Lab Manual for a Mineralogy and Optical Mineralogy Course

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Abstract

The goal of this lab is to teach students to identify minerals by their physical and optical properties. The lab manual is web based and constructed around the textbook DVD by Dyar and Gunter (2008) illustrated by Tasa, with focus on the authors' "Big Ten" minerals (*Fig. 1*). Labs concentrate on four topics: analytical equipment, physical and optical properties, mineral identification, and special projects.

The first two labs are spent introducing the students to the different instruments used for mineral identification. Students are shown the XRD and SEM, or other specialized equipment, and briefly explained the concepts driving them. The next lab introduces the students to the polarizing light microscope (PLM), their primary tool in mineral identification. Students learn the parts of the microscope and their purposes, measure the field of view, calculate total magnification, and how to center the objective lenses. The lab following walks students through a series of exercises demonstrating the optics of the microscope.

The next round of labs focuses on defining and learning the techniques to identify the physical and optical properties of minerals. Lab exercises begin with students comparing the properties of two or three different minerals and then lead to observing the properties of an unknown mineral and identifying the mineral using the DVD database.

After students have learned the different properties and how to identify them, they will apply them to different minerals. The "Big Ten" minerals are split into labs by class (framework silicates, sheet silicates, etc.). Students use the DVD database and lab materials to characterize the properties themselves and to build their own mineral lab manual, which they can use in petrology.

The semester ends with two projects. The first project involves building a spindle stage and using it with the EXCALIBR program to expand the student's understanding of optical properties of minerals. The second project, and the students' final, is a collection of 20 minerals from Latah County, Idaho identified by the students using the techniques and resources learned over the semester.

Table 1.3. The "Big Ten" Minerals

	Mineral group	Mineral species or series	Formula
1		quartz	SiO_2
2		orthoclase	$KAlSi_3O_8$
3	feldspars	albite	$NaAlSi_3O_8$
4		anorthite	$CaAl_2Si_2O_8$
5	micas	muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$
6		biotite	$K(Mg,Fe)_3(AlSi_3O_{10})(OH)_2$
7	amphiboles		$(Ca,Mg,Fe)_7Si_8O_{22}(OH)_2$
8	pyroxenes		$(Ca,Mg,Fe)_2Si_2O_6$
9	olivines		$(Mg,Fe)_2SiO_4$
10		calcite	$CaCO_3$

Figure 1: The 10 most common minerals in the Earth's crust (Dyar and Gunter 2008).

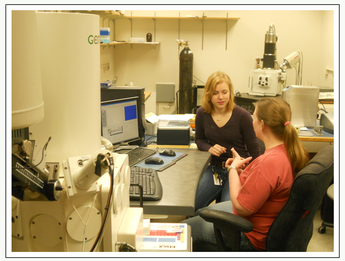
Lab Exercises

Analytical Equipment

Lab 1: Tour of Specialized Equipment used for Mineral Identification
- Samples of halite, sylvite, quartz, opal, and feldspar are analyzed by SEM/EDS and powder XRD.
- Demonstration of why minerals cannot always be identified by either structure or composition alone.

Lab 2: Introduction to the Polarized Light Microscope (PLM)
- Identify the parts of the microscope and their purpose.
- Measure field of view and total magnification for each objective lens.
- Center each objective lens.

Lab 3: Optics of the Microscope
- Determine vibration direction of polarizers using reflection of sunlight.
- Use polarizers to determine vibration of light interacting with the PLM's polarizers, muscovite, glass slides, and calcite rhombohedral.



Physical and Optical Properties

Lab 4: Physical Properties of Minerals
- Compare / Contrast the physical properties of quartz and calcite.
- Practice observing physical properties of minerals on 1 or 2 other known mineral hand samples.
- Identify an unknown mineral hand sample by its physical properties using the DVD mineral database (*Fig. 2*).

Lab 5 - 6: Optical Properties of Minerals
- Measure the refractive index (RI) or fluorite and halite.
- Practice observing optical properties of minerals on 1 or 2 other known minerals in thin section and in grain mount.
- Identify an unknown mineral in grain mount or thin section using its optical properties and the DVD mineral database.

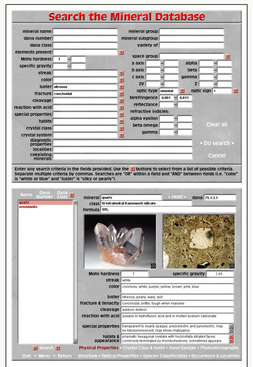


Figure 2: Search page on the DVD mineral database and the resulting minerals (Dyar and Gunter 2008).

Characterization of Minerals

Lab 7 - 11: Characterize Minerals
- Use lab materials and DVD database to characterize the minerals featured each week.
- Build your own lab manual using the DVD database's mineral printouts (*Fig. 3*)
- Labs are broken down according to mineral group:

➢ Lab 7: Framework Silicates	quartz, orthoclase, albite, and anorthite
➢ Lab 8: Sheet Silicates	muscovite, biotite, chlorite, and talc
➢ Lab 9: Chain Silicates	diopside, enstatite, tremolite, and anthophyllite
➢ Lab 10: Ortho – Silicates	olivine, garnet, andalusite, kyanite, and sillimanite
➢ Lab 11: Non – Silicates	calcite, fluorite, pyrite, magnetite

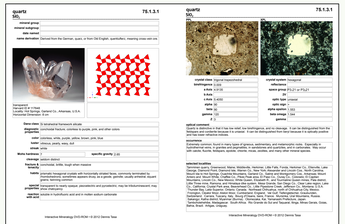


Figure 3: Two- page printout of mineral summary from the DVD database (Dyar and Gunter 2008).

Special Projects

Lab 12 - 13: Spindle Stage and EXCALIBR
- Build a spindle stage using instructions from Dyar and Gunter (2008) or Gunter et al. (2004).
- Use olivine crystals with spindle stage and EXCALIBR program to locate optic axes of crystal.

Lab 14 - 15: Mineral Collection (Final Project)
- Put together collection of 20 minerals from Latah county (*Fig. 4*), using a guide to the county's minerals (Rossenbach 1994).
- Identify minerals using techniques and equipment learned throughout the semester.

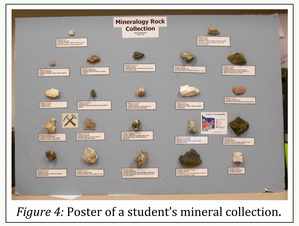


Figure 4: Poster of a student's mineral collection.

Conclusions

- Students can associate both physical, especially optical properties, with the structure and composition of minerals.
- Students gain experience with identifying minerals in the lab and in the field with different analytical methods.
- Students do not memorize the properties of a few minerals, but learn the skills needed to identify any mineral.

References

Dyar, M.D. and Gunter, M.E. (2008) Mineralogy and Optical Mineralogy. Mineralogical Society of America.

Gunter, M.E., Bandli, B.R., Bloss, F.D., Evans, S.H., Su, S.C., and Weaver, R. (2004) Results from a McCrone Spindle Stage Short Course, a New Version of EXCALIBR, and How to Build a Spindle Stage. Microscope, 52, 23-39.

Rossenbach, R.M. (1994) Minerals of Latah County. Master's Thesis, University of Idaho.