YOUNG NATURALISTS

TEACHERS GUIDE

TO "EXPLORERS OF THE UNDERGROUND"

Multidisciplinary classroom activities based on the Young Naturalists nonfiction story in *Minnesota Conservation Volunteer*, July–August 2015, www.mndnr.gov/mcvmagazine

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Minnesota Conservation Volunteer magazine tells stories that connect readers to wild things and wild places. Subjects include earth science, wildlife biology, botany, forestry, ecology, natural and cultural history, state parks, and outdoor life.

Education has been a priority for this magazine since its beginning in 1940. "One word—Education—sums up our objective," wrote the editors in the first issue. Thanks to the *MCV* Charbonneau Education Fund, every public library and school in Minnesota receives a subscription. Please tell other educators about this resource.

Every issue now features a Young Naturalists story and an online Teachers Guide. As an educator, you may download Young Naturalist stories and reproduce or modify the Teachers Guide. The student portion of the guide includes vocabulary cards, study questions, and other materials.

Readers' contributions keep *Minnesota Conservation Volunteer* alive. It is the only state conservation magazine to claim the distinction of being financially supported by contributions from its readers.

Find every issue online. Each story and issue is available in a searchable PDF format. Visit www.mndnr.gov/mcvmagazine and click on *past issues*.

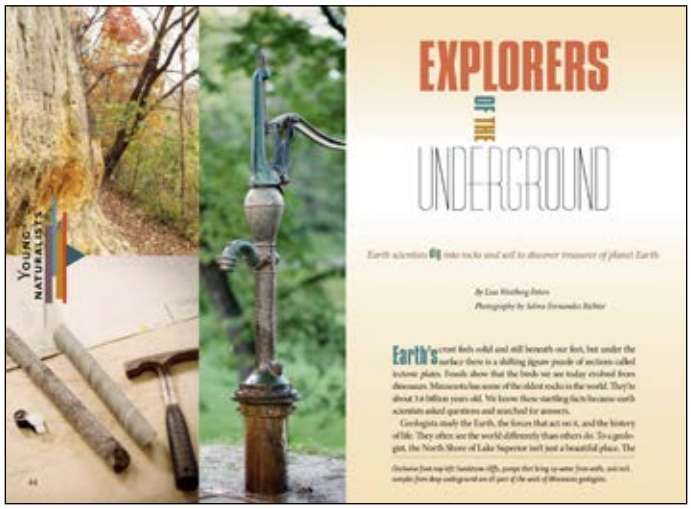
Thank you for bringing Young Naturalists into your classroom!

Prepared by Jack Judkins, Curriculum Connections Minnesota

MINNESOTA CONSERVATION VOLUNTEER

"Explorers of the Underground"

Multidisciplinary classroom activities based on the Young Naturalists nonfiction story in *Minnesota Conservation Volunteer*, January–February 2016, www.mndnr.gov/mcvmagazine



Summary. "Explorers of the Underground" features three earth scientists doing important work for the Department of Natural Resources and the U.S. Geological Survey in Minnesota. Brief biographies of the scientists help readers better understand their fields of study: gravel/sand formations and mining, mineral exploration, and groundwater contamination. *Note: This article has strong connections to eighth grade earth and space science standards.*

Suggested reading levels. Third through middle school grades

Materials. KWL organizer, markers, online text and videos about core sampling (See Web Resources), and other print and online resources your media specialist may provide.

Preparation time. One to two hours, not including time for extension activities

Estimated instruction time. One or two 50-minute class periods (not including extensions)

Minnesota academic standards applications. "Explorers of the Underground" may be applied to the following Minnesota Department of Education standards:

Language Arts Reading Benchmarks Informational Text Grades 3–8

Key Ideas and Details, Craft and Structure, Integration of Knowledge and Ideas, Range of Reading and Level of Text Complexity

Writing Benchmarks Grades 3–8 Text Types and Purposes, Writing Process, Research to Build and Present Knowledge, Range of Writing

Reading Benchmarks: Literacy in in Science and Technical Subjects Grades 6–8 Key Ideas and Details, Craft and Structure, Integration of Knowledge and Ideas, Range of Reading and Level of Text Complexity

Writing Benchmarks: Literacy in History/Social Studies, Science, and Technical Subjects Grades 6–8 Text Types and Purposes, Writing Process: Production and Distribution of Writing, Research to Build and Present Knowledge, Range of Writing

