Vertical and Inclined Axis Rotations in Extensional Settings

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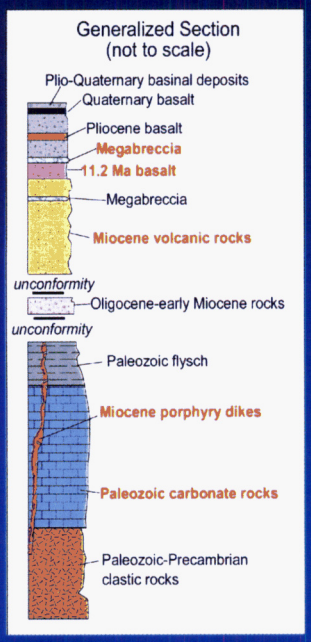
GSA 2002

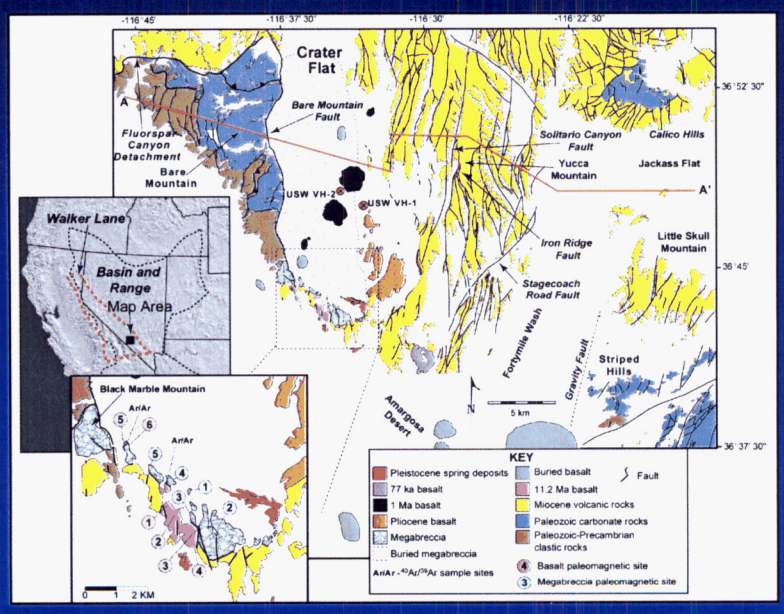


Generalized Stratigraphy of Yucca Mountain Region

Vertical Axis Rotation Data From Paleomagnetic Studies of:

- Paleozoic Carbonate Strata
- Miocene (~14 Ma) quartz-latite dikes
- Miocene (~13-11 Ma) rhyolite tuff strata
- Miocene Basalt (11.2 Ma)
- Miocene carbonate megabreccia

Geologic Setting of Yucca Mountain Region



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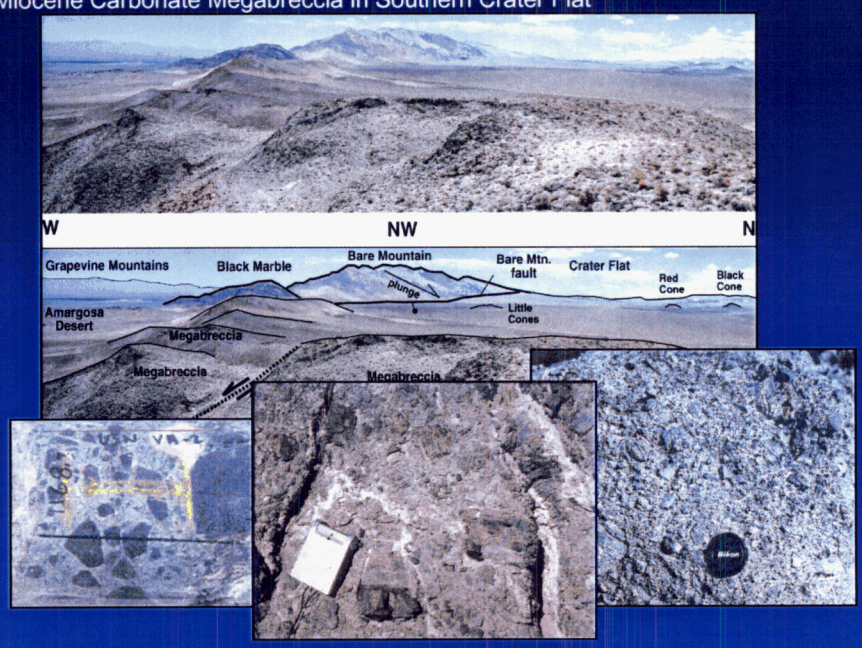
Miocene Carbonate Megabreccia in Southern Crater Flat



