International Session (Oral) | Symbol U (Union) | Union

[U-02_28AM2] Particle Geophysics

Convener: *Hiroyuki Tanaka (Earthquake Research Institute, the University of Tokyo), Hiroko Watanabe (RCNS, Tohoku-U), Cristiano Bozza (U-Salerno), Dominique Gibert (IPGParis), William McDonough (U-Maryland), John Learned (U-Hawaii), Chair: Hiroyuki Tanaka (Earthquake Research Institute, the University of Tokyo)

Mon. Apr 28, 2014 11:00 AM - 12:42 PM 419 (4F)

The great success in the imaging of volcanoes with elementary particles called muons (muography) as well as in the detection of neutrinos generated inside the earth (geo-neutrinos) has resulted in observation opportunities completely independent from the capabilities of conventional geophysical methods. By facilitating the future goals and concerns of the geophysical community, ideally shared among the muography observation group, geo-neutrino observation group, and earth scientists through international and interdisciplinary interactions, the aim is to strengthen the evolution of particle geophysics. Various muographical projects have been promoted worldwide, and each international group has been producing valuable results. Concerning geo-neutrino detection, the quantity of radioactive materials generating heat inside the Earth will be recognized via the frequency of geo-neutrino counts. Since this radioactive heat generation reflects the geodynamics and the chemical composition of the building blocks of our planet, improvements to measurement accuracy will likely yield useful geo-scientific information in the near future. With active cooperation between international communities, we aspire to expand the frontiers of earth observation techniques.

11:45 AM - 11:54 AM

△[U02-P06_PG] Towards a refined regional geological model for predicting geoneutrinos flux at Sudbury Neutrino Observatory (SNO+)

3-min talk in an oral session

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The SNO+ detector is the redeployment of the illustrious Sudbury Neutrino Observatory (SNO) at SNOLAB in Ontario (Canada). After the substitution of heavy water (D₂O) with liquid scintillator (CH₂) inside the inner vessel, in 2014 the 1 kton detector will come on-line and together with KamLAND in Japan and Borexino in Italy will accumulate geoneutrino events. Geoneutrinos are electron antineutrinos originating from beta decays of natural radioactive nuclides in the Earth interior. A fraction of them, generated from ²¹⁴Bi and ²³⁴Pa of ²³⁸U decay chain and from ²²⁸Ac and ²¹²Bi of ²³²Th decay chain, are above the threshold for inverse beta reaction on free protons and can be detected by SNO+. Geoneutrinos are a real time probe of Earth interior, because the flux at the terrestrial surface depends on the amount and distributions of U and Th in the Earth’s reservoirs. To extract global information such as terrestrial radiogenic heat power or to test compositional models of the Bulk Silicate Earth (BSE), the regional contribution to the geoneutrino signal has to be controlled by study of regional geology. We present the 3-D refined geological model of the main reservoirs of U and Th in the regional crust extended for approximately 2x10⁵ km² around SNOLAB, including estimates of the volumes and masses of Upper, Middle and Lower crust, together with their uncertainties. According to the existing global reference model (Huang et al., 2013), this portion of the crust contributes for 43% of the total expected signal at
SNO+. The remaining contributions come from the far field crust (34%), from continental lithospheric mantle (5%) and from the mantle (18%). Since SNO+ will accumulate statistically significant amounts of geoneutrino data in the coming years, the calculated signal that is predicted to be derived from the lithosphere can be subtracted from the experimentally determined total geoneutrino signal to estimate the mantle contribution. The main crustal reservoirs are modeled by identifying three main surfaces: the Moho discontinuity, the top of the Lower Crust and the top of the Middle Crust. About 400 depth-controlling data points obtained from deep crustal refraction surveys and from teleseismic receivers are the inputs for the spatial interpolation performed with the Ordinary Kriging estimator. This method takes into account the spatial continuity of the depths and it provides the uncertainties of the crustal volumes. The Upper Crust is further modeled in detail combining information from vertical crustal cross sections and Geological Map of North America at 1:5,000,000 scale. Seven sub-reservoirs with distinctive characteristics lithologies, metamorphism, tectonic events and chemical composition are identified. The density and the abundances of U and Th in the seven sub-reservoirs are evaluated from the published litho-geochemical databases, including analyses of representative outcrop samples. The Middle and Lower Crust densities and radioactivity contents are evaluated from seismic constraints. The numerical 3D model consists of about 9×10⁸ cells of 1 km × 1 km × 0.1 km dimensions. For each of them geophysical information, such as latitude, longitude, depth and reservoir type, are combined with estimates of the U and Th abundances to predict the geoneutrino signal at SNO+ originated from the regional crust. The total geoneutrino signal at SNO+ is about 12% less than that calculated using the global reference model (Huang et al., 2013).