Press Releases

November 17, 2016
JAMSTEC
The University of Tokyo
Graduate School of Science, Tohoku University
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Tohoku University

Postseismic Slip after 2011 Tohoku Earthquake Detected by Seafloor Observations
- Significant insight to understand the generation process of large earthquakes -

Overview

Dr. Takeshi Iinuma at Research and Development Center for Earthquake and Tsunami, the Japan Agency for Marine-Earth Science and Technology (JAMSTEC: Asahiko Taira, President) and his colleagues, Prof. Ryota Hino, Associate Prof. Naoki Uchida and Prof. Motoyuki Kido from the Tohoku University have investigated the postseismic slip[*1] associated with the 2011 Tohoku Earthquake based on seafloor and terrestrial geodetic data. To examine whether the postseismic slip was spatially separated with the coseismic slip, they applied the finite element method model to exclude the effect of viscoelastic relaxation from observed displacement timeseries data. As a result, it showed clear spatial separation between co- and post-seismic slips on the plate interface off the Pacific coast of Tohoku.

In addition, the postseismic slip was not detected in the northern region of Sanriku-oki, which was not ruptured by the 2011 Tohoku Earthquake. Their analysis of seismic data confirms that 1) the plate interface is still strongly coupled in this area; and 2) the slip rate, which soared in the 2011 Tohoku earthquake, is still large around the area. It suggests that the next earthquake at the rupture area of the 1968 Tokachi-oki Earthquake is likely to occur earlier than the ordinary recurrence interval of about 100 years.

These findings indicate that the generation process of huge megathrust earthquakes is controlled by frictional properties on the fault surfaces. They provide a significant insight to understand generation process of the plate boundary earthquakes. By presenting a model that should be incorporated into earthquake cycle simulations, it is expected to contribute to long-term prediction of earthquakes.

This work was supported by JSPS KAKENHI Grant Numbers JP20244070, JP15K05260, JP26000002 and JP26109007. The above results were published in the online *Nature Communications* on November 17, 2016 (JST).

Title: Seafloor observations indicate spatial separation of coseismic and postseismic slips in the 2011 Tohoku Earthquake

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*1 Postseismic slip: It is a slow slip on the fault following an earthquake. Without emitting seismic waves that cause the ground motion human can perceive, the fault continues to slide at a slow speed. Triggered by stress at the end of the fault slip, it sometimes propagates along the fault surface, which could induce other large earthquakes at a distance of more than 100 km.

