NUCLEAR WASTE TECHNICAL REVIEW BOARD
HYDROLOGY AND GEOCHEMISTRY PANEL

SUBJECT: **PROGRESS IN SATURATED ZONE STUDIES**

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Previous Talks
(NWTRB FULL BOARD)

- Site Potentiometric Level Evaluation (June, 1991)
- Update on fluid in USW UZ-14 (October, 1993)
- USGS/LANL/LBL Saturated-Zone Hydrology Studies (April, 1994)

Outline

☞ Process Models Update

- Regional Framework
- Regional Numerical Model
- Site Framework
- Site Numerical Model

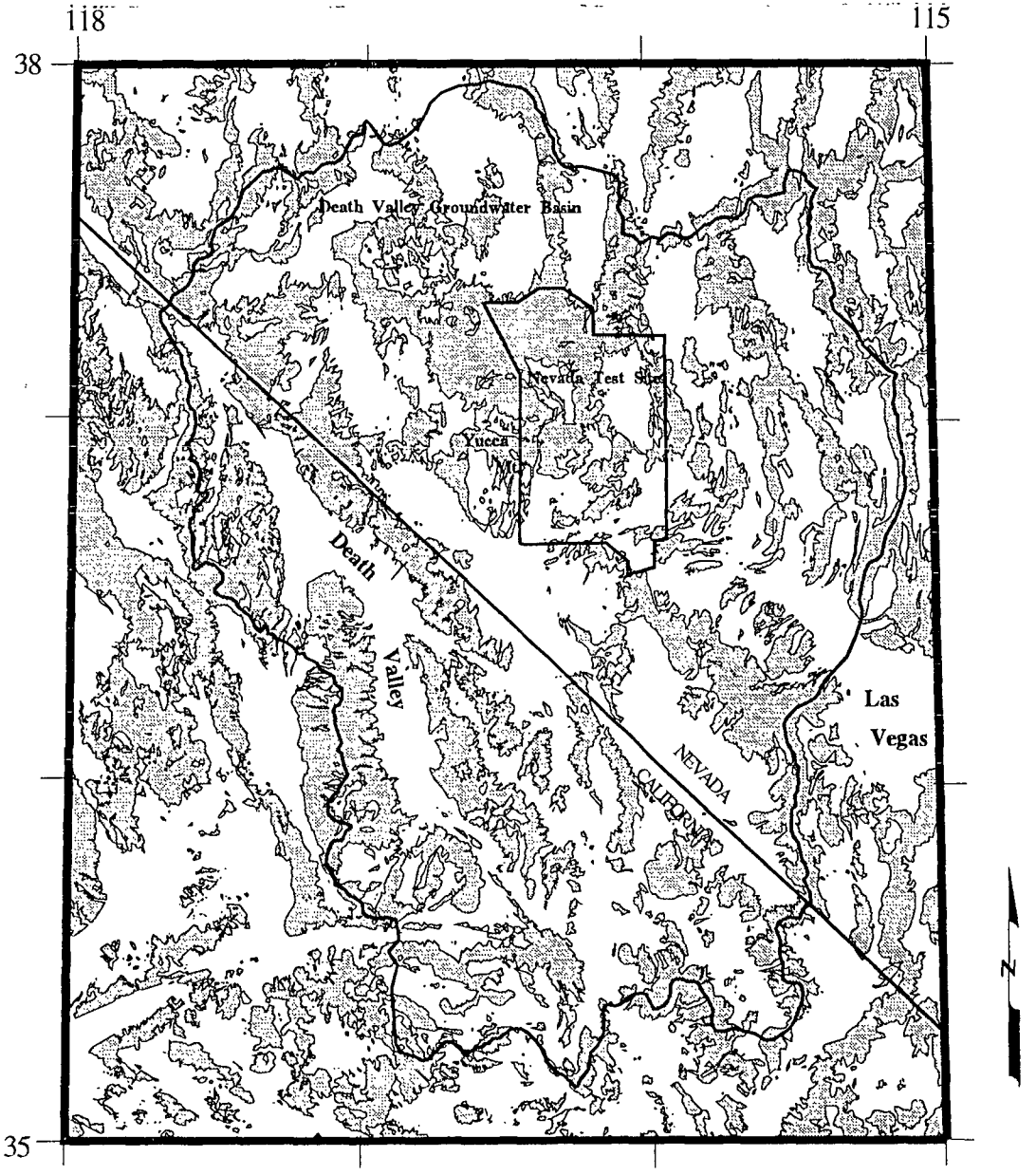
☞ Data Update

- Regional Hydrochemistry
- Potentiometric Surface
- New Water Level Data Points
- Large Hydraulic Gradient, Perched Water
- C-Well Complex Testing
- WT Wells Cleaning and Testing

