Neotectonics

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OVERVIEW

These exercises are intended to familiarize students with active deformation in different tectonic settings by integrating Google Earth, fault displacement, and the ages of young surfaces. A short lecture is used to introduce students to the concepts of cosmogenic exposure dating, offset surfaces, and how to measure offset features. The first exercise uses Google Earth to create a map of active faults for the Himalaya and Tibetan Plateau (Styron et al., 2010). Examples of normal faults and strike slip faults in the Tibetan Plateau are located and images are acquired. These are the basis for a discussion about how these faults accommodate deformation. I n the second exercise students combine ages of surfaces with displacement to calculate time averaged slip rates in the Eastern California shear zone. These are compared to the published geodetic slip rates (Frankel et al., 2007). Students are asked to discuss possible reasons for the differences between geologic and geodetic slip rates.

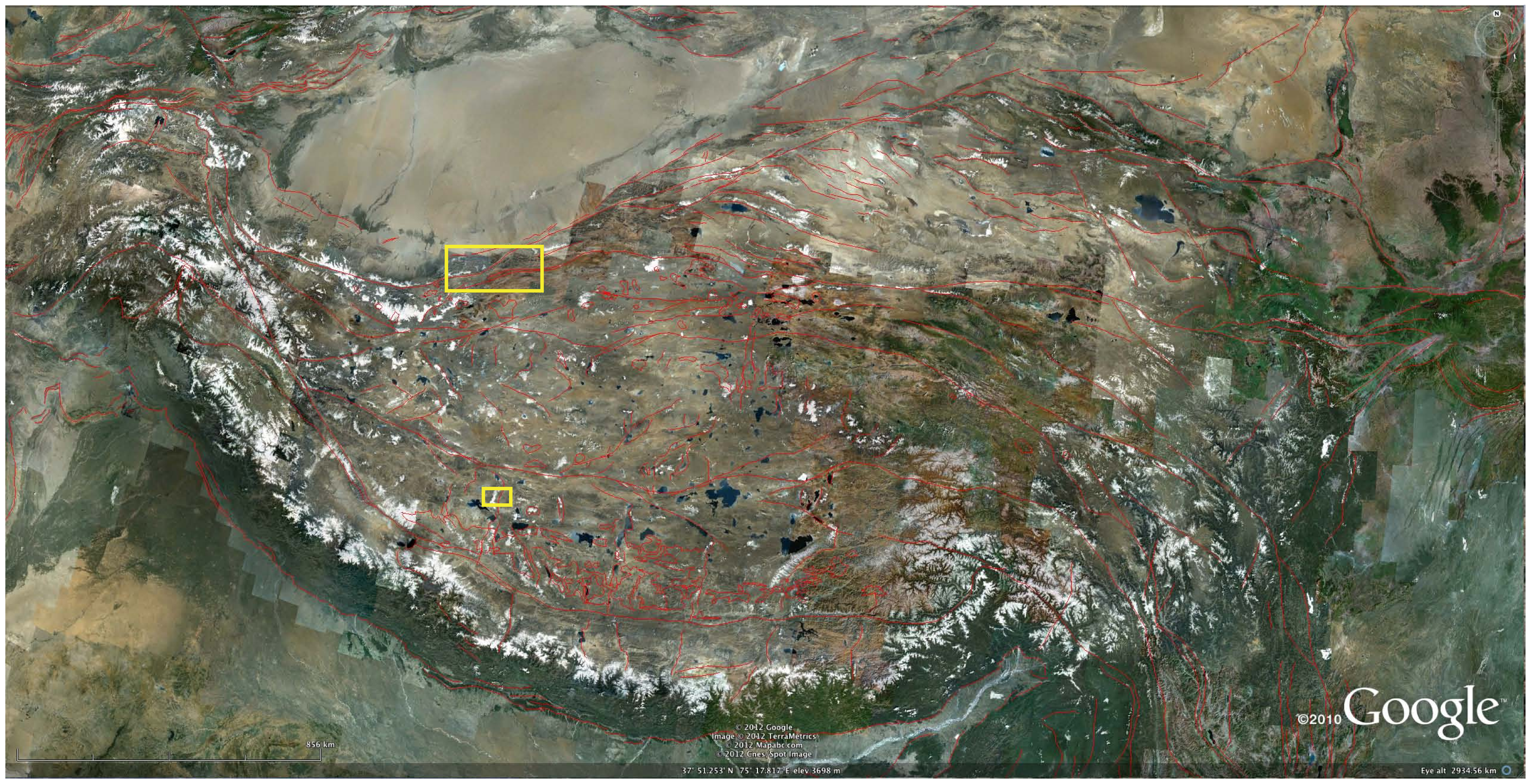

Figure 1: Google Earth map of the Himalaya and Tibetan Plateau. Red lines highlight active faults (Taylor and Yin, 200X). The line work is available as kml files (Styron et al., 2010).

