AMERICULTURE

EXHIBIT

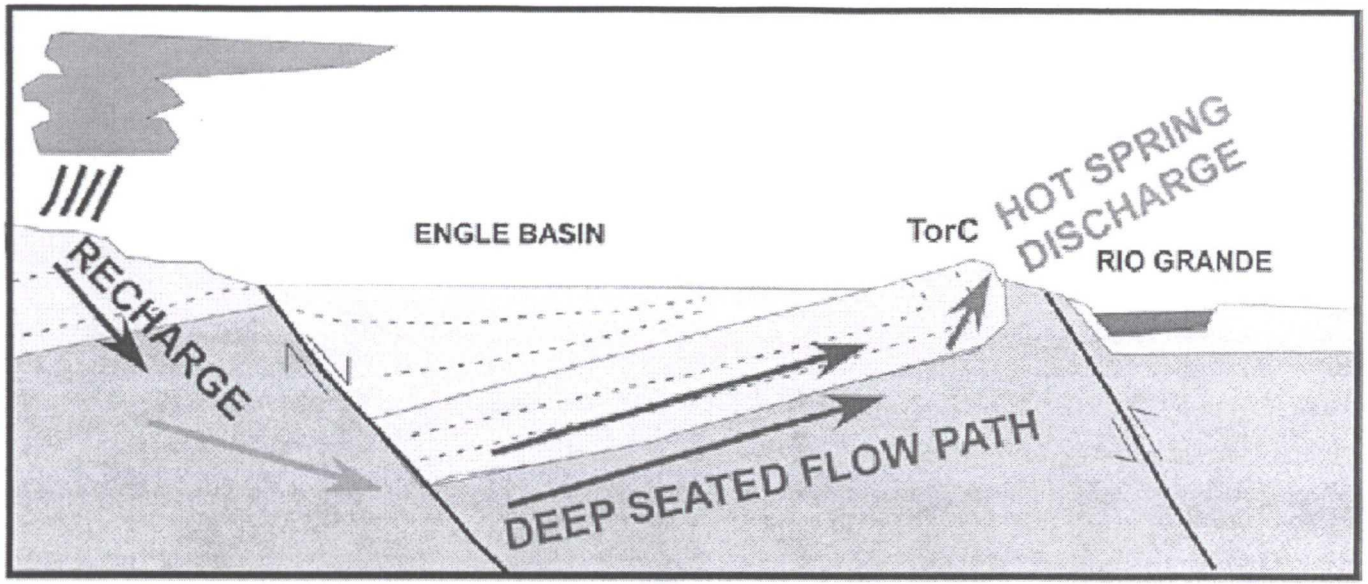
3

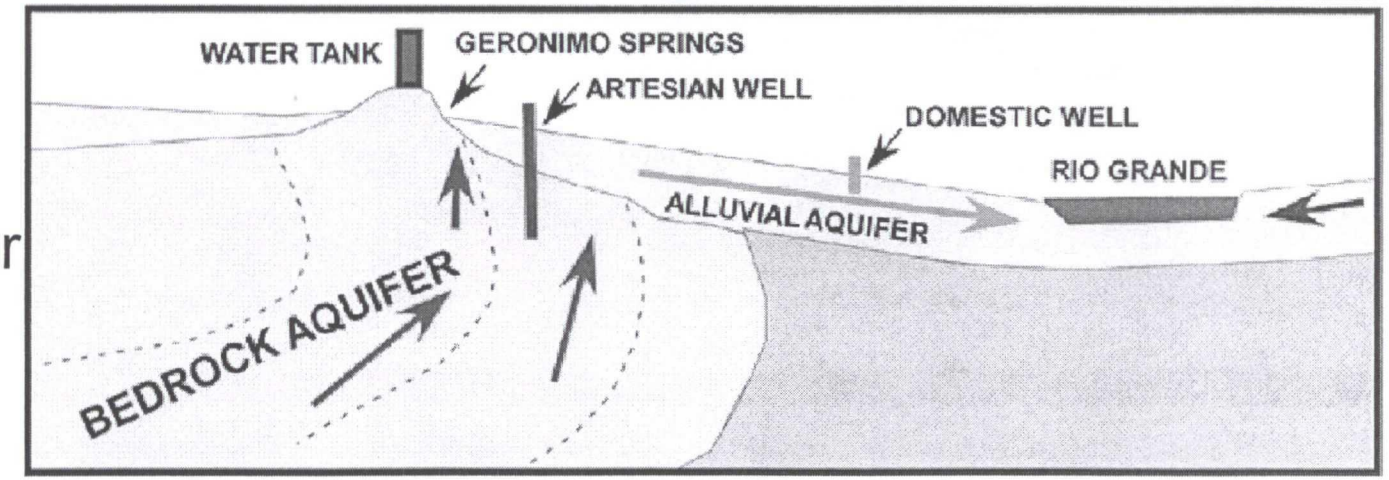
DISCUSSION OVERVIEW

- Basic geologic framework of Lightning Dock geothermal.
- Thermal domains at Lightning Dock geothermal.
- Summary of subsurface geology.
- Water chemistry of thermal water in 45-7.
- Isotopic composition of thermal water in outflow plume.
- Summary of findings.

A HOT SPRING SYSTEM

- 100 to 114° F
- 2,576 ppm TDS
- Flow to river
  +2.7 cfs
  +1,212 gpm
  +1,955 acre-ft/yr

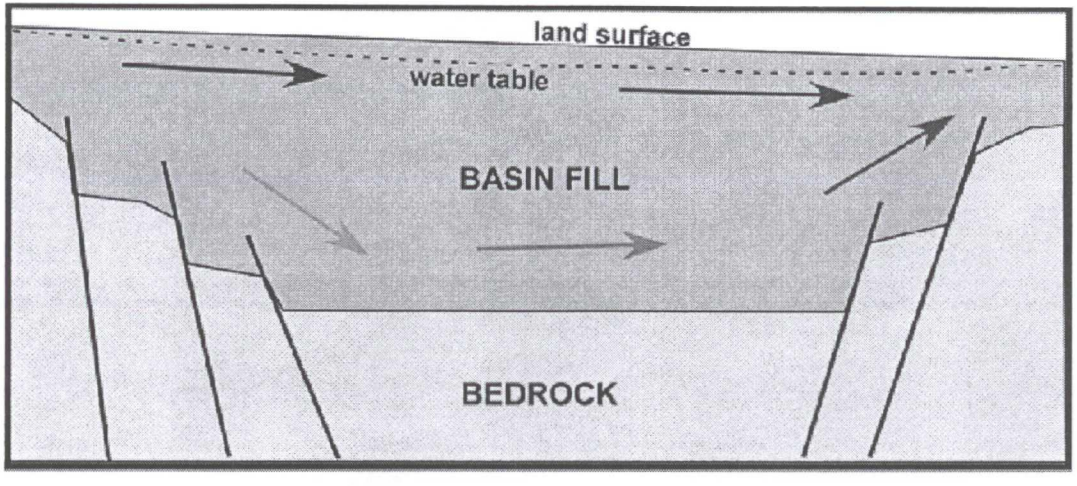




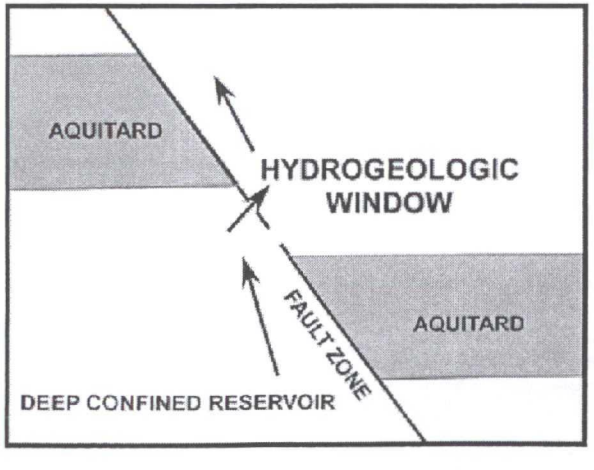
- Thermal and chemical sweep to +10,000 ft depth.
- Temperature gradient 1.6 to 2.5° F per 100 ft depth.
- Regional bedrock ground-water flow system.
- Important local component of salinity in Rio Grande.

