Assessing rates, styles and magnitudes of permanent upper plate deformation

- How is permanent deformation in the upper plate produced? During which portion of the ‘seismic cycle’?
- What proportion of this strain comes from far-field stresses versus subduction zone convergence?
- What parameters control where permanent deformation is located and the kinematics of this deformation?
- What role does bathymetry/roughness on the subducting plate have on upper plate deformation?
- What percentage of the GPS velocity field represents elastic versus permanent deformation?

Assessing these questions often requires information about deformation processes occurring on intermediate (10^3-10^5 yr) timescales and methods in tectonic geomorphology and paleoseismology.

Example 1. Knowledge about timing, rates, spatial distribution and kinematics of deformation using deformed terraces

TC6005 TAYLOR ET AL.: RAPID FOREARC VERTICAL MOTION TC6005

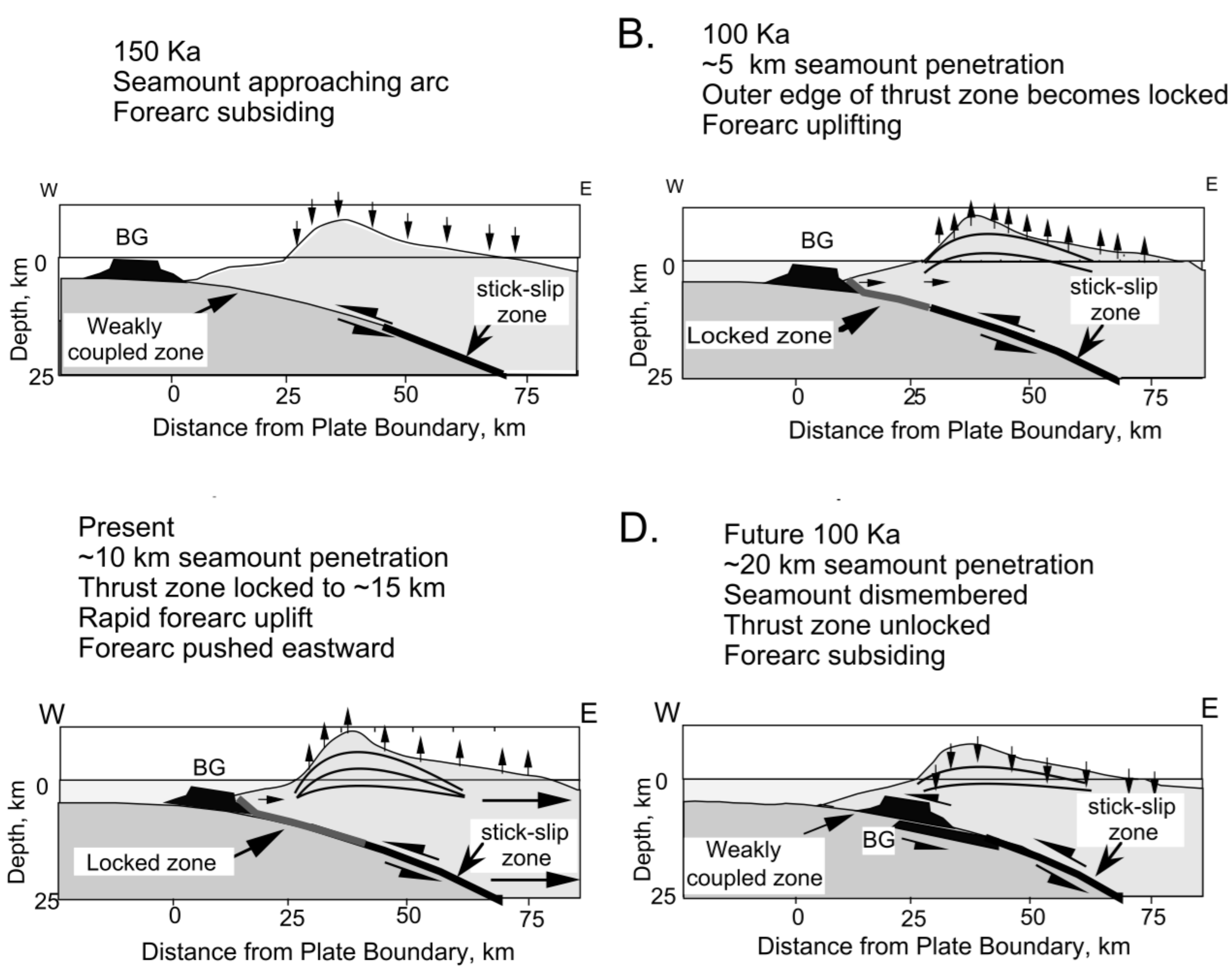
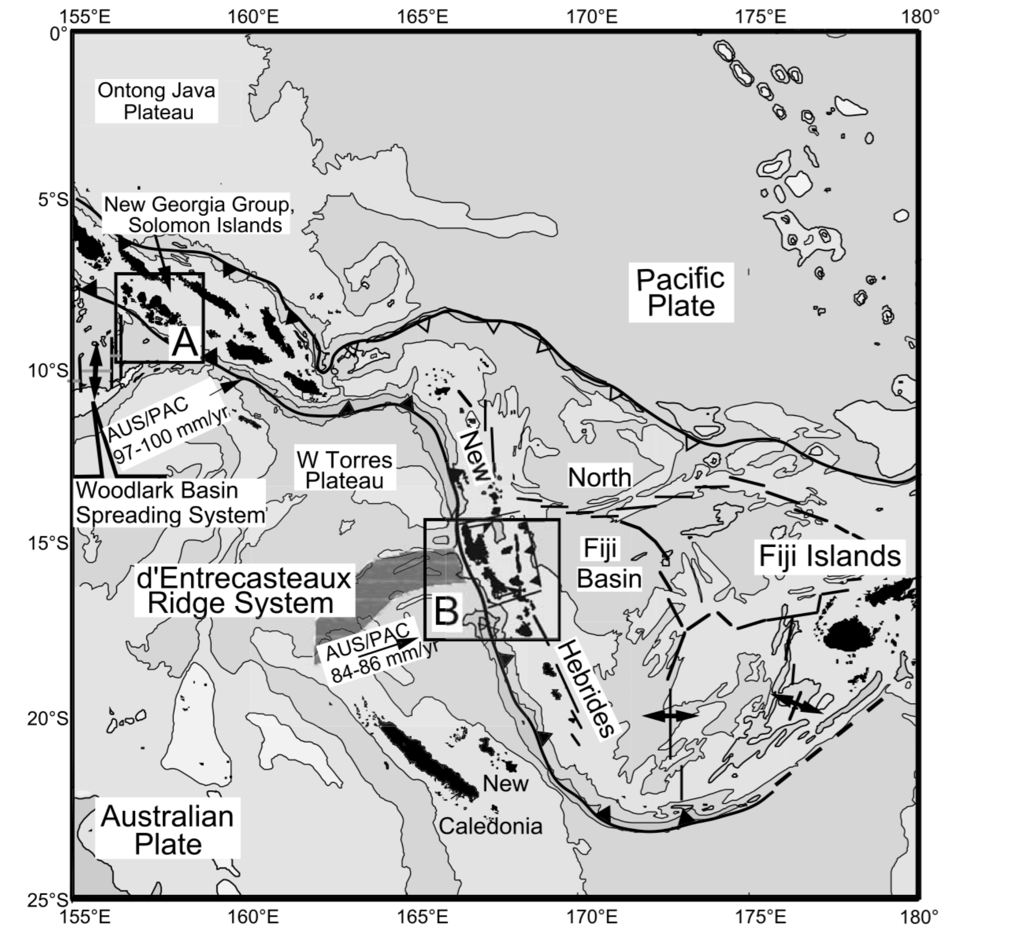


