

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

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

**SUBJECT: SCIENTIFIC INSIGHTS AND RESULTS
FROM ESF INVESTIGATIONS**

PRESENTER: WILLIAM BOYLE

**PRESENTER'S TITLE
AND ORGANIZATION: GEOENGINEERING TEAM LEADER, DOE**

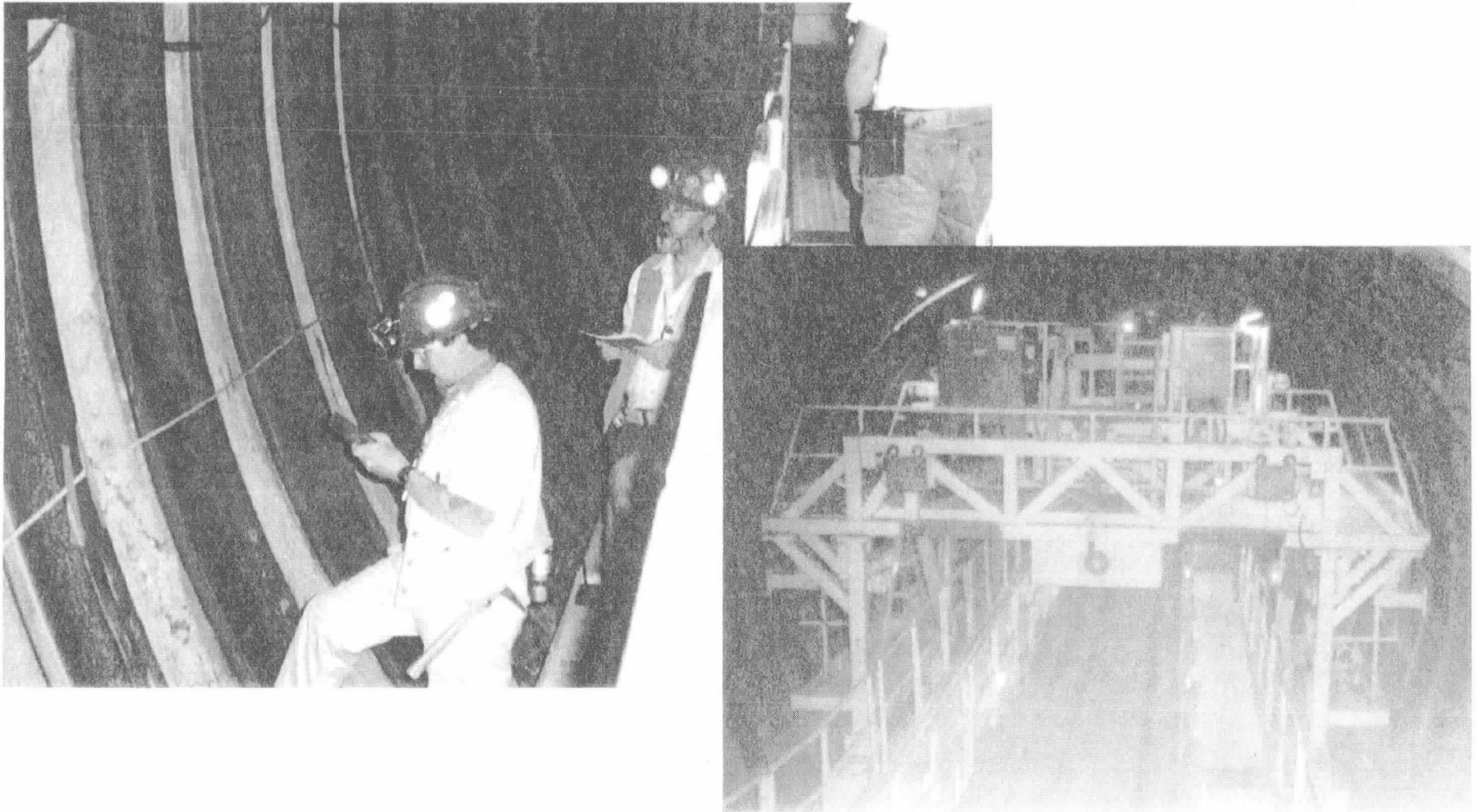
TELEPHONE NUMBER: (702) 794-7595

**ARLINGTON, VIRGINIA
OCTOBER 17-18, 1995**

ESF - Geological Mapping

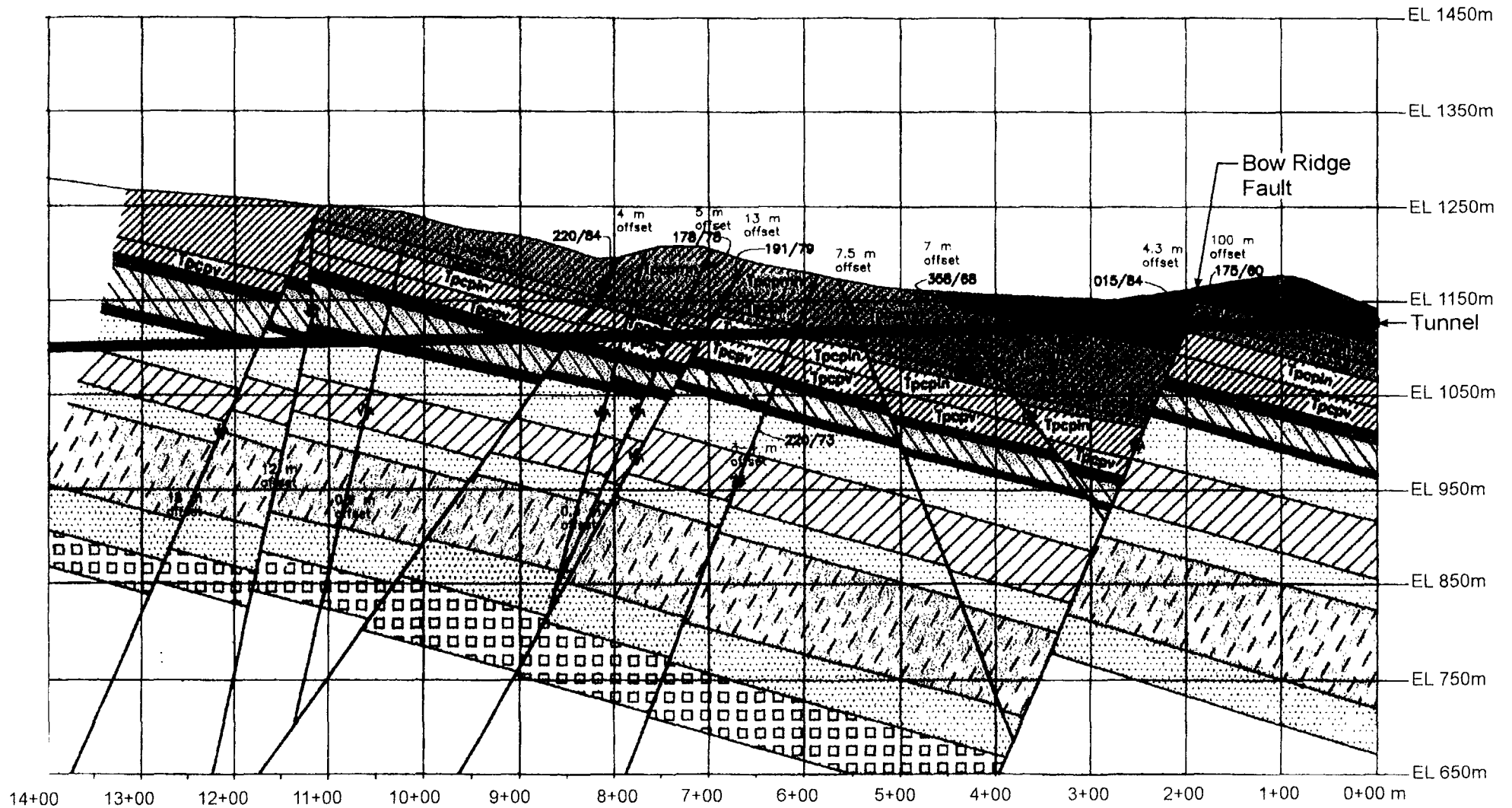
- **ESF - geological mapping data agree with surface based activities**
 - Mapping
 - Drilling
 - Geophysical investigations

