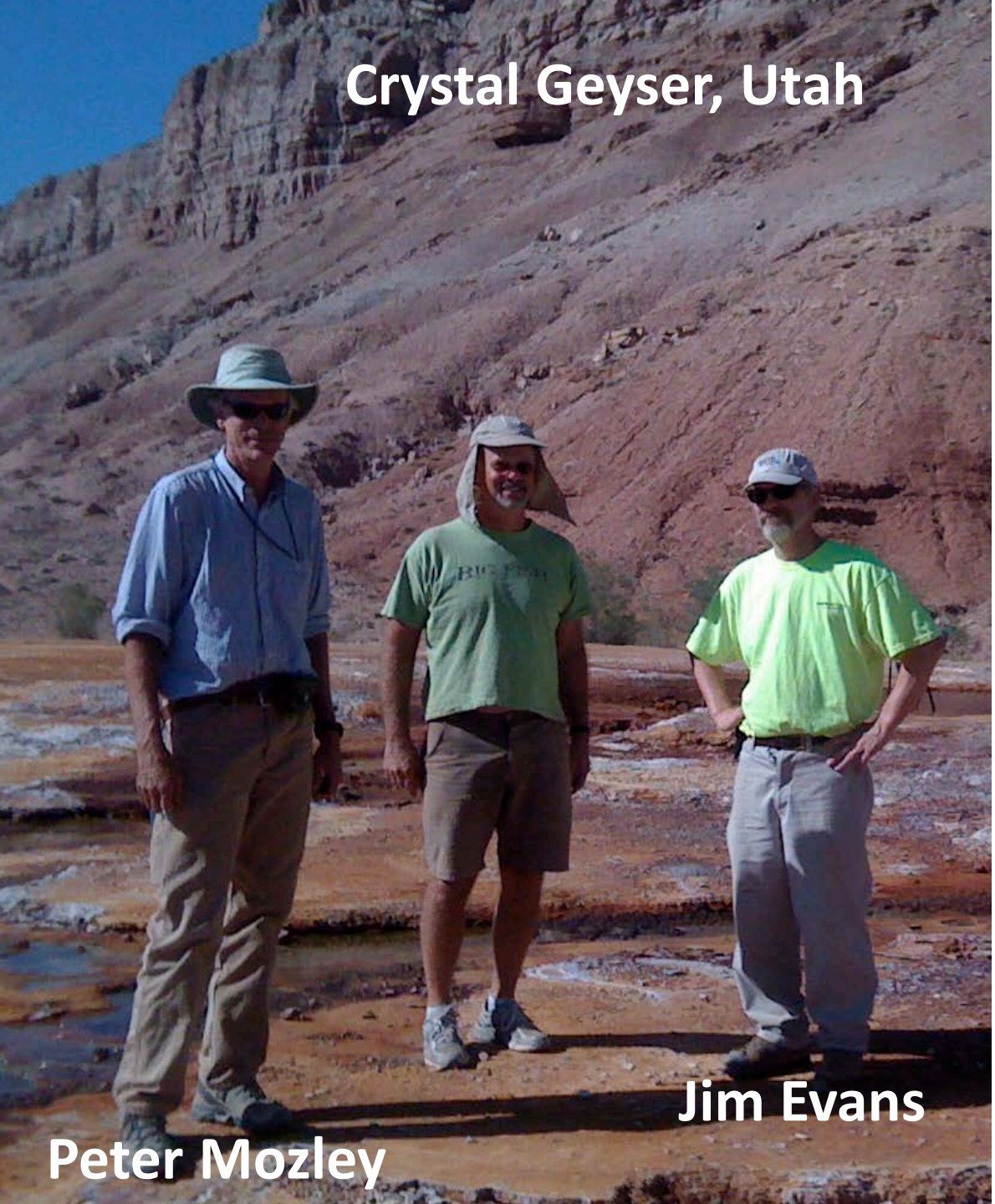
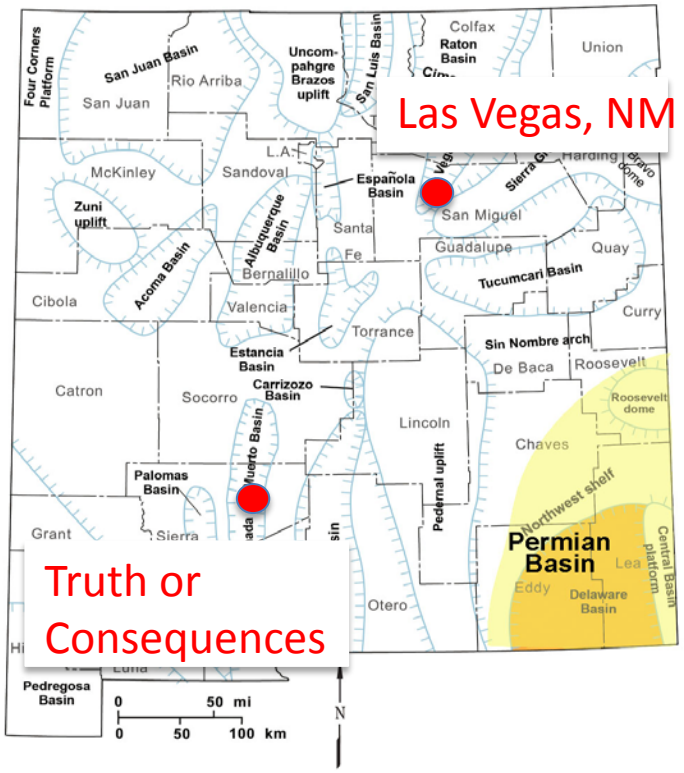