Figure 8. Idealized sequence of forearc vertical motions caused by impinging bathymetric features. (a) Bathymetric feature approaching the forearc. The peripheral slope of the seamount begins to subduct and raise the edge of the forearc. (b) Upper slopes of the impinging object that have lifted the

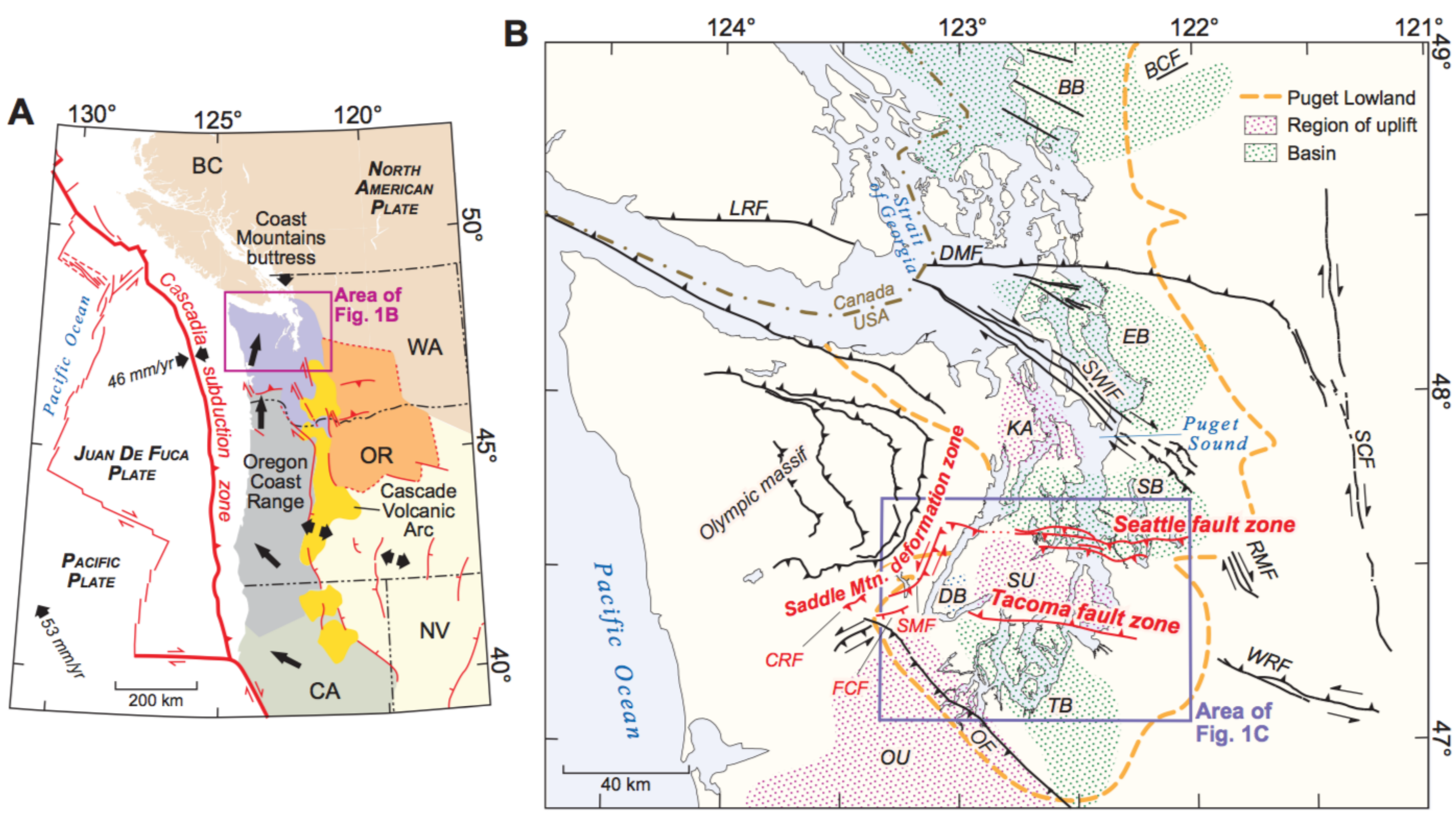
Taylor et al. 2005, Tectonics



The distribution of coral terraces above subducting seamounts and aseismic ridges yields information about rates and spatial distribution of forearc rock uplift in response to seamount subduction.

Example 2. Elucidating surface-rupturing seismogenic crustal faults. Targeted by lidar, field mapping and paleoseismic trenching yield slip history and recurrence interval of active forearc faults in Cascadia. Here, GNSS and seismic network is not sufficient to identify strain accumulating on crustal faults that rupture over long (>1,000 ka) intervals such as the Seattle Fault.

