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Oceanic Transform Fault Seismicity Earthquakes of a Different Kind

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Oceanic Transform Fault Seismicity- Earthquakes of a Different Kind…

Higher Predictability

Short-term, Long-term, and with respect to tectonic parameters

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Scaling between Tectonic and Seismic Parameters

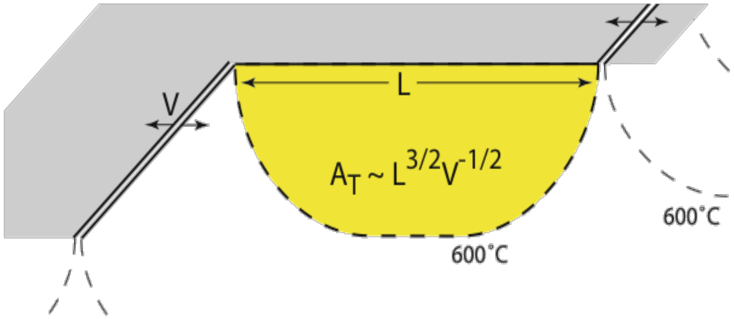
Boettcher and Jordan, 2004, JGR

Tectonic Parameters (L, V, & A_T)

65 Ridge Transform Faults

L ≥ 75 km (totaling≈16,000 km)

QuickTime™ and a decompressor are needed to see this picture.



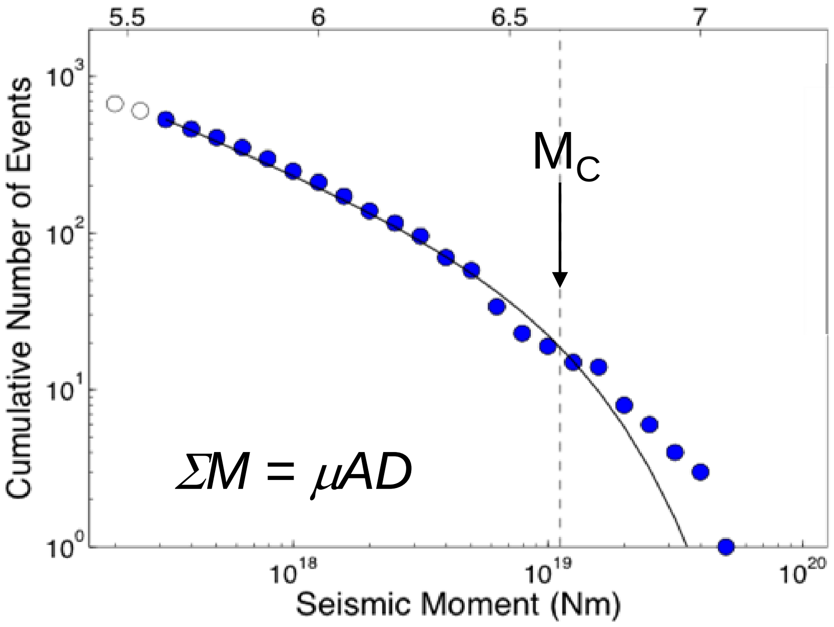
Seismic Parameters (M_C, ΣM, N_0, & β)

ISC Catalog 1964-1999

Global CMT 1976-2001

$$N(M) = N_0\left(\frac{M_0}{M}\right)^3 \exp\left(\frac{M_0 - M}{M_C}\right)$$

(Kagan and Jackson, 2002, GJI)

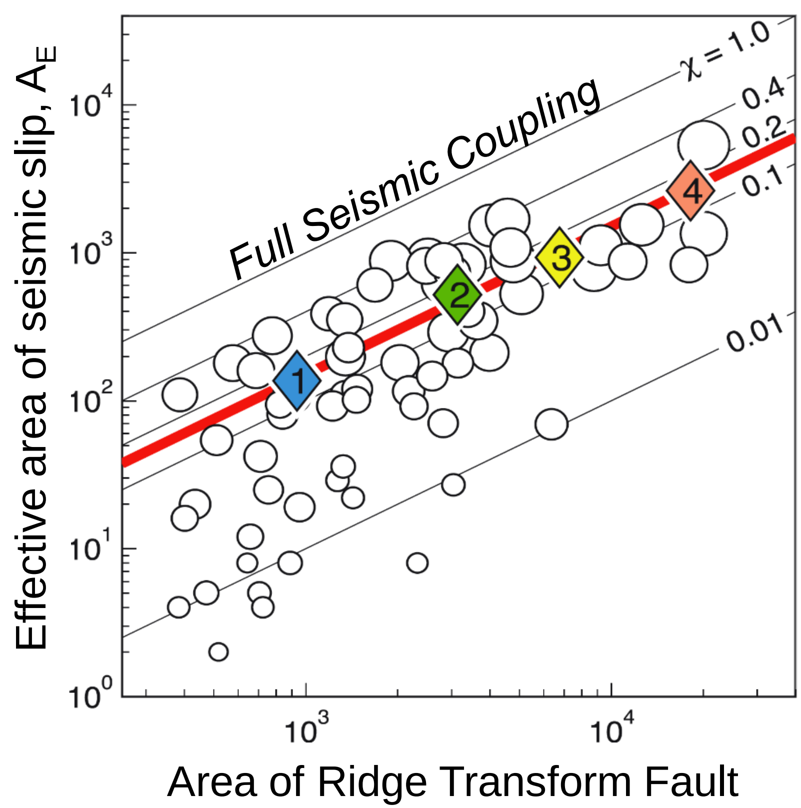


Scaling between Tectonic and Seismic Parameters

Boettcher and Jordan, 2004, JGR

Are oceanic transform faults fully coupled?

