Title : The Synthetic Earthquake Waveform Computation Using the Direct Solution Method with Anomalous Layers in the Lowermost Mantle Structure

Author(s) :
1. Pitchapha Chikunthod **Student ID :** 640510432
2. **Student ID :**
3. **Student ID :**

Major : Geology

Advisor(s) :
1. Associate Professor Dr. Niti Mankhemthong
2.
3.

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ABSTRACT

Understanding seismic wave behaviors in the lowermost mantle is crucial for interpreting Earth's deep structure. This region exhibits complex seismic properties, including variations in wave velocities that affect wave propagation through mechanisms such as reflection, refraction, and scattering. This study investigates how seismic S-wave phases (S, ScS, and SKS) interact with anomalous layers located 0–100 km and 300–400 km above the core-mantle boundary (CMB). By using the Direct Solution Method (DSM) and the Preliminary Reference Earth Model (PREM), synthetic waveforms were generated to analyze amplitude variations caused by these anomalous layers. A synthetic earthquake with a normal fault focal mechanism was modeled at a depth of 350 km. Seismic waves were examined at station distance angles of -75°, -85°, -95°, 75°, 85°, and 95°, across a frequency range of 0.005 to 0.1 Hz. Velocity anomalies ranging from -3% to 3% were introduced into the lowermost mantle to assess their effect on wave behavior. The results reveal that S-wave phases exhibit significant amplitude increases when interacting with anomalous layers, particularly in the transverse and radial seismic components. In contrast, when the lowermost mantle is homogeneous, the amplitude and velocity of seismic waves remain unchanged. Note that the ScS phase, which reflects off the CMB, exhibits the most pronounced amplitude variations. The anomalous layers at 0–100 km above the CMB generate stronger amplitude responses than those at 300–400 km depth, influenced by factors such as the distance angle from the earthquake focus to the seismic receiver and the reflection energy of each seismic phase. This study reveals the role of velocity anomalies in shaping seismic wave characteristics, providing deeper insights into wave propagation through the lowermost mantle that contributes to a better understanding of the structural complexity of the Earth's deep interior.

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