# Nuclear Waste Technical Review Board
# May 15, 2007: Arlington, VA

# Radionuclide Transport from Yucca Mountain and Inter-basin Flow in Death Valley

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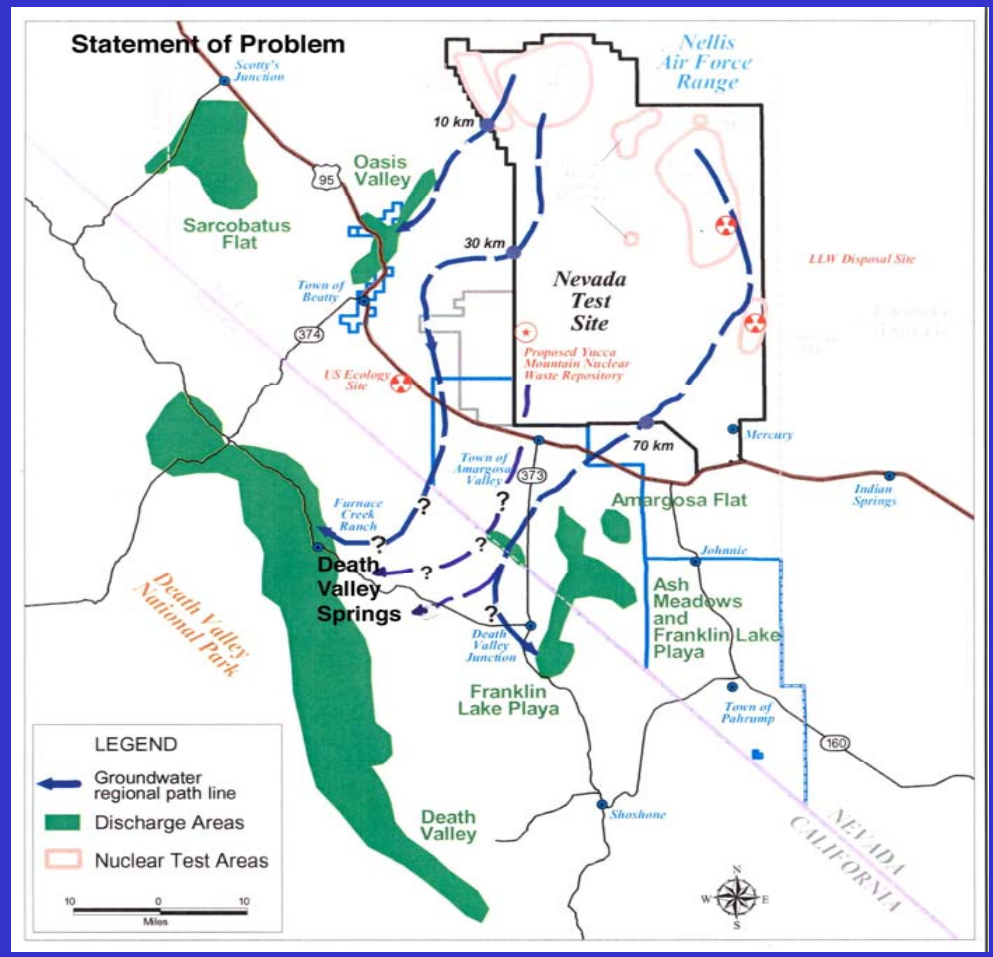
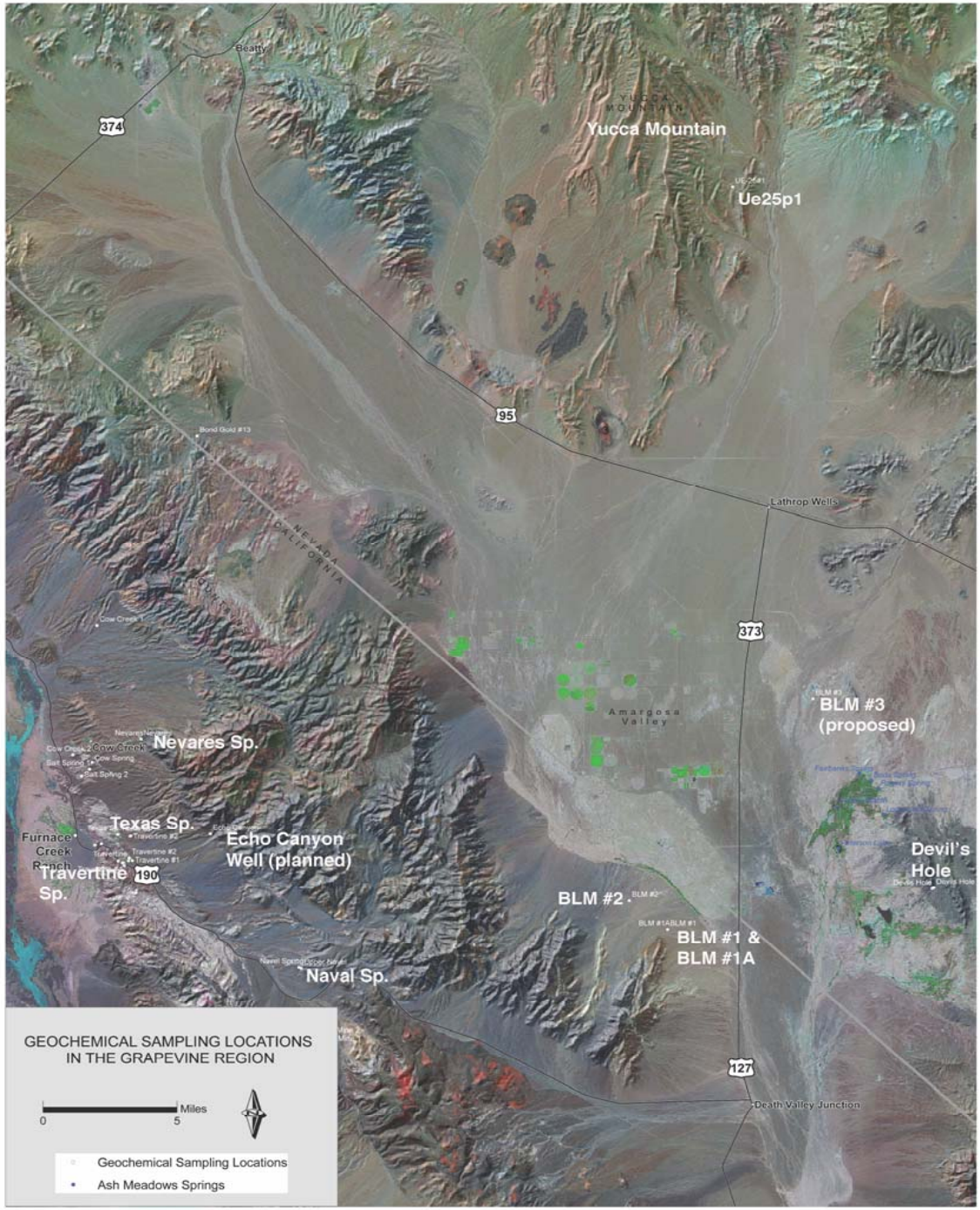
*Studies in Mass & Energy Transport in the Earth*

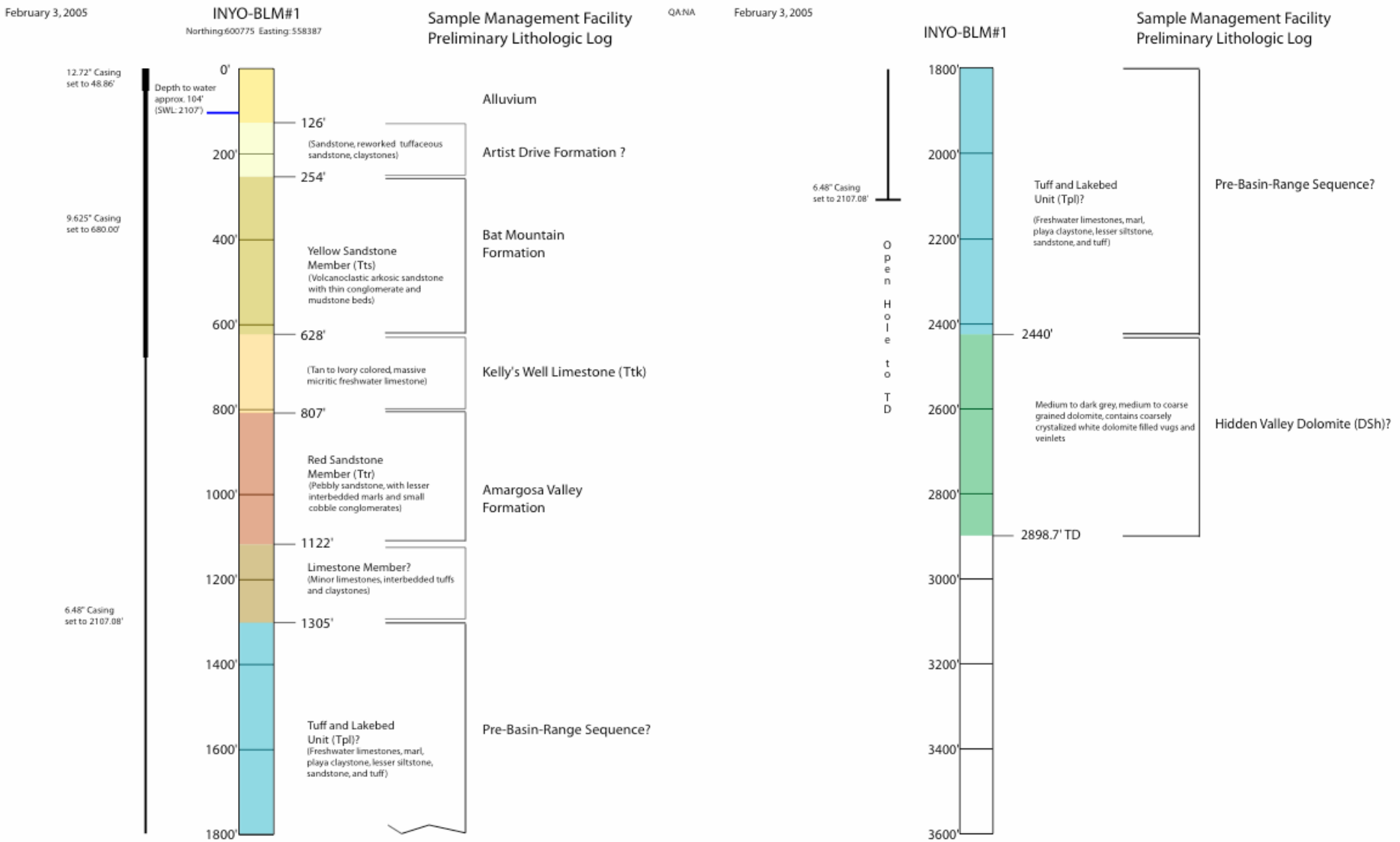
# Inyo County Concerns

Radioactive nuclide transport into the Death Valley region of Inyo County.

