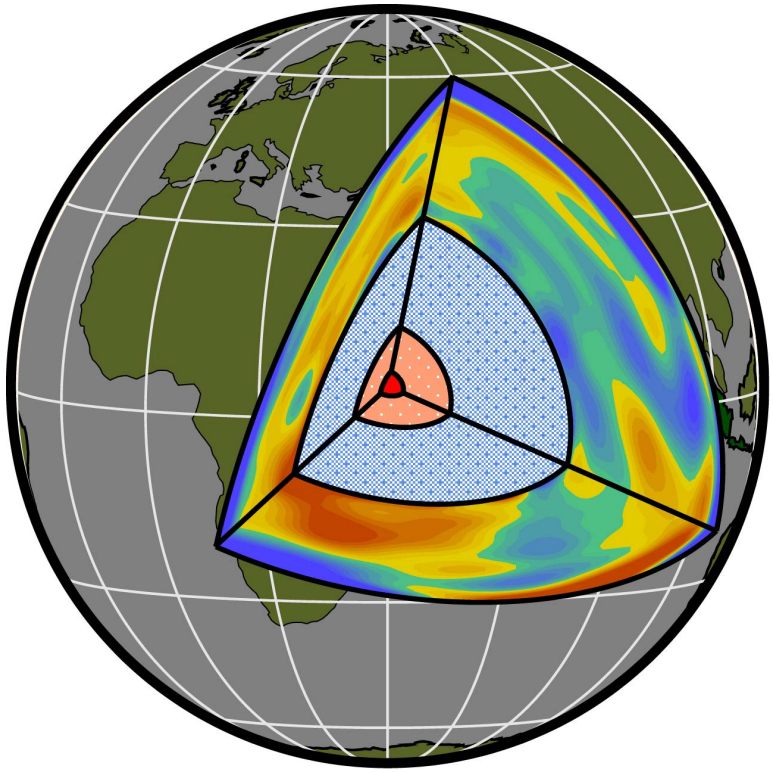
Examples of the Uses of CTBT Verification Data for Advancing Earth Sciences



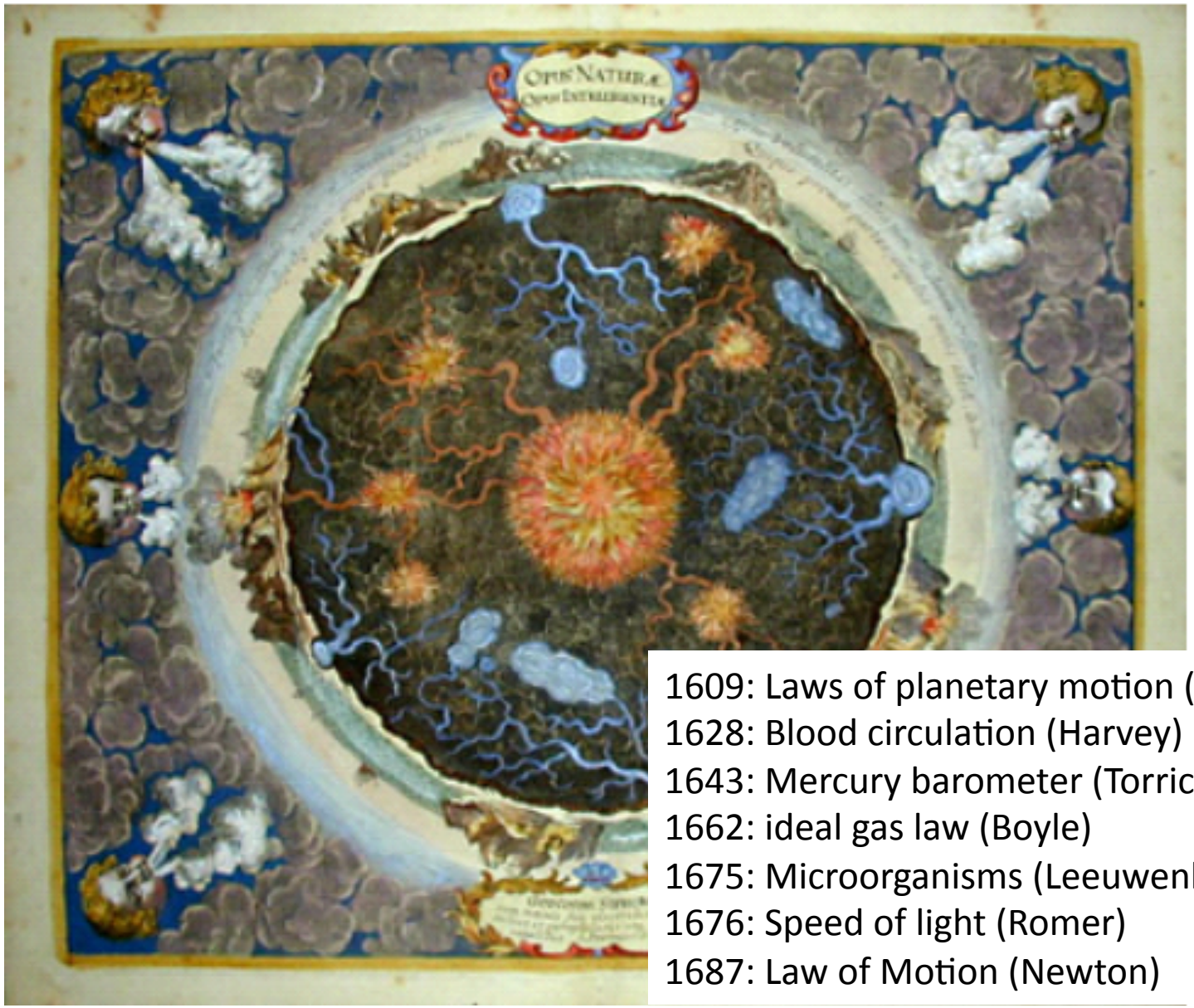
- Studies of the Earth's Interior
- Earth's Core
- Inner-Core Boundary
- Anisotropy of the Inner Core

Miaki Ishii

Department of Earth & Planetary Sciences

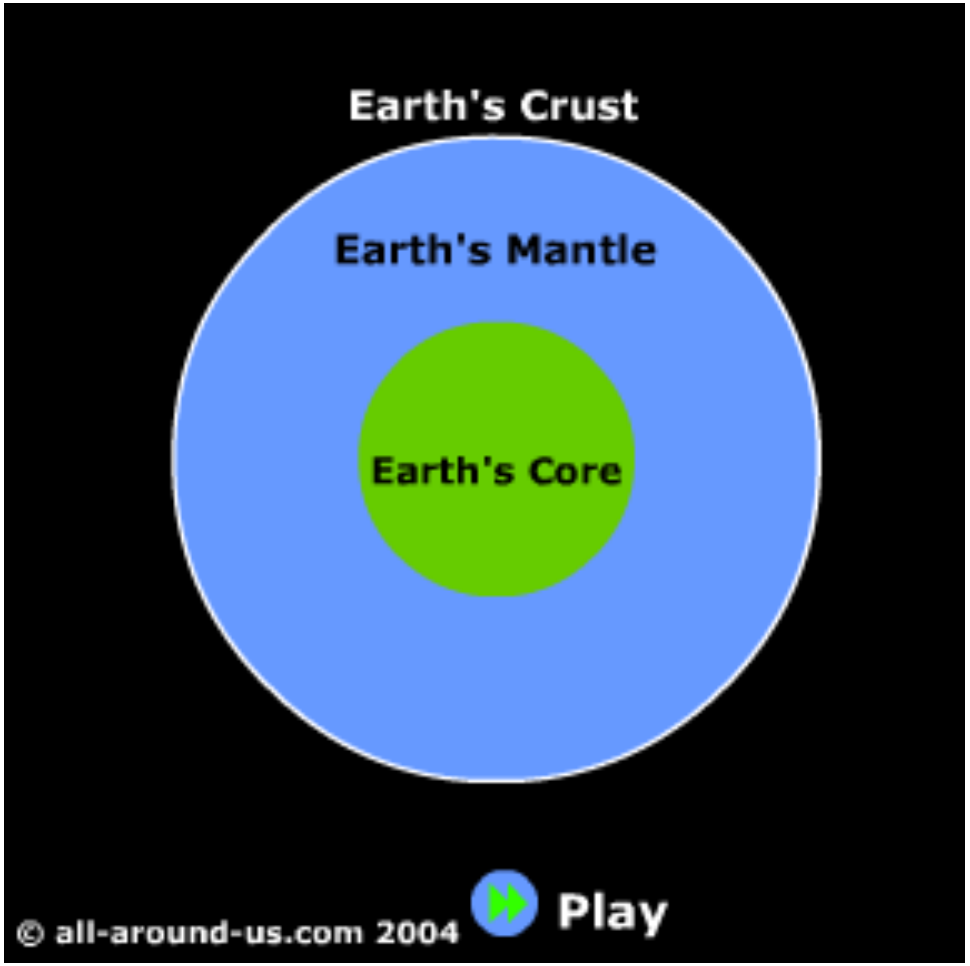
Harvard University

Earth's Interior: Athanasius Kircher (1663)



1609: Laws of planetary motion (Kepler)
1628: Blood circulation (Harvey)
1643: Mercury barometer (Torricelli)
1662: ideal gas law (Boyle)
1675: Microorganisms (Leeuwenhoek)
1676: Speed of light (Romer)
1687: Law of Motion (Newton)

Deepest Hole?



