The CaSEbook Companion to "Inside the Restless Earth"

The 21st Century Center for Research and Development in Cognition and Science Education

This CaSEbook is designed to be a supplement to the "Inside the Restless Earth" unit of the Holt Science and Technology series. It has been developed as part of an experimental study in science education. Reproduction or dissemination of any materials in the CaSEbook Companion is strictly prohibited. The CaSEbook is intended for use in an experimental study being conducted by The 21st Century Center for Research and Development in Cognition and Science Education. More information on the center is available at http://www.cogscied.org/.

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Welcome

The 21st Century Center for Research and Development in Cognition and Science Instruction, the only one of its kind in the United States, was established with funding from the Institute for Education Sciences, a research arm of the United States Department of Education in July 2008. The main challenge for the Center is to incorporate cognitive science principles to existing middle school science curricula and measure the effectiveness of such modifications. Partnering in this endeavor with the Center is a team of cognitive scientists from the University of Pennsylvania, Temple University, and the University of Pittsburgh, who have created the materials in this binder.

If you have been given this binder, you are an integral part of this research study into "what really makes a difference for students learning science." Your faithful implementation of these modifications is critical to the research which will result in meaningful evidence of the effectiveness of the cognitive principles employed in the materials. Your experience using the materials in the classroom with your students and your feedback on their usage is the core of the work of the Center. We are grateful for your willingness to join us in this exciting endeavor. We hope you will find the opportunities to interact with these materials and with other teachers in your grade level to be both stimulating and satisfying. Thank you for joining the team.

The Center's main office is located in Conshohocken, Pa. For more information about the Center and its work, please visit our website at http://cogscied.org/.

How To Use This Binder

At the outset, we would like to thank our pilot teachers who contributed to the evolution of these materials. We have incorporated their thoughtful feedback about the organization of the materials to facilitate teacher use. We hope you find the binder user-friendly!

The first sections of the binder, the introductory materials, serve as an overview of the materials. After a brief description of the project in the Welcome, the remaining sections include a description of the Cognitive Science Principles employed in the modifications, the "Big Ideas" in the unit, Words Students Need to Learn, Table of Contents, and the Overview Calendar of "Inside the Restless Earth" materials.

The remainder of the binder is organized by chapter ordered by days. Each day has its own page listing the Big Idea, teacher and student materials needed, and activities of the day with suggested timing for them. This is followed by actual instructional materials for use on that day. Most days have a Warm-up, a powerpoint slide with follow-up questions in the notes section. They are designed to either review earlier work or to set the stage for that day's topic. This is followed by teacher notes that may include copies of the powerpoint slides for the Contrasting Cases along with teacher notes. Student worksheets for the Contrasting Cases are found in a separate section at the back of the Binder. Some days refer to the use of the Holt text. Teachers are encouraged to use the text in their normal fashion. Some days include copies of Visualization powerpoint slides. Visualizations are discussions about diagrams students encounter in the text. Again teacher notes are included with the powerpoint slides to guide the teacher in those discussions. Weekly quizzes are included with answer keys included on the day they are scheduled to be given. Student quiz masters are included in a separate file at the end of the Binder. Each section of a chapter ends with an End-of-Section Survey which lists the activities and provides space for comments. Teachers are encouraged to fill this Survey in as they go through the activities. These sheets will serve as the basis of discussion at the follow-up Professional Learning Community meetings that are scheduled during implementation.

Included with the Binder is a CD-Rom of powerpoint slides for the Contrasting Cases, the Visualization exercises, and Warm-ups. These are identified by chapter and day. Materials not provided in your Holt kit but required for doing the Contrasting Case activities such as the the rheoscopic fluid are also provided.

We hope you find the organization of the materials in the binder easy to use. As you use the materials, any feedback to improve the binder will be very much appreciated!

Cognitive Principles

The CaSE project approached the development of modifications using four areas of focus derived from current cognitive science research on student learning:

- Contrasting Cases
- Visualizations
- Prior Knowledge and Misconceptions
- Spaced Testing

Each of these draws on well-established principles of cognitive science and has been shown in previous studies to be effective in improving student learning in science.

Contrasting Cases

A typical way of teaching (in science, law, medicine, etc.) is through concrete examples or cases. Cognitive science research has found that some ways of using cases are much more effective for student learning than common practice in teaching with cases; these results can be very surprising to teachers (as they were to many researchers). One result is that asking students to compare across cases is much more effective than asking students to consider each case one at a time (Gentner, Loewenstein, & Thompson, 2003), with one study finding that a comparison between two cases leads to more learning than sequentially studying five cases. Case comparison helps students see the abstract ideas that are true across cases, rather than focus too much on what is specific to each case. This abstract understanding helps them transfer their knowledge to tests and other contexts (Gick & Holyoak, 1983).

Another interesting result relates to the timing of contrasting cases. In most textbooks, case comparison is usually placed as a homework task at the end of a unit of study, asking students to differentiate related ideas they have already learned about. Surprisingly, research has found that case comparison should be done before principles are introduced rather than as a form of practice (Bransford & Schwartz, 2001). The idea is that the case comparison helps students 'see' the critical features that are common across the cases. The students can then use these features to make sense of the principles and laws taught in a lecture, text, or experiment by relating the principles to the critical features they already know.

As a result, we have added contrasting cases early in the instruction of each chapter, to help students build a strong conceptual foundation to ground the instruction that happens later in the chapter. We have focused our choice of contrasting cases on the biggest ideas of each chapter. We have also tried to make the cases interestingly different so students can be surprised with the diversity of cases for which these ideas apply. You will also see that the tasks focus student attention on what is common across cases within a category, and on what is critically different across categories that need to be separated.

Visualizations

Students often fail to make the most of the images that they come across in educational settings. In some cases, they may skip images entirely while reading. When they do look at the images, they often lack the skills to fully appreciate them (Berthold & Renkl, 2009). For example, many teachers are surprised to find that students who are skilled in other ways are unable to follow the arrows, captions and labels in a complex diagram (Hegarty, Kriz, & Cate, 2003). When students do not understand these diagrams, they may come away with an inaccurate understanding of the content, and they might become more likely to skip diagrams entirely to avoid further frustration (Bartholomé & Bromme, 2009).

The visualization exercises are designed to address this problem in two ways. The first is to provide your students with explicit training in common elements of diagrams and other images. At the beginning of the unit, these exercises are very simple, focusing on identifying common elements of images and how to interpret them. As the unit progresses, the exercises build in complexity and become progressively more demanding.

The second thing these exercises are designed to do is promote better habits. Students will not only learn how to make sense of the difficult images they are often confronted with, they will also learn that they MUST make sense of these images. They will learn that once they start to pay close attention to them, the images will help them understand.

