



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



Science Update

Presented to:
Nuclear Waste Technical Review Board

Presented by:
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Las Vegas, Nevada

Outline

- **Geotechnical Field Investigations**
- **Summary of Current Performance Confirmation Activities**
- **Probabilistic Volcanic Hazard Analysis update**



Geotechnical Drilling and Testing Program Activities at the YMP Site



Geotechnical Drilling and Testing Program

- **Additional geotechnical related drilling and testing activities have been conducted since the last science update to the Board (January 2007)**
 - **Recent program activities**
 - ◆ **Enhance confidence in seismic velocity, material dynamic property, and alluvium/colluvium thickness data to support seismic site-response modeling**
 - ◆ **Enhance confidence in the general understanding of geologic structure underlying the surface facilities area**
 - ◆ **Enhance confidence in material property data for foundation design**
 - **Documented in Safety Analysis Report (SAR) Section 1.1.5**



Geotechnical Drilling and Testing Program

(continued)

- **Activities include**
 - **Boreholes**
 - ◆ **Geologic logs**
 - ◆ **Geophysical logs**
 - ◆ **Seismic velocity testing**
 - **Test pits**
 - ◆ **Material density tests**
 - ◆ **Geologic characterization of alluvium/colluvium**
 - **Field Tests**
 - ◆ **Spectral Analysis of Surface Waves (SASW)**
 - ◆ **In situ testing of dynamic properties of alluvium**
 - **Laboratory testing**
 - ◆ **Dynamic property testing**
 - ◆ **Static property testing**



Geotechnical Drilling and Testing Program

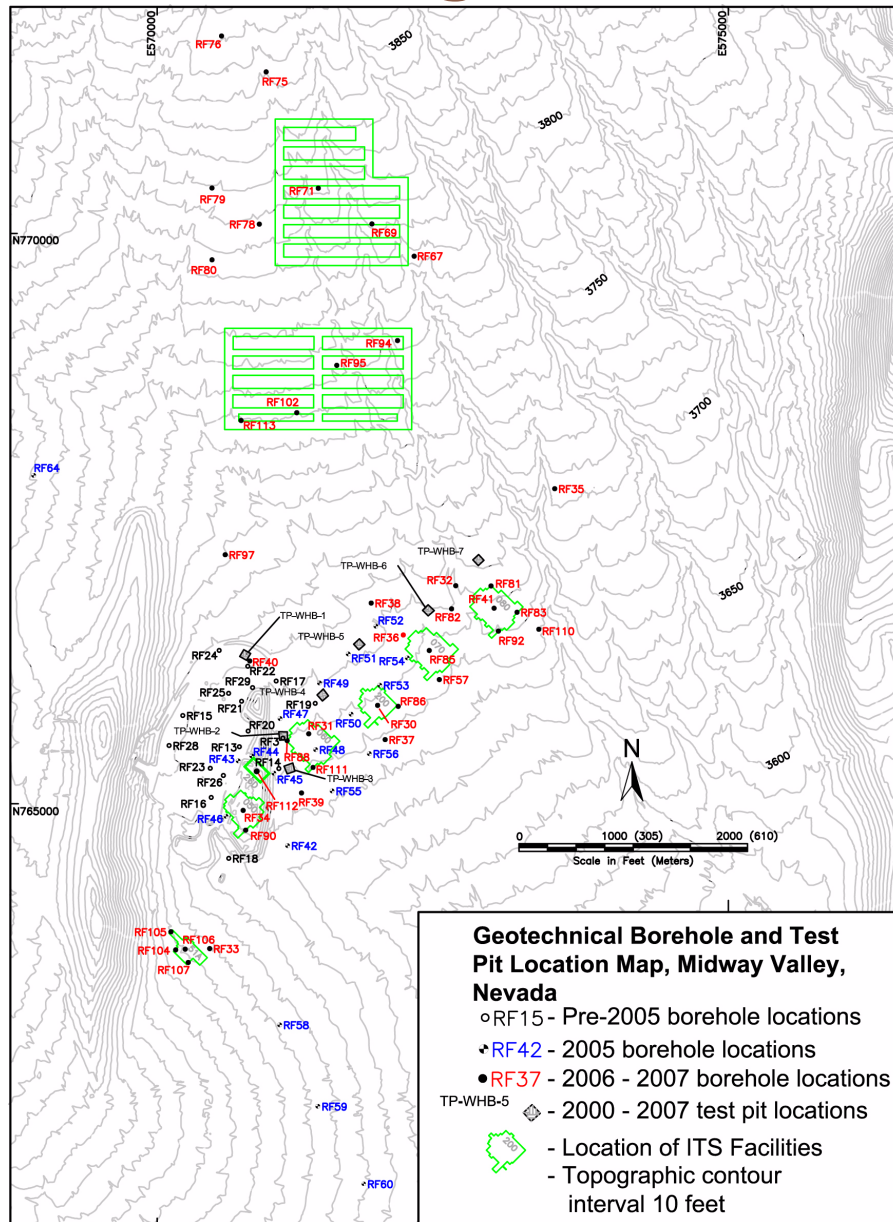
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- **Borehole activities**

