Introduction to the Rheology of Solid Earth

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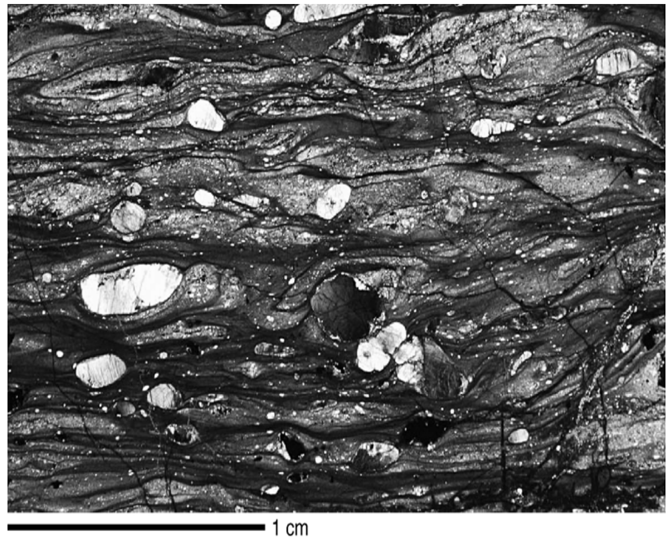
Class Meetings
Monday, Wednesday: 10.00-11.30am
Location
IGPP Munk Conference Room 303
Course name
SIOG261



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Why Study Rheology of Solid Earth?

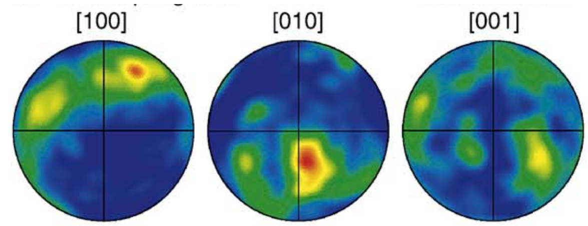
Mineral and Rock Physics is a key component in understanding numerous geological processes that shape the Earth's surface and interior. It combines concepts and principles from geology, geophysics, petrology, and material science. Our knowledge of rheology has significantly improved over the last 30 years, mainly through experimental studies, providing new insights on Earth deformation and dynamics. Rock physics is needed to characterize reservoirs imaged by geophysical data, and to build mechanical earth models for solving geomechanical problems.

Essential Questions

- What are the deformation mechanisms involved in long-term geological processes, such as plate tectonics and mantle convection?
- What are the experimental techniques used to study rock physics?
- What does geophysics teach us about rock physics?
- Is rheology the same for all terrestrial bodies?

