

## Short Course

### *Dynamics and Composition of the Mantle: From the Atomic to the Global Scale*

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The rock cycle is a heterogeneity-producing engine that serves as the corner-stone of geology: igneous processes act like a Maxwell demon constantly separating more felsic from more mafic material. In this way, our understanding of Earth's history rests on the thermodynamics of incongruent melting and on the production of dynamical boundary layers where differentiation occurs. The mantle beneath the surface boundary layer is the source of energy and an active participant in the rock cycle as heterogeneity produced near the surface is constantly being subducted back into the mantle. Once heterogeneity is produced it is difficult to destroy, challenging our views of the "well-mixed" mantle, with profound consequences for our understanding of Earth's evolution.

In this short course, we explore the connections between the properties of materials and the processes that produce them through the window of mantle heterogeneity. The subject builds from fundamental knowledge of the composition and structure of the interior, the thermodynamic principles governing its energetics, the nature of its dynamics, and the governing conservation laws. Practical exercises give students hands on experience with cutting edge codes in mantle thermodynamical modeling and mantle flow, and an opportunity to explore new frontier research directions.

### **Lectures**

#### *Composition of Earth's Interior*

Day 1 1<sup>st</sup> hour: Composition and structure of Earth's interior

Day 1 2<sup>nd</sup> hour: Mineralogy and thermodynamics

#### *Dynamics of the Mantle*

Day 2 1<sup>st</sup> hour: Mantle Convection: Slabs and Plumes

Day 2 2<sup>nd</sup> hour: Mantle Convection: Theory, Approximations and Applications

Day 3 1<sup>st</sup> hour: Vertical Flow-Geoid and Dynamic Topography

Day 3 2<sup>nd</sup> hour: Horizontal Flow-Plate Motions

#### *Heterogeneity*

Day 4 1<sup>st</sup> hour: Geophysics of chemical heterogeneity

Day 4 2<sup>nd</sup> hour: Building a terrestrial planet

### **Practicals**

Day 1,2: Constructing Earth models: Thermodynamic modeling

Day 3,4: Dynamical models of Earth's Geoid and Dynamic Topography