Discussion after presentation by Tom Hanks (USGS, Menlo Park):

Amos Nur (Stanford U.): On the one hand you say there is water in the fault zone but the pressure is hydrostatic. Is that right?

Tom Hanks: In this particular fault zone? - I don't know what's in this particular fault zone.

Amos Nur: The problem is that if there's water in the fault zone it cannot remain at hydrostatic pressure because the porosity decreases with time due to creep or inelastic processes it would become dry. Having hydrostatic pore pressure at a depth of a few kilometers is mechanically unstable. Some process is needed. Either John [Townend] is right or fluid is trapped. So there is a problem: I'm not sure that this conclusion is valid. The second and related issue is, even if pore pressure is hydrostatic, [what happens] during a rupture event.

Tom Hanks: You can generate heat, at least temporarily you can drive the fluid pressures up.

John Townend (Stanford U.): I just think it's important to make it clear that the paper I think you're referring to, the Townend and Zoback Geology paper, addressed permeability structures in intraplate regions, and drew conclusions about stress levels and differential stresses at depth in intraplate regions. We certainly weren't saying anything about the permeability structures of plate-bounding faults. I just want to point that out in case it was being misinterpreted.

Tom Hanks: I would be surprised if - Art and Colin and I disagree on this - water circulation did not affect these heat flow data in some measure. Sure, it can be uplift, it can be erosion, but one of the things I think is going on is the circulation of water to depths of 5 km. That's why we want to drill. I mean, we can make all the assertions we want but we've been doing that for forty years.

Art Lachenbruch (USGS, M.P.): This is a big problem. I don't think we should try to get into the details but I do not think that the illustrations selected clearly identify the problem. It's much more focussed than this, and this cloud of points is really almost irrelevant to the principal issues that we must separate. It's extremely important to know that the heat flow has revealed - and, I think, without much question - that the San Andreas fault passes through a region of high heat flow. It's very distinct and identified with the Coast Ranges, not necessarily with the San Andreas fault at all. As Colin has shown this morning, the San Andreas fault passes diagonally through the Coast Ranges. The media on both sides have very different transmissivities, and very different hydrologic properties, with crystalline rocks on one side, and argillaceous rocks on the other. The change in the heat flow takes place at the edge of the valley, which is the edge of the Coast Range, and not at the San Andreas fault. The area under that chevron there is only a small fraction of the energy represented in the Coast Range anomaly; you would have to have enormous stress on the fault. But there are illustrations that Colin reproduced which show horizontal sections across the San Andreas fault, that reveal these characteristics. The two big things we have to look for are, one, the absence of that peaked anomaly over the fault, and the other is probably explained by a completely separate mechanism, the high heat flow under the Coast Ranges. The relevant data that we presented 20 years ago, and others presented earlier than that, is that if you look carefully at the statistics on cross-sections, the peaked heat flow anomaly has no statistical validity. If you take the heat flows within 10 km of the fault, and the heat flows beyond 10 km, they about the same to within about a percent: the standard deviation is very small. The simplest Byerlee type model would suggest about a 50 percent heat flow anomaly. The thing that Amos talked about won't work, however - in my opinion - that is frictional heating reducing the friction during the earthquake, because it provides no mechanism for reducing the initial stress. It's an enormously complex problem, and it's really the elephant in our living room.