A hard copy of the exercises has been made available in your materials. In addition, for those teachers that have access to digital projectors, all of the exercises have been compiled in PowerPoint files. The exercises are usually quite short, generally requiring no more than five minutes to complete. Your daily schedule will give you an idea about when to conduct each exercise. Usually, the exercises are built around an image from the curriculum, and each exercise is intended to be conducted when you would naturally come to that image. We understand that classes have their own rhythm, and that running a classroom demands some room for discretion. For this reason we identify the best day for each exercise, but of course you should choose the best moment within that day. We also recognize that sometimes even more flexibility is required, so you may occasionally do an exercise on the day before, or the day after it is scheduled, but we strongly encourage you to try to do these exercises on the assigned day. It is also important to understand that these exercises should be done *in addition* to any instruction you would normally attach to a particular image. For example, if there is an exercise that focuses on the arrows within a diagram, this does not mean that you should pass up opportunities to explore other elements of the diagram, elaborate on the content addressed by the diagram, or anything else you would ordinarily do within the flow of your teaching.

We would like to make one final point. While developing these exercises, we often heard teachers predict that they would be "too easy," and that their students had already mastered these ideas, and might even feel put-off. Once they tried them, however, they were frequently surprised by the number of students who clearly needed this sort of instruction. Yes, some of your students will already be skilled with images, but many of them will not be, and for those who are not skilled, the problem runs quite deep.

Prior Knowledge and Misconceptions

Cognitive research shows that one of the strongest predictors of how well a student is likely to learn something is how the new learning is related to what the student already knows and to how their prior knowledge is organized (NRC, 1999, 2006). If the concepts to be learned and the way that they are organized match neatly with a learner's pre-existing knowledge base, then the learning is likely to be smooth and rapid. However, in science, students often lack relevant conceptual frameworks or have frameworks that are not developed enough to support new learning adequately. If students cannot relate new information to a meaningful framework, they will probably resort to memorizing terms that will quickly be forgotten or that will remain in isolation, unable to be connected to other knowledge or applied when relevant.

Science often extends everyday understanding to new levels that cannot be directly seen or experienced in everyday life. For example, much of biology and chemistry involves learning about entities and processes at a microscopic level. To make sense of this, students need to add new levels of concepts and explanatory systems to their understanding of the natural world and then work out how those levels are connected to their pre-existing views of the world (Smith et al. 1997). Several of the modifications in this unit are aimed at helping students develop new frameworks to help them take in scientific ideas that involve new levels of explanation.

Science also involves very large variations in scale. Evolution and some kinds of geological processes, for instance, happen over very, very long periods of time. Space is unimaginably vast. Cells, molecules, and atomic particles are inconceivably small. Learners must stretch their ability to think about large and small magnitudes that extend far beyond their everyday experience. A number of the modifications made throughout this unit, including many of the visualization activities, are designed to help students recognize when extreme scales are relevant and to develop tools for interpreting them in more meaningful ways.

One of the biggest challenges for teaching and learning arises when students have an entrenched misunderstanding that conflicts with the material to be learned. When a larger conceptual/explanatory system is in conflict with new learning, cognitive researchers often say that the student has a *misconception* (Carey, 1991, 2009; Chi, 1992). As cognitive scientists

use the term, a misconception is more than a common factual error or a mistaken belief. It's not just that a student is viewing an isolated concept in a different way; instead, a larger system of concepts and the causal or explanatory frameworks in which they are embedded actively conflict with the material to be learned.

In science, there are a number of misconceptions that are well-documented and very common. Many students, including college students who have successfully completed relevant science courses, have persistent misconceptions in some areas of science. These misconceptions seem intuitive and self-evident to them. In contrast, understanding the causal mechanisms of modern scientific theories is often less intuitive and requires developing more detailed and complex explanatory systems.

Misconceptions tend to be entrenched and automatic in students' thinking, and they are resistant to change. It's important to be aware of them to make sure that teaching and learning activities emphasize scientifically correct views and do not reinforce the misconceptions. However, it's also important to recognize that misconceptions are not easily changed: simply explaining to students that their ideas are incorrect is usually not effective. Countering misconceptions is generally a long, gradual process, in which a new causal/explanatory structure is constructed and applied repeatedly with the students at the same that the students' incorrect alternative way of looking at things is challenged.

The modifications made to the curriculum have been designed with these kinds of learning challenges in mind. The order of concept presentation differs somewhat from the sequence found within the Holt text. The modified materials start with Chapter 3 to help students begin to understand that geologic processes happen over very, very long periods of time. Similarly, the rock cycle is introduced at the end rather than the beginning of Chapter 2 to enable students to build understanding of each formation process before examining how they relate to one another. Places where common misconceptions are likely to arise are addressed in the teacher materials accompanying the modifications. Throughout the unit, the modifications are intended to make the "big ideas" in each chapter more accessible, meaningful, and coherent to middle school students.

Spaced Testing

A large frustration for teachers is how quickly students forget what they have been taught. Cognitive science research has shown that forgetting can be dramatically reduced by occasional revisiting of old concepts in later tests (Rohrer & Pashler, 2007). This practice is called spaced testing, where the test of a concept is spaced out over time rather than massed all in a short amount of time. The longer you want students to remember something, the more important it is to spread out the time between tests.

Another related result is the value of testing per se. Students and teachers often assume that simply re-reading or re-lecturing on prior materials is sufficient for improving retention of material. In addition, with the current high-stakes testing environment, many people feel that students are over-tested. Indeed, when done poorly, testing can have negative effects (e.g., reinforcing the wrong concepts or more superficial levels of understanding). However, cognitive science research has found that, when done well, testing does actually help students better remember material over-and-above spending the same amount of time just revisiting the material (Roediger & Karpicke, 2006). There is some suggestion that short answer questions help more than multiple choice, but both are helpful (McDaniel, Anderson, Derbish, & Morrisette, 2007).

In our modifications, you will see that we have a number of embedded assessments designed to provide timely feedback to you as the teacher and to help improve student learning. First, we have daily warm-up questions at the beginning of most lessons, which are meant to bring to mind prior concepts most relevant to the lesson of the day. Often these concepts are from the previous day, but sometimes they come from earlier weeks of instruction. We use short answer formats because no official grading is required and this format is best for learning. The provided slides include correct answers to support a brief in-class discussion after students have written out their attempts; this provides students with quick feedback on their answers and they can begin the lesson with a more solid foundation.

Second, we have end-of-section quizzes, which include some questions from prior chapters, further encouraging long-term retention of the concepts. Here we also encourage you to go over the quiz results with students the next day. We use multiple-choice to enable quick grading and looking at patterns across students.

Third, we have cumulative end-of-unit tests, which ask students to have a basic understanding of the big ideas from many weeks of instruction, providing a basis for improved retention many months later.

Finally, we have an end-of-year test which asks students to study for and bring back to mind content from earlier in the year, greatly increasing the chances that they will remember this information for years to come. End-of-unit and end-of-year tests will be distributed and graded by the project team at the appropriate times. The warm-up and end-of-section quizzes are provided to you with the other unit materials, so you can embed them in your ongoing instruction and use the results immediately to help reinforce and assess students' learning in progress.