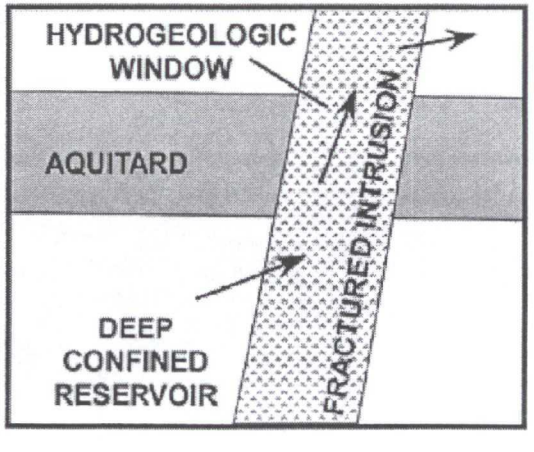
HYDROGEOLOGY

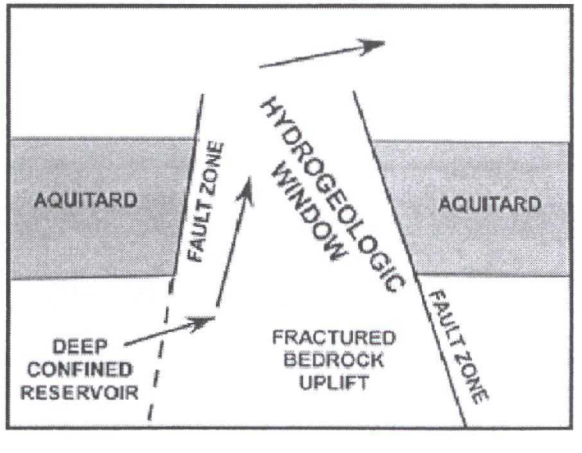
Rift basin ground water flow constrictions (or outlets)



Hydrogeologic windows

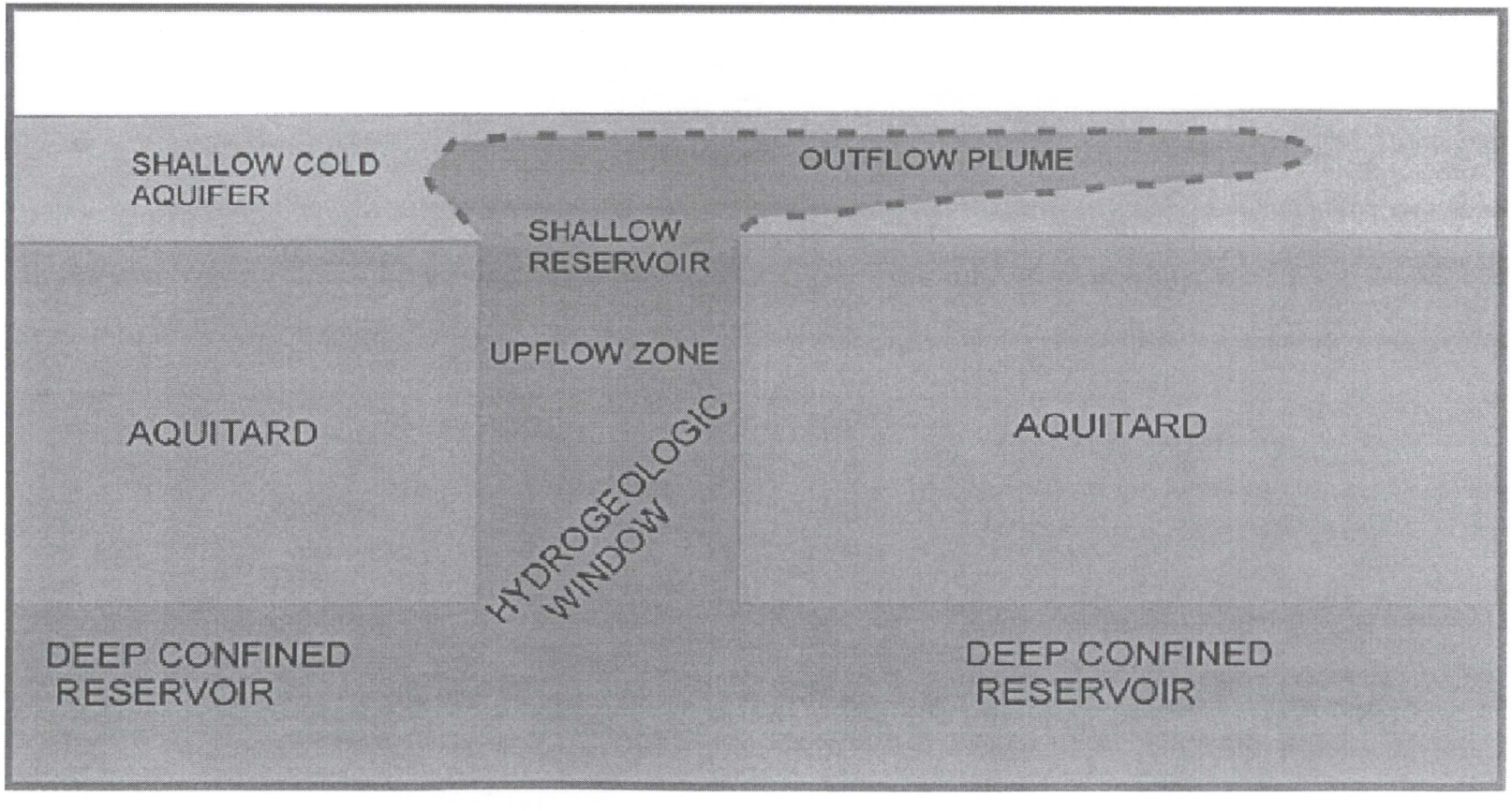






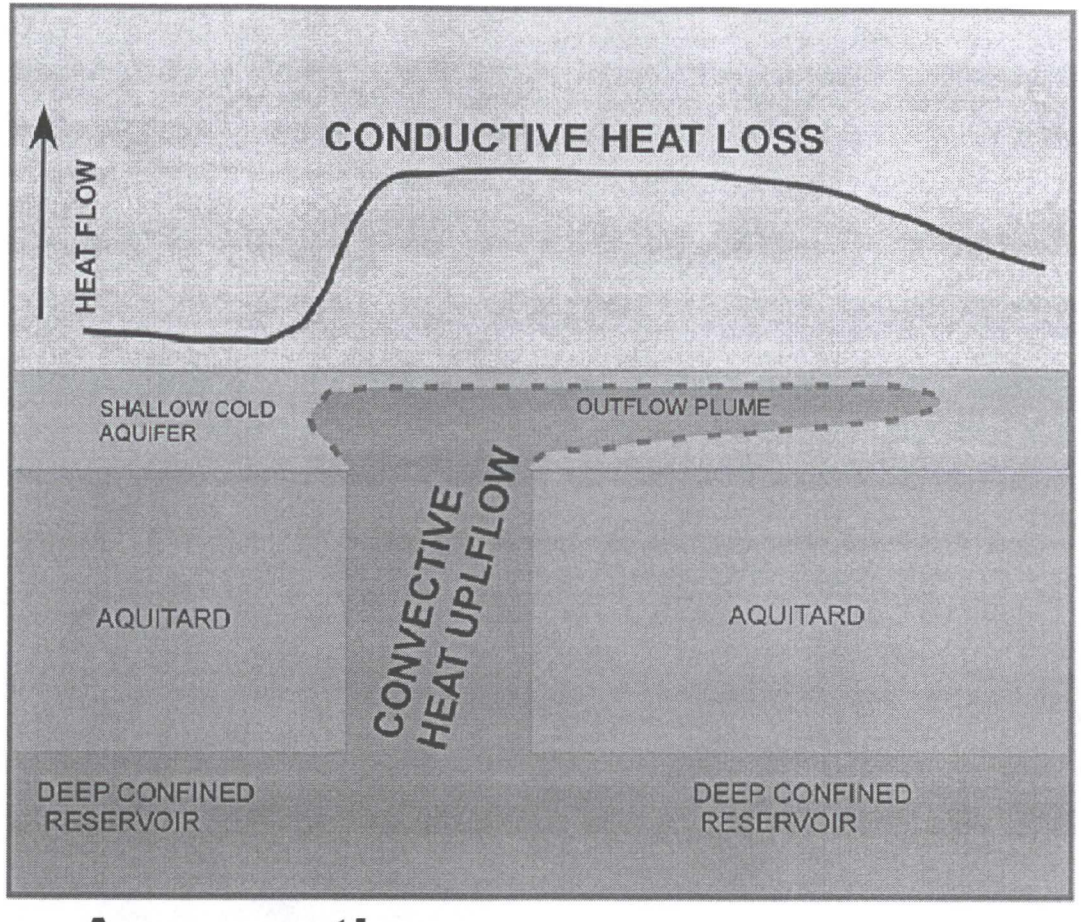
RESERVOIR

- Mixing with near surface ground water.
- Flow direction follows shallow hydraulic gradient.
- Most economic and productive reservoir volume is upflow zone and part of outflow plume.



