Geophysical and Astrophysical Simulations in QuickField

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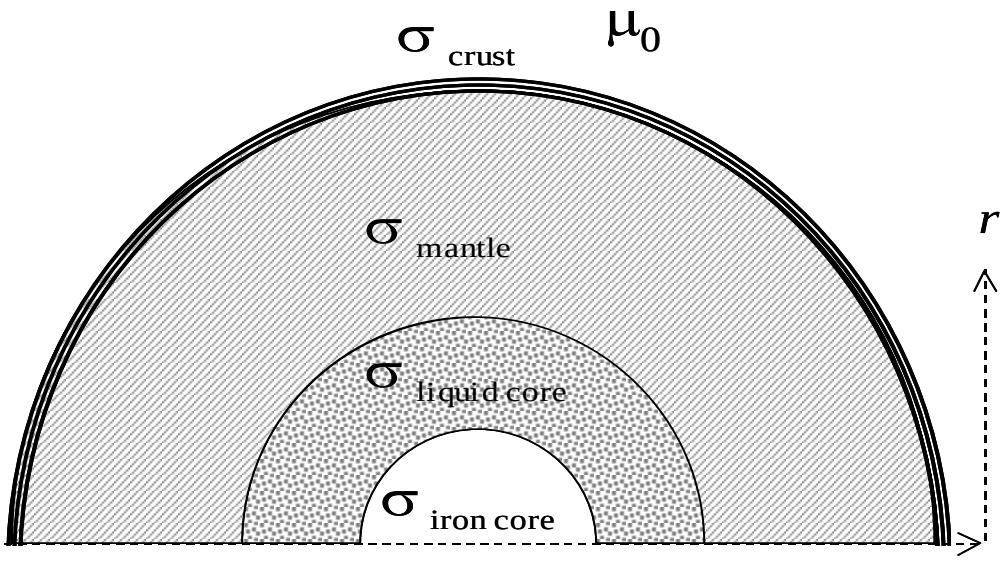
Geophysical Simulations

- Geomagnetic field
- Magnetotellurics simulation
- Electromagnetic well logging simulation
- Hydrothermal vents

Astrophysical Simulations

- Stress in Europa's ice sheet due to tidal interactions with Jupiter
- Induction of currents in Europa's ocean by Jupiter's B-field
- Thermal conduction in spherical bodies

Modeling the Geomagnetic Field



Parameters	
Radius of Earth	6371 km
Radiusof inner core	1216 km
Thickness of outer core	2270 km
Thickness of mantle	2885 km
Thickness of crust	20 km

