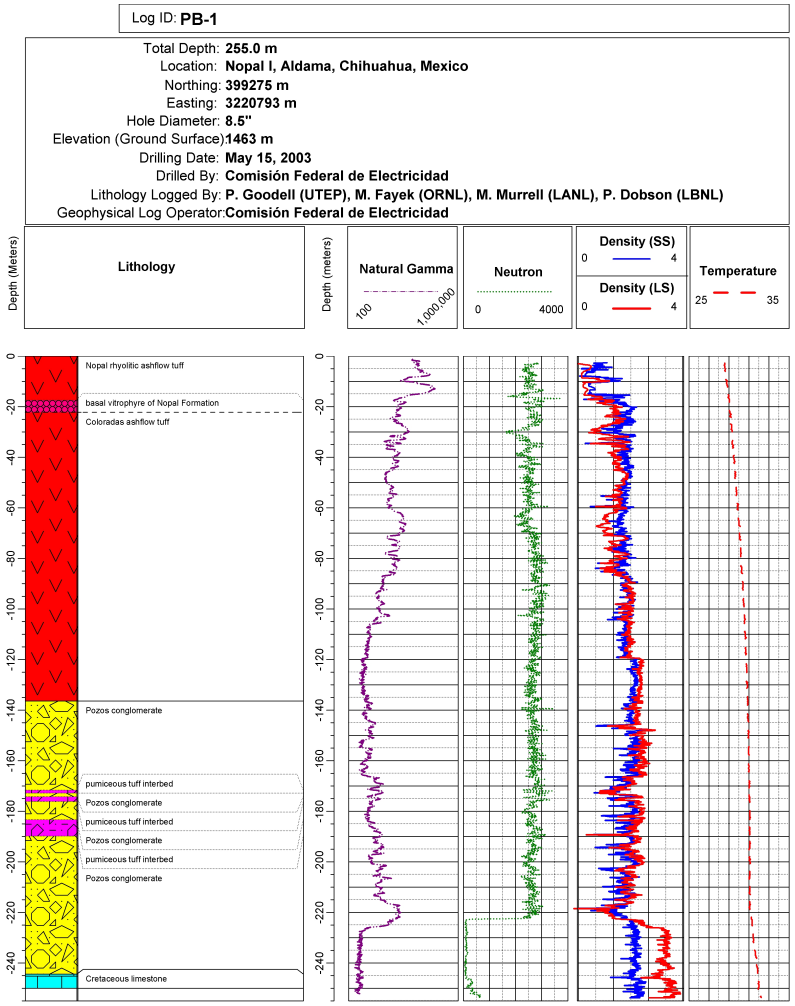


El Sauz 1:50,000 Topography Map
North American 1927 dictum

NA04-001

Geophysical Logging

- **Temperature**
  - **Thermal gradient**
- **Gamma**
  - **Location of mineralized zones**
- **Neutron**
  - **Location of water table**
- **Televiewer**
  - **Location and orientation of fractures**
  - **Location of water table**
- **Density, Caliper, Deviation**