GEOLOGIC MAPPING IN THE ESF

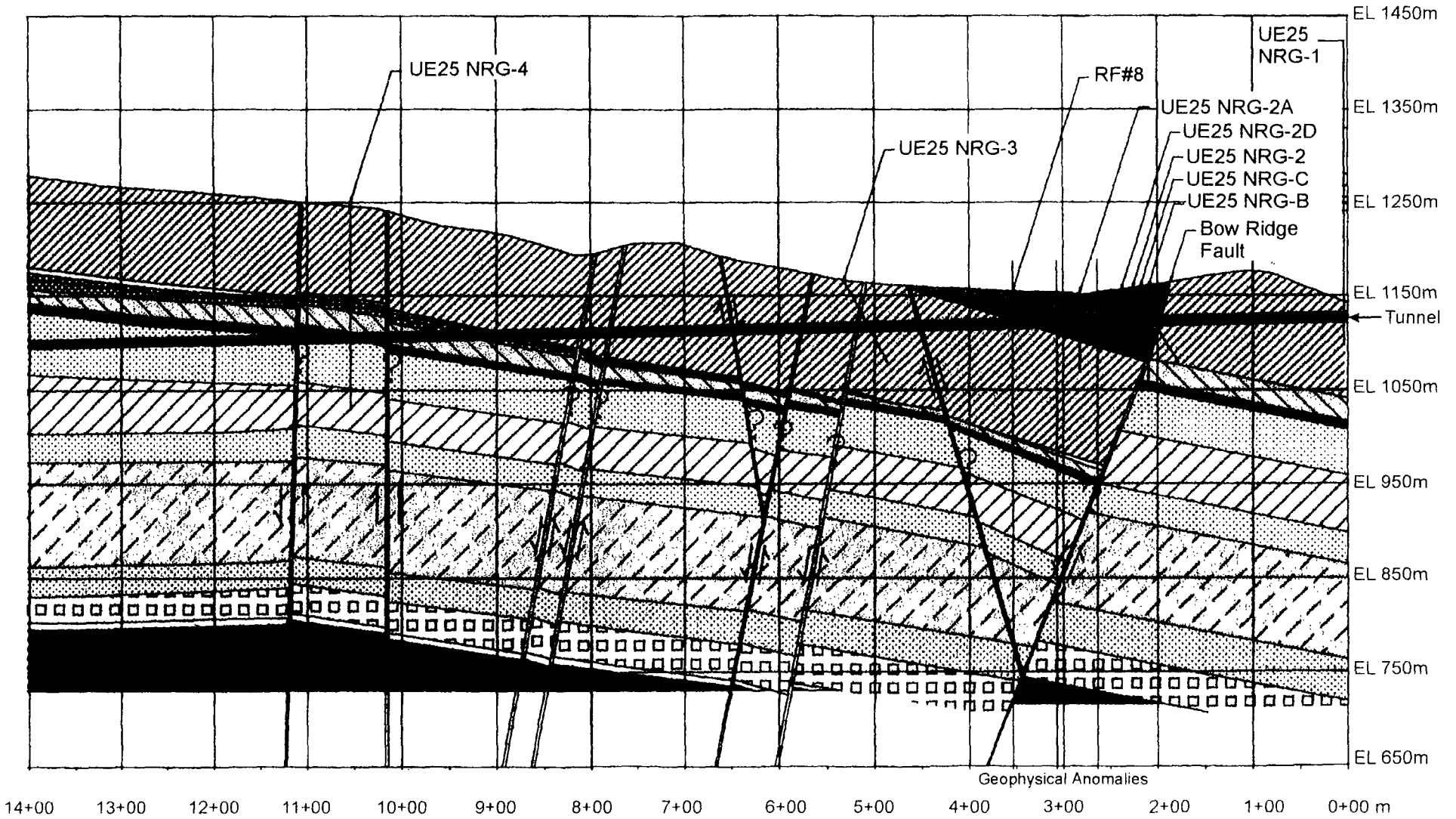


AS OF OCTOBER 11, 1995:	FULL PERIPHERY MAPPING COMPLETED TO	-	CS 21+00 m
	TUNNEL PHOTOGRAMMETRY COMPLETED TO	-	CS 21+00 m
	ROCK MASS QUALITY CLASSIFICATION COMPLETED TO	-	CS 20+76 m
	DETAILED LINE SURVEY COMPLETED TO	-	CS 20+84 m