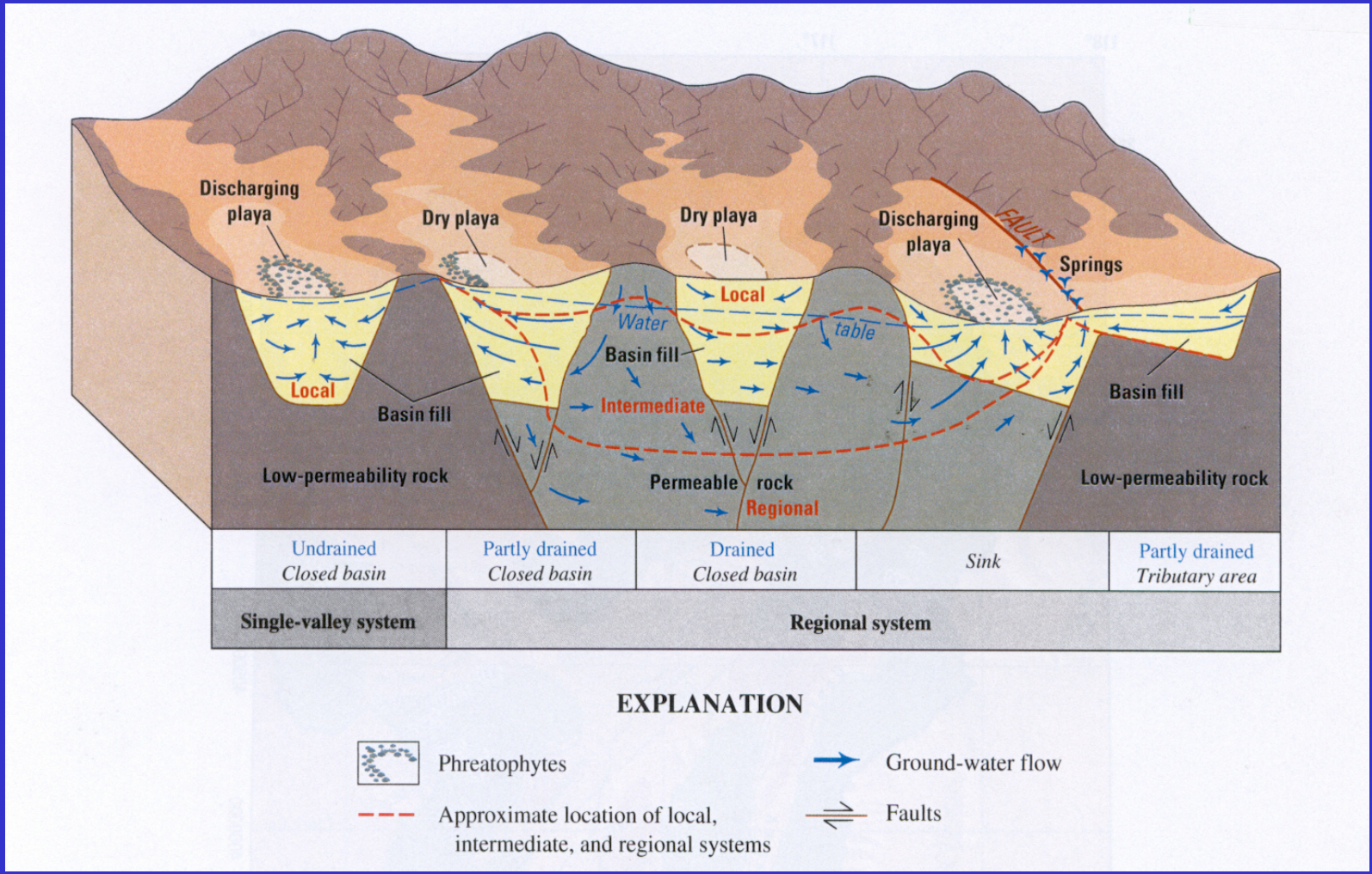



Beatty
374
Yucca Mountain
Ue25p1
95
Lathrop Wells
NEVADA
CALIFORNIA
373
Amargosa Valley
BLM #3 (proposed)
Nevares Sp.
Cow Creek
Texas Sp.
Furnace Creek Ranch
Travertine Sp.
190
Echo Canyon Well (planned)
Devil's Hole
BLM #2
BLM #1 & BLM #1A
Naval Sp.
127
Death Valley Junction
GEOCHEMICAL SAMPLING LOCATIONS IN THE GRAPEVINE REGION
Miles
0
5
Geochemical Sampling Locations
Ash Meadows Springs