➡ No, on average, only ~15% of slip is accommodated seismically

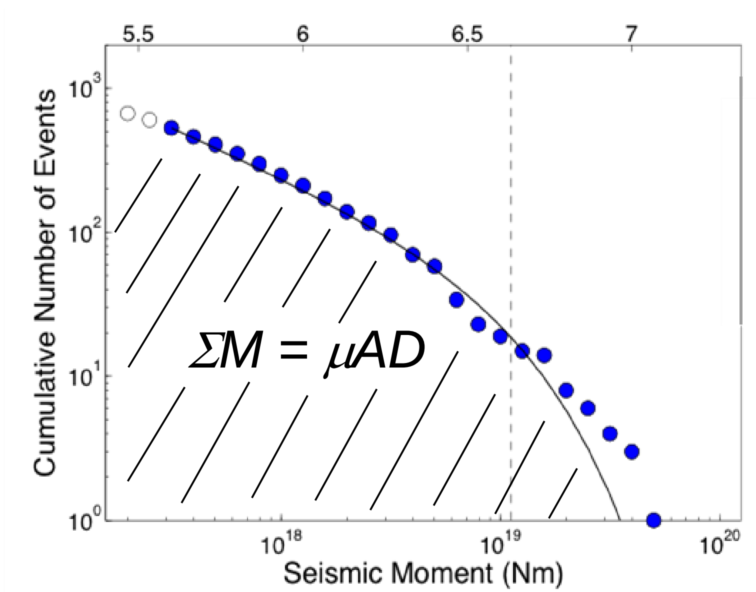


Effective Area of Seismic Slip

$\Sigma M = \mu AD$

$\Sigma M/t = \mu A_E(D/t)$

$\mathbf{A_E = \Sigma M/(t\mu V)}$

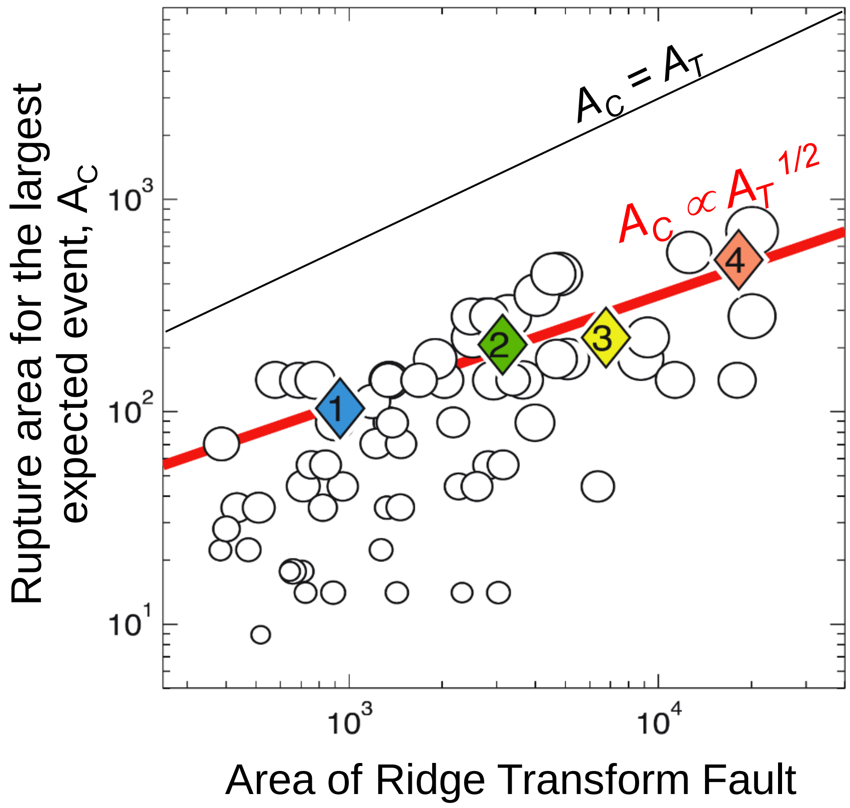


Scaling between Tectonic and Seismic Parameters

Boettcher and Jordan, 2004, JGR

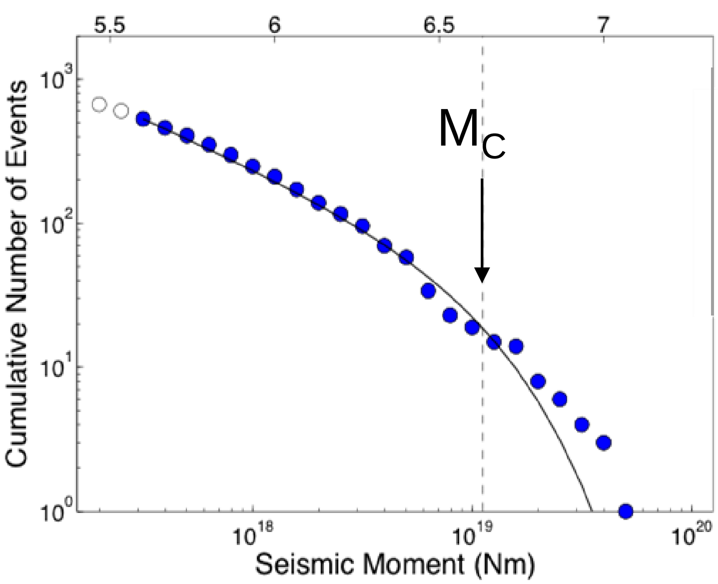
Will the largest event (M_C) rupture the total fault area?