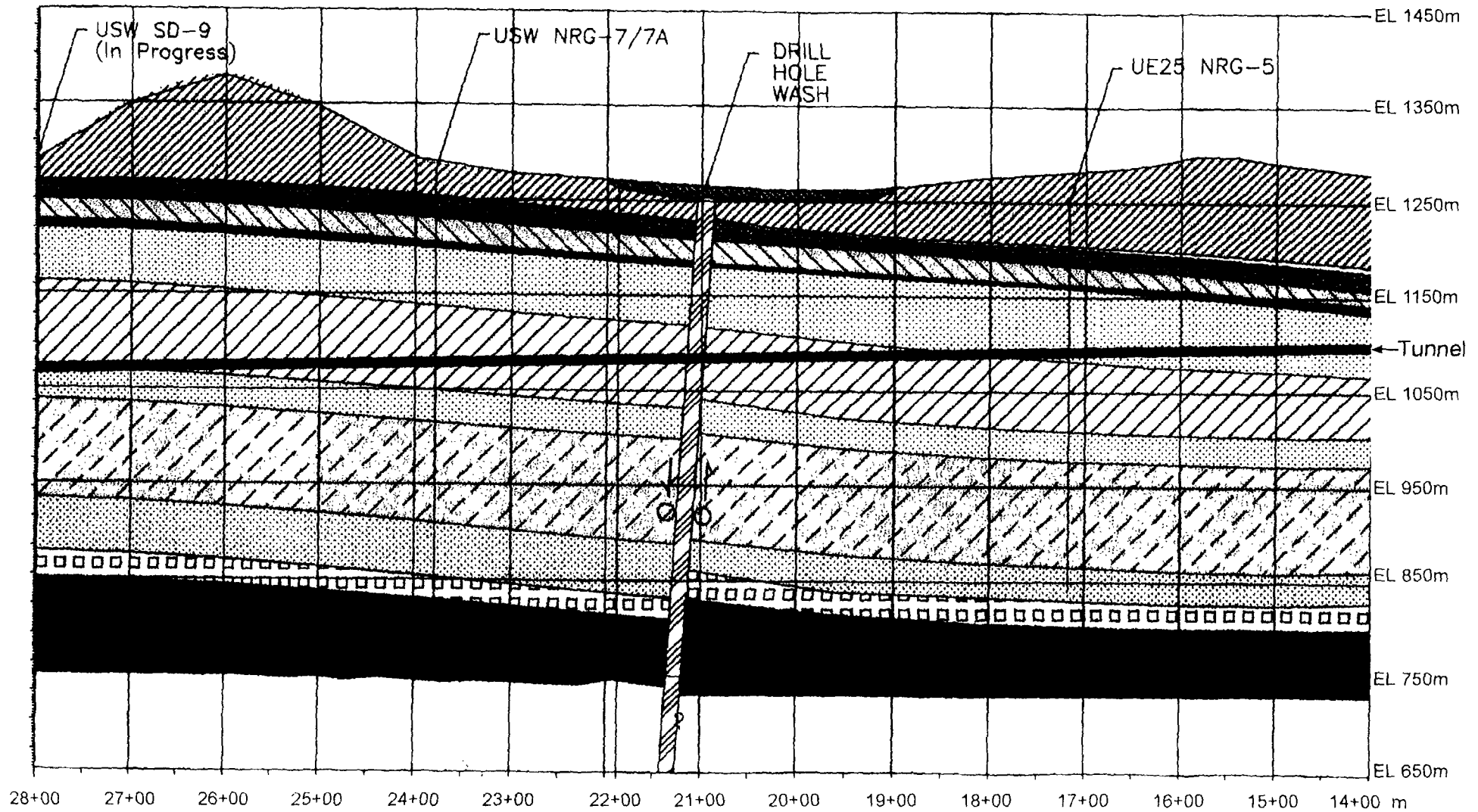
As-Built Section



Preconstruction Section



Preconstruction Section



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	TIVA CANYON	Tpc Tiva Canyon Tuff	TCw
		Tbbt4: pre-Tiva Canyon Tuff bedded tuff	
YUCCA MTN.	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	
		Tptpul: Upper Lithophysal crystal-rich and crystal-poor parts	
		Tptpmn: Middle Nonlithophysal crystal-poor	
TOPOPAH SPRING	TOPOPAH SPRING	Tptpll: Lower Lithophysal crystal-poor	TSw2
		Tptpln: Lower Nonlithophysal crystal-poor	TSw3
		Tptpv: Vitric vitrophyre and non welded subzones	
		Tpbt1: pre-Topopah Spring Tuff bedded tuff	
CALICO HILLS	CALICO HILLS	Tacf: Calico Hill lava flow	
		Tacb: Calico Hills bedded tuff	

