Tectonic Setting of Yucca Mountain, Nevada, in Evaluations of Fault, Earthquake, and Volcanic Hazards

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1

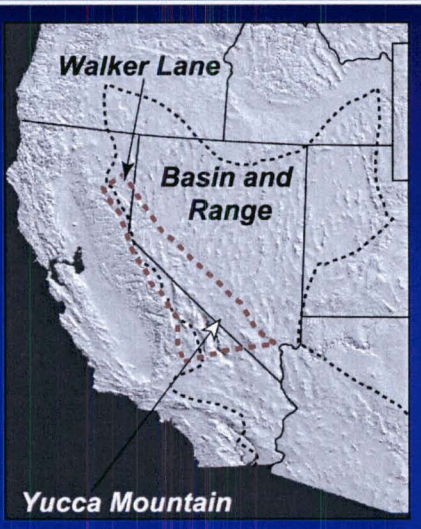
Outline

- Review of Yucca Mountain models
- Incorporation into PSHA
- Review of some existing models
- New data and model for Crater Flat
- What's next

2

Classes of Tectonic Models Proposed for Yucca Mountain

- **Volcano-genic**
  - Miocene silicic volcanism or continental rifting
- **Extension**
  - normal and low-angle detachment faulting
- **Dextral Shear**
  - pull-aparts



3

Volcano-Genic

- **Collapsed Caldera in Crater Flat**
- **Kawich-Greenwater Rift**

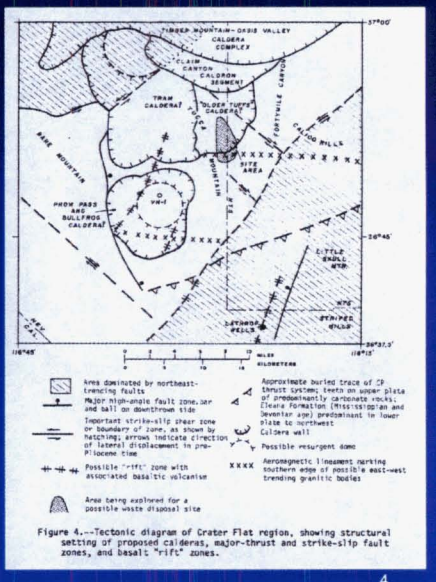
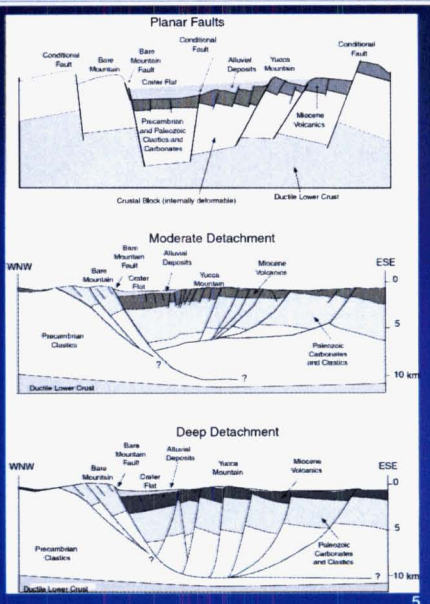


Figure 4.--Tectonic diagram of Crater Flat region, showing structural setting of proposed calderas, major-thrust and strike-slip fault zones, and basalt "rift" zones.

4

Extensional

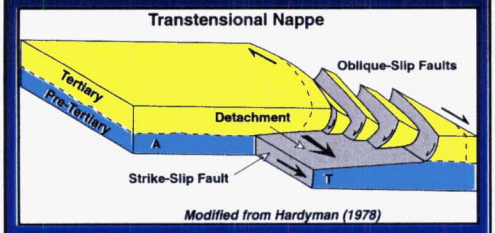
- Listric Normal Faults
- Planar Block Faults
- Regional Detachments



