# Shallow crustal structure in the outer rise of the Japan Trench by high-resolution seismic reflection survey

*YUE SUN[1], Ehsan Jamali Hondori[1], GUO CHEN[1], Tomoko Hanyu[2], Jin-Oh Park[1]

1. Atmosphere and Ocean Research Institute, The University of Tokyo, 2. Kobe Ocean-Bottom Exploration Center, Kobe University

## Introduction

Several historically large earthquakes with magnitude higher than 8 occurred in the Japan Trench subduction zone, with the March 2011 Tohoku earthquake (M 9.0) being the latest one. Obana et al. (2012) suggested that the stress regime of the Pacific plate has changed to a tensional stress down to a depth of 40 km after the Tohoku earthquake. This could have a direct impact on the occurrence of the large normal faulting earthquakes which could trigger a Tsunami. In order to investigate the detailed geological setting of the outer rise of Japan Trench off Sanriku and Miyagi of northeast Japan, we have conducted a high resolution multichannel seismic reflection survey in April 2019.

## Data Acquisition and Processing

We used research vessel *Shinsei-Maru* for survey KS-19-05 to acquire seismic reflection data along two seismic lines. Line 5 off Miyagi passes closely to the epicenter of Tohoku earthquake, and line 1 off Sanriku is in the northern part of the study area. The total length of line was 100 km and 150 km for line 5 and line 1. We used a time-variant band-limited envelope thresholding technique to suppress the strong swell noise. The spiky traces were manually edited to be excluded from data processing, and FX deconvolution filter was applied to further reduce the noise effect. Stacked sections and post-stack time-migrated sections illustrated the high resolution subsurface structure of the Japan Trench outer rise. We then used a layer stripping method to build an interval velocity model in depth domain to apply Kirchhoff prestack depth migration (KPSDM) to develop reliable depth sections.

## Results and Future Work

We could recognize many horst-and-graben structures in the outer rise of the Japan Trench, which develop from the seaside and continue toward the trench axis with clear associated normal faults. There are three major vertical displacements of the normal faults along line 5 that is close to the 2011 Tohoku earthquake epicenter. We also observe a series of horst-and-graben structures that are characterized by normal faults with displacements of several hundreds of meters along line 1. We identify slumping-like structure containing turbidites in the major grabens, which we believe were produced by the normal faulting earthquakes.

We picked top of ocean crust horizon in both line 1 and line 5 when building interval velocity model of KPSDM. Referring to this horizon, we interpreted all the major normal faults in line 1 and line 5, then measured the faults angles and displacements. Also, learned from the method of Fujie et al. (2018), we used the top of ocean crust horizon in both lines to calculate their cubic approximation curves and the difference between them for each line. Overall, line 1 has lager fault displacements but smaller fault angles than line 5. The flaults displacements increase when approaching to the trench axis in both line 1 and line 5, which is consistent with the general trend expected at the subduction zone. However, in line 1

 

within an area of 10 km to 40 km from the trench axis, the faults displacements increase abnormally. This may imply a relationship between this abrubt phenomenon and seismic activity. The faults angles near the trench axis are similar to the faults angles of the area that is far away from trench axis at the seaside. This shows that the faults angles may not be relevant to plate bending. However, at a middle distance about 20 km to 50 km from the trench axis, the faults angles change drastically in both lines. This may be caused by inherent physical properties of the subducting plate rather than plate bending motion.

The results obtained from the two lines are limited, so our future work is to apply our method to other MCS lines in the outer rise of Japan Trench to discuss the relationship between the normal fault development, plate bending, and seismic activity.

Keywords: Japan trench, Outer rise, Multichannel seismic reflection survey, Normal fault

 