The outline of seismic-geoelectromagnetic observation of the core and mantle

Pl: Satoru Tanaka
(D-EARTH, JAMSTEC)

MEXT Grant-in-Aid for Scientific Research on Innovative Areas
2015-2019
“Interaction and Coevolution of the Core and Mantle
~Toward Integrated Deep Earth Science~”
Kick-off symposium, Aug.7-8, 2015
Project Team Members

PI:
Satoru Tanaka (JAMSTEC)

Co-PIs:
Hitoshi Kawakatsu (U.Tokyo)
Nozomu Takeuchi (U.Tokyo)
Hisayoshi Shimizu (U.Tokyo)
Kenji Kawai (U.Tokyo)

Collaborator:
Daisuke Suetsugu (JAMSTEC)

George Helffrich (TiTech)
Christine Houser (TiTech)
Satoshi Kaneshima (Kyushu U.)
Toshiki Ohtaki (AIST)
Introduction

- Anomalous structures at the margin of LLSVP
- Hemispherical inner core
- Velocity gradient at the top and the bottom of the outer core
- Attenuation anomaly in the inner core
Objective

• Seismological and geo-electromagnetic studies on the deep structure of the Earth have contributed to construct a static image of the Earth’s interior.

• However, there have been a few contributions to understand dynamic behavior of materials in the deep Earth.

• In this project, we would like to contribute to an integrated understanding of the Earth’s deep interior based on a new viewpoint, co-evolution of the core and mantle, by geophysical observations.
Target & approach

• Imaging of exact seismic discontinuities, anisotropy, and attenuation structures at the base of mantle near the western edge of the Pacific LLSVP.

• Seismic anisotropy at the base of mantle by waveform inversion and mineral physics interpretation

• Distribution and structure of ULVZs at CMB in and far from LLSVP

• Whole Earth tomography with improving the resolution especially at CMB

• Imaging of the electrical conductivity anomaly at the CMB.

• Seismic structures of the outer and inner cores
Method

- Collecting new data
  (Seismology: Undisclosed data & new observation)
  (Geo-electromagnetism: Long term data by Satellite obs. & marine cable)

- International collaboration
Method: Seismology

- A virtual huge seismic network: UNited seismic network for Deep Earth Research (UNDER)

Existing & disclosed networks: China, India, and Australia

Currently operating networks: Ontong Java Broadband Ocean Bottom Seismograph network
Method: Seismology

• A new observation: Thai Seismic ARray (TSAR)
Method: Seismology
Method: Seismology

Outer and inner cores

Mantle: LLSVP and its margin

Detailed talks will be given by Kawai, Houser, and Helffrich
Improvement of global tomography

After Takeuchi (2012)
Method: Geo-electromagnetism

- Analysis and modeling of Geomagnetic Jerk by satellite data

In the future
Submarine Cable Voltage
Local geomagnetic jerk around 2007.0

Observatory data

Jerk amplitude at 2007
CHAOS-4 model (Olsen et al. 2011)

\[
\Delta \dddot{A}_{t=2007} = \dddot{A}_{t=2008.5} - \dddot{A}_{t=2005.5}
\]

\(\Delta \dddot{X}\)

\(\Delta \dddot{Y}\)

\(\Delta \dddot{Z}\)
Expected results and collaboration with the other research projects

Integrated Deep Earth Science

- Seismic heterogeneity, anisotropy, and attenuation at the CMB and inner core
- ULVZ, D'' discon.
- The outer core
- Electrical conductivity at the CMB
- Improved global tomography

Dynamics research (A01-1)
Element partitioning (A02-2)

Numerical simulation (A04)

Neutrino obs. (A03-2)