# Inyo BLM #1 Well Log

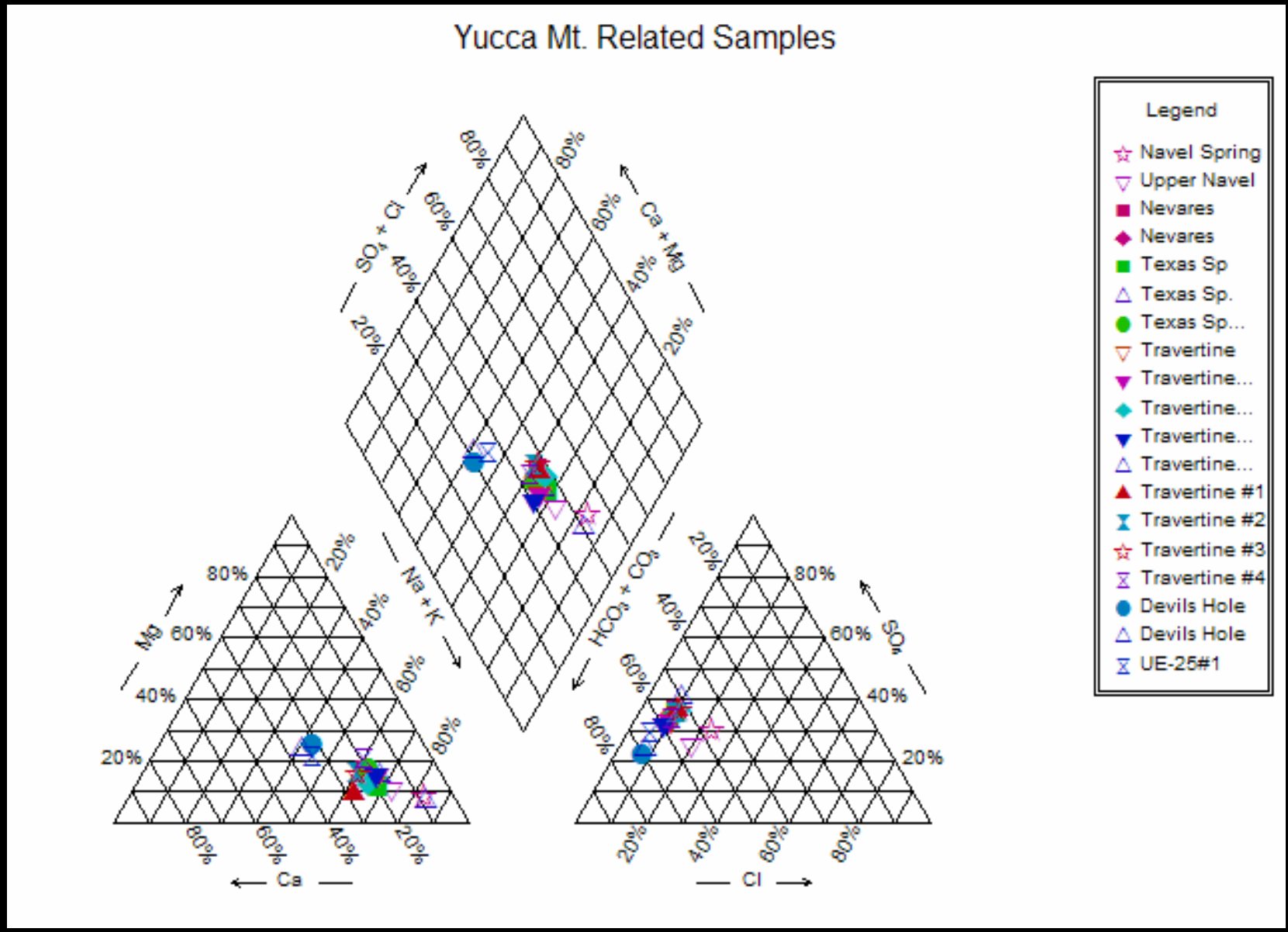


# Basin & Range Geologic Framework

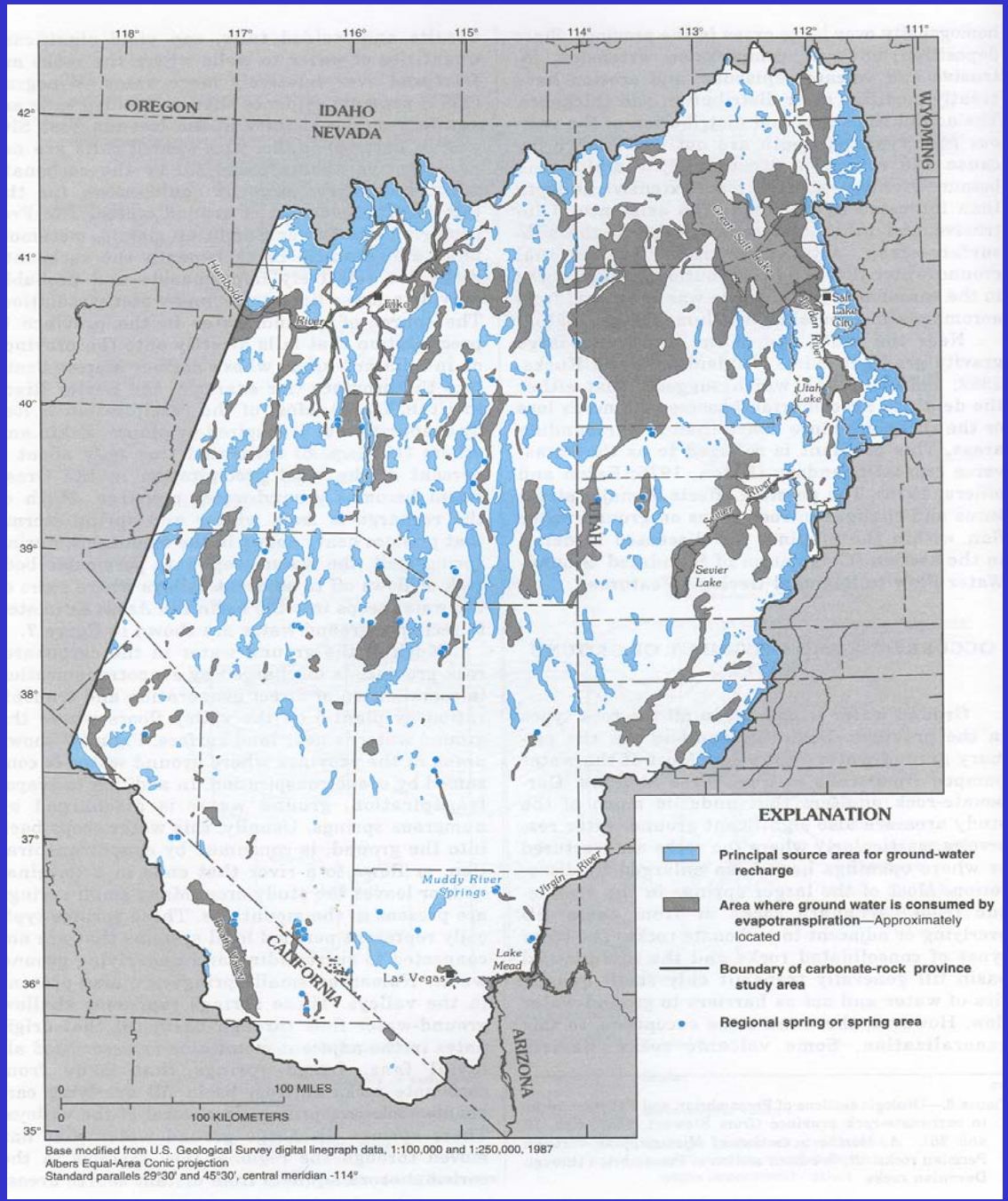



Winograd Hypothesis

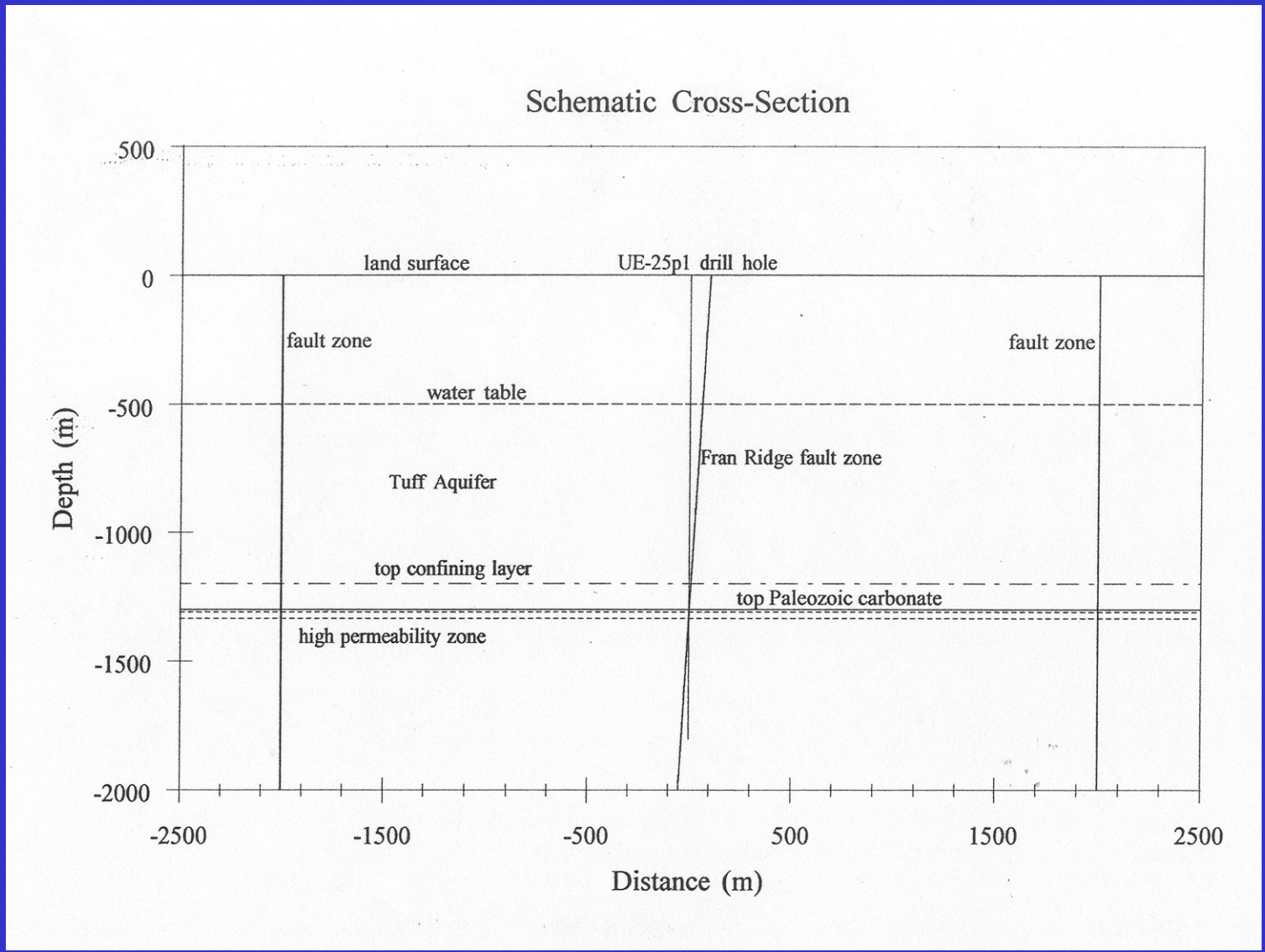
# Yucca Mt. Related Samples



# Carbonate Rock Terrain



# Yucca Mountain Drilling



# Map Showing Boundaries of NTS and Death Valley Regional Models

Belcher, et. al., 2004

# Complex Geology

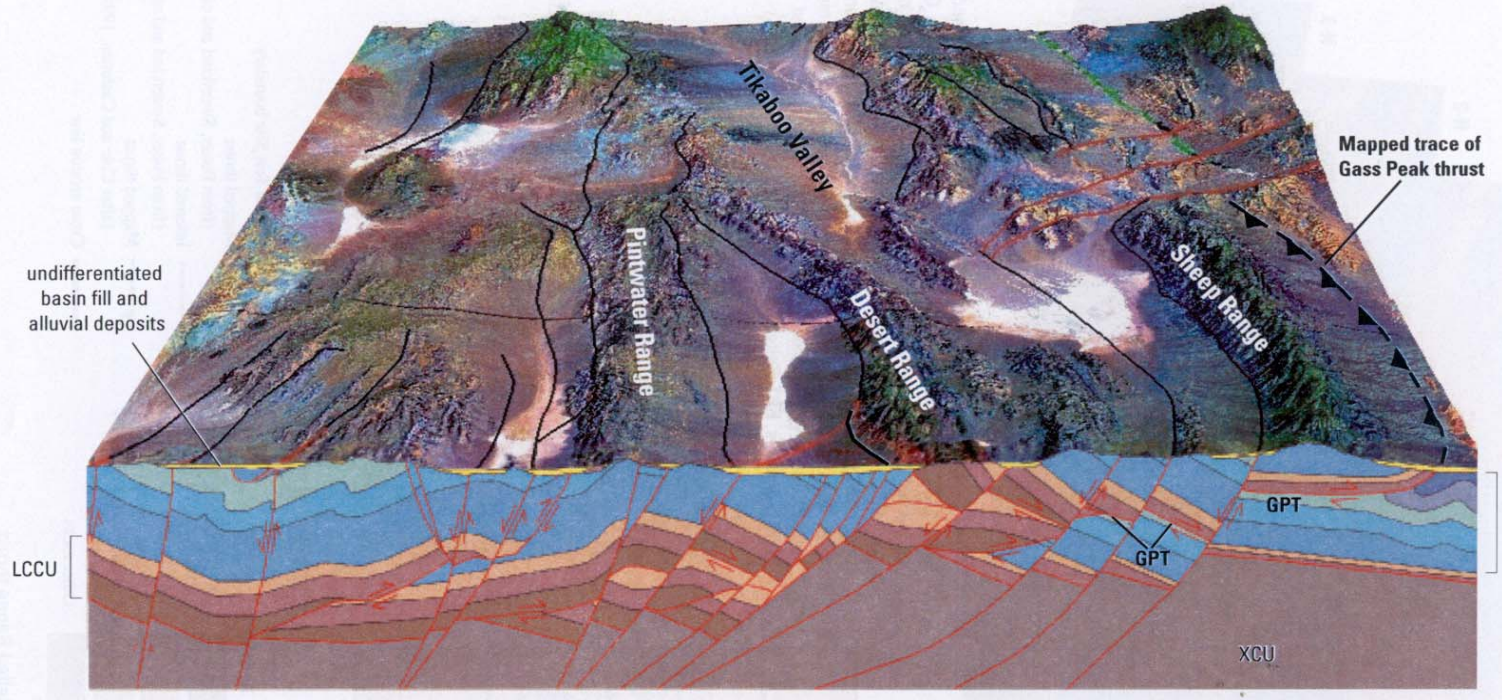
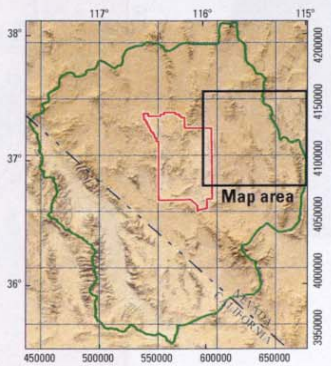



Image is false-color composite combining LANDSAT 6 spectral bands 2, 5, and 7 in RGB (Red-Green-Blue) space. Individual bands were processed to display their full dynamic range. The image was further processed in hue-saturation space to emphasize specific geologic features.