TOTAL CONDUCTIVE HEAT LOSS

- $q_z = k(dT/dz)$
  - q_z conductive heat flow(mW/m^2)
  - k thermal conductivity (W/m^oK)
  - dT/dz temperature gradient ($^oC/km$)
  - k = 1.8 W/m^oK basin fill
  - k = 2.2 W/m^oK volcanics
- $Q = \Downarrow q_z dA - \Downarrow q_b dA$
  - Q total system heat loss
  - q_b regional heat flow (90 mW/m^2)
  - dA area of integration (km^2)

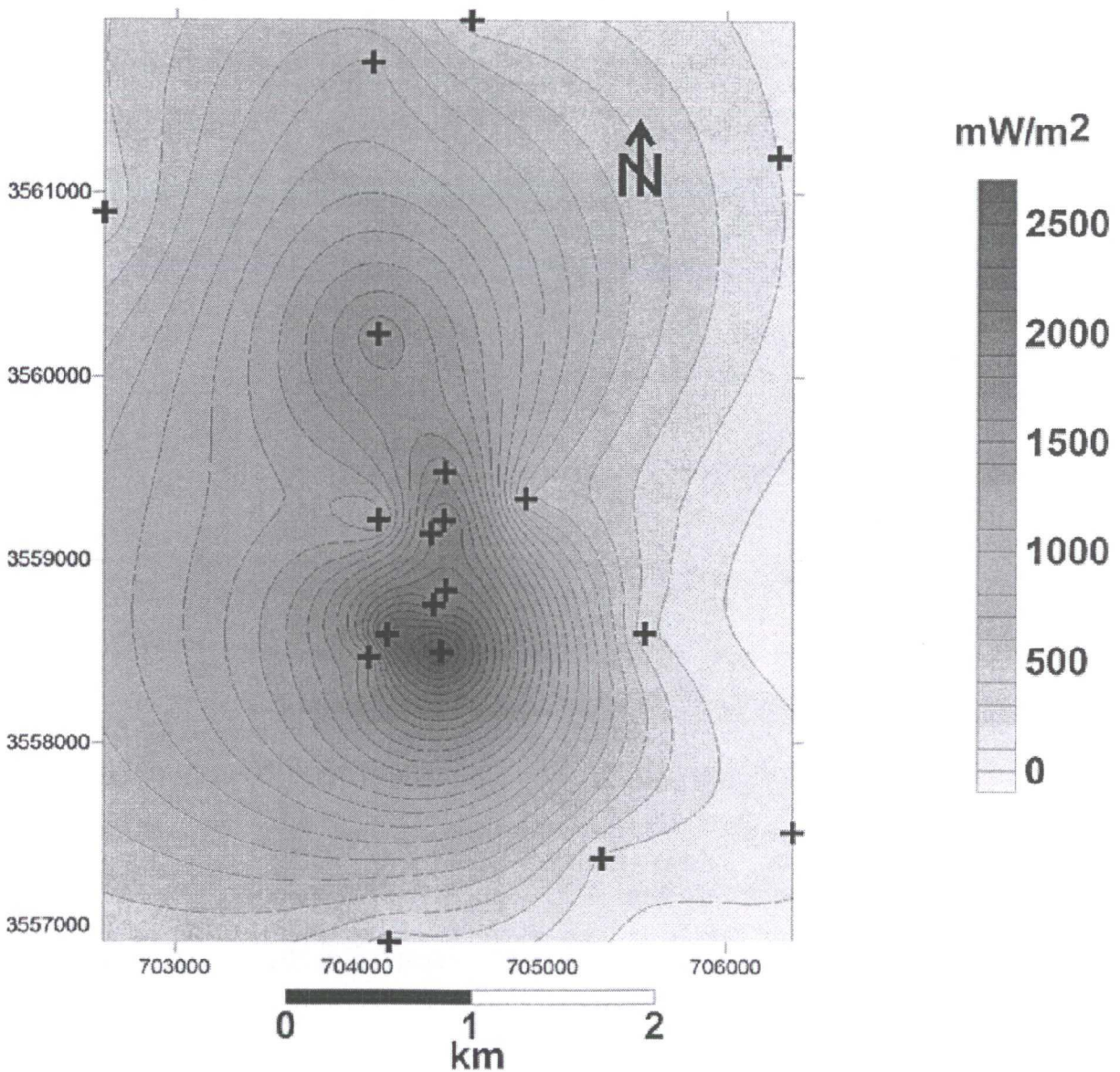


Assumptions:

- All heat is lost by conduction over top of outflow plume.
- Estimated thermal conductivity does not introduce excessive error.
- Borehole density is adequate to characterize system.

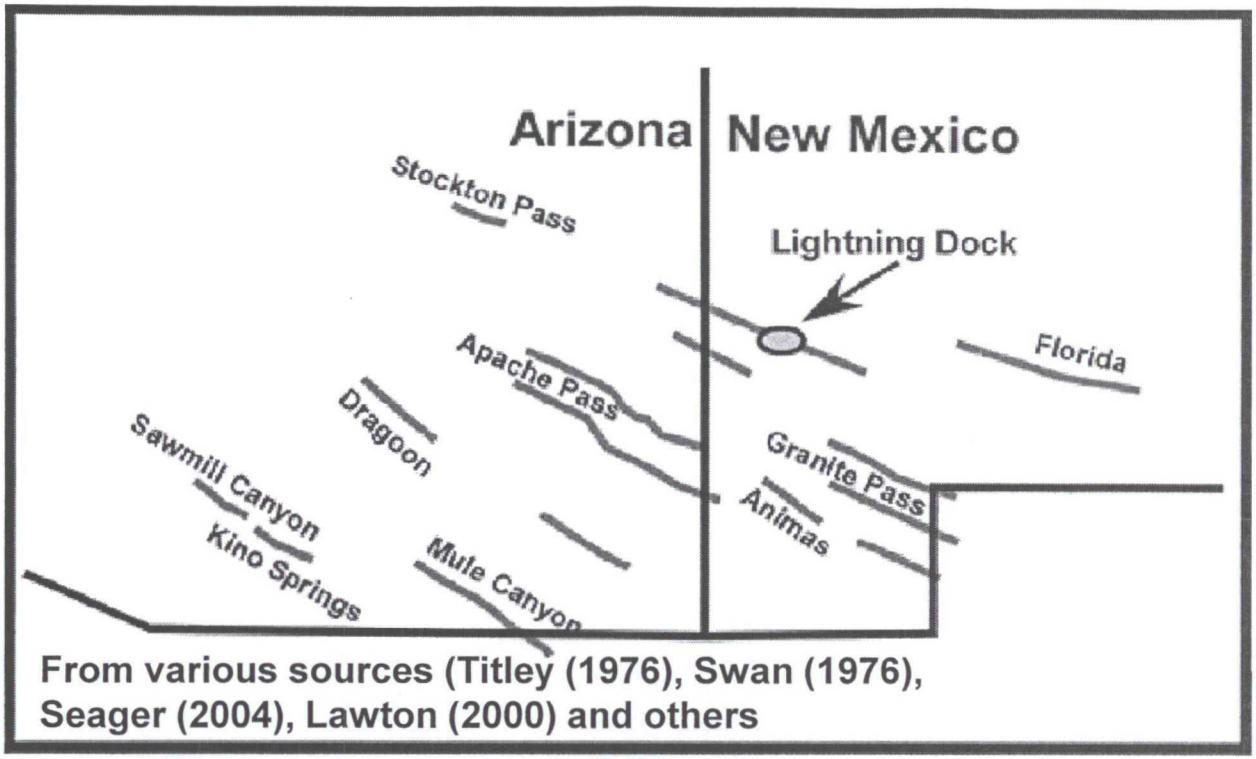
LIGHTNING DOCK HEAT FLOW

- Maximum Heat Flow
  2543 *m*W/m^2
- Area of Heat Flow
  over 90 *m*W/m^2
  17 km^2
- Reservoir Volume
  <1 to 4 km^3
- Heat Loss
- <10 MWt
- Natural recharge
  >300 gpm
  <1,200 gpm

