Discussion of Parkfield/San Andreas Fault papers

Shelly. Migrating tremors illuminate complex deformation beneath the seismogenic San Andreas fault. Nature (2010) vol. 463 (7281) pp. 648-652

There was a long discussion of the meaning of Figure 2. What constitutes a tremor family? A tremor family is essentially a matched filter, from a set of 21 different low-frequency earthquake waveforms identified in a previous study. The prototype waveforms are then cross-correlated with station timeseries looking for a match as indicated by a high (but not defined in paper) correlation coefficient.
How does Figure 2 show tremor migration? The figure shows tremor migration in the length and recurring signals of the tremor wave trains.

Figure 3: we questioned the significance of the detail shown around the Parkfield earthquake. What are the error bars? Is the deviation around the mean significant or is it within the error? We concluded (a) that the event variation around the time of the Parkfield earthquake was not proven to be significant, and (b) we would like to see some variation in the (unstated) correlation coefficient to see how that influences the graph.

Figure 4: we noted the difference in color scales between parts (a) and (b), and that (b) is an expanded section of (a). Class consensus was that (a) was not very useful, and that (b) did use the change in color scale to effectively show a general increase in tremor frequency after the Parkfield earthquake.

There was some discussion of Figure 1, and the physical significance and mechanisms behind the depth banding of earthquakes and tremor, with earthquakes occurring in the 0-15km depth range, and tremor occurring around 25km depth. Is the region from 15-25 subject to ductile slip? If it is in ductile slip, how could we measure that? Is the tremor a function of properties of the crust/mantle interface?

Thomas et al. Tremor-tide correlations and near-lithostatic pore pressure on the deep San Andreas fault. Nature (2009) vol. 462 (7276) pp. 1048-1051

A key point in this paper is the presence of fluids in the tremor region. The increase of fluid pore pressure decreases rock strength. The assumption is that if small strain causes tremor, the presence of fluids enabled the tremor. We considered the observations interesting but the conclusions speculative.

There was an extended discussion of why tremor is of interest, and of the significance of tremor. Tremor is significant because it becomes part of the total calculation of fault loading, and needs to be included in fault models. The presence of tremor changes many of the existing earthquake physics models. Tremor is also a relatively new type of earthquake signal, as yet not well understood. It adds information not previously available which may influence our understanding of earthquake mechanics.

Carpenter et al. Frictional behavior of materials in the 3D SAFOD volume. Geophysical Research Letters (2009) vol. 36 (5) pp. L05302

Low frictional coefficients in the San Andreas Fault are calculated from fault slip area and resulting heat flow. There was some questions of how the heat flow was measured, possibly from the SAFOD borehole instruments. Various factors such as the presence and movements of fluids may have an effect on heat flow measurements.

The study used rock samples from the SAFOD drilling holes, but only had access to samples from the west side of the fault, not from within the fault itself. The serpentinite samples were collected from a nearby mine, and talc samples where from a mine in New York. It was already known that serpentinite is weak, but there are two findings here of interest: (1) Serpentinite alone is not weak enough to account for the low coefficient of friction; the conclusion is that fluids must also be involved. (2) Rock samples from depth near but not in the fault zone are strong, so the fault itself must be structurally and/or mineralogically different. This paper appeared to be the lead-in for a possible following study once core material from the fault is available for study. One participant questioned why the test did not include clay & fault gouge collected from surface exposures of the fault.

There was some discussion of the geologic cross-section figure, which was created at ASU by Thayer & Arrowsmith. The class discussed the formations created by subduction processes, which would possibly be a source of serpentinite.