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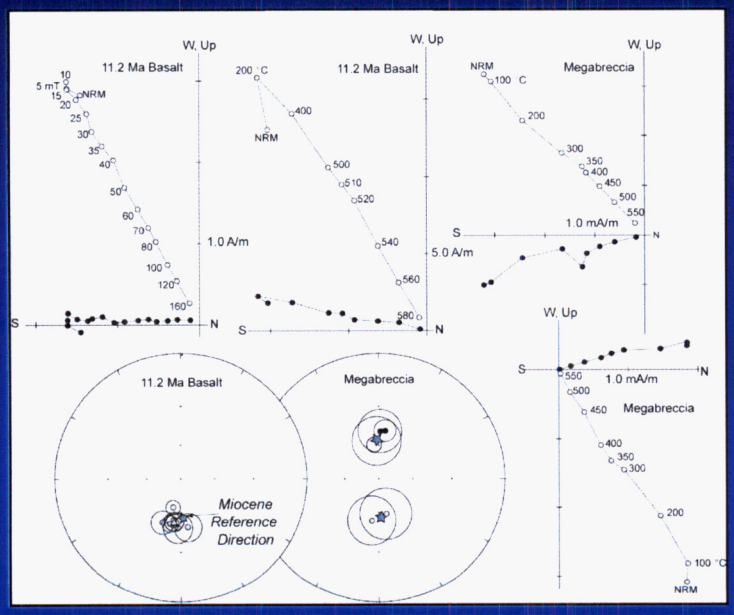
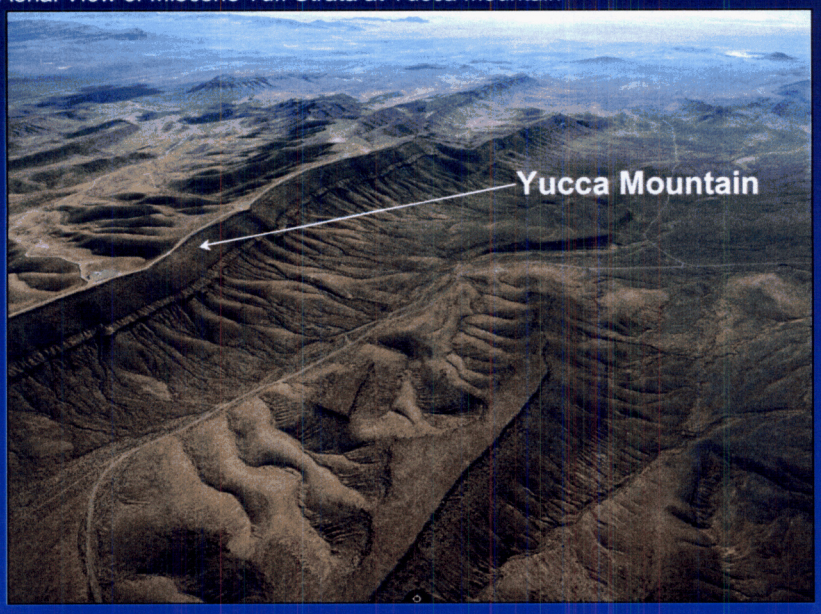
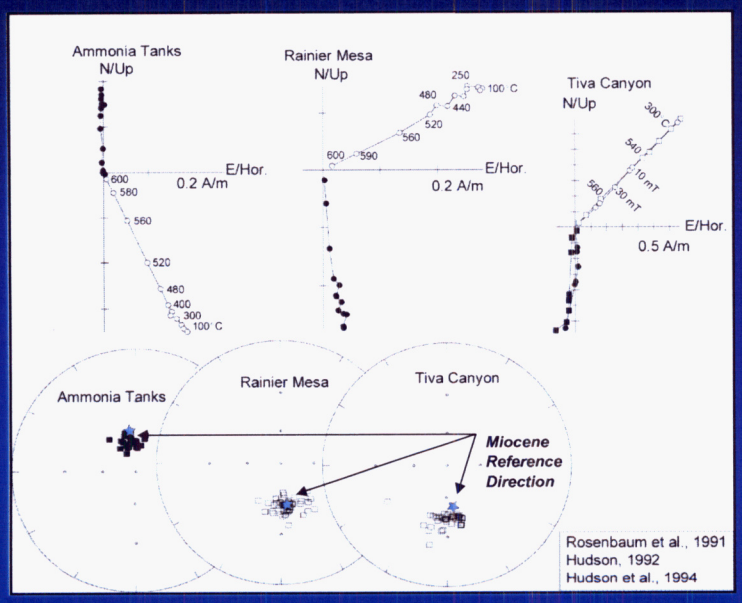
Paleomagnetic Results from Miocene Megabreccia and 11.2 Ma Basalt