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List of Big Ideas

days 1 & 2
- The world we live in gradually emerged over about 4.6 billion years.
- Humans have only existed for a tiny fraction of that time.

day 3
- The world we live in gradually emerged over about 4.6 billion years.
- The Grand Canyon only formed about 10 million years ago, but its rocks reveal geologic events that happened as many as 1.7 billion years ago.
- Earth's history is also recorded in fossils.

day 4
- Earth's history is divided into eons, eras, and periods based on major changes that occurred at those times.

day 6
- Both rocks and minerals are naturally formed solids.
- Minerals are elements or compounds.
- Rocks are mixtures that usually contain minerals.

day 7
- A mineral is a naturally formed, inorganic solid that has a definite crystalline structure.

day 8
- Properties like luster, streak, cleavage, and fracture can be used to identify minerals.

day 9
- Properties like hardness and density, and special properties like magnetism and radioactivity can be used to identify minerals.

day 11
- A mineral's properties are determined by how it forms and what it is made of.

day 12
- Reclamation reduces the harmful effects of mining by returning land to its original condition after mining is completed.

days 13 & 14
- There is heat and pressure inside the Earth, and they get more and more extreme the deeper you go.
- The Grand Canyon only formed about 10 million years ago, but its rocks reveal geologic events that happened as many as 1.7 billion years ago.
- Igneous rocks form when molten rock cools and hardens.
- Sedimentary rocks form when particles settle and get compacted and cemented together. (day 14 only)

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List of Big Ideas

day 16
- Igneous rocks form when molten rock cools and hardens.
- Magma forms when solid rock melts.

day 17
- Intrusive igneous rock forms beneath Earth's surface, where the temperature is hot and cooling is slow.
- Extrusive igneous rock forms at or near Earth's surface, where the temperature is cooler and cooling is fast.

day 20
- Sedimentary rocks form when particles settle and get compacted and cemented together.
- Sedimentary rocks form at or near Earth's surface.
- The particles that make up sedimentary rocks can be fragments of other rocks, minerals that are dissolved in water, or the remains of organisms.

day 21
- Sedimentary rock formations contain layers, or strata, which form through a process called stratification.

day 22
- When particles settle, the heaviest particles tend to settle first, and the lightest particles tend to settle last.

day 23
- Metamorphic rocks form when an existing rock changes because of heat and/or pressure.
- Metamorphic rocks form deep beneath Earth's surface, where heat and pressure get more and more extreme the deeper you go.

day 24
- Igneous rocks form when molten rock cools and hardens.
- Sedimentary rocks form when particles settle and get compacted and cemented together.
- Metamorphic rocks form when an existing rock changes because of heat and/or pressure.
- Weathering is when rocks break apart to form small pieces or bits.
- Erosion is when something like water or wind picks up loose bits of rock.
- Transport is when the water or wind carries the bits of rock to another place.
- Deposition is when the water or wind slows down and the loose bits settle.
- The rock cycle is a series of processes that cause rocks to change from one type to another.
- Depending on what happens to it, any type of rock can change into any other type of rock.

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List of Big Ideas

day 26
- Metamorphic rocks form when an existing rock changes because of heat and/or pressure.
- When metamorphic rocks are forming, increased pressure can prevent them from melting.

day 27
- Metamorphic rocks form when an existing rock changes because of heat and/or pressure.
- Sometimes heat and pressure will cause the minerals in a rock to combine and form new minerals.

day 28
- Deformation is a change in shape that happens when heat and pressure cause a rock formation to fold, bend, or twist.

day 29
- When a rock is changing because of pressure, its grains tend to line up with each other.

day 31
- Weathering is when rocks break apart to form small pieces or bits.
- Erosion is when something like water or wind picks up loose bits of rock.
- Transport is when the water or wind carries the bits of rock to another place.
- Deposition is when the water or wind slows down and the loose bits settle.
- Uplift is when movements inside the Earth push rocks to the surface.
- The rock cycle is a series of processes that cause rocks to change from one type to another.
- Depending on what happens to it, any type of rock can change into any other type of rock.

day 32
- The rock cycle is a series of processes that cause rocks to change from one type to another.
- Depending on what happens to it, any type of rock can change into any other type of rock.

day 33
- Rocks can be classified by composition, which is the minerals and other materials that make up a rock.
- Rocks can also be classified by texture, which is the size, shape, and arrangement of the grains that make up a rock.

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List of Big Ideas

day 36
- Based on composition, the Earth has three layers – crust, mantle, and core.
- The core is the densest layer, and the crust is least dense.

day 37
- Based on physical properties, the Earth has five layers – lithosphere, asthenosphere, mesosphere, outer core, and inner core.

day 38
- The lithosphere is the rigidly solid outer layer of the Earth that consists of the crust and upper mantle.
- The lithosphere is divided into pieces called tectonic plates.

day 39
- Continental drift is the hypothesis that the continents once formed a single land mass, and they broke apart and drifted to their present locations.
- Sea-floor spreading is when new oceanic crust forms as tectonic plates move apart and magma rises and solidifies.

day 41
- When part of a fluid is warm and part is cool, the warm part rises and the cool part sinks.
- This results in a motion cycle called a convection current.

days 42 & 43
- Convection currents in the mantle cause tectonic plates to move.
- Divergent motion is when plates move apart, and convergent motion is when they move toward each other.
- Divergent boundaries form when plates move apart, and convergent boundaries form when they move toward each other.

day 44
- Based on physical properties, the Earth has five layers – lithosphere, asthenosphere, mesosphere, outer core, and inner core.
- The lithosphere is the rigidly solid outer layer of the Earth that consists of the crust and upper mantle.
- Convection currents in the mantle cause tectonic plates to move.
- Tectonic plates move very slowly, no more than a few centimeters per year.

days 45 & 46
- The movements of tectonic plates can cause rock layers to bend or break.
- When a rock layer breaks and forms two blocks of rock that grind past each other, the surface where they meet is called a fault.

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List of Big Ideas

day 49
- Many earthquakes and volcanoes are caused by the movements of tectonic plates.

day 50
- Most earthquakes happen near the edges of tectonic plates because the moving plates grind against each other.
- Grinding plates can cause rock to change shape and, when it bounces back to its original shape, energy is released that causes an earthquake.

day 51
- Earthquakes release energy in seismic waves that travel away from the epicenter in all directions.

day 52
- A volcano is an opening that allows magma and gases to flow out onto Earth's surface.

day 53
- Magma that contains a lot of water or silicon tends to cause explosive eruptions.

day 54
- Magma erupts as either lava (liquid) or pyroclastic material (solid).
- Pyroclastic material can range in size from huge boulders to tiny particles of volcanic ash.

day 56
- Eruptions release large amounts of ash and gases that can block sunlight and cause global temperatures to drop.

day 57
- Eruptions can cause drastic changes in Earth's surface.

day 58
- Magma often forms near the edges of tectonic plates, where pressure decreases enough to lower rock's melting point to its current temperature.
- Once formed, magma rises toward the surface because it is less dense than the surrounding rock.

day 59
- Mid-ocean ridges form at divergent boundaries.
- When ocean crust sinks at convergent boundaries, it releases water that mixes with the surrounding rock and lowers its melting point.