Crystalline Basement & Precambrian Fault Permeability Global and New Mexico Perspectives

Mark Person, New Mexico Tech

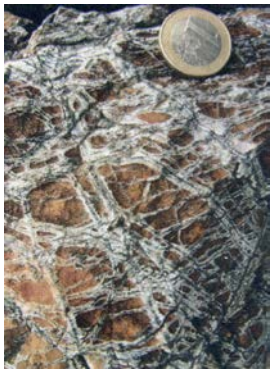
Collaborators:
Peter Mozley New Mexico Tech
Jim Evans (Utah State University)

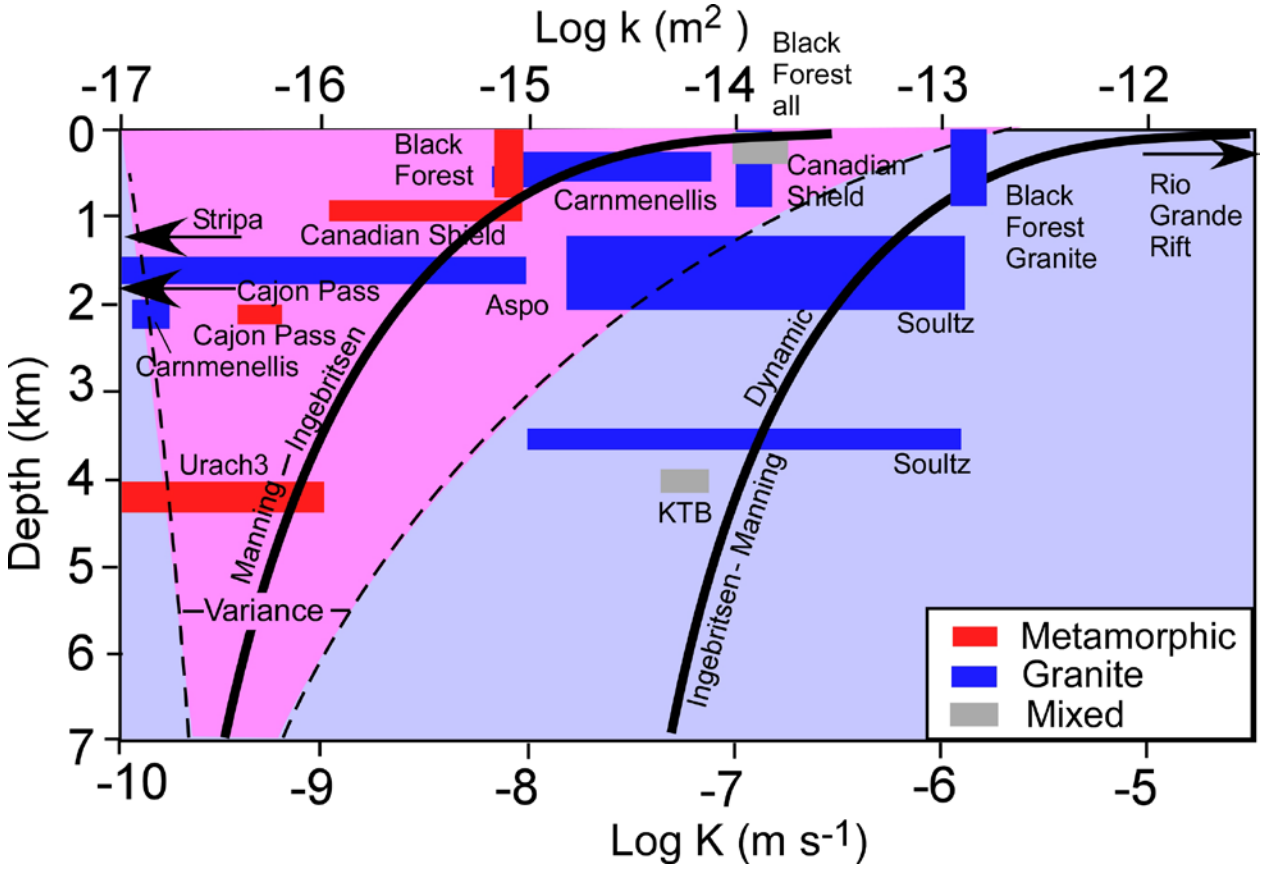


Global Perspective: Crystalline Basement Permeability