- **43 boreholes drilled and logged in 2006-2007 to enhance confidence in the geotechnical characterization of the surface facilities area GROA (see SAR Section 1.1.5.2.7.2)**
 - ◆ **Borehole geophysical logs were conducted to measure lithological and engineering properties of subsurface horizons and for correlation of stratigraphic horizons between boreholes**
 - ◆ **Downhole velocity surveys were performed in new boreholes to provide information on compressional and shear wave velocities in the immediate vicinity of each borehole**
 - ◆ **Detailed geologic logs were compiled producing engineering geology descriptions of the alluvium and underlying non-welded and welded tuffs based on either the sonic or conventional core samples**
 - ◆ **Borehole optical televiewer data was obtained from the boreholes providing an oriented view of the borehole wall which is used to evaluate foliation direction and angle, structural fault direction and angle, as well as providing further resolution of fracture and lithophysae density and orientation**



Geotechnical Drilling and Testing Program



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SAR Figure 1.1-129



Geotechnical Drilling and Testing Program (boreholes - continued)



Typical Sonic Core Rig Operation



Sample Management Processing Alluvium Core



Geotechnical Drilling and Testing Program

(continued)

- **Test Pit activities:**

- **Three test pits (TP5, TP6 & TP7) were recently excavated, complementing four previously completed in 2000**
- **The pits were used to provide geologic characterization of the underlying soil units (alluvium) in the area of the planned buildings and were included in the SAR**
 - ◆ **‘Water Replacement Ring Density Tests’ and ‘Sand Cone Tests’ were conducted to obtain soil property information on the underlying material (ASTM Standard D-5030-04 and ASTM Standard D 1556-00, respectively)**
 - ◆ **Approximately 30 large diameter naturally cemented alluvium samples were collected from the pits for material properties testing in the laboratory**



Geotechnical Drilling and Testing Program (test pits - continued)



Test Pit in the North Portal Facilities Area



**Ring Density Test Being Performed
in a Test Pit**



Geotechnical Drilling and Testing Program (test pits - continued)



Approximately 30 large diameter samples were carved and collected from the pits, and machined for material properties testing in the laboratory



Geotechnical Drilling and Testing Program

(continued)

- **Additional Spectral Analysis of Surface Waves (SASW) testing was performed in the vicinity of the North Portal facilities in 2007, augmenting the 100+ SASW sites tested from 2000-2006 to enhance confidence in data supporting the SAR**
 - **SASW testing is a global, nondestructive and nonintrusive measurement used to supplement the information from borehole methods used to characterize velocity properties of the soil and rock**
 - **SASW data are interpreted as shear-wave velocity as a function of depth over the length of the survey line**
 - **The majority of these SASW surveys was in the expanded facility area of Midway Valley, particularly focused on the aging pad areas and the northwesternmost building locations that have not been previously tested**



Geotechnical Drilling and Testing Program (SASW Field Testing - continued)



**Vibroseis Truck called the
“Liquidator” used in 2007 to
produce the surface signal
for the measurement**



Geotechnical Drilling and Testing Program

(continued)

- **Status and Conclusions**

- **Data from these recent field and laboratory investigations is being compiled in an addendum to the January 2008 data report “Geotechnical Data for a Geologic Repository at Yucca Mountain, Nevada,” TDR-MGR-GE-000010**
- **Impact studies are being conducted by the Lead Laboratory to evaluate the consistency of new data with those used to support SAR analyses**
- **As described in SAR Section 1.1.5.2.7.2, initial examination of the cores, geologic logs, and geophysical logs from boreholes drilled and test pits excavated indicate that they are consistent with previous geologic observations**