Course Description

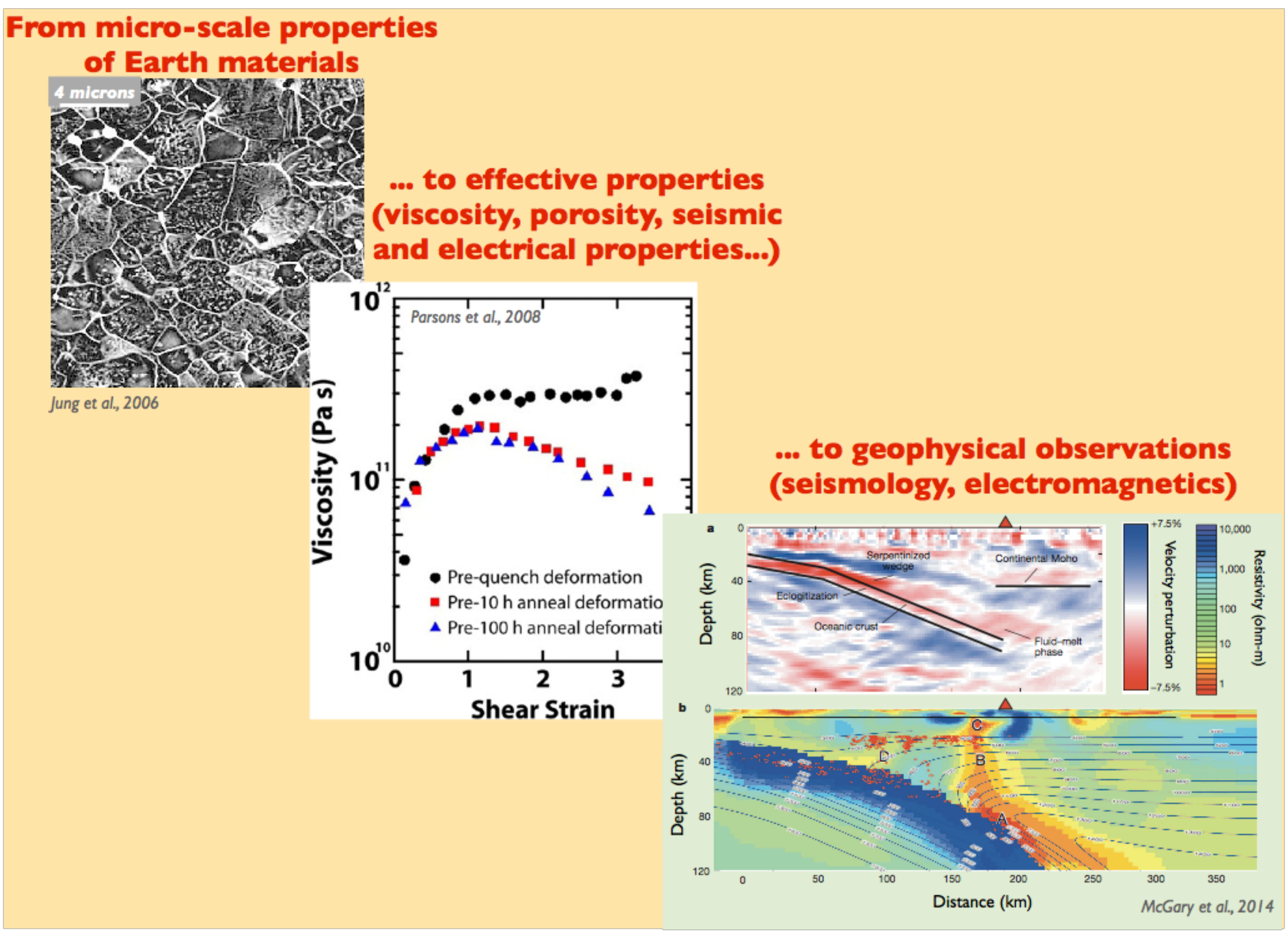
This course provides a framework for understanding the intrinsic properties of rocks, such as mineralogy, diffusion, and deformation (strain, stress, elasticity, anisotropy). It explores fundamental aspects of geological processes (plate tectonics, mantle convection) with an emphasis on how to use this understanding in the construction of mechanical earth models and in quantitative inter-pretation of geophysical data. The course follows a change in scale: from micro-scale processes, to rock-scale mechanisms (and how they relate to microscopic properties), to planet-scale considerations. A variety of applications (mostly for the Earth, but also for other terrestrial bodies) and real data examples are presented.



Pole figures, Warren and Hirth, 2006

Optional texts

- *Deformation of Earth Materials*, Shun-ichiro Karato, Cambridge University Press
- *Creep of Crystals*, Jean-Paul Poirier, Cambridge University Press



Tentative Course Schedule

Week	Topics
1	Introduction to diffusion, stress, strain, elasticity*
2	Micro-scale processes (defects, dislocation)*
3	Rock-scale processes: Diffusion I (thermodynamics)
4	Rock-scale processes: Diffusion II (self-diffusion, chemical diffusion, fluxes)
5	Rock-scale processes: Deformation I (dislocation creep, diffusion creep) + *Hour exam*
6	Rock-scale processes: Deformation II (dynamic recrystallization, grain growth, grain boundaries)
7	Rock-scale properties: Viscosity, porosity, electrical conductivity, seismic velocities; effect of water and melt
8	Planet-scale properties: Rheology of the Earth and other terrestrial bodies (the Moon, Mars, Mercury, Venus)
9	Planet-scale properties: Seismic and electrical anisotropy
10	*Project presentations* + *Final exam*

*Elasticity and micro-scale processes are further detailed in course SIO225 – Physics of Earth Materials and will therefore be only briefly discussed in this course.

Course Grade

Homework: 30%
Hour exam: 30%
Final exam: 40%

To Succeed in this Course

- Meet assignment deadlines and requirements
- Ask questions, whether they are content or skill related, further your thinking, be curious
- Take responsibility for your learning

Main Learning Goals of this Course

- Students will be familiar with rheological properties of the Earth's interior
- Students will know the principles of diffusion theory and understand the main deformation mechanisms
- Students will be able to interpret geophysical properties (seismic parameters, electrical conductivity) in terms of rock properties
- Students will think more critically about the interior of terrestrial planets in terms of structure and dynamics
- Students will develop skills in expressing themselves orally and in writing