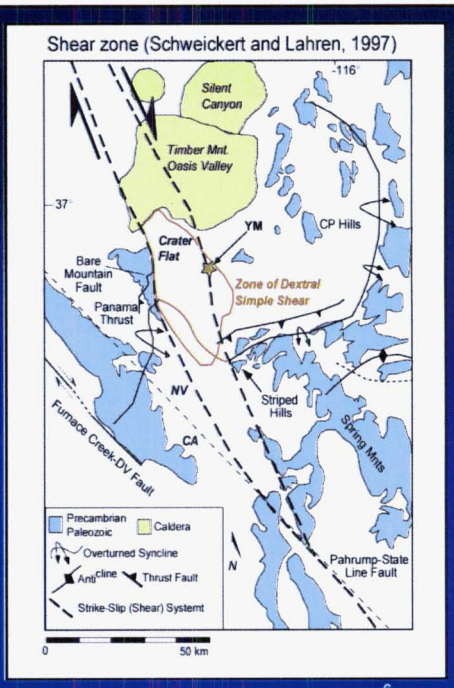
5

Dextral Shear

- Amargosa Desert Fault System



- Pull-Apart Basins, Rhombocasm, Sphenocam



6

Tectonic Models Based on Voluminous Data

- structural
- stratigraphic
- geochemical
- paleomagnetic
- radiometric
- seismic
- gravity
- magnetic
- borehole
- geomorphic
- paleoseismic
- earthquake
- geodetic
- chronological
- electromagnetic
- hydrologic
- petrologic
- petrophysical

7

Incorporation of Models into PSHA

- "*Murphy's Razor*"
  - Additional research often increases uncertainty.
  - No single tectonic model adequately incorporates all the data and information.
- **PSHA (and especially an expert elicitation) well suited for incorporation of this kind of uncertainty.**
  - DOE PSHA incorporated large variety of models.
  - Albeit some models given higher weight than others.

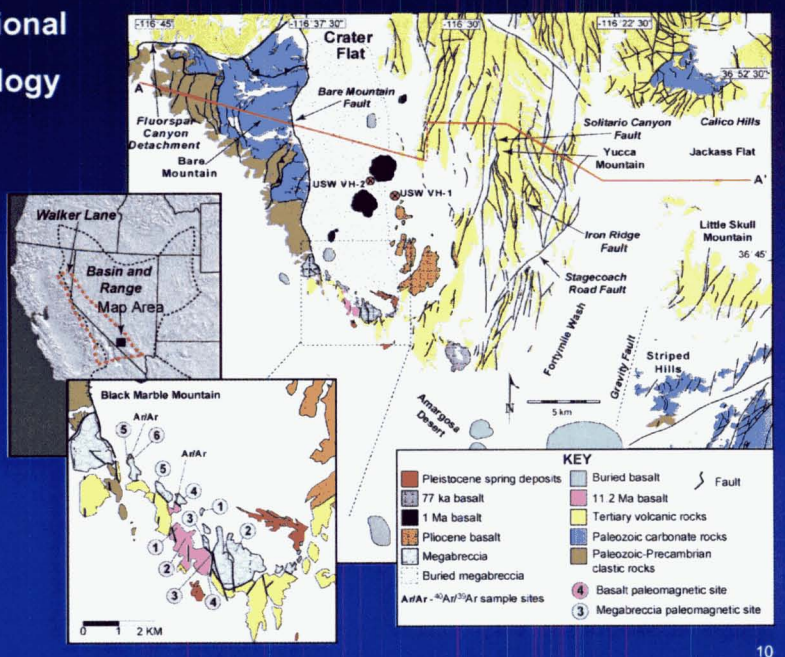
8

New Data and Model for Crater Flat

- Paleomagnetic and radiometric age data from Miocene basalt and megabreccia in southern Crater Flat.
- Revised 2D magnetic and gravity models across Crater Flat.
- Structural interpretation of Crater Flat Basin as the hanging wall of Bare Mountain Fault.

