Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SIT02-05 会場:211 時間:4 月 29 日 15:15-15:30

日本沈み込み帯の流体と地震
Fluids and earthquakes in the Japan subduction zone

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Detailed tomographic images are determined for the source areas of large crustal and megathrust earthquakes that occurred in the Japan subduction zone during 1995?2013, thanks to the availability of the dense Japanese seismic network that could locate accurately the mainshocks and aftershocks of those large earthquakes and provide high-quality arrival-time data for tomographic imaging. Suboceanic events are relocated precisely using sP depth phase. Large crustal earthquakes in the forearc region such as the 1995 Kobe earthquake (M 7.2) and the 2011 Iwaki earthquake (M 7.0) might be triggered by fluids that are released from the dehydration of the subducting slab and directly ascend to the crust and enter an active fault zone. In contrast, along the volcanic front and in back-arc areas, the seismogenic layer in the upper crust is thinned and its mechanical strength is weakened because of ascending hot magmas and fluids which are produced by a combination of slab dehydration and corner flow in the mantle wedge. Large crustal earthquakes are apt to take place at the edge portion of the thinned seismogenic layer which exhibits low velocity, high Poisson’s ratio, and high electrical conductivity. To clarify the generating mechanism of the 2011 Tohoku-oki earthquake (Mw 9.0) and the induced tsunami, we determined high-resolution tomographic images of the Northeast Japan forearc. Significant lateral variations of seismic velocity are visible in the megathrust zone, and most large interplate thrust earthquakes are found to occur in high-velocity (high-V) areas. These high-V zones may represent high-strength asperities at the plate interface where the subducting Pacific plate and the overriding Okhotsk plate are coupled strongly. A shallow high-V zone with large coseismic slip near the Japan Trench may account for the mainshock asperity of the 2011 Tohoku-oki earthquake. Because it is an isolated asperity surrounded by low-velocity patches, most stress on it was released in a short time and the plate interface became decoupled after the Mw 9.0 earthquake. Thus the overriding Okhotsk plate there was shot out toward the Japan Trench and caused the huge tsunami. Further details of the role of arc magma and fluids in the nucleation process of a large earthquake can be clarified by high-resolution geophysical imaging and multidisciplinary studies of the earthquake fault zones.

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キーワード: 流体, 地震, 日本列島, 沈み込み帯, マグマ, スラブ
Keywords: fluids, earthquakes, Japan Islands, subduction zones, magma, slab