

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

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

SUBJECT: UPDATE ON SITE INVESTIGATIONS

PRESENTER: DENNIS WILLIAMS

**PRESENTER'S TITLE
AND ORGANIZATION: DEPUTY ASSISTANT MANAGER, SCIENTIFIC PROGRAM
YUCCA MOUNTAIN SITE CHARACTERIZATION OFFICE
LAS VEGAS, NEVADA**

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**LAS VEGAS, NEVADA
JANUARY 10-11, 1996**

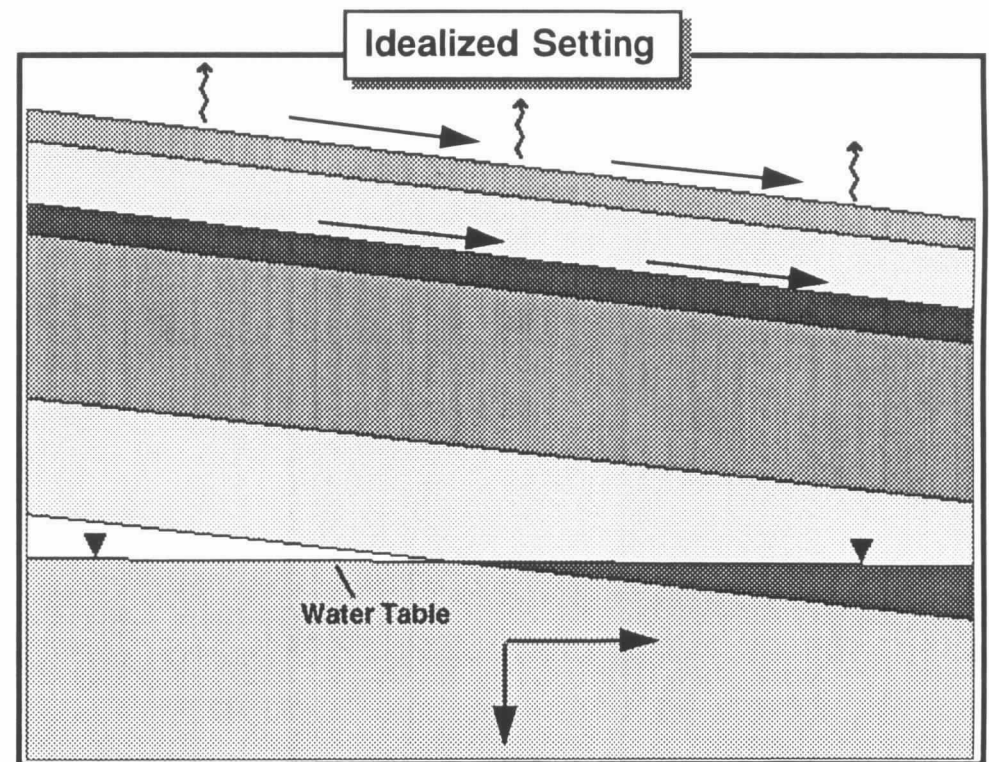
Site Investigations Update

- **Surface-based (C-borehole complex, pump out)**
- **Relationship to the Waste Isolation Strategy**
- **Geology**
 - surface-based predictions versus underground observations
 - Drill Hole Wash fault
 - repository horizon
 - rock quality
- **Hydrology**
 - water-age dates
 - fracture-fill age dates
 - gaseous-phase (pneumatic)
 - hydrologic observations in the ESF (predicted versus observed)

Waste Isolation Strategy

- **Hypotheses**

- Low seepage of groundwater
- Long containment times of radionuclides
- Low mobilization rate of radionuclides
- Long transport times through engineered barrier
- Long transport times and large dilution in the natural barrier



Preliminary

Relationship of the Waste Isolation Strategy to Site Investigations: Hydrology and Geology

- **Hydrologic processes are key to waste isolation in the natural barrier**
- **Hydrologic processes are in large part dependent on the stratigraphy/structure of the geology**
- **The geology provides the “Framework” for the hydrologic processes behavior**
- **Site investigations provide data and analyses for the “framework” and processes**

Surface Based Predictions versus Underground Observations

Predicted	Projected Ramp Sta. at Contact (m)	Projected Dist ² in Unit (m)
Rainier Mesa Tuff (Tmr and Pre-Rainier Mesa Bedded Tuff (Tmbt1)) Pre-Pah Canyon Tuff Bedded Tuff	1+96 10+28	71 34
Observed	Station	
Bow Ridge fault zone (placing Pre-Rainier Mesa Tuff against Tiva Canyon Tuff) Pre-Pah Canyon tuffs	1+99.5 to 2+02m 10+20 to 10+75m **	

¹ Range reflects uncertainty due to possible faults under Daylight Valley. Distance given to where tunnel roof projected to intersect contact

² Inclined distance along ramp

PRELIMINARY PREDECISIONAL DRAFT

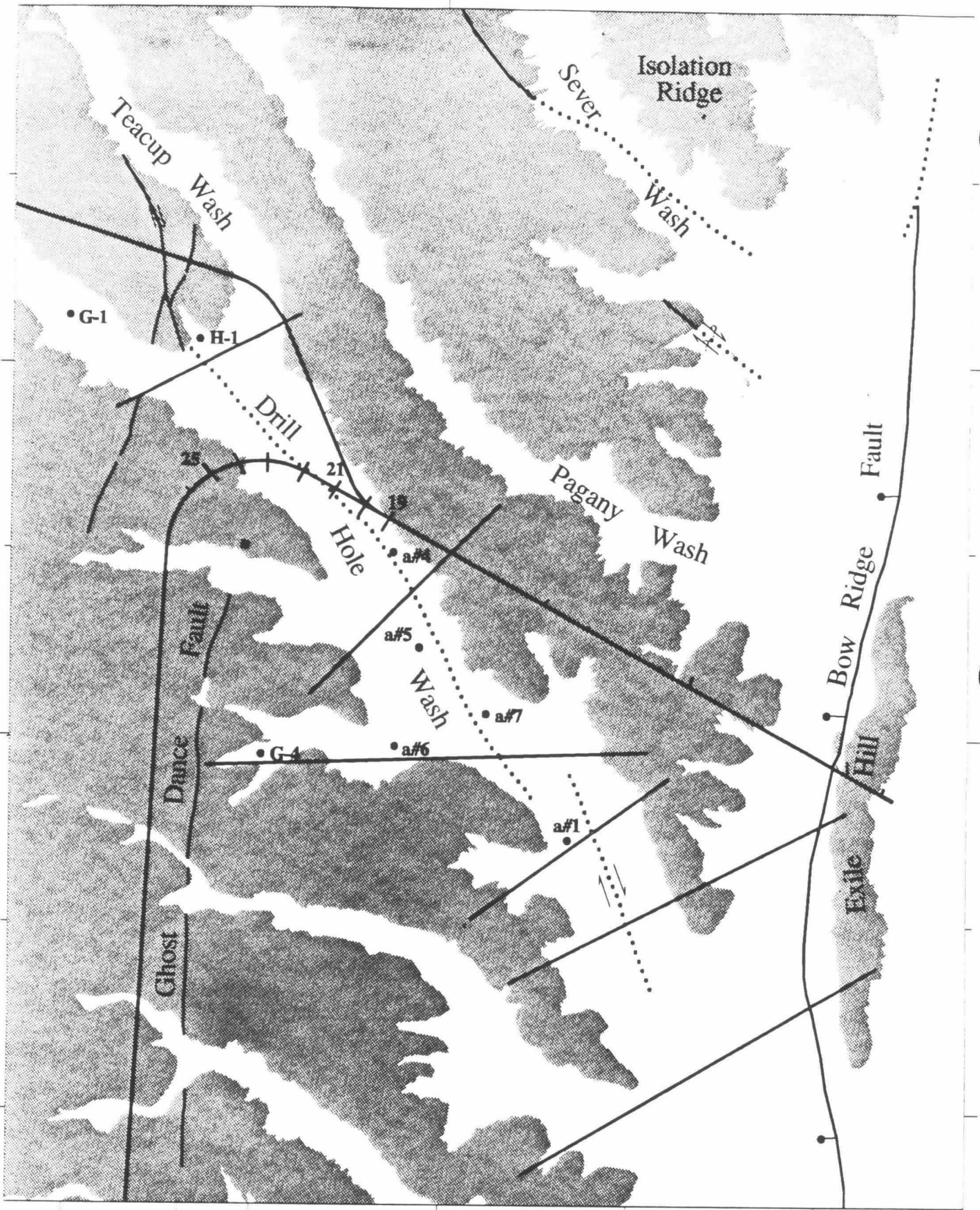
“Drill Hole Wash Fault” Predicted versus Observed