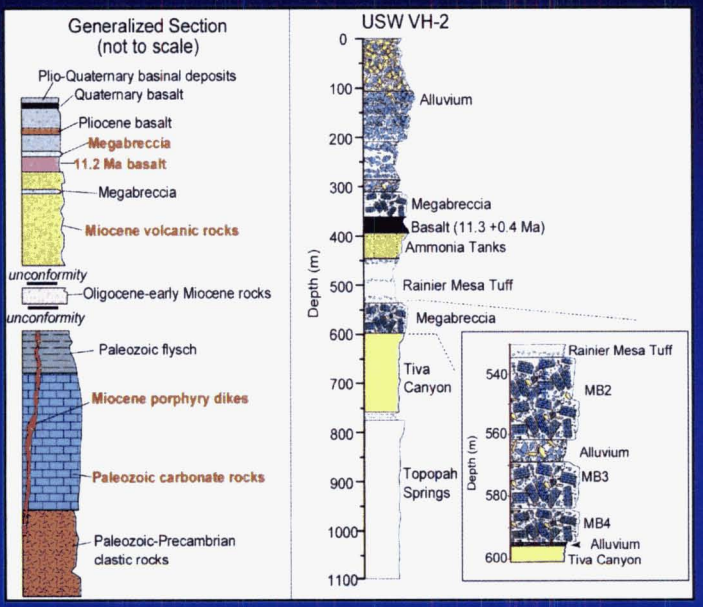
9

Regional Geology



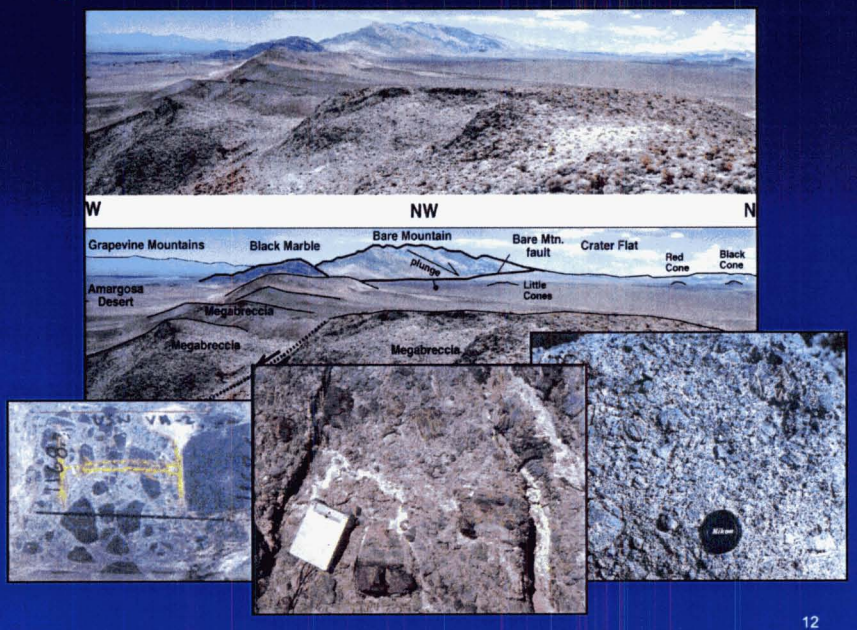
10

Generalized Stratigraphy



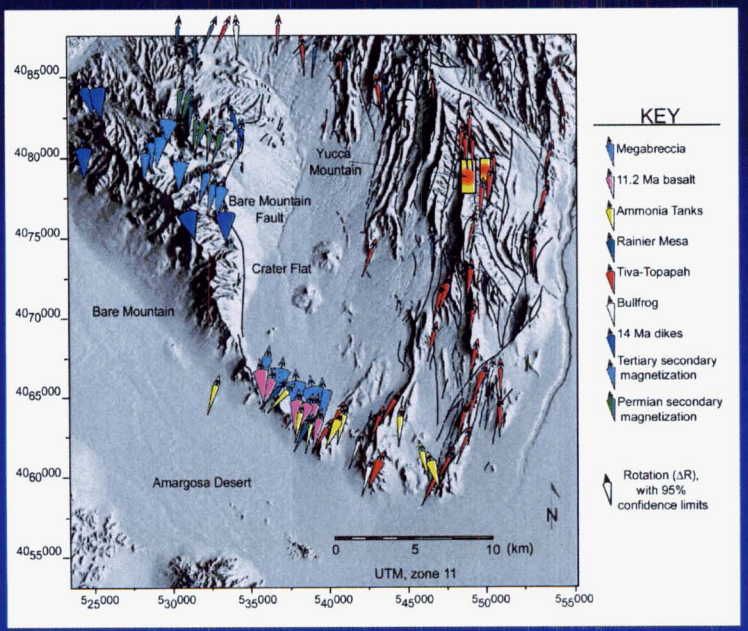
11

Megabreccia Exposed in Crater Flat and Well VH-2



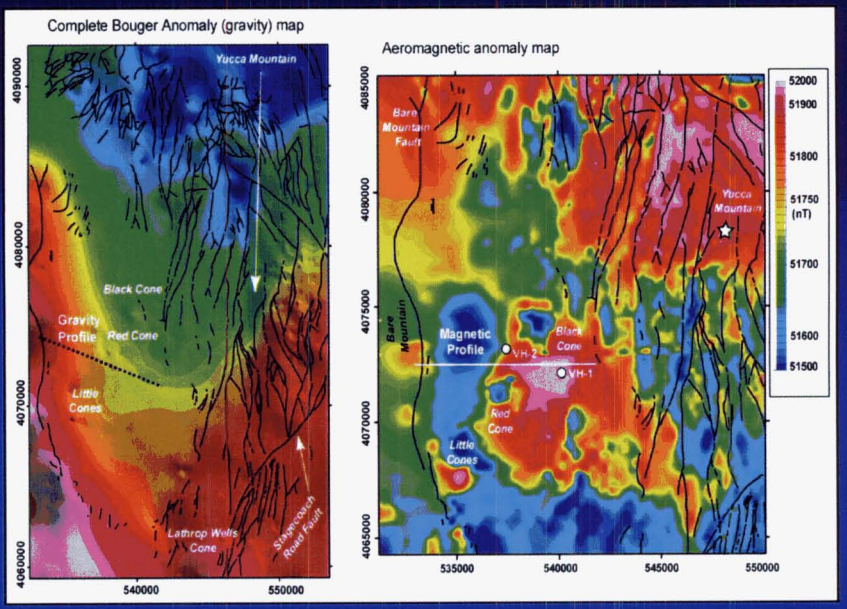
12

Summary of Paleomagnetic Vertical-Axis Rotation Data



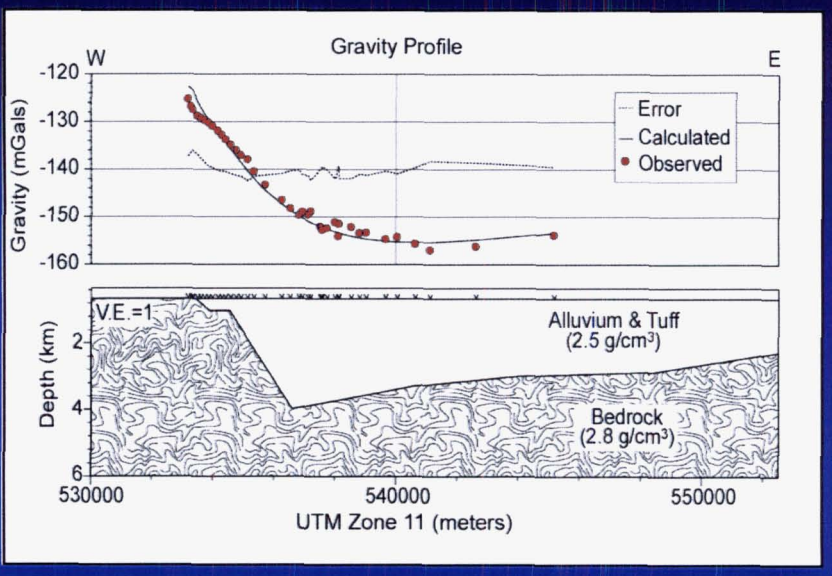
13

Gravity and Magnetic Data



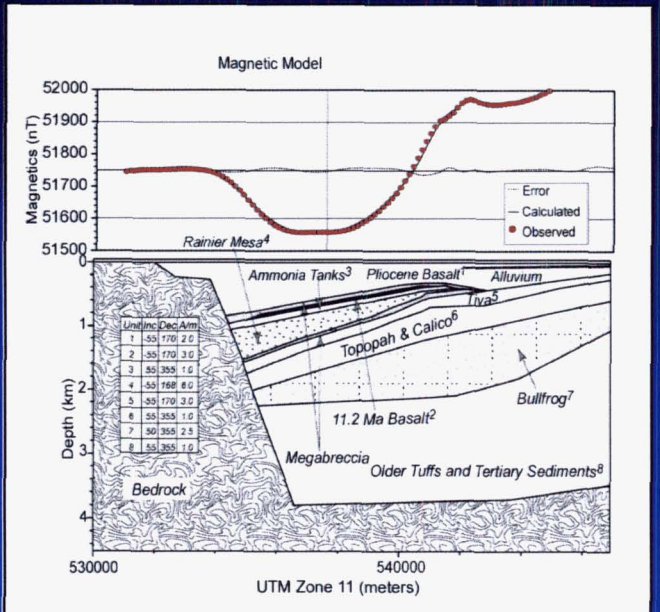
14

Gravity Model for Crater Flat



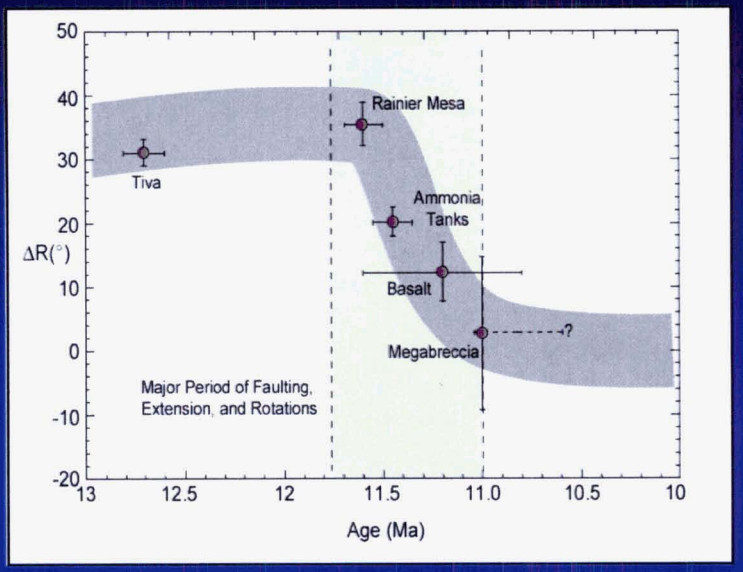
15

Magnetic Model for Crater Flat



