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**Additional Supporting Information (Files uploaded separately)**

Figure S1 – 101 mainshock seismicity map bundle

Table S1

**Introduction**

Auxiliary materials comprise explanatory text, 6 figures and 1 table that supplement the main text.
**Text S1.** Description of the misclassified ruptures of Figure 4.

Eight events are not correctly classified (relative to the designated categories) by the regression models shown in Figure 4. Aspects of their individual seismicity characteristics are noted here.

Six events designated as Domain A ruptures were misclassified as Domain B based on the three parameter regression:

(1) 9-Oct-1995 $M_w$ 8.0 Mexico. This sequence has no short-term intraplate seismicity among the few early aftershocks and has a very large interplate aftershock that lowered the long-term intraplate/total moment rate. The overall long-term activation of intraplate activity is otherwise supportive of a Domain A rupture (Figure S1, event ID 22).

(2) 24-Feb-1996 $M_w$ 7.5 Peru. The overall long-term intraplate activity is supportive of Domain A rupture, however the lack of any seismicity during the short-term window affects the result of the identification algorithm (Figure S1, event ID 27).

(3) 3-Jan-2009 $M_w$ 7.7 Papua. This sequence had a very large interplate aftershock that dropped the short-term intraplate/total moment rate. The long-term activation of intraplate activity is supportive of a Domain A rupture (Figure S1, event ID 74).

(4) 15-Jul 2009 $M_w$ 7.8 New Zealand. The subduction zone is relatively young and the event has oblique slip indicating that slip-partitioning is not developed. It is also not clear that there are well-developed Domain A and Domain B zones as yet. Thus, while mainshock slip suggests a Domain AB rupture, the designation is more uncertain than for other events and is given an asterisk in Table S1. (Figure S1, event ID 75).

(5) 27-Feb 2010 $M_w$ 8.8 Maule, Chile. This event is just below the breakthrough decision line in Figure 4. It was designated as a Domain A event based on slip extending to near the trench in the northern and southern regions of the rupture, but only about 20% of the rupture length appears to involve coseismic slip in Domain A. There is significant intraplate activity near the shallow large-slip zones, including significant lower magnitude activity. We add an asterisk to this event in Table S1 to note the limited extent of rupture of Domain A. (Figure S1, event ID 77).

(6) 16-Sep-2015 $M_w$ 8.3 Illapel, Chile. This event did not trigger large intraplate activity, but clearly has shallow rupture in most slip models that incorporate
tsunami observations. There is intensive intraplate activity seaward of the shallow slip zone, but the magnitude of that activity is below our cut-off of $M_w = 5.2$. (Figure S1, event ID 100).

Two events designated as Domain B ruptures were misclassified as Domain A based on the three parameter regressions:

(7) 1-Jan-1996 $M_w$ 7.8 Sulawesi. The slip model suggests a Domain B rupture, despite the relatively large magnitude for this region. The relatively high intraplate background and aftershock rates suggest a breakthrough event. It is plausible that the slip depth is overestimated or that there was weak slip through Domain A for this event, so the designation as Domain B is given an asterisk in Table S1. (Figure S1, event ID 24).

