**Figure S1** Detailed seismicity map and trench-perpendicular cross-section of the area near Padang. Map projection is chosen such that it is aligned with the trend of the trench (330°). The focal mechanism is plotted at the Quick-CMT centroid location (http://www.globalcmt.org). Numbered events show hypocentres of the main shock and four locatable aftershocks (see Table 1). Large circles show locations of earthquakes recorded during a recent temporary experiment in the area (Apr 08-Feb 09, ref. 5), and small circles show Engdahl locations⁶. On the cross-section, events within 60 km either side of the profile (centered on the centroid location), are plotted in colour, and all others in grey. The main event was relocated by hand-picking a selection of the global data, and incorporating data from the BMG and GEOFON networks recently installed in Indonesia⁷. Compared to the USGS-NEIC location, these additional data reduce the minimum epicentral distance from 500 km to less than 80 km, and increased the number of stations at less than 1000 km epicentral distance from 3 to 23. Because of their small size and the fact that the largest aftershock was hidden within the coda of the main event, the aftershocks could only be detected at local and regional stations, and a few exceptionally quiet teleseismic ones. Aftershocks were located relative to the main event using the classic master event approach. Note that the relative locations of the recent events, the Engdahl catalogue, and the seismicity from the temporary network are all approximately correct, but that the CMT centroid is determined using a different approach and subject to different bias, and therefore its location relative to the other points is not reliable.

**Figure S2** Aftershocks locations are determined with the master event method relative to the main shock (in red). The events are projected onto the plane spanned by the potential slip vectors according to the Quick-CMT focal mechanism. Slip vector 1 corresponds to slip along the plane striking 72°, and slip vector 2 corresponding to the plane striking 193°. In this projection, the focal mechanism would look like a pure strike-slip, with the compressional quadrant containing most
teleseismic rays (at the bottom of the focal sphere in geographic coordinates) in the lower right, and
the dilatational quadrant in the SE of the focal sphere to the top right. If all aftershocks were
located on the main slip plane, they would lie on the x-axis (if the slip was along plane 1), or the y-
axis (if the slip was along plane 2). Ellipses show 90 % confidence intervals.

**Figure S3** Samples of displacement seismograms for regional and teleseismic stations, sorted by
epicentral distance. The seismograms are aligned according to the observed P arrival time, and
predicted arrival times for P, pP and sP are indicated by vertical bars (IASPEI91 model). All
seismograms are scaled individually.

**Figure S4**, Interaction stress on the megathrust from the Padang earthquake as in Fig. 1c but from
to the failure on the NS nodal plane; all stress calculations in the paper use the Okada method and
the results are robust to reasonable variations in the main calculation parameters. The interaction is
again complex but is generally strong and fluctuating deep on the megathrust where the perceived
earthquake threat is low and weak and generally slightly negative under Siberut where the perceived
threat (defined here as the local strength of coupling between the plates) is high. Note, however, the
area of increased stress to the east of Siberut which coincides with strong coupling in Fig1b.

**Figure S5**, Total interaction stresses on the megathrust from the 2005, 2007 (Ref. 1 and references
therein) and 2009 events using the same definitions as for Fig. 1c. **a.** Assuming the EW nodal
plane and **b.** the NS plane.
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<th>Longitude (°)</th>
<th>Depth (km)</th>
<th>GAP (°)</th>
<th>DMIN (km)</th>
<th>#P phases $^1$</th>
<th>#S phases $^1$</th>
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**Table 1** Hypocentral parameters for the main shock and locatable aftershocks, numbers in brackets show in phases columns indicate phases available for location relative to the main shock using master-event method.
FIGURE S3
FIGURE S4