Oceanic Transform Fault Seismicity Earthquakes of a Different Kind

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Oceanic Transform Fault Seismicity Earthquakes of a Different Kind
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<sub>T</sub>)**

65 Ridge Transform Faults

L ≥ 75 km (totaling≈16,000 km)

![Tectonic Parameters Diagram]

**Seismic Parameters (M<sub>C</sub>, ΣM, N<sub>0</sub>, & 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)

\[
ΣM = μAD
\]
Are oceanic transform faults fully coupled?

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

Effective Area of Seismic Slip

\[ \Sigma M = \mu AD \]

\[ \Sigma M/t = \mu A_E(D/t) \]

\[ A_E = \Sigma M/(t\mu V) \]
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 \(A_T^{1/2}\)

\[
A_C = M_C / \mu D_C
\]
Scaling between Tectonic and Seismic Parameters

Global CMT Data from 65 faults 2000-2005
**Scaling between Tectonic and Seismic Parameters**

Global CMT Data from 65 faults 2000-2005

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

**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

9 Mw ≥ 5.5, Mar. 1996 - Nov. 2001

Discovery Quebrada
Gofar
Simple prediction algorithm -
Mw ≥ 5.5 are preceded by a foreshock within 1 hour and 15 km
Simple algorithms can achieve large (500-1000) probability gains over random!

Probability of alerts, P(F)

Failure to predict probability, 1-P(F|M)
Seismic Cycles and Earthquake Predictability
McGuire, 2008, BSSA

Molchan error diagram for r=15 km:

- Alarms following every hydroacoustically detected event
- ETAS Simulation
- Random guessing
- 99% Confidence bound for random guessing
Using our Scaling Relations $M_C$ for East Pacific Rise faults we expect

<table>
<thead>
<tr>
<th>L (km)</th>
<th>V (cm/yr)</th>
<th>$M_C$</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>14</td>
<td>6.0-6.2</td>
</tr>
<tr>
<td>70</td>
<td>14</td>
<td>5.8-6.0</td>
</tr>
</tbody>
</table>

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

- $M_W \geq 5.5$
- $4.5 \leq M_W \leq 5.5$
- Hydroacoustic detection
McGuire’s 2008 Quebrada-Discovery-Gofar OBS Experiment
McGuire’s 2008 Quebrada-Discovery-Gofar OBS Experiment

September 18, 2008, $M_W \geq 5.5$ Gofar Earthquake

- $M_W \geq 5.5$
- $4.5 \leq M_W \leq 5.5$
- Hydroacoustic detection
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.
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.