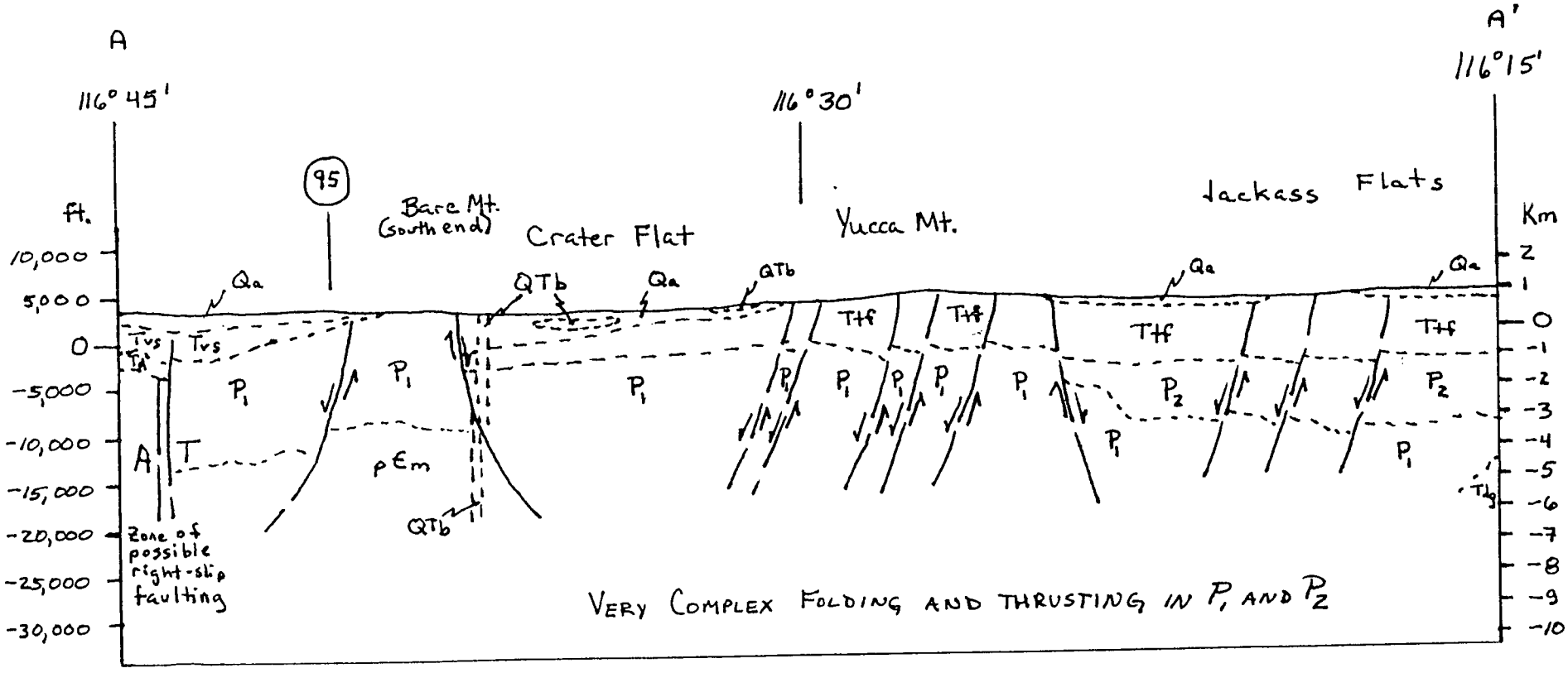
☞ Saturated Zone Studies and TSS

Regional Framework

(C. FAUNT)



Typical Regional Cross Section
(T.L.T. GROSS & G.I. SMITH, U.S.G.S. PP 1370-F)