Stratigraphic Study of PB-1 Core

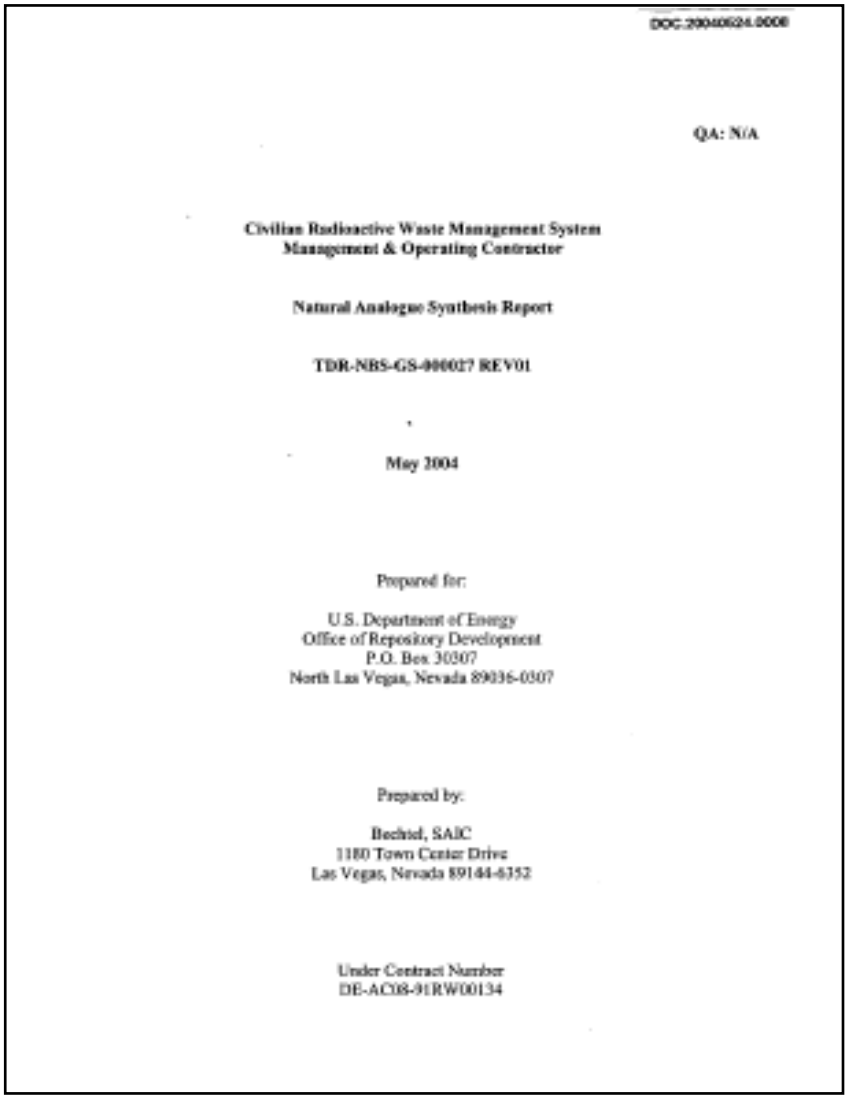
- Description of core samples
- Petrographic description of thin sections
- Delineation of lithologic contacts
  - Nopal Formation (44 Ma)
  - Coloradas Formation
  - Pozos Formation
  - Cretaceous Limestone

Sampling of New Peña Blanca Wells

- **Two methods used**
  - **Bailer method**
  - **Bennett pump**

Natural Analogue Synthesis Report Update

- **Section on Peña Blanca contains:**
  - **Stratigraphic and petrographic descriptions of 3 new boreholes**
  - **Interpreted geophysical logs**
  - **Water table elevations**
  - **U, Th, and Ra isotopic analyses of new water samples**



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QA: N/A

Civilian Radioactive Waste Management System
Management & Operating Contractor

Natural Analogue Synthesis Report

TDR-NBS-GS-000027 REV01

May 2004

Prepared for:

U.S. Department of Energy
Office of Repository Development
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Development of OST&I Technical Work Plan

- **Eight Integrated Subprojects**
  - **Characterization of rock and hydrologic properties**
  - **Seepage**
  - **Colloids**
  - **Radionuclide transport**
  - **In situ isotopic analysis of minerals**
  - **Prior high-grade stockpile site and hydrology**
  - **Numerical flow and transport model**
  - **Total system performance assessment model**