- Permeability Mean & Variance decays with depth
- Dynamic (based on Heat Flow Geophysics & Petrology data)
- Permeability Around Well Bore Annulus 8 Times Greater than Far Field Conditions
- Estimated Permeability @ 4km ~ 10^{-16} m^2

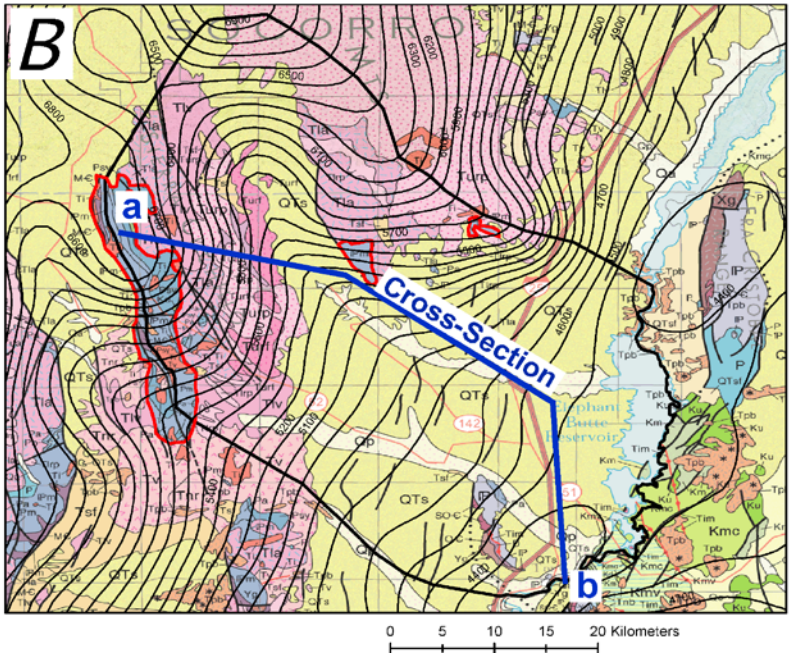
Inferred Permeability Below Deepest Borehole