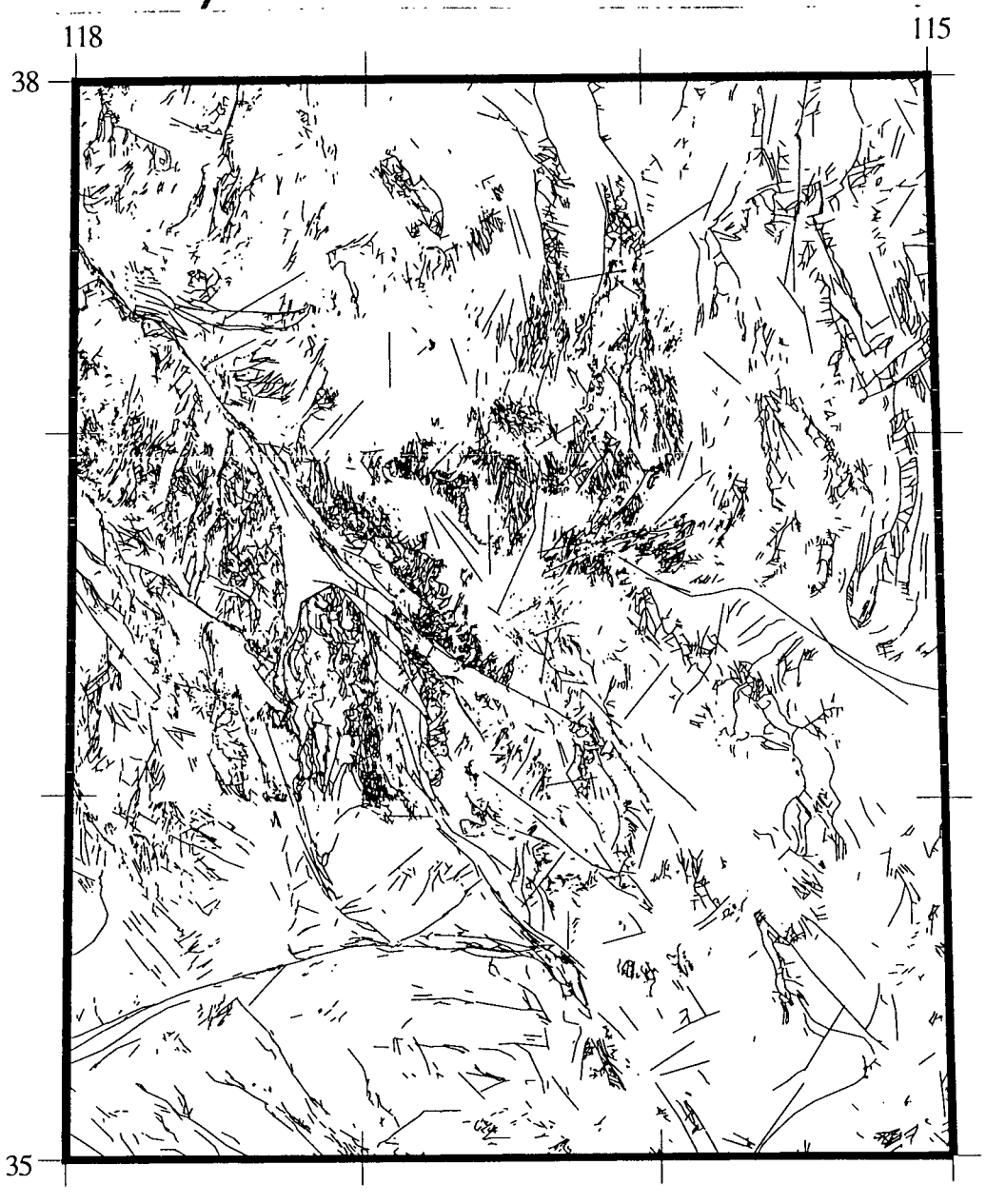


3-D Geoscientific Information System (GSIS)

- **Build Framework Independent of Numerical Model Grid**
- **Uses Arc-Info, Intergraph, CP-3, and Stratamodel**
- **Ten Units to 3,000 m Depth**
- **Complete Integration of Available, Quality-Assured 3-D Hydrogeologic Data**
  - Maps
  - Cross Sections
  - Point Data
  - Remotely-Sensed Data

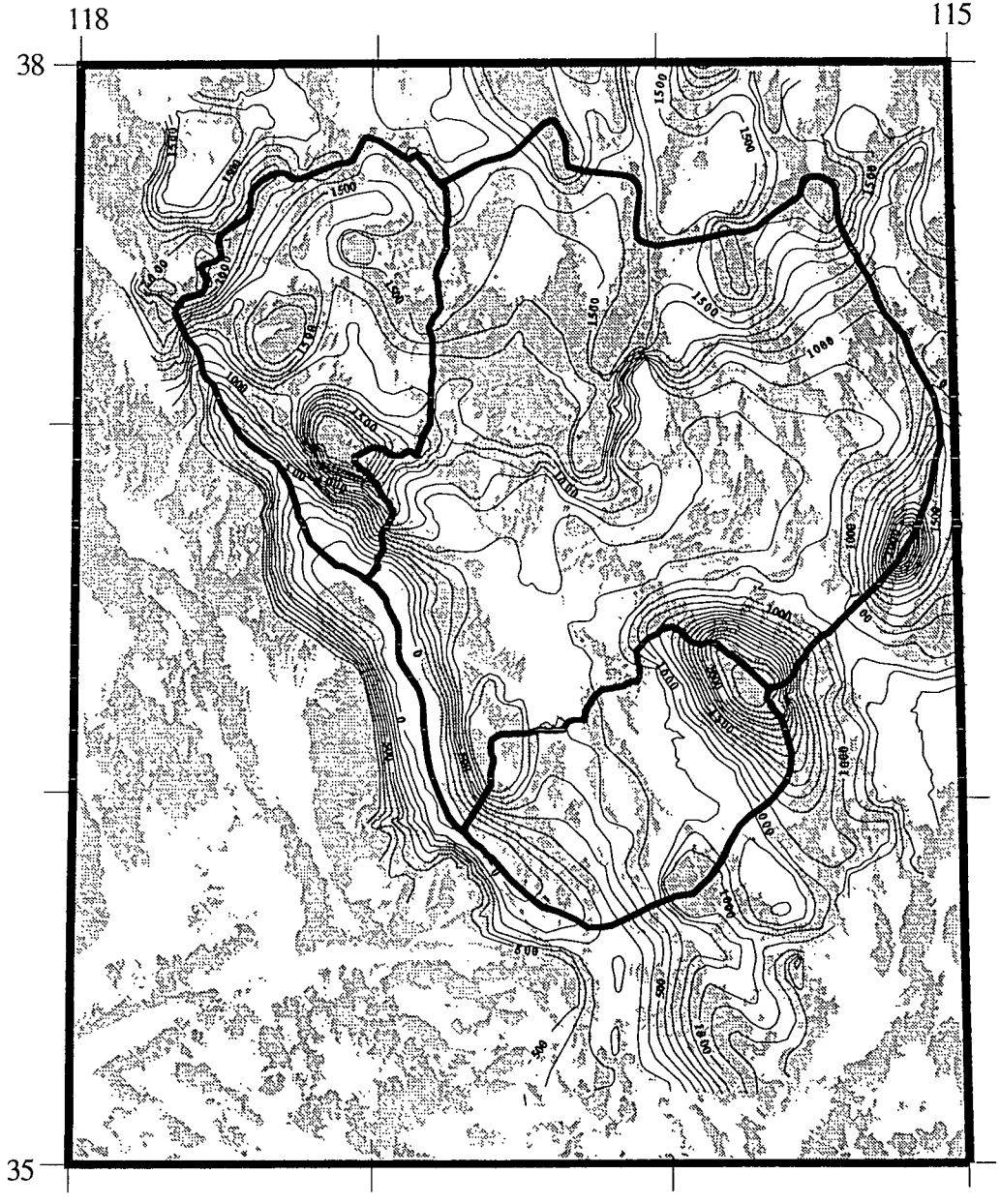
Regional Fault Map
(C. FAUNT)

