PART IV

DYNAMICS OF SUPERPLUMES

INTRODUCTION

Part IV contains a description of the dynamical issues involved in the generation of superplume in the lower mantle.

Superplume (Fig. 1), as the major physical mechanism for driving dynamics in the lower mantle, is the major subject of this book and therefore deserves some considerations from a dynamical standpoint. However, the physical aspects of superplumes are under debate: whether they are of a thermal or chemical nature or both, or, one big plume, or a cluster of smaller plumes colliding with each other (Schubert et al., 2004).

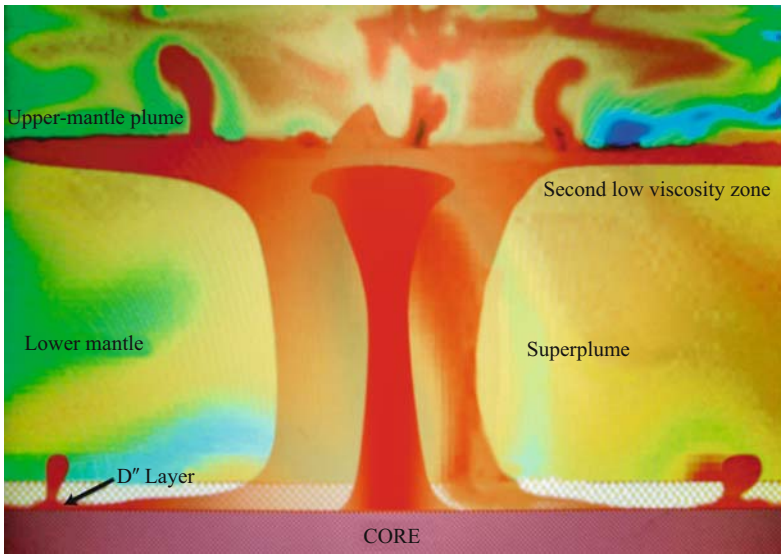


Figure 1. Schematic illustration of the multi-scale nature of mantle plume and superplume based on calculations by Matyska and Yuen (2005) and drawn artistically by Ying-chun Liu.

D. A. Yuen et al. (eds.), Superplumes, 237–238.
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Yuen et al. studied the various conditions for thermal convection in the mantle in which superplumes can be generated, particularly by radiative thermal conductivity in the lower mantle in the presence of the post-perovskite phase change. Post-perovskite and the electron spin-transformation of wüstite may play a significant role in promoting the radiative heat transfer. Hofmeister treats the subject matter of thermal conductivity in her chapter, where she outlines the possible applications of radiative and grain-size dependent thermal conductivity in the lower mantle and how this may impact on the growth of superplume and plume enrichment with iron.

Deschamps et al. review the recent progress of the research about thermal and compositional effects in present-day mantle circulation, based on seismic tomography and the separation of the chemical from the thermal effect in the interpretation of today's mantle dynamics.

Karato provides an extensive review of the recent progress in mineral physics on the role of hydrogen in physical properties of minerals. The role of hydrogen is particularly important in relation to the dynamics of the near surface layer (i.e., lithosphere-asthenosphere) and the MBL, but is potentially important also in the dynamics of the D″ layer. Hydrogen can modify the viscosity of minerals by several orders of magnitude, and its role sometimes becomes more important than the thermal effects.

REFERENCES

Matyska, C., and D.A. Yuen (2005) The importance of radiative heat transfer on superplumes in the lower mantle with the new post-perovskite phase change. *Earth Planet. Sci. Lett.*, 234, 71–81.

Schubert, G., G. Masters, P. Olson, and P.J. Tackley (2004) Superplume or plume clusters? *Phys. Earth Planet. Inter.*, 146, 147–162.