2次元重合前深度マイグレーションによる宮城沖日本海溝沈み込み帯の地質構造

Detailed tectonic structure of the Japan Trench subduction zone off Miyagi by 2D pre-stack depth migration imaging

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The 2011 Tohoku earthquake (Mw 9.0) has been extensively examined by many geophysical data from state-of-the-art observational networks deployed both globally and locally. There were lots of studies to investigate the tectonic structure of the 2011 coseismic rupture zone. However, there were a few detailed seismic reflection images about both shallow and deep structure, because of the complicated geologic structure. In order to figure out detailed geologic structure and P-wave velocity modelof the Japan Trenchsubduction zone off Miyagi, northeast Japan, we tried to do 2D pre-stack depth migration (PSDM) imaging using multi-channel seismic (MCS) reflection data acrossthe2011 Tohoku coseismic rupture zone. Pre-processing to get CDP gathers with high S/N ratio includes trace editing, pre-filtering, spherical divergence correction, debubbling, deghosting, and surface-related multiple attenuation (SRMA).After air gun shots, a main pulse and following bubble oscillations were recorded, even though the air gun was tuned. In order to suppress the periodic bubble oscillations, we designed debubble filter. We used shot gather data with gain, trace header modification, sort and static application to extract the bubble signature from the raw MCS data, eventually producing a filter with ~30 Hz bubble waveform.In marine MCS data acquisition, source (air gun) and receiver (streamer cable) ghosts are recorded as notches in power spectrum. These secondary wavefield usually corrupts the raw data, depending on offset, time and geologic dip. We designed deghost filter to reduce the source and receiver ghosts. Like no other time before, we used both horizon-based tomography and grid-based tomography during the PSDM processing. Horizon-based tomography and grid-based tomography are global approaches which involve a solution of simultaneous set of equations for calculating the updating parameters of the velocity-depth model. In the horizon-based tomography, we built a depth-velocity model along which the residuals were picked, and updated both the depth surfaces and velocity of each layer. The updates are calculated at equally spaced spline nodes and then interpolated. After the horizon-based tomography, we inputted this velocity section into 2D auto-picker and calculated the QC semblance for defining a complete depth surface and updated for velocity at equally spaced points on a 2D grid. We recognize a bright reflector as the topmost oceanic crust (i.e., plate interface) of the Pacific plate subducting beneath the overlying Okhotsk plate, which can be traceable to more than 100 km landward from the Japan Trench axis. The seaward Pacific plate is characterized by horst and graben structure with normal faults. A strong reflector of Moho discontinuity, which is observed beneath the oceanic crust before subduction, is also observed even after subduction of the Pacific plate, up to more than 100 km landward from the Japan Trench axis. In the upper plate, we identify the Neogene sedimentary layer overlying the Cretaceous erosional unconformity, andseverallargereversefaultsdevelopingwithin theCretaceous basement. The backstop interface showshigh amplitude and negative polarityreflection that may be indicative offluid-rich fault. We observe a reflection of Arc Moho at depth of about 20 km. We can also observe megalens structure along plate interface at about 15-20 km depth, which is similar in Costa Rica subduction zone.