Predicted

- 2100 meters: No fault zone observed

Observed

- 1900 & 1940 meters
 - NW-trending faulting observed between
 - vertical offset ~ 4-6 m
 - strike-slip movement
- 2265 meters
 - N-trending fault
 - vertical offset of ~ 2.2 m









N770000ft

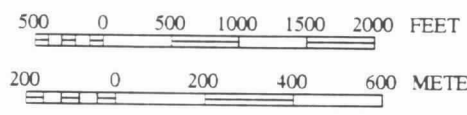
N766000ft

N762000ft

KEY

-  Slingram (electrical) survey line
-  ESF with station location
-  Fault position determined by electromagnetic surveys

-  Borehole
-  Colluvium
-  Bedrock

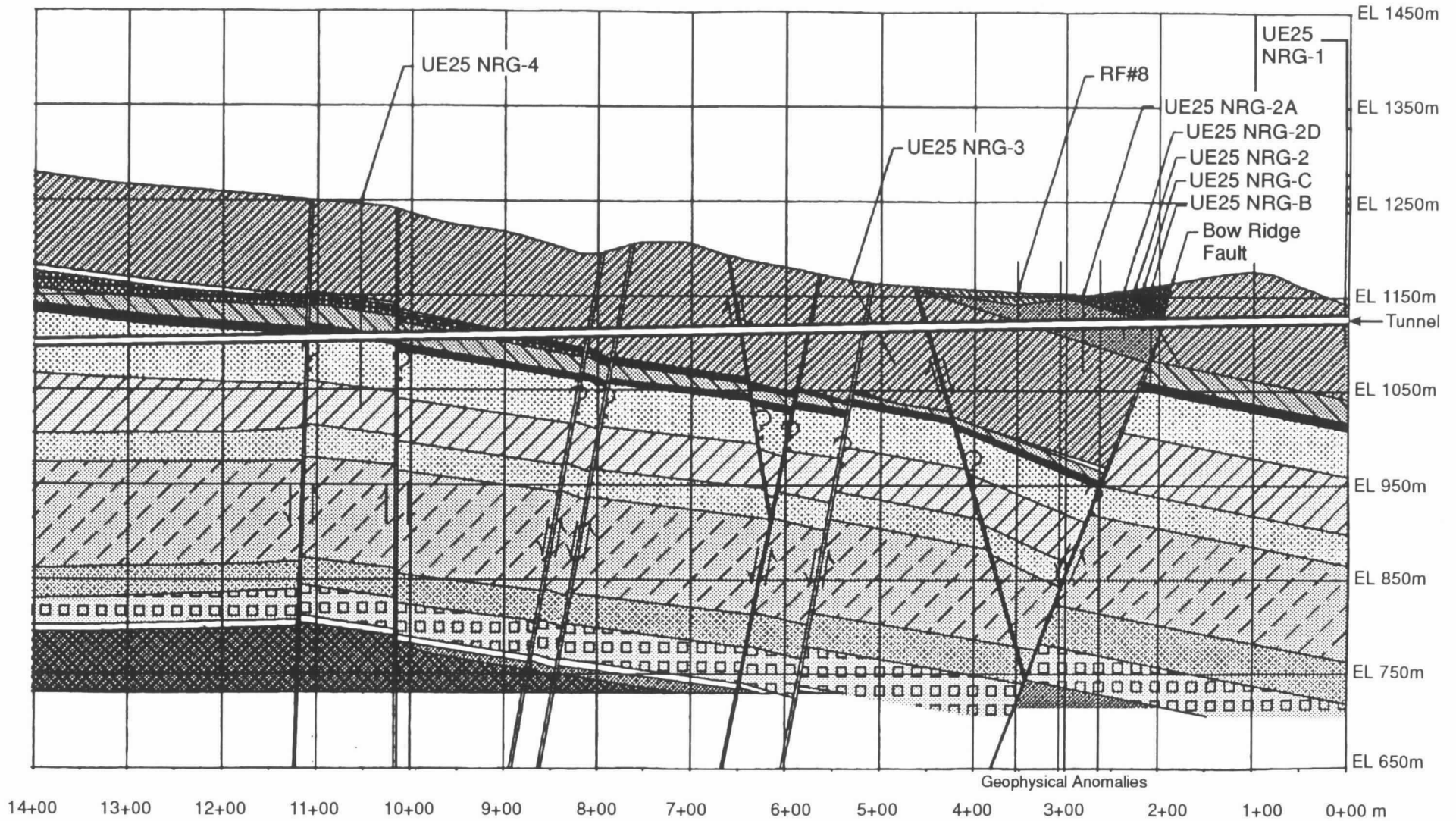


Yucca Mountain Site
Characterization Project



GEOPHYSICS AND THE
DRILL HOLE WASH FAULT

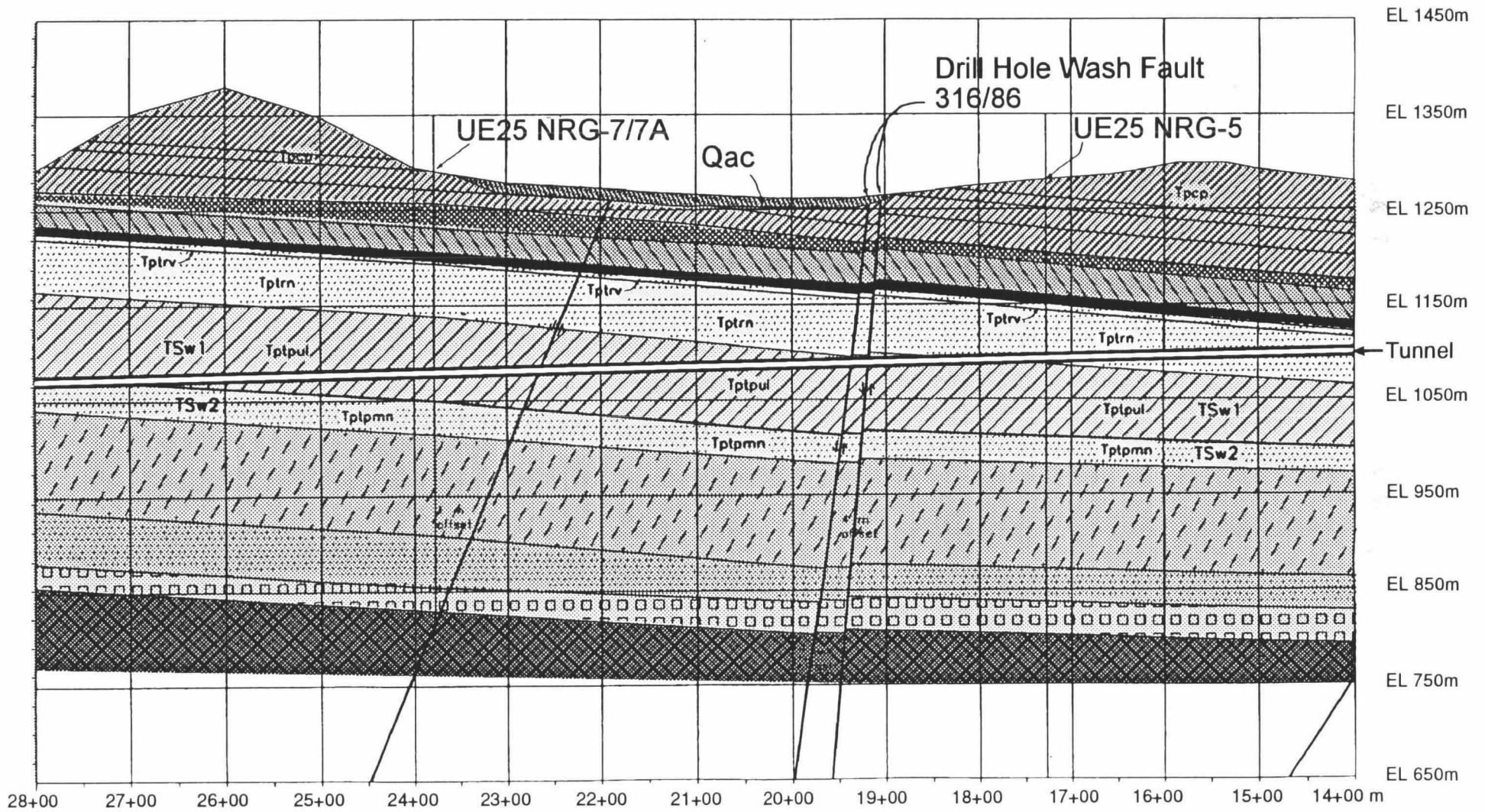
Preconstruction Section



Preliminary

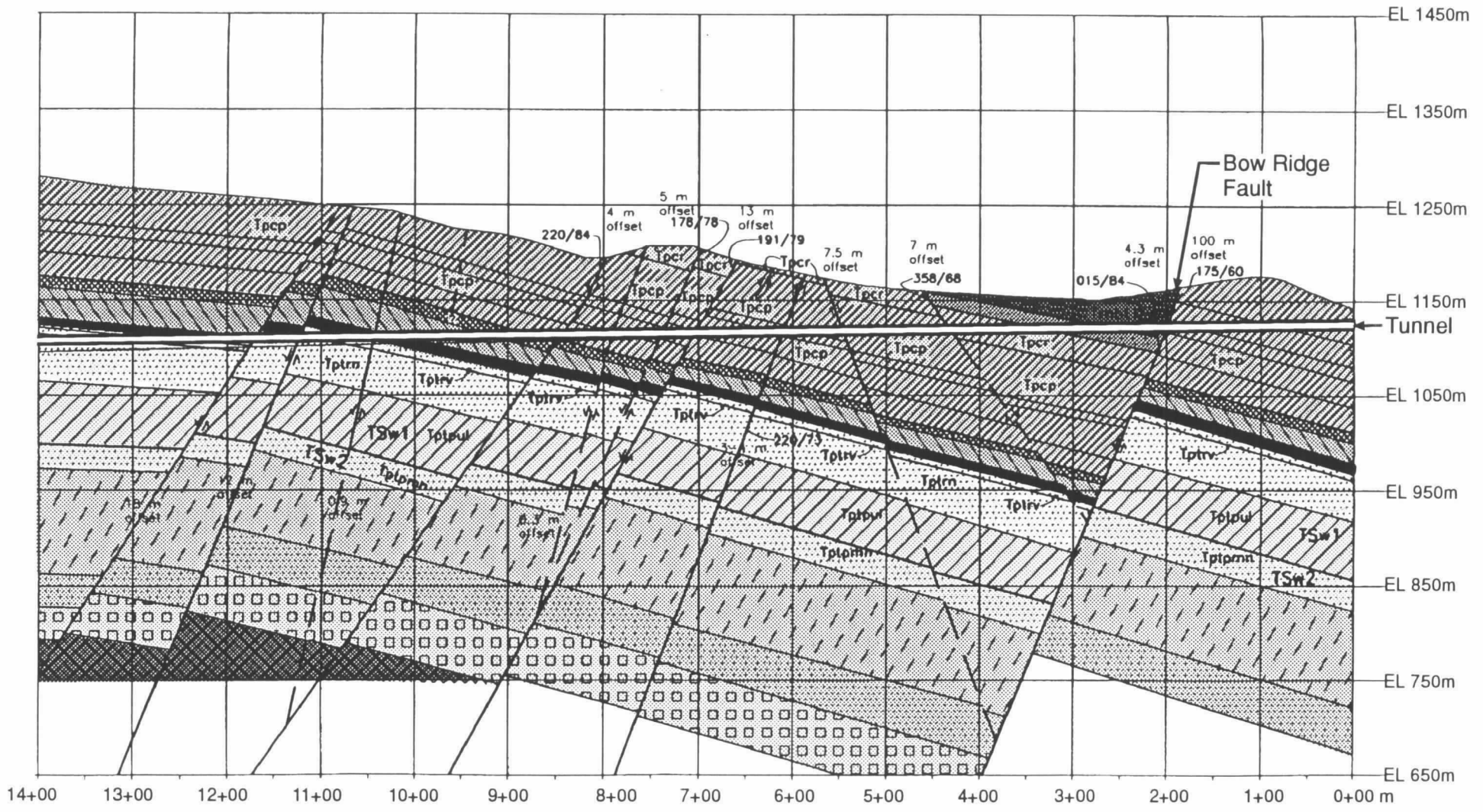
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As-Built Section
























Preliminary

As-Built Section










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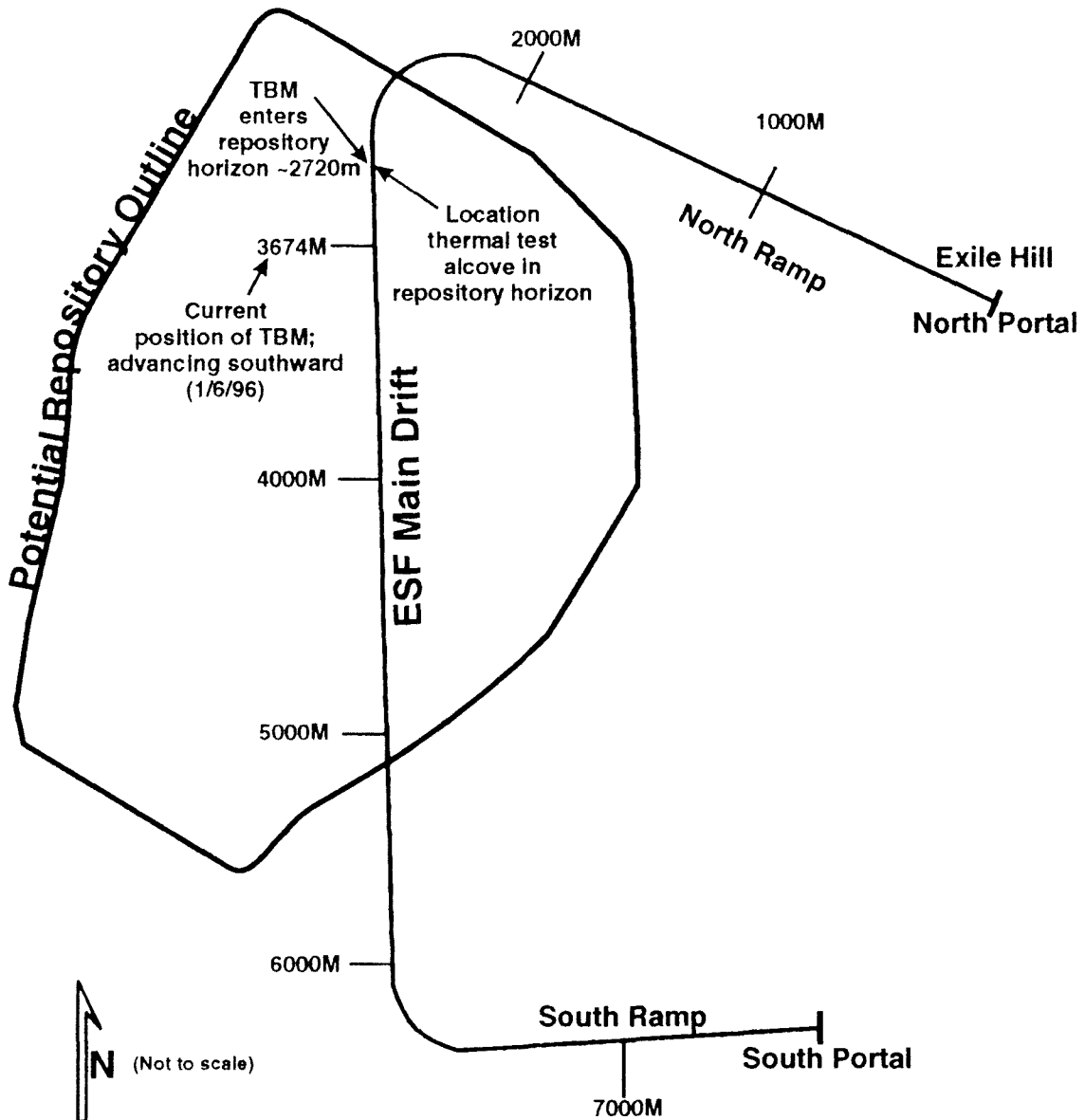
Symbols