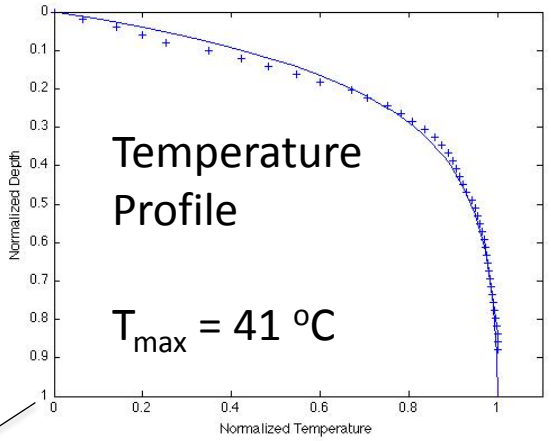


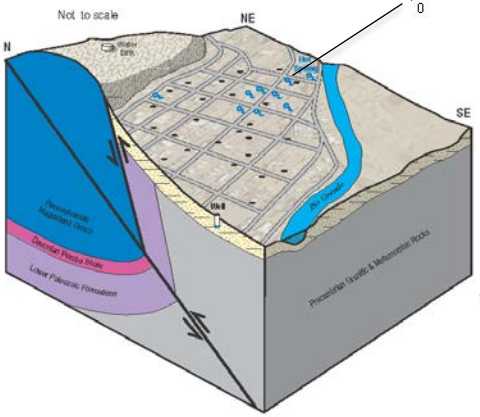


Stober & Bucher (2007) Hydrogeology Journal v 15: p. 213–224
Stober & Bucher (2015) Geofluids v. 15, p. 161–178
Ingebritsen & Gleason (2015) Geofluids Editorial on Crustal Permeability Thematic Issue

Fluid Circulation within Crystalline Basement: Truth or Consequences Hydrothermal System