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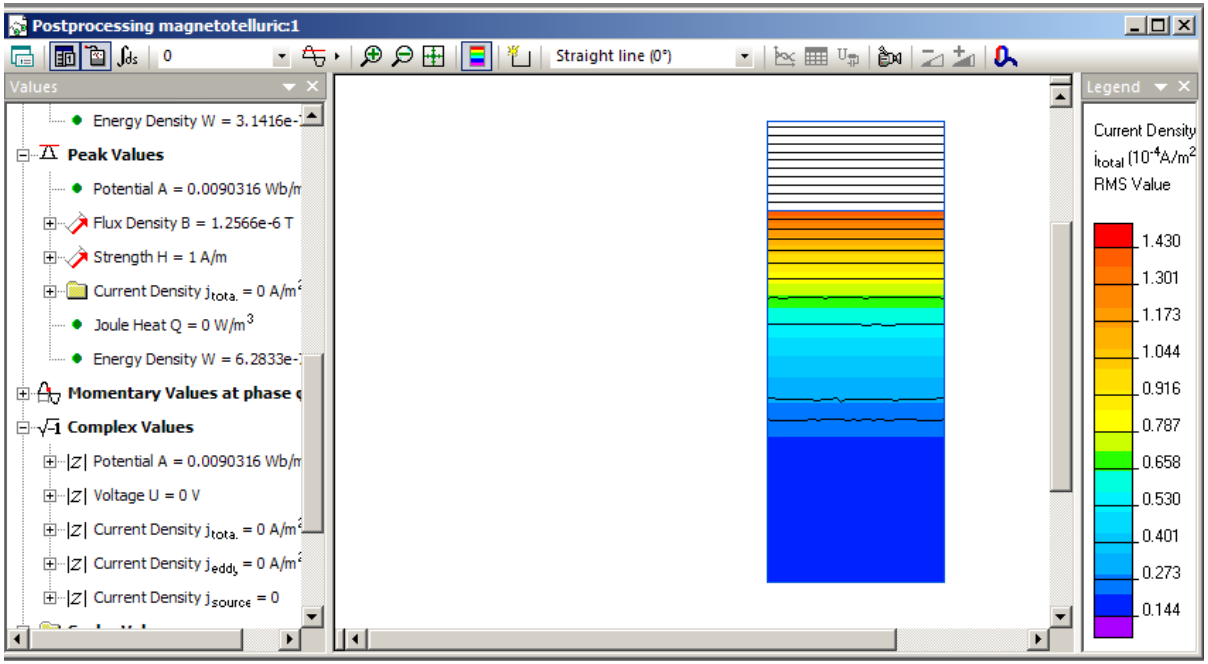
Cross section of the Earth showing the solid iron core, surrounding liquid core, mantle and the crust. The earths crust varies in thickness between 10-60 km whereas the equatorial radius of the planet is 6378 km.

Geometry: Axial symmetry – Magnetostatics calculation

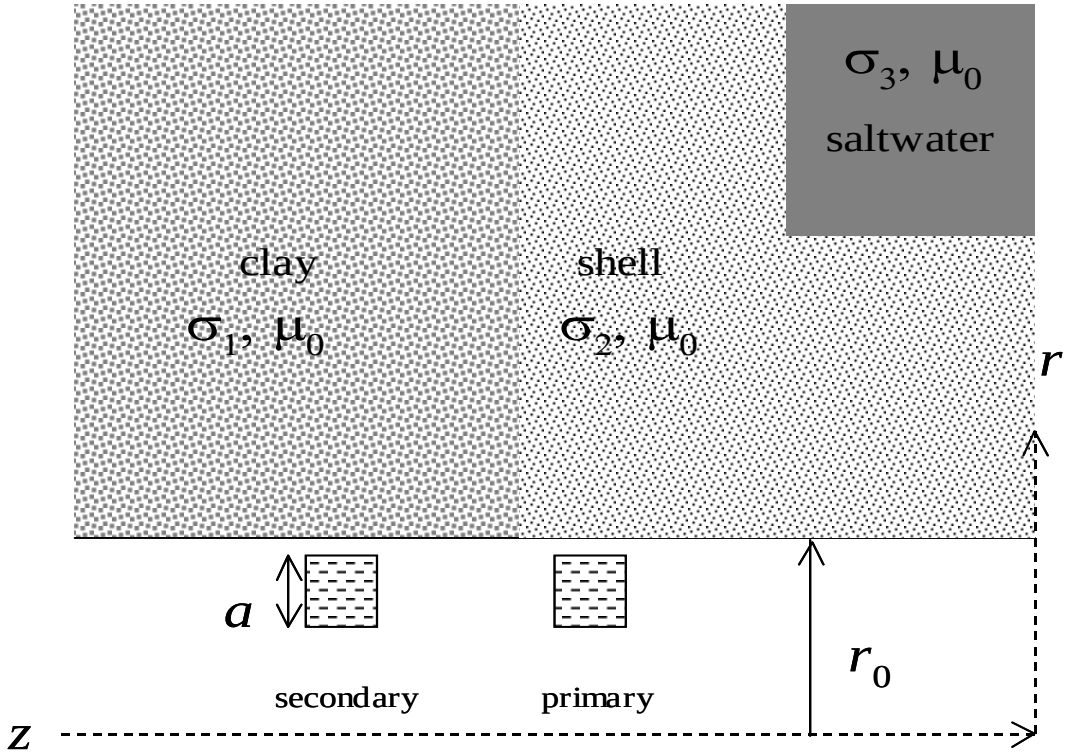
Magnetotellurics simulation

- Induction of currents in the Earth's crust

Parameters	
Variations in Earth's B field	1.3 μT
Period	100 s
Local crust permeability	1.02



