Geo-neutrino measurements with KamLAND

K. ISHIDOSHIRO[1]* (FOR KAMLAND COLLABORATION)

[1]Research Center for Neutrino Science, Tohoku University, Sendai 980-8578, JAPAN
(*correspondence/:koji@awa.tohoku.ac.jp)

KamLAND experiment

The Kamioka Liquid-scintillator Antineutrino Detector (KamLAND) is a 1 kton liquid scintillator surrounded by 53 nuclear reactor units in JAPAN. Following the Fukushima nuclear accident in March 2011, the entire Japanese nuclear industry, which generates > 97% of the reactor neutrino flux at KamLAND, has been subjected to a protracted shutdown. The reactor-off period provides a unique opportunity to measure gen-neutrino with KamLAND.

Geo-neutrino analysis [1]

The data reported here are based on a total live-time of 2991 days, which includes the recent reactor-off period. Assuming a chondritic Th/U mass ratio, we obtain a geo-neutrino flux of $3.4^{+0.8}_{-0.8}$ x10^6 cm^{-2}s^{-1} from ^{238}U and ^{232}Th at the KamLAND location. The geo-neutrino flux translates to a total radiogenic heat production of $11.2^{+7.9}_{-5.1}$ TW from ^{238}U and ^{232}Th. The flux estimation is significantly improved by the reactor-off data. The geodynamical prediction with the homogeneous hypothesis is disfavored at 89% C.L. (Fig. 1) The observed flux is in agreement with the predictions from existing BSE models (geodynamical [2], geochemical [3] and cosmochemical [4]) with in ~ 2σ.

Future prospects

The ability of discriminating between models is limited by the statistical uncertainty. KamLAND contines to measure for getting further statistics. In the future, improved measurements with higher statistics and lower background is desired. Directional geo-neutrino detection is also required to further understand the deep interior of the Earth.

[1] A. Gando *et al*.., arXiv:1303.4667. [2] D. L. Turcotte and G. Schubert, Geodynamics, Applications of Continuum Physics to Geological Problems, second ed. (Cambridge Univ. Press, Cambridge, 2002). [3] W. F. McDonough and S.-s. Sun, Chem. Geol. 120, 223 (1995). [4] M. Javoy *et al*.., Earth and Planet. Sci. Lett. 293, 259 (2010).

Natural analogue study on long term alteration of bentonite (1) - Geochemistry and clay mineralogy-

TOMOKO ISHII[1], HISAO SATOH[2], KOHEI YAMAGUCHI[2], JIRO ETO[1], TOSHIAKI OHE[3]

[1] Radioactive Waste Management Funding and Research Center, Tokyo, 104-0052 JAPAN(ishii@rwmc.or.jp)
[2] Mitsubishi Materials Corp., Saitama pef.,330-8508 JAPAN
[3] Tokai Univ., Kanagawa pref., 259-1292 JAPAN

In order to evaluate the long-term behavior of the bentonite in geological disposal sites for TRU waste, the prediction of alkaline alteration by cement influences is very important. We conducted geochemical analyses of natural bentonite suffered from Ca-rich groundwater as a natural analogue of bentonite barrier after ~100kyr..

The drilling survey was carried out on geothermal site at a Japanese island arc basin to find similar environment to the bentonite barrier influenced by cement leachates. The hot spring water near the site has high concentration of Ca and pH. We drilled down to GL-250 m, and the tuffaceous bed was recognized in the depth of GL-240m. The sedimentary age of the bed was estimated as 8.2 - 5.6 Ma by analysis of microfossils. Post-sedimental thermal history was estimated to be 20-40 degrees by analysis of stable isotopes. According to whole-rock XRF data, this bentonite could have been altered from basalt-dacite (granite) bimodal igneous rocks. Backscattered electron imaging on the bentoite identified coexisting Na/Ca-smectite and heulandite (Fig.1).

Even in such a Ca-rich condition, Na-smectite still remains without complete conversion to Ca-smectite. Geochronology by fision track dating and ^{36}Cl/Cl suggested about 10Ma for ignesou age and 2Ma for groundwater entrapment. The composition of present groundwater was estimated as the mixture of rainwater and near hot spring water from a result of principal component analysis.

It is inferred that the Na-type smectite could have coexisted with the Ca-type in the bentonite for this geologic time-scale. This natural analogue may suggest a supporting evidence of smectite stability at the repository.

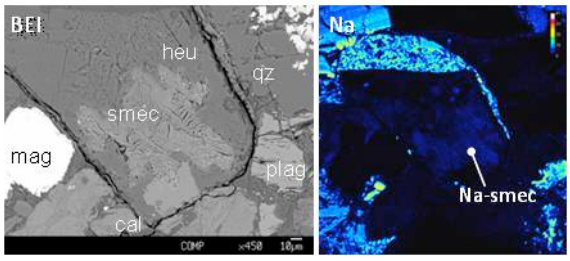

Fig.1 BEI and Na-map of the altered bentonite.

This research is a part of "Development of the technique for the evaluation of long-term performance of EBS (FY2007-2012)" under a grant from the Agency of Natural Resources and Energy , the Ministry of Economy Trade and Industry of Japan (METI).

DOI:10.1180/minmag.2013.077.5.9