STRATIGRAPHIC NOMENCLATURE DEVELOPED BY USGS



DRILL HOLE WASH FAULT ZONE
LOCATION AND ATTITUDE UNCERTAIN

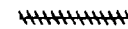
BOW RIDGE FAULT ZONE



MINOR FAULT, ? -ATTITUDE UNCERTAIN



PROPOSED NORTH RAMP ALIGNMENT



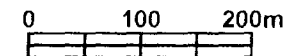
APPROXIMATE



STRIKE-SLIP SEPARATION INTO PAGE



STRIKE-SLIP SEPARATION OUT OF PAGE



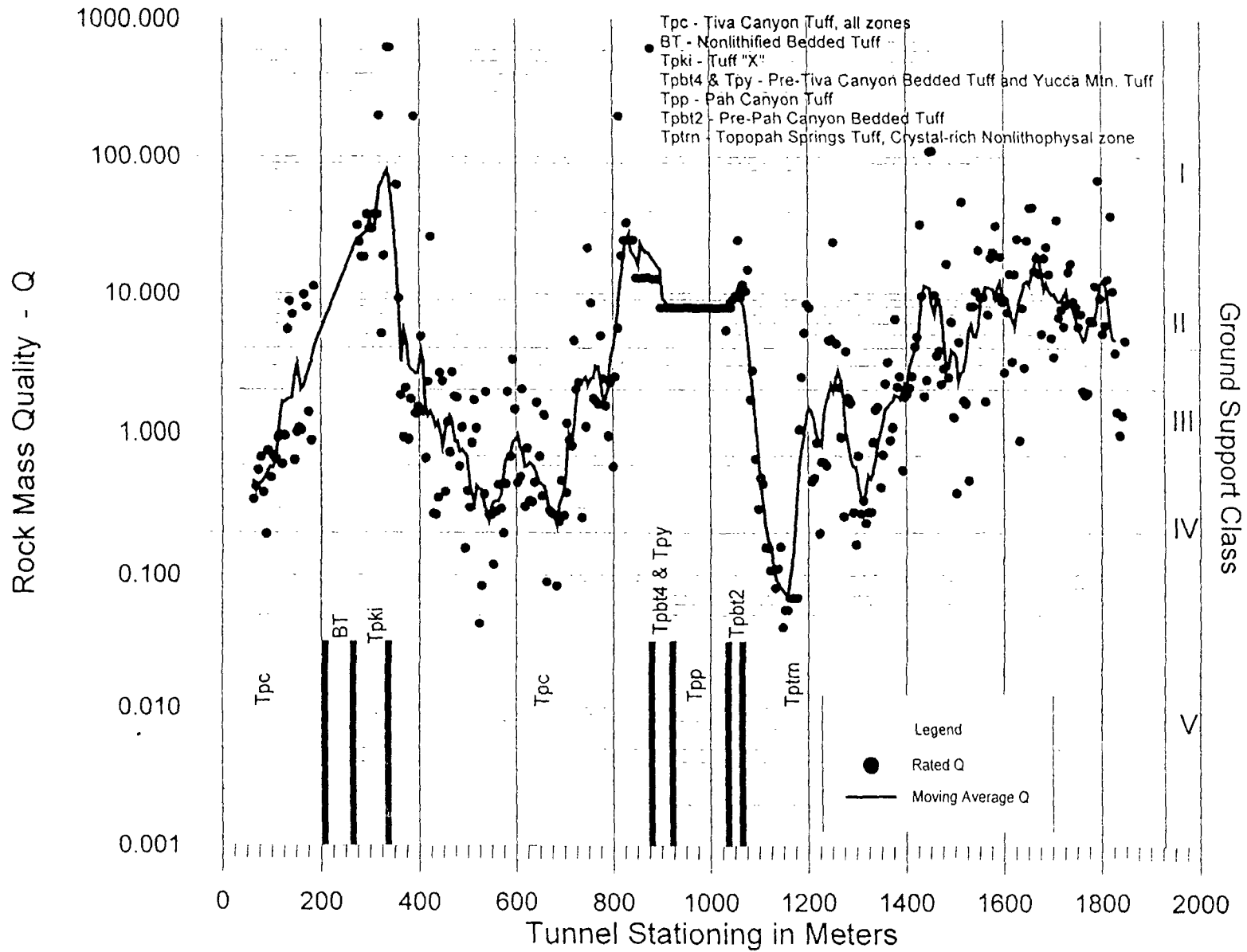
SCALE

Rock Mass Quality

- **TSw1 is measurably better than TCw**
 - **Less fracturing**
- **Reexamination of drilling records and lab tests**
 - **Increase in rock mass quality is reasonable**
 - » **Lower strength and Young's modulus**
 - **Decrease in rock mass quality possible in repository horizon**

North Ramp Rock Mass Quality (Q) versus Tunnel Station (m)