Performance Confirmation Program Summary of Current Activities

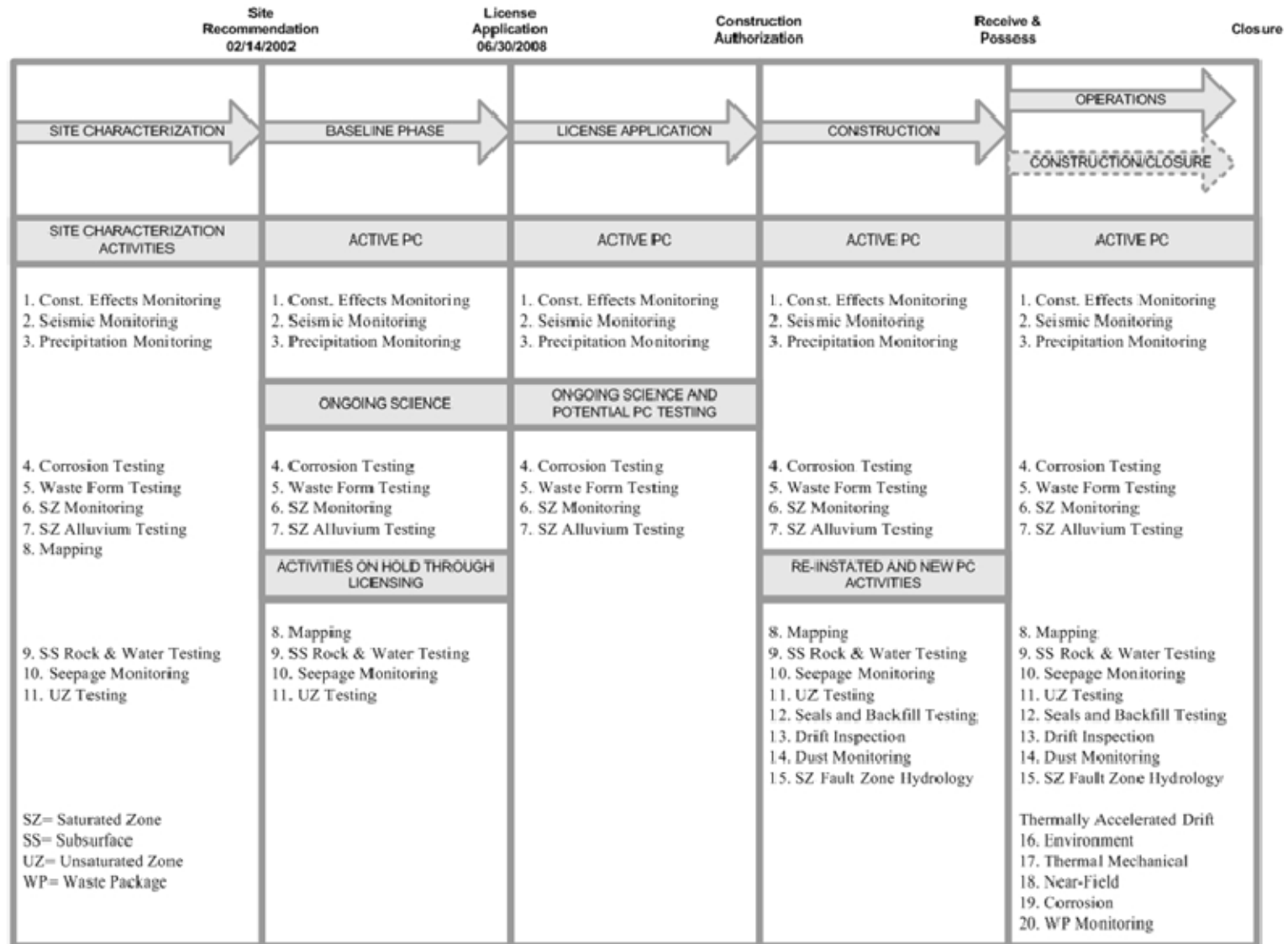


Performance Confirmation Program Summary of Activities

- **The Performance Confirmation (PC) Program is designed to confirm the adequacy of assumptions, data, and analyses that support the findings used to permit construction of the repository and waste emplacement**
- **SAR Chapter 4 identifies 20 activities for PC including in situ monitoring and field and laboratory tests**
- **The following schedule illustrates a general framework for the current PC activities commensurate with schedules for construction and waste emplacement (see next slide)**



Performance Confirmation Program



Source: Performance Confirmation Annual Report Fiscal Year 2008, TDR-MGR-MD-00062 Rev 01, Fig. 1-1