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Words Students Need to Learn

Inside the Restless Earth contains some important terms that students need to learn. These words and their meanings are listed in the table below. The first two columns show when and where each word is introduced. If the word is introduced during a contrasting case activity, the number indicates the slide on which it is defined, usually in the notes section. Otherwise, the number refers to a page in the textbook (T).

This table is not intended to be distributed to students. Research shows that it is not effective to simply give students a list of words and definitions to memorize. Rather, it is important to introduce each word carefully, making sure students understand the meaning and can describe it in their own words.

Feel free to revise each definition to include words and ideas that are familiar to your students. Whenever appropriate, subsequent slides ask students to review these words and their meanings, and we encourage you to look for additional opportunities to do so. It is particularly effective to get students to talk about closely related concepts and identify similarities and differences between them.

day	slide or page	word	meaning
4	T-82	geologic time scale	a diagram of Earth's history that is divided into parts (eons, eras, and periods) based on major changes that occurred at those times
4	T-83	extinction	the death of every member of a species
6	9	rock	a naturally formed solid that contains one or more minerals or other Earth materials; rocks are mixtures
6	9	mineral	a naturally formed, inorganic solid with a crystalline structure; minerals are elements or compounds
7	T-5	native element	a mineral that is composed of only one element
7	T-6	silicate minerals	minerals that contain both silicon and oxygen; usually contain other elements as well; most of Earth's crust is made of silicate minerals
8	T-8	luster	how the surface of a mineral reflects light
8	T-9	streak	the color of a mineral in powdered form
9	T-10	hardness	a measure of the ability of a mineral to resist scratching
9	T-10	density	heaviness-for-size; the ratio of mass to volume; a characteristic property of a material; does not change with sample size
14	2	compacting	to squeeze something into a smaller space
14	2	cementing agent	a chemical that glues stuff together

day	slide or page	word	meaning
14	8	fossil	a remnant or trace of an organism that is embedded and preserved in a rock
16	T-36	magma	hot, liquid rock that forms when the minerals that make up a rock change from solid to liquid
17	T-38	intrusive	igneous rock that forms beneath Earth's surface, where the temperature is very warm and cooling is slow
17	T-39	extrusive	igneous rock that forms at or near Earth's surface, where the temperature is cooler and cooling is fast
24	12	rock cycle	a series of processes that causes rocks to change from one type to another
33	T-33	composition	the minerals and other materials that make up a rock
33	T-34	texture	the size, shape, and arrangement of the grains that make up a rock
37	T-99	lithosphere	the rigidly solid outer layer of the Earth that consists of the crust and the outer edge of the mantle
38	T-100	tectonic plate	one of the pieces into which the lithosphere is divided
41	7	convection current	the circular motion that happens when part of a fluid is warmer than the rest
42	5	divergent	the motion or type of boundary that results when convection currents in the mantle push tectonic plates away from each other
42	5	convergent	the motion or type of boundary that results when convection currents in the mantle push tectonic plates toward each other
45	T-114	fault	a crack in Earth's surface in which two blocks of rock grind past each other
52	T-156	volcano	an opening that allows magma and gases to flow out onto Earth's surface
53	T-158	magma chamber	an underground pool of molten rock that feeds a volcano
54	T-159	pyroclastic material	a solid material that forms when magma shoots into the air and hardens or when solid rock shatters because of an explosive eruption

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warm-up 6	warm-up 7	warm-up 8	warm-up 9	quiz 2
day 6 Compare Rocks & Minerals (cc 1.1)	day 7 vis 1.1a - e What is a Mineral? (1.1 – pp. 4-7)	day 8 vis 1.2a, b Identifying Minerals (1.2 – pp. 8-9)	day 9 vis 1.2c More Properties of Minerals (1.2 – pp. 10-11)	day 10 reteach based on quiz 2
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day 11 vis 1.3a Mineral Formation (1.3 – pp. 12-13)	day 12 vis 1.3b, c Mining & Use of Minerals (1.3 – pp. 14-17)	day 13 Trilobite Hunter (cc 2.2, part a, ign)	day 14 Compare Formation (cc 2.2, part b, sed)	day 15 reteach based on quiz 3
warm-up 16	warm-up 17	warm-up 18	quiz 4	warm-up 20
day 16 vis 2.2a, b Origins of Igneous Rock (2.2 – pp. 36-37)	day 17 vis 2.2c Igneous Rock Formations (2.2 – pp. 38-39)	day 18 comprehensive review	day 19 quiz 4 = 40 minutes	day 20 vis 2.3a, b Sedimentary Rock (2.3 – pp. 40-42)
warm-up 21	warm-up 22	warm-up 23	warm-up 24	quiz 5
day 21 vis 2.3c Stratification (2.3 – page 43)	day 22 Let's Get Sedimental (lab, pp. 50-51)	day 23 Compare Formation 2 (cc 2.4, part a)	day 24 The Rock Cycle (cc 2.4, part b)	day 25 reteach based on quiz 5
warm-up 26	warm-up 27	warm-up 28	warm-up 29	quiz 6
day 26 vis 2.4a Origins of Meta-morphic Rock (2.4 – pp. 44-45)	day 27 vis 2.4b, c, d Metamorphic Properties (2.4 – pp. 46-47)	day 28 Metamorphic Structures (2.4 – pp. 48-49)	day 29 Metamorphic Mash (lab, page 185)	day 30 reteach based on quiz 6

Overview of Restless Earth (days 31-60)

