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Cover image: (top) purple garnet sand along a beach at Waskesiu Lake, Prince Albert National Park, Saskatchewan, photo by Scott Colville CC BY 4.0; (bottom) purple sand under the microscope Joyce McBeth CC BY 4.0.

Introduction

Welcome! Our vision for this project was to create a Canadian introductory physical geology lab manual that is more accessible and affordable for our first-year physical geology students. Since this is an open text, we can also update or modify it quickly to integrate improvements. At the University of Saskatchewan, in addition to our first-year course in physical geology that includes a lab, we offer an introductory physical geology course that does not have a lab component (primarily as a science elective for arts students). Our hope is this manual can be useful to these students too, offering them self-directed hands-on practice with geoscience problems and supplementary text resources.

We were fortunate that we didn't have to start from zero on this project: Bradley Deline, Randa Harris, and Karen Tefend of the University of West Georgia had prepared a [Laboratory Manual for Introductory Geology](#) that we have adapted. Each chapter of this manual is broken down into introduction, overview, and exercises sections. The introduction provides learning objectives and a short vocabulary list, the overview sections provide useful background concepts, and the exercises sections are problems students will (or could) cover in physical geology course labs. Several labs also contain practice or extra questions; these are materials that don't fit in our labs at the University of Saskatchewan but may be useful as supplemental activities for our students. Much of the content for the introduction, overview, and exercises sections of each chapter were based on [Deline, Harris & Tefend's manual](#), but we have extensively rewritten several chapters to align with our programming at USask (specifically the introductory chapter, the exercises on minerals and rocks, and the geological structures chapter). We have also modified the original edition to include more Canadian content and examples, and in most cases, we have changed imperial units to metric.

We are grateful to Bradley Deline, Randa Harris & Karen Tefend for creating the first edition of this text and for helping us along with our questions about the manual - it was a delight to work with the firm foundation you provided! We thank the University of Saskatchewan Gwenna Moss Centre for Teaching and Learning (GMCTL) and the Department of Geological Science for financial support for this project. We are grateful to Jordan Epp at USask Teaching and Learning for his support with PressBooks and Heather Ross at GMCTL for her guidance and encouragement. We are also grateful to Todd LeBlanc for assisting Tim with test-driving the manual in labs before we started the project; his experiences provided critical insights on directions for revisions, particularly for the geological structures chapter. Thank you to our TAs and students for their feedback on the first version of this edition of the manual, we have incorporated numerous edits in this version to address their suggestions.

In the second edition of this manual, we plan to expand the chapters to include others from the first American edition by Deline et al (e.g., plate tectonics) as a resource for our students. If you find errors in the current edition or are interested in contributing images, exercises, examples of Canadian geology or other content to the next edition (or adapting the text for your own use) please let us know. Please direct comments and suggestions to Joyce McBeth at joyce.mcbeth@usask.ca. We hope you find the resources in this manual helpful - please let us know what you think!

-Joyce McBeth, Michael Cuggy, Karla Panchuk, Tim Prokopiuk, Lyndsay Hauber, & Sean Lacey

Department of Geological Sciences, University of Saskatchewan, SK, Canada, January 2019 (v.2).

Acknowledgements

This lab manual is an adaptation of the following chapters from [Laboratory Manual for Introductory Geology](#) (2015), First Edition, written by Bradley Deline, Randa Harris, & Karen Tefend.

Original Chapter Number	Original Author	Adaptation Chapter Number(s)
1	Deline	6
3	Tefend & Deline	7
5	Harris	10
7	Harris	2
8	Tefend	3
10	Deline	4
11	Tefend	5
12	Harris & Deline	8
13	Harris	9

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Lab Guide For USask GEOL 121 Students

Welcome University of Saskatchewan GEOL 121 Students! We are glad you are joining us to learn about geology this semester, and we hope you enjoy your experience here. Geology is a challenging and rewarding science. You will probably learn things this semester that will stay without you throughout your life and help you understand the world around you more completely.