Exercise 1: Tibetan Plateau

The Tibetan plateau is the largest orogenic plateau on Earth. Major earthquakes occur, but the majority of seismic activity is <6 M. Young faults that form on the surface attest to this seismic activity. Upload the kml files (on Blackboard) to Google Earth. Select open in the file menu and open the kml files. This should import the faults onto Google Earth. Locate an example of a strike-slip and normal fault and record their lat/long/elevation. Take images of location where a Quaternary surface is offset. Using these images with the map of active faults on the Tibetan plateau, discuss how the faults that you choose fit into the larger system of active faulting. Based on these observations, propose a model for how these faults accommodate deformation in the plateau.

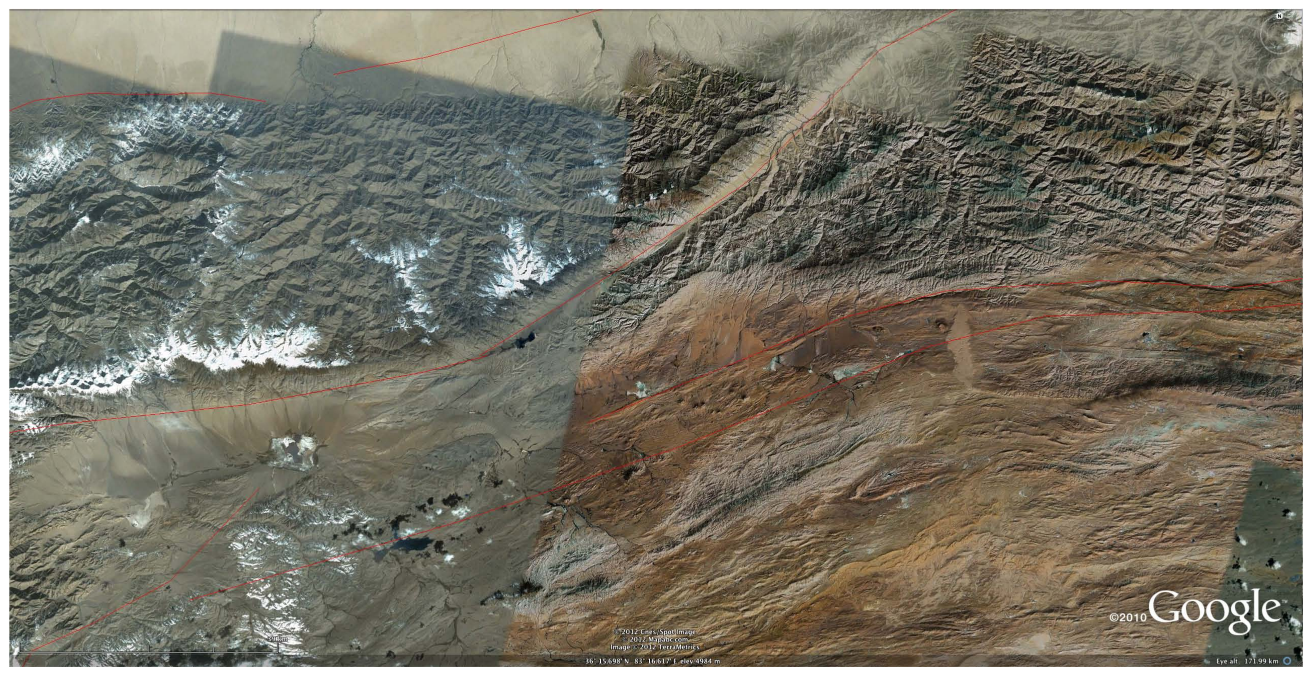

Figure 2: Example of a strike-slip fault.

