Constraining Earth's composition, mineralogy and its heat production

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Abstract

Geoneutrinos, produced during beta decays of naturally occurring radioactive isotopes in the Earth, are a unique direct probe of our planet's interior. The kTon-scale, underground, liquid scintillation detectors in Japan and Italy, which measure the flux of these electron anti-neutrinos, reveal that radiogenic heat from the decay of Th and U (only detectable signal) contributes between 20% and 50% of the Earth's present-day power (46+/-3 TW). Geoneutrino studies are providing quantitative constraints of the amount of uranium and thorium inside the Earth. Knowing precisely the absolute U and Th content of the Earth defines the planet's nuclear power budget for the heat producing elements. It also explicitly defines the absolute abundances of the refractory elements in the planet, which in turn specifies the mode proportion of Ca-pervoskite in the lower mantle. I will report on the latest data from geoenutrino studies and the data expected to be obtained over the next 8 years. These data will critically evaluate competing models of the bulk silicate Earth (i.e., low, medium, and high Q models, respectively, 10, 20, and 30 ppb U, Th/U = 4, and K/U =1.4x10ˆ4) and exclude some at the 1-sigma level. By 2025 there are projected to be 5 detectors counting the Earth's flux of geoneutrinos (10ˆ25/s); each will define locally the radiogenic power in the immediate (500 km) crust and collectively, the global array of detectors will define the residual radiogenic power left in the mantle and the Earth's Th/U value. Ongoing studies presently reveal that the Earth's Th/U value is 3.9 +/-0.15, a value coincident with that of the solar system. Consequently, given the marked differences in the partitioning behavior of Th and U between metal and silicate, this well constrained Th/U value for the bulk silicate Earth documents that negligible Th and U is in the core. Geoneutrino studies provide critical constraints on the power driving plate tectonics, mantle convection, and the geodynamo.

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