16

Paleomagnetic Rotations Constrain Age of Faulting



17

Conclusions

- **Basin architecture controlled by 3D geometry of Bare Mountain fault**
- **Vertical-axis rotations from horizontal shear in hanging wall**
  - age and timing of extension constrained by age of vertical-axis rotations
  - main stage of basin growth between ~12 and 11 Ma., slip rates 1-3 mm/yr
  - since 11 Ma basin growth slow, slip rate 0.06 mm/yr or less
- **Geology also indicates rapid basin growth ~12-11 Ma**
  - wedge of Rainier Mesa adjacent to Bare Mountain
  - megabreccia younger than 11.2 Ma from over-steep Bare Mountain

18

Conclusions

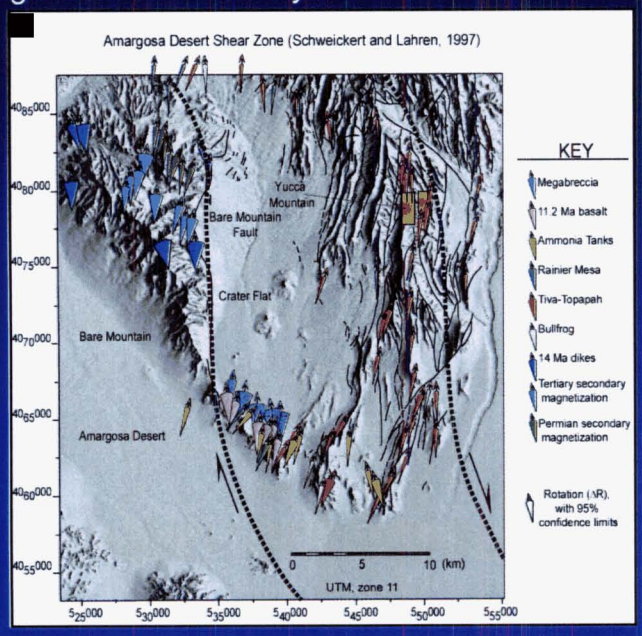
- **Implications for Seismic Hazard Assessment**
  - many faults at Yucca Mountain may not extend through entire sesimogenic crust.
  - Bare Mountain fault is the master fault in Crater Flat Basin
  - most of the fault slip occurred in Miocene (12-11 Ma)
- **Implications for Volcanic Hazard Assessment**
  - Many volcanic features localized along pre-existing structures.
  - No tectonic evidence to subdivide Crater Flat Basin into discrete source zones.