12 km (7.6 miles)

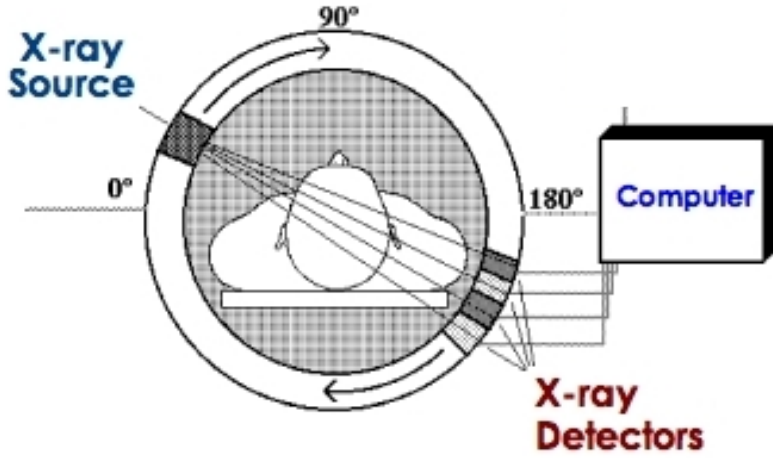
Mount Everest = 8.8 km high

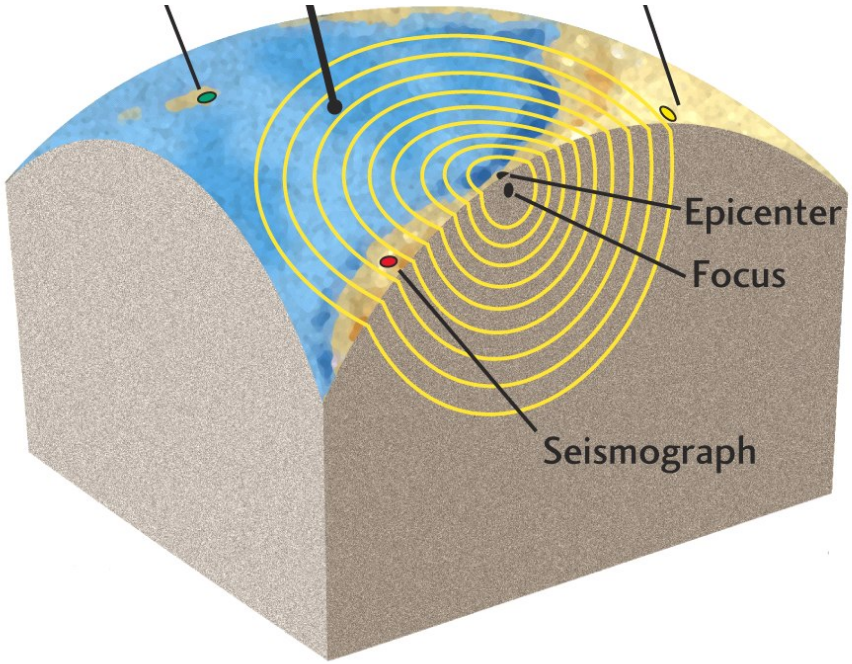
Radius of Earth = 6371 km

➔ less than 0.2%

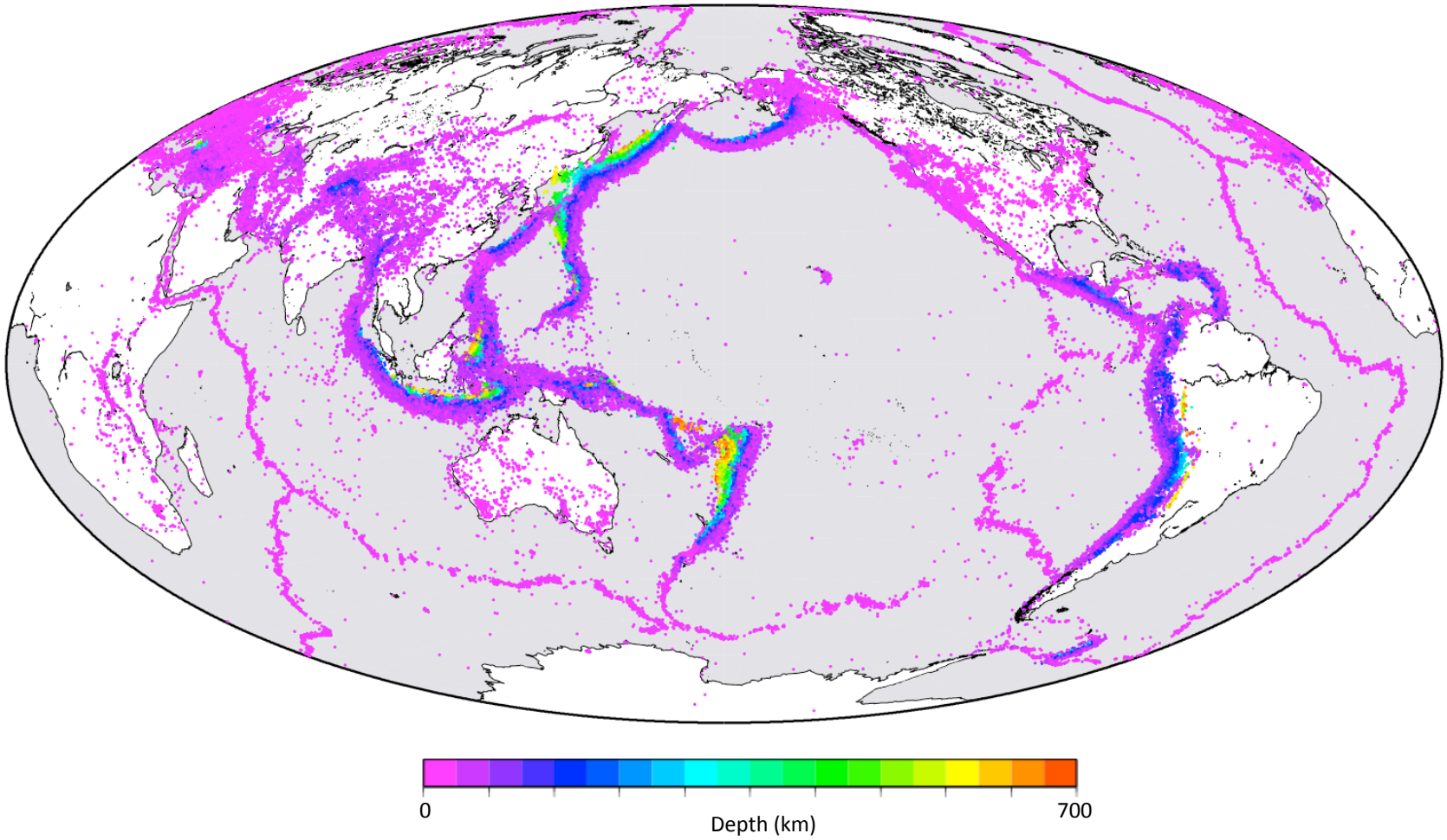
http://www.all-around-us.com/images/fla/ecrust.swf