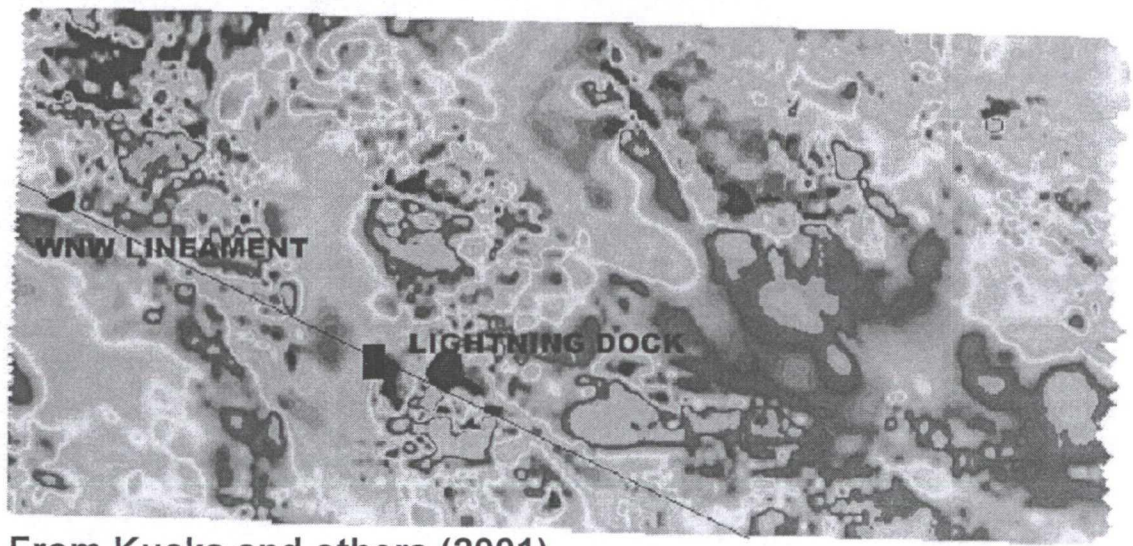


LIGHTNING DOCK REGION

- Potential for deep seated fracture permeability
- Structures have long and repeated deformation history

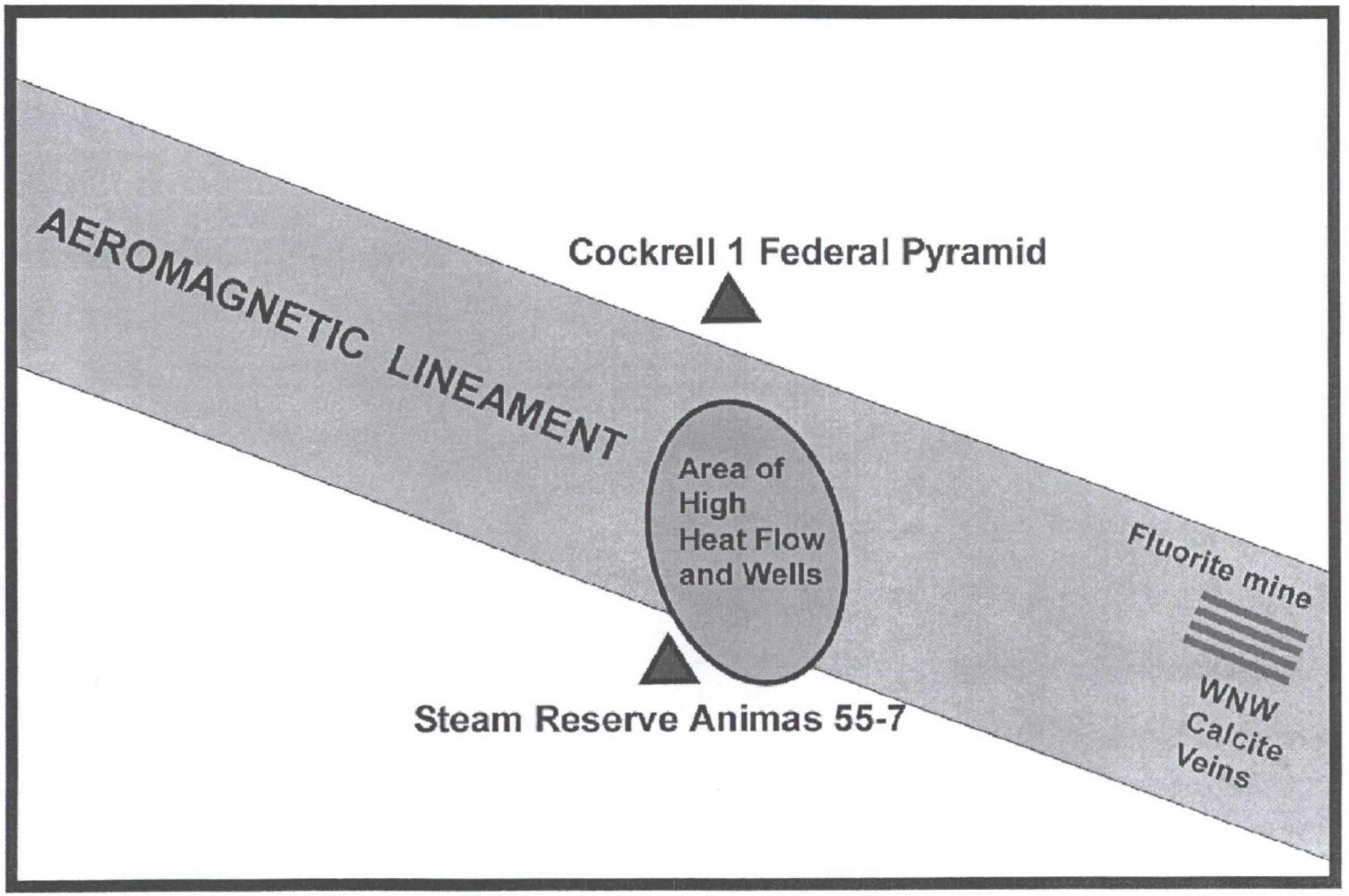


From various sources (Titley (1976), Swan (1976), Seager (2004), Lawton (2000) and others

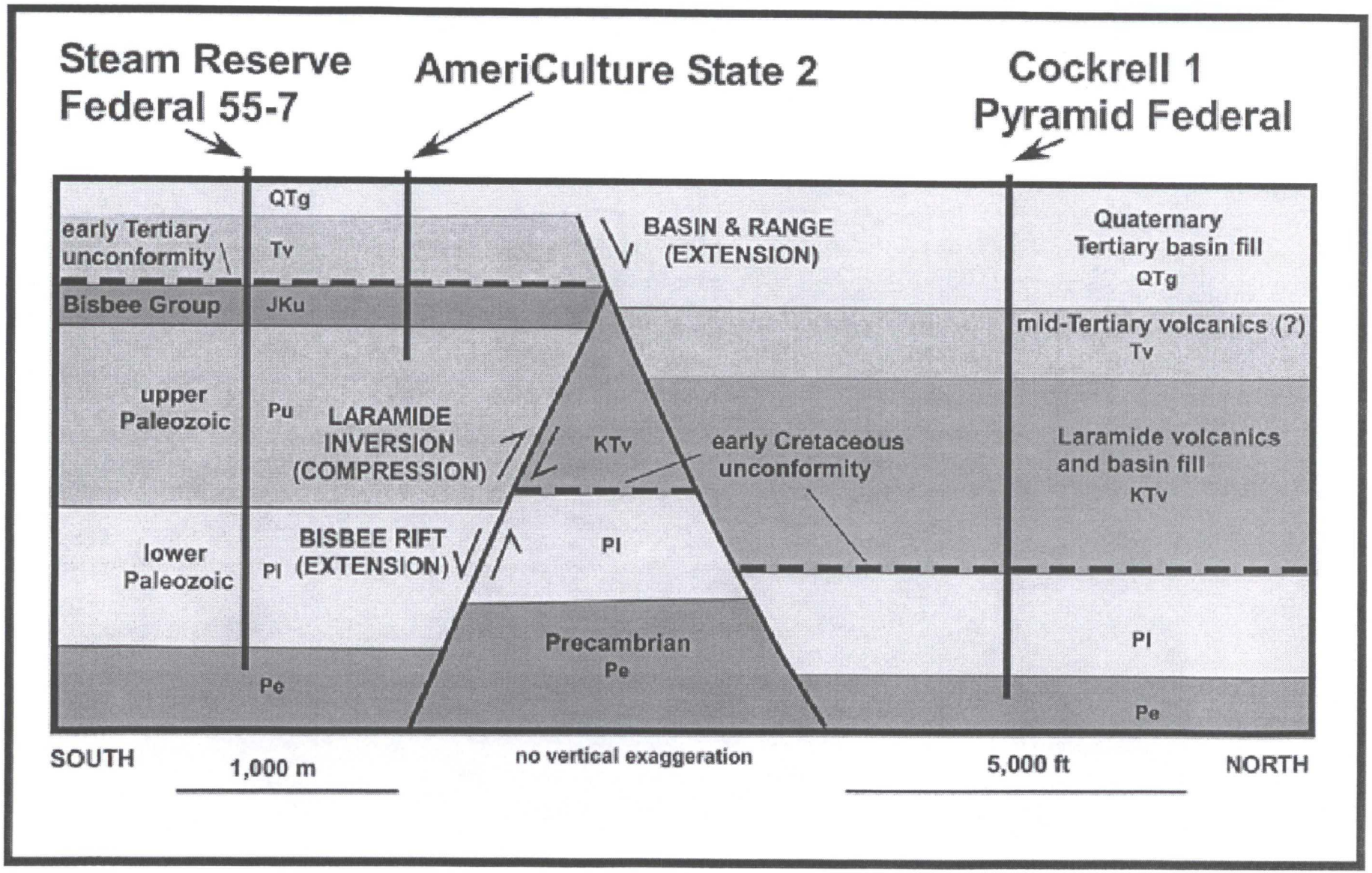


From Kucks and others (2001)