warm-up 31	warm-up 32	warm-up 33	warm-up 34	quiz 7
day 31 Earth Processes (2.1 – pp. 28-29)	day 32 vis 2.1a, b Compare Rock Cycle Diagrams (2.1 – pp. 30-32)	day 33 vis 2.1c Rock Classification (2.1 – pp. 33-34)	day 34 comprehensive review	day 35 quiz 7 = 40 minutes
warm-up 36	**warm-up 37**	**warm-up 38**	**warm-up 39**	**quiz 8**
day 36 vis 4.1a, b Composition of the Earth (4.1 – pp. 96-97)	day 37 vis 4.1c Structure of the Earth (4.1–98-99;102)	day 38 vis 4.1d Tectonic Plates (4.1–pp.100-01)	day 39 vis 4.2a, b, c Restless Continents (4.2–pp.104-07)	day 40 reteach based on quiz 8
warm-up 41	**warm-up 42**	**warm-up 43**	**warm-up 44**	**warm-up 45**
day 41 Compare Convection Models (cc 4.3a)	day 42 Compare Plate Motion (cc 4.3b)	day 43 vis 4.3a Tectonic Plate Boundaries (4.3–pp.108-109)	day 44 vis 4.3b Tectonic Plate Motion (4.3–pp.110-111)	day 45 vis 4.4a, b, c, d Deforming Earth's Crust (4.4–pp.112-119)
warm-up 46	**warm-up 47**	**quiz 9**	**warm-up 49**	**warm-up 50**
day 46 Oh, the Pressure! (lab, pp.186-188)	day 47 comprehensive review	day 48 quiz 9 = 40 minutes	day 49 Compare Major Events (cc 5.1)	day 50 vis 5.1a, b Origins of Earthquakes (5.1–pp.130-133)
warm-up 51	**warm-up 52**	**warm-up 53**	**warm-up 54**	**quiz 10**
day 51 vis 5.1c Seismic Waves (5.1–pp.134-135)	day 52 vis 6.1a Types of Eruptions (6.1–pp.156-157)	day 53 vis 6.1b Magma (6.1 – p.158)	day 54 vis 6.1c What Erupts? (6.1–pp.159-161)	day 55 reteach based on quiz 10
warm-up 56	**warm-up 57**	**warm-up 58**	**warm-up 59**	**quiz 11**
day 56 Volcanoes & Climate Change (6.2 – p.162)	day 57 vis 6.2a, b Types of Volcanoes (6.2–pp.163-165)	day 58 vis 6.3a, b Causes of Eruptions (6.3–pp.166-167)	day 59 vis 6.3c Tectonic Plates & Volcanoes (6.3–pp.168-171)	day 60 reteach based on quiz 11

DAY 1

Compare Time Scales, Part 1

This lesson is the first half of contrasting case activity 3.5, in which students compare two different kinds of diagrams that depict the Earth's history.

Big Ideas

- The world we live in gradually emerged over about 4.6 billion years.
- Humans have only existed for a tiny fraction of that time.

Materials

Teacher:

1. slides – day01.ppt

Students:

1. table & timeline – worksheets 1 & 2
2. numeric comparison table – worksheet 5

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
35 minutes – cc activity – compare time scales, part 1

Warm-Up Activity

These activities are usually designed to assess and reinforce student understanding of one or more big ideas from a recent lesson. Some warm-ups will ask about an idea from earlier in the unit, particularly when the idea is important to that day's lesson. Today's warm-up is different. Its purpose is to elicit students' initial ideas about the ages of Earth and the human race.

Each warm-up is displayed on a separate slide, so it can be displayed as students enter the room. On each slide, only the questions are displayed initially. The answers will appear on mouse click or keypress. The notes contain follow-up questions you can ask when you go over the warm-up with your students. The slide and notes for Day 1 are on the next page.

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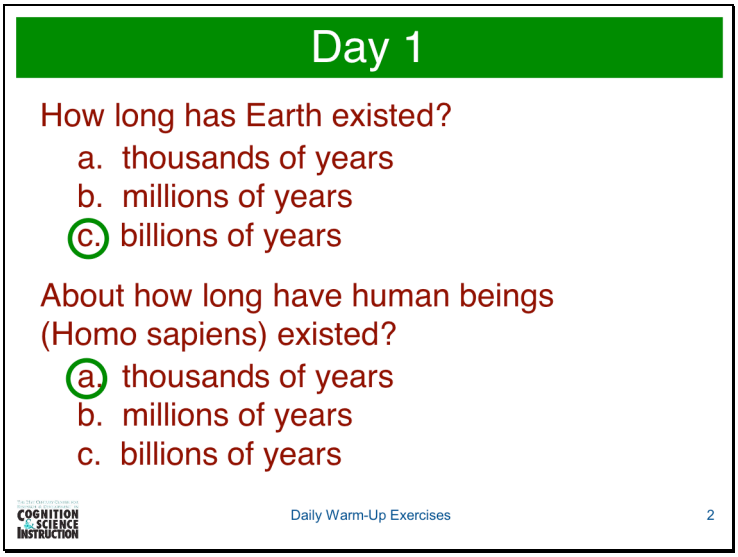
Day 1 – Compare Time Scales, Part 1

Warm-Up Activity



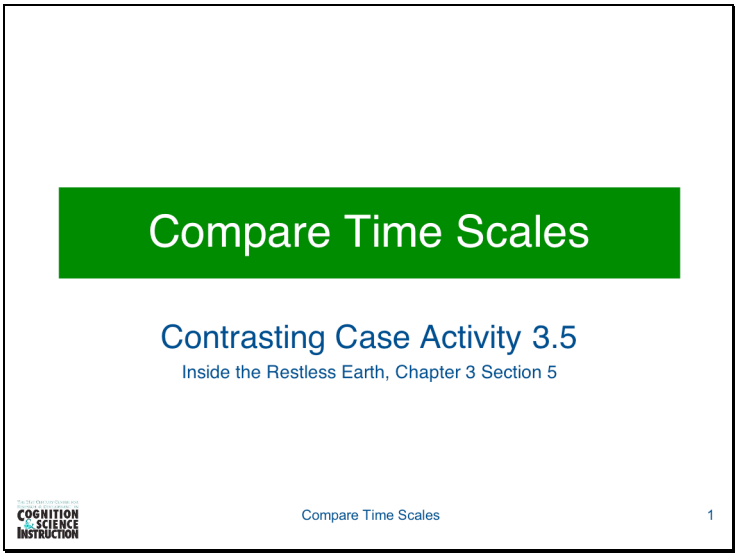
Tell your students that they are not expected to know the answers to these questions. The purpose is to elicit their initial ideas. The circles will appear on keypress, but you might want to wait until the end of the lesson to reveal the answers.

Compare Time Scales, part 1

Two things make geological time scales hard for students to understand. First, students are used to historical time lines, which tend to start at the beginning and move forward. But geological time scales usually start with the present and move backward into the past. Second, they involve extremely long periods of time and very large numbers. The numeric scales (table and timeline) will help students begin to get used to working with large numbers and starting with the present and moving backward into the past. The proportional scales (clock and football field) will help them interpret the large numbers. Together, the two sets of time scales will help students begin to understand that the world we live in gradually emerged over a very long period of time, and that humans have only existed for a tiny fraction of that time.

Day 1 – Compare Time Scales, Part 1

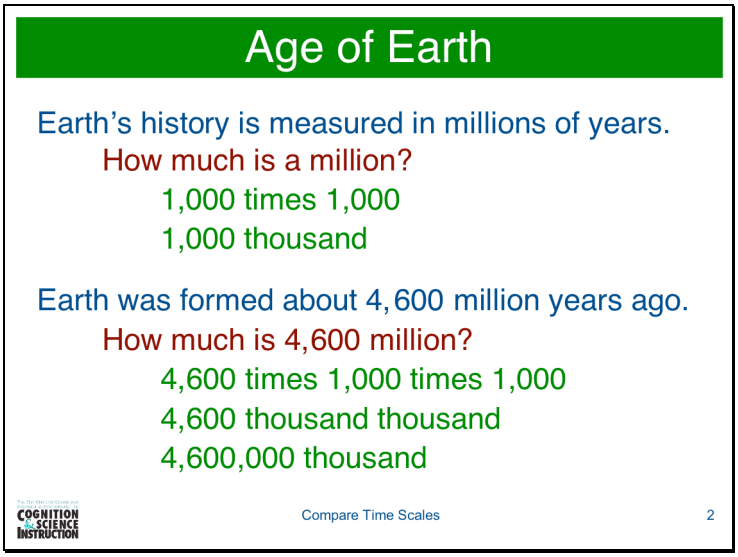
Compare Time Scales, part 1 (cont.)
Students compare the numeric scales in part 1 and the proportional scales in part 2. If your students finish part 1 before the end of the class period, have them get started on part 2 (described under Day 2).