Internal Structure





Earthquake Distribution

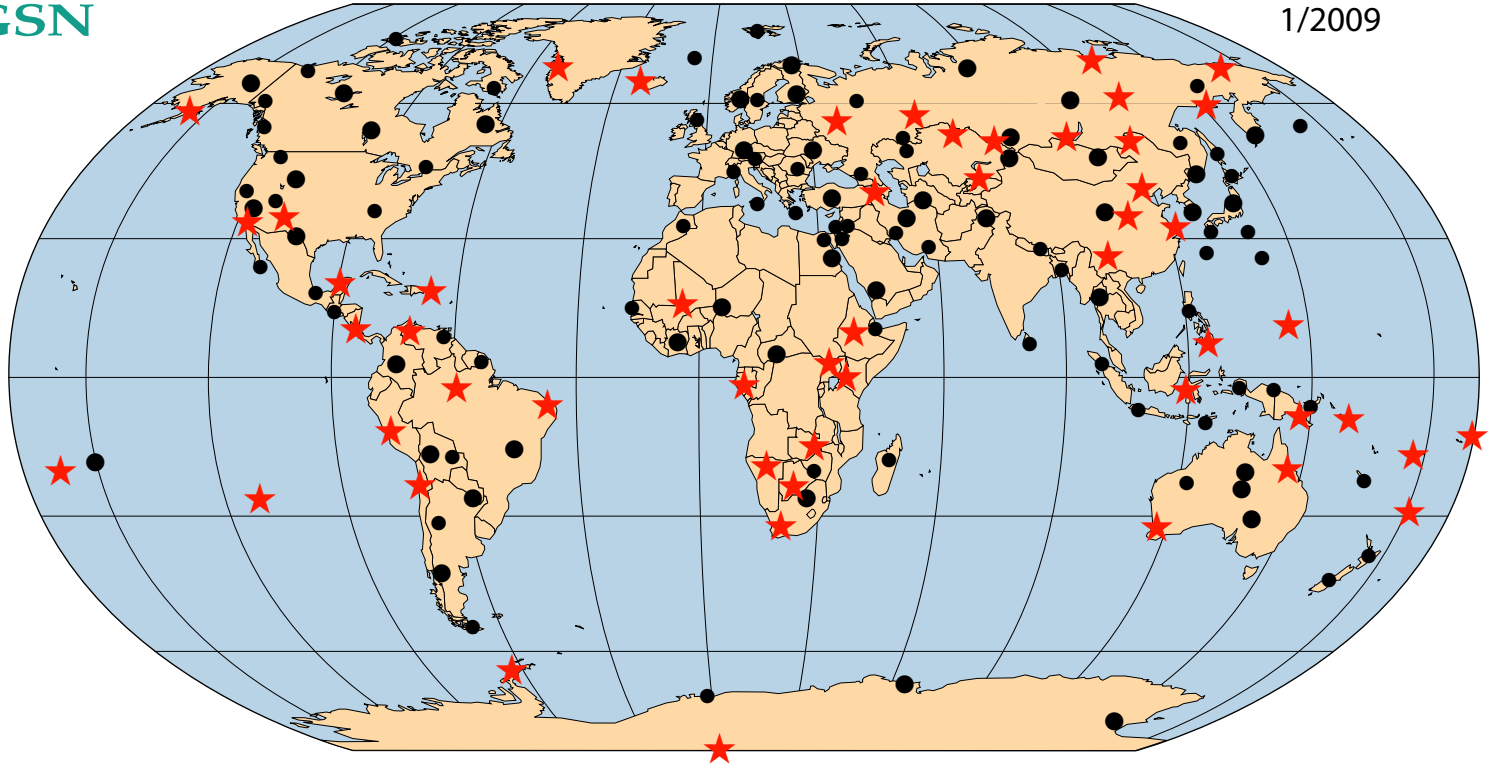


NEIC PDE Catalogue 1990~2008

GLOBAL SEISMOGRAPHIC NETWORK

& INTERNATIONAL MONITORING SYSTEM (IMS)

1/2009



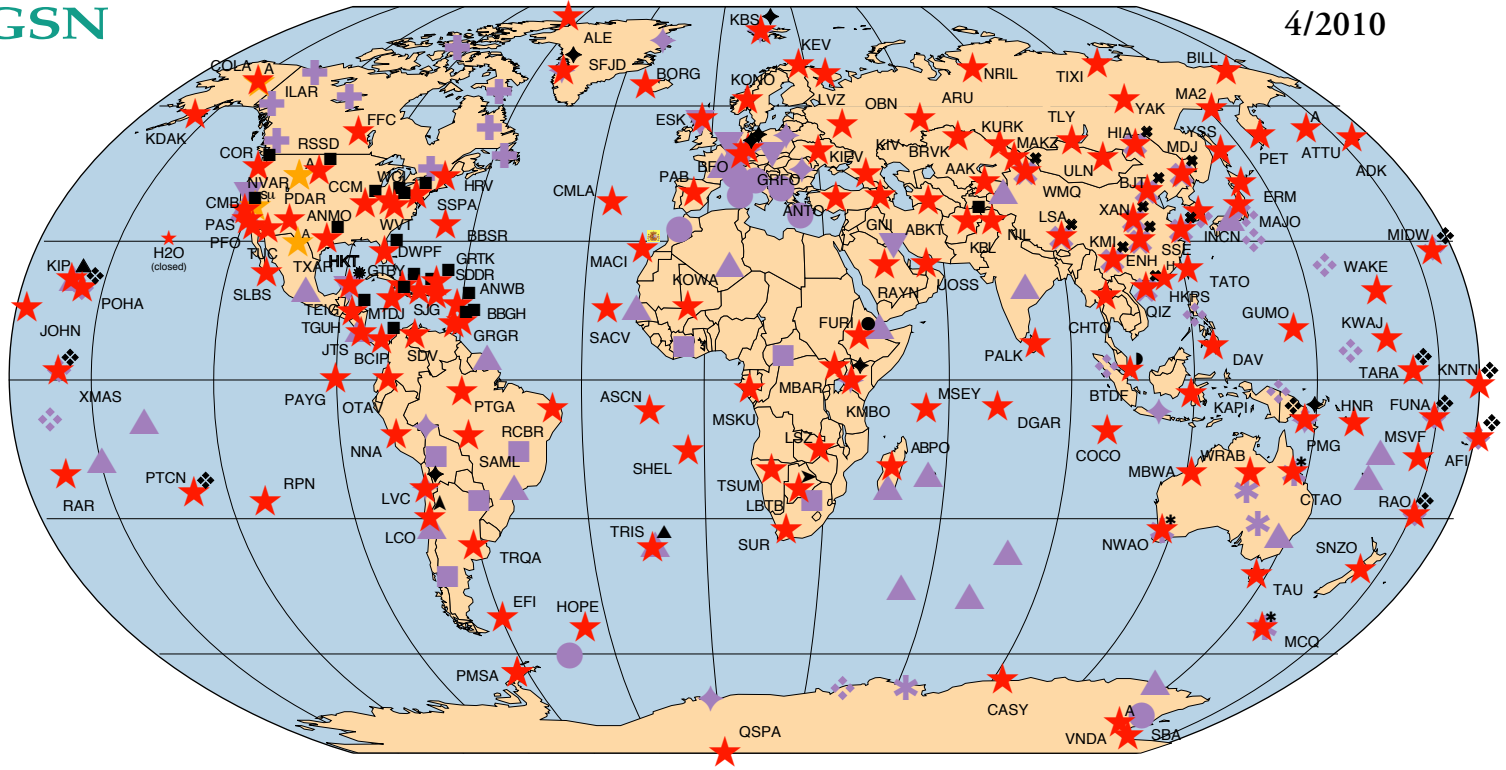
★ GSN IMS Designated Stations

● Other IMS Seismic Stations

GLOBAL SEISMOGRAPHIC NETWORK

& INTERNATIONAL FEDERATION OF DIGITAL SEISMOGRAPHIC NETWORKS

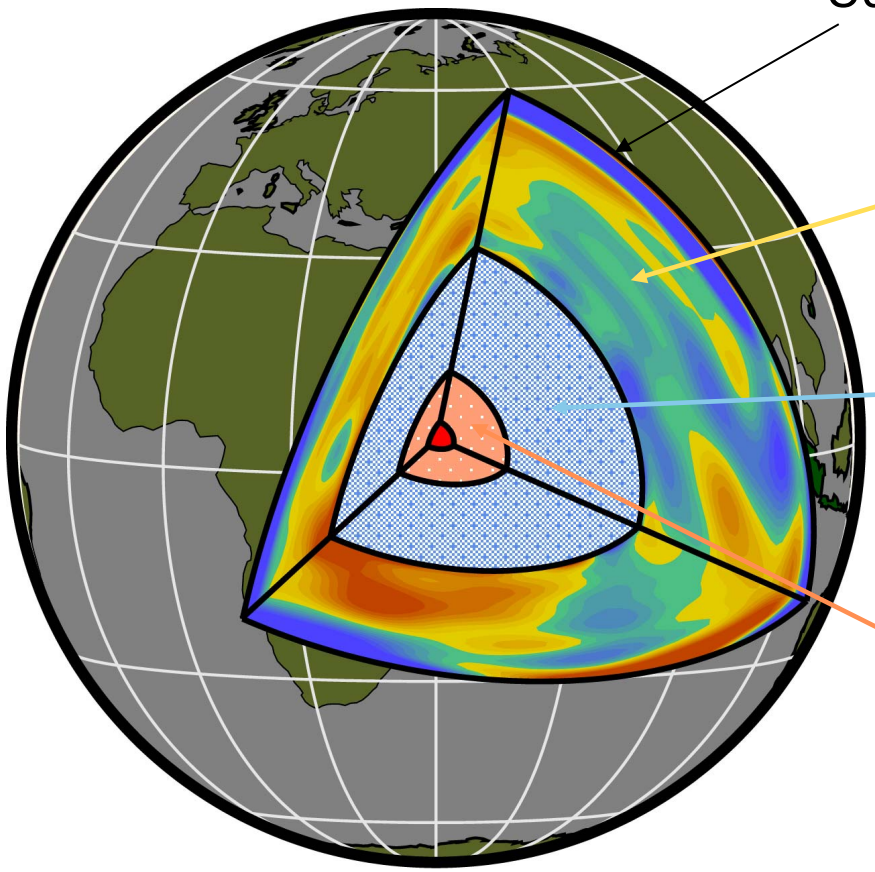
4/2010



IRIS Current | Affiliate Array | IRIS International & National Cooperative Sites: Geoscope | Japan | Mednet | Geofon/AWI/BGR/BFO | China/USGS | Mexico | Singapore | Botswana | Spain | Australia | HKO | USGS | AFTAC | SMU