➡ No… and furthermore A_C scales as $A_T^{1/2}$



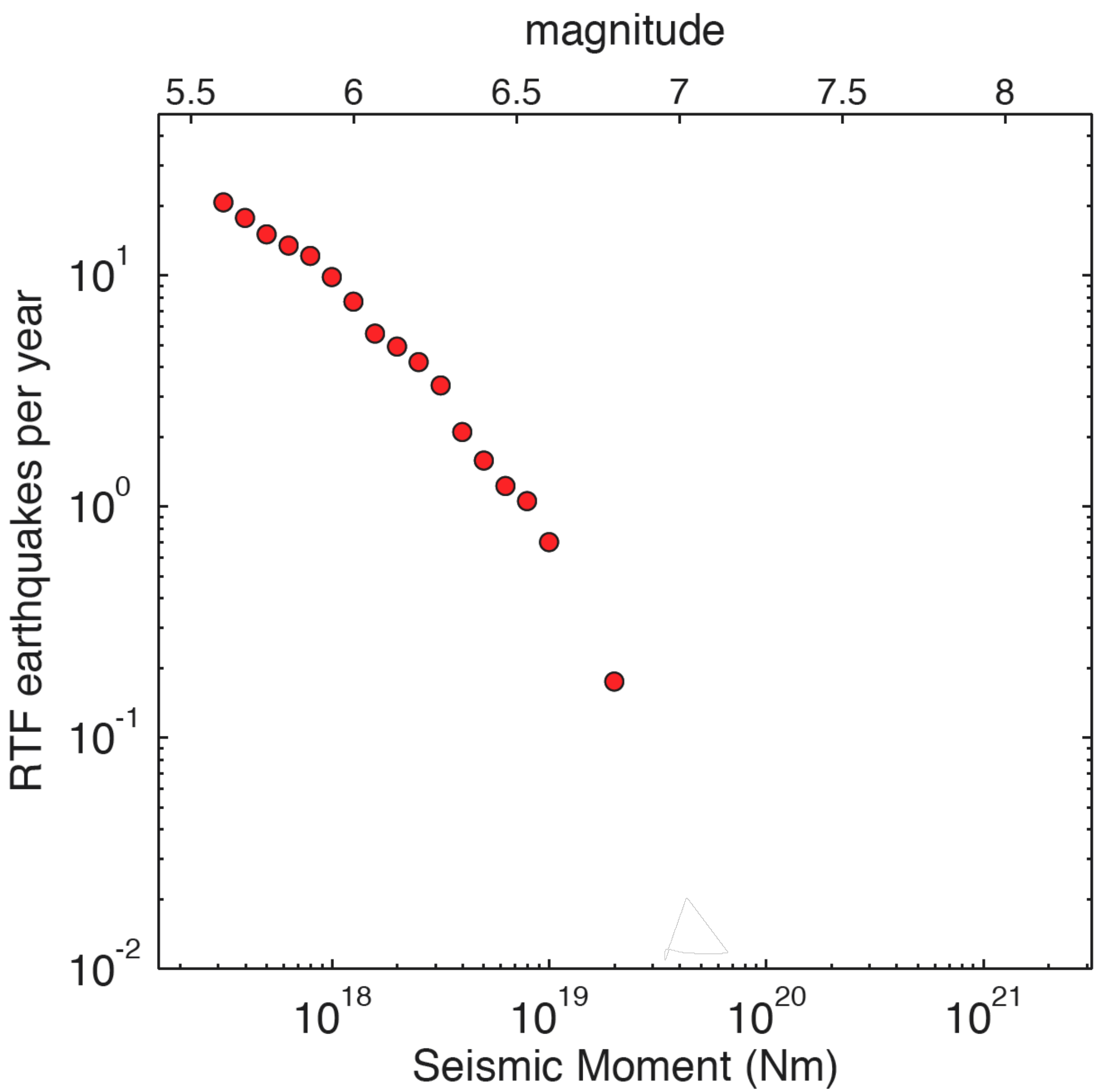
Rupture Area of Largest Expected Event

$\boldsymbol{A_C = M_C/\mu D_C}$



Scaling between Tectonic and Seismic Parameters

Global CMT Data from 65 faults 2000-2005



Scaling between Tectonic and Seismic Parameters

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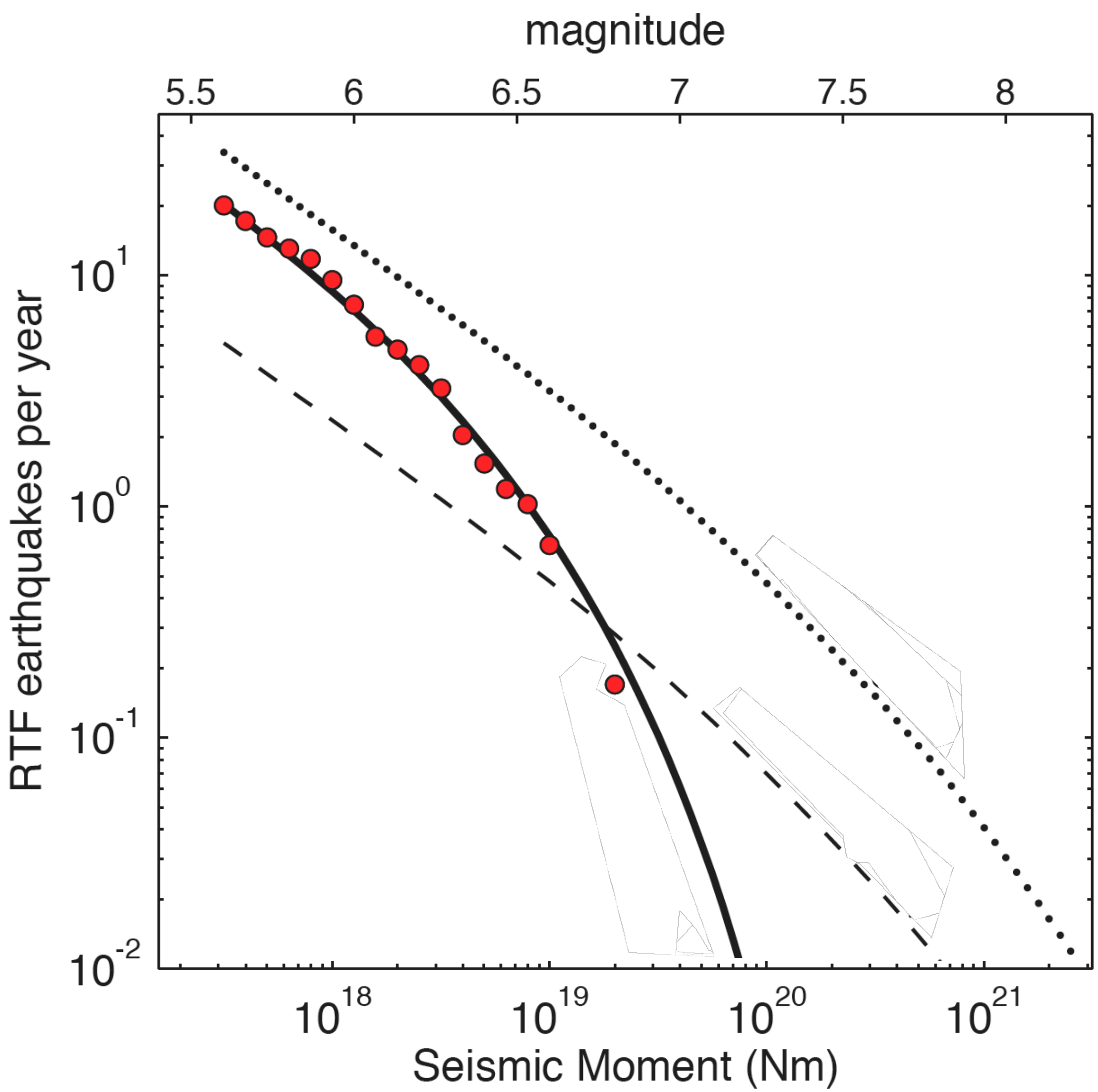


Computed magnitude-frequency curves are calculated assuming tapered Gutenberg-Richter distribution, L's & V's