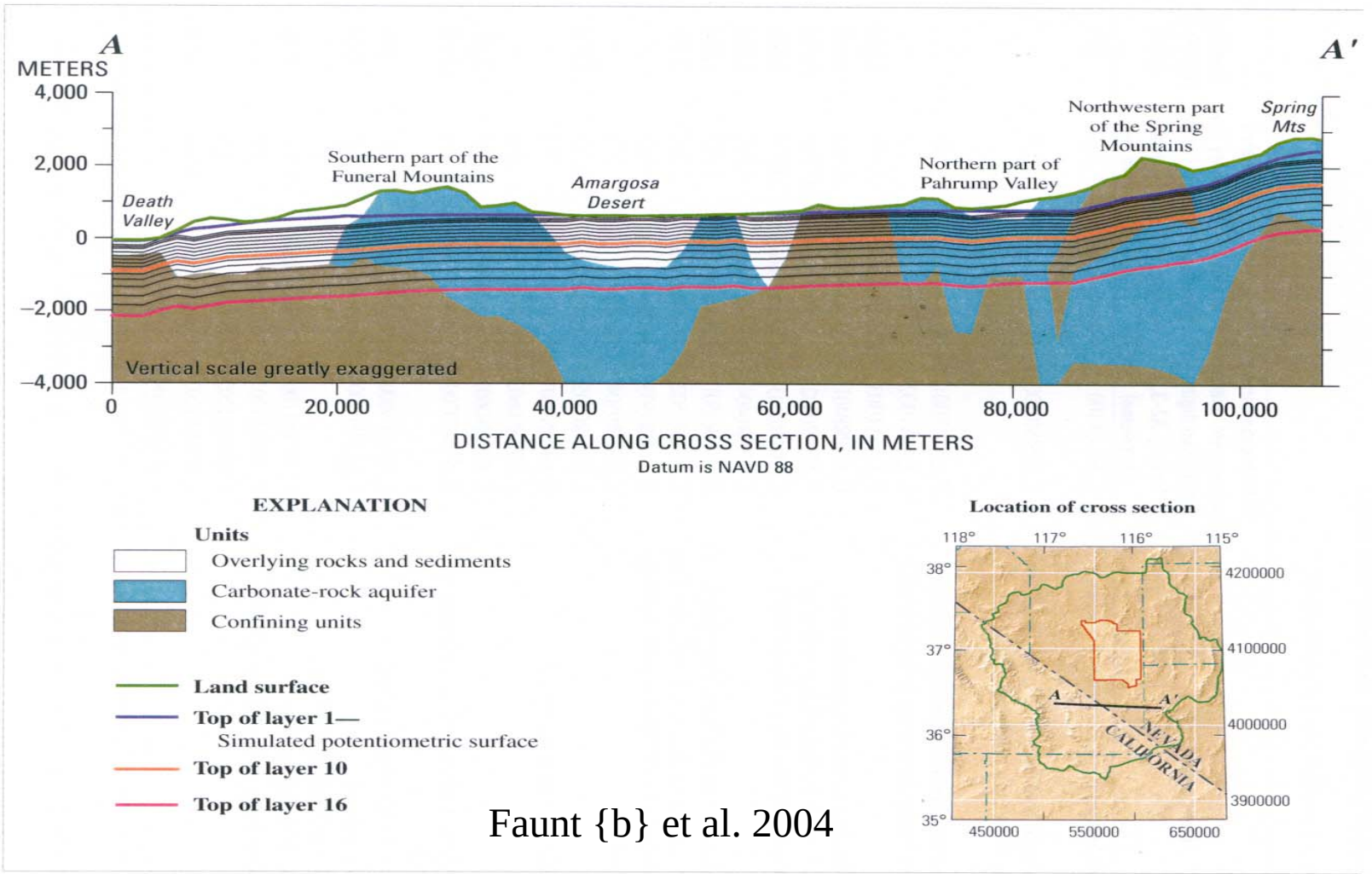

Cross section geology from Sweetkind, Dickerson, and others (2001) section H-5. View is to the north. GPT, Gass Peak thrust

**EXPLANATION**

**Mapped and inferred faults from surface geologic mapping** (from Potter, Sweetkind, and others, 2002)

- Strike-slip fault
- Normal fault
- Thrust fault

# USGS 16-Layer DV Regional Model Section Through Southern Funeral Mt. Range

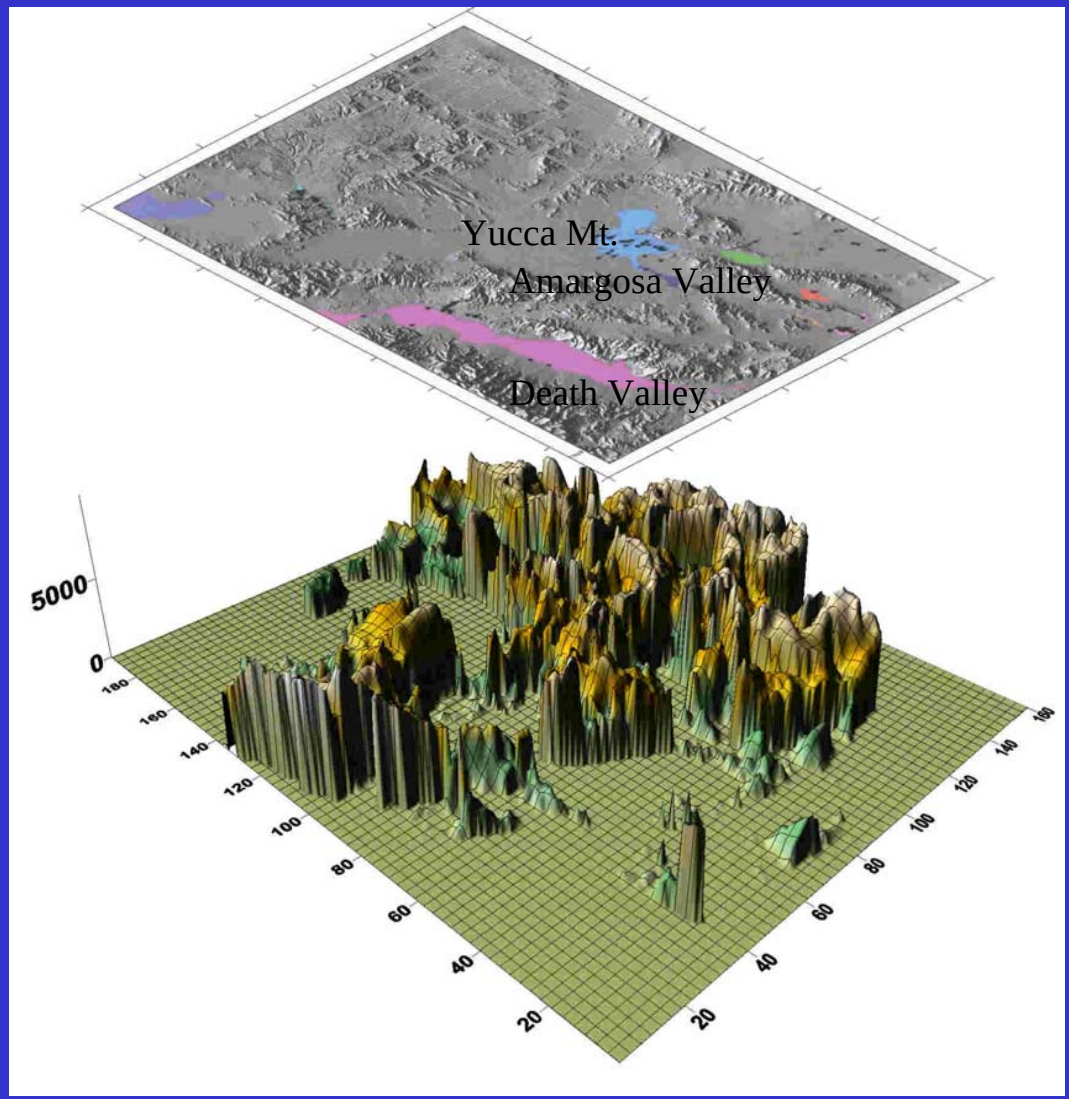



Faunt {b} et al. 2004

# Distribution of Carbonate Rocks in Death Valley Regional Flow System

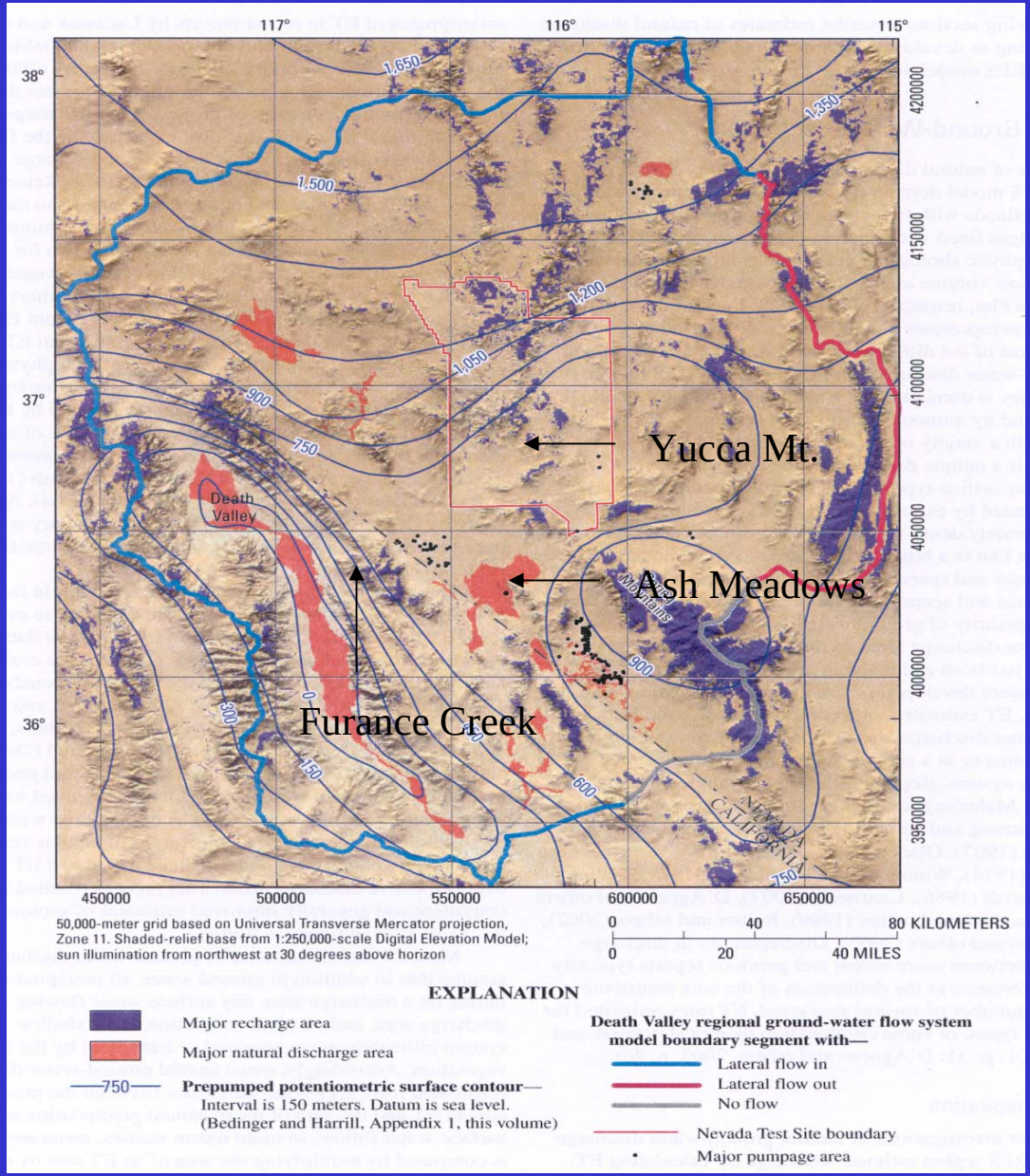
**Physical Evidence for Hydraulic Connection**