- Nearly 40,000 Fault Traces
- Divided into Conduits, Barriers, and Neutral



Regional Potentiometric Surface

(F. D'AGNESE)



Regional Water Balance
(F. D'AGNESE)

- Recharge 107,000 AF/Yr
- Interbasin Inflow 127,000 to 180,000 AF/Yr

- Evapotranspiration 197,000 AF/Yr
- Spring Discharge 37,000 AF/Yr
- Pumpage 53,000 AF/Yr

- Change in Storage 0 to 53,000 AF/Yr

Regional Numerical Model
(F. D'AGNESE)

- **Based on MODFLOW Code**
- **Initial Grid**
  - 190 Rows (1,500 meters)
  - 150 Columns (1,500 meters)
  - 4 Layers (1,500 meters)
  - 75,000 Active Nodes
- **Revised Grid (in progress)**
  - 150 Rows (1,500 meters)
  - 150 Columns (1,5000 meters)
  - 3 Layers (750, 1000, & 1500 meters)
  - Simplified Boundary

Site Conceptual Model

- **Not Based on Definite Hydrologic Boundaries**
  - North beyond Large Hydraulic Gradient
  - West into Crater Flat
  - South into Amargosa Valley
  - East into Jackass Flats

- **Boundary Conditions from Regional Model**

- **Area much larger than site UZ and geologic model**

Site Hydrologic Units
(With Dominant Geologic Units)

- **Upper Volcanic Aquifer**
  - Densely Welded Part of Topopah Spring
- **Upper Confining Unit**
  - Basal Vitrophere of Topopah Spring
  - Calico Hills
  - Uppermost Prow Pass
- **Lower Volcanic Aquifer**
  - Crater Flat Tuff (Prow Pass, Bullfrog, Tram)
- **Lower Confining Unit**
  - Bedded Tuffs, Lavas, and Breccia
  - Lithic Ridge Tuff
  - Older Tuffs and Flows
- **Carbonate Aquifer**
  - Lone Mt. Dolomite
  - Roberts Mt. Dolomite

Large Hydraulic Gradient Hypotheses

- **"No Big Deal" Model**
  - Flow is in Calico Hills
  - Calico Hills is tight elsewhere on NTS
  - Tight ⇒ Large Hydraulic Gradient
- **Dike or "Tight Fault" Model**
- **Spillway Model**
  - Hydrothermal Alteration (?)
  - Eleana Formation (?)
- **Drain Model**
  - Buried Graben Under Northern YM
  - Northern Boundary Fault Drains Water to Carbonate Aquifer
  - Supported by Gravity and Aeromagnetic Data
  - Supports Low Heat Flow Beneath Yucca Mountain
- **Semi-Perched Model**
  - Trying to Contour Two Different Surfaces
  - Upper Volcanic Aquifer to North
  - Lower Volcanic Aquifer to South
  - Water Levels in Upper Confining Unit Difficult to Interpret

Site Numerical Model (Process Model)

- **FEHMN Code (Los Alamos)**
  - Finite Element, Heat and Mass Transfer
  - Porous Media, Dual Porosity, Dual Permeability
  - Arbitrary, Flexible Element Geometry
  - Initially will use as Porous Media without Heat
  - Same Code has been used by PA (G. Barr)