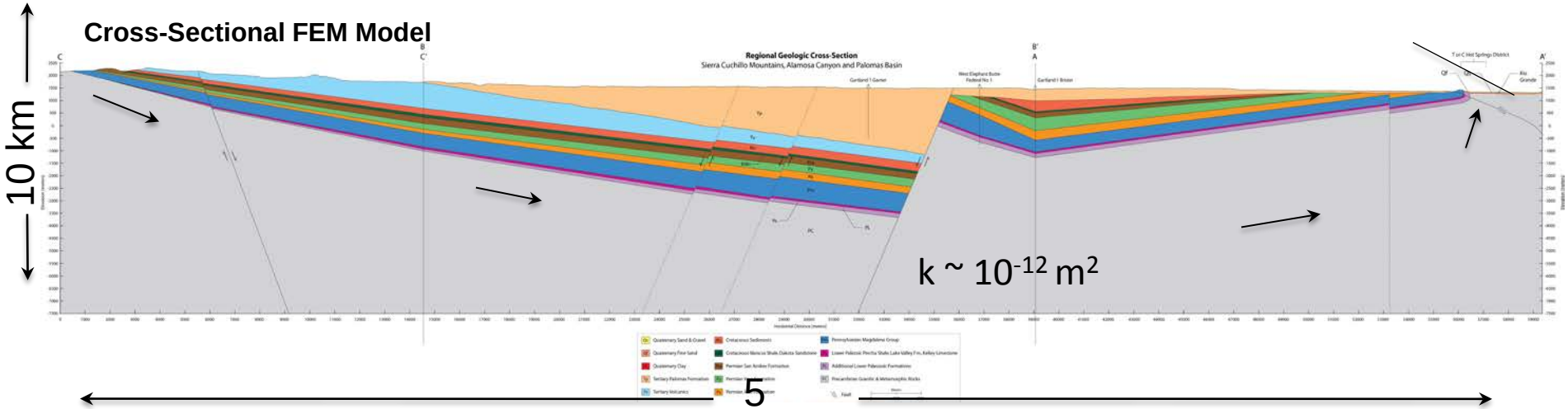




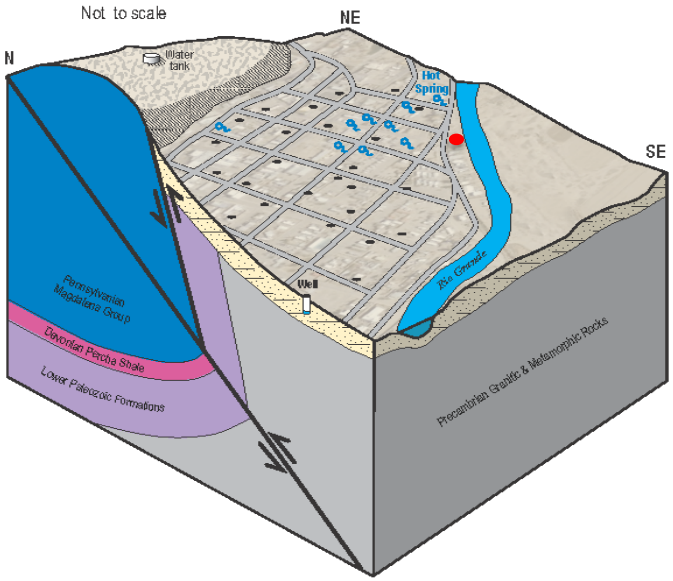


^{14}C age 6,000 to 10,000 Years

Cross-Sectional FEM Model

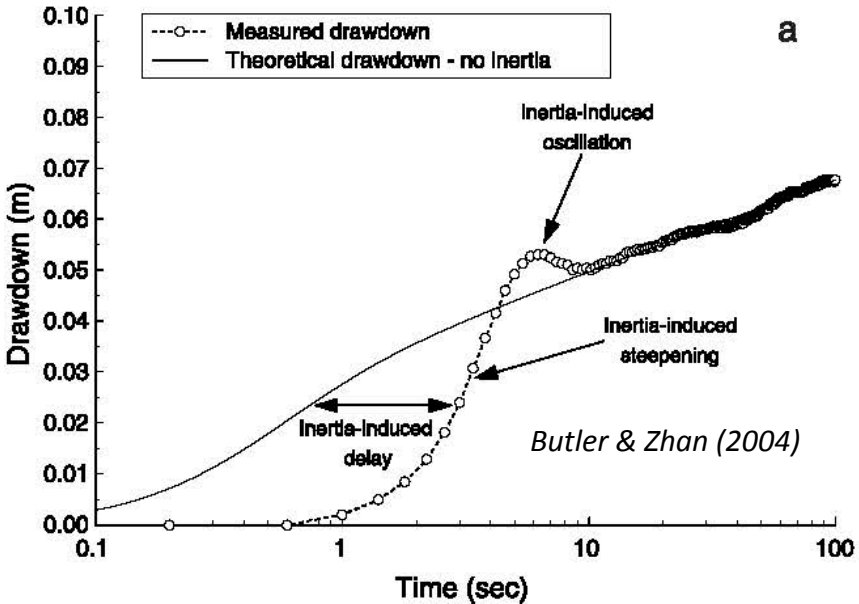


Truth or Consequences, New Mexico
Crystalline Basement Aquifer Test, June, 2015
$k = 5.2 \times 10^{-10}\ m^2$, 530,000 mD, Depth ~ 70 m