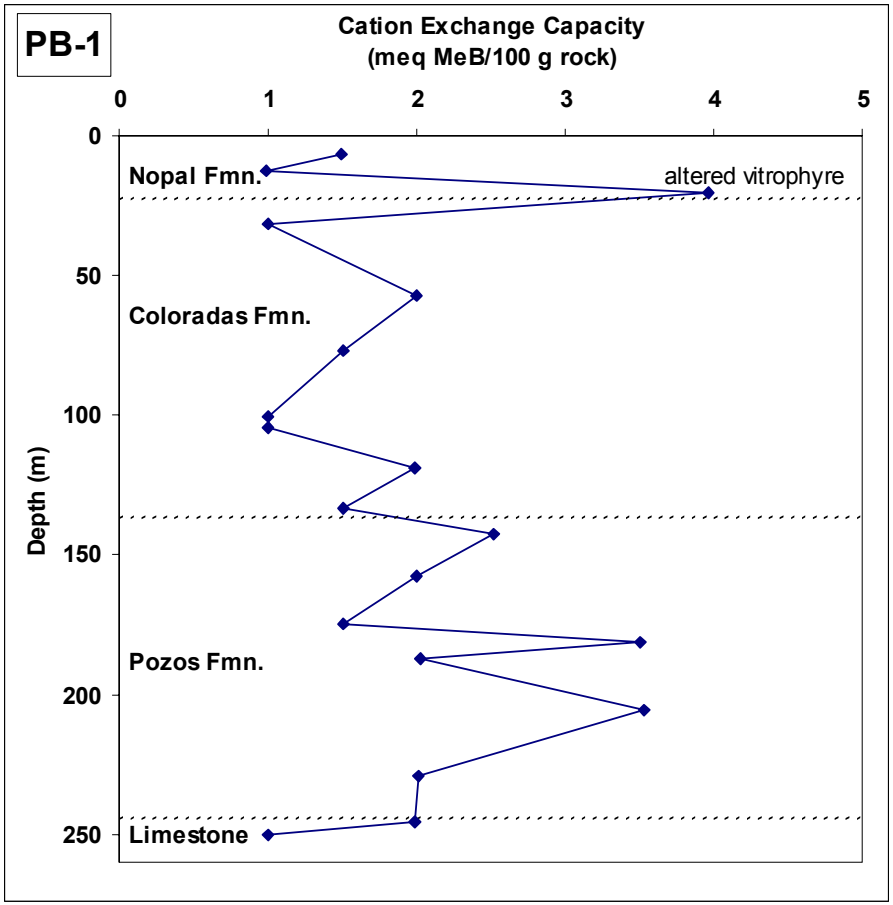
OST&I Project Participants

- LANL
- LBNL
- University Texas El Paso
- ORNL
- University of Tennessee
- University of Southern California
- Framatome
- Instituto de Ecología
- Universidad Autónoma de Chihuahua

Nopal I deposit

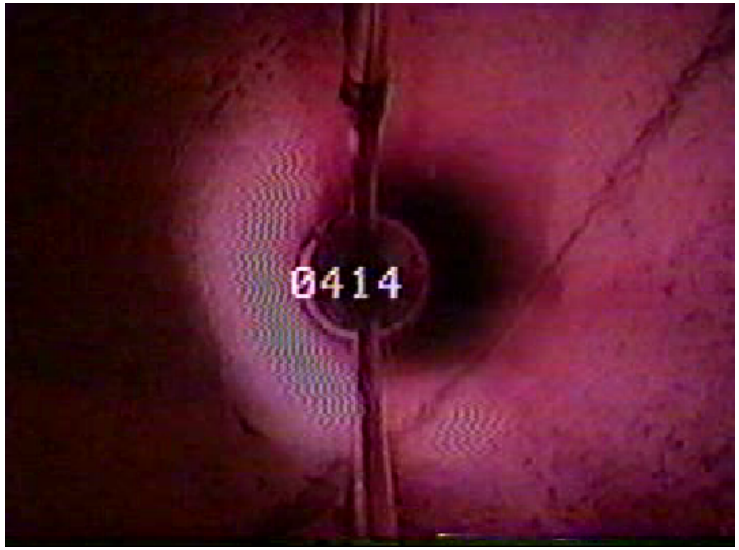
Characterization of Rock and Hydrologic Properties

- **Measurement of key rock properties being conducted to constrain flow and transport models, including:**
  - **Porosity**
  - **Permeability**
  - **Moisture retention**
  - **Fracture density**
  - **Mineralogy**
  - **Ion exchange capacity**



