The influence of initial condition and plate history on geodynamical predictions of thermochemical structures

One conceptual mantle model that attempts to explain the large, low seismic velocity regions beneath Africa and the Pacific involves large thermochemical piles in the lowermost mantle. Using geologically recent plate motion history as surface boundary conditions, geodynamical studies have been performed to predict the present day location and shape of an intrinsically more-dense, primitive lower mantle reservoir. One shortcoming of this approach is that we only have reasonable plate history data for the past 120 million years, and the geologic record is less complete for earlier times. We have investigated the role of initial condition and plate history, and it was found that initial condition does play a large role in the prediction of present-day thermochemical structures. We also find that plate history is important, meaning that using present day plate motions is not enough. Reasonable, yet somewhat unsatisfactory predictions occur if a Pangea configuration is assumed from Permian times until 120 million years ago. Strangely, we find that the best prediction, as compared to tomography, occurs when we use the artificial initial condition of a ubiquitous dense layer. These results lead to several subtle inferences about the state of thermochemical convection, if it exists in the lower mantle.