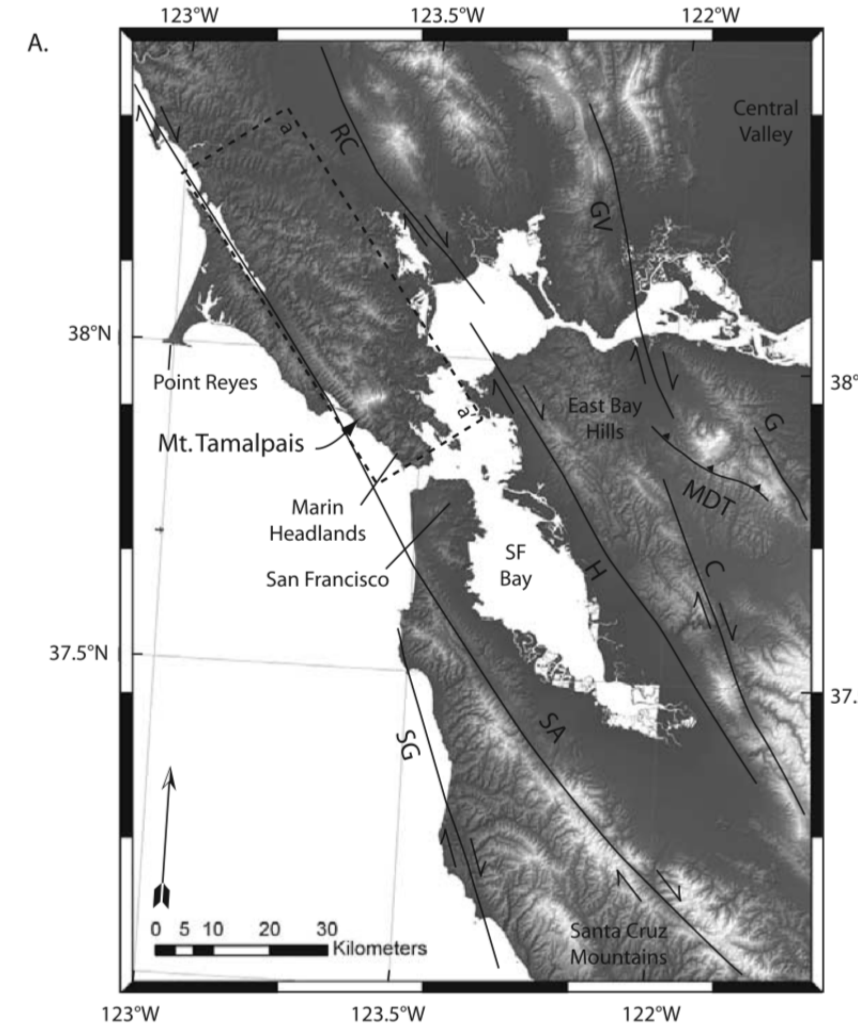
Surface-deforming earthquakes in Puget Lowland