Performance Confirmation Program Summary of Activities

- **There are currently three active Performance Confirmation activities described in PC Test Plans:**
 - **Construction Effects Monitoring
(convergence monitoring of the subsurface)**
 - **Precipitation Monitoring**
 - **Seismic Monitoring**



Performance Confirmation Program Summary of Activities

- **Construction Effects Monitoring**
 - **Monitors rock deformation and evaluates mechanical properties in underground openings (currently the Exploratory Studies Facility) to evaluate tunnel stability assumptions under ambient conditions**

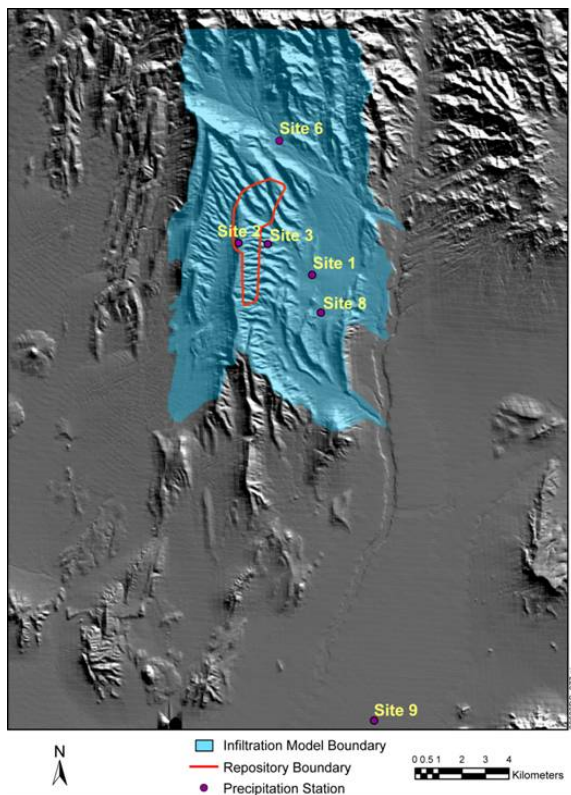


Installation of Extensometer Gages in Tunnel Rib (left) and Tunnel Back (right)



Performance Confirmation Program Summary of Activities

- **Precipitation Monitoring**
 - Monitors precipitation quantity and rate
 - Data compared to historic baseline



Left: Location of six precipitation sites around Yucca Mountain. Above: Typical precipitation site showing tipping bucket gauge, storage module, and data logger.



Performance Confirmation Program Summary of Activities

- **Seismicity Monitoring**
 - Monitors regional seismic activity within ~50 km of YM
 - Evaluates surface and subsurface fault displacement, if any, after significant local or regional seismic events
 - Compares data to Probabilistic Seismic Hazard Analysis



Underground Strong-Motion
Seismic Monitoring Station



Probabilistic Volcanic Hazard Analysis: Update



Expert Elicitation

- **Probabilistic Volcanic Hazard Analysis Update (PVHA-U) (TDR-MGR-PO-000001 REV 00) conducted according to procedure and fully consistent with NUREG-1563**
- **Availability of additional data (high-resolution aeromagnetic survey, drilling of buried basalt units) and evolution in the science of volcanic hazard analysis led the Project to conduct an update to the PVHA**
- **Panel of 8 experts participated in a 4-year process including**
 - **Five workshops and one field trip**
 - **Three individual elicitation interviews**
 - **Documentation of the individual assessments**
- **Final result is the equally-weighted average of the 8 individual assessments and models**