Australia | Canada | France | Germany | Italy | Japan | U.S. | Other

Internal Structure



Ocean and Heterogeneous solid crust

1% by volume

Heterogeneous solid mantle

83% by volume

Homogeneous liquid outer core

16% by volume

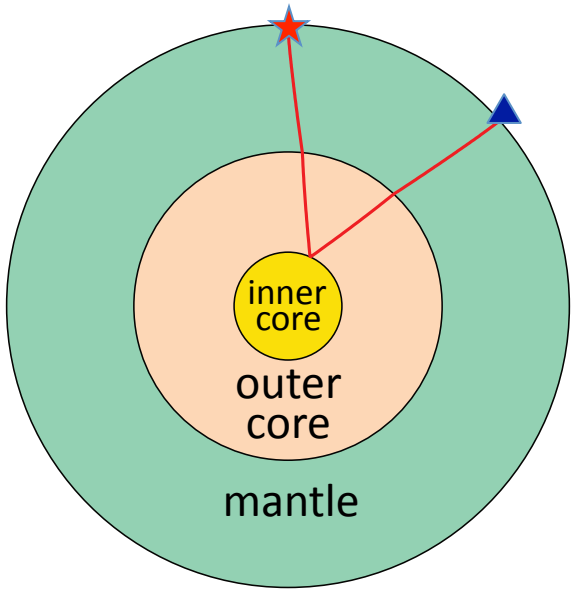
Homogeneous (?) solid inner core

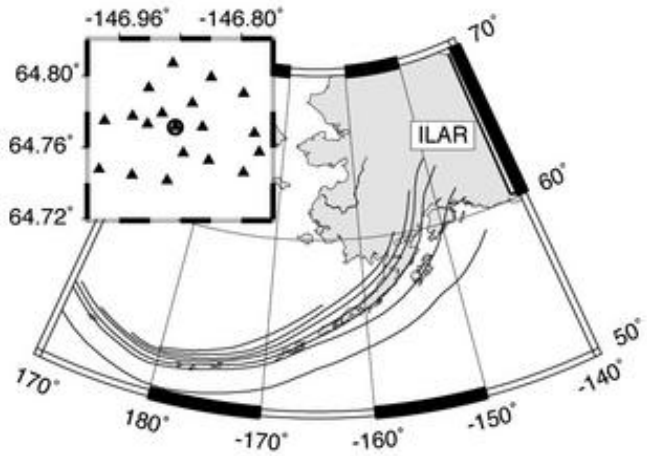
0.7% by volume

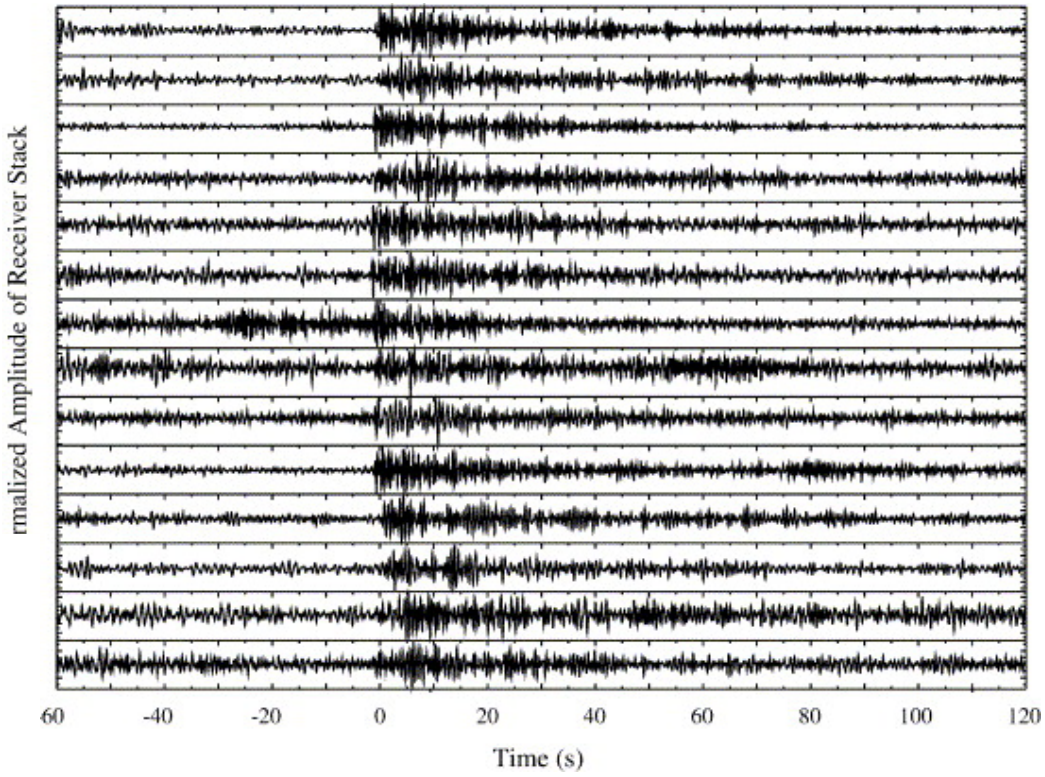
Earth's Inner Core

- discovered by Inge Lehmann (1936)
- 1221 km radius
  - Moon: 1737 km
  - Earth: 6371 km
- 9.84×10^{22} kg mass
  - 134% of moon
  - 1.6% of Earth
- 5150 ~ 6371 km depth

Reflection from the Inner Core



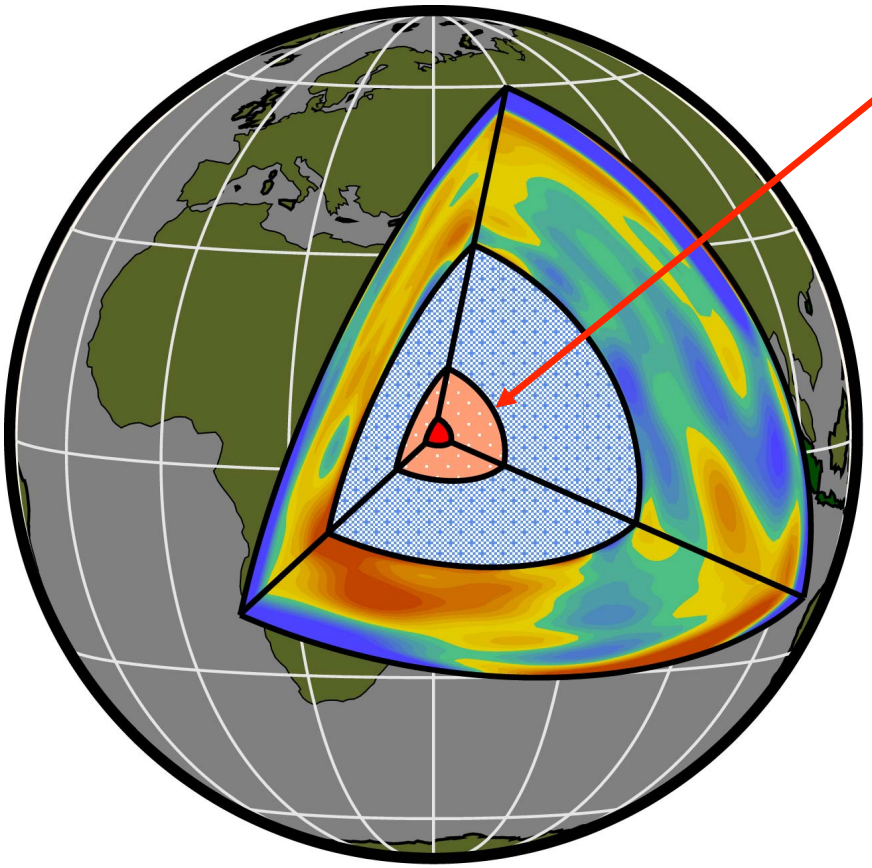




Koper & Dombrovskaya (2005)

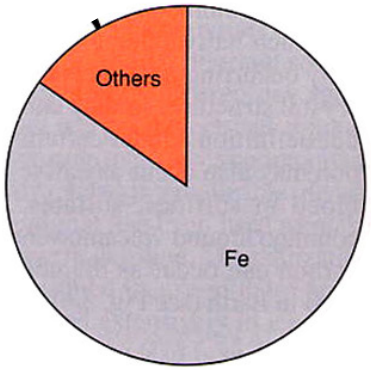
http://www.iris.edu/hq/gallery/photo/5732