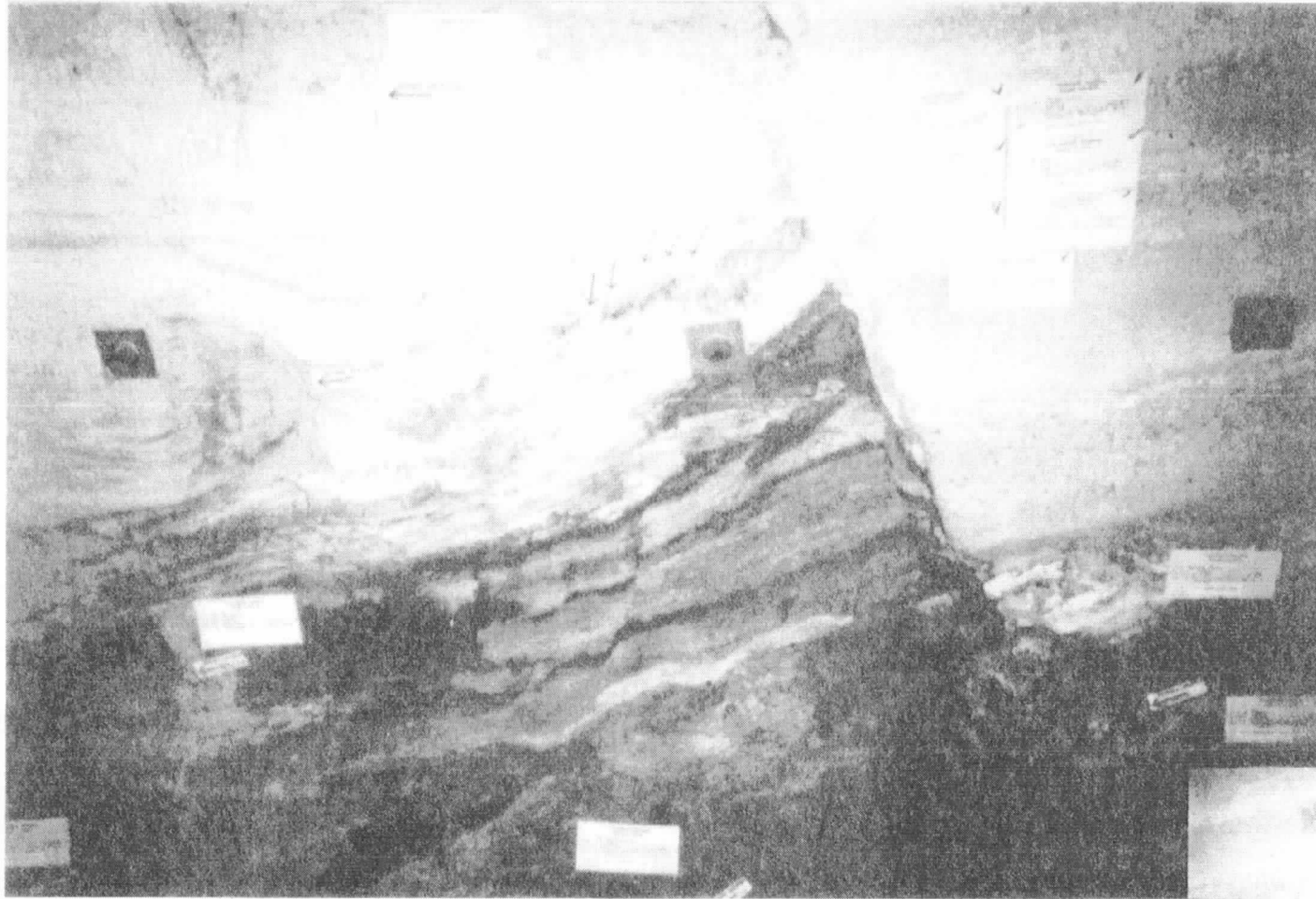
Preliminary - for information only



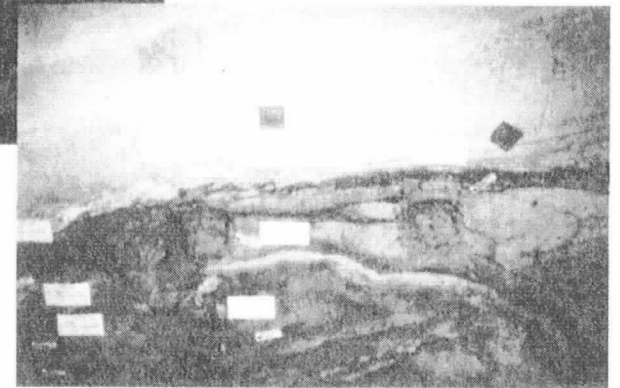
Fumarole

- **Awaiting further analyses**
 - Fumarole deposit?
 - Weathered paleosol?
 - Some evidence of elevated groundwater temperature
 - Some specimens elevated in Pb, Zn
 - » Far below any economic value
- **Located in the PTn**
 - Similar zones observed on west slope of Yucca Mountain

