Thorium and uranium power plate tectonics, but not the geodynamo

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Radioactive decay of potassium (K), thorium (Th), and uranium (U) power the Earth's engine, with variations in $^{232}Th/^{238}U$ recording planetary differentiation, atmospheric oxidation, and biologically mediated processes. We report several thousand $^{232}Th/^{238}U$ (κ) and time-integrated Pb isotopic (κ_{Pb}) values and assess their ratios for the Earth, core, and silicate Earth. Complementary bulk silicate Earth domains (i.e., continental crust $^{CC}\kappa_{Pb} = 3.94^{+0.20}_{-0.11}$ and modern mantle $^{MM}\kappa_{Pb} = 3.87^{+0.15}_{-0.07}$, respectively) tightly bracket the solar system initial $^{SS}\kappa_{Pb} = 3.890 \pm 0.015$. These findings reveal the bulk silicate Earth's $^{BSE}\kappa_{Pb}$ is $3.90^{+0.13}_{-0.07}$ (or Th/U = 3.77 for the mass ratio), which resolves a long-standing debate regarding the Earth's Th/U value. Experimental studies find marked differences in the partitioning of U and Th during core formation. We performed a Monte Carlo simulation to calculate the κ_{Pb} of the BSE and bulk Earth for a range of U concentrations in the core (from 0 to 10 ng/g). Comparison of our results with $^{SS}\kappa_{Pb}$ constrains the available U and Th budget in the core. Negligible Th/U fractionation accompanied accretion, core formation, and crust - mantle differentiation, and trivial amounts of these elements (0.07 ppb by weight, equivalent to 0.014 TW of radiogenic power) were added to the core and do not power the geodynamo.