Electromagnetic well logging simulation



Earth Resistivity (Ωm)	
Average	100
Dry earth	10^3
Slate	10^7
Sand stone	10^8
Wet soil	10-100
Sea water	1-5

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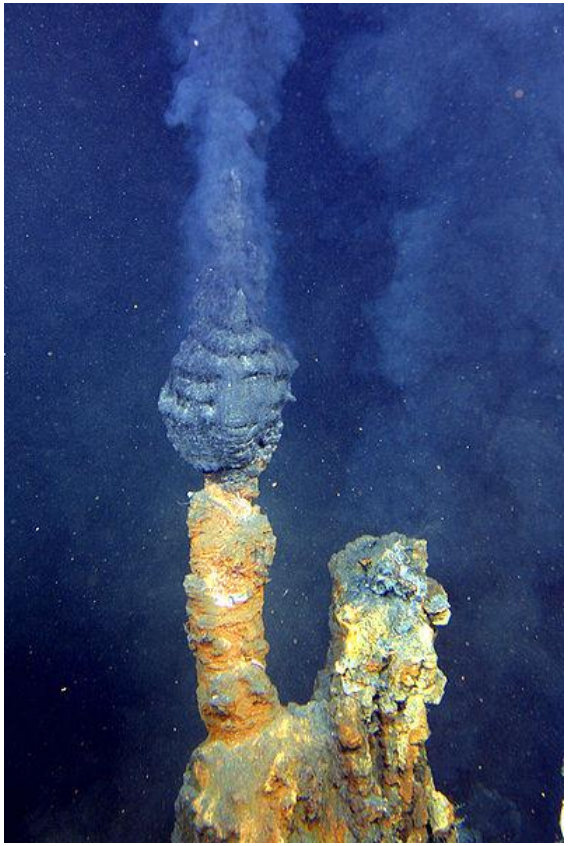
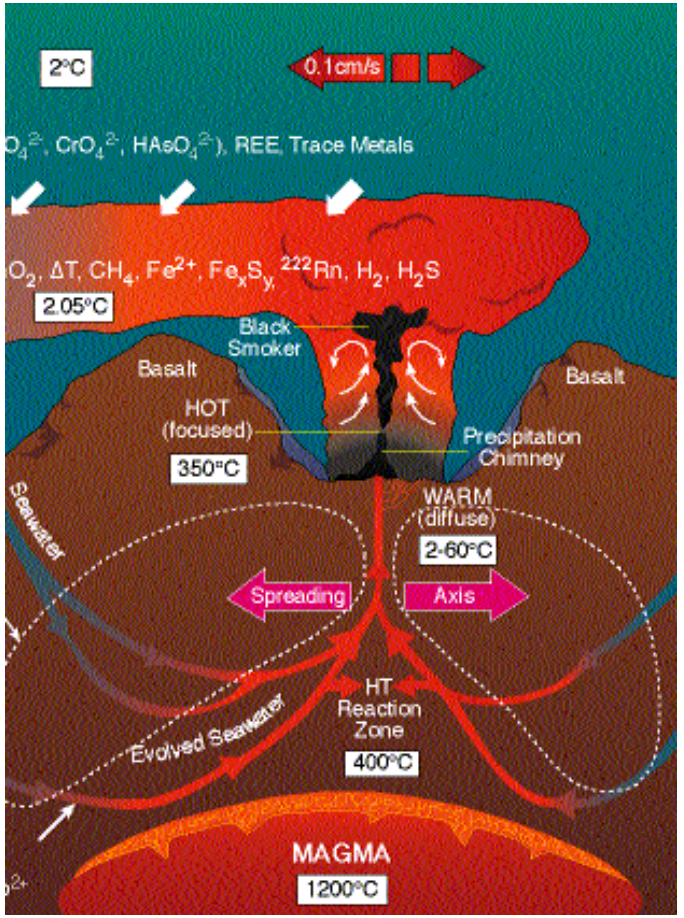
Figure E- 6.24: Well logging simulation: excitation and receiver coils are translated through a borehole passing through geological formations with differing conductivity.