RECENT GEOLOGIC CONDITIONS IN THE ESF



FUMAROLE ENCOUNTER AT APPROX. 10+35 METERS



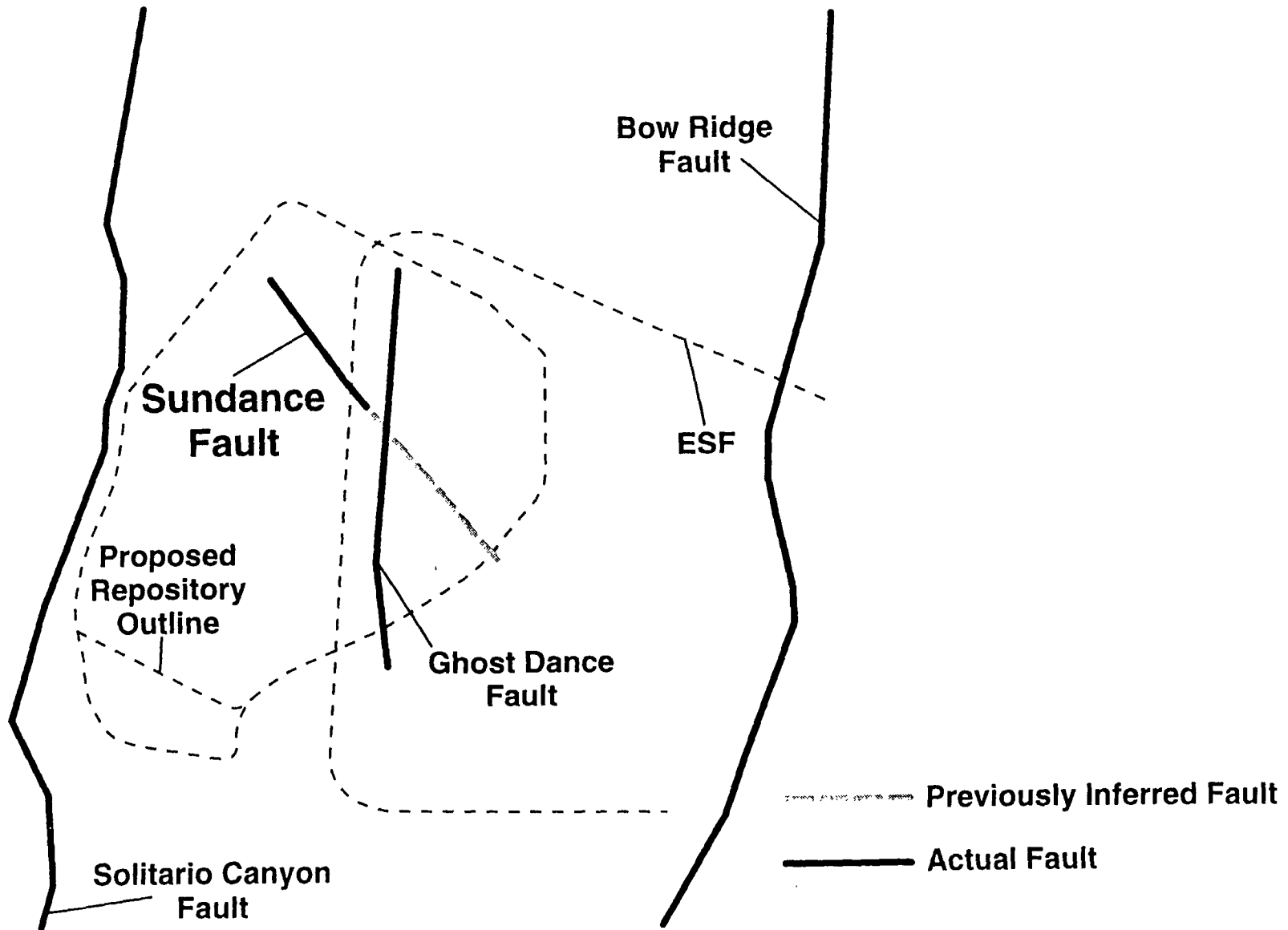
Hydrology

Pneumatic Monitoring

- **Preliminary results of pneumatic monitoring during TBM advancement**
 - **PTn retards gas flow but not a complete barrier to gas flow**
 - **TSw pneumatic lag-time may be reduced (TBM)**
 - **TCw and TSw data show fracture network is**