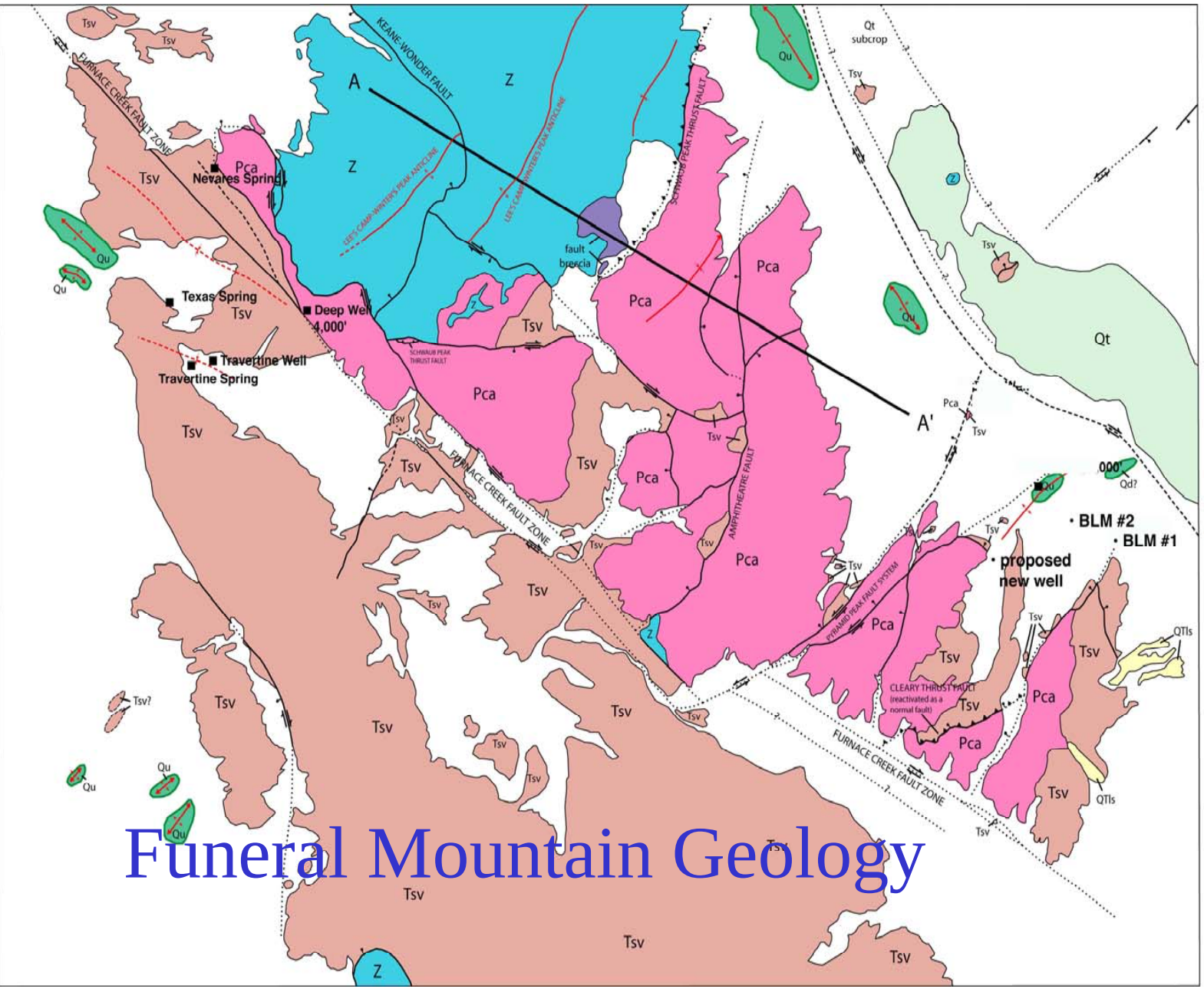
- Over 5,000 m thickness in many areas
- Carbonate underlies Yucca Mt., Amargosa Valley, Southern Funerals Mt.



# USGS Model Output: water table contours

San Juan, et. al., 2004






Qt QUATERNARY TRAVERTIVE DEPOSITS

QTls QUATERNARY/TERTIARY LANDSLIDE DEPOSITS

Tsv TERTIARY SEDIMENTARY AND VOLCANIC ROCKS

Pca PALEOZOIC CARBONATE AQUIFER

Z LOWER CAMBRIAN TO PROTEROZOIC CLASTIC CONFINING UNIT

Qu INFERRED QUATERNARY UPLIFT

Qd INFERRED QUATERNARY DEPRESSION

Normal Fault; dashed where inferred; dotted where concealed

Strike-slip fault; dashed where inferred; dotted where concealed

Thrust fault; dotted where concealed

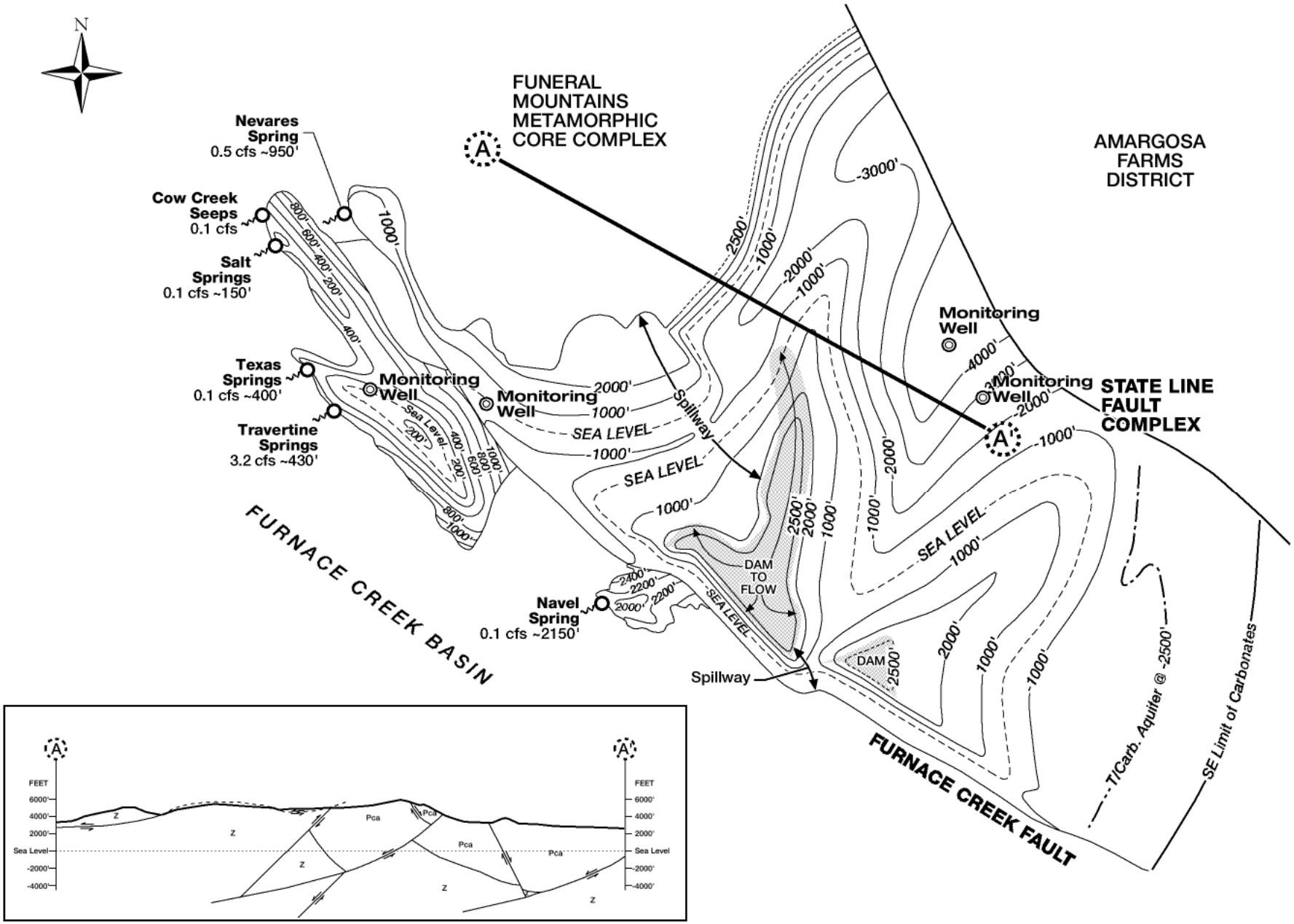
Anticline; arrow indicated direction of plunge