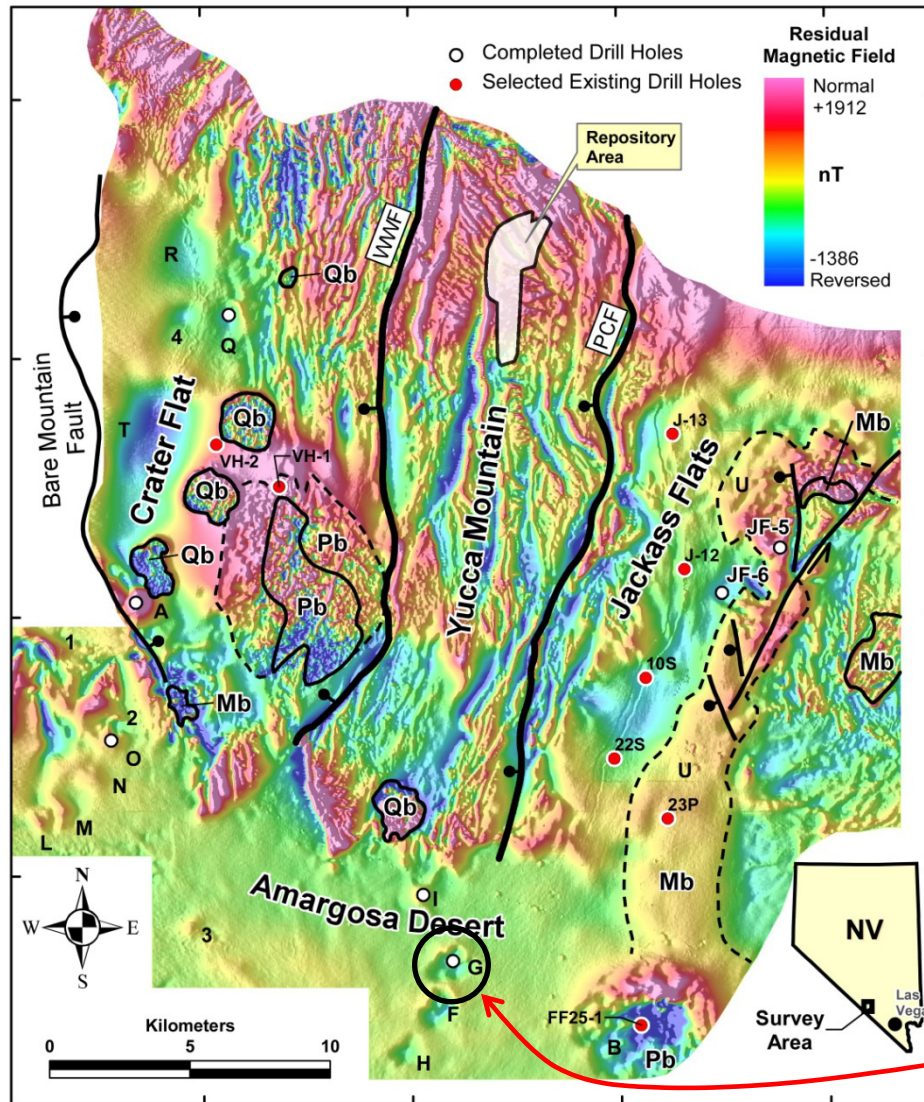


Members of the PVHA-U

Dr. Bruce M. Crowe Battelle Memorial Institute	Dr. Alexander R. McBimey University of Oregon, Emeritus
Dr. William R. Hackett Integrated Science Solutions Inc.	Dr. Michael F. Sheridan University at Buffalo
Dr. Charles B. Connor University of South Florida	Dr. George A. Thompson Stanford University
Dr. Mel A. Kuntz U.S. Geological Survey, retired	Dr. Frank J. Spera University of California at Santa Barbara