 - » **Highly interconnected**
 - » **Covers large areal extent**

Stratigraphic-Structural Studies

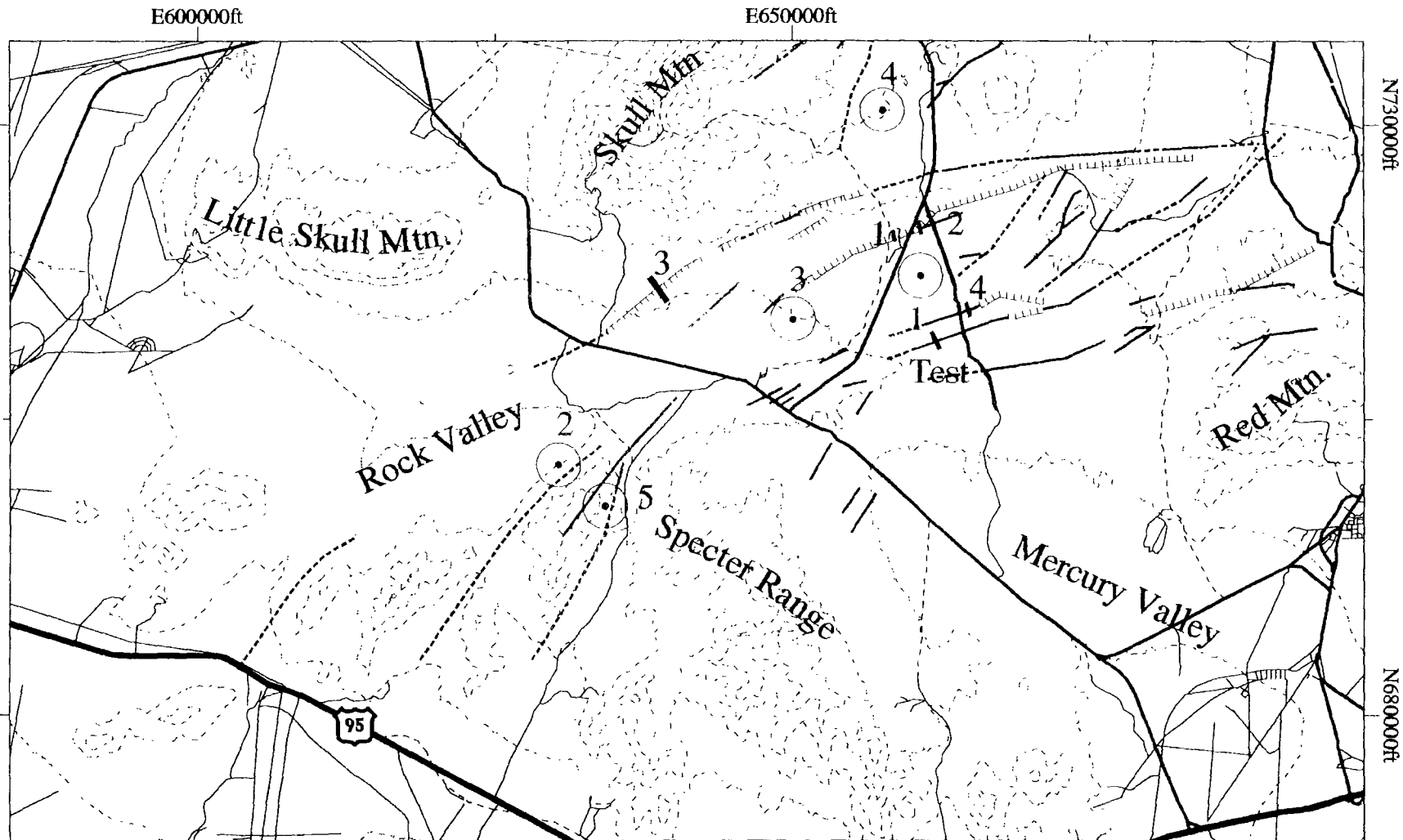
- **Sundance Fault Zone**
 - ~750 m length (20 Percent of prior estimate)
 - **Narrow and discontinuous**
 - **Maximum vertical offset (~12 m)**
 - **Does not extend or offset**
 - » **Solitario Canyon Fault**
 - » **Ghost Dance Fault at Antler Ridge**