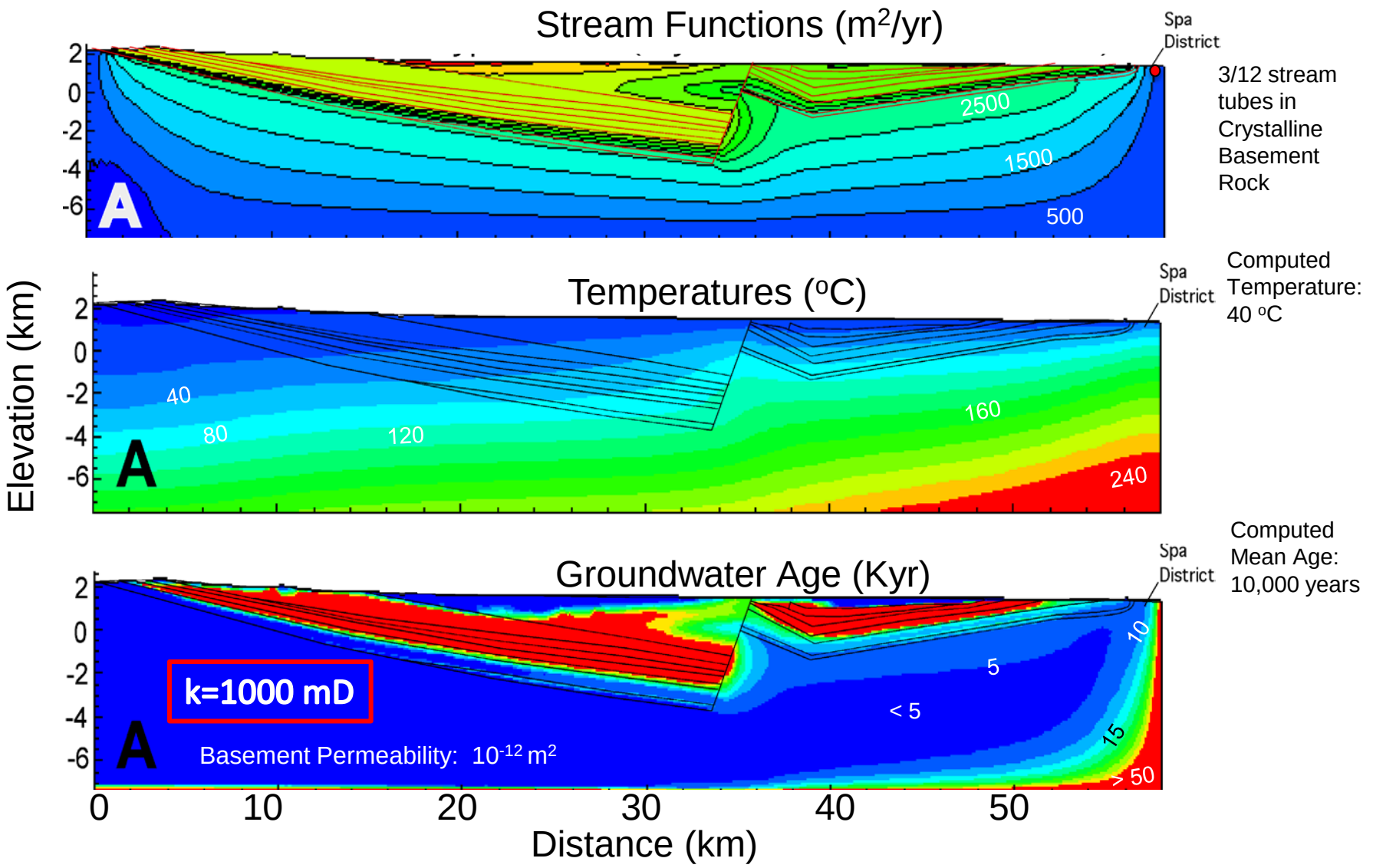
Pumping rate = 287 gpm
Duration of pumping = 99.317 mins (5,959 s)

