Neutrino geophysics and energetics of the Earth

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Cosmo-chemical approach, using the CI Carbonaceous Chondrite meteorites as a basic ingredient of the Earth, successfully modeled the bulk chemical composition of the Earth. Combining physical properties known from the seismological analysis, lithology tells us the crystal structure and chemical constitution of rocks in each layer of the Earth. However, since the deep part of the Earth is essentially unreachable, there is no direct observation about the chemical composition of the whole Earth. Neutrinos from radioactive elements in the Earth, such as Uranium, Thorium and Potassium, have been expected to bring direct insight into the bulk Earth chemical composition, because their cross section is extremely small and travel to the surface practically without any interaction.

Neutrinos are also expected to provide fruitful information on Earth's energetics, because neutrino sources are also heat sources, and the radiogenic heats are believed to contribute a large part of Earth's heat budget, among other heat sources such as primordial energy of planetary accretion and latent heat of core solidification. Needless to say, all Earth's activities such as earthquakes, volcanoes, terrestrial magnetism and plate tectonics are all powered and controlled by the Earth's heat generation and heat transportation processes. Thus, understanding the Earth's energy generation processes, as well as the present condition of the Earth's energy sources, is essential to all fields of earth sciences.

Kamioka Liquid-scintillator AntiNeutrino Detector (KamLAND), which consists of 1000 tons of ultra-pure liquid scintillator surrounded by 1879 photomultiplier tubes, has discriminative sensitivity to the electron-type antineutrinos and is capable to detect few MeV neutrinos. Although KamLAND is designed primarily to detect antineutrinos from nuclear power reactors and demonstrate neutrino oscillations, it is also the first detector sensitive to terrestrial antineutrinos (geo-neutrinos). Here we evaluate a potential of the KamLAND detector, and a possible use of neutrinos for geophysical research, namely neutrino-geophysics.

We also present future prospects of KamLAND and the other possible geo-neutrino detectors. We suggest that Hawaii island is the most suitable site detecting chemistry and radioactivity of the lower mantle and core, which is essential to understand the earth's energetics and origin and evolution of the core dynamo.