Earthquake source discussion *Ralph Archuleta and John Vidale*, Sept. 18, 2008

Points in general discussion in order discussed

We need to include accurate slip models in the simulation of strong motions with to improve hazard estimates.

Can we use the same instruments to record strong and weak motions? (Not now, and not cheaply.)

Acoustic and displacement measurements of rock mechanics experiments may augment field seismic observations.

Deep earthquakes are also an enigma, and therefore a topic of interest.

Induced earthquakes may also provide clues in that such situations may have different known constraints than earthquakes on tectonic faults.

A grand challenge is to understand the factors controlling the strength of a fault. Both during slow and fast slipping episodes, although it may be more sensible to discuss the two separately.

More needs to be learned about how faults are loaded during the interseismic period.

What determines the magnitude of tsunamis aside from the magnitude of earthquakes, including factors such as splay faults and slow rupture. Inclusion of hydroacoustic data and coastal seafloor morphology are useful.

What are the causes of intraplate earthquakes, and are they higher stress drop than plate boundary events? Intraplate differences from interplate seismicity matter for nuclear regulatory investigations.

The factors affecting earthquake rupture dynamics are so interrelated that it is all one entangled problem.

Why aftershocks are delayed may deserve a dedicated program.

Are there precursors to earthquake? Has been discounted due to dubious history, but remains an important goal. Precursors are likely on at least on very small space and time scales, but the big question is whether such precursors are detectable.

How do slow earthquakes scale, and are they all manifestations of a single process? The adherence to a single scaling relation and large difference from traditional earthquakes is surprising, and should be checked carefully.

We should include in situ samples from drilling and exhumed faults in fault behavior investigation.

Paleoseismic investigations are critical for understanding the earthquake cycle. This is a lesson learned from San Andreas studies, and is also evident for studies of the hazard of the Central US.

As a decade or two passes, we will observe repeats of some large historical events, which will help constrain the degree of characteristic earthquake behavior.

The fractal character of seismicity in terms of rupture, fault geometry, and aftershocks is becoming increasingly evident. Perhaps defining discrete events is artificial and more statistical points of view are necessary. The feedback of mainshock rupture on increasing or decreasing stress heterogeneity in the immediately surrounding region is not yet clear.

Scaling of slip, particle velocity, length, stress drop, etc. need further investigation. These results are necessary for confident estimation of maximum likely accelerations.

The resolution of slip models for earthquakes needs work, perhaps before we can interpret studies across many earthquakes, where results may be overconfident and variations resulting from different methodology.

Themes from righthand group

ETS – how, relation to regular earthquakes, hazard implications

Ability to predict range of possible earthquake behaviors

Ability to predict aftershocks given mainshock details

Construction of an earthquake model quantifying influence of geometry, fluids, gouge, and rock composition

Mapping asperities near cities

How common are earthquake storms in paleo history and therefor in the future

Degree of predictibility of rupture direction

Understanding of controls on rupture complexity

Themes from lefthand group

How does an earthquake start, continue, stop?

Geometry, fractal nature of faults

Establish a relation between earthquake physics and earthquake statistics.

Large RAMP facility (in the field, perhaps measuring noise continuously, tremor, site effects in urban areas) to record aftershocks immediately after a large event. ~100. Must be telemetered to stream data into regional network.

Arrays of boreholes near the fault.

Constitutive laws that explain the full range of earthquakes from slow earthquakes to the largest events.

Are mechanics for intraplate, deep and interplate earthquakes different?

Develop a plan for response to a major/great earthquake in the US.

Predictability of fault properties and effect on earthquakes ruptures

Deformation from a full range of mechanisms. Constitutive laws that explain the full range of earthquakes from slow earthquakes to the largest events.