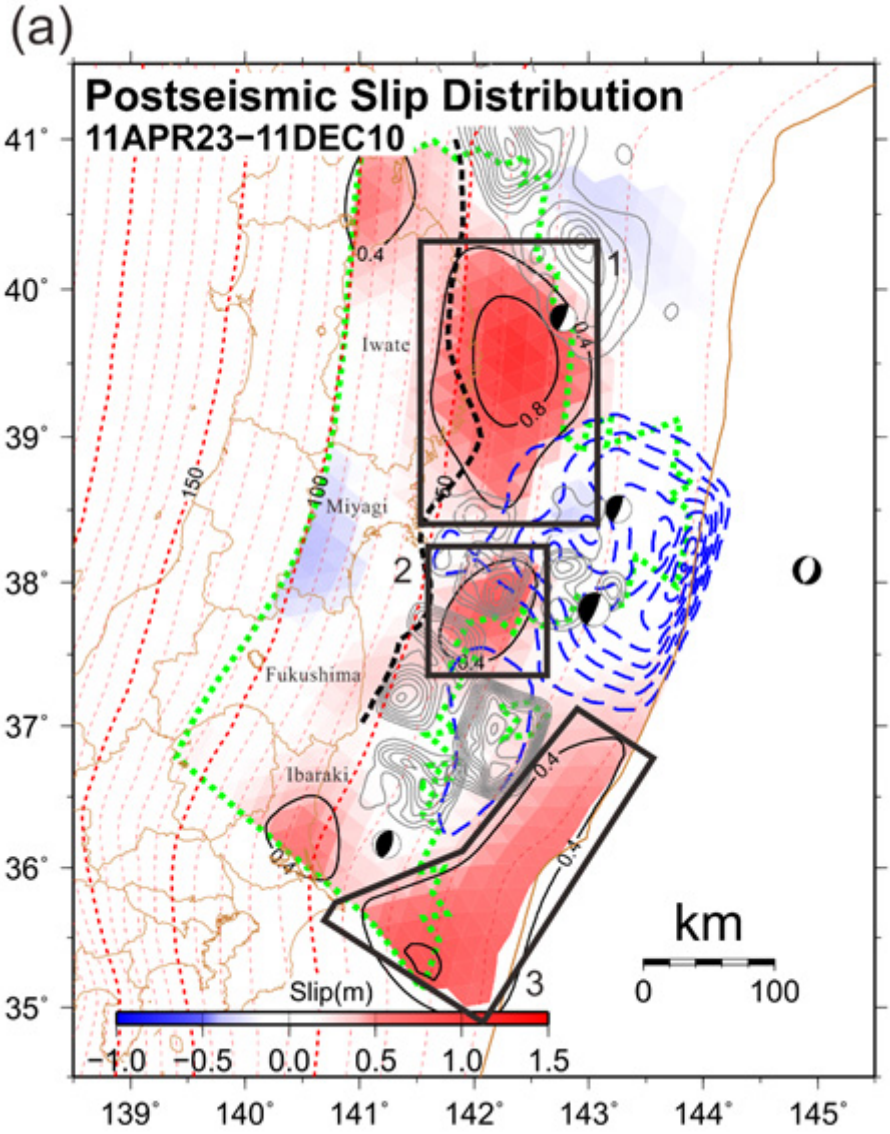

Figure 1. Cumulative distribution of the estimated postseismic slip of the 2011 Tohoku Earthquake.
Each triangular fault is coloured according to its dip-slip component of postseismic slip. The color scale for the postseismic slip is shown at the bottom of the panel: The positive value indicates reverse fault slip and the negative normal fault slip. The black contours of the magnitude of slip are shown at 0.4-m intervals. The black boxes 1, 2 and 3 indicate the subareas of substantial postseismic slip. The blue dashed contours represent the coseismic slip distribution. The black dashed line denotes the down-dip limit of the interplate earthquakes, while the broken red lines the depth of the subducting plate interface. In areas surround by the green dotted lines, the estimated postseismic slip distribution is well-resolved. The grey contours show the rupture area of past large interplate earthquakes.