Full Coupling

M_C fills entire fault area

15% Coupling

M_C fills entire fault area

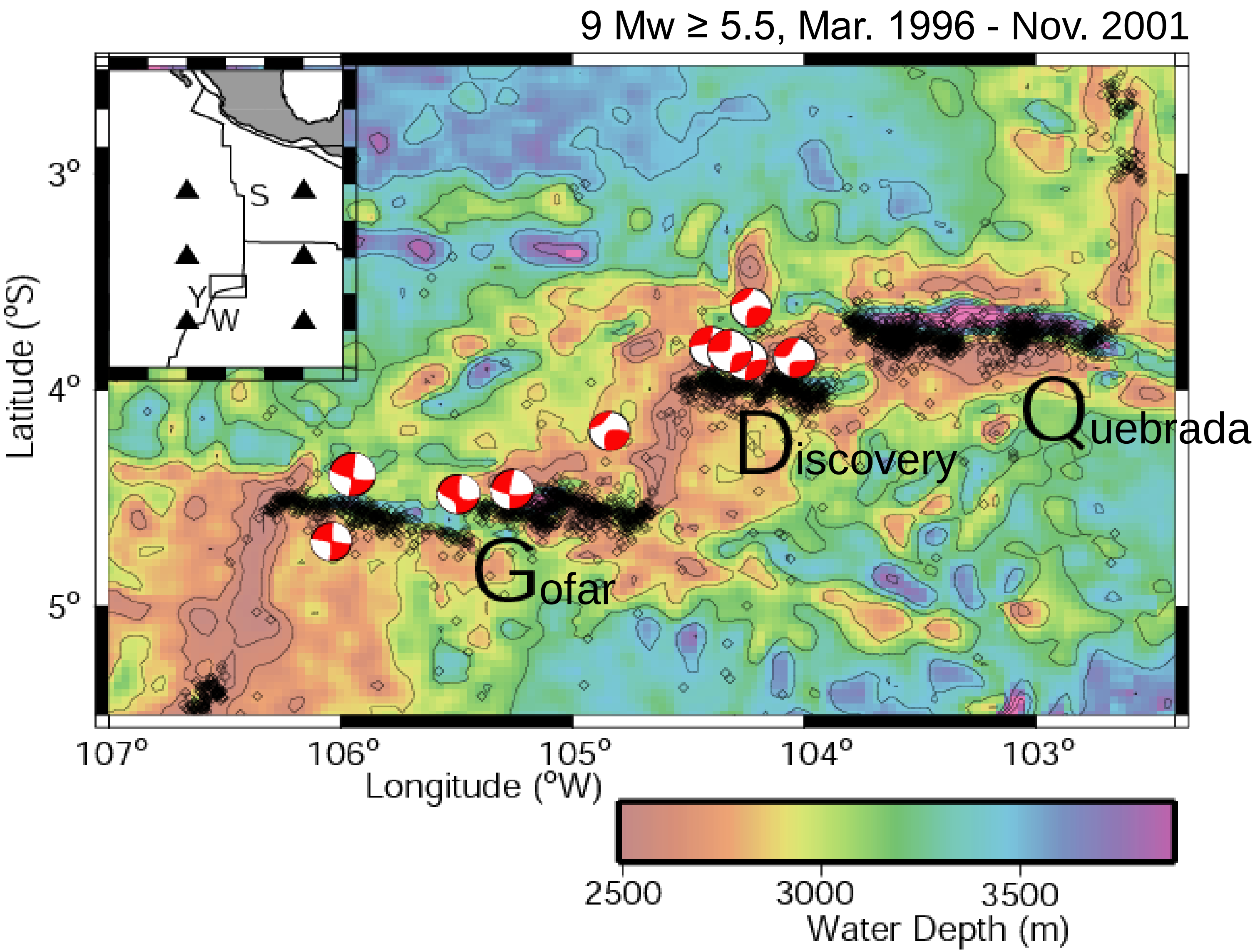
Observed Scaling Relations

15% Coupling

M_C scales as fault area to the 1/2 power

Short Term Earthquake Predictability

McGuire, Boettcher, and Jordan, 2005, Nature

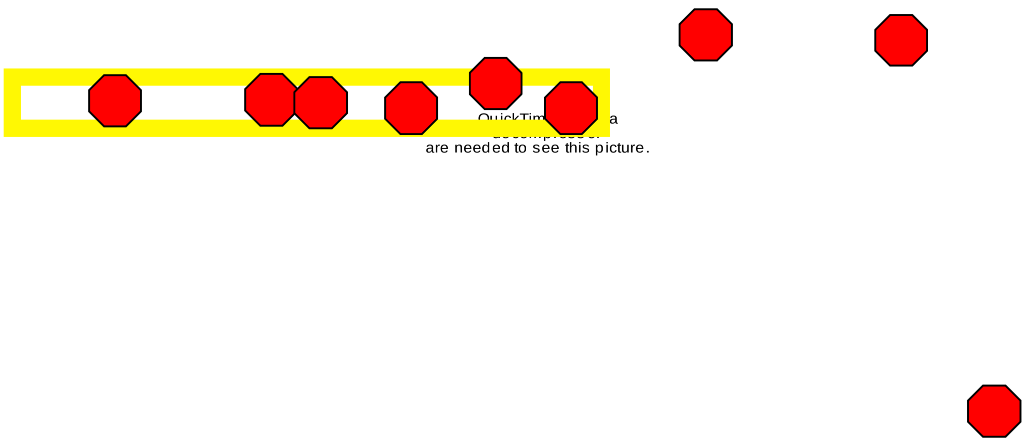


Short Term Earthquake Predictability