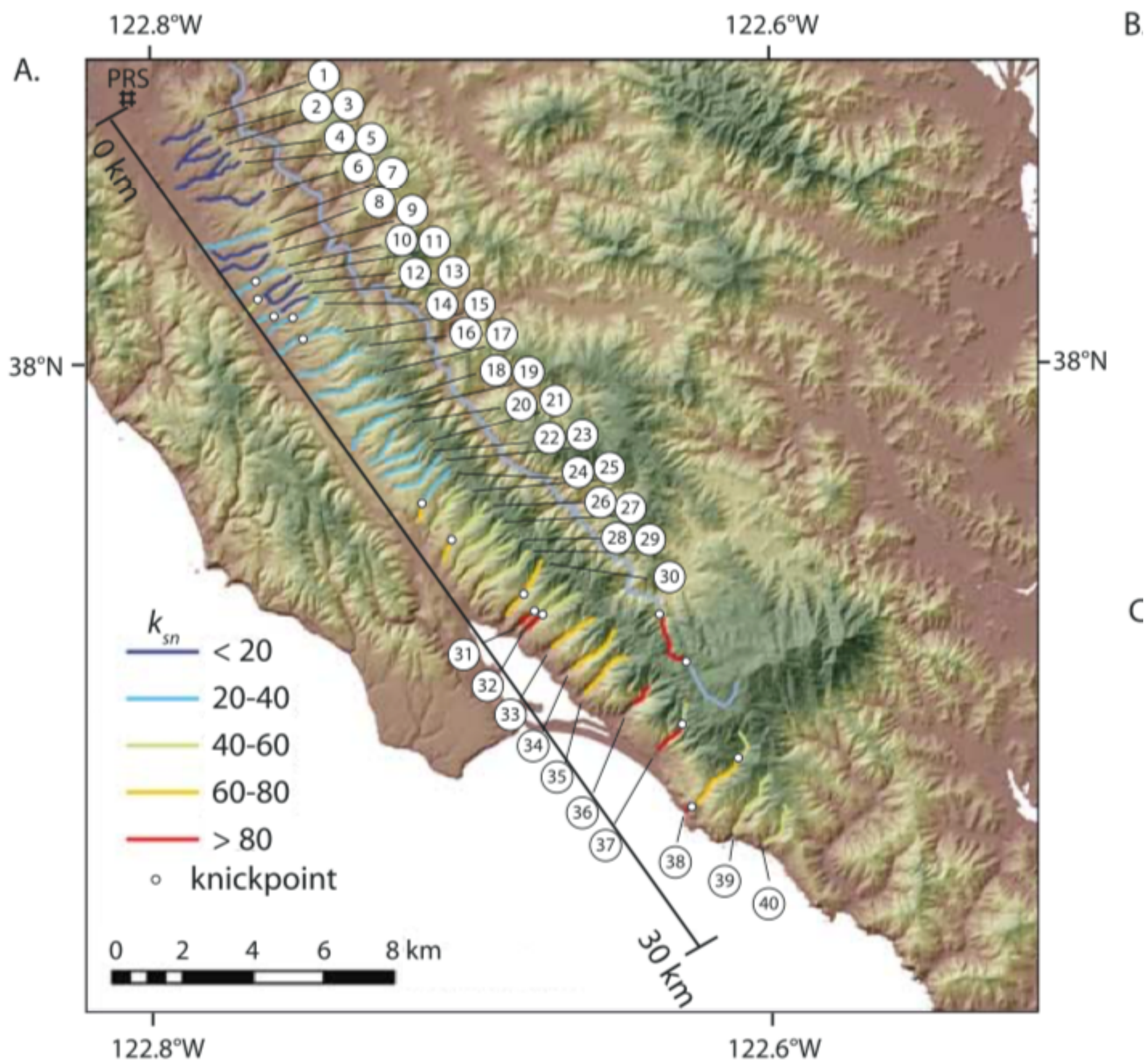


Nelson et al. 2014-Geosphere

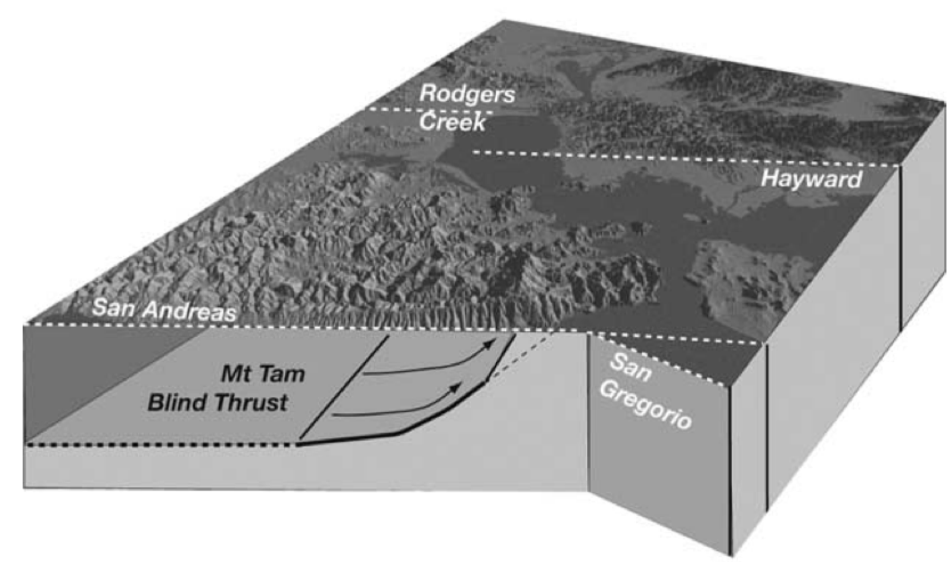
Example 3. Landscape morphology, topography, can constrain deformation rates above blind or buried structures.

Topography, patterns of incision, erosion used to infer spatial distribution of rock uplift rates —> location, geometry and kinematics of blind faults such as beneath Mt Tamalpais near San Andreas Fault.





KIRBY ET AL.: DIFFERENTIAL ROCK UPLIFT IN MARIN COUNTY



Kirby et al. 2007- JGR

What datasets are needed for a SZO?

- High resolution topography - ***Airborne lidar***
- Erosion rates across various time scales using a variety of systems (cosmogenic nuclide dating, low temperature thermochronology)
- Knowledge about climate, sedimentation rates, depositional settings
- Ages of key deformed or uplifted surfaces, etc.
- Detailed field work, tectonic-geomorphic mapping, paleoseismic trenching