Mathematics
Grades 3–4
3.1.1.1; 3.1.1.5; 4.1.1.2

Science Grades 3, 4, 5, 7, and 8
Earth and Space Science
4.3.1.3.1; 4.3.2.3.1; 8.3.1.1.1; 8.3.1.1.3; 8.3.1.2.1; 8.3.1.2.2; 8.3.1.3.2; 8.3.1.3.3
Physical Science
8.2.1.1.2; 8.2.3.1.1
Nature of Science and Engineering
3.1.1.1.1; 3.1.3.2.2; 5.1.1.1.1; 5.3.1.2.1; 5.3.4.1.1; 7.1.3.4.1; 8.1.3.3.1; 8.1.3.4.1
Human Interactions with Earth Systems
8.3.4.1.2

Arts Grades K–12
1. Artistic Foundations: Visual Arts
2. Artistic Process: Create or Make: Visual Arts
3. Artistic Process: Perform or Present: Visual Arts
4. Artistic Process: Respond or Critique: Visual Arts

Current, complete Minnesota Academic Standards are at www.education.state.mn.us. Teachers who find other connections to standards are encouraged to contact *Minnesota Conservation Volunteer.*

Preview. (1) See www.abc.net.au/btn/story/s2685424.htm for a video you may use to introduce this topic. There is an inexpensive app for iPad at Kids Discover that will complement the video. (2) You may follow with a **KWL** (Ogle, 1986) activity. To find out what your students already know (**K**) about geology, divide the class into small groups to brainstorm their ideas. Give each student a copy of the organizer (see www.teach-nology.com/web_tools/graphic_org/kwl.) and encourage each to make notes during the group discussion. Repeat step one by asking

what students would like to learn, or what questions they have, about the topic (**W**). Record their questions on poster board for reference. As you read and discuss the article you will begin to compile the (**L**) lists, or what they learn while reading the article and related materials and participating in extension activities. KWL gives you the opportunity to introduce interdisciplinary connections you will make during extension activities. If you use the article in science, math, or art class, you may wish to focus your prereading activity on academic standards that apply for that class. (3) See www.teachervision.fen.com/tv/printables/TCR/0743932080_007.pdf for a brainstorming web download.

Vocabulary preview. See the copy-ready vocabulary list included in this guide. You may wish to modify the list based on your knowledge of your students' needs or the subject you are teaching. Pretesting vocabulary individually, in small groups, or with your entire class can be an effective vocabulary preview strategy. You may then post-test at the conclusion of this activity (see Assessment section below). Italicized words are not generally included on the list or in the study cards.

You may wish to use the study cards found at the end of this guide. Cut along the horizontal lines; fold in the middle, and tape or staple. Study cards (see *Strategic Tutoring*, Hock, Deshler, and Schumaker 2000) can be applied to any subject area. On one side of the card, in large letters, write a key word or phrase students are expected to know. In smaller letters, frame the word or phrase in a question or statement. On the other side of the card, in large letters, write the answer to the question. Finally, in smaller letters, frame the answer in a question or statement. Blanks are provided to allow you or your students to add new words or phrases.

Study questions overview. Study questions parallel the story (the answer to the first question appears first in the article, followed by the second, and so on). **Preview the questions with your class before you read the article.** You may wish to read the story aloud and complete the study questions in class, in small groups, or as an independent activity. The questions may be assigned as homework, depending on the reading ability of your students. Inclusion teachers may provide more direct support to special needs students (see Adaptations section). The study questions may be also used as a quiz. Note: Items with an asterisk require varying degrees of critical thinking.

Adaptations. Read aloud to special needs students. Abbreviate the study questions or highlight priority items to be completed first. If time allows, remaining items may be attempted. Peer helpers, paraprofessionals, or adult volunteers may lend a hand with the study questions. With close teacher supervision, cooperative groups can also offer effective support to special needs students, especially for extension activities.

Assessment: You may use all or part of the study guide, combined with vocabulary, as a quiz. Other assessment ideas include: (1) Ask students to describe what they learned about geology. See the "learned" list from your **KWL** activity. (2) Students may write multiple-choice, true-

false, or short-answer questions. Select the best items for a class quiz. (3) How many big ideas about geology are in this article? In small groups or as individuals, students may create posters that combine visual art, writing, and oral presentations. Posters may focus on one scientist, or compare and contrast two or all three. Posters and presentations are an excellent strategy for allowing students to demonstrate what they have learned.