McGuire, Boettcher, and Jordan, 2005, Nature

Simple prediction algorithm-

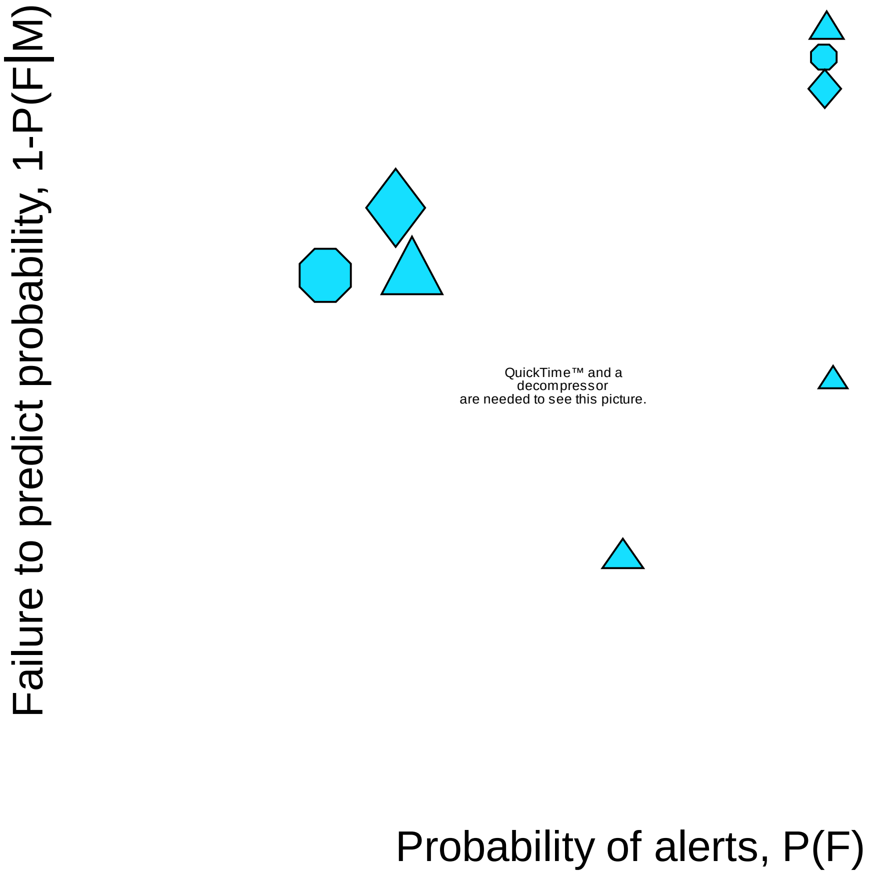
Mw ≥ 5.5 are preceded by a foreshock within 1 hour and 15 km



Short Term Earthquake Predictability

McGuire, Boettcher, and Jordan, 2005, Nature

Simple algorithms can achieve large (500-1000) probability gains over random!