Aerial View of Miocene Tuff Strata at Yucca Mountain



Paleomagnetic Results from Miocene Tuff Strata at Yucca Mountain



Rosenbaum et al., 1991
Hudson, 1992
Hudson et al., 1994

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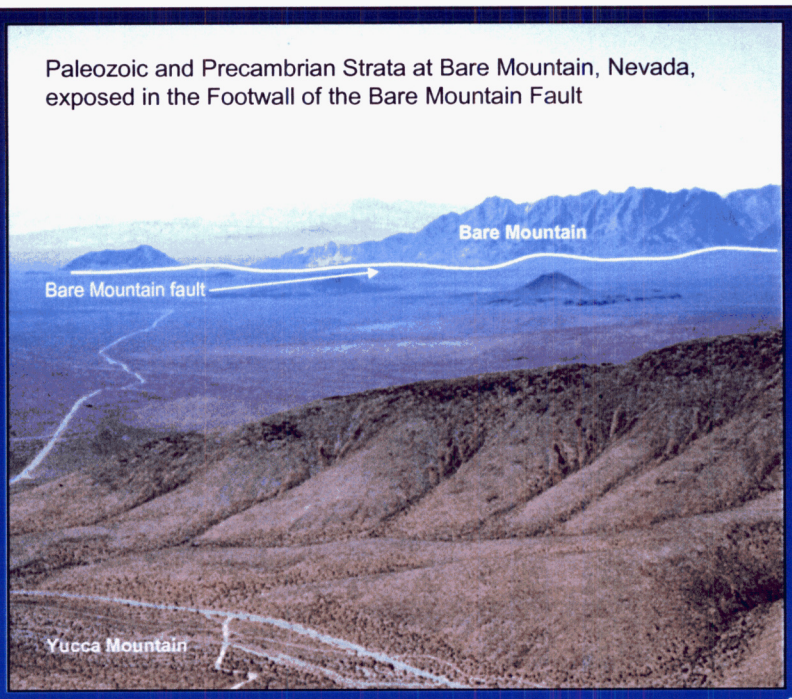
Paleozoic and Precambrian Strata at Bare Mountain, Nevada, exposed in the Footwall of the Bare Mountain Fault



