GCOE/AOB Seminar

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講演題目・内容

1) "Toward understanding slip-to-the-trench in megathrust earthquakes"
Earthquake, tsunami and geodetic data of the 2011 Tohoku-oki earthquake show that the fault rupture propagated to a shallow part of the subduction zone.
However, these observations alone cannot clarify whether the coseismic slip fault extended up the plate boundary interface all the way to the trench axis, mainly because of low near-trench resolution. In addition, several seismological studies suggested a structural anomaly, such as a subducted seamount, in an area of the rupture initiation, but a previous wide-angle seismic data show smoothly landward dipping oceanic crust. In order to examine a coseismic mega-thrust fault extending from the hypocenter to the trench axis, we processed seismic data acquired during a rapid response geophysical cruise soon after the earthquake, from 14th to 30th March in 2011. Comparing those data with one obtained before the earthquake in 1999, we found a remarkable coseismic structural difference in trench-filled sediment. As conventional multi-channel seismic data could not resolve a detailed fault image in the trench-filled sediment, additional high resolution seismic data were acquired from 22nd October to 11th November in 2011. We found, from the high resolution seismic data, a 3-km-long, ~350-m-thick deformed/upheaval structure showing a compressional structure (i.e., thrust-up structure) with reverse faults branching from an interface within the subducting sedimentary layer, which is interpreted as the coseismic master fault reaching to theseafloor. We believe that deformation structures we observed in the Japan trench axis preserve record of a slip-to-the-toe earthquake and can be used to identify where a large slip to the toe has occurred along the trench, not only during the 2011 earthquake but also during past tsunamigenic earthquakes. In order to understand along-trench extension and records of this type of earthquakes, we started a new five-years geophysical-geological project from 2011, including high resolution seismic, micro-bathymetry and piston-coring to cover the entire Japan trench. In our presentation, we will introduce an outline and preliminary results from this project.

2) "Imaging deep reflectors using SI and PSDM of wide-angle seismic data"
Pre-stack depth migration (PSDM) of wide-angle seismic data has a high potential to image deep reflectors, because the amplitude of deep reflection generally becomes large at far offset. However, PSDM has been rarely applied to the actual wide-angle seismic data. This is because the seismic migration intrinsically requires dense data set to image reflectors by constructive interference and practical wide-angle data are usually too sparse to apply PSDM. Seismic Interferometry (SI) can dramatically change the situation. The SI can generate dense, virtual receiver (or shot) gathers from a sparse wide-angle data set. The synthesized dense gathers enable us to apply several advanced imaging techniques of MCS analysis such as the seismic migration. Using the actual airgun-OBS data obtained in the north-western Pacific plate, we calculated dense virtual receiver gathers (0.2km spacing) from the sparse (6km spacing) OBS data by applying SI. Using this virtual data set, we applied wide-angle PSDM and examined the requirements for the successful imaging of structural boundaries within the oceanic plate. As a result, we found that, (1) 6km OBS spacing is enough to image seafloor, basement, and the oceanic Moho within the oceanic plate, (2) imaging results depend on the migration velocity

models, and (3) the reflection traveltime tomography gives us an appropriate migration velocity model. In this presentation, I explain the basic principles of this approach, and discuss effective ways to image structural boundaries using wide-angle seismic data.

3) "Near-trench aftershocks of the 2011 Tohoku-oki earthquake"

After the 2011 Mw 9.0 Tohoku-Oki Earthquakes, aftershocks with a normal-faulting focal mechanism have been activated both in the overriding plate and incoming/subducting Pacific plate near the trench axis [e.g., Asano et al., 2011]. We conducted ocean bottom seismograph (OBS) observations using short-period and broad-band OBSs near the Japan Trench from August to October 2011. These OBSs were deployed on the landward slope including the area, where the several tens of meters co-seismic displacement was observed [e.g., Fujiwara et al., 2011], with approximately 10 to 20 km separation in horizontal. Earthquakes were detected from continuous seismograms obtained by the OBSs. The phase arrival times were picked manually. We determined the hypocenters by using a grid search method in a 2-D velocity model based on the active seismic survey [Ito et al., 2005]. Focal mechanisms were also estimated from polarities of the first motion of P-wave arrivals. The obtained results show that normal-faulting earthquakes occurred within the overriding plate. These earthquakes likely relate to the normal fault system in the overriding plate. On the other hand, no earthquakes have been observed within the toe of the overriding plate, where the several tens of meters of co-seismic slip displacement along the plate interface occurred during the 2011 Tohoku-oki Earthquake. Earthquakes located within the subducting plate have a strike-slip faulting focal mechanism. These earthquakes are considered to be an aftershock activity of the Mw 7.0 strike slip event occurred on July 10, 2011.

4) "An application of seismic interferometry to ocean bottom seismometer records"

Detection of temporal variations of subsurface seismic structure potentially provides information on time-dependent processes occurring within the Earth. In this study, we used ambient seismic noise recorded on 1-year continuous records of broadband ocean bottom seismometers (BBOBSs) that are deployed on outer rise of the Japan Trench. The observation period contains the time of the 2011 great Tohoku-Oki earthquake (Mw9.0). This condition potentially allows us to estimate temporal variations of seismic structure underneath the seafloor. As a result for the structure below the BBOBS sites, auto-correlating ambient seismic noise, we found persistent reflections of /S /waves from the bottom of a ?350-m thick marine sedimentary layer. The two-way travel times of reflected /S/ waves, which vary as a function of the polarization direction, indicate a velocity anisotropy of ~1.7% in the sedimentary layer. The fast direction is estimated to be trench-parallel, possibly due to cracks or normal faults formed by bending of the plate in the outer rise. For temporal variations, the travel time also shows a coseismic velocity reduction of ~2%, with slightly reduced anisotropy, within the layer. The change gradually recovered to pre-earthquake conditions through 4 months after the earthquake, although recovery was not complete during the period of the observation. Such coseismic changes can be explained either by increases of crack density and crack sphericity within the suddenly stressed sedimentary layer or by channeling and networking of water flow in the strongly shaken sedimentary layer.

主 催：東北大学 グローバルＣＯＥプログラム
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