Seismic Cycles and Earthquake Predictability

McGuire, 2008, BSSA

QuickTime™ and a
decompressor
are needed to see this picture.

Short-Term
Predictability

QuickTime™ and a
compressor
picture.

Long-Term
Predictability

Molchan error diagram for r=15 km:

Alarms following every hydroacoustically detected event

ETAS Simulation

Random guessing

99% Confidence bound for random guessing

Long Term Earthquake Predictability

Using our Scaling Relations M_C for East Pacific Rise faults we expect

L (km)	**V(cm/yr)**	**M_C**
120	14	6.0-6.2
70	14	5.8-6.0

Average slip in $M_W \approx 6.0$ is approximately

50-100 cm

Short Seismic Cycles, 5-10 years

Seismic Cycles and Long-Term Predictability

McGuire, 2008, BSSA

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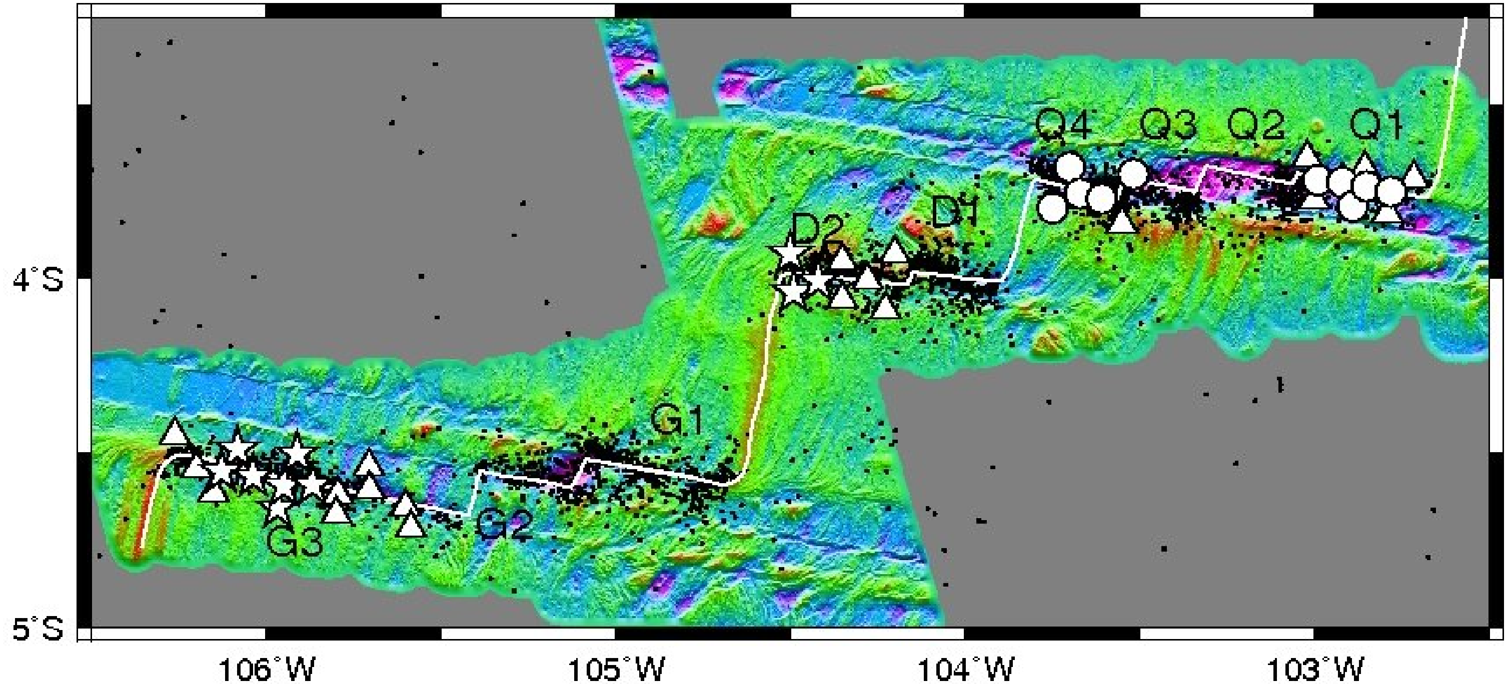
$M_W \geq 5.5$

$4.5 \leq M_W \leq 5.5$

Hydroacoustic detection

McGuire's 2008 Quebrada-Discovery-Gofar OBS Experiment



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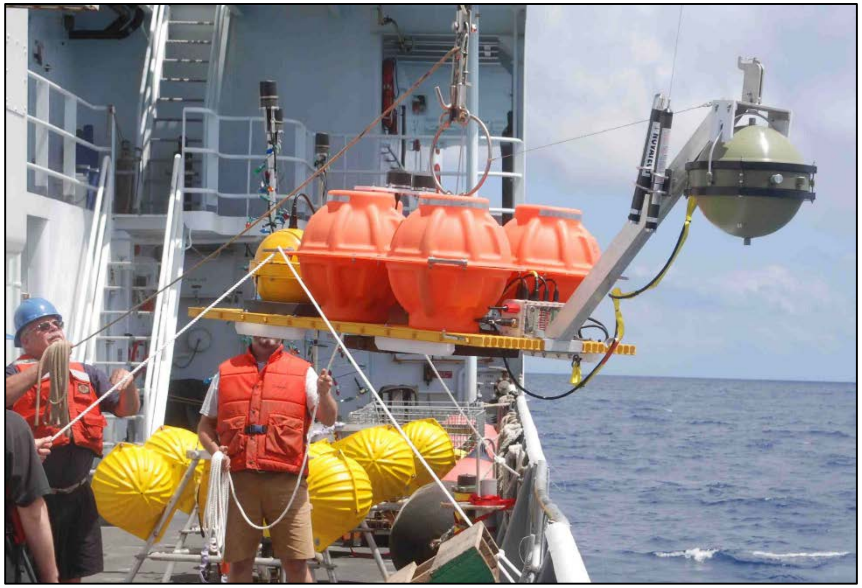