Fractures and Veins

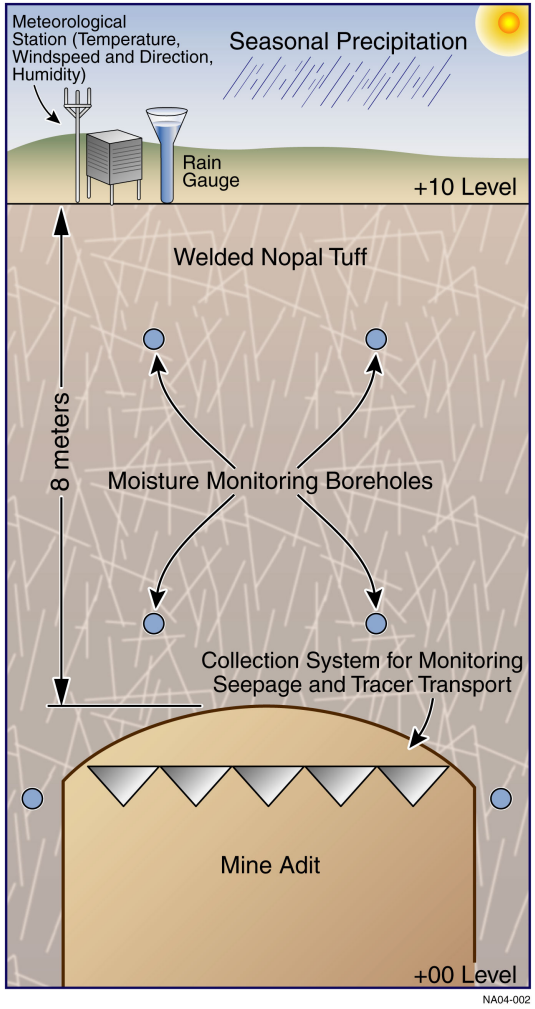
- Detailed surface fracture study (Pearcy et al., 1995) noted key role of fractures for U transport at Nopal I deposit
- Many fractures in PB-1 core are mineralized
  - Hematite, limonite, goethite
  - Silica, calcite
  - Kaolinite
- PB-1 core and video log used to characterize fractures at depth