Extension activities. Extensions are intended for individual students, small groups, or your entire class. Young Naturalists articles provide teachers many opportunities to make connections to related topics, to allow students to follow particular interests, or to focus on specific academic standards.

1. "Ask a Rock," Agate Hounds," and "Minnesota's Rocky Roots" are great companion pieces for "Explorers of the Underground" (see Related Articles). You may encourage students to include content from related articles in evaluation and/or other extension activities.
2. Your students can discover many other articles about geology in the *Minnesota Conservation Volunteer* archives. Teaching your students how to access archived stories will open a world of learning opportunities.
3. Why is mining metals such as nickel and copper in northern Minnesota so controversial? See Web Resources for links to content that will explore the pros and cons of this current debate.
4. Invite students to bring in interesting rocks for a classroom collection. As rocks come in, attempt to classify them by color, texture, and mineral content. See Web Resources for rock identification activities.
5. Take a field trip to your school forest, state park, or scientific and natural area. Contact a naturalist at the state park to plan a program for your class.

Web resources

DNR

www.dnr.state.mn.us/rocks_minerals/index.html
www.dnr.state.mn.us/lands_minerals/index.html
www.dnr.state.mn.us/lands_minerals/underground/mining_methods.html

Geology Videos

www.abc.net.au/btn/story/s2685424.htm
www.bing.com/videos (core sampling)
www.bing.com/videos (soil core sampling)
www.bing.com/videos (South Carolina DNR, core sampling and mapping)
www.bing.com/videos (Core sampling, New Zealand)

Activities

http://oceanexplorer.noaa.gov/edu/learning/player/lesson01/l1la1.htm
www.kidsgeo.com/geology-games/rocks-game.php
http://teachbesideme.com/identify-rocks-with-kids/

Copper and Nickel Mining in Minnesota

http://blogs.mprnews.org/todays-question/2013/12/is-copper-nickel-mining
https://www.minnpost.com/dc-dispatches/2014/07/will-coppernickel-mining
http://www.polymetmining.com/northmet-project/overview/
http://archive.kare11.com/news/extras/article/1046495/26/Copper-nickel-mining
http://www.miningminnesota.com/

Apps for Teachers

www.kidsdiscover.com/apps-for-kids/geology-ipad (see YouTube video for demo: https://www.youtube.com/watch?v=kMuvskmPjy4)

Minnesota DNR Teacher Resources

www.mndnr.gov/education/teachers/index.html
www.mndnr.gov/dnrkids/index.html

*Note: All websites were active at the time of this guide's publication. However, some may no longer be active when this guide is accessed.

Related articles

In addition to the related articles listed below, every *Minnesota Conservation Volunteer* article published since 1940 is now online in searchable PDF. See www.mndnr.gov/mcvmagazine. Young Naturalists articles and teachers guides are found at www.dnr.state.mn.us/mcvmagazine/young-naturalists.html.

March–April 2002
"Geological Wonders"
https://webapps8.dnr.state.mn.us/volunteer_index/past_issues/article_pdf?id=525

July–August 2005
"The Wonder of Water" (YN article with teachers guide)
http://files.dnr.state.mn.us/mcvmagazine/young_naturalists/young-naturalists-article/water/water.pdf
"Adventure Underground"
https://webapps8.dnr.state.mn.us/volunteer_index/past_issues/article_pdf?id=1954

March–April 2008
"Gauging Ground Water"
https://webapps8.dnr.state.mn.us/volunteer_index/past_issues/article_pdf?id=3379

"Drop into History"
https://webapps8.dnr.state.mn.us/volunteer_index/past_issues/article_pdf?id=3381

March–April 2010
"Let's Find Out" (YN article with teachers guide)
http://files.dnr.state.mn.us/mcvmagazine/young_naturalists/young-naturalists-article/find_out/find_out.pdf

July–August 2011
"Agate Hounds" (YN article with teachers guide)
http://files.dnr.state.mn.us/mcvmagazine/young_naturalists/young-naturalists-article/agate_hounds/agate_hounds.pdf

July–August 2012
"Digging Into the Promise of Copper"
https://webapps8.dnr.state.mn.us/volunteer_index/past_issues/article_pdf?id=7942

January–February 2013
"Ask a Rock" (YN article with teachers guide)
http://files.dnr.state.mn.us/mcvmagazine/young_naturalists/young-naturalists-article/rocks/rocks.pdf

References.