Syncline; arrow indicated direction of plunge

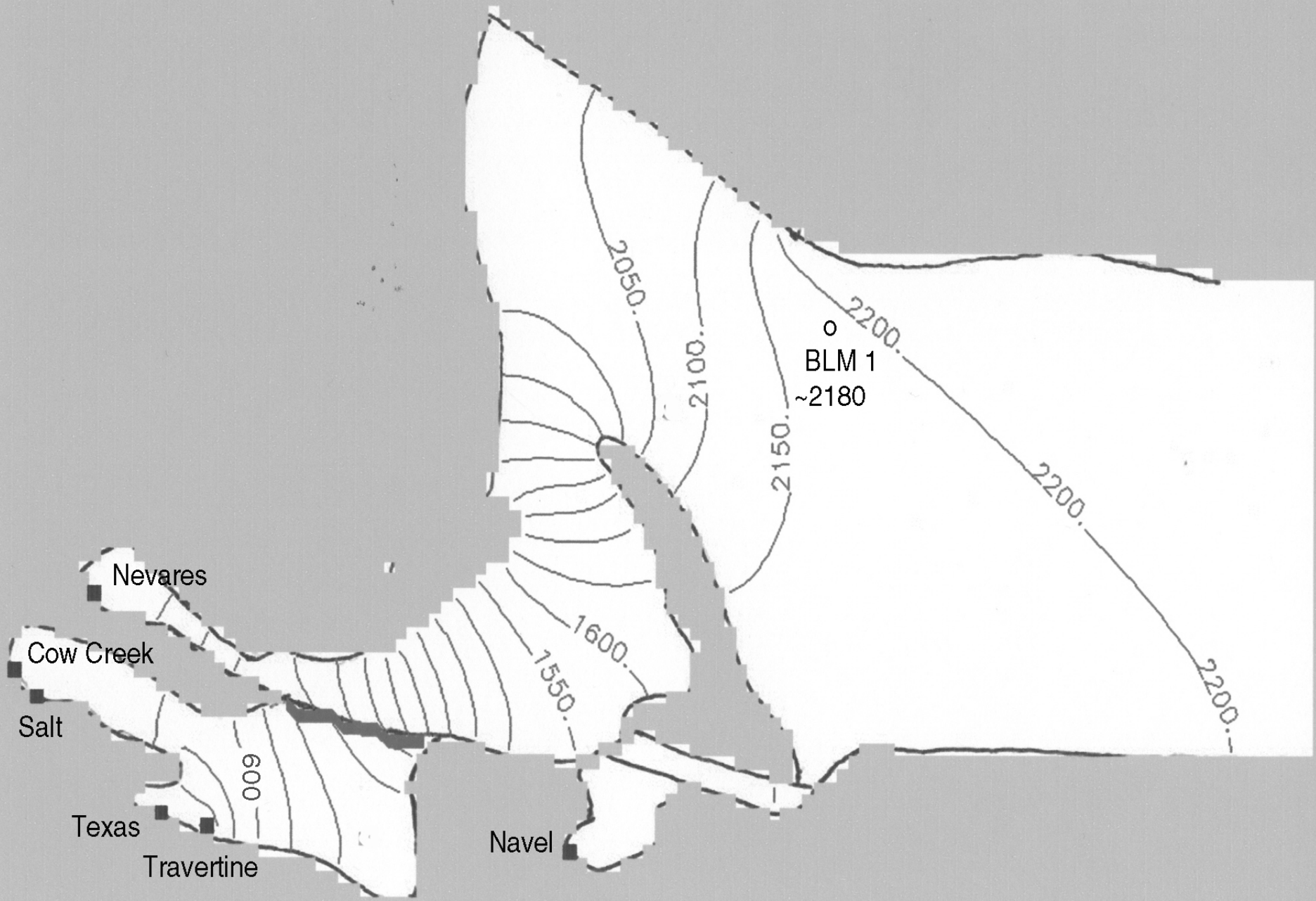
**GEOLOGICAL FRAMEWORK MODEL: SOUTHERN FUNERAL MOUNTAIN RANGE**

**Map shows Death Valley Springs and Proposed Lower Carbonate Monitoring Wells.**

# Funeral Mountain Geology



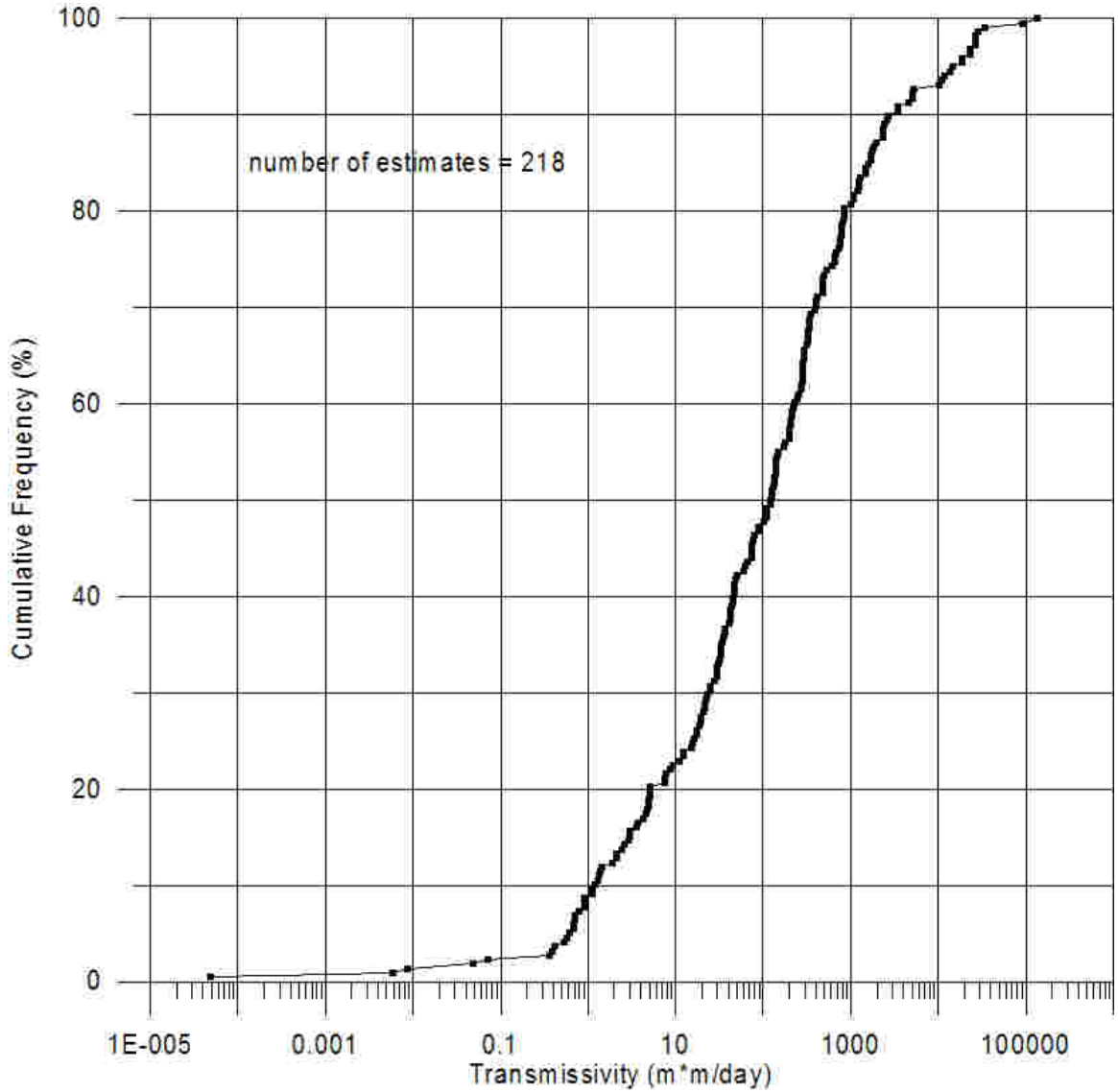

**Spillway model, version 2:** same as figure 4, except that this is a bounding case in which the thickness of the aquifer at the spillways is maximized.


2050.
2100.
2150.
2200.
2200.
2200.
o
BLM 1
~2180
1600.
1550.
600
Nevares
Cow Creek
Salt
Texas
Travertine
Navel

# Model Comparison

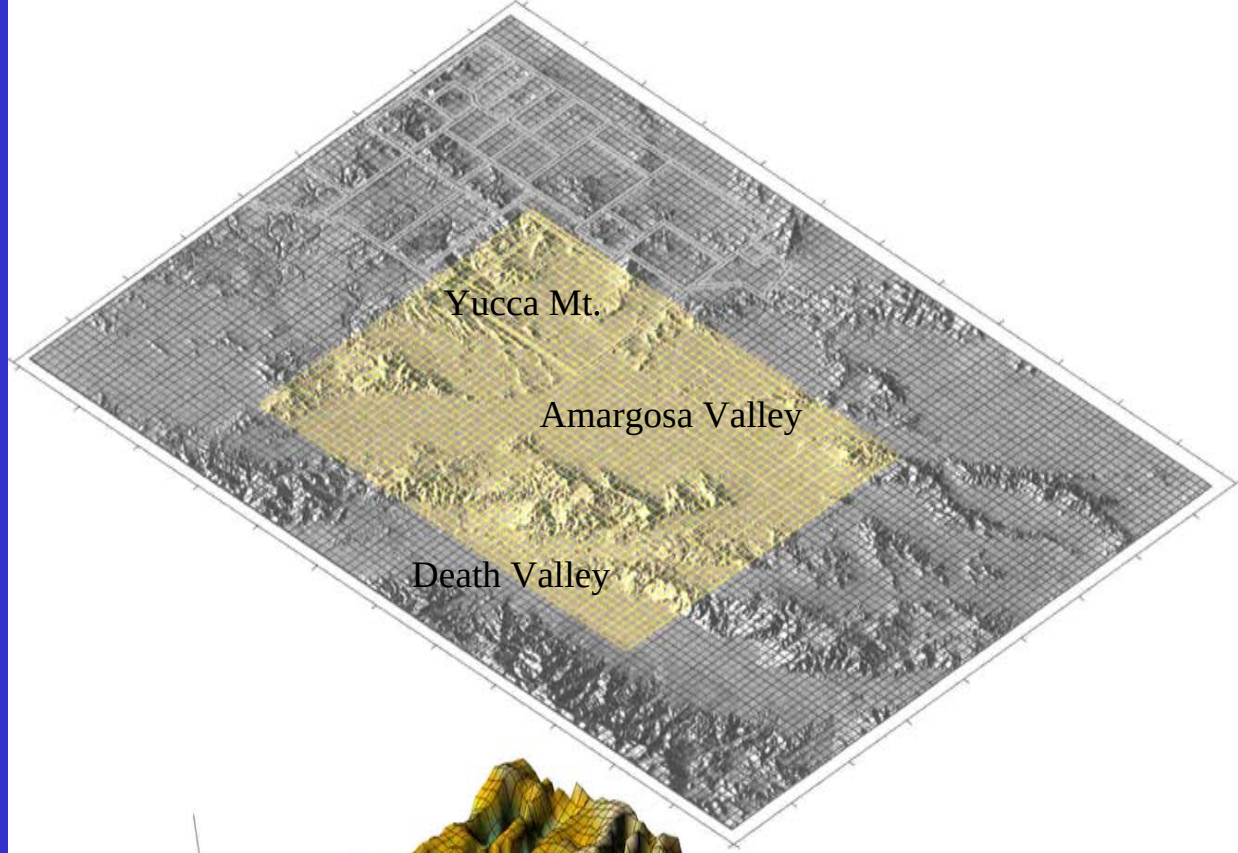
| Spring | Elevation (ft) | Flow (cfs) | Model (cfs) |
|---|---|---|---|
| Navel | 2150 | 0.10 | 0.11 |
| Nevares | 950 | 0.50 | 0.47 |
| Travertine | 430 | 3.20 | 3.26 |
| Texas | 400 | 1.00 | 0.89 |
| Cow Seeps | 150 | 0.10 | 0.08 |
| Salt | 150 | 0.10 | 0.08 |
| Total | | 5.00 | 4.89 |