We have a few rules to help you get the most out of your lab experience this semester and to keep things running smoothly. Please respect and follow these guidelines:

- attend lab in **your assigned section**.
- you must complete all lab assignments and hand in all assignments that TAs mark in order to pass the course. If you do not, you will get an incomplete in the class. If you hand in assignments late without prior approval you will receive a 0 in that lab.
- if you will be absent from lab, contact the lab coordinator (Michael Cuggy, [michael.cuggy at usask.ca](mailto:michael.cuggy@usask.ca)) **before** you are absent.
- if you are absent due to illness contact the lab coordinator as soon as possible to arrange to attend an alternative lab. The longer you wait the harder it is to accommodate you so please contact the lab coordinator as soon as you are aware you are going to be (or have been) absent.
- Note that each lab is only offered for one week of the semester, so if you miss a week it will be very difficult to make up.
- Do not lick the rocks! Some of them might have a characteristic taste but remember - hundreds of students handle these samples each year, and if you lick the samples you are probably tasting their sweat, viruses, and bacteria! Your TA can tell you whether the mineral or rock sample has a distinctive taste or not.
- Many of the rock and mineral samples contain metals that you should not ingest. Wash your hands after each lab where you handle rocks and/or mineral samples.
- During quizzes and exams, students are explicitly forbidden to talk, share materials, look at exam sheets other than their own, or in any other way participate in activities that could be perceived as cheating. Concerns with students who do any of these things will be resolved according to the [student academic misconduct process flow chart](#). All students should read and be familiar with the [Regulations on Academic Student Misconduct](#).

AES students:

- contact the lab coordinator (Michael Cuggy, [michael.cuggy at usask.ca](mailto:michael.cuggy@usask.ca)) (not your TA!) at the start of the semester or as soon as possible to arrange to write the rock and mineral quiz at a different time.
- arrange with AES to write the lab final exam. Their standard rules and deadlines apply for writing the lab final exam as for midterms or final exams arranged through AES. If you do not arrange in advance with them we will not be able to accommodate your request for accommodation.

Please be respectful of your TAs' time:

- be punctual - come to labs on time.
- pay attention when they are presenting at the start of each lab.
- Learn your TAs' names.
- read the overview section prior to attending the lab and come to labs prepared to learn.
- if you are struggling, let your TA know as soon as possible - the sooner you let them know, the more they can help you.
- visit your TA during their office hours or arrange for a mutually-convenient time via email in advance.
- ask lots of questions during the labs and use the time assigned for the labs. A big part of the responsibility for getting the most out of your labs belongs to you, so use the opportunities you are given to learn.

How to succeed in GEOL 121 labs:

- attend all the labs and complete the lab exercises.
- review your lab exercises in preparation for the rock and mineral exam and the lab final exam.
- If you are struggling - get help from your TA as soon as possible, and consider working with a tutor
- geology is a collaborative discipline, so we expect students will work together to learn and complete their lab assignments. However! Be honest with yourself - if you redid the lab on your own, could you do it? If not, spend more time preparing for the quiz and exam, because you will have to work on your own during those tests. Be respectful of your lab partners - contribute equally to lab work as a team.

There are a few things you will need to bring to lab with you:

- rock and mineral identification kit that can be purchased from the bookstore (for Rock and Mineral Labs and quiz)
- pen, pencil, and eraser
- pencil crayons
- geometry set (including protractor, ruler, drafting compass, for Structure and Earthquake Labs)

Good luck with the labs and we hope you enjoy learning about geology this semester!

USask GEOL 121 Rock & Mineral Quiz Information

The rock and mineral quiz tests students on their ability to identify the rocks and minerals covered in the first few labs of the course. It is worth 10 % of your final grade for the course.

The format for the rock and mineral quiz:

- Bring a printout of the [rock and mineral quiz sheet](#), your mineral identification kit and pen or pencils.
- The Rock and Mineral quiz takes place in your regular lab section. Other lab sections cannot accommodate additional students due to fire regulations and limited resources so it is critical that students take the quiz in the section where they are registered.
- It is a closed-book quiz. You are not allowed use your lab books or keys in the quiz.
- Students must work independently during the quiz; cheating will not be tolerated. Please familiarize yourself with the USask academic integrity policy.
- You will be required to name a total of 34 rock and mineral specimens. Some rocks or minerals could appear more than one time. The specimens will be similar to the ones you saw in your labs. They will NOT be numbered with the same numbers they were marked with in your labs.
- You will have 90 seconds to identify and name each specimen. After this time, you will get a new specimen for 90 seconds, and so on, until you have seen each of the 34 specimens. You will only have one chance to look at each specimen.
- You will fill in each rock and mineral specimen on your answer key beside the number corresponding to the number on the specimen. Only one student will begin with specimen #1, so make sure you are putting the answers in the correct place in on your quiz paper.
- There is only one correct answer per question – if you put down more than one answer your TA will mark the question incorrect.
- You can ask your TA if a specimen would react to dilute HCl acid, or if it would taste salty.
- AES students: contact the [lab coordinator](#) (Michael Cuggy, [michael.cuggy at usask.ca](mailto:michael.cuggy@usask.ca)) (not your TA!) at the start of the semester or as soon as possible to arrange to write the rock and mineral quiz at a different time.