Inner-Core Boundary

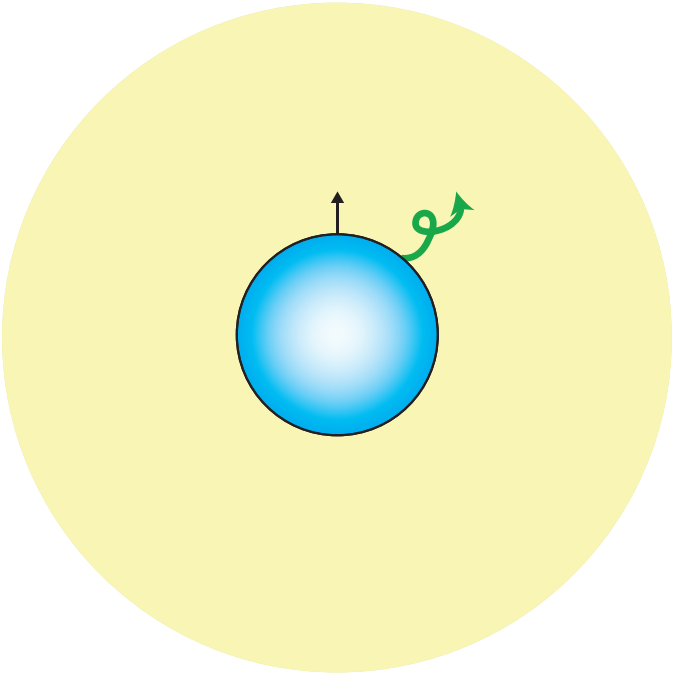


liquid outer core

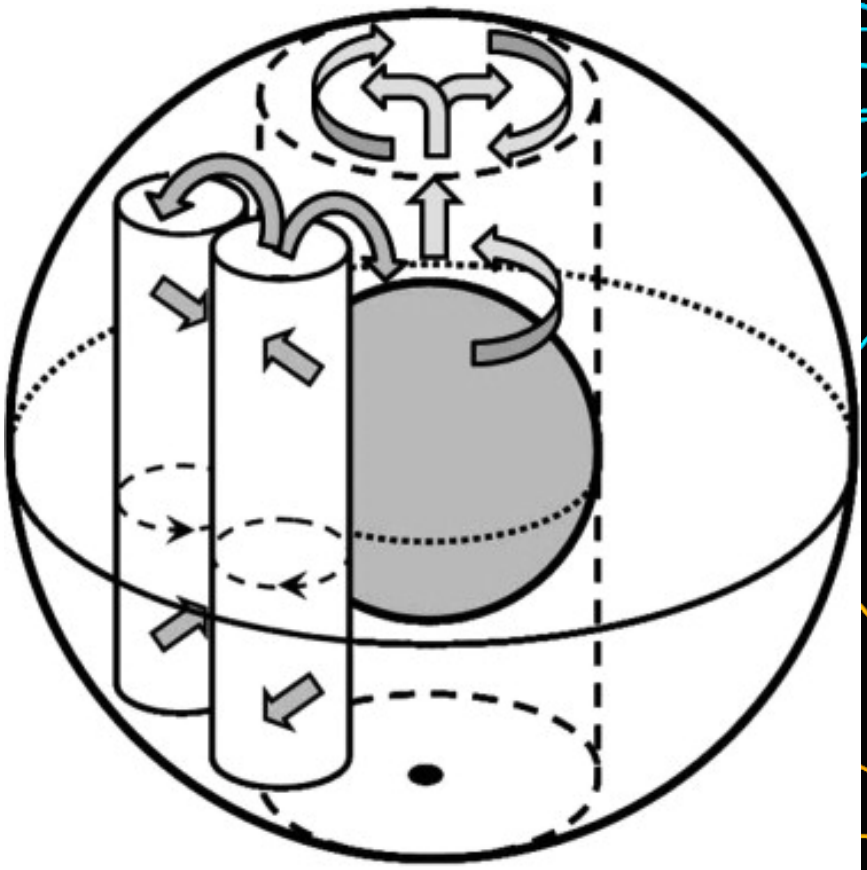
solid inner core



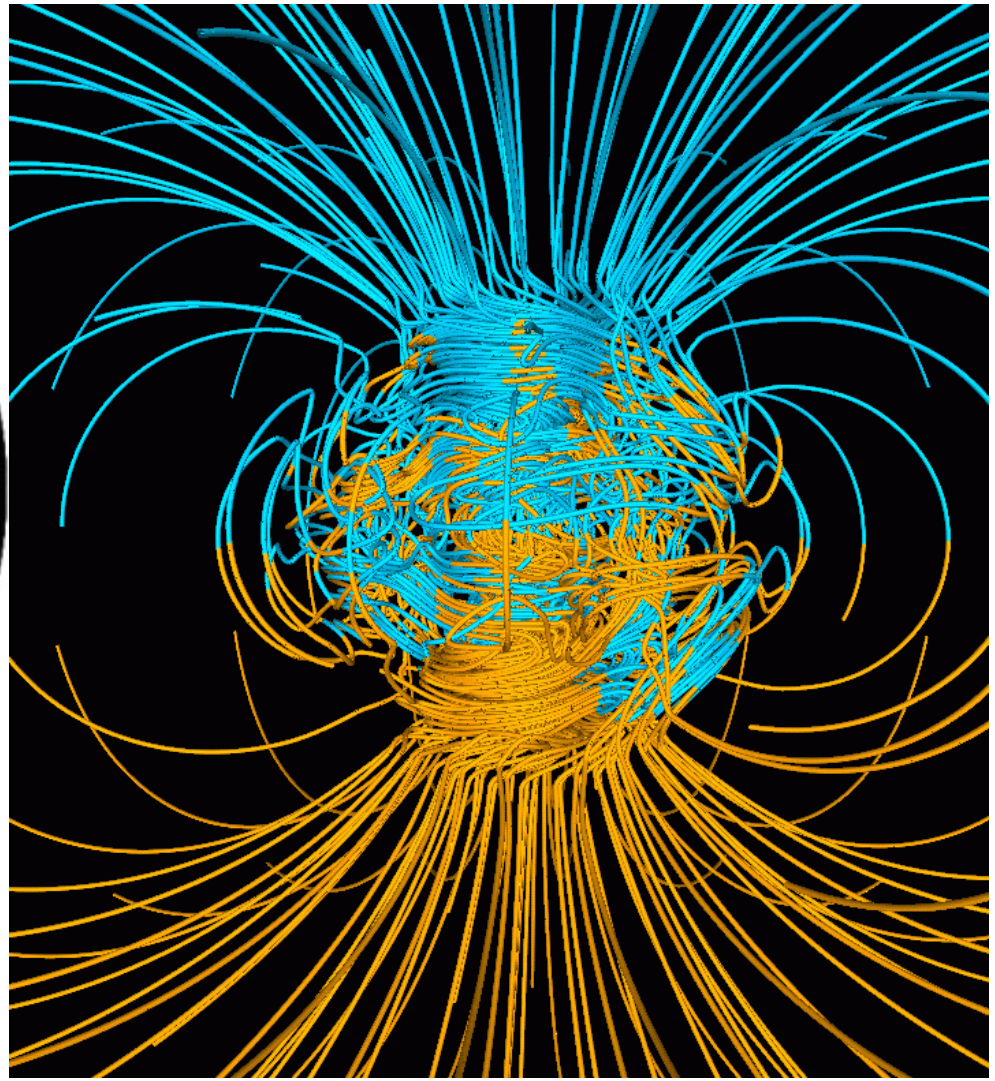
$\Delta\rho = 0.52 \pm 0.24$ g/cm^3



Convection in the Outer Core

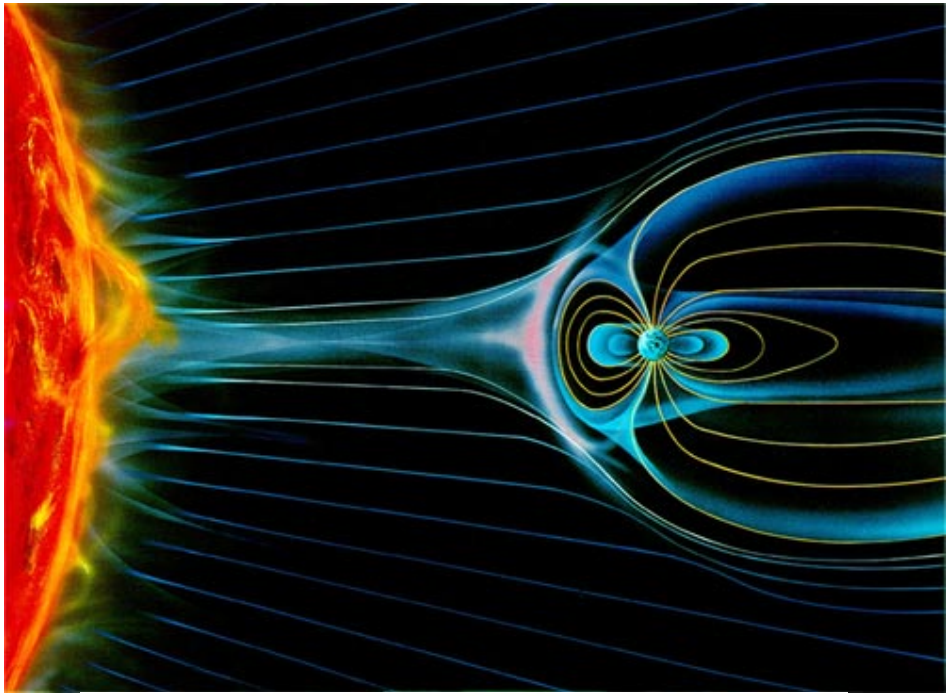


Christensen (2011)

