Constraints on the Geometry of the Ventura-Pitas Point Fault System at Depth & Implications for Hazards

Ventura – Pitas Point Fault

John H. Shaw


basin shape
Why does fault geometry at depth matter?

**Determines size and location of the earthquake source**

**Impacts potential linkages with other fault systems**

**Influences how we ascribe deformation signatures (geologic or geodetic) to fault slip rates**

**Impacts dynamic rupture and wave propagation**
Why does fault geometry at depth matter?

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Hubbard et al., (2014, BSSA)
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Impacts dynamic rupture and wave propagation

- 3D Distribution of slip is complex
  - Slip rates are fast near coast where large paleo-uplift events have been found
  - Max slip is on lower ramp at depth, which agrees with Hubbard et al. (2014)
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Determines size and location of the earthquake source

Impacts potential linkages with other fault systems

Influences how we ascribe deformation signatures (geologic or geodetic) to fault slip rates

Impacts dynamic rupture and wave propagation (ground shaking & tsunami hazards)
Constraints on the shallow fault geometry

VB1 (Industry Line)

Hubbard et al., (2014)
Based on well and seismic constraints, the fault dips 45-55° N to a depth of about 6km.

Lack of direct constraints on deep fault geometry

3D seismic

5s TWTT $\approx 7.5$ km
Possible deep fault geometries

Planar fault

Mid-crustal detachment

Deeper ramp to north

Hubbard et al., (2014)
Support for a mid-crustal detachment

- Presence of syncline defining north flank of Ventura and Dos Cuadras/Rincon folds
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Redin et al., (2009; 1998)
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• Presence of syncline requires shallowing of fault
- Note inconsistent slip of stratigraphic horizons in section a

Figure 14-25. Cross sections for problem 14-8. (a) Inadmissible cross section; (b) possible cross section.

Marshak and Mitra (1988)
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Support for a mid-crustal detachment

- Presence of syncline defining north flank of Ventura and Dos Cuadras/Rincon folds

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  - Note inconsistent slip of stratigraphic horizons in section a
  - Note inconsistent restored line lengths

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Marshak and Mitra (1988)
Synclines and detachments

Seismic example: Sichuan basin

Field Example

Seismic Example: Argentina

 axial surface
fault
axial surface
fault

Kicking Horse Canyon, Alberta, Canada (JHS/PDB)
Synclines and fault bends

Suppe et al., (1983)

Hubbard et al., (2014)
Offshore Ventura – Pitas Point fault

Redin et al., (2009; 1998)
Support for a mid-crustal detachment

- Presence of regional Miocene detachment level south of the Pitas Point fault

Shaw et al., (2014)
Support for a mid-crustal detachment

- Presence of regional Miocene detachment level south of the Pitas Point fault
Support for a mid-crustal detachment

- Presence of regional Miocene detachment level south of the Pitas Point fault

Shaw et al., (2014)
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We favor the presence of a mid-crustal detachment in the Ventura – Pitas Point fault, based on:
• structural balancing constraints
• presence of a regional Miocene detachment
Structural segmentation controlled the 2015 Mw 7.8 Gorkha earthquake rupture in Nepal

*Hubbard et al., 2016*