Hydraulic Tests in Highly Permeable Aquifers

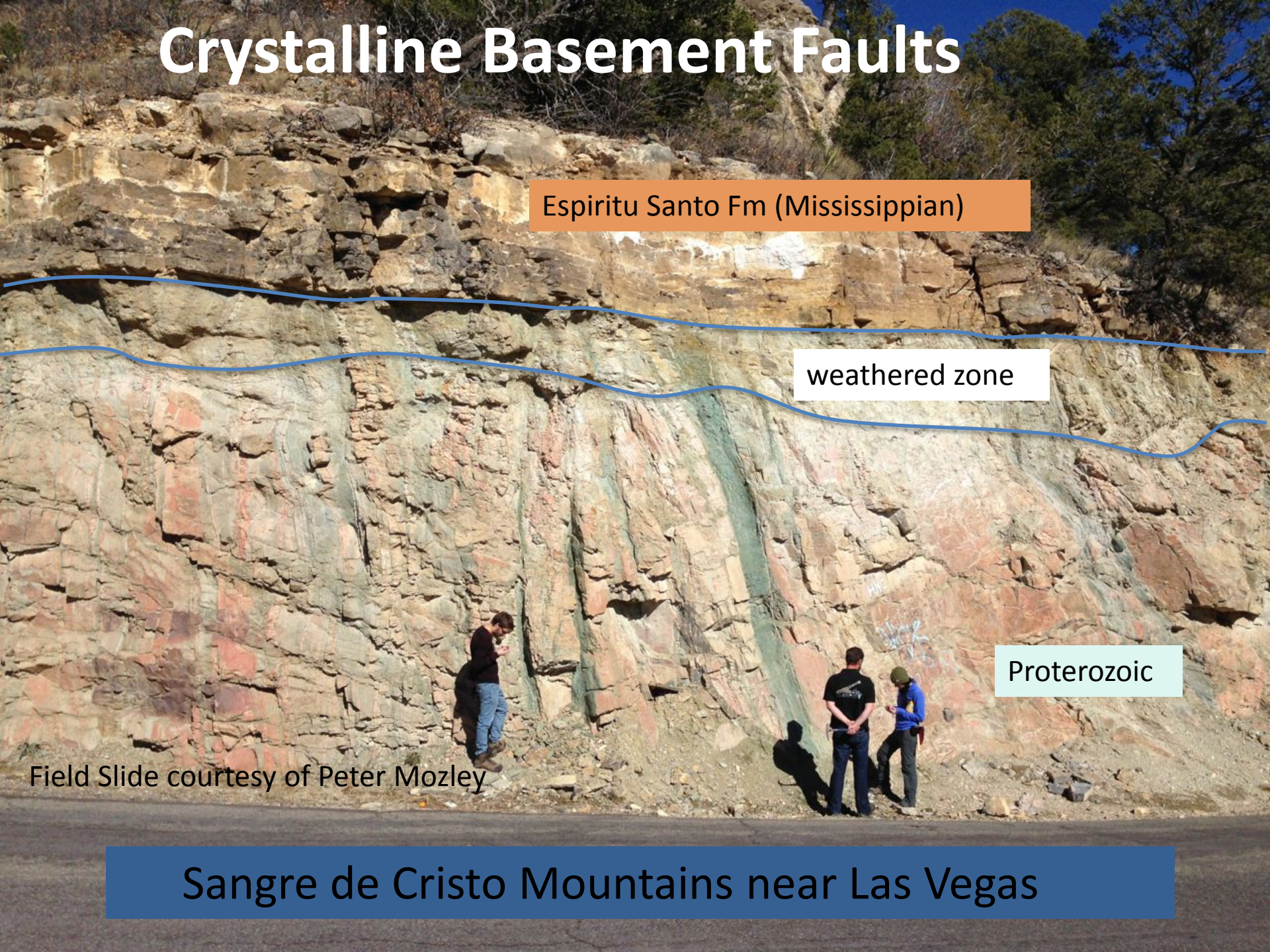


Butler & Zhan (2004)

Estimating Crystalline Basement Permeability For Truth or Consequences Hydrothermal System Using Cross-Sectional Hydrothermal Models