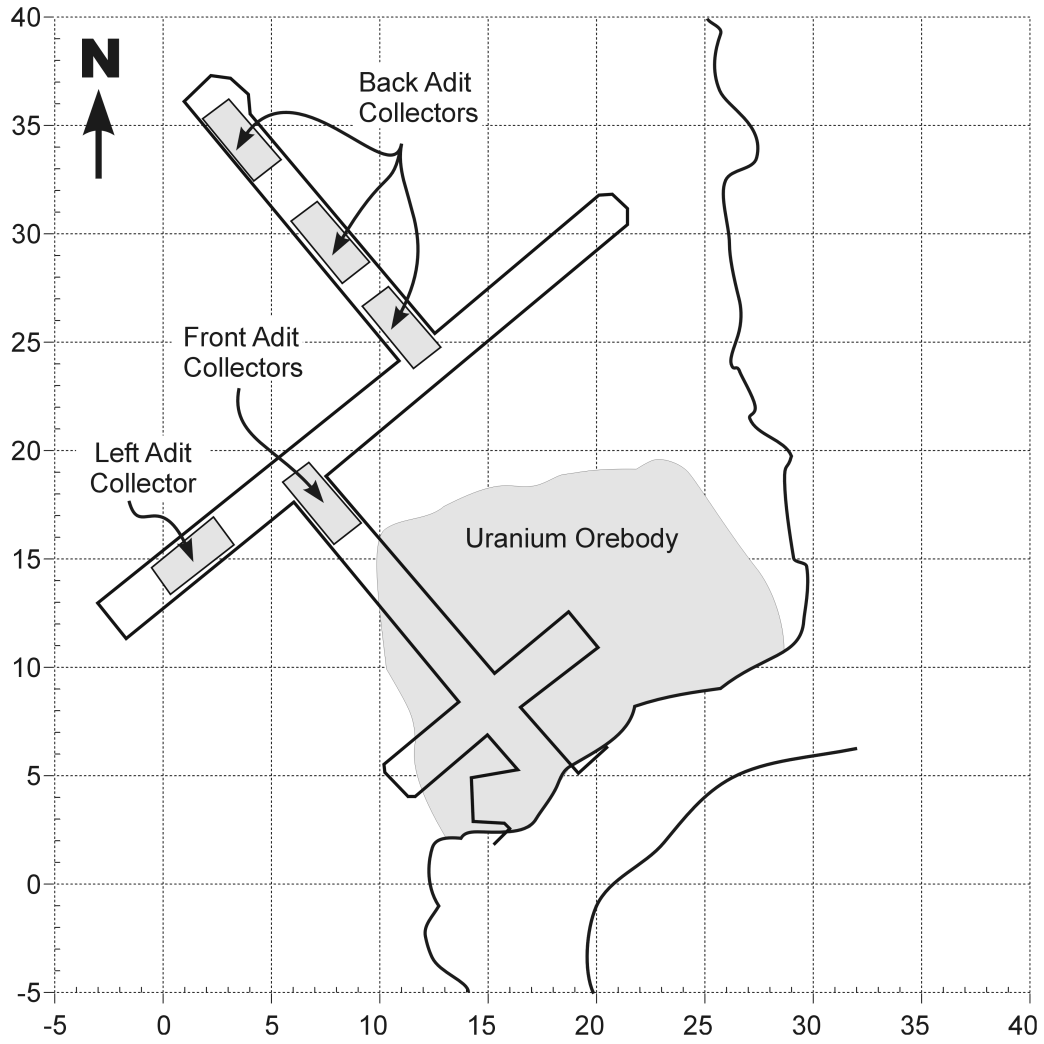
Televiewer image and corresponding core sample with breccia vein (calcite + limonite ± jarosite) in Coloradas ash-flow tuff (~127 m)

Passive Seepage Study

- **Old seepage collection system upgraded in April 2005**
  - **240 collectors, each with a collection area of 0.3 x 0.3 m**
  - **180 collectors deployed in back adit, 60 in front adit**
- **Instrumentation added in November 2005**
  - **2 humidity/temperature probes**
  - **6 collection columns with pressure transducers**
  - **Atmospheric pressure transducer**
  - **Data logger powered by batteries**



