

GEOL 221 Mineralogy and Mineral Optics
Course Syllabus
SAN DIEGO STATE UNIVERSITY

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Lecture: MW 1000-1050, Lab: MW 1400-1640 CSL 425

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Course Prerequisite: Credit or concurrent registration in Geol 200; high school chemistry & trigonometry or credit or concurrent registration in college chemistry and trigonometry.

Required Texts: Introduction to Mineralogy, William D. Nesse, Oxford University Press.

Other required materials: Hand lens; calculator

Introduction: Mineralogy is a fundamental topic in geology. Minerals are the basic ingredients of the solid earth (and terrestrial planets) and knowledge of mineralogy is central to diverse disciplines in the geosciences including economic geology, environmental sciences, petrology, sedimentology, structural geology, geochemistry, and geophysics. Chemistry of course is even more fundamental than mineralogy and since minerals are naturally occurring chemical compounds, chemistry is a prerequisite.

A primary objective of this course is to develop a broad overview of the minerals that form the earth - their nature, origin and evolution. Chemical composition and physical conditions dictate the formation and stability of minerals in and on the earth. As different minerals grow, the physical arrangements of atoms result in various forms of symmetry. The science of crystal symmetry is "crystallography". We will explore the fundamental principles of crystallography and crystal-chemistry. These principles govern and describe the architecture of minerals at the atomic level and are responsible for their properties and stabilities. We will study the nature of the dominant minerals that make up the bulk of the earth. We will learn the methods to identify minerals in hand specimens and using X-ray diffraction, as well as the use of the electron microprobe for the determination of mineral compositions.

A major part of the course is devoted to mineral optics in preparation for the study of rocks in thin section (i.e. petrography) using a polarizing light microscope. Topics to be covered include familiarization with the microscope, the elementary principles of crystal optics, the immersion method, isotropic, uniaxial, and biaxial optics, and the study of minerals in thin section. By the end of the semester students should be able to readily identify the major rock-forming minerals in thin section. This provides a foundation for study of igneous, metamorphic and sedimentary rocks.

Specific Course Objectives.

- Learn to identify common rock-forming minerals in hand specimens. Emphasis is on field identification using a handlens.
- Know the basic principles that govern the structures of ionic materials.
- Understand the basic principles of crystallography and symmetry and their relationship to physical properties of minerals.
- Know the structures and compositions of the most common rock forming minerals.
- Understand why different minerals are stable under different conditions of pressure and temperature in terms of the competition between internal energy, entropy and volume.
- Learn the basics of mineral optics and how to identify basic rock forming minerals in thin section using the polarizing microscope.
- Apply X-ray diffraction methods to identify minerals on the basis of their structural features.
- Understand the basics of electron microprobe methods to determine mineral compositions.

Grades

Your grade for the class will be based on:

- a) Exams - Two midterm exams and a comprehensive final exam, each worth 100 points.
- b) Weekly lab assignments & lab final exam
- c) Homework assignments & Quizzes
- d) Research presentation
- e) Two Fieldtrips, (1) Day trip to Sacatone Springs pegmatite district in east San Diego (2) Camping trip to Mojave Desert

Lab Schedule

Week 1

Introduction to rock forming minerals in hand sample

Week 2

Physical properties of minerals in hand specimen

Week 3

Crystal Chemistry – bonding, coordination, structure, compositional variations

Week 4

Crystal Chemistry – silicate minerals

Week 5

Crystallography – symmetry elements

Week 6

Crystallography – crystal systems

Week 7

X-Ray Diffraction Techniques (XRD)

Week 8

X-Ray Diffraction Techniques (XRD)

Introduction to Scanning Electron Microscopy & X-Ray Fluorescence (XRF) spectra

Week 9

The Polarizing Microscope: General feature, types, optical system, parts, precaution and adjustments, orthoscopy and conoscopy.

Week 10

Theories of light: Wave theory, speed of light, Wave motion, Color of light. - Refraction: Snell's law, Index of refraction, Dispersion, Critical angle, Total reflection, Determination of indices of refraction with the microscope.

Week 11

Mineral Preparations for Microscopic Study: Types of preparation, material used, cutting and polishing.

Week 12

Optical Mineralogy in Ordinary light: (3 lectures)

Color, Shape, Form, Cleavage, Fracture, Inclusions, Index of refraction.

Week 13

Optical Mineralogy in Plane Polarized light: Double refraction, Polaroid and Nicol Prism, Pleochroism, Ordinary and Extraordinary rays, Isotropic and anisotropic minerals,

Week 14

Optical Mineralogy in Crossed-polarized light: Interference of waves, Extinction, Interference colors, Anomalous interference colors, Newton's scale of colors, Twinning, Zoning, Accessory plates, elongation, vibration planes.

Week 15

Conoscopic Microscopy: Indicatrix, Types of interference figures, Uniaxial minerals, Biaxial minerals, Optic sign, 2-V angles, Optical orientation, dispersion of biaxial minerals.