Do subduction earthquakes foreshadow their arrival?

John Vidale
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Talk outline

Subduction geometry
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- Correlations
  - Not much use
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- Possible run-aways
  - Aseismic slip
  - Fluid
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  Not much use
Possible run-aways
  Aseismic slip
  Fluid
Possible symptoms
  Accelerating moment release
  Acc. correlation with tides
  Changing b-value
  Acc. corr. w/ focal mech.
Possibilities and clues
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Long-term build up of stress

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More exotic processes in nucleation zone

Tuesday, July 26, 2011
Subduction cross-section

Figure from Steve Malone

Locked Accretionary Prism
Juan de Fuca Plate
North American Plate

Slow slip zone
The locked plate interface

Dragert et al., 2004
Many facets of ETS in Japan

Obara
Many facets of ETS in Japan

Obara

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Central Japan subduction structure

Locked ETS region Stable Slip

Hirose et al., 2008, Shelly et al., 2006, Audet, 2009, Abers et al., 2009

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Central Japan subduction structure

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High Fluid Pressure

LFEs

subducting Moho

Plate Interface

Moho

background is DVs (%)
ETS in space and time

Suggestion of non-local fluctuations

Courtesy Mike Brudzinski
ETS in space and time

Suggestion of non-local fluctuations

Courtesy Mike Brudzinski
Tiny earthquakes triggered by slow slip

Vidale et al., 2011
Fig. 1 (A) Time series of the cumulative number of shallow VLFEs (pink line) to the south, off Cape Ashizuri [pink circles in (B)], cumulative number of tremor sources in the downdip (blue line) and updip (red line) regions in the Bungo channel [blue and red dots in (B)], and (black dots) detrended GPS displacement record (east component) at Ohtsuki [green square in (B)] with respect to Kamitsushima [red square in (B) inset].
Sumatra as an example of four proposed more definitive precursors

Figure 2. (a) Temporal variation of $p$-value in the area of the Sumatra-Andaman earthquake. A time window of 3000 days, which is represented by horizontal bar, is shifted by 500 days. (b) Frequency distribution of tidal phase angles in the 3000 days prior to the Sumatra-Andaman earthquake. Solid curve represents a sinusoidal function fitted to the distribution.
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• These could result from increased aseismic slip on the future fault plane, or the nucleation part of the future fault plane.
Focal mechanism evolution

Jiang and Wu, BSSA, 2005

(a) 1986/01/01-1990/12/31
(b) 1988/01/01-1992/12/31
(c) 1990/01/01-1994/12/31
(d) 1992/01/01-1996/12/31
(e) 1994/01/01-1998/12/31
(f) 1996/01/01-2000/12/31
(g) 1998/01/01-2002/12/31
(h) 5 years before the great Indonesia earthquake
(i) mainshock
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- Factors are perturbations
- Not run-aways
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- My personal view:
  - Seismicity is most sensitive proxy for stressing and run-away processes, followed by geodesy, and
  - little evidence for precursors now, and hope is fading.