Seismic traveltime inversion including semi-automatic identified later phases - Progressive model development method (PMDM) ver. 2

Toshinori Sato[1], Norihiro Oishi[1]

[1] Chiba Univ.

1. Introduction

Refraction experiments using artificial sources are one of the major methods for revealing the velocity structure of crust and uppermost mantle. In recent years some authors have developed inversion methods for 2-D refraction analyses. Such inversion methods can estimate the uncertainty and resolution of model parameters, and provide quantitative estimates of the reliability of the estimated models. However, because the optimization problem of traveltime fitting for 2-D structures is highly non-linear, these inversion methods depend strongly on the initial model. In these methods, moreover, phase identification by visual inspection is needed before the inversion.

We developed an inversion method for 2-D refraction experiments, Progressive model development method (PMDM ver.1), that allows progressive improvement of velocity structure through a sequence from one-dimensional (1-D) models to pseudo 2-D models, and then 2-D models (Sato and Kennett, 2000). This presentation shows modified PMDM (PMDM ver.2), which can deal with later phases.

2. Method of analysis

We modified PMDM ver.1 to be able to use later phases such as reflection. First, we make groups of picked data whose phase seems to be same. Then we conduct the least square method to estimate the most probable phase for each group using the velocity structure model calculated only with the first arrival data (the result of PMDM ver.1). This method identifies phases of picked data by computer automatically. Only data picking and grouping need visual inspection. Because of phase identification for groups, the reliability of the identification is higher than phase identification for each picked datum.

If the difference between the velocity structure model calculated only with the first arrival data and the true structure is not small, the above method has some probability to make mis-identification of phases. To avoid this, we estimate the best 2 phases for groups that have high probability of mis-identification. Then we calculate 2-D inversion for each phase. This modification increases the amount of computation. When there are N groups that take 2 phases, combination of phases is 2 to the N-th. However, this modification makes the method more robust.

3. Results of calculations

We conducted a numerical simulation using the above method (PMDM ver.2). The results show that the resolution of lower layer boundaries and velocities of lower parts of each layer are much improved. Even if we use a bad initial model, the result of the inversion using correct phases becomes the best estimated model. We also conducted the method for a real data.