Using Active Source Seismology to Image a Strike-Slip Fault Damage Zone as a Function of Depth, Distance and Geology

Results

Fault Detections Near Mapped Fault

Exponential Scaling to 2 km Distance

(top) Fracture probability relationship versus distance from central mapped strand. P is mean probability of the ith voxel being a fault in a spatial bin of N voxels. Fracture probability decays with distance from the central strand to ~2.2 km from the fault (note, different x-axis in upper left). The background, low fracture probability, begins at 2.2 km and at greater distances fracturing increases due to the Wilmington fault (and its damage zone) at the eastern edge of the seismic volumes. (bottom) Shows spatial relationship between fracture density and distance from the central strand, and the red line indicates the least squares exponential fit through the data extending from the central fault strand to the background (2.2 km).

Methods

Detecting & Mapping Faults

Data

Active Source Seismics

- 3D volumes
  - C-01-76SC-3D ~ 1976 Chevron MCS
  - Area ~ 300 km²
  - Bin spacing = 25 x 50 m
  - B-388-84SC-3D ~ 1984 Shell MCS
  - Area ~ 50 km²
  - Bin spacing = 12.5 x 25 m

- 2D seismic lines
  - W-30-82SC-2D ~ 1981 Western Gebo MCS
  - 20 m shot spacing
  - 6 s record length, 4 m sample rate

Well - Lithology & Geophysical Logs

P0296-1, P0296-2, P0296-12, P0300-1, P0300-2, P0301-3, P0301-5, P0301-6

https://walrus.wr.usgs.gov/namss/

Similar yet Unique Trends in Different Geologic Units

- 1. Pico - Franciscan (2.5 - 5 Ma) interbedded shales and sandstones (coarse)
- 2. Monterey - Franciscan Sandstones and conglomerate (fined)
- 3. Wilmington - Franciscan Sandstone
- 4. Mohnian - Franciscan Uplifted chert

Left figure shows an example of dip-steered diffusion filtered seismics in black and white color scale. Overlain, the vertical teal line is the manually mapped central fault strand. The rainbow colored lines are mapped 3D horizons projected into the inline, that mark lithological differences that have been tied to paleoestonic interpretation of formation tops. These formation tops are used as upper and lower bounds to constrain average fracture probability as a function of distance per unit. Note the different exponential fit slopes in different units and variable background (horizontal portion) in the different units.