McGuire's 2008 Quebrada-Discovery-Gofar OBS Experiment

September 18, 2008,
M_W 6.0 Gofar Earthquake

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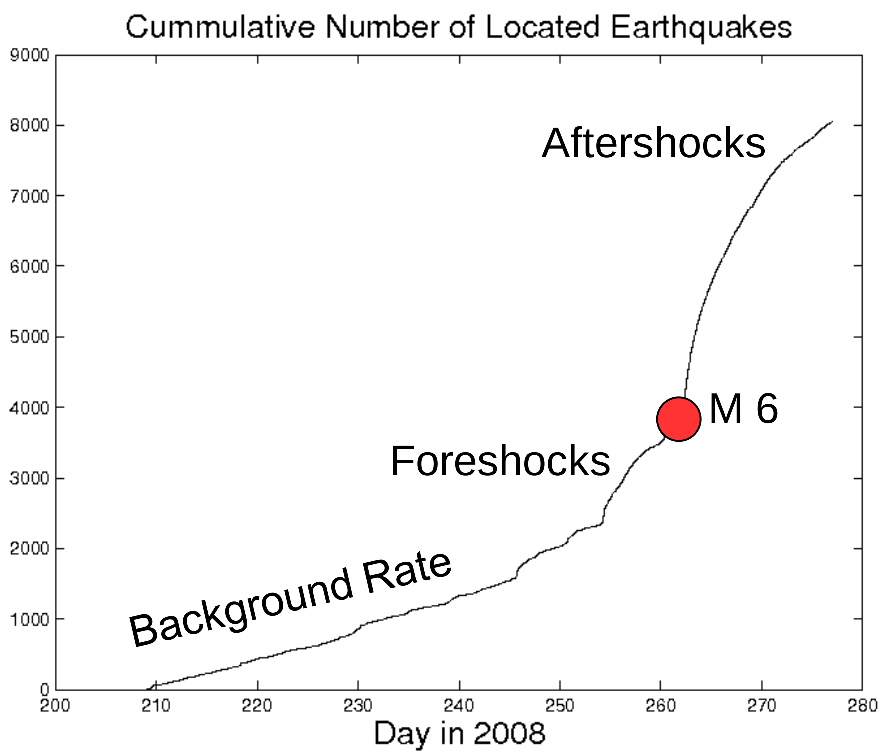
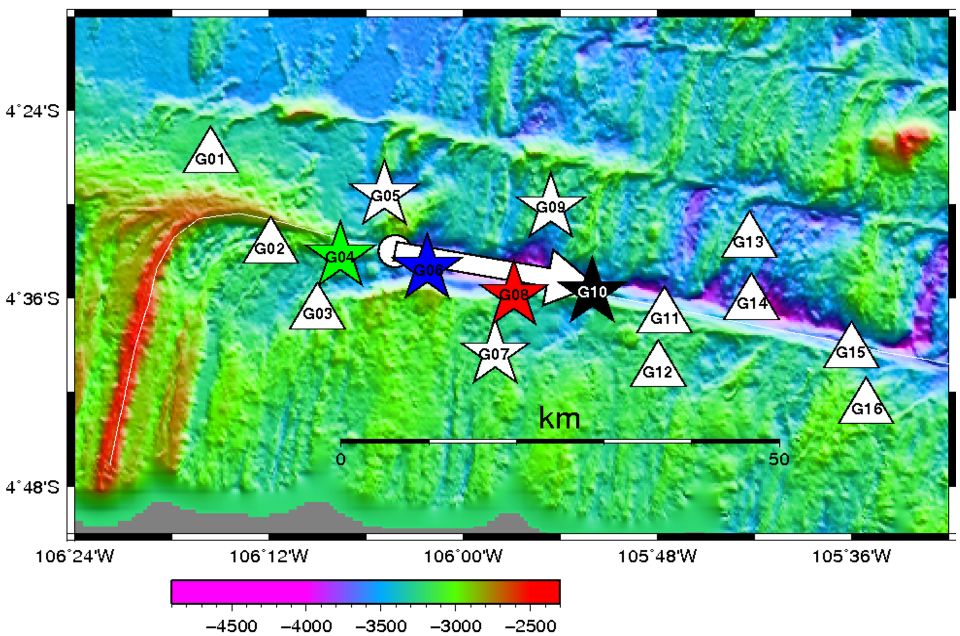
$M_W \geq 5.5$

