O135-P004 **Room: Poster Session Hall** **Time: May 19**

Evaluation of travel times for first arrivals and later phases using graph method especially for the crustal structure analysis

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Seismic tomography techniques have been rapidly developed to interpret crustal seismic refraction data. Forward modeling approaches, however, are also necessary to examine an initial model for inversion and/or later phases. Ray-paths and travel times of later phases, as well as fastest arrivals, such as reflection, later refraction and P-SV converted waves, provide indispensable information for seismic crustal structure analyses. Although the shooting algorithm is popular, useful and very rapidly, it has serious drawbacks. When velocity models are complicated, the ray-paths such as head waves and diffracted ones may be difficult to determine, even if a dense ray fan is used. The wave front methods on a regular grid are robust even with complicated structures, but basically compute only first arrivals. We develop new algorithms to compute first and later reflection arrivals, later refraction arrivals and converted waves using the wave front method based on the slowness network nodes mapped on a multi-layer model. A number of important ray types should be considered if we study the continent-ocean transitional structure. One of such ray types is the travel path for the Pg traveling through the semi-continental lower crust - Pn traveling through a part of oceanic upper mantle. This ray type should be compared to Pg through a part of the lower crust in the semi-continental lower crust - Pn through the upper mantle of the semi-continental and the pure-oceanic parts. Similarly, a seismic phase traveling Pn and then Pg is also important and it may be observed if the crustal thickness is larger.

The algorithm can evaluate ray paths and travel times for these two refracted waves, separately. The second important consideration are made on the PmP. For the PmP phase along the continent-oceanic transitional Moho discontinuity, significant later arrivals (Pm2P) appear from the steep slope of the transitional Moho discontinuity zone. The algorithm can generate Pm2P arrivals for such zone. The Pm2P makes a cusp on the record section.

To confirm the accuracy of the proposed method, we compute arrival travel times and ray-paths for the continental-oceanic transition zone model and compare the solutions with those by the synthetic waveforms obtained by the Finite Difference Method (FDM). In the model, an OBS is located at 175km distance from the left-hand side of the model and sources are at the ocean surface. The travel time fields are obtained as common-receiver profiles for the first and later refraction arrivals. The comparison of synthetic waveforms and modified travel time calculation are excellent agreement. The algorism has been applied for the real OBS refraction data obtained by the Japanese continental shelf survey carried out by the Hydrographic and Oceanographic Department, Japan Coast Guard.