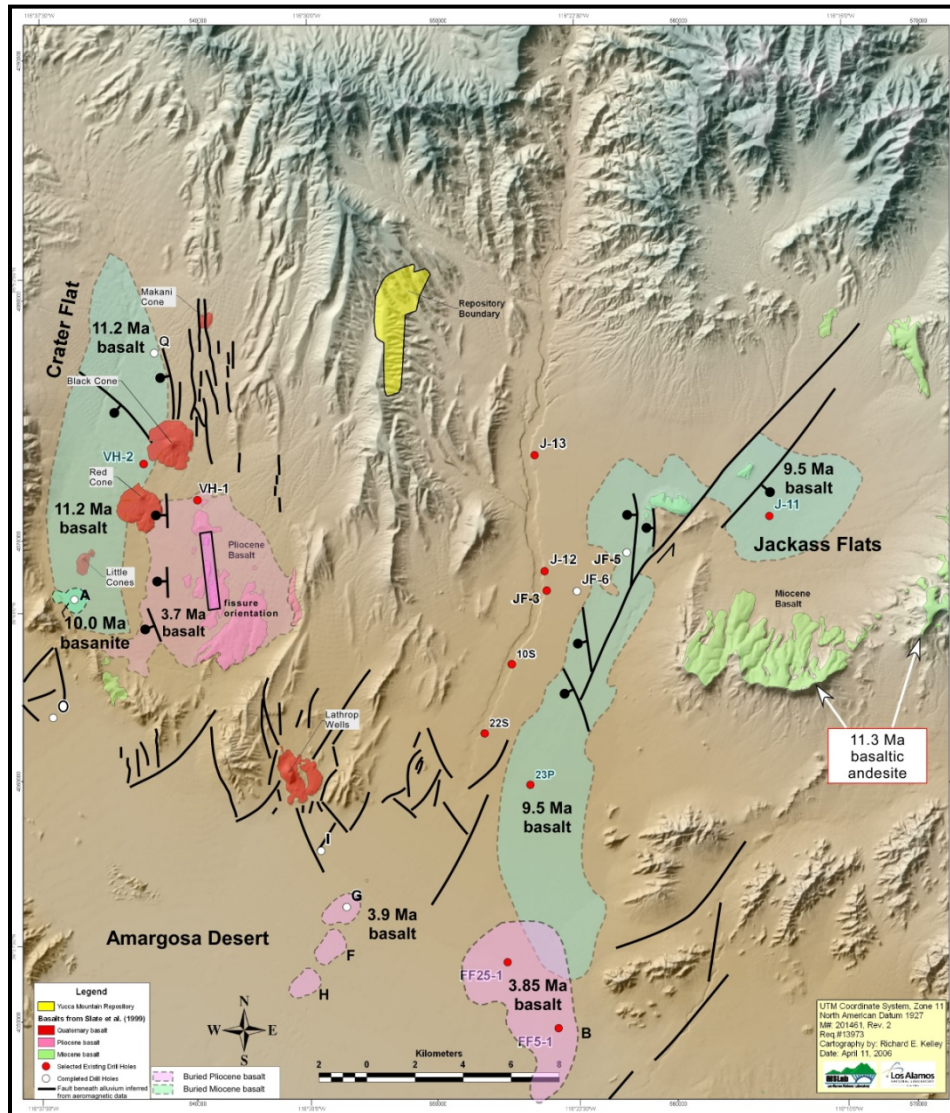
Aeromagnetic Survey and Drilling Program



- PVHA-U driven by need to assess impact of buried basaltic features on the probability of volcanic intersection
- ~30 magnetic anomalies identified as potentially caused by buried basalt
- Seven features drilled - four basalts and three faulted tuff units
- Youngest buried basalt is 3.9 Ma, other three >9 Ma



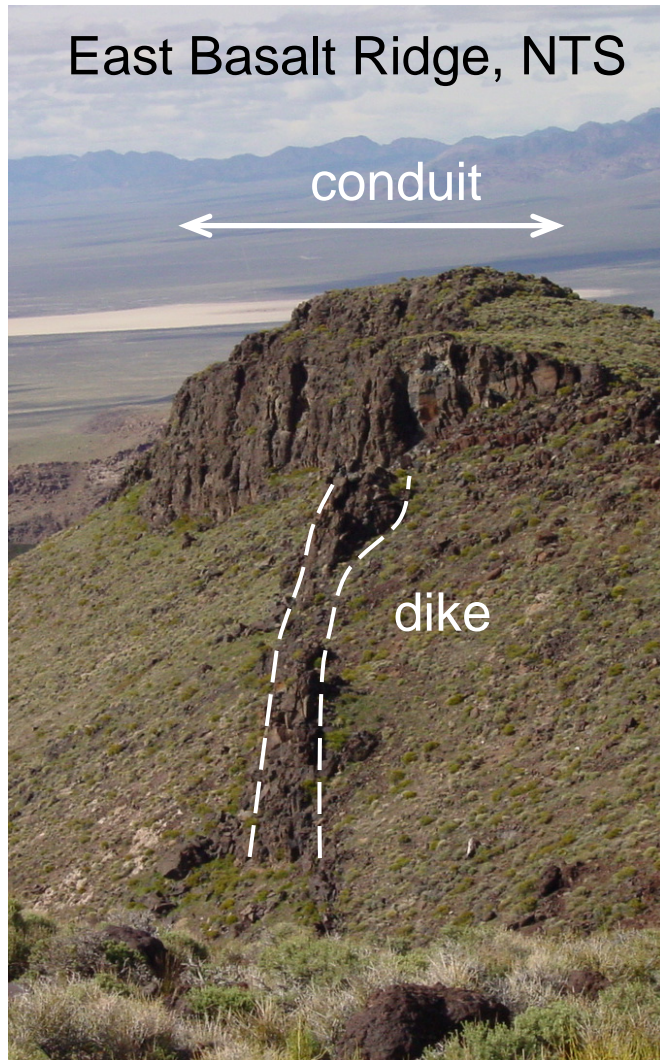
Geophysical Survey/Drilling Data Synthesis