A WNW STRUCTURE CONTOL AT LIGHTNING DOCK

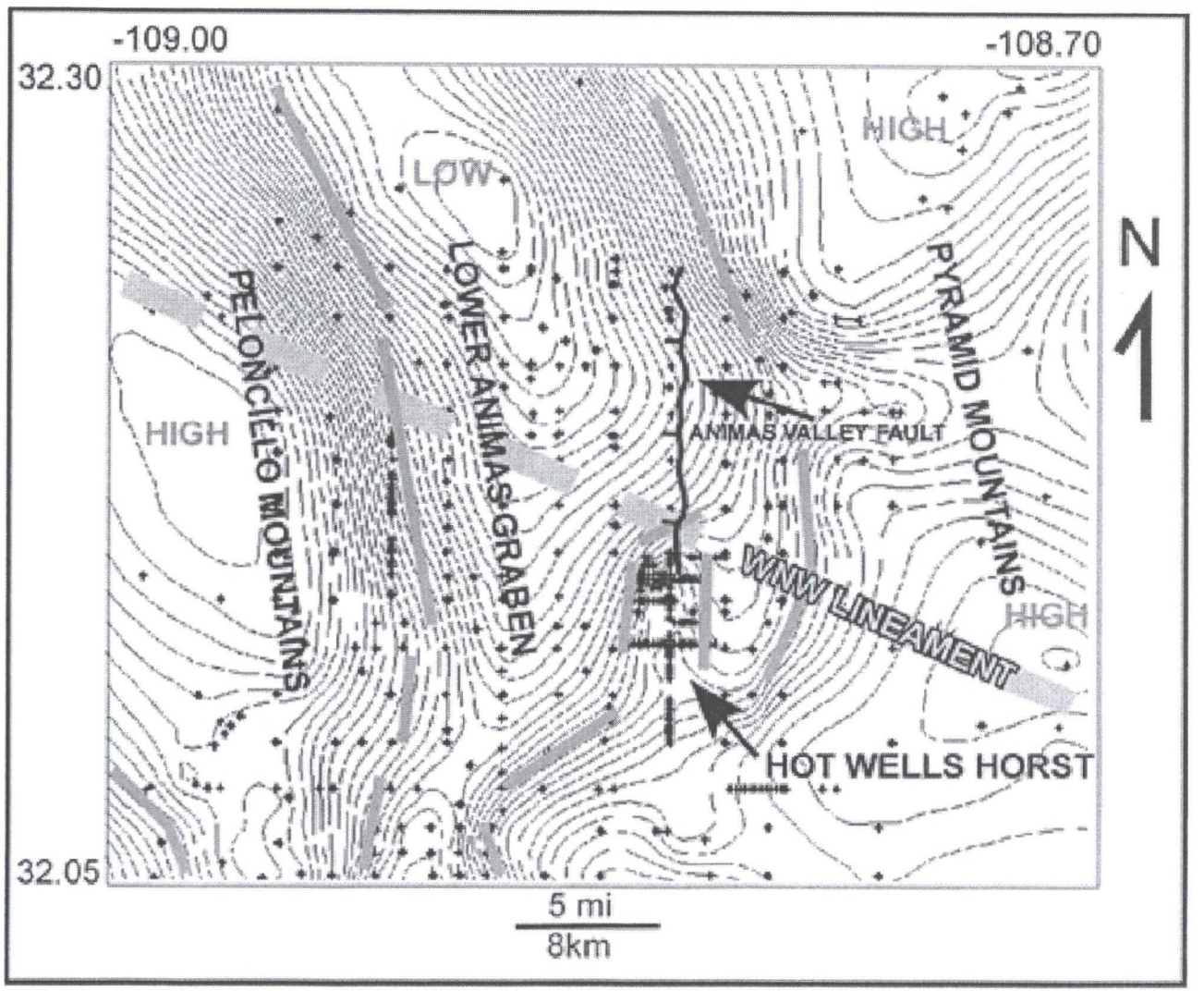


DIAGRAMMATIC CROSS SECTION OF DEEP SUBSURFACE AND MAJOR TECTONIC INVERSION OF A WNW FAULT

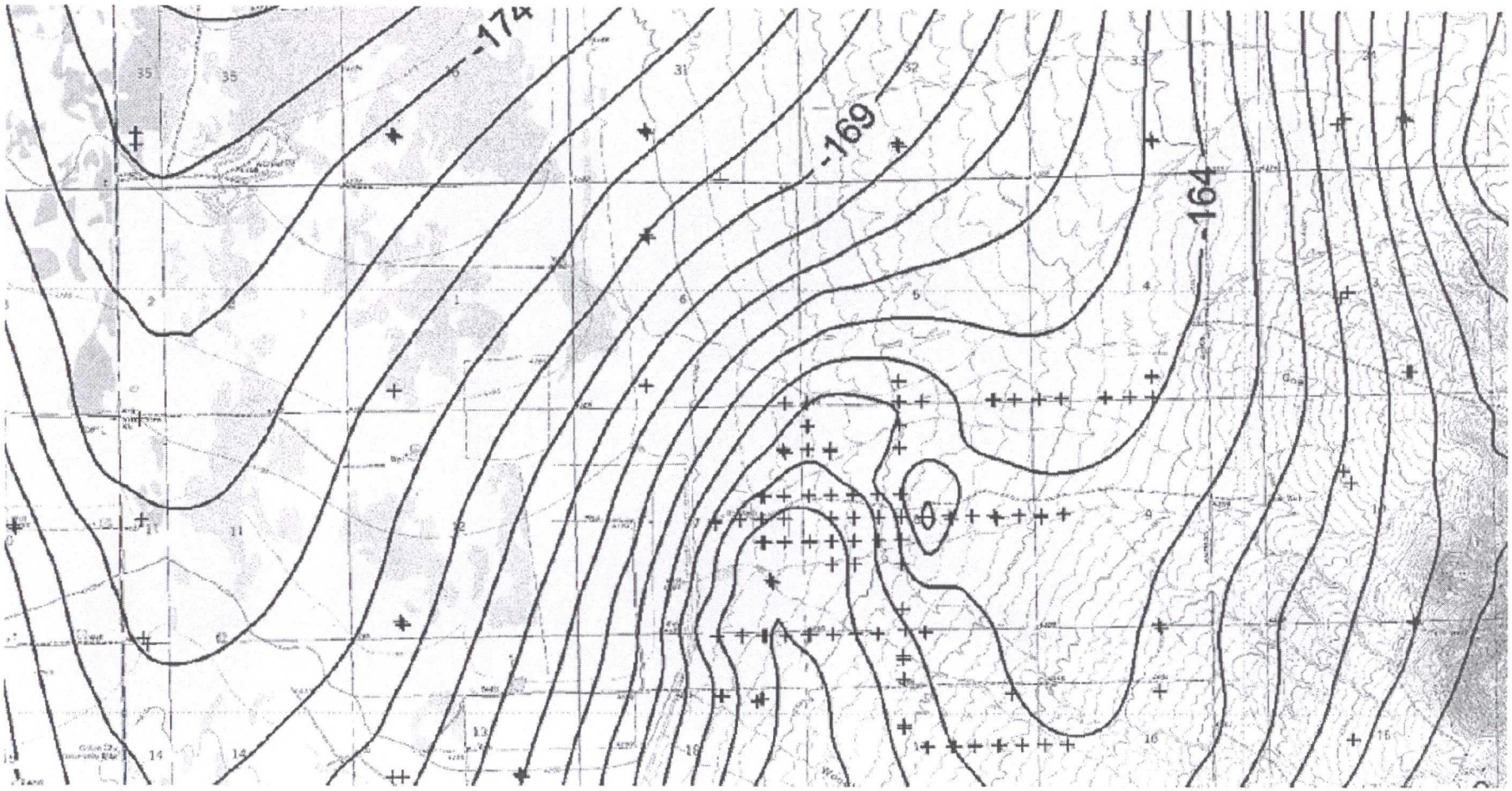


COMPLETE BOUGUER GRAVITY MAP OF LIGHTNING DOCK REGION

Geothermal system is contained within a buried intrabasin horst block.