Rock Valley Fault Zone

- **Results from trenching and earthquake records**
 - **Rock Valley Fault considered active**
 - **Significant potential for future earthquakes**
 - **Possible strong ground motion at Yucca Mountain**

Rock Valley Earthquakes (1993 - 1995)

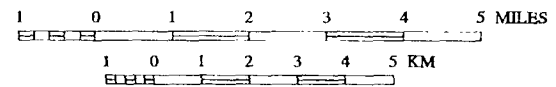


-  Fault Trench
-  Earthquake Epicenter
-  Fault
-  Fault Scarp
-  Inferred Fault
-  Rock Valley Seismic Reflection Line (1995)

ROCK VALLEY FAULT EPICENTERS

#	Date	Focal Depth	Local Magnitude
1	*5/16 - 6/5/93	<1.0km	3.1 - 4.2
2	3/24/94	1.2km	4.3
3	3/12/95	6.25km	2.8
4	3/22/95	5.5km	1.3
5	9/07/95	3.8km	3.5

*Cluster of Events



Contour Interval 100 Meters



YMP-95-600.1

Rock Valley Earthquake

- **September 7, 1995**
 - **20 Miles south of Yucca Mountain**
 - **Slight ground shaking at Field Operations Center**
 - **(5 Miles north of epicenter)**
 - **Magnitude 3.5**
 - **Focal depth ~4 Km**
 - » **Initially thought to be shallower**
 - **Strike-slip focal mechanism**
 - » **Consistent with fault zone strike**

CONSOLIDATED SAMPLING IN THE ESF



LIST OF STUDIES SUPPORTED BY CONSOLIDATED SAMPLING PROGRAM:

- LABORATORY DETERMINATION OF MECHANICAL PROPERTIES OF INTACT ROCK
- LABORATORY DETERMINATION OF THE MECHANICAL PROPERTIES OF FRACTURES
- IN-SITU DESIGN VERIFICATION
- CHARACTERIZATION OF THE EFFECT OF INTRODUCED MATERIALS ON CHEMICAL AND MINERALOGICAL CHANGES IN THE POST-EMPLACEMENT ENVIRONMENT
- WATER MOVEMENT TESTS, REV. 1
- CHARACTERIZATION OF THE PERCOLATION IN THE UNSATURATED ZONE - SURFACE-BASED STUDY
- CHARACTERIZATION OF THE PERCOLATION IN THE UNSATURATED ZONE - ESF INVESTIGATION
- MINERALOGY, PETROLOGY, AND CHEMISTRY TRANSPORT PATHWAYS
- HISTORY OF MINERALOGIC AND GEOCHEMICAL ALTERATION OF YM
- BIOLOGICAL SORPTION AND TRANSPORT
- CHARACTERIZATION OF STRUCTURAL FEATURES IN THE SITE AREA
- CHARACTERIZATION OF YUCCA MOUNTAIN QUATERNARY REGIONAL HYDROLOGY
- UNSATURATED ZONE HYDROCHEMISTRY
- LABORATORY THERMAL PROPERTIES

AS OF SEPTEMBER 22, 1995, 919 SAMPLES HAVE BEEN COLLECTED IN THE STARTER TUNNEL, ESF NORTH RAMP AND ALCOVES IN SUPPORT OF 14 STUDY PLANS.