$4.5 \leq M_W \leq 5.5$

Hydroacoustic detection

September 18, 2008, Mw 6.0 Gofar Transform Earthquake

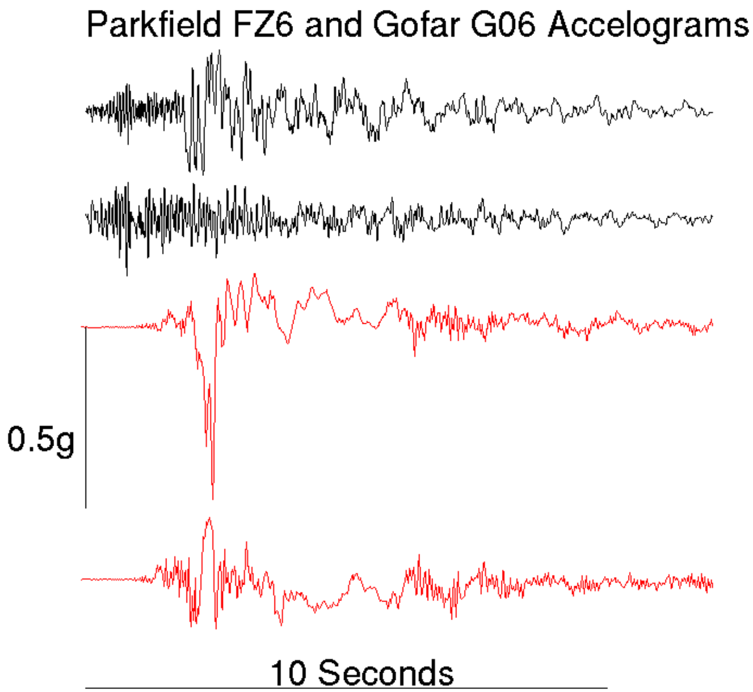


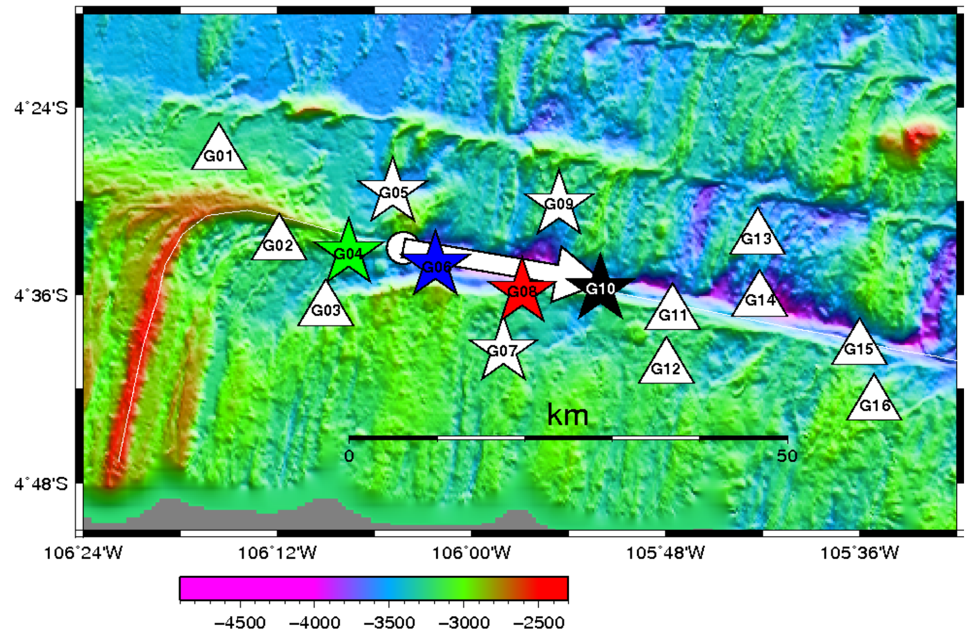


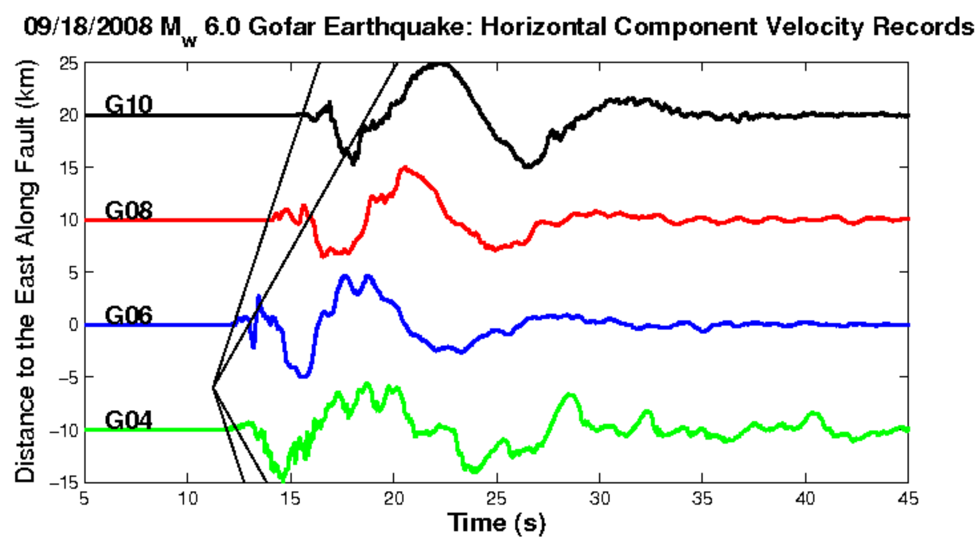
High rate of foreshocks for about one week before the M6.

We will be able to locate ~5000 foreshocks in the last week before the rupture and use this spatial information to evaluate the presence or absence of aseismic fault slip.

September 18, 2008, Mw 6.0 Gofar Transform Earthquake







Very smooth rupture to the east, probably at a velocity approaching the S-wave speed.
=> low fracture energy

A finite-fault model will give us information about the friction law and the spatial relationship between the foreshocks and mainshock slip.