Structure and Properties of the San Andreas Fault in Central California: Recent Results from the SAFOD Experiment

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#### San Andreas Fault Observatory at Depth (SAFOD)

The central scientific objective of SAFOD is to directly measure the physical and chemical processes that control deformation and earthquake generation within an active platebounding fault zone.



#### SAFOD Drilling Target: Repeating Earthquakes



Key objective of SAFOD is to observe the nucleation and propagation of repeating earthquakes in the near field region

Nadeau et al. 2004, Waldhauser and Ellsworth 2004 circle size = 9 MPa stress drop model







#### SAFOD Phase 1 Drilling: June - October 2004 (Pilot Hole drilled in 2002)

#### SAFOD Phase 2 Drilling: June - September 2005



What's to come? SAFOD Phase 3 Drilling: June - August 2007

Phase 3: Coring the Multi-Laterals

Mill through casing and continuously core 4 holes extending 250 m from main hole <u>to</u> <u>intersect actively deforming traces</u> <u>of San Andreas Fault.</u>

Conduct fluid pressure, permeability and hydrofrac tests in core holes.

Leave one core hole open for longterm fluid pressure monitoring in the fault zone.



## Wireline Logging and Logging While Drilling



## **Phase 2 Geophysical Logs**



## But Where is the San Andreas Fault?







## Seismology Inside the San Andreas Fault



# M 1.0 in SF-LA Target Zone



- P and S arrivals clipped
- S-wave principally on components transverse to bore hole
- S-wave arrival difficult to pick due to source finiteness
- S-P interval about 50 msec
- Double-difference relocation using cross correlation data from HRSN by Bob Nadeau places event between SF and LA

# Seismograms recorded in the SAFOD Main Hole confirm the Pilot Hole stress drop results.



Presented by K. Imanishi at Spring Joint Meeting, May 2006

# Near Field Observation of "L.A." Target in the SAFOD Main Hole



#### January 23, 2005 "L.A." Recurrence



Near field recording on Stage 2 sonde at 420 m range and whole-space synthetics (40 msec triangular source time function)

#### M 1.3 Earthquake in San Andreas Fault Zone Feb 6, 2006 Recorded Downhole at 3260 m (EQ ~4 km below sonde)



## **Dispersion Analysis**



Fundamental mode locked P mode dispersion curve for 30 m low velocity channel.

# Questions?