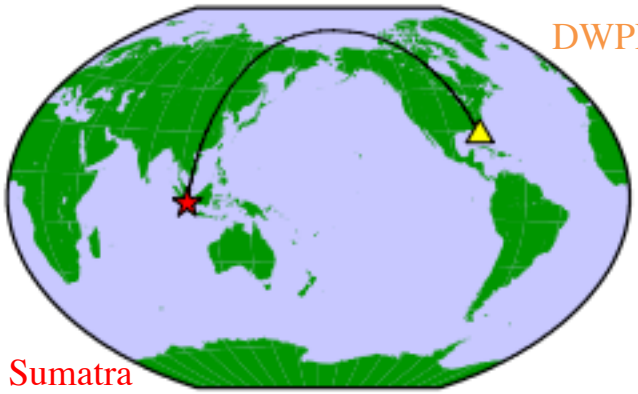


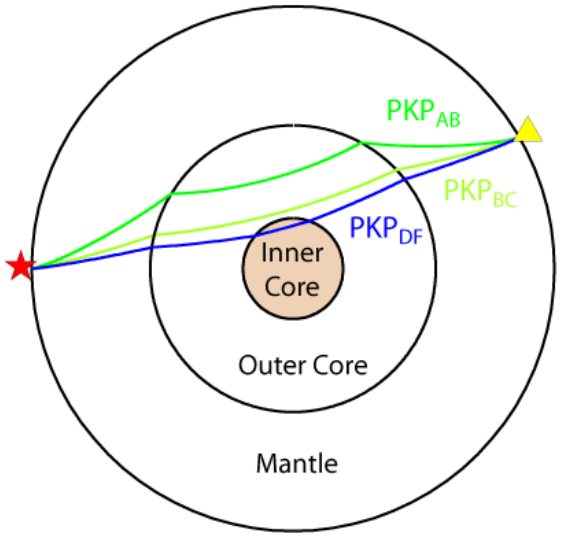
Glatzmaier & Roberts (1995)

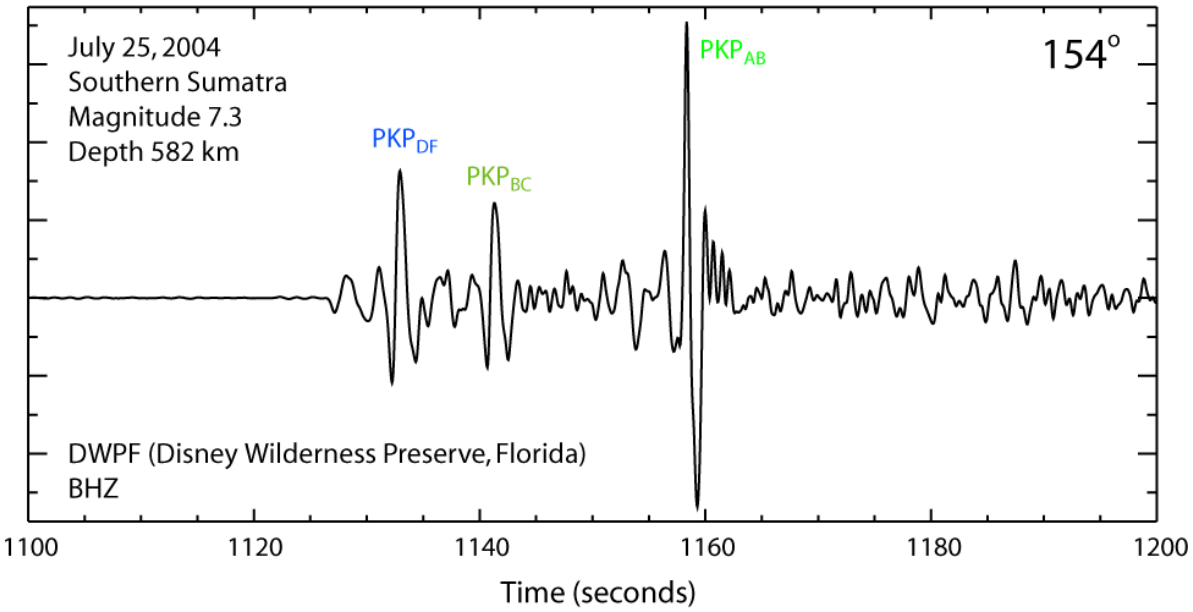
Earth's Magnetic Field



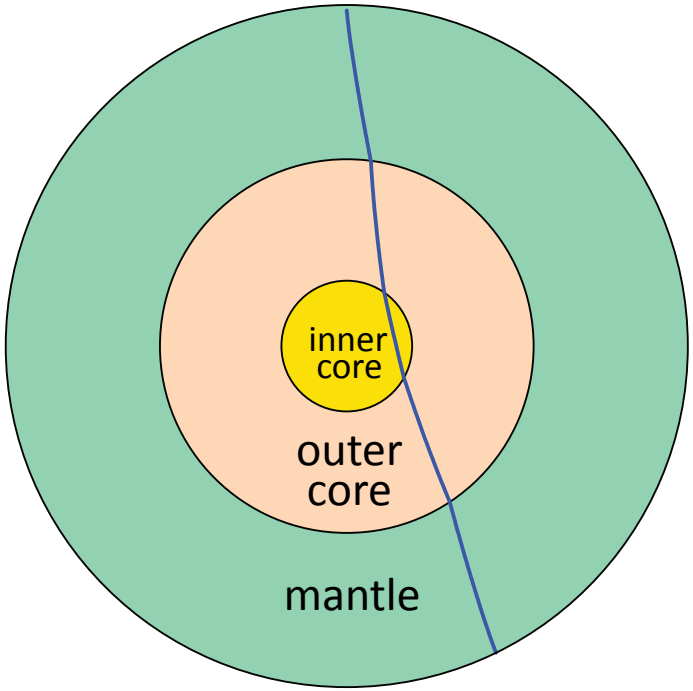
Body Waves: July 25, 2004 Southern Sumatra Mw 7.3

