Composition of Earth's mantle and its variance

Tanya Lubetskaya and Jun Korenaga

Yale University, USA

We present a new statistical method to construct a model for the chemical composition of Earths mantle along with its variance. Our fundamental assumptions are essentially the same as the so-called pyrolite approach; primitive mantle can be located by the melting trend exhibited by mantle peridotites, with cosmochemical constraints on the relative abundance of refractory lithophile elements. Though this pyrolite approach involves the least number of assumptions thus perhaps most satisfactory compared to other approaches, its previous implementations suffer from questionable statistical treatment of geochemical data, leaving the uncertainty of model composition poorly quantified. In order to properly take into account the influence of data variance (i.e., scatters in peridotite data) on this geochemical inference, we combine the following three statistical techniques: (1) modeling a nonlinear melting trend in the multidimensional compositional space through the principal component analysis, (2) determining the most primitive mantle composition on the melting trend by simultaneously imposing all of cosmochemical constrains with least squares, and (3) mapping scatters in original data into the variance of the final composition model through the Monte Carlo bootstrap resampling method. The new composition model is shown to be substantially depleted in refractory lithophile elements, compared to previous models. Revising global heat budget and noble gas budget with this new model indicates the large-scale homogeneity of Earth's mantle.