GROUP	FORMATION	INFORMAL UNITS	THERMO-MECHANICAL UNITS
TIMBER MOUNTAIN TUFF	RAINIER MESA	 Qac: Alluvium	UO
		 Tmr: Rainier Mesa Tuff	
		 Tmbt1: pre-Rainier Mesa Tuff bedded tuff	
		 Tpki: tuff unit "X"	
		 Tpbt5: pre-tuff unit "X" bedded tuff	
TIVA CANYON		 Tpc Tiva Canyon Tuff	TCw
		 Tbbt4: pre-Tiva Canyon Tuff bedded tuff	
YUCCA MTN.		 Tpy: Yucca Mountain Tuff	PTn
		 Tpbt3: pre-Yucca Mountain Tuff bedded tuff	
PAINTBRUSH TUFF	PAH CANYON	 Tpp: Pah Canyon Tuff	TSw1
		 Tpbt2: pre-Pah Canyon Tuff bedded tuff	
		 Tptrn: Crystal-rich nonlithophysal crystal-rich vitric zone	
TOPOPAH SPRING		 Tptpul: Upper Lithophysal crystal-rich and crystal-poor parts	TSw2
		 Tptpmn: Middle Nonlithophysal crystal-poor	
		 Tptpll: Lower Lithophysal crystal-poor	
		 Tptpln: Lower Nonlithophysal crystal-poor	
		 Tptpv: Vitric vitrophyre and non welded subzones	
CALICO HILLS		 Tpb1: pre-Topopah Spring Tuff bedded tuff	TSw3
		 Tacf: Calico Hill lava flow	
		 Tacb: Calico Hills bedded tuff	

STRATIGRAPHIC NOMENCLATURE DEVELOPED BY USGS

	DRILL HOLE WASH FAULT ZONE LOCATION AND ATTITUDE UNCERTAIN
	BOW RIDGE FAULT ZONE
	MINOR FAULT, ? -ATTITUDE UNCERTAIN
	PROPOSED NORTH RAMP ALIGNMENT
	APPROXIMATE
	STRIKE-SLIP SEPARATION INTO PAGE
	STRIKE-SLIP SEPARATION OUT OF PAGE

ESF Construction Status: TBM Penetrates Repository Horizon



Preliminary

Potential Repository Horizon

Lithologic Characteristics

Distinguishing Lithologic Features

- 1 - High lithophysal content numerous small lithophysae
- 2 - grey/purple color
- 3 - few large continuous fractures
- 4 - small round lithophysae
- 5 - few recognizable vapor phase partings

Upper Lithophysal

Middle Non-Lithophysal

Lithophysae > 10%

Lithophysae < 10%

Lithophysae > 2%

Lithophysae < 2%

- 1 - low lithophysal content
- 2 - red/purple color
- 3 - numerous high angle fractures
- 4 - small flat lithophysae

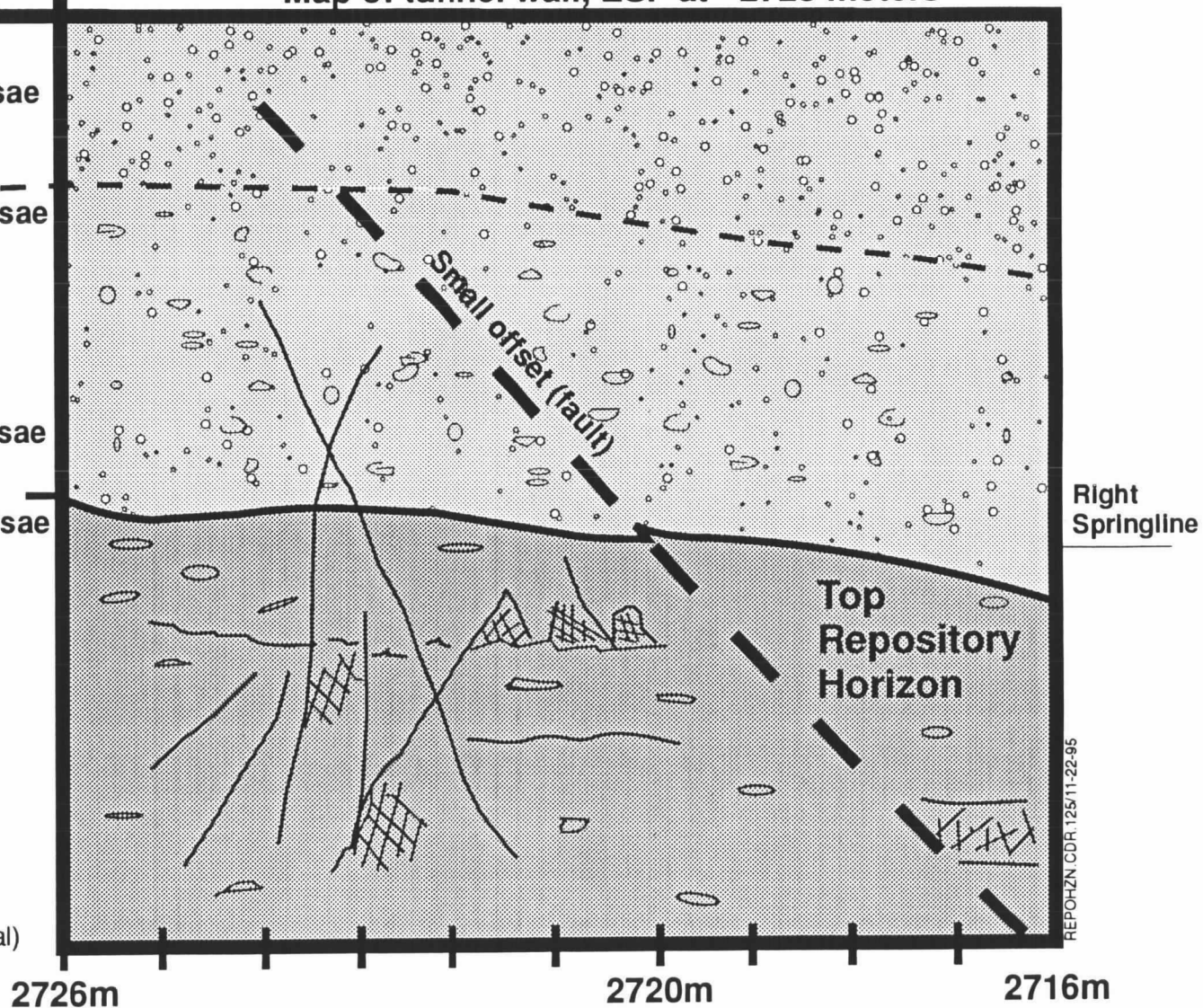
KEY

 Fractured rock

 Lithophysae

 Vapor phase parting (sub horizontal)