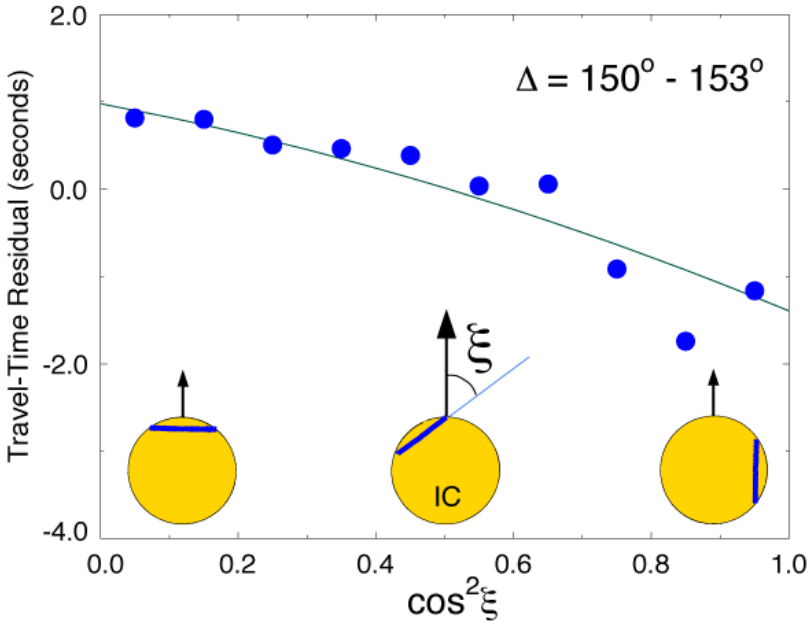




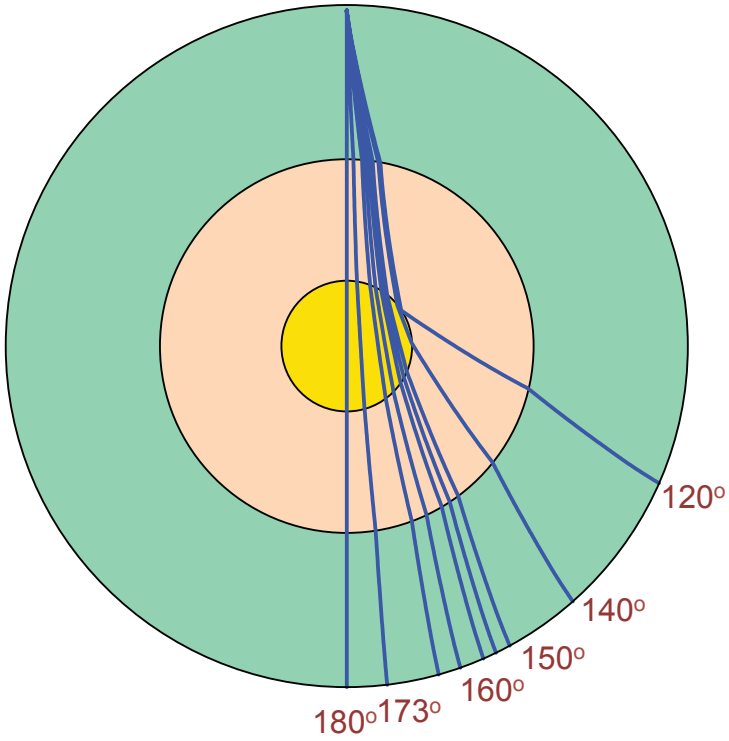


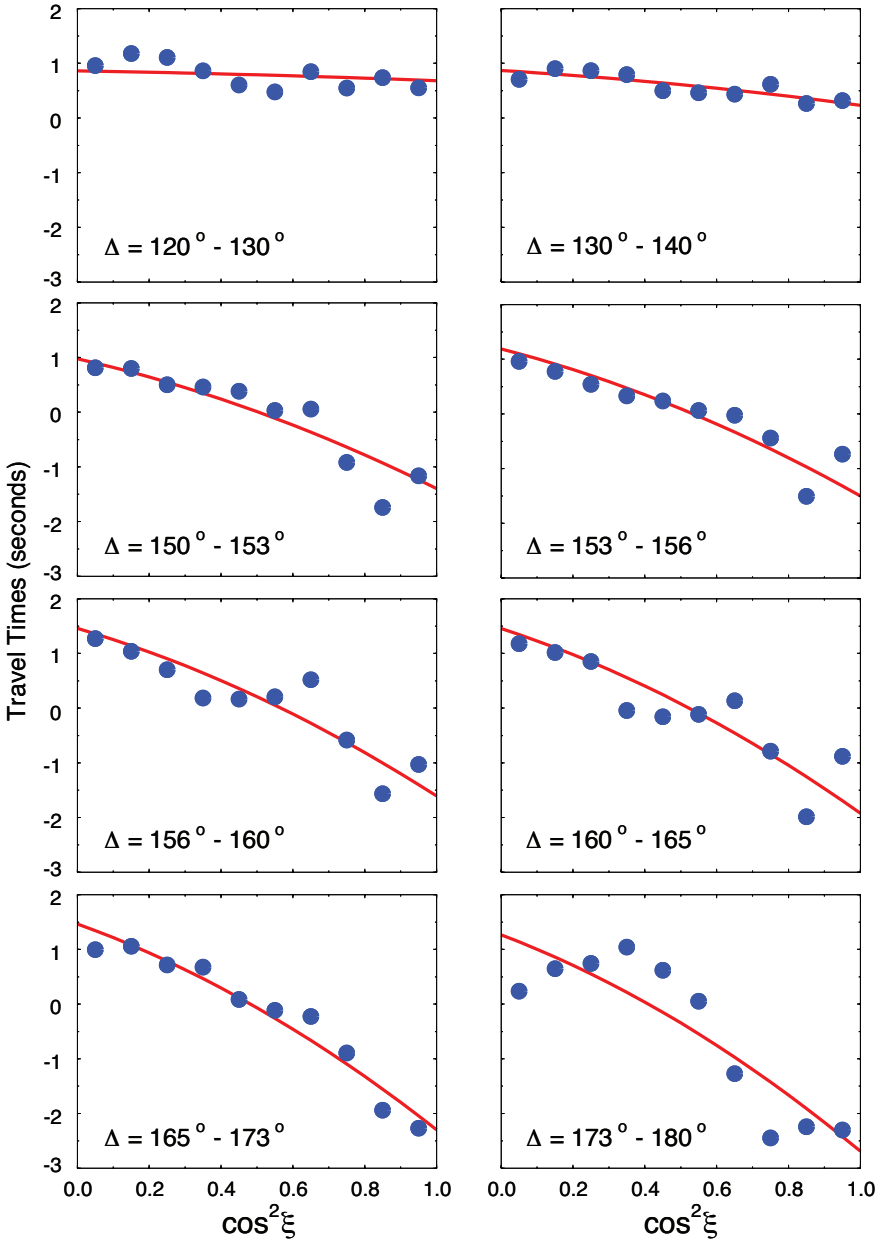
Inner Core Observations



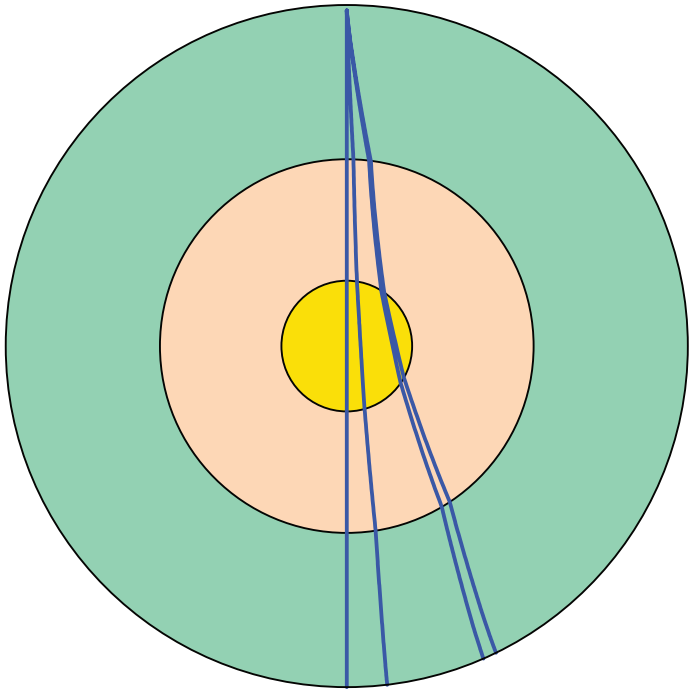


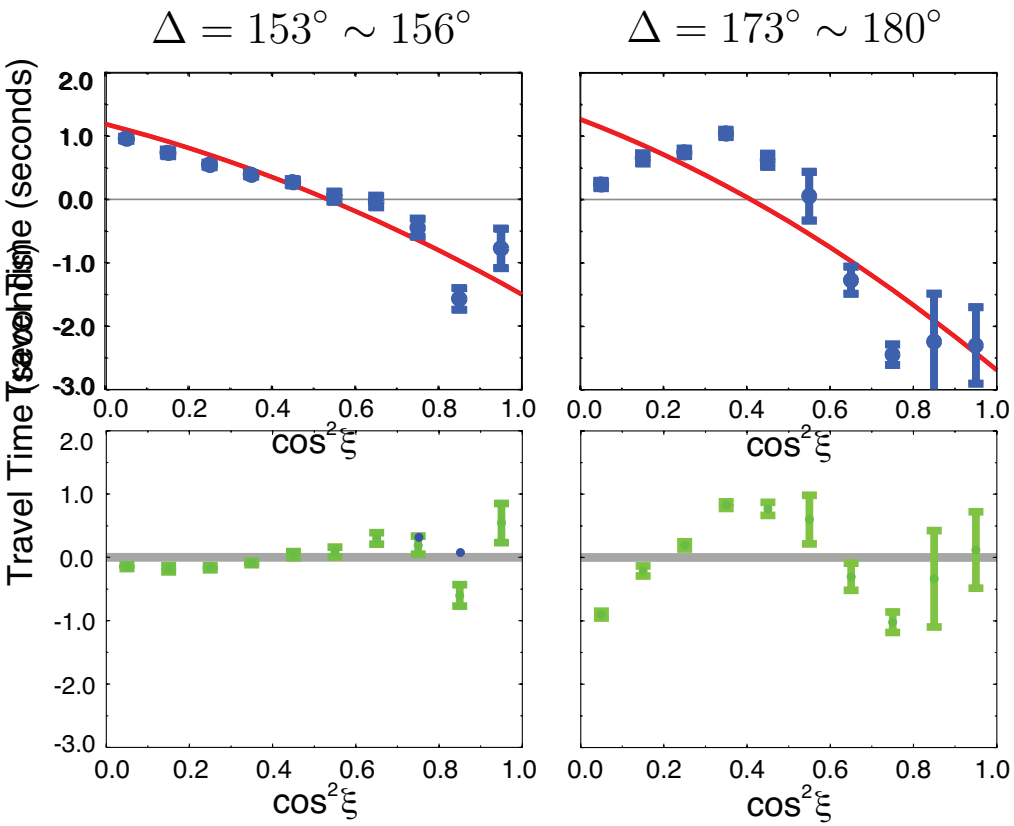
Seismic Wave Travel-Time Observations





Inner Core Layers



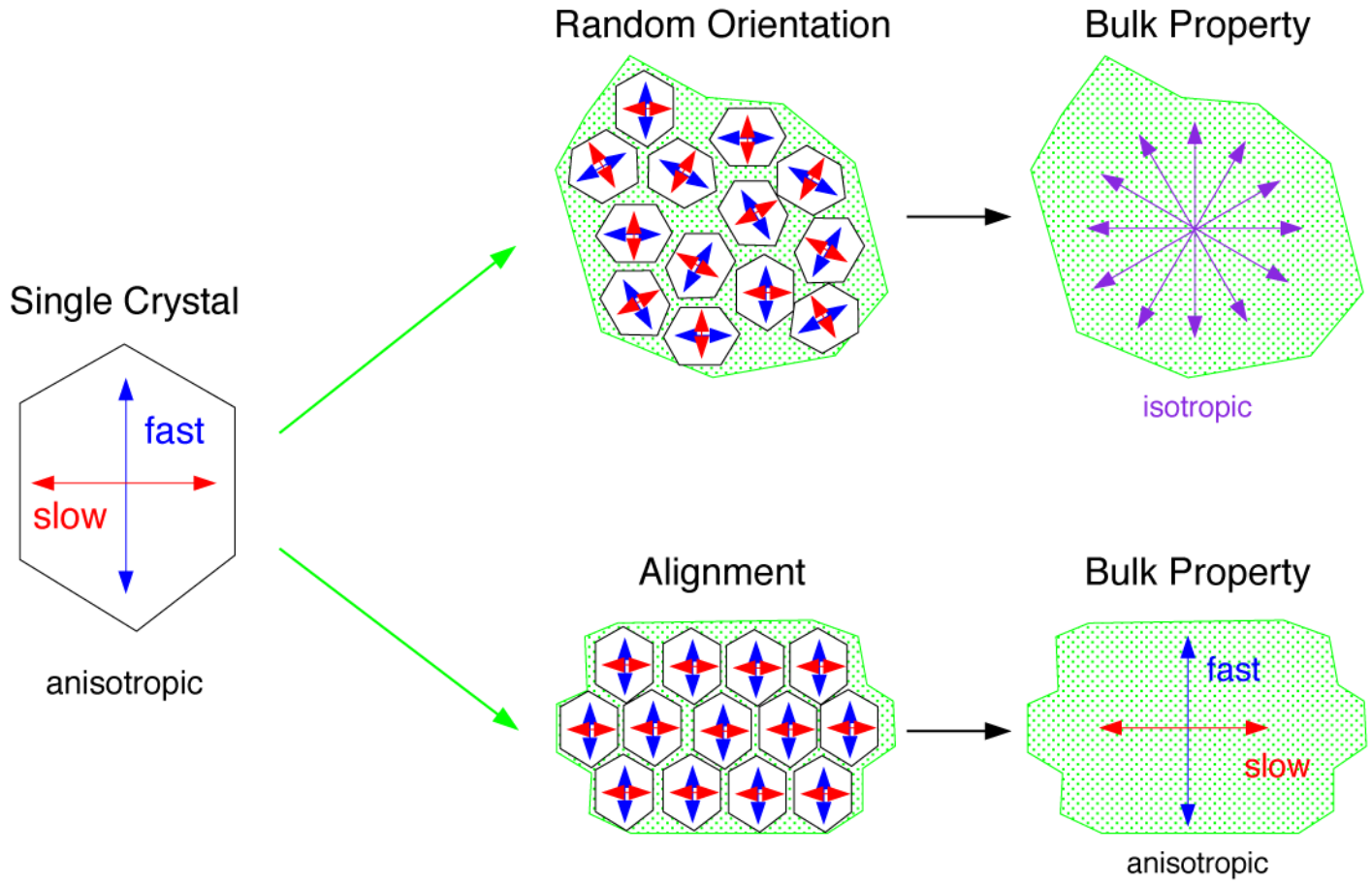


→ two distinct layers

Earth's Innermost Inner Core

- reported in 2002
- 300 km radius
  - Inner Core: 1221 km
  - Moon: 1737 km
  - Earth: 6371 km
- 0.01% by volume
- change in anisotropy

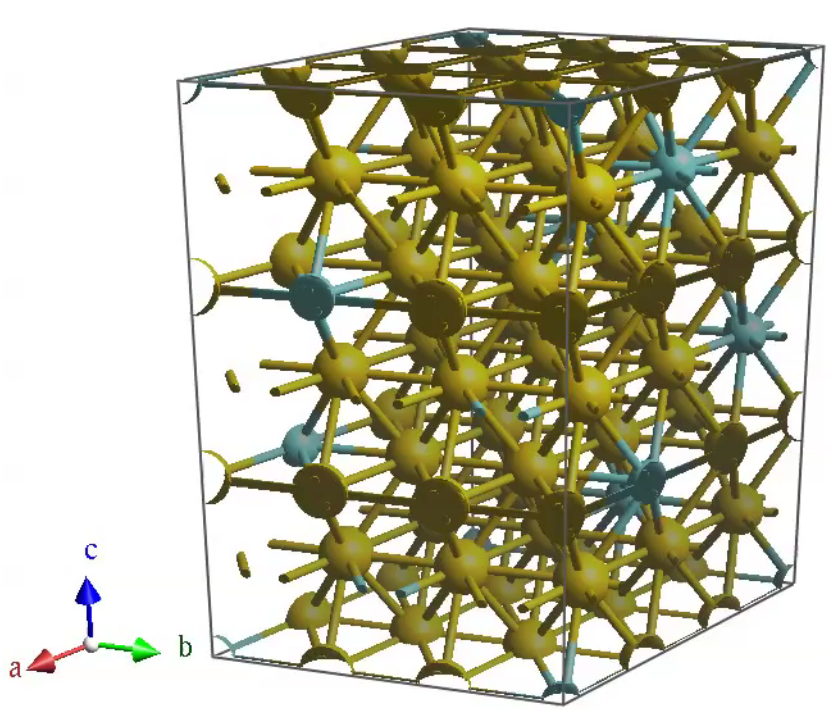
Observed Anisotropy