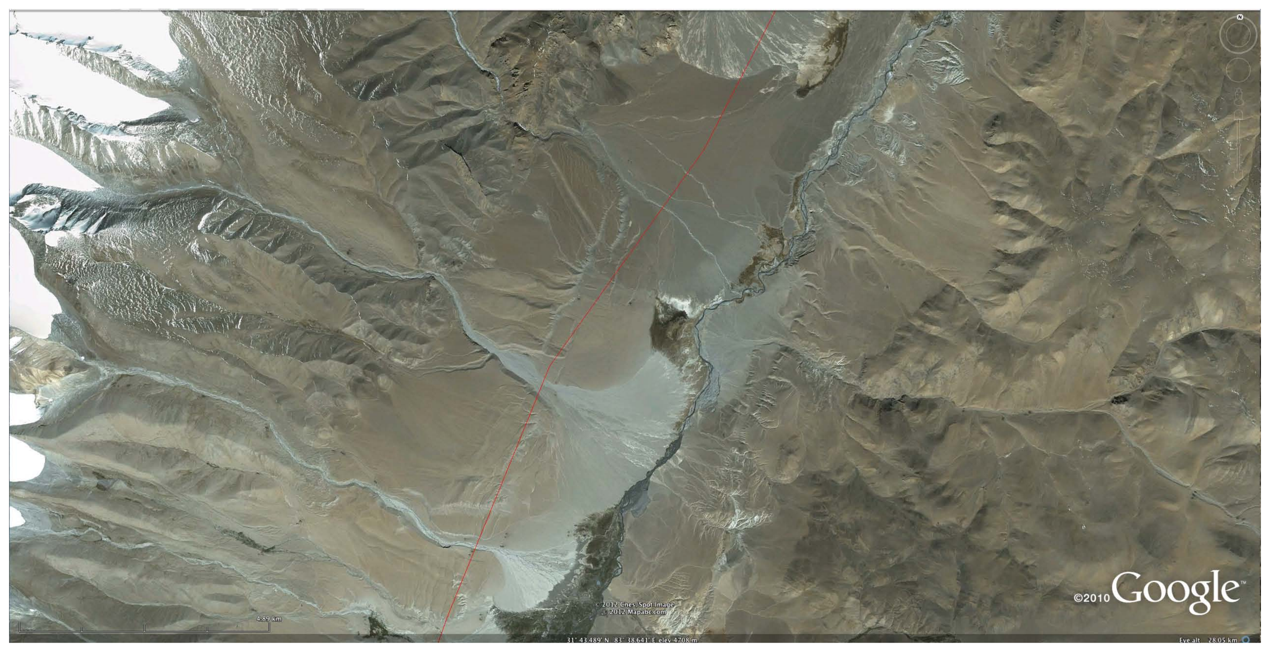

Figure 3: Example of a normal fault.

Exercise 2: Eastern California shear zone

A transition zone occurs between the San Andreas fault and the Basin and Range province. Here many young faults truncate Quaternary deposits (e.g., alluvial fans). Cosmogenic exposure dating was used to date some of these surfaces. Use the ages from the northern Death Valley strike-slip fault in combination with the slip rates below (Frankel et al., 2007) to calculate a time-averaged slip rate for three sections of the fault. Three other fault systems have a similar data set. Combine the slip rates from these faults to estimate total displacement accommodated by faults in the Eastern California shear zone (ECSZ).

Geodetic campaigns using global positioning systems (GPS) positioned one either side of the ECSZ estimate total right-lateral displacement of ~8-10 mm/yr since their installation. How does this compare with the estimates that you obtained using the geologic data? Discuss possible causes for significant differences between the geologic versus geodetic slip rates.

1) Red Wall canyon 70 ± 20 ka 297 ± 9 m
2) Furnace creek: 94 ± 11ka 290 ± 20 m
3) Indian creek: 71 ± 8 ka 178 ± 20 m

Figure 4: Map of topography and Quaternary faults in the northern Eastern California shear zone (Frankel et al., 2007).

REFERENCES

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Styron, R., Taylor, M., Okoronkwo, K., 2010, Database of active structures from the Indo-Asian collision: Eos, Transactions, American Geophysical Union 91. 20 (May 2010): 181-182.

Taylor, M. and Yin, A., 2009, Active structures of the Himalayan-Tibetan orogen and their relationships to earthquake distribution, contemporary strain field, and Cenozoic volcanism: Geosphere, v. 5, 199-214.