GEO 320 Earth Materials: Core to Crust (4 credits, incl. Lab)

This is a core course for Geo majors, Earth Materials. It has aspects of classical mineralogy, petrology, and Earth history courses. Prerequisites are intro geology, first semester chemistry. This course has a required four-hour laboratory, a required ~6-hr Museum visit, a two-day field trip, and individual research.

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Goals for the course

- Students will be able to describe an integrated view of planet Earth based on fundamental principles of geology, mineralogy, and planetary formation and evolution.
- For a local field site, students will formulate a hypothesis-driven research plan in mineralogy, taking advantage of appropriate analytical techniques in mineralogy and geochemistry, achievable within a semester time frame.
- Students will be able to interpret a combination of new x-ray diffraction (XRD), x-ray fluorescence (XRF), TEM, and/or SEM data given related information regarding geological setting, hand sample physical properties, thin section analysis, and literature review in order to define the mineral assemblages, sample provenance, relevance to regional geology, and environmental implications.
- Students will be able to integrate their research findings with those of peers in developing a consensus model that (a) explains mineral occurrences and interplay (micro- and macroscopic) in field samples, and (b) holds up to public scrutiny (as a consensus model and as individual components) at a departmental mini-poster symposium.

Along the way, you will build skills and knowledge in field research, science writing, poster design, oral presentation, collaborative group work, regional environmental history, and more!

Introduction

How do Earth materials relate to the very structure of our planet, from core to crust? Where do different minerals exist, and why? Where did they form, and why? How do field outcrops and observations inform immediately our understanding of the planet underfoot and as an entity? How does the mineral evolution of our planet impact its future, and our every day lives?

(Earth Materials is here designed under a core-to-crust concept umbrella covering content spanning mineralogy/petrology/Earth processes, embracing active learning, collaborative

learning, process of science/research, writing/presentation skills, and field experiences. Contextualizing geological content with case studies, local/regional/global geology, human uses of the Earth, and a sense of how Earth evolves over time is paramount.)

Components and Timeline

Core

Week 1. The core as an environment: what's stable, why, how do we know.
Week 2. Hot-shot minerals: fundamental characteristics, identification tips.
Week 3. Hot-shot minerals: origin, occurrences, the story of cor rocks
Week 4. Hot-shot minerals: informing Earth history...gravity, geomagnetism, planetary differentiation, can we see the core-mantle-boundary,what you need to know about meteorites
*Overnight trip to field site, survey and collect field samples. Probably Blackstone Group serpentinites or coastal accretionary wedge rocks (igneous and metamorphosed sediments?)

Labs will introduce relevant minerals in hand sample and thin section, important core minerals will be studied as case studies, meteorites as rich sources of information.

Mantle

Week 5.The mantle as an environment: what's stable, why, how do we know.
Week 6. Hot-shot minerals: fundamental characteristics, identification tips.
Week 7. Hot-shot minerals: origin, occurrences, the story of mantle rocks
Week 8. Hot-shot minerals: informing Earth history...mantle convection, kimberlites, komatiites, perovskite structures and density gradients/seismic wave propagation, mantle rocks as habitat/the dynamic duo of olivines and chemosynthesis
*Visit the Harvard Mineralogical Museum to experience the meteorites!

Labs will introduce relevant minerals in hand sample and thin section, windows into the mantle will be studied as case studies (e.g., oceanic crust characteristics, ophiolites, serpentinites), visit outcrops and consideration of underlying structural geology, ODP archive samples of forearc serpentinites feature in a lab project (XRD, thin sections, geological setting, petrologic gleanings)

Week 9: Spring Break! No class, no lab, just R&R!

Crust

Week 10.The crust as an environment: what's stable, why, how do we know (and what we haven't already touched on in previous discussions).
Week 11. Hot-shot minerals: fundamental characteristics, identification tips.
Week 12. Hot-shot minerals: origin, occurrences, the story of crustal rocks and tying in to Earth history...igneous, metamorphic, sedimentary rocks and a re-envisioned rock cycle, clays, carbonates, sulfates, oxides and planetary atmospheres

Labs will introduce relevant minerals in hand sample and thin section, field visits to type crustal rocks, who cares about carbonates and clays anyway!? Hazen paper on mineral diversity and time. Synthesis of course material to date, analysis of individual mineralogical “footprint” and necessary minerals to society.

Wrap-up

Week 13. Minerals as indicators of planetary environments over space and time.

What you need to know
What you can do: engage in the course!
What I can do: help you learn to teach yourself what you need to know, provide mentorship and access to research tools and data, set the bar for course achievements.

Getting help
Bring to every class
Books etc
Class meetings outside the normal times
Attendance—the nitty gritty
Due dates
Writing
Grades
Standards
Emergencies.
Report to designated meeting place and stay put! I need to account for your whereabouts.

Disabilities.
We make reasonable adjustments for those of you with documented disabilities. Obtain University-sponsored documentation, meet with me at the beginning of the course to allow enough time to edit course materials as needed.

Tear-off signature page.
Read and sign that you've read, understood, and will give it your best shot!

1. Mineralogy of the mantle: density and rock physical properties, seismicity, mantle convection, plate tectonics, margin petrogenesis.
2. Mineralogy of the crust: diversity and unlikely endmembers/outliers, necessary processes and products, unique aspects of terrestrial surface mineralogy.
3. Earth as mineralogical entity: a whole greater than the sum of its parts, planetary habitability and mineralogy, human uses of the Earth, environmental history and ethics. Labs will depend on synthesis of course material to date, analysis of individual mineralogical "footprint" and necessary minerals to society, discussion/journaling components featured esp. since students are working on finalizing individual research projects and poster presentations at this time.

What assessment strategies will you use, and how will they help you assess student progress toward the goals?
Road checks at completion of every activity.
Gray area ID to close each class.
Lots of practical quizzes, tag teaming ok for a more open ended question to close—all add up to a personalized manual of mineralogy/petrology.
Concept sketches at least for each thematic component.
Final poster and class web page.