

Project Proposal for Geodynamics

Jia Zhang

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1 Introduction

The mechanism of deep earthquakes remains one of the major questions in seismology since their discovery from 1920s (Turner, 1922; Wadati, 1928). It has long been recognized that the occurrence of deep earthquakes is problematic, since brittle failure should be prohibited by confining pressure at great depth. Rock strength does increase with pressure, but a few hundred MPa, which is equivalent to 10-20 km depth, suffices to inhibit most fracture, and elevated temperature activates ductile mechanisms that operate at stresses less than the fracture strength [1].

In addition, deep earthquakes show some differences with shallow brittle faulting earthquakes, such as a dependence of source duration and rise time on earthquake depth (Houston and Williams, 1991), much lower aftershock production rates (Page, 1968), and a dependence of magnitude-frequency relations and aftershock productivity on slab temperature (Wiens and Gilbert, 1996) [2].

Many different mechanisms have been proposed over the years for deep earthquakes, including plastic instabilities (Bridgman 1936), shear-induced melting (Griggs 1954), instabilities accompanying recrystallization (Post 1977; Ogawa 1987) and polymorphic phase transformation (Bridgman 1954) [3]. The phase change hypothesis was more highly populated with the assumption of a sudden implosion radiate the seismic energy without faulting. However, seismic evidence now precludes this possibility because deep earthquakes have double-couple motions similar to those of shallow events. Therefore, a new theory should be developed to explain the mechanism of the deep earthquakes.

2 Targets

Nowadays, seismological observations, in combination with mineral physics experiments and geodynamic calculations provide some new views of the mechanism and interpretation of deep earthquakes.

As for this project, I will review some basic seismological observations concerning deep earthquakes (deeper than 300km), and discuss their implications for the mechanism of deep earthquakes and the geodynamics of plate motion.

Here are some targets I am going to archive:

- Comparison of deep and shallow earthquakes
- Previous theories of mechanisms and their limitation
- New understanding of mechanism of deep earthquakes with new seismological observations

References

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- [2] Douglas A. Wiens, Seismological constraints on the mechanism of deep earthquakes: temperature dependence of deep earthquake source properties, *Phys. Earth Planet. Inter.* **127**, 145-163 (2001).
- [3] H. W. Green, Heidi Houston, The mechanics of deep earthquakes, *Annu. Rev. Earth Planet. Sci.* **23**, 169-213 (1995).