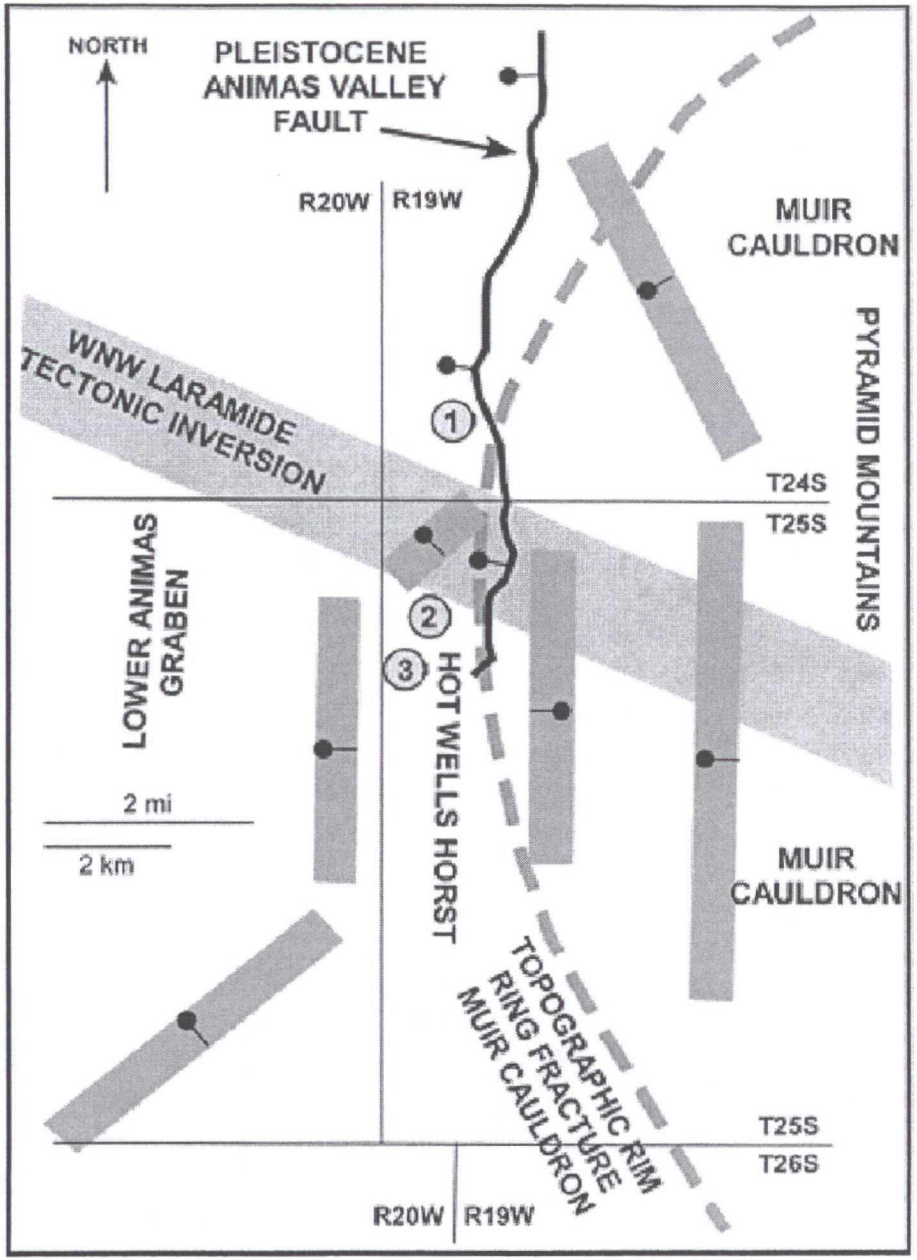


GRAVITY ON
TOPOPGRAPHIC MAP

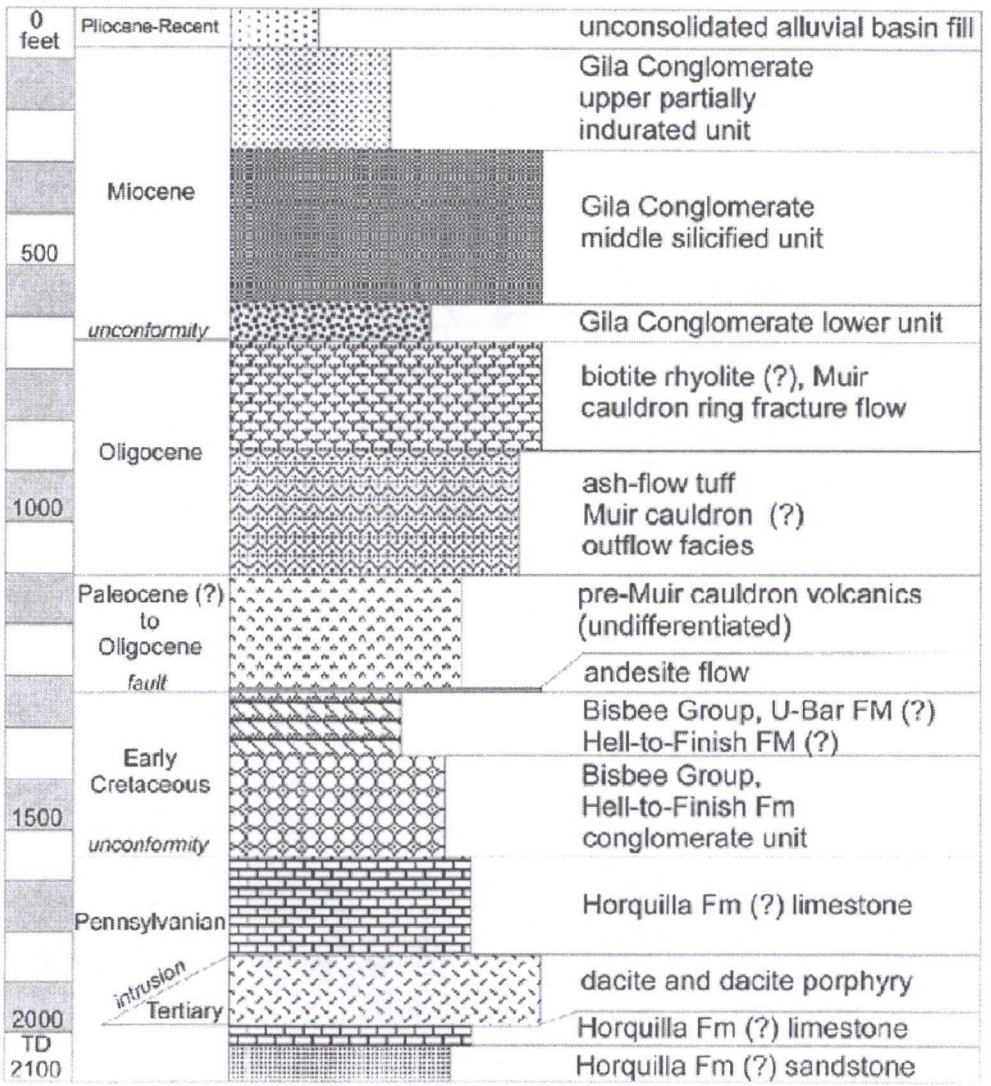


SUMMARY OF LIGHTNING DOCK STRUCTURAL ELEMENTS

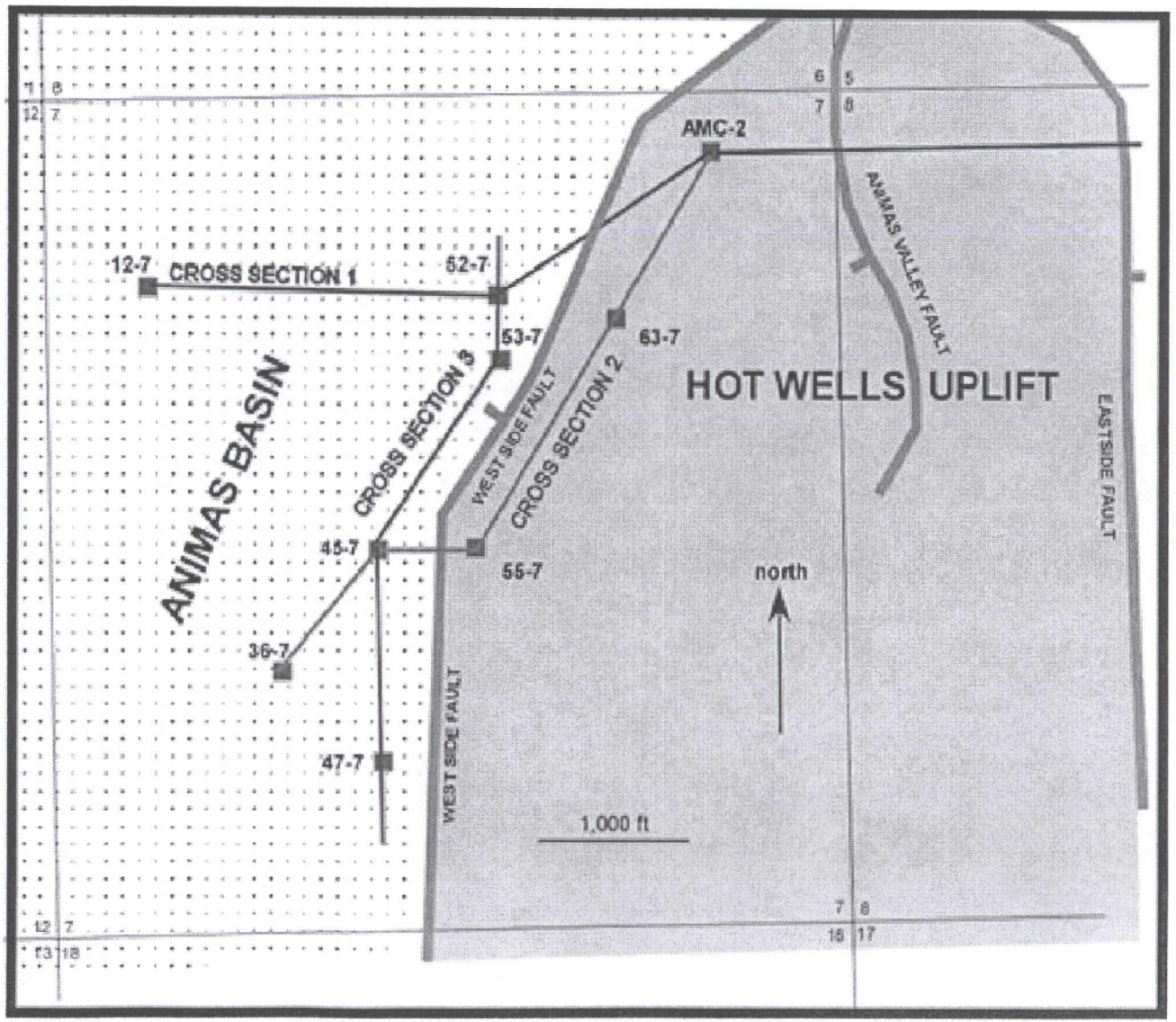
1) Cockrell 1 Pyramid
2) AmeriCulture 2
3) Steam Reserve 55-7



SUMMARY GEOLOGIC LOG OF THE AMERICULTURE 2 WELL



LOCATION MAP OF WELLS, FAULTS, AND CROSS SECTION LINES



GEOLOGIC CROSS SECTION 1

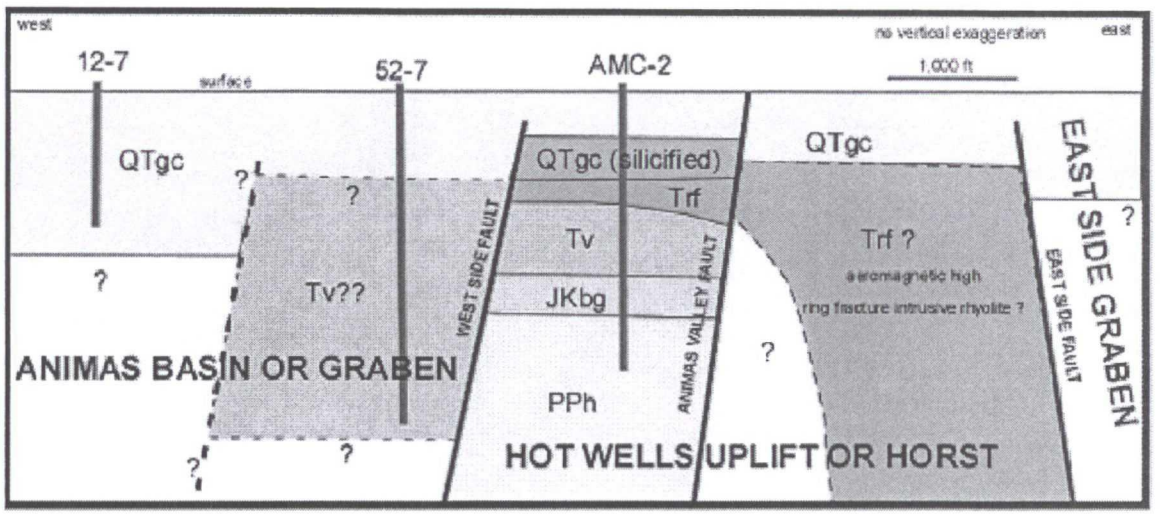
