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東北沖地震後の急速な応力回復から示される巨大地震発生の不規則性
Randomness of megathrust earthquakes implied by rapid stress recovery after the 2011 Tohoku-oki earthquake

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Constraining the recurrence of megathrust earthquakes is genuinely important for hazard assessment and mitigation. The prevailing approach to model such events worldwide relies on the segmentation of the subduction zone and quasi-periodic recurrence due to constant tectonic loading. In this study, we have used the earthquake catalog of the Japan Meteorological Agency (JMA) and analyzed events recorded along a 1,000-km-long section of the subducting Pacific Plate beneath Japan since 1998 to map the relative frequency of small to large earthquakes, expressed by the slope of the frequency-magnitude distribution of earthquakes (the so-called b-value). Evidence from laboratory experiments, numerical modeling and natural seismicity indicates that the b-value is negatively correlated with the differential stress.

Our analysis reveals that the spatial distribution of b-values reflects well the tectonic processes accompanying plate motion. However, there is no evidence of distinct earthquake-generation regions along the megathrust, associated with the so-called ”characteristic earthquakes”.

Nevertheless, we show that parts of the plate interface that ruptured during the 2011 Tohoku-oki earthquake were highly stressed in the years leading up to the earthquake, as expressed by mapped, very low regional b-values. Although the stress was largely released during the 2011 rupture, thus leading to an increase in b-values immediately after the megathrust event, the stress levels (i.e., b-values) quickly recovered to pre-megaquake levels within just a few years. This suggests that the megathrust zone is likely ready for large earthquakes any time with a low but on average constant probability.

Our results imply that large earthquakes may not have a characteristic location, size or recurrence interval, and might therefore occur more randomly distributed in time. The findings also bring strong evidence that the size distribution of earthquakes is sensitive to stress variations and its careful monitoring can improve the seismic hazard assessment of the megathrust zone.

Reference:
Thessa Tormann, Bogdan Enescu, Jochen Woessner, Stefan Wiemer, Randomness of megathrust earthquakes implied by rapid stress recovery after the Japan earthquake, *Nature Geoscience*, **8**, 152-158, doi:10.1038/ngeo2343, 2015.

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