Geometry: Axial symmetry

Hydrothermal vents



Parameters	
Chimney length	1 m
Chimney diameter	0.1 m
Basalt temperature	300 – 400 C
Water Temperature	2– 3 C



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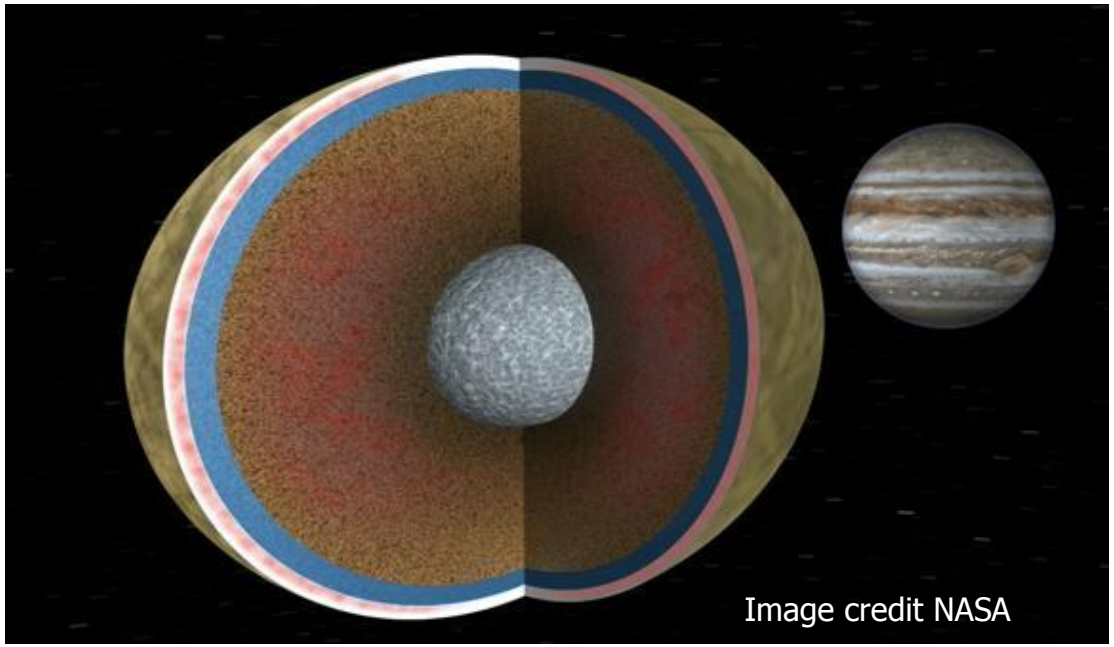
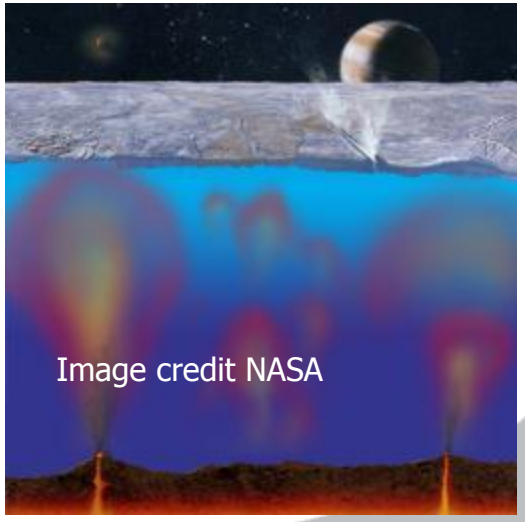
Stress in Europa's ice sheet due to tidal interactions with Jupiter