- Survey and drilling results greatly increase confidence that basalt and tuff can be distinguished based on a comparison of the magnetic characteristics of buried features and known surface features
- Age and extent of basalt features in basins surrounding Yucca Mountain now known with high confidence
- New understanding that basaltic feeder dikes are primarily intruded along NNE-trending, high-angle faults



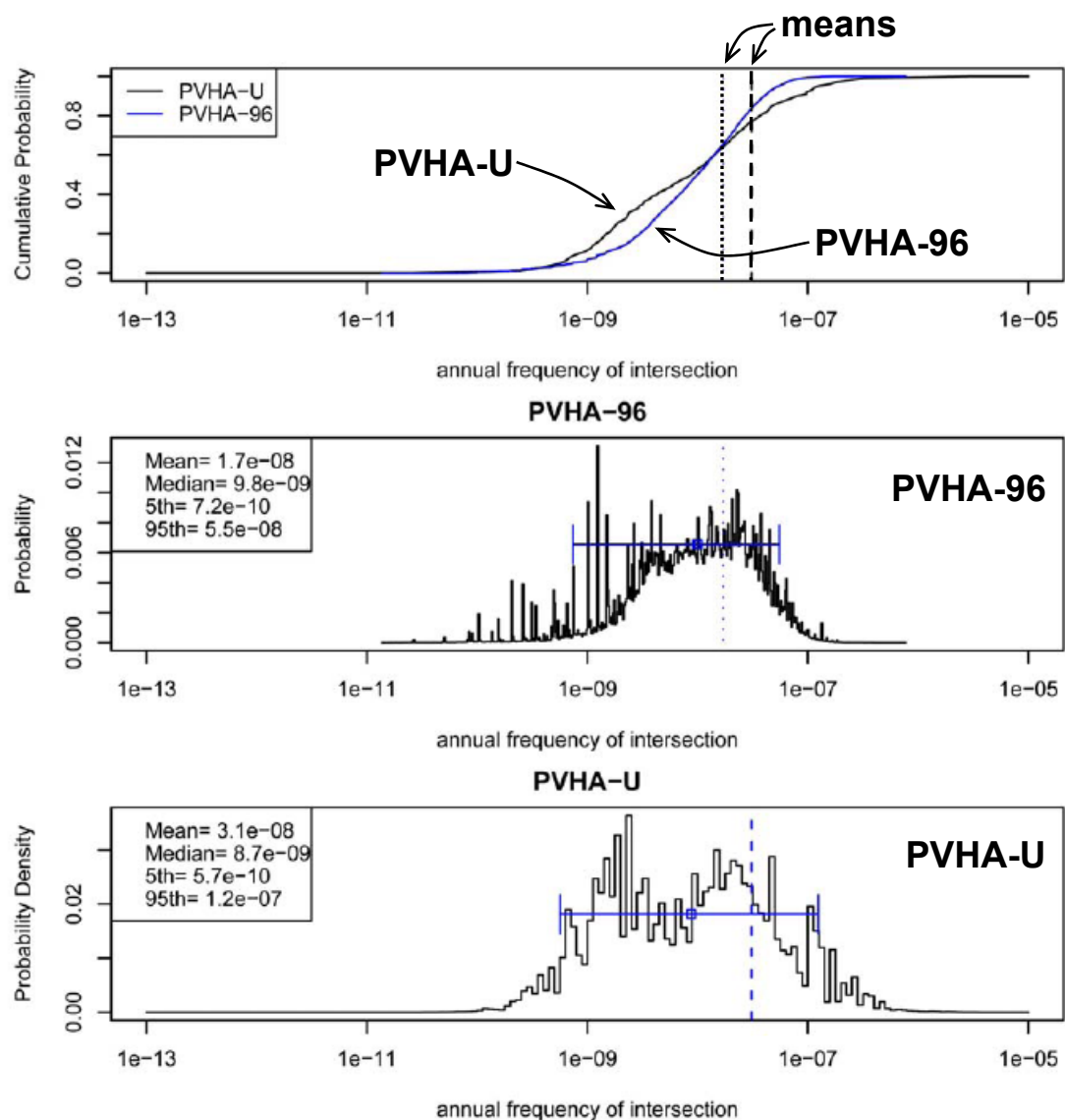
Eroded Analog Studies



- Provided volcanic event characteristics for Waste Packages Hit calculations used for TSPA-LA (dike length and dike swarm parameters, conduit diameter at repository depth)
- Date provided to PVHA-U expert panel to inform definitions of event characteristics, which impact estimates of frequency of event intersection