19

Back Up Slides

20

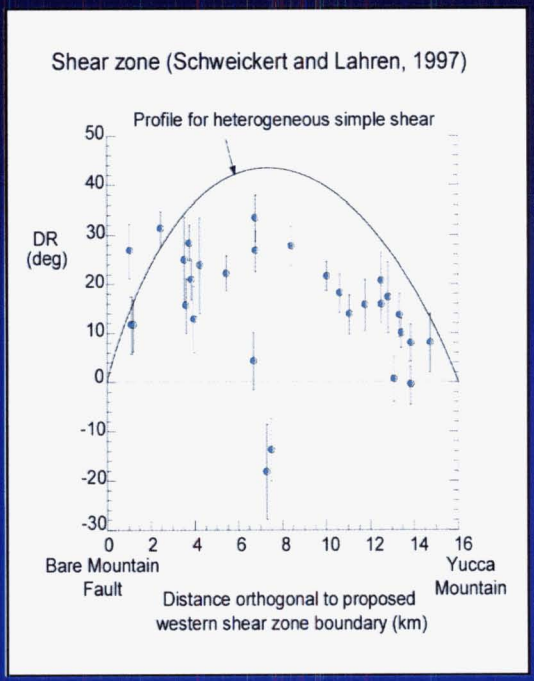
Amargosa Desert Fault System



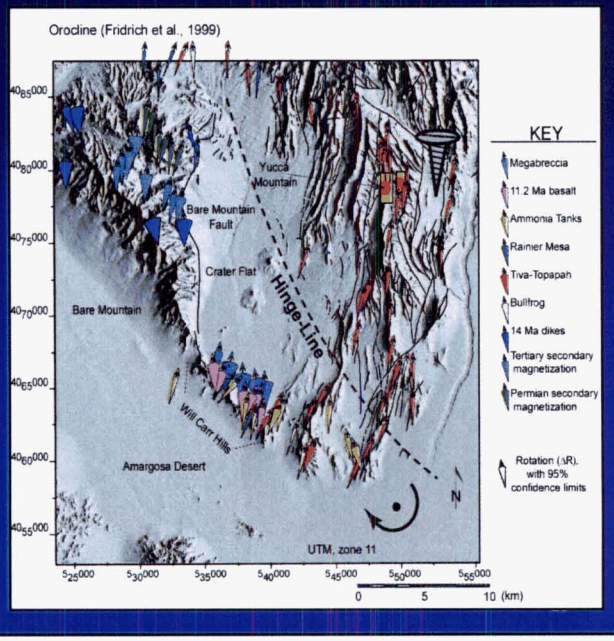
21

Paleomagnetic rotation data do not fit expected shear profile

(Stamatakos and Ferrill, 1998)

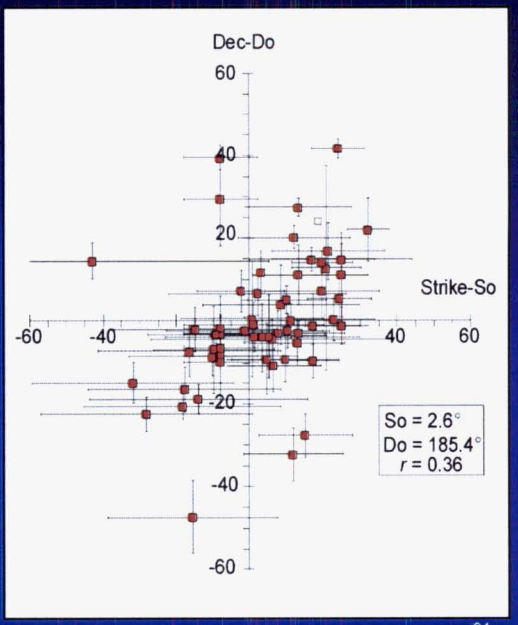


Yucca Mountain Orocline



Paleomagnetic rotation data do correlate with orientation of faults

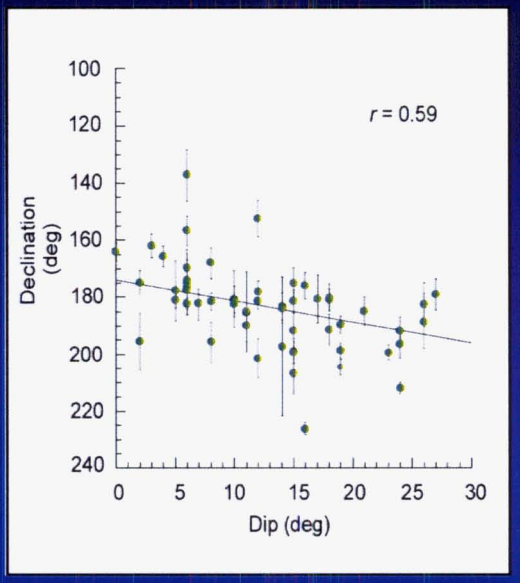
(Stamatakos and Ferrill, 1998)