Hock, M.F., Deshler, D.D., and Schumaker, J.B. *Strategic Tutoring*. Lawrence, Kan.: Edge Enterprises, 2000.

Ogle, D.S. K-W-L Group Instructional Strategy. In A.S. Palincsar, D.S. Ogle, B.F. Jones, and E.G. Carr (Eds.), *Teaching Reading as Thinking: Teleconference Resource Guide*, pp. 11–17. Alexandria, Va.: Association for Supervision and Curriculum Development, 1986.

Study questions answer key.

1. What have fossils revealed about birds and dinosaurs? **Birds evolved from dinosaurs.**
2. Rocks along the shore of Lake Superior were once **molten lava.**
*3. Use the Venn diagram to compare and contrast the work of an archeologist with that of a geologist. **Answers will vary. Encourage students to focus on similarities as much as differences. For example, both are scientists who rely on keen observation of large and extremely small objects.**
4. What valuable material is Heather Arends looking for? **Gravel and sand**
*5. Why is it important to reclaim land after mining is finished? **Answers will vary. Encourage students to think beyond erosion prevention to how reclaimed land benefits the ecosystem.**

6. What is silica sand, and why is it valuable? **Silica sand is very hard and round, and is used in drilling for natural gas and oil.**
7. Why did Dave Dahl change his mind about his future career? **Dave enjoyed the outdoors. He liked the camping and traveling that geologists do.**
*8. Describe the photo on page 50. **Answers will vary. Encourage detail. What is Dave doing and why?**
9. GIS means **Geographic Information System.**
10. Geologists use GIS to make **digital maps for other geologists and land managers.**
11. What kind of maps helped geologists find the Cuyuna Iron Range? **Old maps, called historical maps, were used in the 1950s.**
12. What do drill cores tell scientists about Minnesota? **Drill cores tell scientists the geologic history of Minnesota and where to explore for valuable minerals.**
13. Explain how fishing line helps Mindy Erickson do her job. **She uses the fishing line and hook to retrieve equipment that accidently drops to the bottom of a well.**
14. What does a hydrologist study? **Hydrology is the study of water, both above and below ground.**
15. What is arsenic, and why should we pay attention to it? **Arsenic is a toxic chemical that can get into groundwater. Arsenic is tasteless and odorless, so people don't know it's in their drinking water. Arsenic can cause cancer.**
*16. What do art and science have in common? **Answers will vary. Both involve observation and creativity.**
**Challenge:* Match each item in Column A with its partner from Column B.
7 300,000 1. Number of counties in Minnesota
5 1,100,000,000 2. Acres of School Trust Land
6 500 million 3. Weight in pounds of a box of rocks
1 87 4. Age in years of oldest rocks in Minnesota
3 30 5. Number of years ago when North America almost split
8 1,800 million 6. Age of silica sand
4 3,600,000,000 7. Number of boxes of core samples
2 3.5 million 8. Number of years ago that a big meteor crashed
9 9,000,000 9. Weight of the rock collection

Minnesota comprehensive assessments answer key

1. Mindy Erickson works for **C. the United States Geological Survey.**
2. The DNR's rock library is located in **A. Hibbing.**
3. What is "one sentence in the book of Minnesota's history"? **B. A core sample of rock**
4. Heather Arends originally was interested in **C. archaeology**
5. What do the photos on page 44 tell you about this story? **Answers will vary. The photos foreshadow the topics of the story.**

Vocabulary answer key

arsenic poisonous metallic element that may contaminate groundwater

bedrock solid rock beneath soil or gravel

crust Earth's rocky outer layer

debris scattered fragments of something wrecked or destroyed

evolve to develop gradually from one form to another

fossil preserved remain or trace of a plant or animal that lived long ago

glaciers large, dense bodies of ice that form on land and move under their own weight

microscope instrument for viewing objects too small to be seen by the naked eye

lava volcanic rock liquefied by heat

sandstone sedimentary rock composed of sand-size grains of minerals or rocks

sediments particles of rock broken down by weathering or erosion and transported and deposited by wind, water, or glaciers

tectonic plates large slabs of solid rock that comprise Earth's crust and upper mantle