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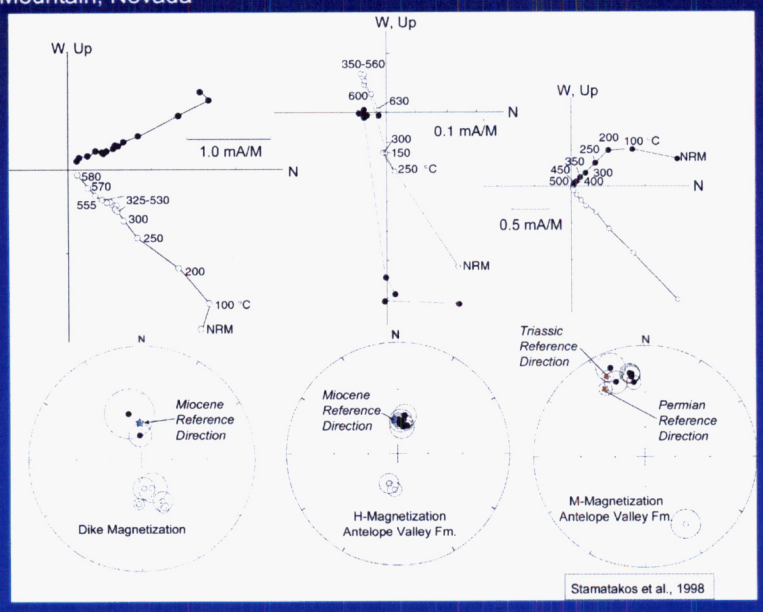
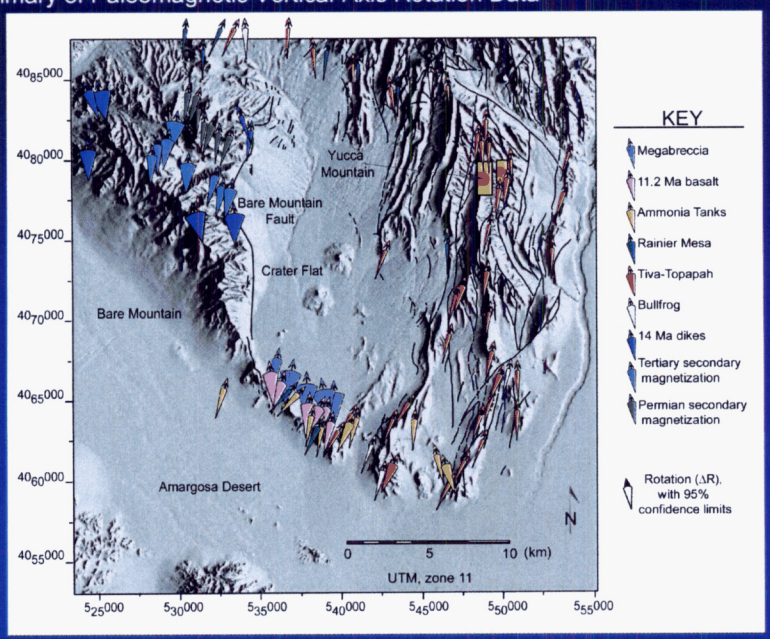
Paleomagnetic Results from Paleozoic Carbonate Strata and Miocene Dikes at Bare Mountain, Nevada