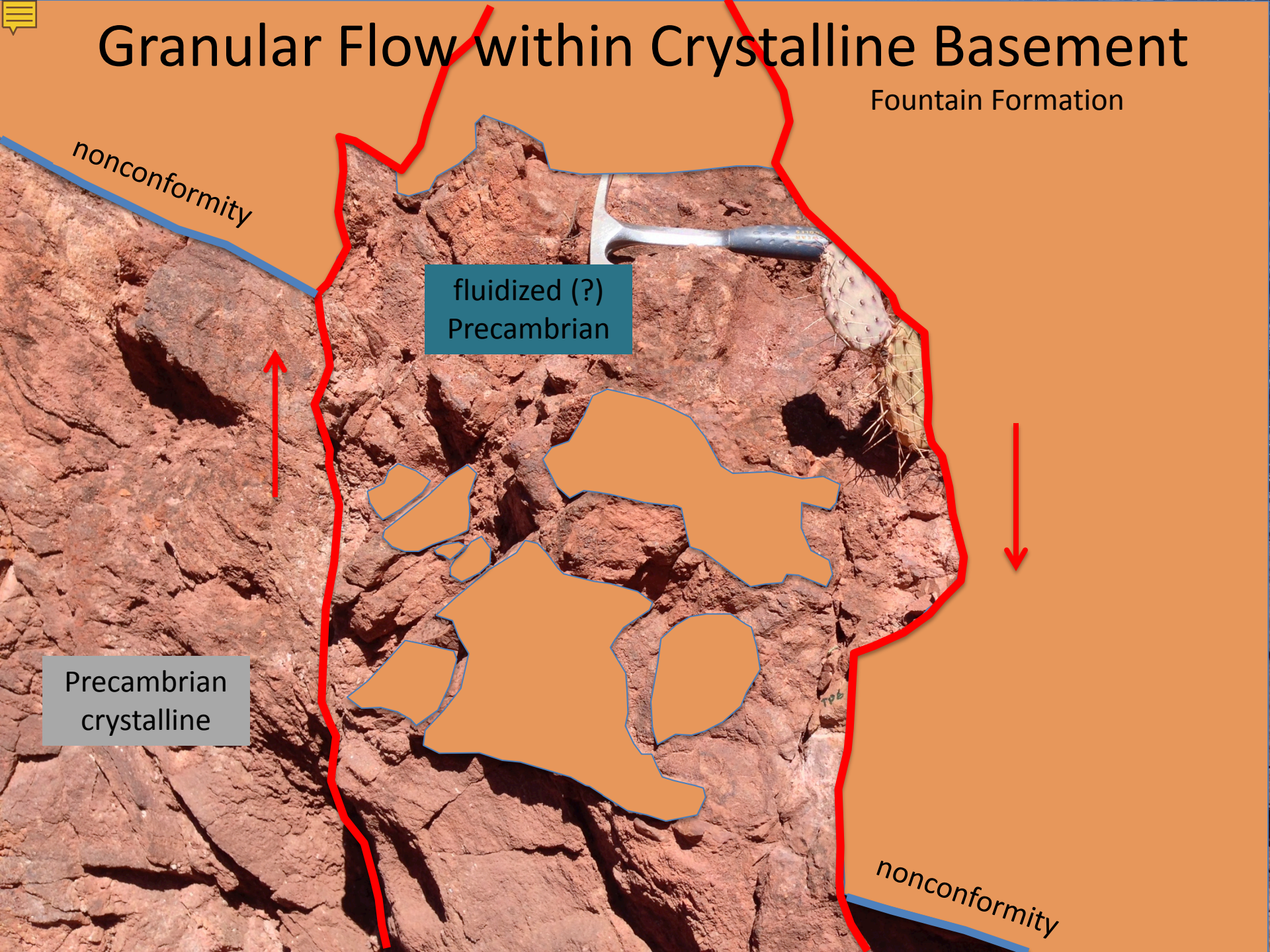


Crystalline Basement Faults



Sangre de Cristo Mountains near Las Vegas

Granular Flow within Crystalline Basement



Conclusions

- **Global data sets suggests considerable variability of permeability at 4 km depth. Typical permeability @ 4 km ~ 10^{-16} m^2**
- **Crystalline basement rocks within a mine repository @ 1 km depth will, on average, have higher permeability and higher permeability variability than wells would encounter at 4 km depth**
- **Crustal-scale hydrothermal models of fluid flow, heat transfer, and environmental tracers are well suited to determine in situ permeability conditions and properties at depth prior drilling**
- **The crystalline basement in tectonically active areas such as the Rio Grande Rift can be very permeable (10^{-10} to 10^{-12} m^2)**
- **Warm springs hosted in crystalline basement that have relatively young discharge water (< 10,000 years old) are good indications of relatively high permeability (10^{-12} m^2) conditions within the crystalline basement at depth of 4 km**
- **Precambrian faults can have distinctive properties at the sedimentary basin-crystalline basement interface. High clay content in crystalline basement weathered zone can cause ductile flow of crystalline basement rocks into basal sedimentary basin units**