How to succeed on the rock and mineral quiz:

- To succeed on the rock and mineral quiz it is critical that students attend and participate in the labs. There is no substitute for working through the rock and mineral identification methods we teach you in the labs. It takes practice to learn how to accurately identify rocks and minerals. Ask your TA lots of questions if you are struggling!
- As you study, try to write down as much information as you can about each specimen (not just the name - even if you are sure you know what it is!). What characteristics can you use to help identify the mineral? Write down details such as cleavage, lustre, streak, hardness, crystal habit, colour, and foliation.
- On your quiz you can also note characteristics of your mineral or rock. This is very useful if you are unable to identify the rock or mineral when you are looking at it, but then remember what the sample is later in the quiz.
- Test yourself - as you get more confident with rock and mineral identification, get your lab partner to test you with the specimens provided in the lab. This is an effective way to review and will help you build confidence before the quiz.

Good Luck!

USask GEOL 121 Lab Final Exam Overview

The lab final exam is comprehensive; it covers material from all the labs. It is worth 10 % of your grade for the course.

General information about the lab final exam:

1. The lab final exam is three hours long and is a closed-book exam (i.e., notes are NOT permitted during the exam). You will be required to do exercises similar to those you did in the lab.
2. Students must each bring all of the materials that they will need for the exam. Coloured pencils, pens, pencils with erasers, ruler, compass and a protractor are recommended. Blank paper will be provided for the structure cross-sections. Calculators are permitted.
3. Cheating will not be tolerated. Collaboration is NOT permitted on the final. Please familiarize yourself with the USask academic integrity policy.
4. Students are **strongly** encouraged to check their work when they finish their exam! If you have extra time at the end of the exam, take time to check you have answered all questions. Check your answers for accuracy and completeness.
5. AES students: arrange with AES to write the lab final exam. Their standard rules and deadlines apply for writing the lab final exam as for midterms or final exams arranged through AES. If you do not arrange in advance with them we will not be able to accommodate your request for accommodation.

Content covered on the exam:

- a. Introduction to Canadian Geology: review Saskatchewan and Canadian mineral and energy resources and know approximate locations of several major resources in Saskatchewan and Canada (e.g., nickel is a resource found in Ontario).
- b. Rocks and minerals will be covered on the lab final exam but there will be no actual specimens to examine during the exam. Students must know the basic properties of the rocks and minerals, including things such as what metals are found in the economic minerals, number of cleavage planes where relevant, and rock classifications. These questions will probably be fill-in-the-blank or multiple-choice style questions.
- c. Relative and absolute dating: students will be provided with a cross-section diagram and they must be prepared to correctly order the strata using the principles of stratigraphy and to provide a geological history in point form based on this analysis.
- d. Students are responsible for understanding the principles of topographic maps (scale, elevations, topographic profile, vertical exaggeration).
- e. Earthquakes (if this lab was covered this semester): know definitions, be able to locate the epicentre of an earthquake.
- f. Structural Geology - the exam will contain questions where students will be tested on their knowledge of:
 - Preparing structural sections (L.O.T.S.)
 - Calculating true thickness
 - Geological history

- Folds - relative ages, using symbols to label fold axes and dip directions on geological maps, how to draw folds in a cross-section
- Faults – types of faults and features of faults (hanging wall, foot wall), determining and labelling relative direction of movement, how to draw faults in cross-sections and how to indicate on geological maps
- Unconformities - how to indicate on cross-sections and on geological maps
- Strike and Dip – definitions, labelling correctly on maps and how to use to construct cross-sections
- Horizontal and vertical beds and rules of Vs – recognizing features on geological maps

Good luck!