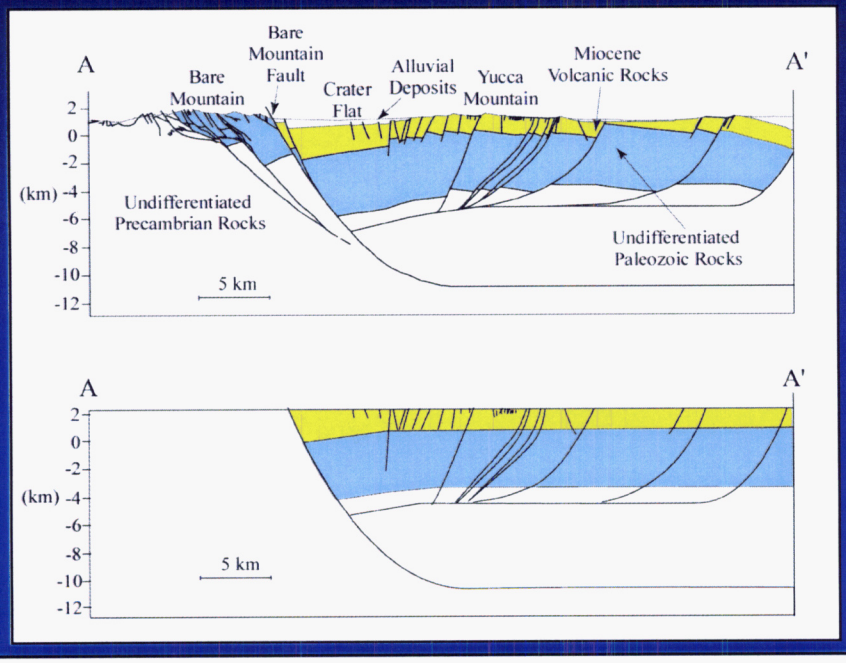


Stamatakos et al., 1998

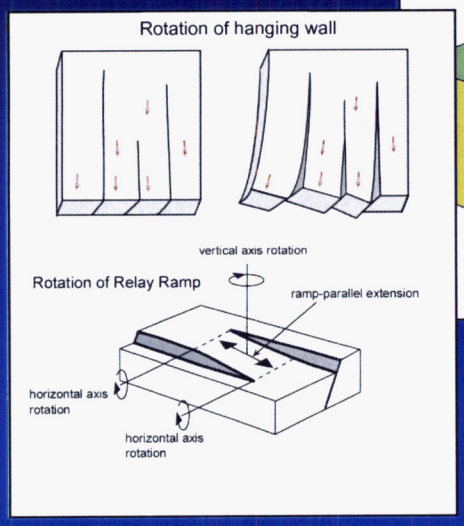
Summary of Paleomagnetic Vertical-Axis Rotation Data

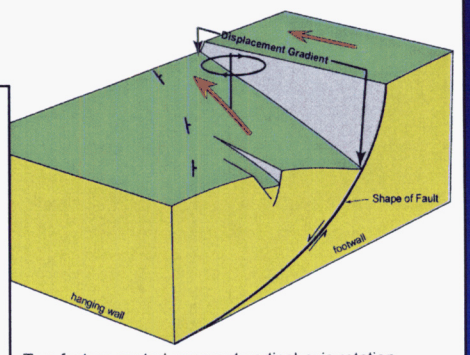


Cross-Section Across Crater Flat and Yucca Mountain



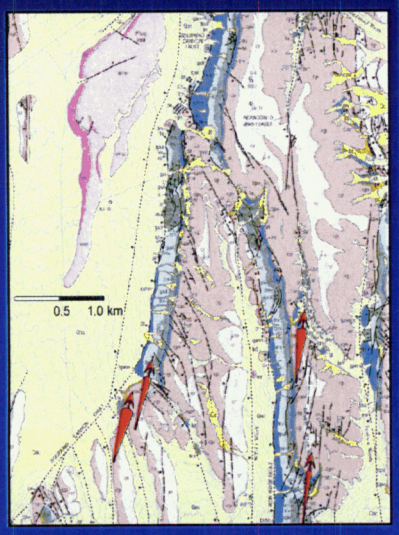
Models for how vertical-axis rotations are manifest in normal fault systems

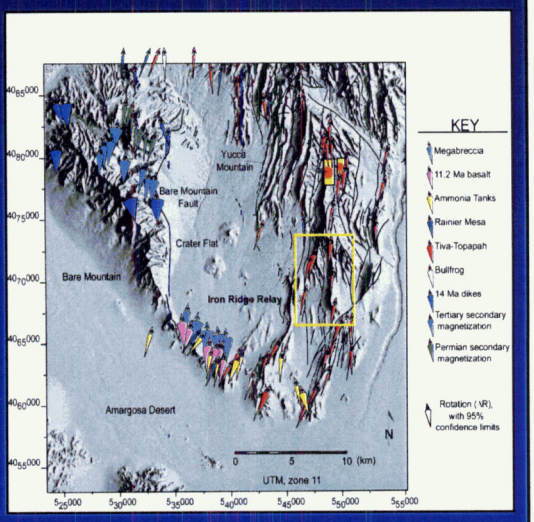




Two factors control apparent vertical-axis rotation, displacement gradient and shape of the fault

