What is Parkfield?

A tiny cow town.

Home of the Parkfield Earthquake Prediction Experiment: a project involving 100s of people for decades that has produced about 800 publications.

A major battleground over earthquake prediction and between the concepts of repeatability and variability.
Early 1980’s view: the prediction

Seismograms from the Netherlands imply similar events
Early 1980’s view: Seismograms Berkeley imply similar hypocenters (starting points) for 1922, 1934, and 1966.

Early 80’s view: possible precursors

Seismograms from Berkeley show that there was an M5 foreshock 17 minutes before the mainshock.
Early 80’s view: possible precursors

Surface cracking about 2 weeks before the 1966 mainshock?

Early 80’s view: possible precursors

Fault Creep 9 hours before 1966 mainshock breaks a pipe?
Building an experiment

Seismic Networks

Creepmeters
Strainmeters

The 2-color laser on Carr Hill
Parkfield Monitoring Sites

Strong Motion Records: 1966 vs. 2004

From Susana Custudio, UCSB
and Liu et al., BSSA, in press.
Devising an alert scheme

And then you wait..........

"Parkfield remains the best identified locale to trap an earthquake." – Hager Committee Report (1994) to the National Earthquake Prediction Evaluation Council
Lessons from running the alert system:
- Bridging the gap from science to action
- Communicating to the public: say who isn't at risk
- When not to communicate
- The problem of communicating probabilities: KISS vs. truth
- The role of the media
- The importance of plans to overcome inertia and doubt
And then, on September, 28, 2004

Were there precursors in 2004?  
Strain changes prior to 2004 Parkfield Earthquake?  
Statistically insignificant and not compatible with slip at the hypocenter.
Were there precursors in 2004?
Strain changes prior to 2004 Parkfield Earthquake?

From Johnston et al., BSSA, in press, 2006

Were there precursors in 2004?
Strain changes prior to 2004 Parkfield Earthquake?

From Johnston et al., BSSA, in press, 2006
Slip in 1934, 1966, and 2004

Geodetic Models

Estimated slip in 1934 earthquake

Estimated slip in 1966 earthquake

Estimated slip in 2004 earthquake

Slip in 1966 and 2004

Seismic Models

From Murray and Langbein, BSSA, in press, 2006

Could we tell the 1966 and 2004 earthquakes apart from geology?

Geologic Slip in 1966 and 2004 is a little different.
But could we tell them apart from paleoseismology (the art of mapping prehistoric ground cracks)?

Could you tell them apart if you got to only look for cracks in 2 places?

If not, can paleoseismology tell us much about the details of earthquake repeatability and variability?

After Rymer et al. 2005 and Brown et al., 1967
Are the Parkfield Mainshocks a Cyclic Non-Random Sequence?

Basic Sequence
1857, 1881, 1901, 1922, 1934, 1966, 2004

WARNING: POSSIBLE SELECTION BIAS AHEAD

Are the Parkfield Mainshocks a Non-Random Sequence?

Basic Sequence
1857, 1881, 1901, 1922, 1934, 1966, 2004

Lognormal COV=0.45
Are the Parkfield Mainshocks a Non-Random Sequence?

Basic Sequence
1857, 1881, 1901, 1922, 1934, 1966, 2004

Are the Parkfield Mainshocks a Non-Random Sequence?

Basic Sequence
1857, 1881, 1901, 1922, 1934, 1966, 2004

Confidence rejecting random = 98%
Are the Parkfield Mainshocks a Non-Random Sequence?
1881 and later
1881, 1901, 1922, 1934, 1966, 2004

Could the Parkfield Earthquake Just be Random?
Jackson and Kagan get 23% random chance of occurrence from 1967 to 2004
Accumulated slip over two earthquake cycles

Note different color scales.


Are Parkfield Earthquakes Trapped Between the Creeping Segment and Cholame Valley

EXPLANATION
- San Andreas Fault
- 2004 Surface breaks
- Liquefaction

Ruth Harris, USGS

Frontyner et al., BSSA, submitted
But there is no fault bend, jog, or stepover at the depths where earthquakes happen.

Simpson et al. Model:

Observerved warp in fault implies that Cholame Valley has been a boundary to rupture behavior for many earthquake cycles.

1857 Segment Is Locked

When 1857 Segment Fails, the warp stays in the near surface because near surface materials are not completely elastic.

Parkfield Segment Fails Frequently Causing a Warp

From Simpson et al., BSSA, in press, 2006.
Geologic Controls on Rupture?

View of NE side of San Andreas Fault

- 1966 hypocenter
- 2004 hypocenter
- Permanente Terrane

Bob Jachens based on geologic mapping, gravity, magnetics, and 3D seismic velocity models.