Seepage Collection Layout

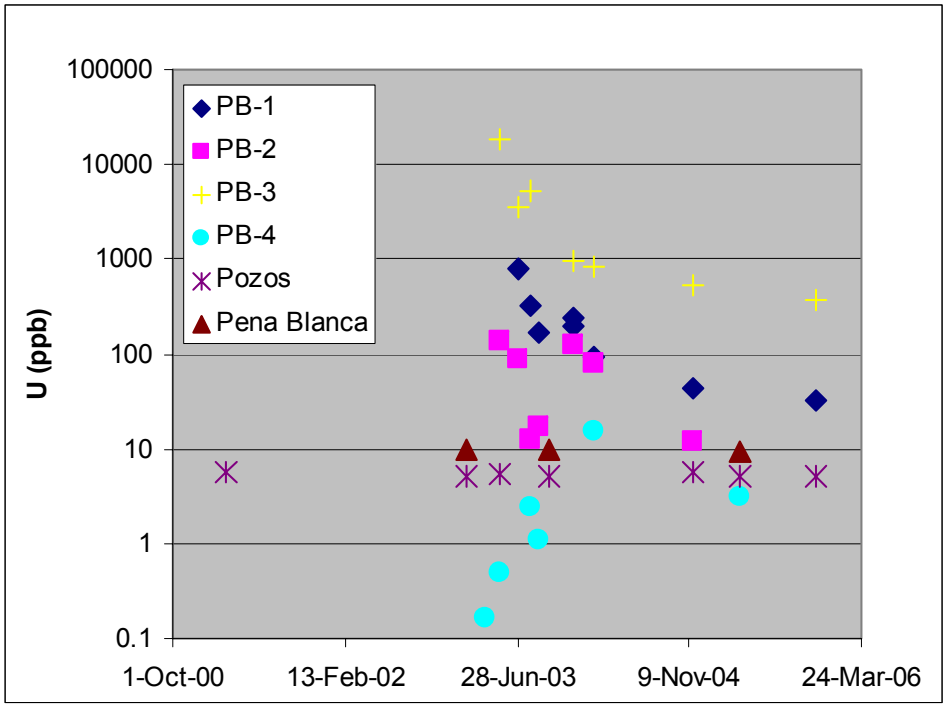


Colloids

- Suite of chilled unfiltered samples for colloid analysis collected from wells Nov. 2004
- Comparison of U concentrations of unfiltered and ultra-filtered water samples indicate that ~95% of uranium is dissolved

Radionuclide Transport

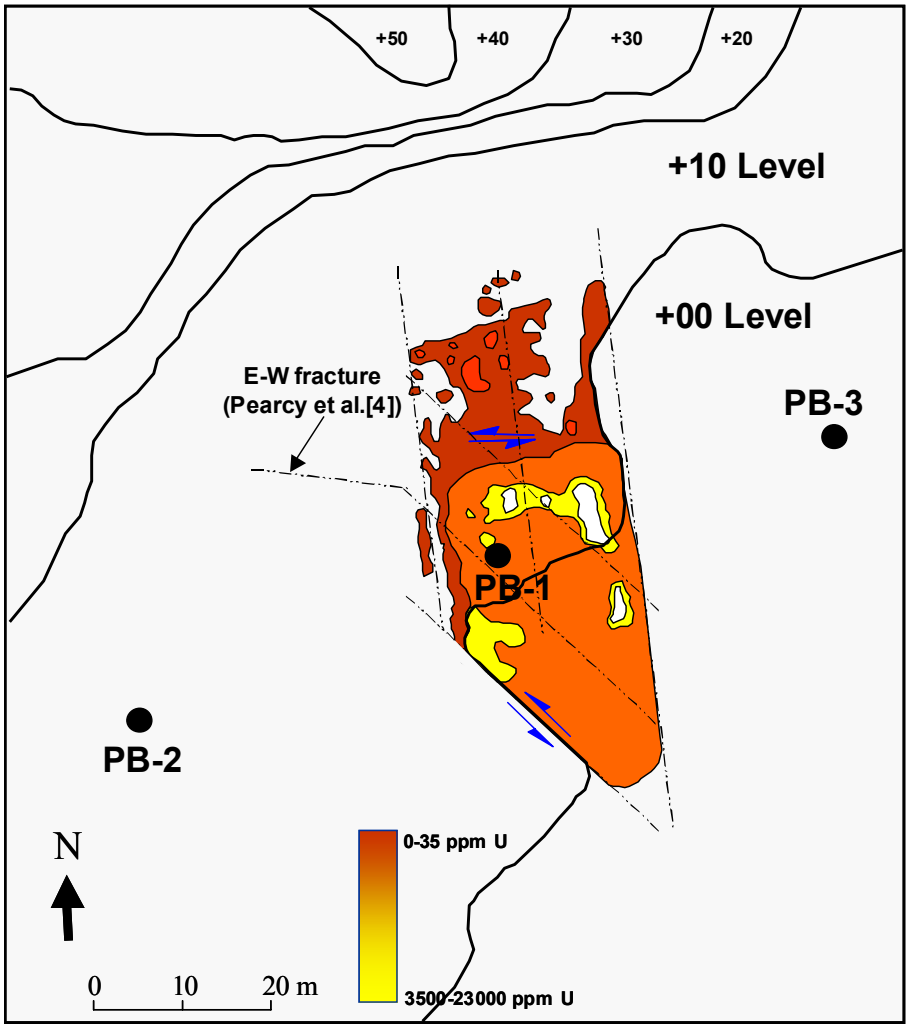
- **Sampling of SZ and UZ waters to determine:**
  - **Behavior of long-lived radionuclides**
  - **Behavior of short-lived radionuclides**
  - **Relative mobility of radionuclides**
  - **Sources and sinks of radionuclides**