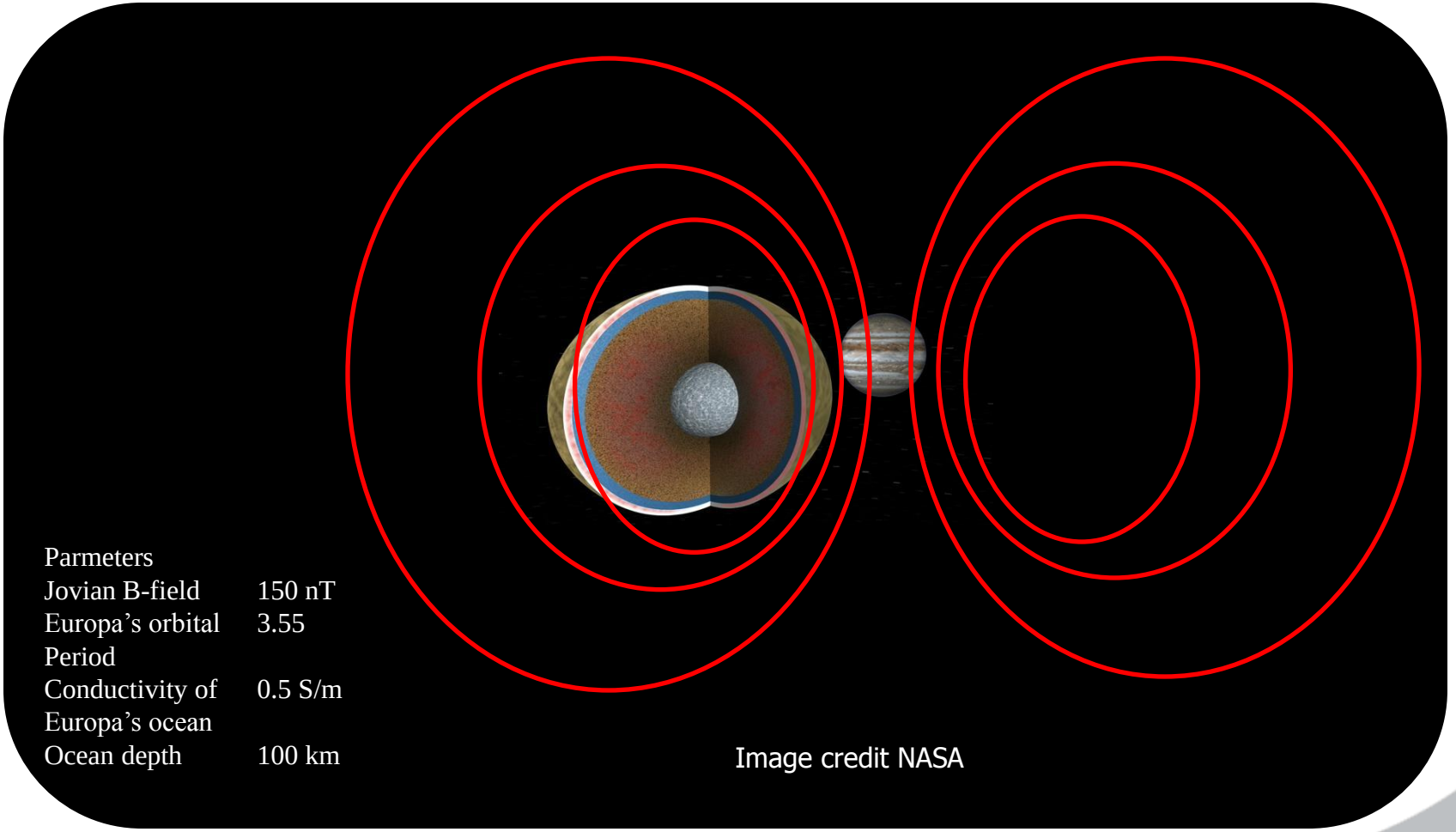
$$F_z = \frac{2GMmr}{R^3}\cos\theta$$

$$F_r = -\frac{GMmr}{R^3}\sin\theta$$

Parameters	
Mass of Jupiter	M = 1.9 E+27 kg
Mass of Europa	m = 4.8 E + 22 kg
Center-to-center separation between Jupiter and Europa	R= 6.71 E+5 km (max 6.77 min 6.65)
Radius of Europa	r = 1565 km
Ice thickness	20 km
Young's modulus ice	6 GPa