(8) 11-Jun-1996 $M_w$ 7.1 Samar. The slip model suggests Domain B rupture. However, it is a relatively large event for this region, with intensive intraplate activity, including long-term outer rise activity that lies outside our spatial window. It is plausible that the slip depth is overestimated or that there was weak slip through Domain A for this event, so the designation as Domain B is given an asterisk in Table S1. (Figure S1, event ID 31).
Table S1. Mainshock information including event id, rupture domains (uncertain Domain A ruptures are noted with asterisks), date, location, moment magnitude, scaled magnitude (defined in main text), maximum observed earthquake magnitude, the ratio between the intraplate and all seismic moment rates of the background, short-term, and long-term activity. The last column is the Domain Classification Index $\hat{D}$ predicted from Eq. 2; positive values indicate seismicity patterns consistent with Domain A rupture, and negative values indicate seismicity patterns consistent with Domain B rupture.
**Figure S1.** Bundle of maps of the seismicity patterns for 101 mainshocks. The seismicity sequence from the global centroid-moment tensor (GCMT) catalog prior to and following each of the mainshocks is shown in maps for varying time intervals: from 1976 (or from 14 days after any prior event in the source region with magnitude greater than 0.2 units less than the mainshock magnitude) to 60 days before the mainshock (blue panel), from the 60 days preceding the event (light blue panel), in the first 14 days after the event (light red panel), and after the first 14 days to the end of 2016 (or up to 60 days before any later event in the source region with magnitude greater than 0.2 units less than the mainshock magnitude) (red panel). Large-slip zones (> 50% of the maximum slip) are shown as pink polygons. The mainshock mechanism is in magenta, the blue-filled mechanisms are foreshocks on the megathrust, red-filled mechanisms are aftershocks on the megathrust. The rectangular area indicates the source region for which seismic moments are summed. The blue dashed circle is an alternate source region discussed in the text. Below each panel is shown a lower hemisphere stereographic plot of the distribution of the compressional (P), tensional (T), and null (B) principal stress axes of the corresponding seismicity with respect to the P, T, and B axis of the mainshock (solid diamonds). Events having focal mechanism solutions with P, T, and B axes all within 30° of the mainshock values are indicated by filled color symbols, and these are identified as interplate events. A time magnitude plot is presented in the lower left panel for the interval 1976 to 2016, with a linear temporal distribution between the beginning and ending of each of the four time windows (with color coding indicating the interval of the seismicity in the maps of similar color outline). Seismic moment rate for each category of events for the four different time windows (with consistent color coding) is shown by the histograms at the bottom right.
Figure S2. Calculation of magnitude of completeness (Mc) and b-value for the GCMT catalog. (a) The cumulative magnitude distribution together with the Mc (5.2) with a b-value (power law slope) of one for the Gutenberg-Richter scaling relationship $N=10^{-bM-Mc+a}$, calculated for entire catalog between 1990 to 2016. (b) Mc is computed iteratively from the goodness of fit using a Kolmogorov-Smirnov test between observed and theoretical Gutenberg–Richter distributions with b-value from maximum likelihood estimation selecting the smallest magnitude for which the difference between the distributions is negligible ($\Delta D=0.025$).
Figure S3. Cumulative seismic moment (a and b) and number (c and d) of aftershocks for 101 major and great megathrust mainshocks for all events in the two weeks after each mainshock in the circular search areas in Figure S1. The mainshocks are subdivided into events that rupture at least Domain A (a and c) and those with ruptures confined to Domain B (b and d). Interplate faulting is indicated with brown tones and intraplate activity with green tones, with distinct faulting subcategories being labeled.
Figure S4. The ratio of short-term (14-day) aftershock cumulative moment to preceding background rate (magenta diamonds) and long-term aftershocks rate to preceding background rate (gray circles) for all 101 mainshocks using the rectangular search areas in Figure S1, for interplate thrust aftershocks (left two columns) and intraplate aftershocks (right two columns) as functions of $M_W$ and $M_{Scaled}$ (defined in text). Mainshocks are separated into those that rupture at least Domain A or just Domain B. Lines are log-linear regressions for cases with sufficient distribution of values along the horizontal axes.
**Figure S5.** The ratio of two-week aftershock cumulative moment to preceding background rate (magenta diamonds) and long-term post-mainshock rate to preceding background rate (gray circles) for all 101 mainshocks calculated from the circular search areas in Figure S1, for all interplate thrust aftershocks (left two columns) and intraplate aftershocks (right two columns), for mainshocks that rupture at least Domain A or just Domain B, as functions of $M_{W}$ and $M_{Scaled}$ (defined in text). Lines are simple log-linear regressions for cases with sufficient distribution of values along the horizontal axes.
Figure S6. Gutenberg-Richter earthquake magnitude distributions for composite seismicity of short-term (14-day) aftershocks for (a) all intraplate aftershocks (green circles) and all aftershocks (gray boxes) for Domain A ruptures, and (b) all interplate aftershocks (black boxes) and all aftershocks (brown circles) for Domain B ruptures. The log-linear slope (b-value) of each magnitude distribution is calculated using the maximum likelihood method.