High definition imaging of the Japan Trench by OBS Array of Arrays: Does shallow tectonic tremor occur in the plate interface?

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The Japan Trench is the host to various scale and slip behavior of seismic activities, such as the M9 Tohoku-Oki megathrust earthquake, slow slip events, low frequency tremors and very-low frequency earthquakes (VLFEs). Since these events occur under the seafloor, observation capability of the onshore seismic network is limited due to far distance from their source regions. During 2016 and 2017, we have performed the dense OBS Array of Arrays observation in the offshore Fukushima prefecture near the trench axis to achieve high resolution imaging of the shallow portion of the Japan Trench. Our network consists of three OBS arrays. Each array consists of one broad band OBS, and six 1Hz short period OBSs. These seven OBSs form a triangular array of 300m to 500m of interstation distance, which results in the array diameter of ~1km. High resolution imaging of complicated seismic phenomena (such as tectonic tremor) is enabled by installing the arrays in the vicinity of the target region. Based on visual inspection of the observed data, we have identified two episodes of low frequency tremors, triggered dynamically by M7.8 event in offshore Solomon Islands on December 2016, and M7.7 event in offshore Kamchatka Peninsula on July 2017. In both cases, the tremors were accompanied by arrival of Rayleigh waves. The episode of December 2016 lasted 7 minutes, and ceased after passage of Rayleigh wave. On the other hand, the episode of July 2017 continues even after passage of Rayleigh wave, and lasted for more than 12 minutes.

To reveal the origin of these tremors, we apply a beamforming technique to estimate back azimuth and slowness of incoming wave observed by the arrays. Observed tremors are beamformed in horizontal components of OBSs after their absolute orientations are determined using particle-motion of T-phase. From the resulting beam, we have estimated epicenters of the tremors every 60 seconds using only azimuthal information at each array. In this presentation, we are going to discuss about depth of the tremor sources from observed slowness. The tremor activities probably indicate the potential for the occurrence of shallow slow slip events near the Japan Trench, in which VLFEs and after slip were activated after the 2011 Tohoku-Oki earthquake.

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