Map of tunnel wall, ESF at ~2720 meters

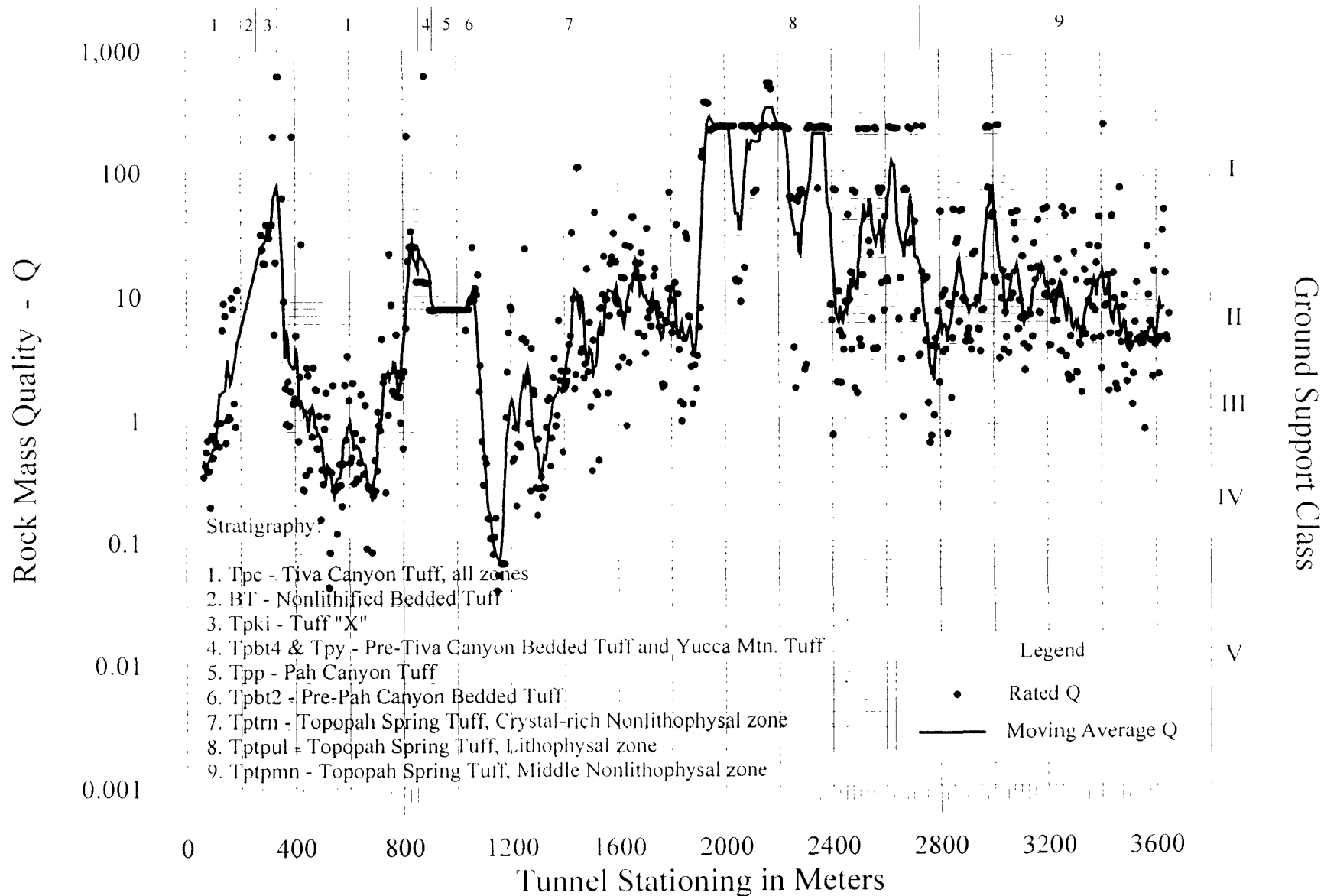


Right Springline

REPOHZN CDR 125/11-22-95

Preliminary

Stratigraphy



PRELIMINARY

Comparison of Moving Average and Rated Q Values in the North Ramp

Hydrology

- **Water-age dates**
- **Fracture-fill age dates**
- **Gaseous-phase (pneumatic)**
- **Hydrologic observations in the ESF
(predicted versus observed)**

Preliminary Water Age Dating

- Tiva Canyon and Paintbrush

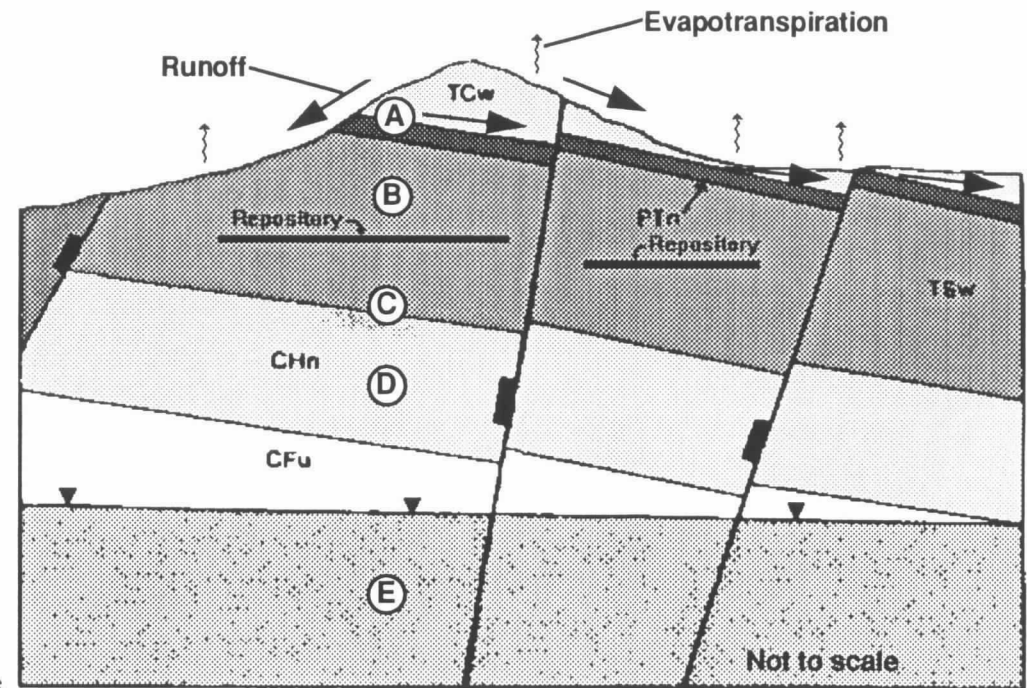
- modern (bomb pulse) water
 ^{36}Cl , ^3H (A)

- Topopah Spring and Calico Hills

- 200,000 yrs
 ^{36}Cl (unsaturated matrix water) (B)
- 5,000 to 10,000 yrs
 ^{14}C (perched water) (C)
- modern (bomb pulse) water
 ^{36}Cl , ^3H (mixed ?) (C)
- 200,000 yrs
 ^{36}Cl (unsaturated matrix water) (D)

- Water Table (aquifer)

- about 15,000 yrs (^{14}C) and < 50,000 yrs
(^{36}Cl) (E)