U concentrations in SZ wells

In Situ Isotopic Analysis of Minerals

- **Structural controls on U mineralization**
- **Paragenesis and geochronology of Nopal I deposit**
  - **Ion probe analysis of minerals from outcrop and core samples**
  - **Multiple stages of U mineralization**
  - **Isotopic constraints on mineralization temperatures**

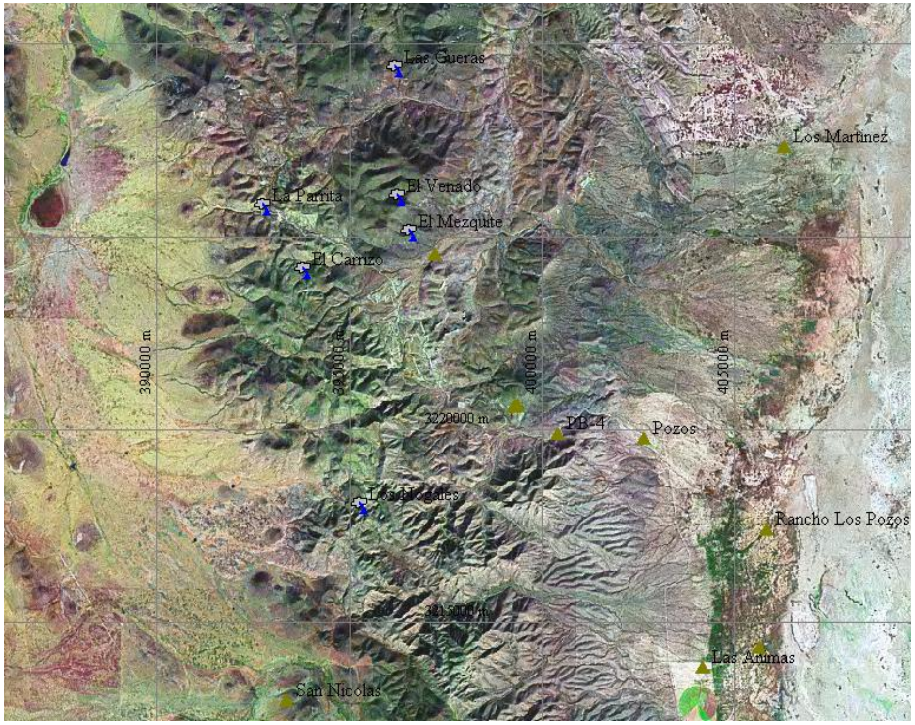


Prior High-Grade Stockpile Site

- Isolated ore boulders serve as point sources for radionuclide transport over ~20 y period
- Gamma-ray characterization of U-series intermediate daughters (^{210}Pb, ^{234}U, ^{234}Th, ^{230}Th, ^{226}Ra, ^{214}Pb, ^{214}Bi, and ^{234}Pa) in soils
- Modeling to determine role of aqueous vs. aeolian transport of radionuclides

Hydrology of Peña Blanca Region

- Regional flow from W to E
- El Cuervo basin (E of Sierra Peña Blanca) destination of flow
- Similar groundwater elevations for PB-1, PB-2, PB-3, and PB-4 wells (~1240 masl)
- Similar groundwater elevations for Pozos, Pozos Ranch, and Las Animas wells (~1198 masl)

