2011年東北沖巨大地震震源域の三次元構造
Seismic imaging of the source zone of the 2011 Tohoku-oki earthquake

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The great 2011 Tohoku-oki earthquake (*Mw* 9.0) is the best-documented megathrust earthquake in the world, but its causal mechanism is still in controversy because of the poor state of knowledge on the nature of the megathrust zone. *Zhao et al*. (2011) used seismic tomography to study structural heterogeneity in the megathrust zone and suggested that lateral structural variations atop the subducting Pacific slab, such as the subducted seafloor topography, seamounts and sediments, affected nucleation of the 2011 Tohoku-oki earthquake. In contrast, *Bassett et al*. (2016) used residual topography and gravity data to constrain the Tohoku forearc structure and proposed that variations in the forearc lithology of the overriding Okhotsk plate were the main cause of along-strike variations of the Tohoku-oki slip behavior. In this work we constrain the structure of the Tohoku forearc using seismic tomography, residual topography and gravity data. We apply a tomographic method (*Zhao et al*., 2002) to invert 144,354 *P*-wave arrival-time data recorded at 382 permanent seismic stations in Tohoku from 4760 local shallow and intermediate depth earthquakes that occurred during January 2000 to June 2016.

Our results reveal a close relationship between structural heterogeneities in and around the megathrust zone and rupture processes of the 2011 Tohoku-oki earthquake (*Liu and Zhao*, 2018). Its mainshock nucleated in an off-Miyagi area with high seismic velocity, low seismic attenuation and strong seismic coupling, indicating a large asperity (or a cluster of asperities) in the Tohoku megathrust zone. Strong coseismic high-frequency radiations also occurred in high-velocity patches, whereas large afterslips took plate in low-velocity areas, which may reflect changes in fault friction and lithological variations. These results indicate that structural anomalies in and around the Tohoku megathrust originate from both the upper Okhotsk plate and the lower Pacific plate, which controlled the generation and rupture processes of the 2011 Tohoku-oki earthquake. This huge earthquake was caused by collision of harder rocks in both the upper and lower plates.

This work sheds new light on the causal mechanism of megathrust earthquakes. It also suggests that the location of a future great earthquake may be pinpointed by investigating the detailed structure of the megathrust zone.

In this presentation, we will also show our new results obtained by adding the data recorded by the S-net that has been installed in the eastern Japan forearc region under the Pacific Ocean.

References

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