QTgc – basin fill/Gila Conglomerate

Trf – ring fracture zone rhyolite

Tv – Tertiary volcanics

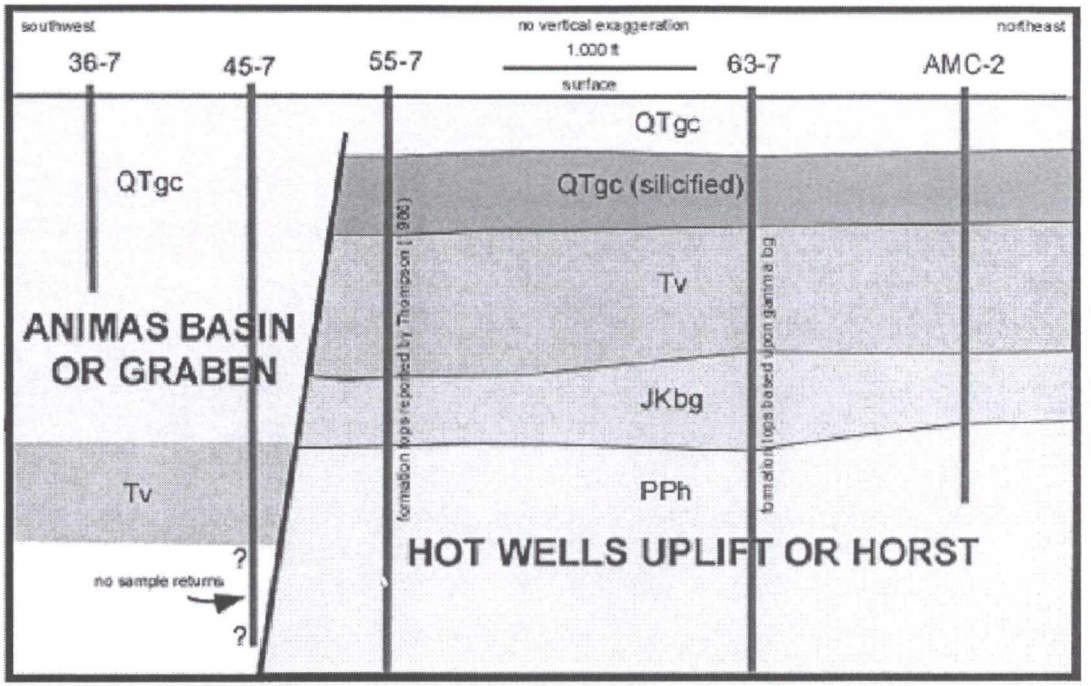
JKbg – Mesozoic Bisbee Group

PPh – Paleozoic limestone



GEOLOGIC CROSS SECTION 2

- 45-7 is completed in the Animas graben.
- 55-7 is completed in the "hot wells" horst block.
- 45-7 and 55-7 are in different thermal regimes with different reservoir hosts.
- 45-7 is completed in the Animas graben.