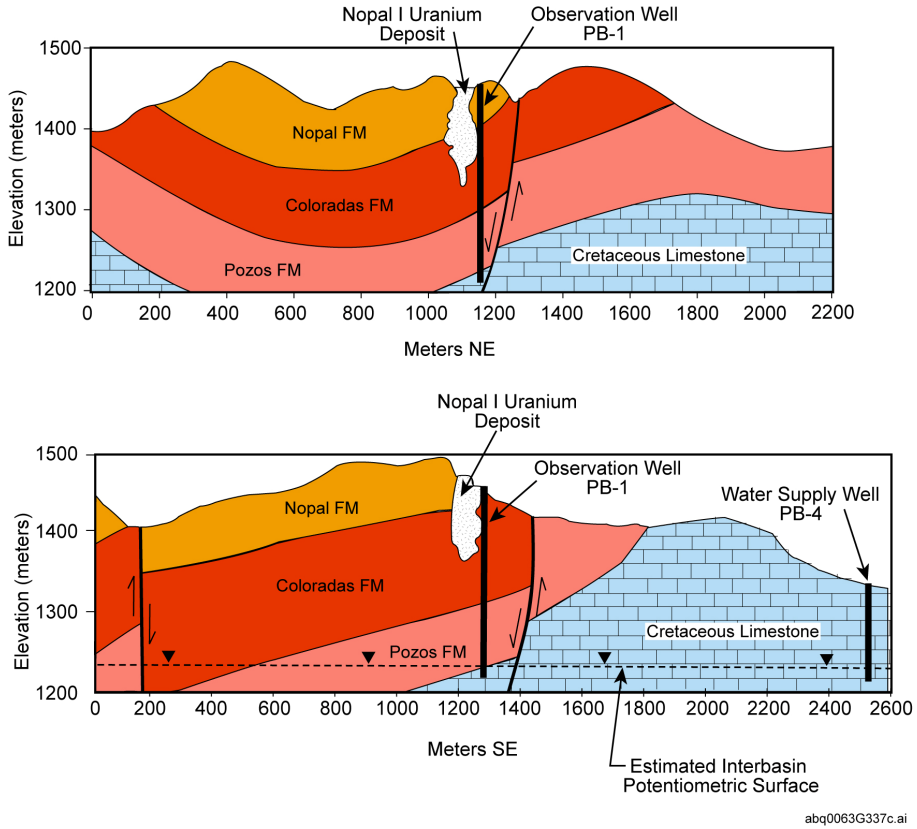


Numerical Flow and Transport Model

- Other subprojects will generate input data for numerical flow and transport model
- Geologic and hydrologic models used to develop numerical grid
- Will conduct 2-D and 3-D numerical simulations of UZ and SZ flow and transport and compare results with observed radionuclide concentrations
- Sensitivity analyses will be used to identify key areas of uncertainty

Total System Performance Assessment Model

- Construct Goldsim numerical model to predict radionuclide transport at Nopal I
- Compare predicted vs. observed concentrations of radionuclides
- Evaluate effectiveness of TSPA model



Peña Blanca Session at 2005 Geological Society of America Meeting

- Session convened by Ardyth Simmons (LANL) and Patrick Dobson (LBNL)
- Presenters from LANL, LBNL, University of Tennessee, USC, University Texas El Paso, Framatome, NRC, Center for Nuclear Waste Regulatory Analyses, CSU Chico, Instituto de Ecología, Universidad Autónoma de Chihuahua, University of Paris
- 19 oral presentations followed by a discussion session

Key Work Tasks – FY06

- Collect large-volume samples from PB-1, PB-2, and PB-3 for short-lived radionuclide analysis
- Conduct interference test of PB wells during pumping to determine flow properties of aquifer
- Continue with seepage sampling, analysis, and modeling
- Continue with ion probe analyses of U minerals
- Complete prior high-grade stockpile study
- Complete rock property characterization
- Complete geologic and hydrologic models, construct numerical grids, and initiate numerical simulations of flow and transport
- Present existing study results at the International High-Level Radioactive Waste Management Conference in May 2006

Planned Field Visits to Peña Blanca

- **March 2006**
  - Replace temperature/humidity probes
  - Download seepage instrumentation data
  - Monitor seepage levels and collect samples
- **June 2006**
  - Conduct high-volume sampling of PB-1, PB-2, and PB-3 wells for short-lived radionuclides
  - Conduct interference tests of PB wells during pumping