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What is the composition of Earth?

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There is a disconnect between isotopic and geoneutrino observations that constrained the composition of the Earth. Recent papers discussing the latest results from 142Nd measurements of chondrites conclude that the Earth's bulk Nd isotopic composition is enriched in 142Nd relative to chondrites, and it has a higher Sm/Nd relative to chondrites (Frossard et al., 2022, Science; Johnston et al., 2022, Nature). These isotopic observations are interpreted as evidence for the loss of a differentiated fraction of mass from the Earth (e.g., collisional erosion and/or giant impact processes).

Here we present the latest results from global geoneutrino experiments. Abe et al. (2022, Geoph. Res. Lett.) reported a geoneutrino flux at the KamLAND (Japan) location, and Agostino et al. (2020, Phys. Rev. D) similarly reported a flux at the Borexino (Italy) location. Sammon and McDonough (2022, EPSL) updated the near-field, geological model for the Borexino lithosphere, while McDonough and Sammon (2023, in review) did the same for the KamLAND lithosphere.

Accordingly, existing particle physics experiments constrain the Earth's absolute abundances of Th and U (refractory lithophile elements) and remaining fraction of primordial energy. A combined data analysis using KamLAND and Borexino geoneutrino experiments affirms the Earth has 20.1 (+1.3, $2s_m$) TW of radiogenic power, 20 ng/g U and 76 ng/g Th and sets the proportions of refractory lithophile elements at 2.7 times that in CI carbonaceous chondrites. These results provide the only global measurement of the bulk silicate Earth (BSE). This result compares favorably with independent estimates (for the proportions of mildly incompatible refractory lithophile elements (e.g., HREE, Ca, Al) based on the composition of mantle peridotites (cf., 20 ng/g U and 79 ng/g Th (McDonough and Sun, 1995)).

The SNO+ detector (Canada) has been measuring the Earth's geoneutrino emission for more than a year and a geological analysis of its lithosphere has predicted it expected flux. It is anticipated that this experiment will report its findings in one to two more years. Together these three detectors provide a global coverage of the northern hemisphere's mantle contribution to the Earth's geoneutrino flux.