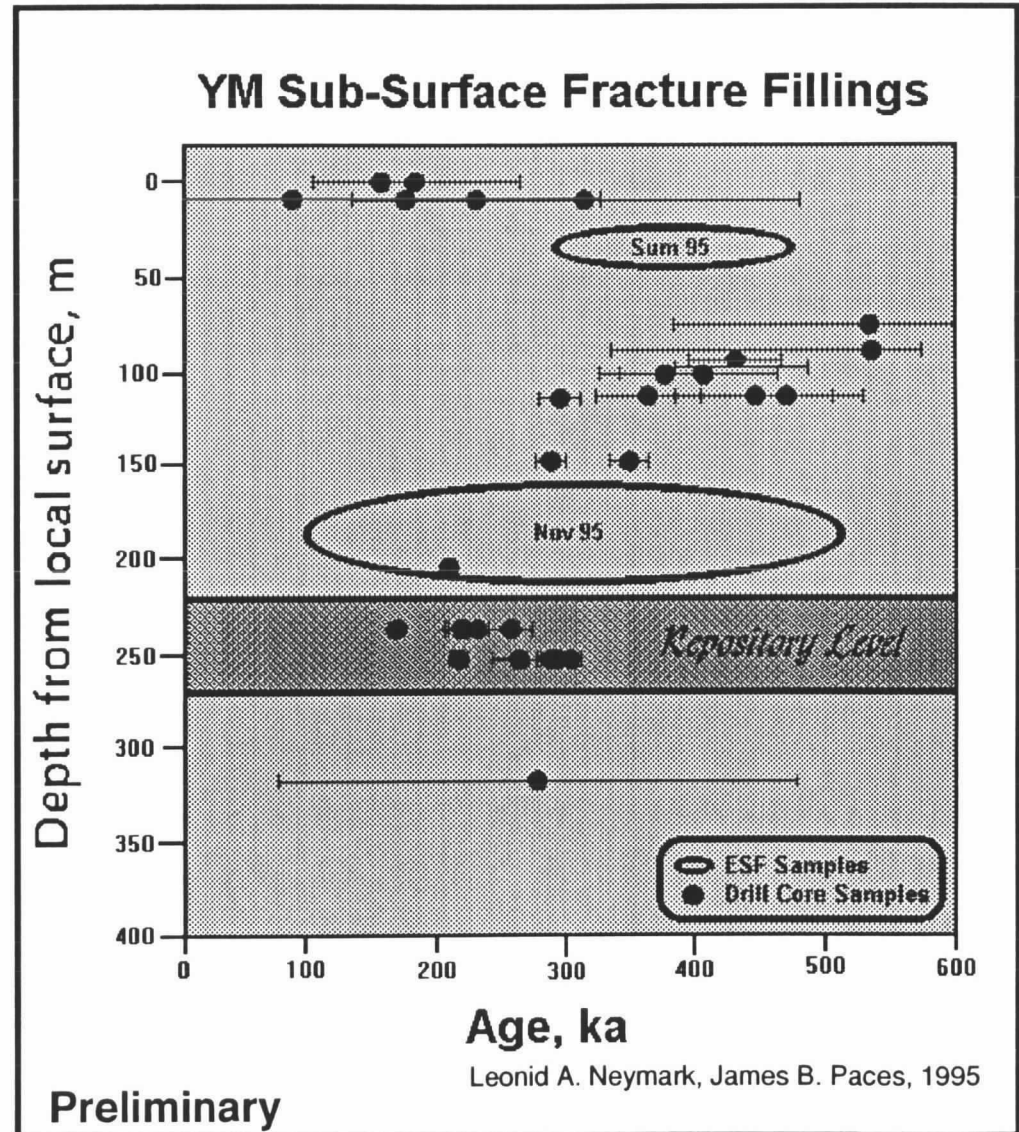


Preliminary

Geochronology of Fracture-Filling Minerals

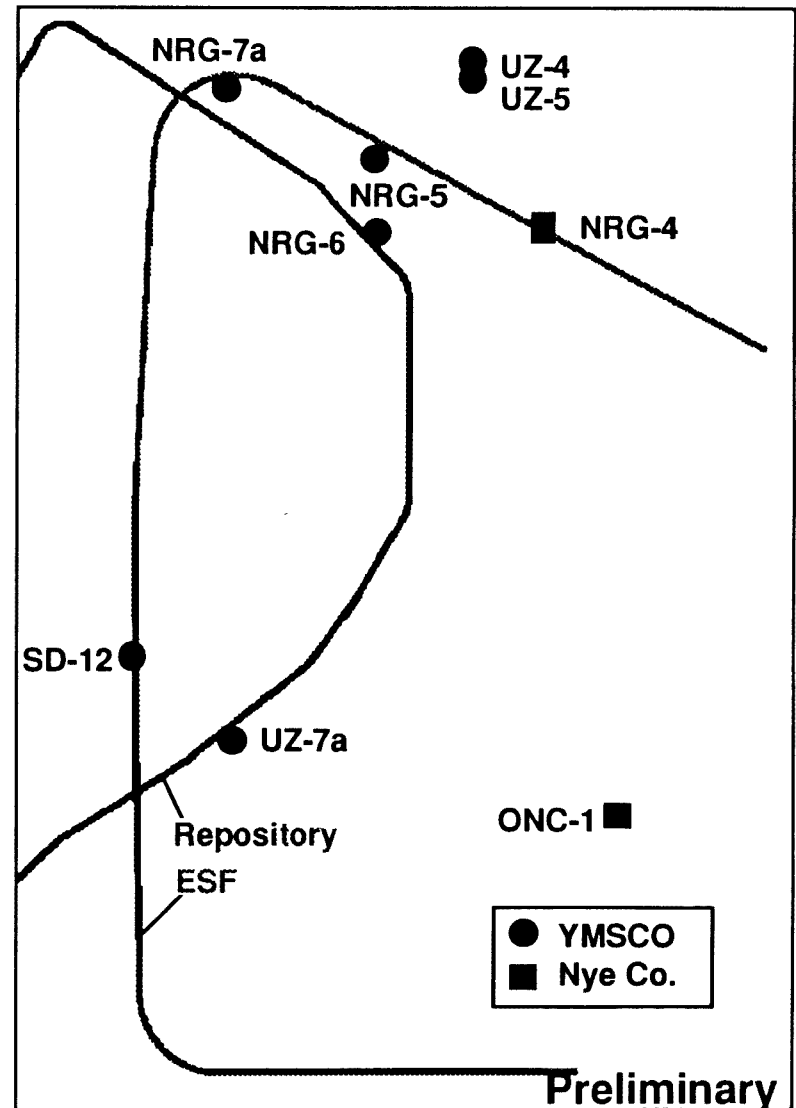
-- Preliminary Results --

- 50 to 80 analyses (U-Series)
 - calculated age estimates
- Apparent ages 100 to 1,000ka
- ESF analyses 94 to >500ka
 - cluster 240 to 310ka
- Repository analyses 150 to 310ka