Materials needed:
- table & timeline (worksheets 1 & 2)
- numeric comparison table (worksheet 5)

Day 1 – Compare Time Scales, Part 1

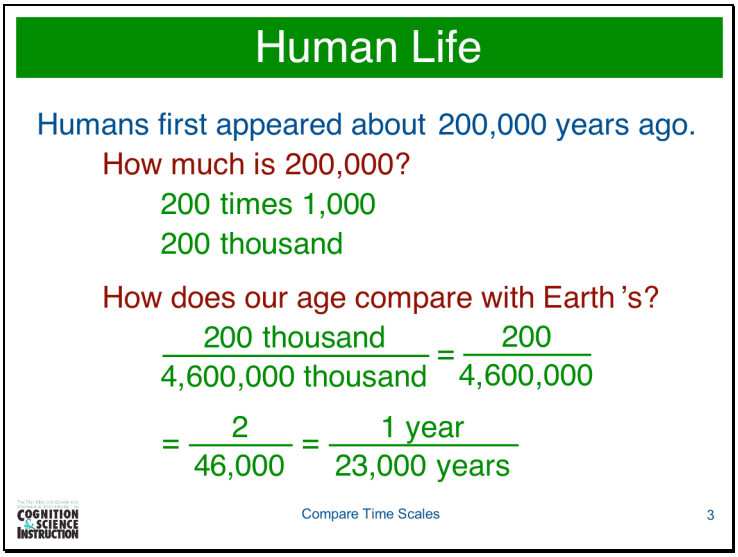
Compare Time Scales, part 1 (cont.)



The purpose of this slide is to help students begin to comprehend the very large numbers involved in geologic time scales.

Day 1 – Compare Time Scales, Part 1

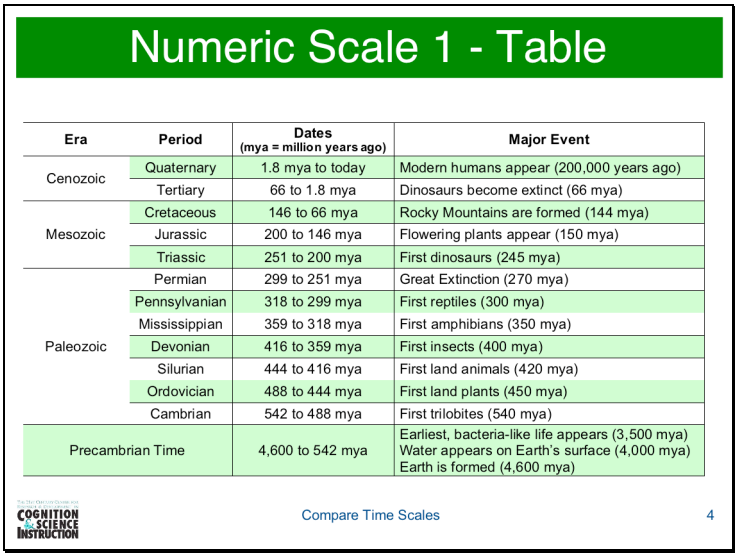
Compare Time Scales, part 1 (cont.)



This slide may help students begin to understand how old Earth is and how young the human race is by comparison. When you reduce the fraction comparing our age to Earth's, you see that, for every year that humans have existed, Earth has existed for over twenty thousand years.

Day 1 – Compare Time Scales, Part 1

Compare Time Scales, part 1 (cont.)



Numeric Scale 1 - Table

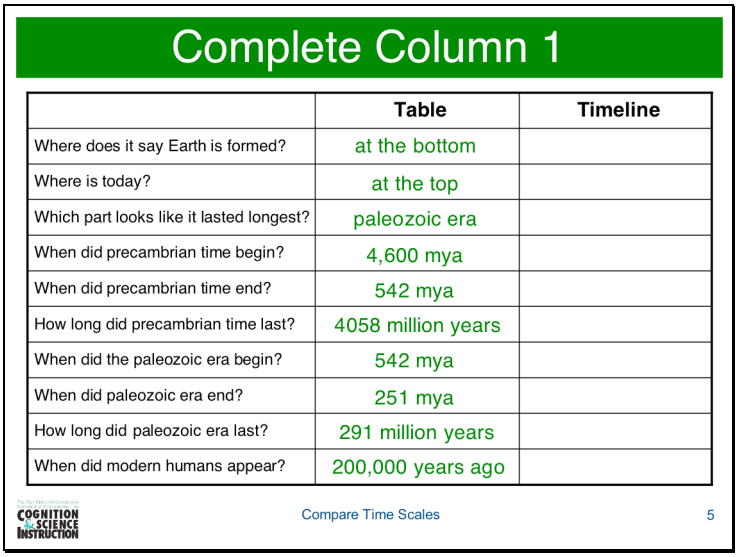
Era	Period	Dates (mya = million years ago)	Major Event
Cenozoic	Quaternary	1.8 mya to today	Modern humans appear (200,000 years ago)
	Tertiary	66 to 1.8 mya	Dinosaurs become extinct (66 mya)
Mesozoic	Cretaceous	146 to 66 mya	Rocky Mountains are formed (144 mya)
	Jurassic	200 to 146 mya	Flowering plants appear (150 mya)
	Triassic	251 to 200 mya	First dinosaurs (245 mya)
Paleozoic	Permian	299 to 251 mya	Great Extinction (270 mya)
	Pennsylvanian	318 to 299 mya	First reptiles (300 mya)
	Mississippian	359 to 318 mya	First amphibians (350 mya)
	Devonian	416 to 359 mya	First insects (400 mya)
	Silurian	444 to 416 mya	First land animals (420 mya)
	Ordovician	488 to 444 mya	First land plants (450 mya)
	Cambrian	542 to 488 mya	First trilobites (540 mya)
Precambrian Time		4,600 to 542 mya	Earliest, bacteria-like life appears (3,500 mya) Water appears on Earth's surface (4,000 mya) Earth is formed (4,600 mya)

Distribute the table and timeline (worksheets 1 & 2). As you do this, reassure students that they will not be required to memorize all the information in these diagrams. Much of it will become familiar as they move through this section, but they won't be expected to know the names, dates, and major events of all the eras and periods.