- **Site Grid currently being Designed**

- **Model will be Fully 3-D**

- **Model will handle Faults somewhat Realistically**

- **Model will include Carbonate Aquifer**

Site Concepts to be Tested

- **Importance of Faults ?**
  - Porous Media Only
  - Faults Carry All Flow

- **Steady-State Assumption ?**
  - No Modern Recharge
  - Episodic (Rare) Recharge
  - Modern Recharge

- **Focused Recharge in Major Washes ?**
  - Fortymile Wash
  - Yucca Wash
  - Windy Wash

- **Hypotheses about Large Hydraulic Gradient ?**

- **Sensitivity to Climatic Changes ?**

Data for Models
(MODEL FODDER)

- Regional Hydrochemistry
- Updated Potentiometric Surface (SHG)
- New Water Level Data Points
- LHG and Perched Water
- G-2 Borehole Testing
- C-Well Testing; Raymond Prototype Site
- WT-Series Borehole Cleaning, Testing, and Sampling

Regional Hydrochemistry

(D. PERFECT; C. FAUNT)

- **Hydrochemistry Data Base for the Death Valley Region; U.S. Geological Survey Open-File Report 94-305**

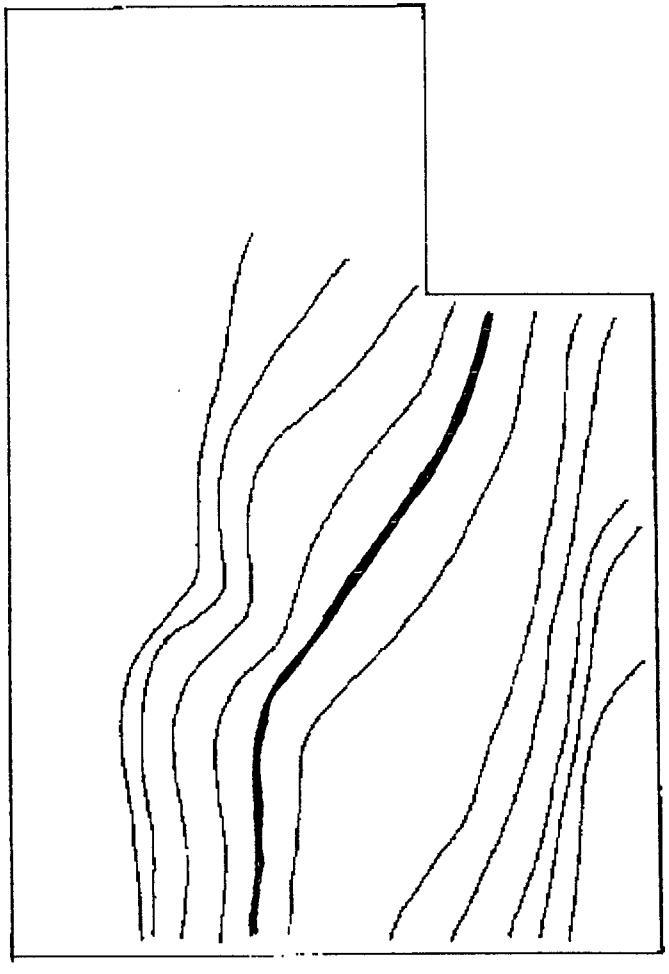
- **Lotus 1-2-3 Data Bases**
  - 62 Columns; 39 Constituents
  - 4,738 Analyses in First Data Base (Full Set)
  - 3,733 Analyses in Second Data Base (Balance Chemically)

- **USGS Director's Approval 5/19/94**
  - DOE Concurrence 6/9/94
  - Camera-Ready Completed 7/20/94
  - Expected Distribution (without diskettes) soon

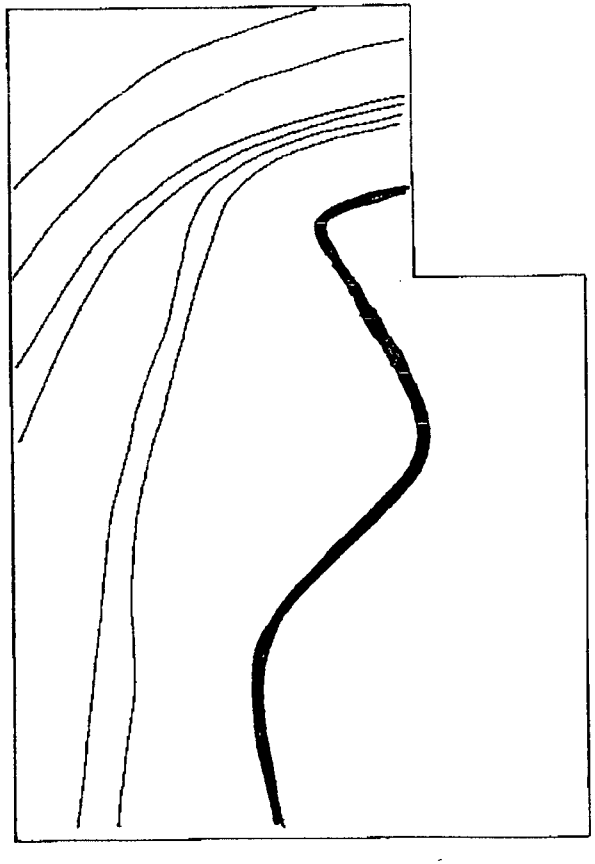
Updated Potentiometric Surface

☞ USGS WRIR 93-4000: Revised Potentiometric-Surface Map, Yucca Mountain ...