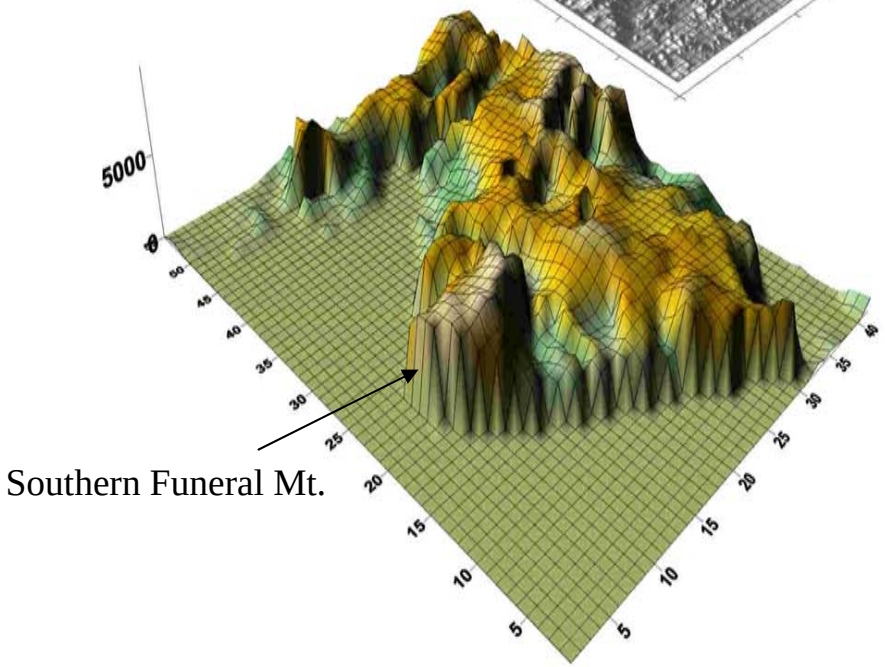
# Frequency Distribution Transmissivity




permeability: 1 m/day ~ $10^{-12}$ m*m

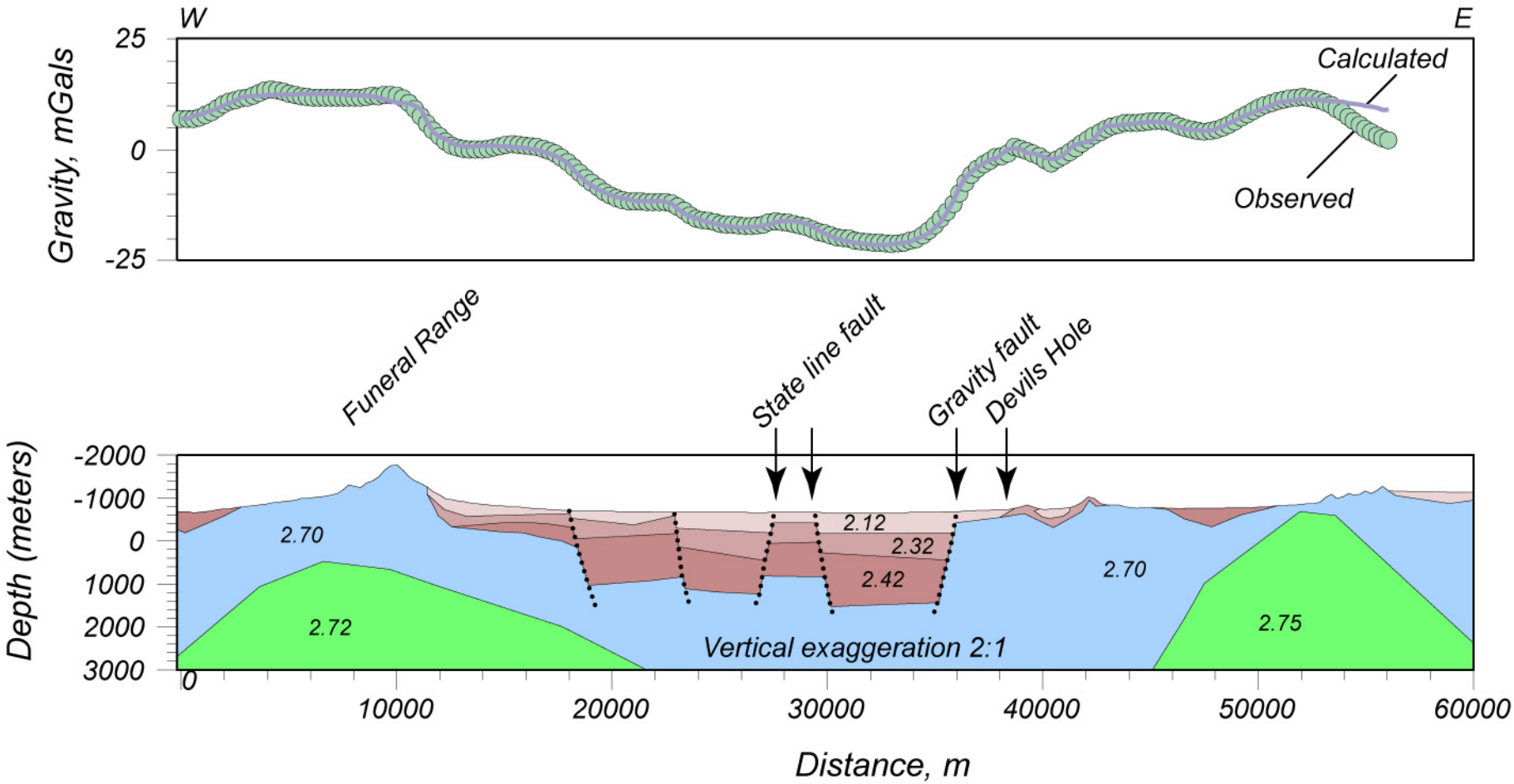
# Smaller Model Area




Southern Funeral Mt.

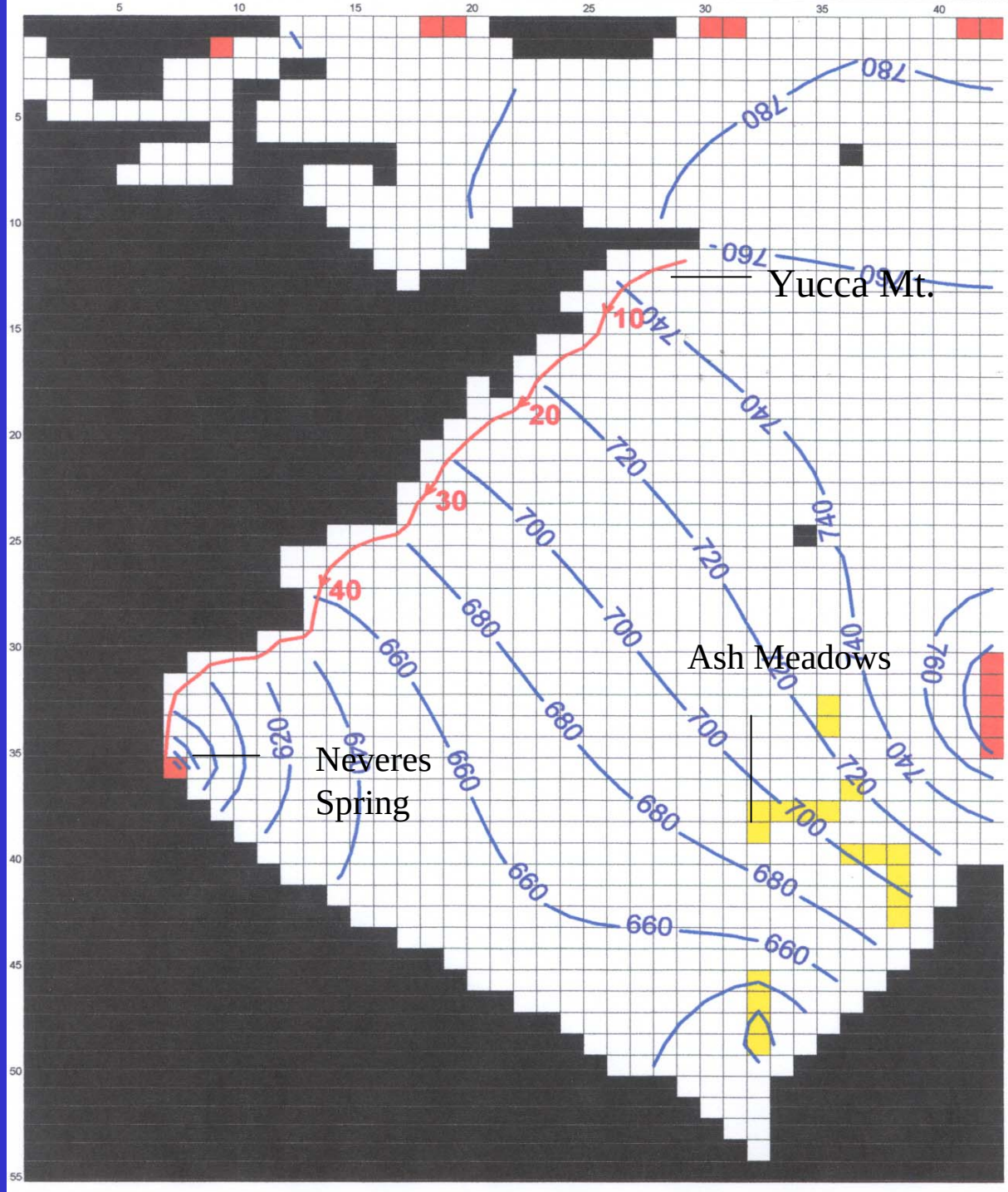
# Preliminary gravity model across the Amargosa trough