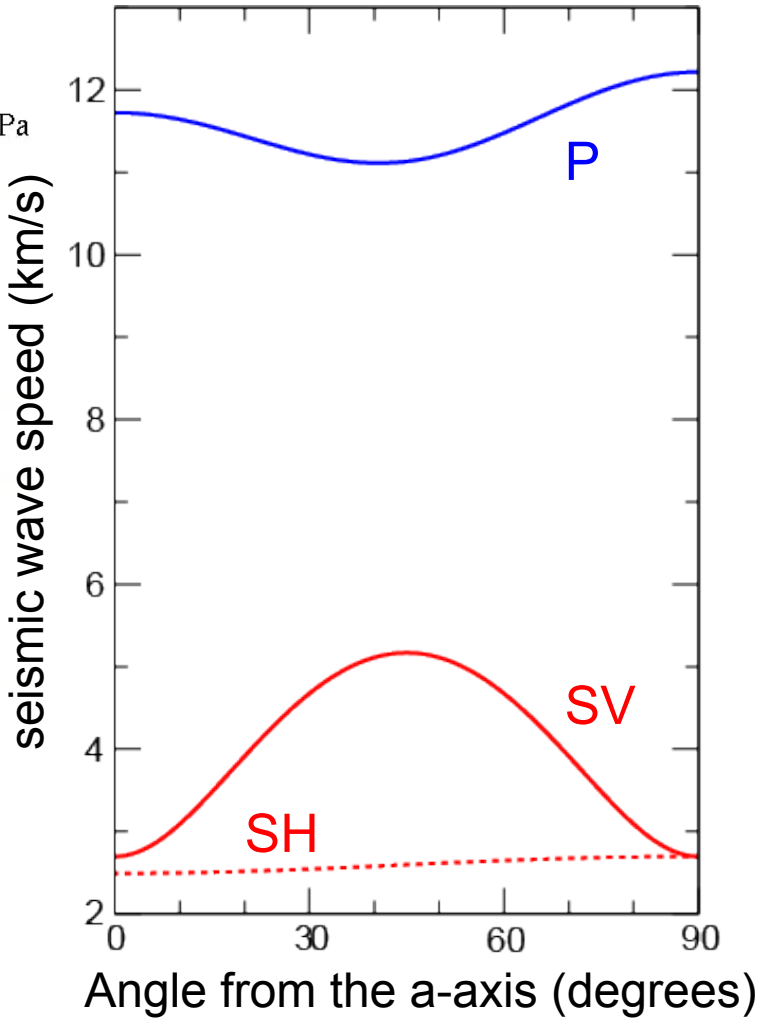
Mineral Physics

Seismology

Ab Initio Calculations

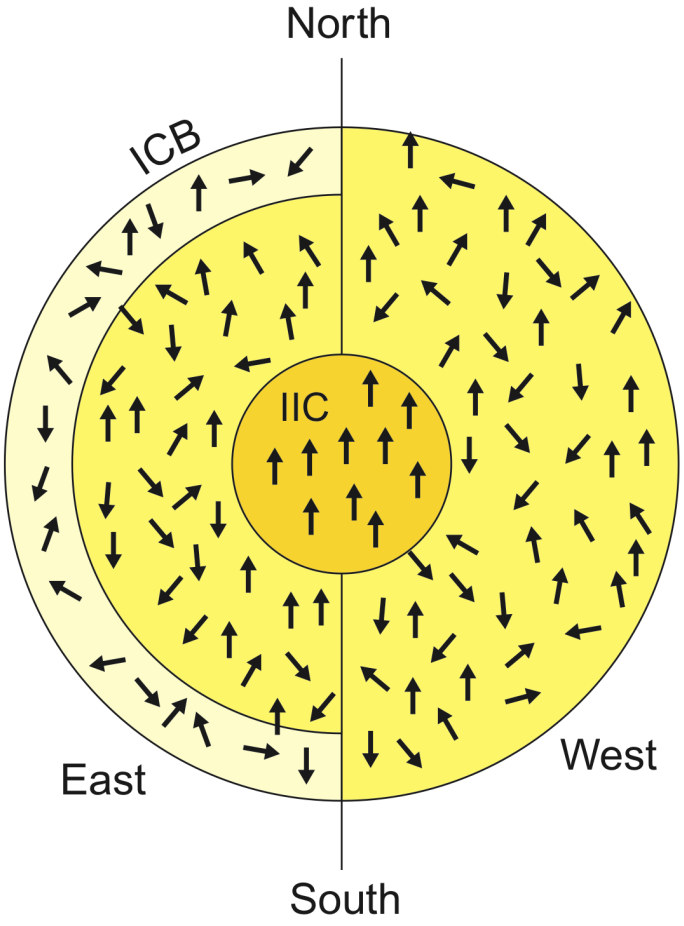


12.49 g/cm^3



Kuwayama (2011)

Summary



- Recordings of Ground Motion
  - event detection
  - studies of the Earth's interior
- Inner-Core Boundary
  - reflected waves
  - impedance contrast
  - input for geodynamo simulations
- Inner-Core Anisotropy
  - transmitted waves
  - change in anisotropy
  - innermost inner core
  - iron alloy at high temperature & pressure
- multi-disciplinary study of the Earth

February 15, 2013 03:20:26 Meteor Event