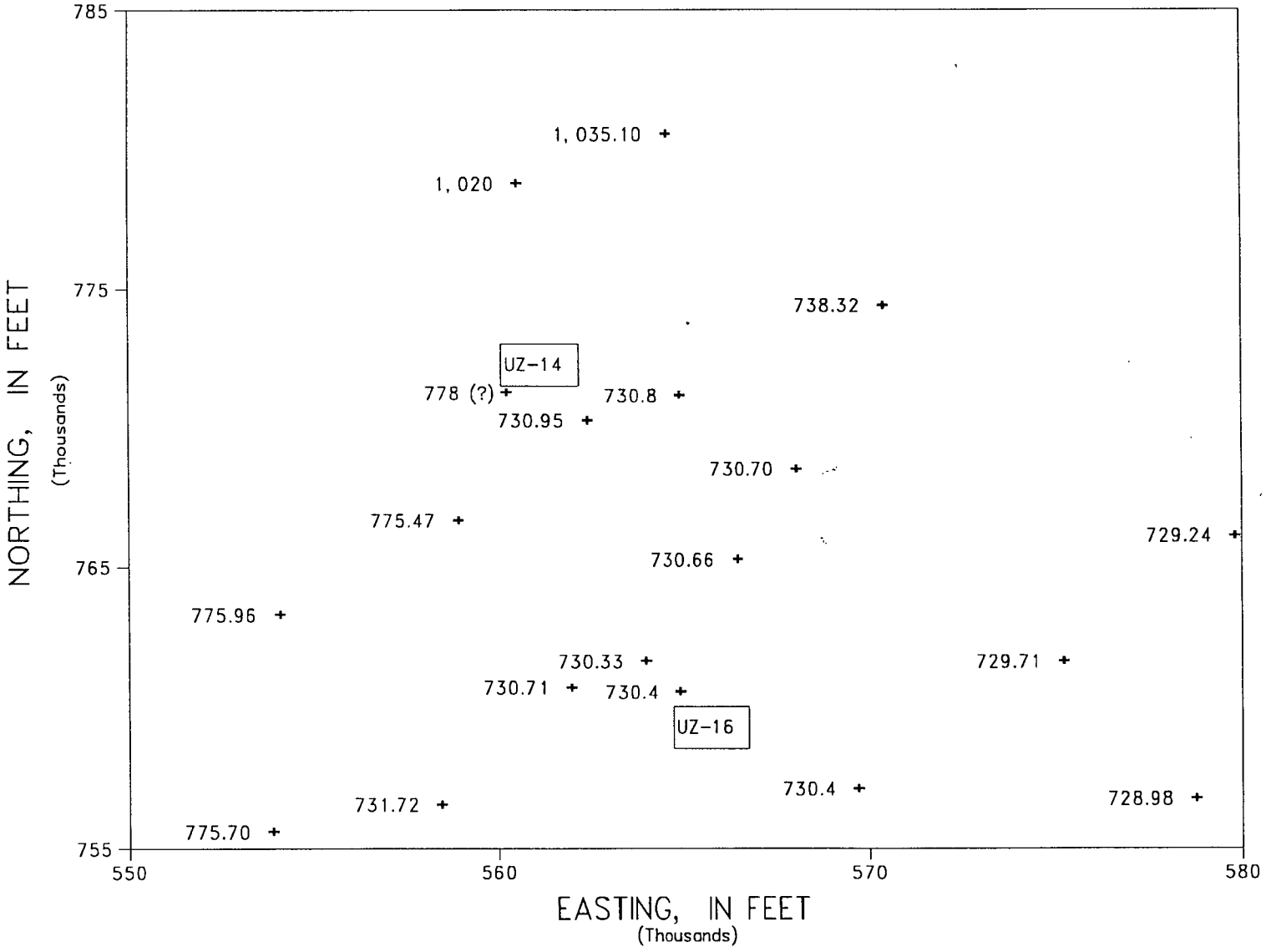
1994



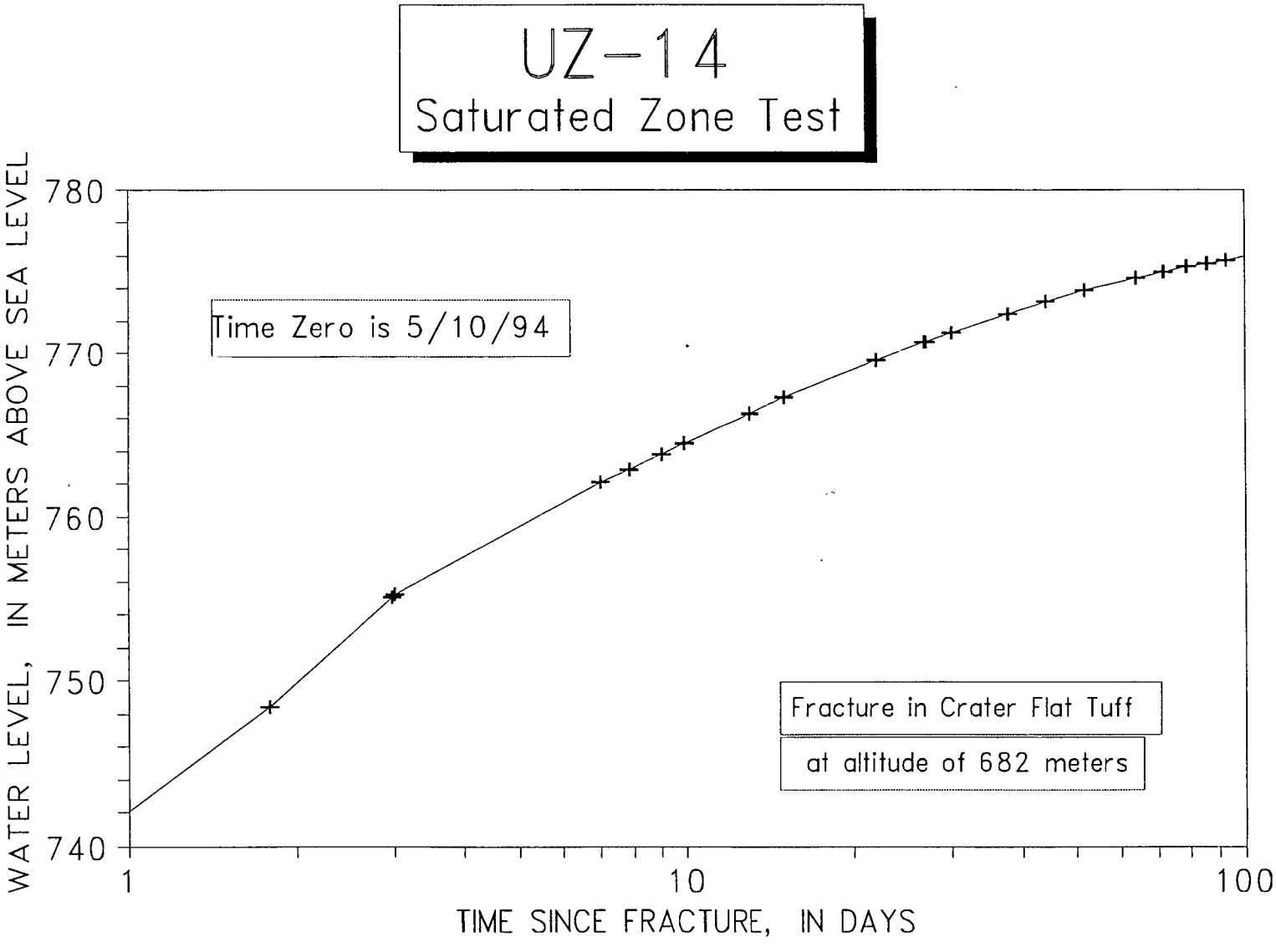
1984



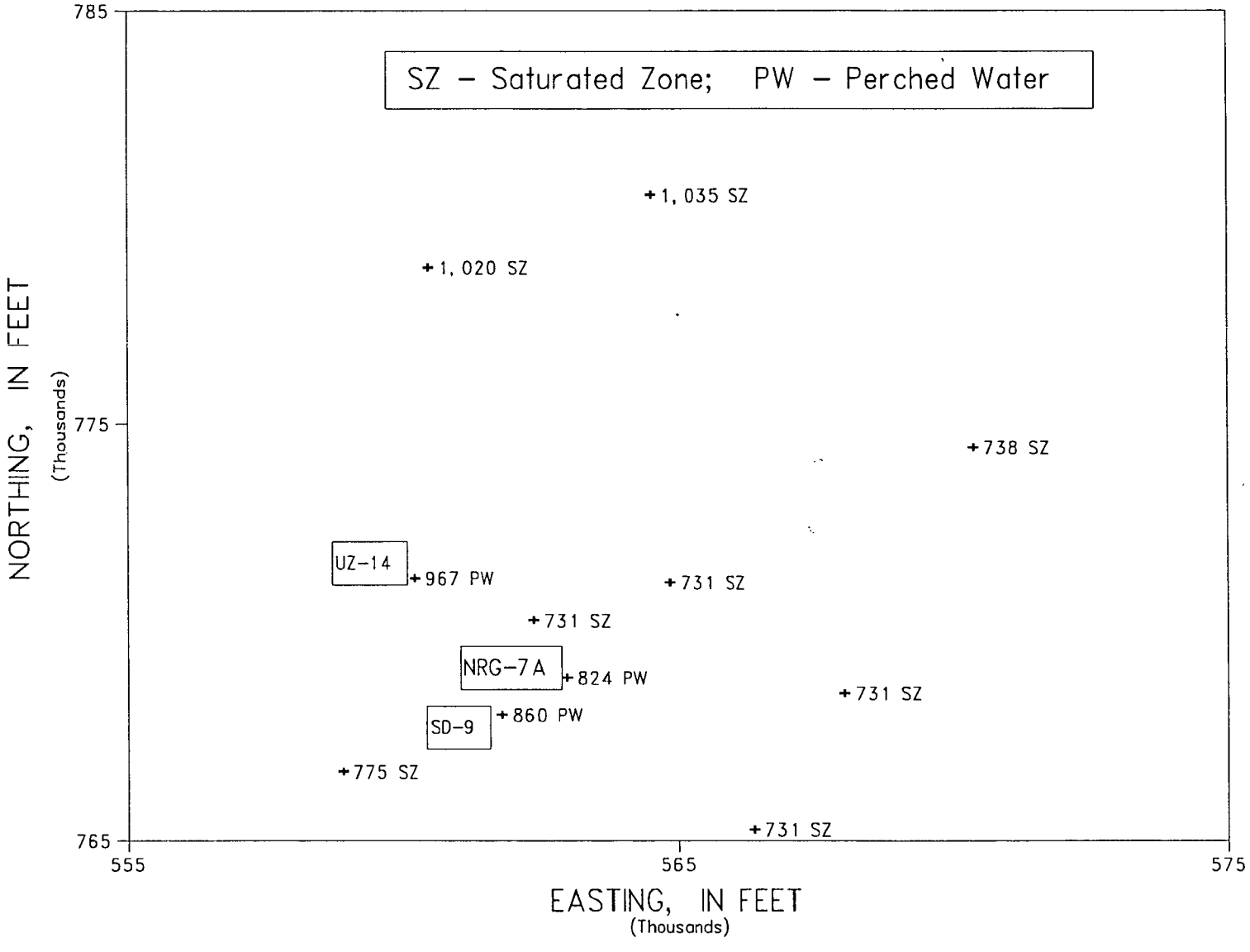
New Water Level Data Points



New Water Level Data Points



LHG and Perched Water



Plans and Large Hydraulic Gradient

☞ G-2 Testing

- Flow Surveys; Temperature, TV & Nuclear Logs
- Determine Hydraulic Properties
- Obtain Hydrochemical Samples
- December 1994 (6/2/94 Drilling Schedule)

☞ WT-23 Borehole

- About 1/3 Up the Large Hydraulic Gradient
- TD is 150 ft below base of Calico Hills (Borehole Catalog 9/93)
- Scheduled to Reach TD Sept. 1995 (6/2/94 Drilling Schedule)

☞ WT-24 Borehole

- About 2/3 Up the Large Hydraulic Gradient
- TD is 150 ft below base of Calico Hills (Borehole Catalog 9/93)
- Scheduled to Reach TD late FY-1996

C-Well Testing; Raymond Prototype Site

☞ Raymond California Prototype Site

