Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

U02-17 Room:419 Time:April 28 16:15-16:30

Geophysical Inversion of Geo-Neutrino Flux Data: Formulation for Reveling Chemical Structure in the Earth

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Observation of geo-neutrino flux enables us to constrain distribution of radiogenic heat sources in the Earth (e.g., Enomoto et al. 2007, EPSL). Although the data provides unique information, resolution was limited because the observed data has been just one scalar quantity (geo-neutrino flux at the observational site). However, recent challenge to directional measurements by the RCNS group will greatly improve the resolution, because the observed data becomes a vector quantity with large dimension (geo-neutrino flux as a function of incident angle and azimuth).

In this study, I will formulate geophysical inverse problem to effectively constrain where and how much we have radiogenic heat sources in the Earth. Following procedures by Enomoto et al. (2007), we first categorize reservoirs of radiogenic elements (e.g., crust, bulk mantle, slab and LLSVP) and develop a reference distribution model of radiogenic elements in the Earth. We then compute a synthetic geo-neutrino flux pattern (as a function of incident direction) for each reservoir category. We assume that the observed flux can be expressed by linear combination of synthetic patterns and define their coefficients as model parameters.

The optimal coefficients can be obtained by solving an inverse problem. If the reference model is perfect, every coefficients should be equal to one. If the optimal coefficient deviates from one, it suggests that the assumed concentration was not appropriate for that reservoir category. This formulation should be useful for geophysical interpretation. For example, if the coefficient for LLSVP is large, we can suggest that a large amount of crustal material is accumulated in the LLSVP.

At the time of presentation, besides the details of the above formulation, I plan to show expected resolution when we use data obtained by the ongoing KamLAND experiment.

Keywords: geo-neutrino, KamLAND, geophysical inversion