Ask students to look at the table and explain the note at the top of the Dates column. The note says MYA stands for million years ago. Help your students understand that all the numbers in this table show how many millions of years ago something happened. [The numbers match the numbers used in the textbook. Geologists have since adjusted many of the period dates. You can find current information at: http://geosociety.org/science/timescale]

Day 1 – Compare Time Scales, Part 1

Compare Time Scales, part 1 (cont.)

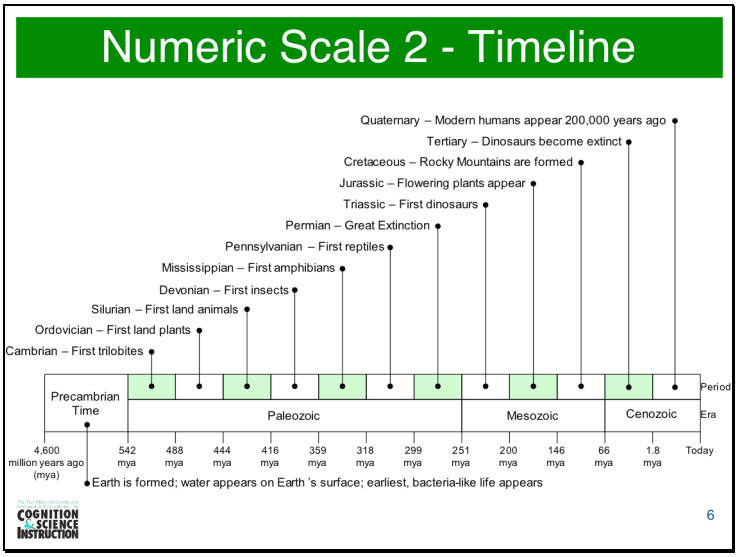


Distribute the numeric comparison table (worksheet 5) and have students work in pairs to complete the first column. [The questions in the first column are shortened. See the student worksheets for the complete questions.]

Answers will appear one-by-one on keypress.

Day 1 – Compare Time Scales, Part 1

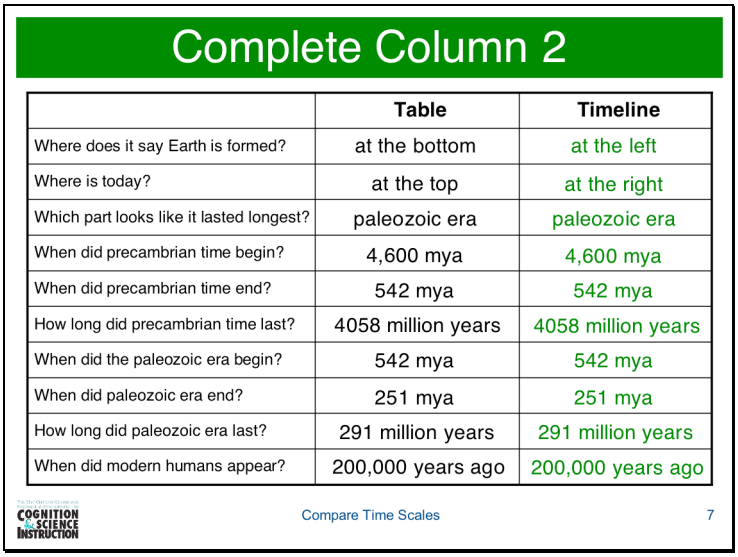
Compare Time Scales, part 1 (cont.)



Ask students to examine the timeline. Ask someone to explain what mya means, then have them complete the second column of the comparison table.

Day 1 – Compare Time Scales, Part 1

Compare Time Scales, part 1 (cont.)



Complete Column 2

	Table	Timeline
Where does it say Earth is formed?	at the bottom	at the left
Where is today?	at the top	at the right
Which part looks like it lasted longest?	paleozoic era	paleozoic era
When did precambrian time begin?	4,600 mya	4,600 mya
When did precambrian time end?	542 mya	542 mya
How long did precambrian time last?	4058 million years	4058 million years
When did the paleozoic era begin?	542 mya	542 mya
When did paleozoic era end?	251 mya	251 mya
How long did paleozoic era last?	291 million years	291 million years
When did modern humans appear?	200,000 years ago	200,000 years ago

Answers will appear on keypress.

Day 1 – Compare Time Scales, Part 1

Worksheet 1

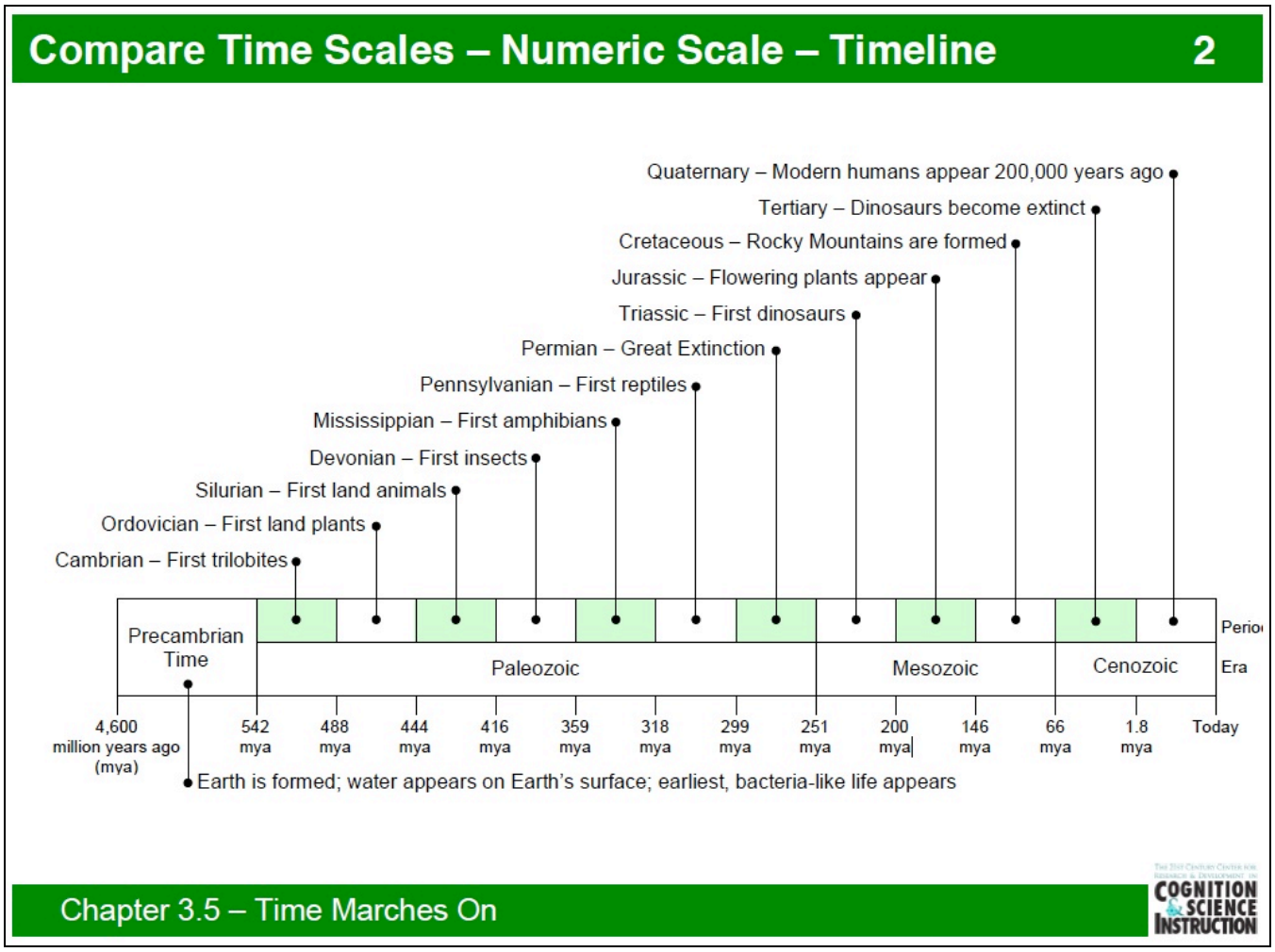
Compare Time Scales – Numeric Scale – Table 1