QTgc – basin fill/Gila Conglomerate

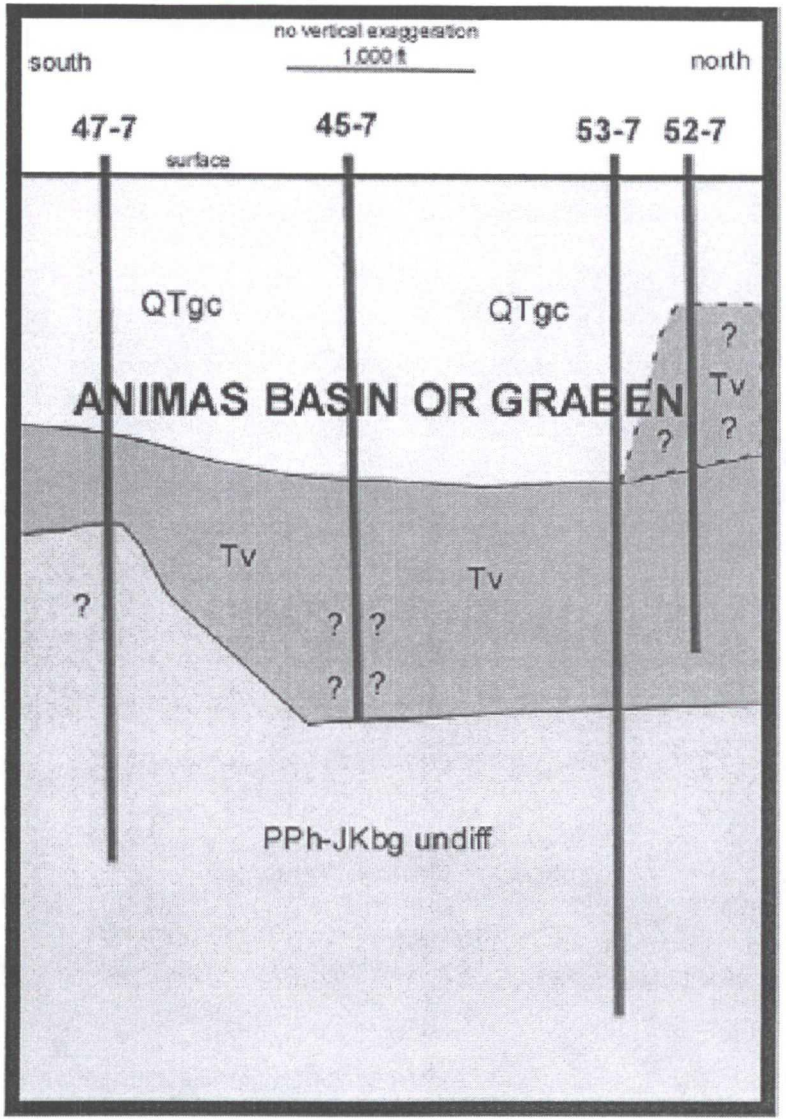
Tv – Tertiary volcanics

JKbg – Mesozoic Bisbee Group

PPh – Paleozoic limestone

GEOLOGIC CROSS SECTION 3

Wells 45-7 and 53-7 are completed in the Animas basin or graben.



QTgc – basin fill/Gila Conglomerate

Tv – Tertiary volcanics

JKbg – Mesozoic Bisbee Group

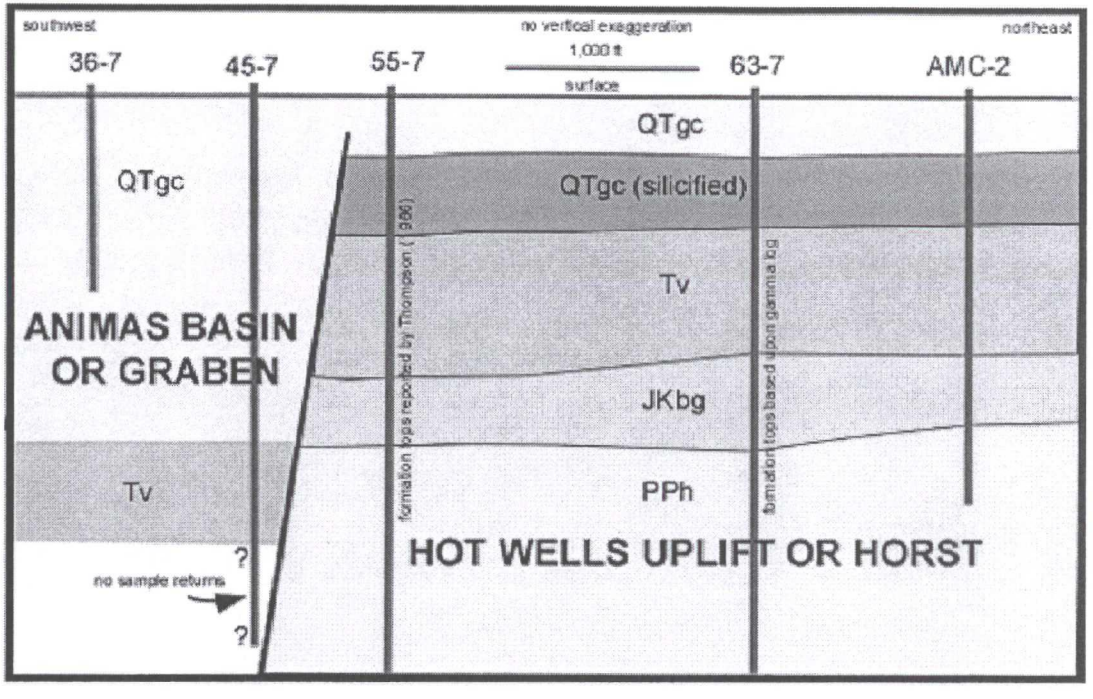
PPh – Paleozoic limestone

GEOHYDROLOGY AND THERMAL REGIME OF 45-7

GEOCHEMISTRY
1 March 2011 sampling
Turner Laboratories, Tucson

Data:
- TDS 580 mg/L
- Silica 120 mg/L
- Cl 44 mg/L
- SO4 220 mg/L
- Na 250 mg/L
- Things don't add up? Why?

Interpretation:
- Conductively-heated fresh basin-fill water adjacent the western boundary fault of the "hot wells" horst.
- Quartz (silica) equilibrates with water at temperatures approaching 150 C very rapidly.
- Reservoir is not sustainable without induced flow across fault from the reservoir in the "hot wells" horst.



QTgc – basin fill/Gila Conglomerate

Tv – Tertiary volcanics

JKbg – Mesozoic Bisbee Group

PPh – Paleozoic limestone

45-7 CHEMISTRY DISCUSSION

- TDS (total dissolved solids) less than fresh water source for drilling fluid (March, 2011).

- Chemistry of January 2012 is different after pumping and breakthrough of water across fault zone.

- Chemistry of January 2012 also appears to show enhanced TDS and silica concentration from mixing of injection of boiled and evaporated early production from 45-7 into 55-7.

ISOTOPIC EVIDENCE FOR RESERVOIR AND FLOW PATH

SAMPLE	SITE	D/H	18O/16O	13C/12C	34S/32S	87Sr/86Sr
AM1	Burgett #1	-76	-9.9	-10.6	8.50	0.728344
AM2	Burgett #C	-76	-10.0	-8.6	8.55	0.725616
AM3	Burgett #6	-77	-10.8	n/a	8.34	0.727433
AM4	Americulture Fed	-70	-10.1	-10.0	8.84	0.728861

- Carbon isotopes are too low for water that has flowed through Paleozoic carbonate rocks (0 to +6)

- Sulfur isotopes show very little variation and suggest a single mineral source such as pyrite. The sulfur isotope ratio is too low for Paleozoic marine sulfate (+10 to +30) and is consistent with magmatic ratios (accessory pyrite in volcanics and intrusives).

- Strontium isotope ratios are too high for flow through Paleozoic carbonate rocks and mafic and intermediate volcanic rocks (<0.710) and indicates flow through rhyolite and granite of mid-Tertiary to Precambrian age.

SUMMARY OF FINDINGS 1

NOTE: Same as presented to OCD in April 2009 hearing

- The Lightning Dock system is a very small geothermal system and will not sustain power production greater than 2 or 3 MW.

- The nature of the upflow zone is not well defined except to infer that it is very localized and may be less than a few tens of acres in planar cross section area.

- The geothermal fluids do not flow across or originate in Paleozoic carbonate rocks.

- Proposed injection and production wells are located from one another in dramatically different hydrogeologic domains.

- Characterization of deep resource potential is not well defined and can only be classified in an immature exploration stage.

- Excessive production and injection or improperly located wells will quench the current resource.

SUMMARY OF FINDINGS 2 part 1

- Well 45-7 is completed in a separate basin reservoir than the horst or uplift reservoir that 55-7 is completed.
- Well 45-7 chemistry (3/2011- Turner Labs) is consistent with basin-fill associated with rhyolite clast compositions or rhyolite.
- High silica represents equilibration of heated fresh water with quartz and disassociation of the primary dissolved silica species into secondary species at high pH and does not indicate a primary geothermal fluid.
- Well 55-7 and well 45-7 are completed in different reservoirs. Any production from 45-7 should be injected into a deep basin location and not in the horst block.

SUMMARY OF FINDINGS 2 part 2

- Injection into 55-7 during pump test shows water level rising from 80 ft depth to surface between 1/16/2012 and 1/24/2012.

- Production of 45-7 between 1/16/2012 and 2/3/2013 shows drawdown over 110 ft with injection.

- Sustainability of constant mass and energy flow from reservoir for commercial power and no impact to current use of geothermal heat and water rights holders is highly questionable.