Example: rotations in the Iron Ridge relay ramp





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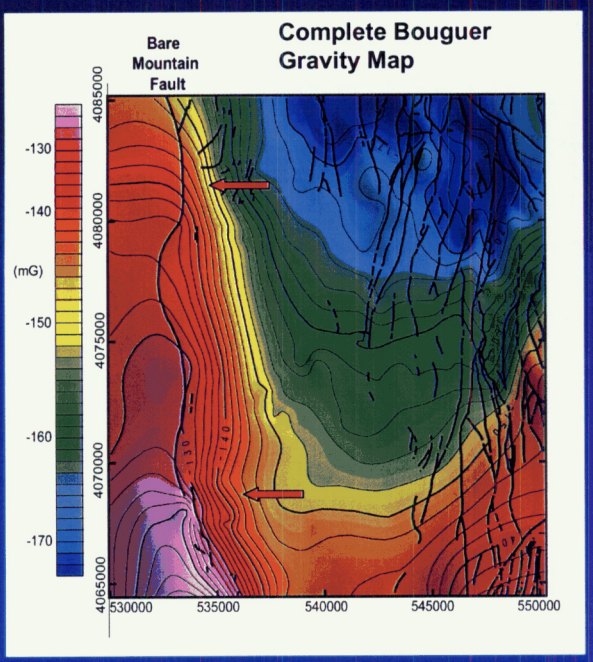
Complete Bouguer Gravity Map



Dip of the Bare Mountain Fault:

Shallower in Northern Crater Flat (~45°)

Steeper in southern Crater Flat (~70°)

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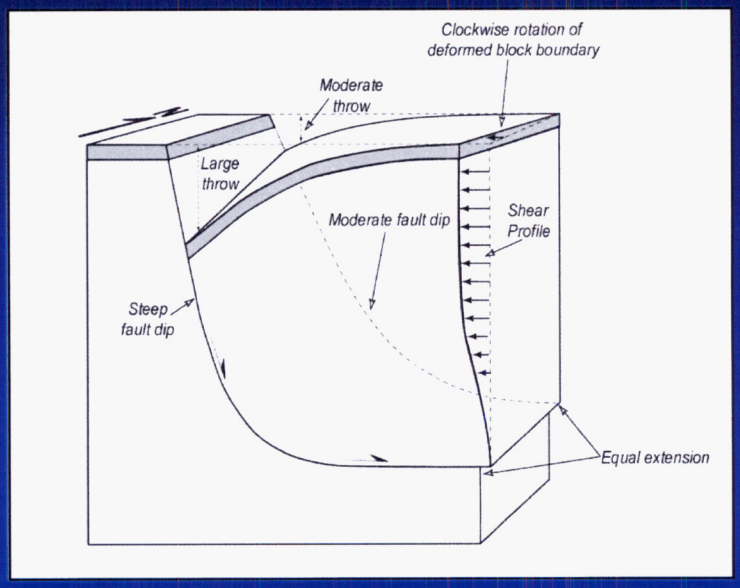
Model of hanging wall deformation above listric Bare Mountain Fault



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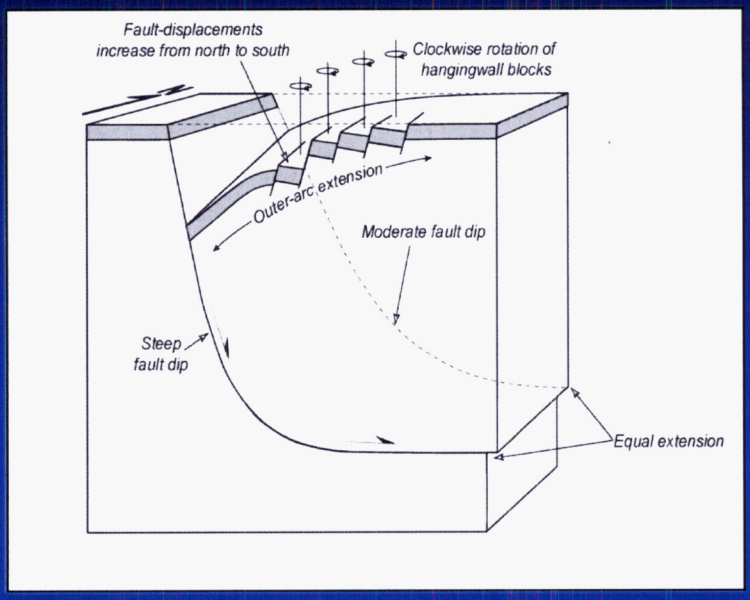
Model of hanging wall deformation above listric Bare Mountain Fault