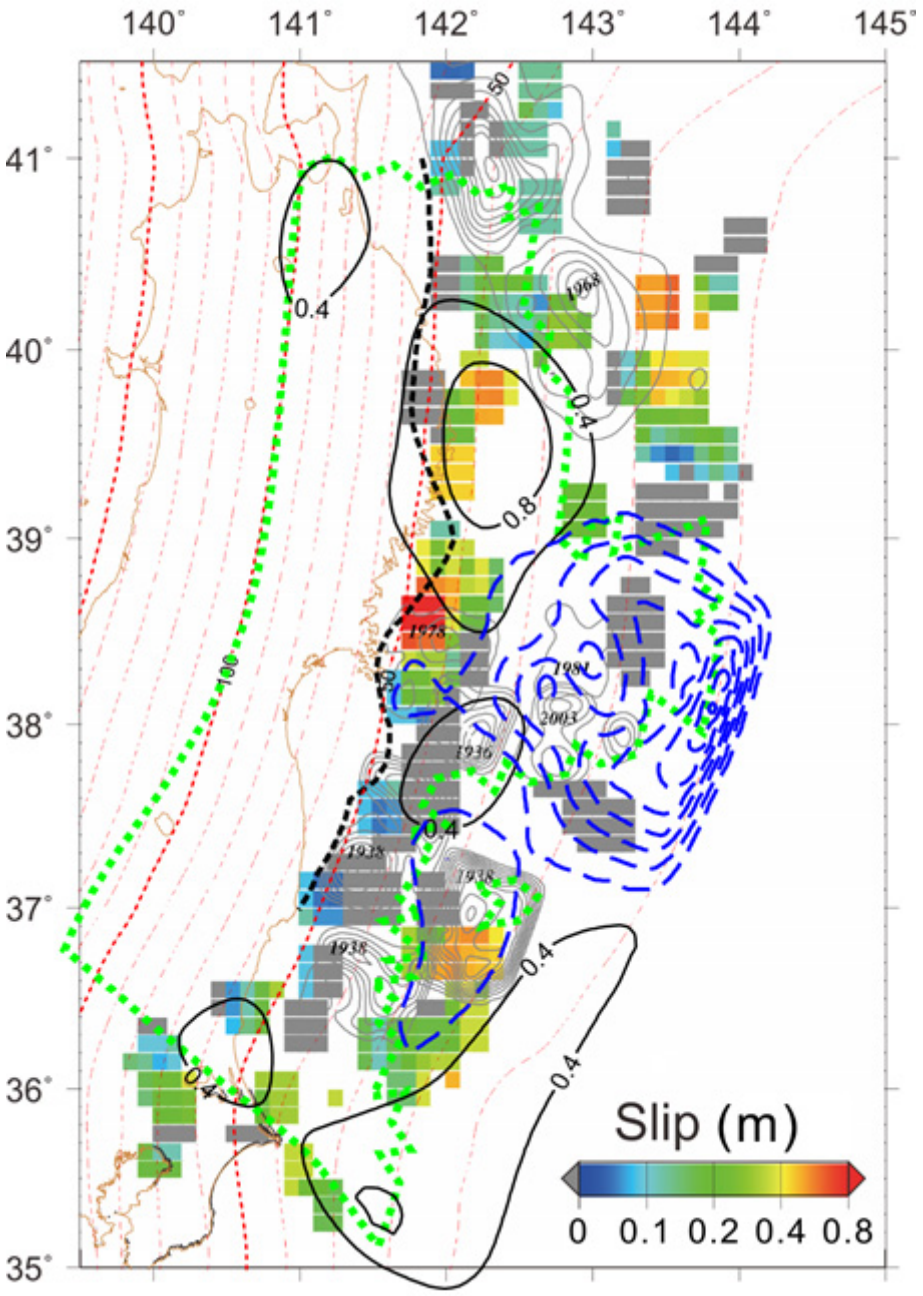

Figure 2. Postseismic slip from small repeating earthquakes.
Postseismic slip distributions estimated from small repeating earthquakes and terrestrial and seafloor geodetic data. The colour map shows the average cumulative slip estimated from 3 or more repeating earthquake groups in 0.3° × 0.3° windows, where the grey zones indicate no repeater activity during the period of the window. The black contours represent postseismic slip distribution based on geodetic data (identical to the black contours in Figure 1).

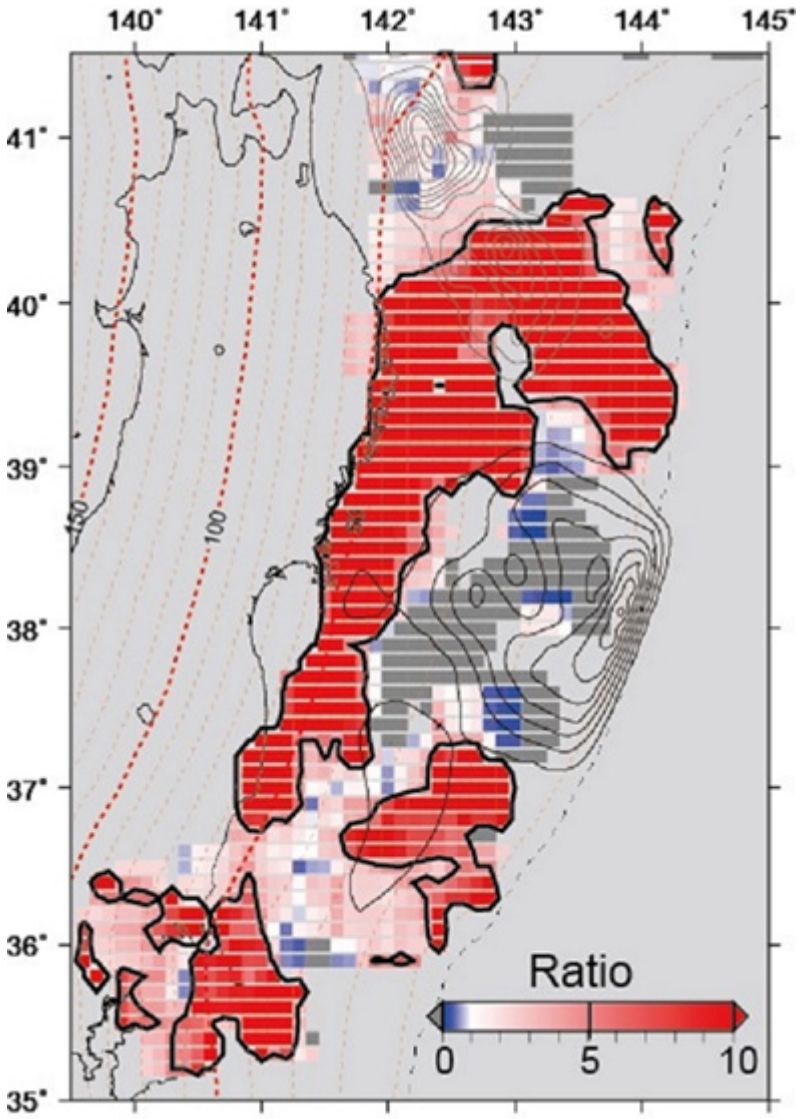

Figure 3. Acceleration of aseismic slip based on the thrust faulting earthquake activities.
The ratio shows occurrence rates (the number of earthquakes in unit time) of interplate earthquakes for the period after (23 April 2011 to 10 December 2011) and before (January 2008 to 11 March 2011) the 2011 Tohoku Earthquake. Thick black solid contours delineate the areas in which the rate is 5 times (or more) than during the preseismic period. Thin black contours represent the coseismic slip distribution. The broken red lines show the depth of the subducting plate interface. The grey contours show the rupture area of 1968 Tokachi-oki earthquake.

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