- Prototype Equipmenet
- Perfect Methodology

☞ C-Well Phase-I (1/94 to 7/94: Prolonged to 1/95?)

- Packer string equipment shakedown
- Develop PC-based data aquisition system
- Collect shut-in pressures from various zones

☞ C-Well Phase-II (Delayed from 7/94 to 1/95?)

- Reinstrument wells with ParoScientific transducers
- Place pump and shroud in UE-25c #3 (or another well)
- Conduct cross-hole tests: Hydraulic properties
- Follow with (or possibly concurrent) tracer tests: Transport properties

WT-Series Cleaning, Testing, & Sampling

☞ Develop Existing WT Holes

- Drilled with air-foam in early to mid 1980's
- Never developed or cleaned

☞ Prepatory for Hydrochemical Characterization

- Hydrochemical samples will be collected and analyzed
- Samples will not fulfill Study Plan concept of hydrochemical characterization

☞ Will Give Qualitative Information on Hydraulic Properties

- Monitor discharge
- Measure drawdown
- Compute specific capacity

☞ Planned for FY-1995 and FY-1996

- Originally planed six for FY-1995 and eight for FY-1996
- Budget constraints may limit FY-1995 to three

What Saturated Zone Studies *CAN* take to TSS (end of FY 1997)

- Completed Regional Framework and Numerical Model
- Site Framework and Numerical Model to Extent of Data Set
- Improved Characterization of LHG
- Flow and Transport Properties at c-Well Complex
- Qualitative Areal Understanding of Hydraulic Properties

What Saturated Zone Studies *CANNOT* take to TSS

- Good Understanding of Role of Faults
- Full Understanding of Fracture/Matrix Flow at Site
- Full Characterization of LHG
- Transport Properties Throughout the Site
- Good Understanding of Carbonate Aquifer