Interactive method for the crustal structure analysis using OBS-control sources

Kei Murase[1]; Gou Fujie[2]; Ryuji Kubota[1]; Junzo Kasahara[3]

[1] Kawasaki Geol. Eng.; [2] JAMSTEC; [3] JCSS

When we estimate the crustal structure in an oceanic region, we often do not obtain a good result from the traveltime inversion alone, because of a nonlinear nature effects of the such an travel time inversion. In order to obtain accurate enough structures, we need to use an integrated approach including the forward modeling and other methods.

We have developed an interactive analysis system for the crustal study on the basis of the sophisticated tools originally developed by Fujie et al. (2000). Modeling and Pasteup both have excellent graphical user interface. Theoretical travel times and raypaths are calculated by the graph method made by Kubota et al. (2005). In this paper, we describe functions and features of our system.

The new interactive system has two major functions: Modeling and Pasteup.

Modeling and Pasteup can be run under X-Window circumstance of Linux OS. Under such computer circumstances, we can do the crustal structure analysis by a note-PC. Most of human interface is done by a mouse.

Modeling is a forward analysis software to perform crustal structure modeling, travel time calculation for refracted first and later arrivals, reflected arrivals, P-S converted waves, and headwaves, raypath calculations, depth-time section conversion and gravity modeling. We define the crustal structure by several layers with velocity grids on the layer interface. If a discontinuous layer boundary is required, we can define two different velocities for the above and the below the particular layer boundary.

Pasteup has functions of OBS record section display by wiggle, variable area, and color pallet coding, filtering, geometrical spreading correction, stacking, reduced travel time display, MCS record section display, traveltime picking and apparent velocity estimation. We evaluate amplitudes on records. During interactive analysis, we also display MCS time section on Pasteup window. By the conversion from depth to time of the velocity structure model, we directly compare MCS reflection data and our velocity model.

We can manipulate a mouse to define and/or modify grid points and layers in a model.

Using working crustal structure model, we can calculate traveltimes and raypaths, and superpose on a working OBS record section on the Pasteup window. Although we can calculate traveltimes and raypaths for multiple OBSs simultaneously on modeling window, we usually superpose only one of those on corresponding OBS. If necessary, we can process multiple OBS record section simultaneously on Pasteup window, but it is a bit pain works due to limitation of screen resources. We can include later arrivals for analysis. Theoretical travel times and picking travel times for the observed record sections are saved on a file.

We can compare traveltime picking based on observed records and theoretical travel times on Pasteup window. Through the interactive analysis, we can obtain the best fit model for observed data. The average fitting is approximately 20-30ms if arrivals are clear enough. We use forward velocity model for the input of traveltime inversion to minimize non-linear effect of travel time inversion. By use of forward analysis, we also evaluate kind of waves for later arrivals. It is great help to use full wave information on seismic records. After the forward modeling and travetime inversion, we use synthetic waveform calculation to confirm the accuracy of the model. We confirmed the effectiveness of our procedure of analysis. Gravity data are also used to evaluate the correctness of the resultant model. In the actual processing; we used over 200 OBSs and every 200m airgun shots for the longest survey line.