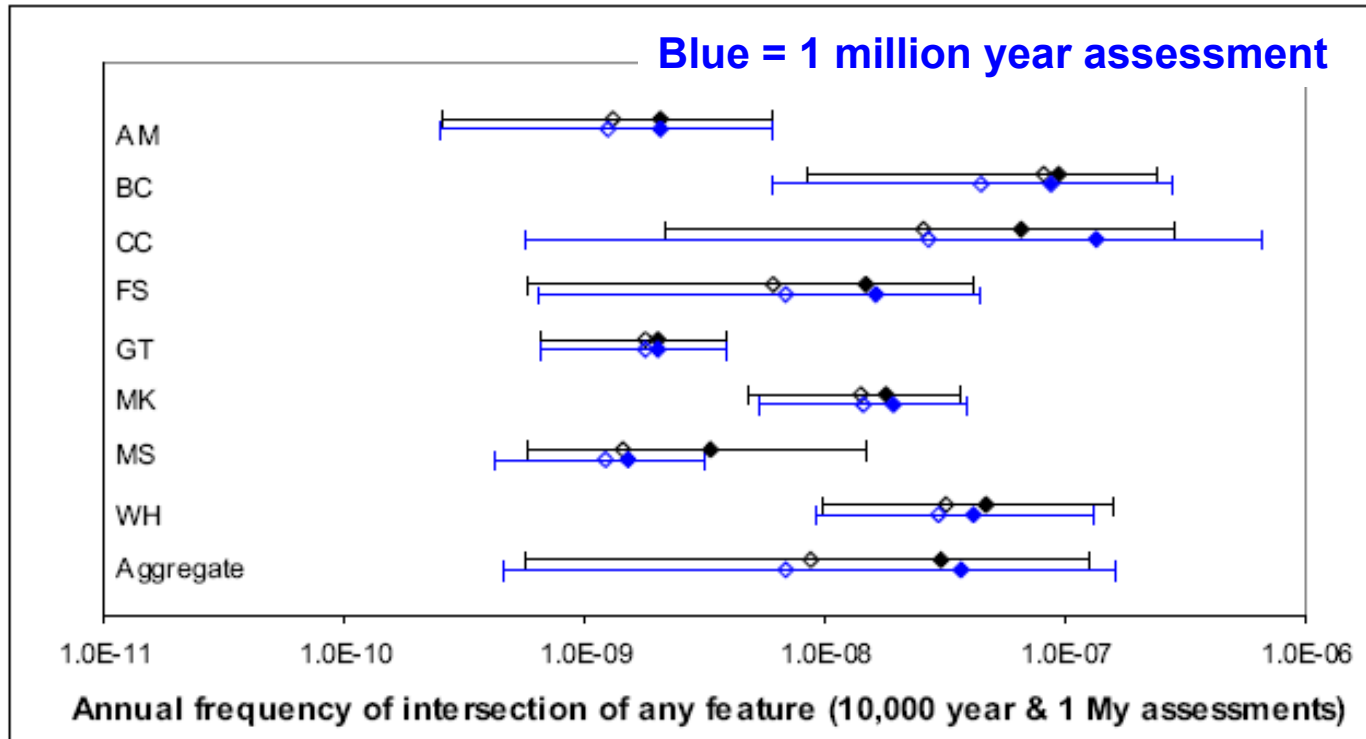
PVHA-U Results



- Hazard assessments informed by new data
- More thorough treatment of definition of volcanic event to include dike swarms, conduits and sills
- PVHA-U mean annual intersection probability of 3.1×10^{-8} ; increase from 1996 PVHA mean annual probability of 1.7×10^{-8}
- PVHA-U results have broader distribution with more weight in the tails indicating an expansion in the uncertainty
- Greater uncertainty probably due to consideration of a wider set of alternative conceptual models



10,000 vs. 1 Million year assessment



- Assessed at future times of 10,000 (or t=0) and 1 million years
- Aggregate means of 3.1 and 3.8×10^{-8} , respectively
- Increased uncertainty in assessment for the 1 Myr time frame



Summary

- **Science activities for Yucca Mountain continue**
 - **Geotechnical testing**
 - **Performance confirmation**
 - **Other activities, including work at the United States Geological Survey**
- **Results are reported to the Nuclear Regulatory Commission and published as analyses are completed**