24

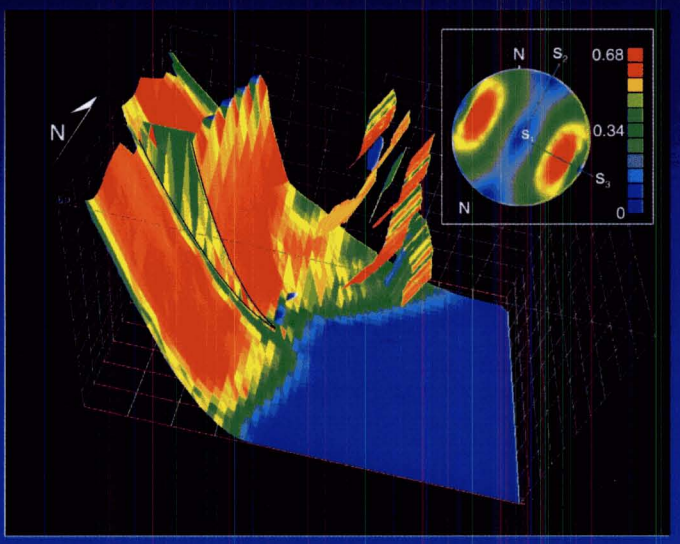
Paleomagnetic rotation data correlate with stratal tilt

(Stamatakos and Ferrill, 1998)

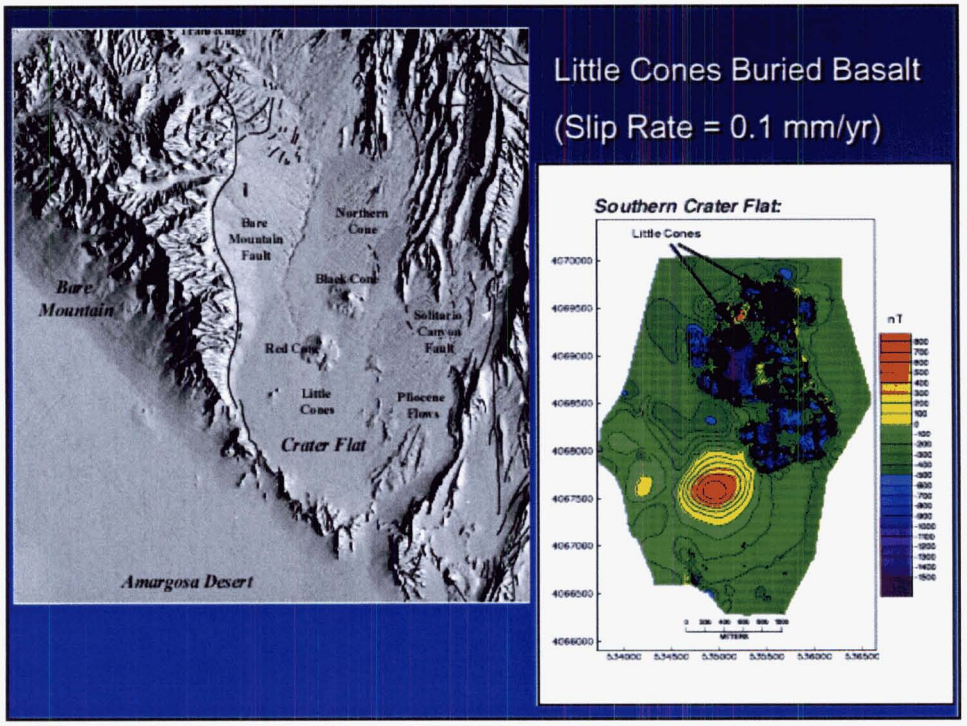


25

3D Stress™ OF Yucca Mountain, Nevada



26


Little Cones Buried Basalt
(Slip Rate = 0.1 mm/yr)
Bare Mountain
Bare Mountain Fault
Northern Cone
Black Cone
Solitario Canyon Fault
Red Cone
Little Cones
Pliocene Flows
Crater Flat
Amargosa Desert
Southern Crater Flat:
Little Cones
nT
METERS