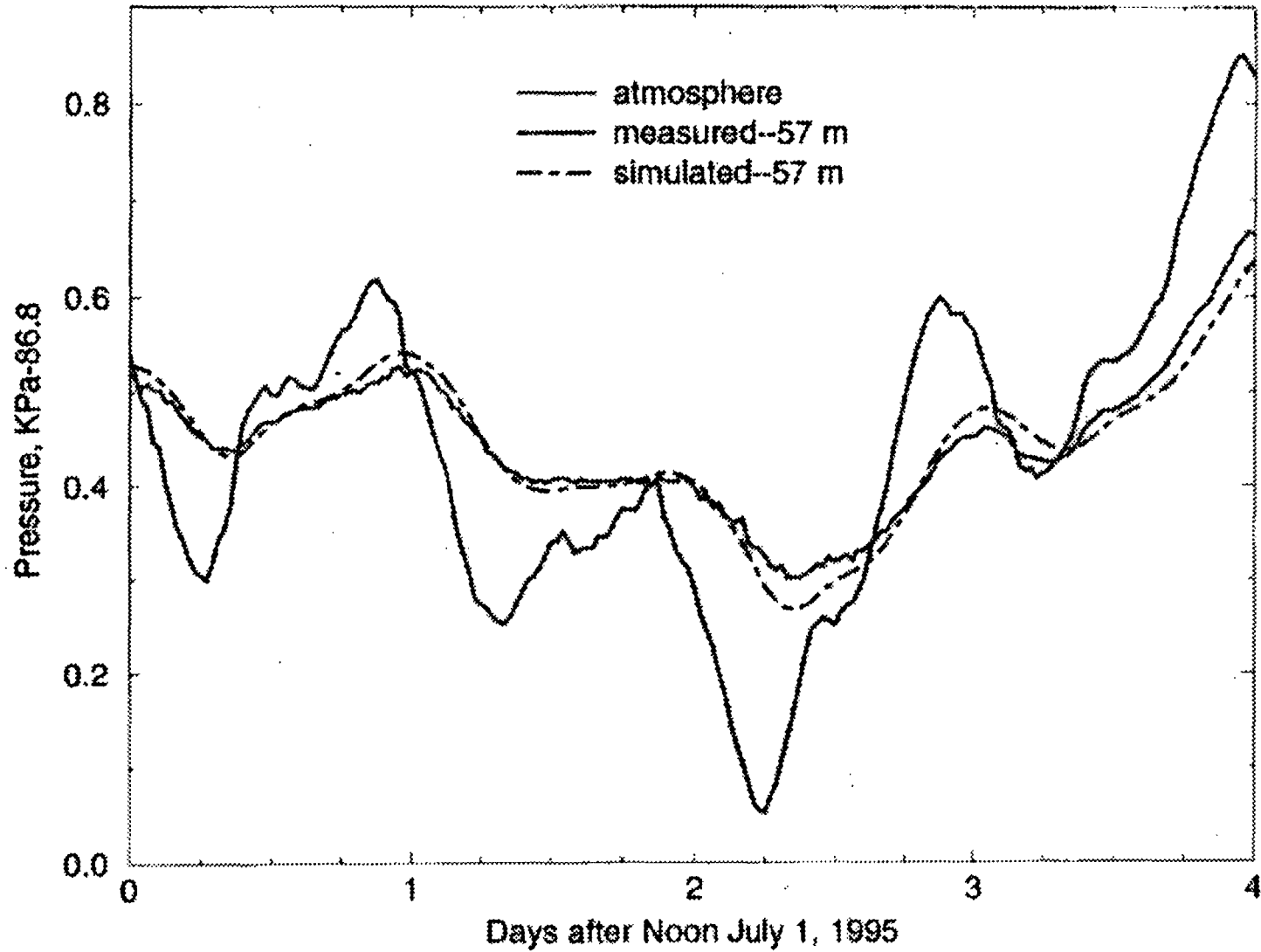
Pneumatic Testing/Monitoring

- DOE currently monitoring seven boreholes
- Nye County monitoring an additional two boreholes
- Response at depth to barometric pressure fluctuations recorded
- Pneumatic response to ESF penetrating PTn recorded
- Pressure response calculations made with UZ gas flow model