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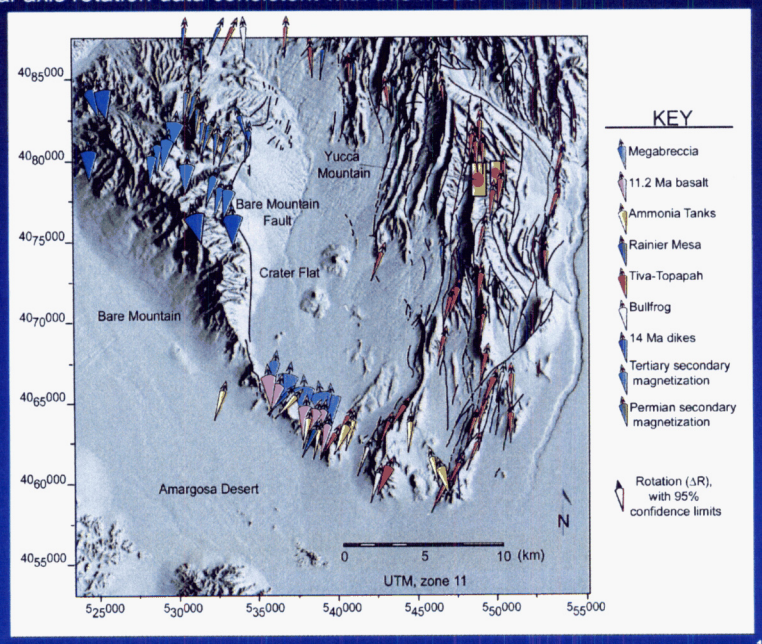
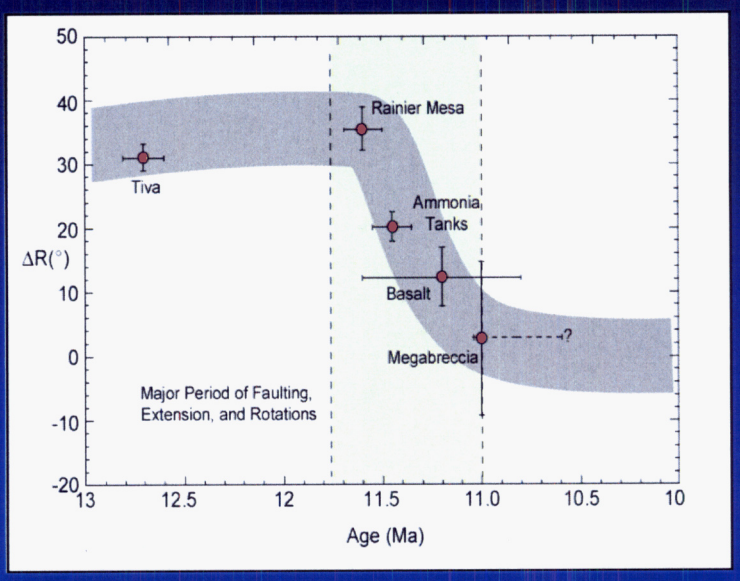
Vertical-axis rotation data consistent with this model



Paleomagnetic Rotations (ΔR) Constrain Age of Faulting



Conclusions

- **Basin architecture controlled by 3D geometry of Bare Mountain fault**
  - fault steepens from north to south
  - steeper fault segments less efficient at accommodating extension
- **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
- **Geology also indicates rapid basin growth ~12-11 Ma**