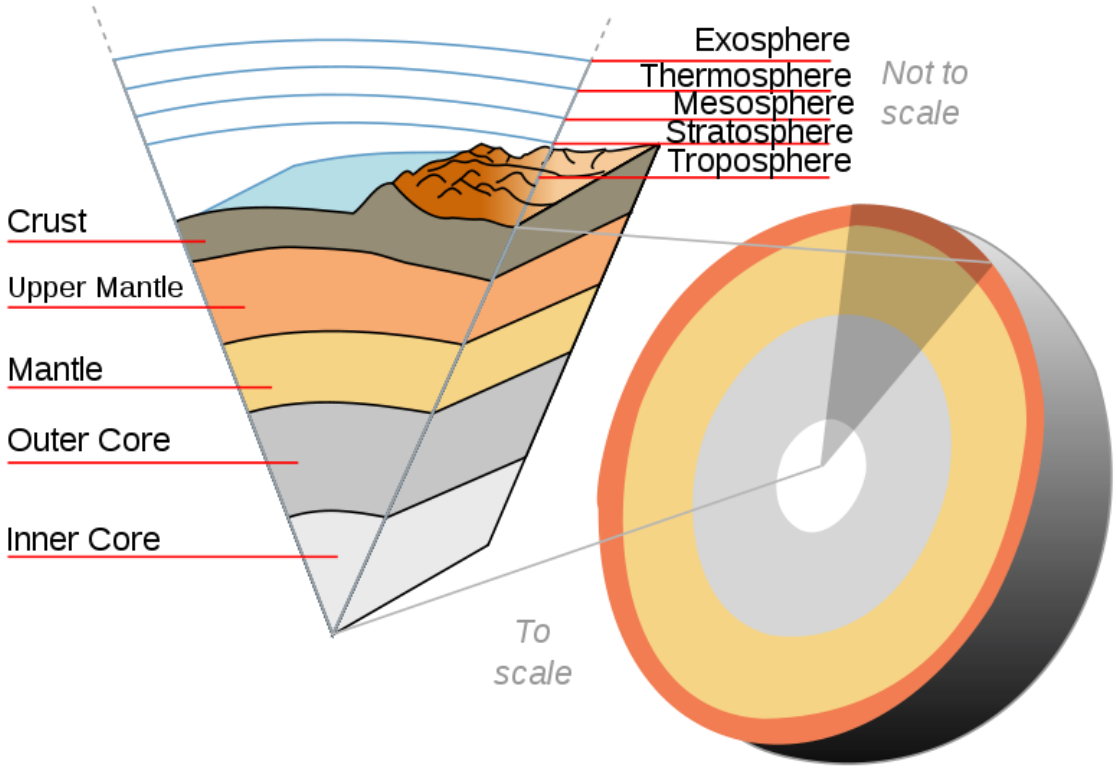
Induction of currents in Europa's ocean by Jupiter's B-field



Parmeters	
Jovian B-field	150 nT
Europa's orbital Period	3.55
Conductivity of Europa's ocean	0.5 S/m
Ocean depth	100 km

Image credit NASA

Thermal Conduction in Spherical Bodies



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