Simulation results, NRG5

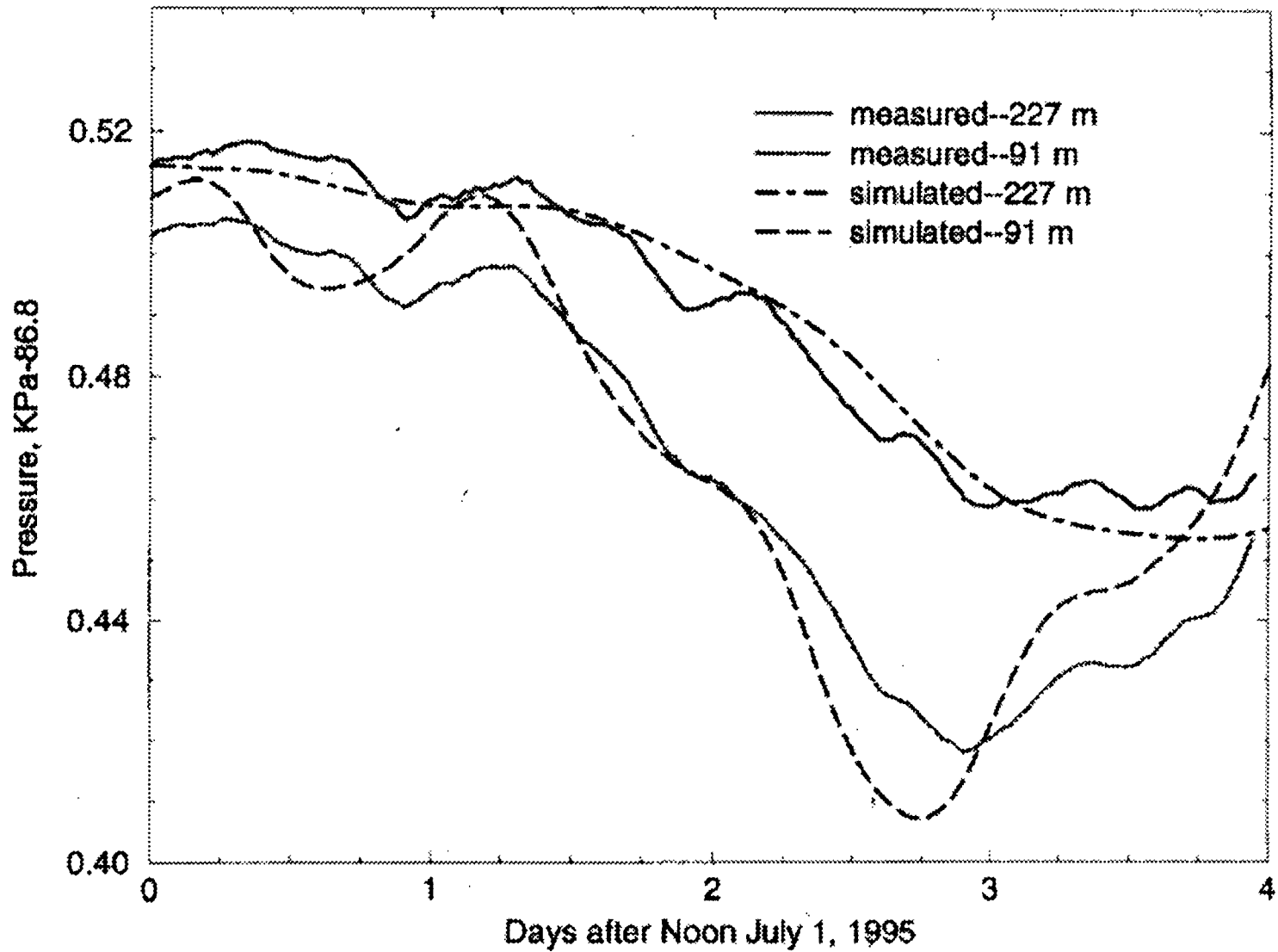
Eight days allowed for equilibration



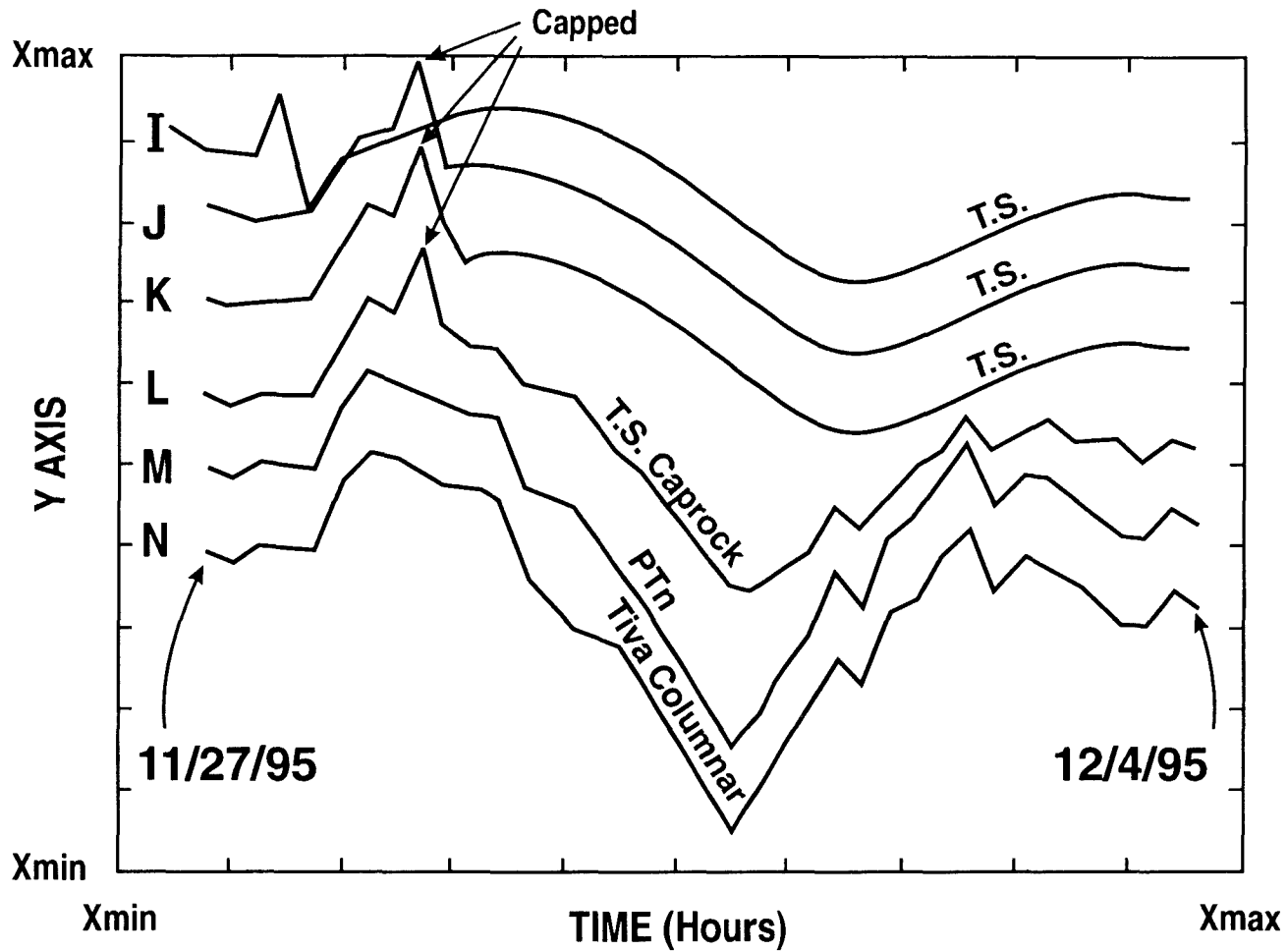
DRAFT

Simulation results, NRG5

Eight days allowed for equilibration



DRAFT



Preliminary

STA	UNIT	DEPTH	STA	UNIT	DEPTH
I	Upper Lith	560 ft	L	Crystal Rich Vitric Cap	302 ft
J	Upper Non Lith	422 ft	M	Crystal Poor Vitric - PTn	252 ft
K	Upper Non Lith	352 ft	N	Columnar - Tiva Canyon	215 ft

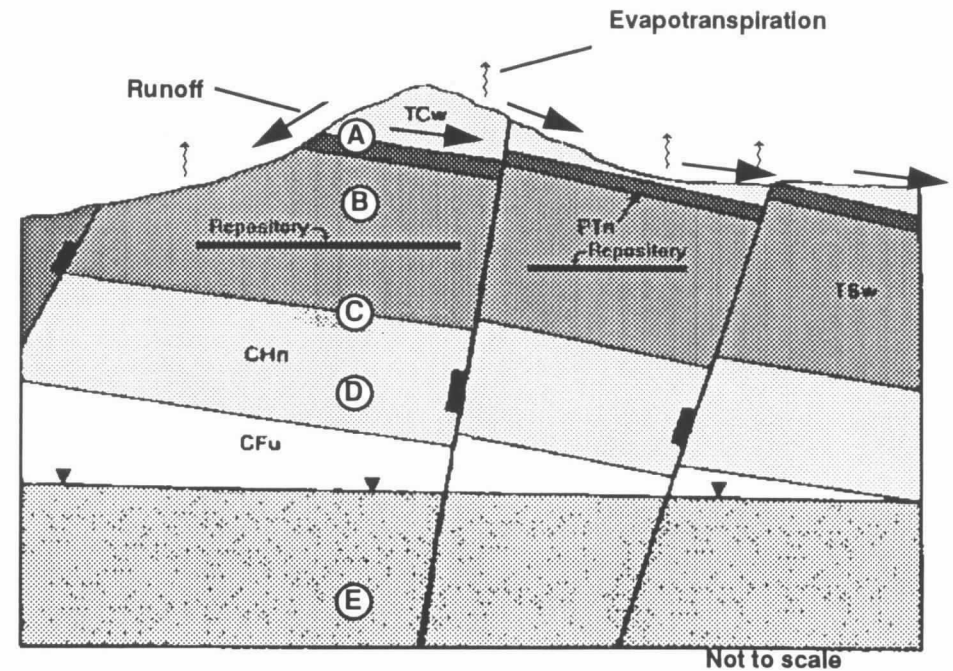
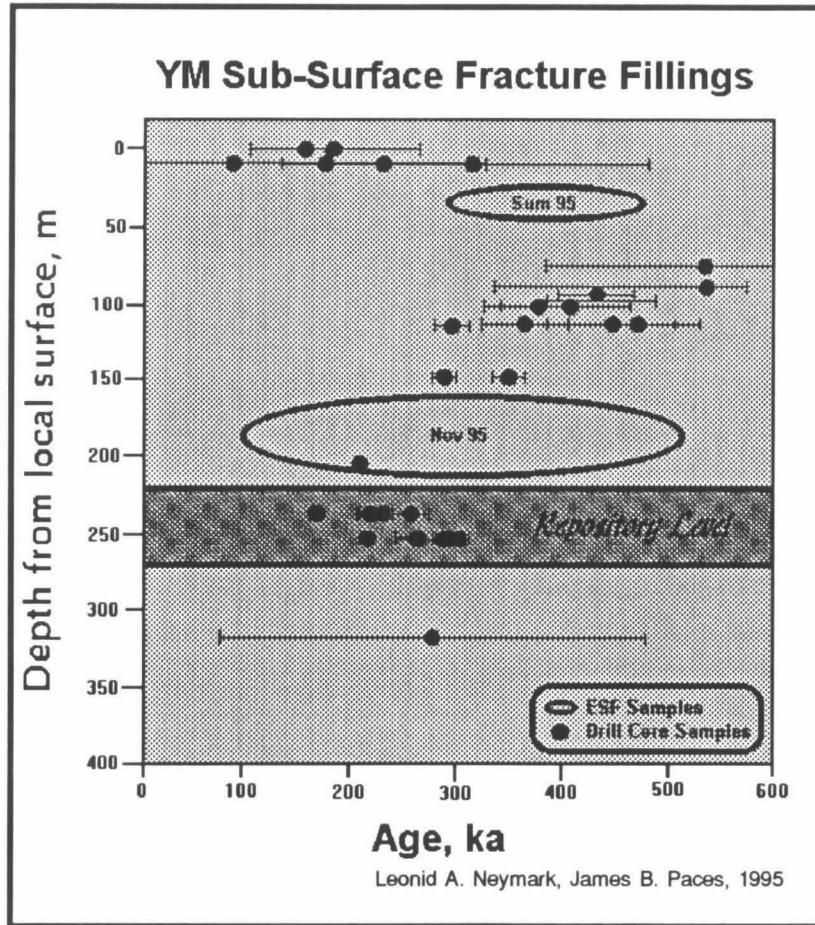
Hydrologic Observations in the ESF

- Predicted high saturations in the ESF observed (~ 0.90)
- Saturations in the TSw lower than overlying units (~0.60)
- No perched water encountered (initial 2 miles of excavation)
- No dripping fractures observed

Preliminary Conclusions: Water-Age Dating

- **“Paintbrush” impedes downward flow**
- **“Topopah Spring” water flow in rock matrix is very slow (~.01-.1 mm/yr calculated)**
- **Faults/fractures may act as zones that allow water to flow to lower portions within the geologic section**
- **Perched water may represent lateral flow component (W to E) near the Topopah Springs and Calico Hills contact**
- **Saturated zone water originates primarily from recharge areas north of the site**

Summary Age Dates



Repository

- ~ 200ka (^{36}Cl) "water"
- ~ 150 to 310ka (U-series) "fracture-fill"

Preliminary

What Have We Learned?

- **Ability to predict from surface-based tests**
 - stratigraphy
 - geologic contacts
 - rock quality
 - pneumatic response
- **Surface-based tests alone can not provide the entire geologic story**
- **Must also go underground to verify subsurface conditions (3-D)**
- **Both surface and subsurface geologic and hydrologic studies enhance understanding of the site**
- **Great news with respect to potential repository constructibility, available space, and the beginnings of an understanding of how the hydrology works in the unsaturated zone at the repository horizon**