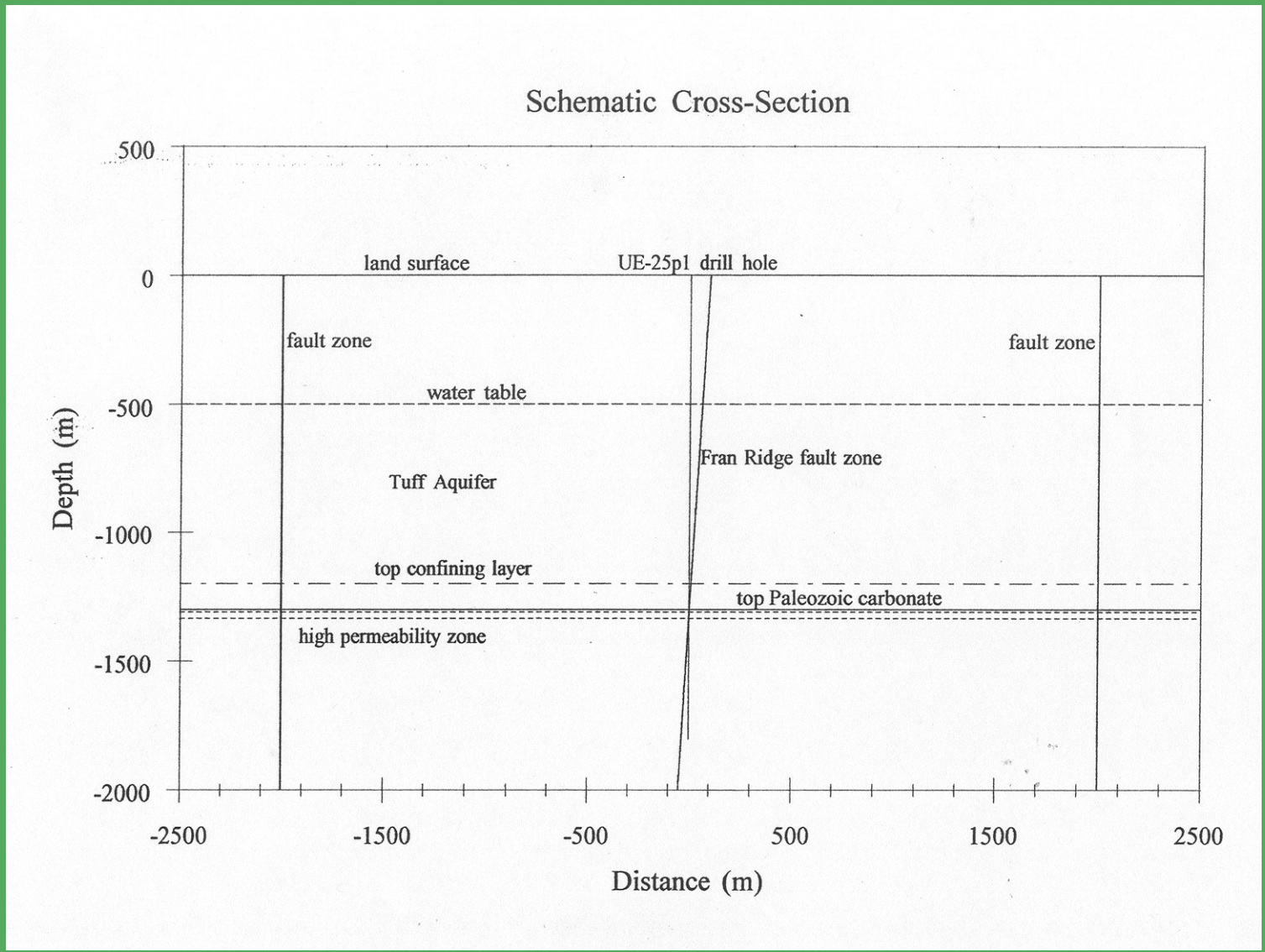
Simple
One-layer
model

Velocity of flow:
v = (k/p) grad h

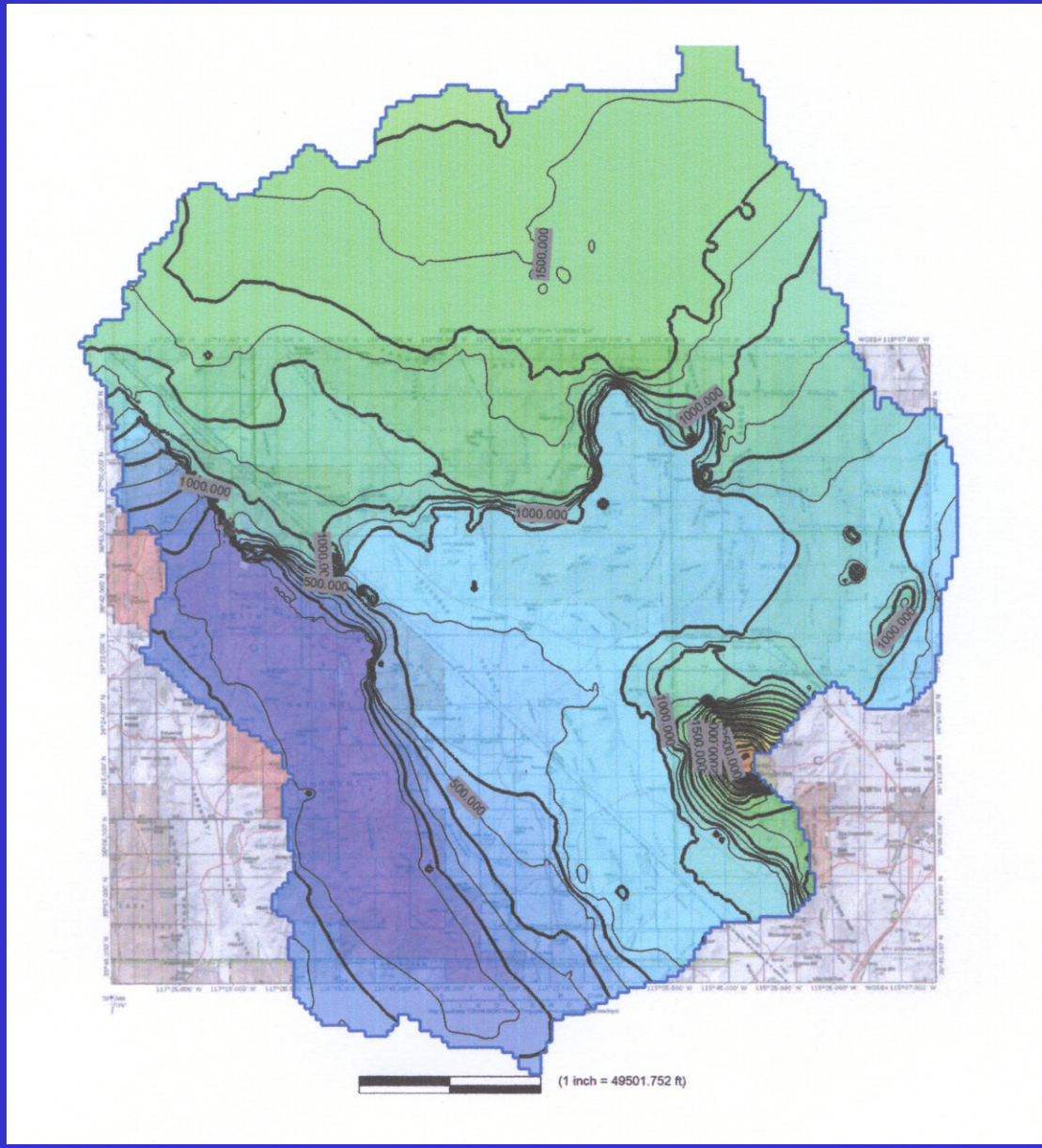
p (porosity) = ?
p = 0.001 model



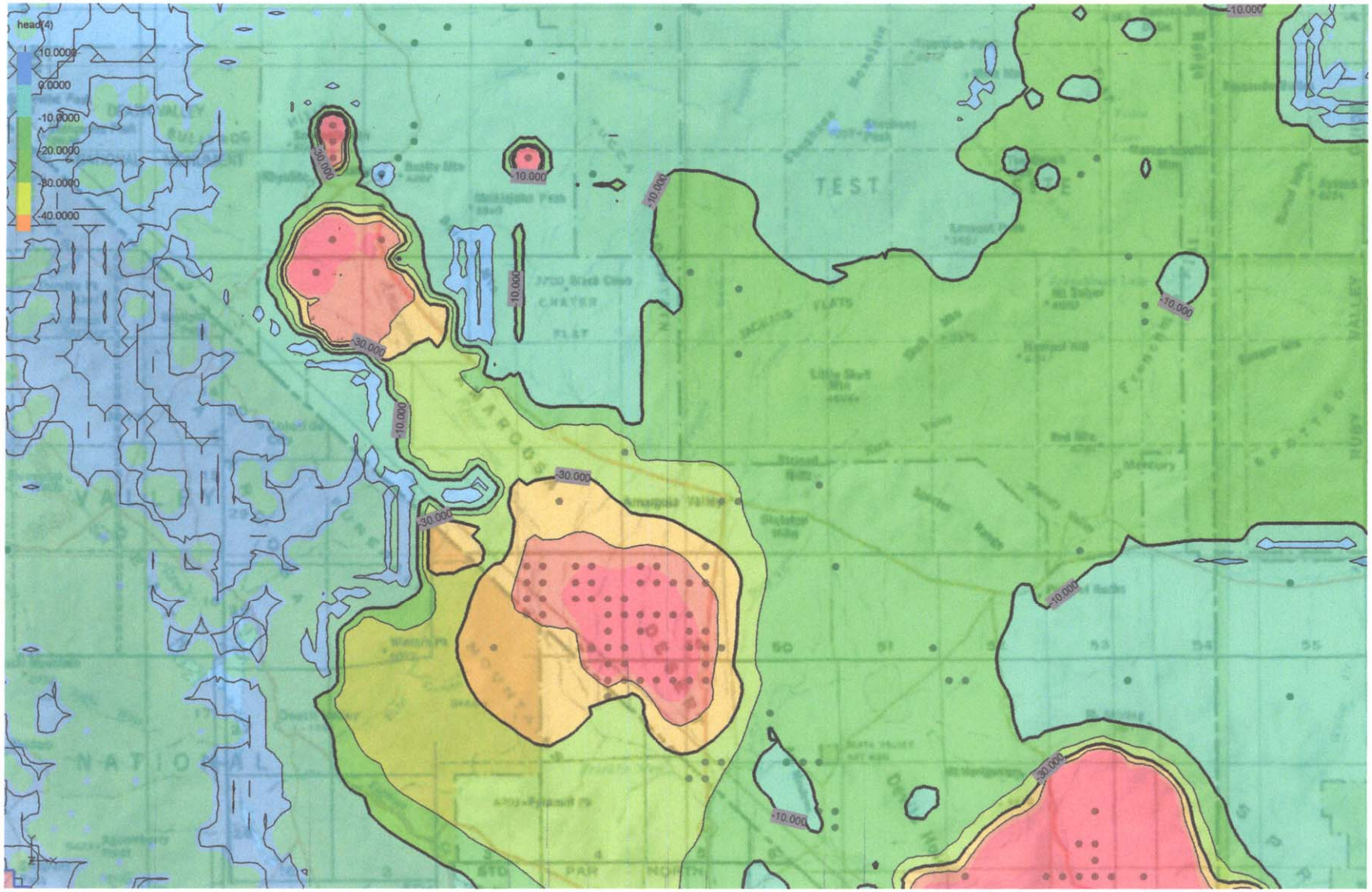
# Yucca Mountain Drilling



# USGS Death Valley Regional Model: 1998 Computed Head



# Drawdown: 1998 to 2998



# CONCLUSIONS

- Yucca Mountain underlain by Carbonate Aquifer—highly transmissive, low porosity (creates high gw velocity)
- Aquifer extends to Death Valley springs—pathway to biosphere
- Currently upward head gradient protects aquifer
- Head relationship is vulnerable to future groundwater development for water supply
- Geochemistry, geological mapping, drilling, and numerical modeling support inter-basin flow theory for Death Valley region