Era	Period	Dates (mya = million years ago)	Major Event
Cenozoic	Quaternary	1.8 mya to today	Modern humans appear (200,000 years ago)
	Tertiary	66 to 1.8 mya	Dinosaurs become extinct (66 mya)
Mesozoic	Cretaceous	146 to 66 mya	Rocky Mountains are formed (144 mya)
	Jurassic	200 to 146 mya	Flowering plants appear (150 mya)
	Triassic	251 to 200 mya	First dinosaurs (245 mya)
Paleozoic	Permian	299 to 251 mya	Great Extinction (270 mya)
	Pennsylvanian	318 to 299 mya	First reptiles (300 mya)
	Mississippian	359 to 318 mya	First amphibians (350 mya)
	Devonian	416 to 359 mya	First insects (400 mya)
	Silurian	444 to 416 mya	First land animals (420 mya)
	Ordovician	488 to 444 mya	First land plants (450 mya)
	Cambrian	542 to 488 mya	First trilobites (540 mya)
Precambrian Time		4,600 to 542 mya	Earliest, bacteria-like life appears (3,500 mya) Water appears on Earth's surface (4,000 mya) Earth is formed (4,600 mya)

Chapter 3.5 – Time Marches On

Day 1 – Compare Time Scales, Part 1

Worksheet 2



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Day 1 – Compare Time Scales, Part 1

Worksheet 5

Compare Numeric Time Scales

	Table	Timeline
Where in the diagram does it say Earth is formed?		
Where in the diagram is today?		
Look at the three eras and precambrian time. At first glance, which looks like it lasted longest?		
When did precambrian time begin?		
When did precambrian time end?		
How long did precambrian time last?		
When did the paleozoic era begin?		
When did the paleozoic era end?		
How long did the paleozoic era last?		
When did modern humans appear?		

Chapter 3.5 – Time Marches On

DAY 2

Compare Time Scales, Part 2

This lesson is the second half of contrasting case activity 3.5, in which students compare two different kinds of diagrams that depict the Earth's history.

Big Ideas

- The world we live in gradually emerged over about 4.6 billion years.
- Humans have only existed for a tiny fraction of that time.

Materials

Teacher:

1. slides – day02.ppt

Students:

1. clock & football field – worksheets 3 & 4
2. proportional comparison table – worksheet 6

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
35 minutes – cc activity – compare time scales, part 2

Compare Time Scales, part 2

Students compared two numeric time scales in part 1. In today's lesson, they compare two proportional scales. The first portrays Earth's history as a 24-hour day. The second portrays it as a 100-yard football field. The comparison of the clock and field diagrams is followed by a class discussion of differences between numeric and proportional scales. If your students finish the discussion before the end of the class period, start section 3.5 of the textbook (see Day 3).

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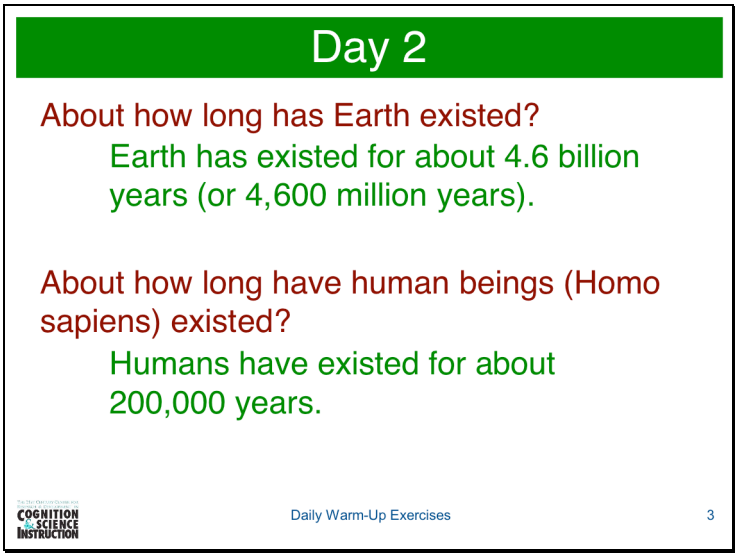
Day 2 – Compare Time Scales, Part 2

Warm-Up Activity



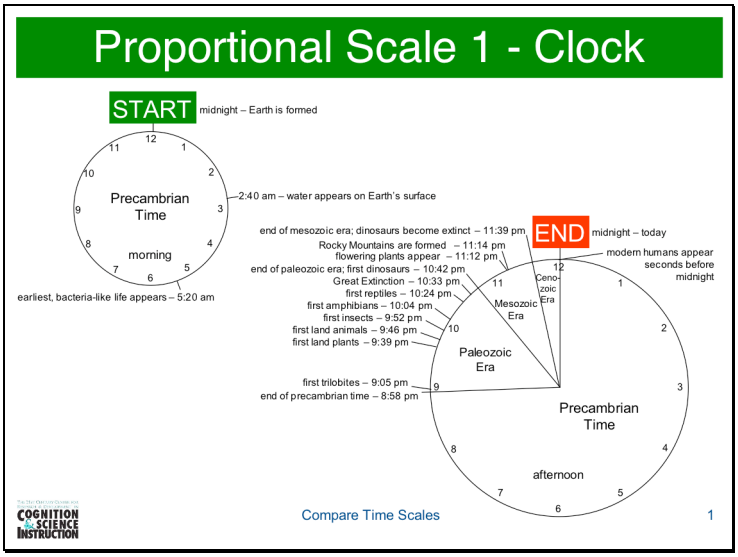
How much is a million?
1000 times 1000

How much is 4.6 billion?
4.6 times 1000 times 1000 times 1000
4,600 times 1000 times 1000
4,600,000 times 1000

How much is 200,000?
200 times 1000

Day 2 – Compare Time Scales, Part 2

Compare Time Scales, part 2 (cont.)



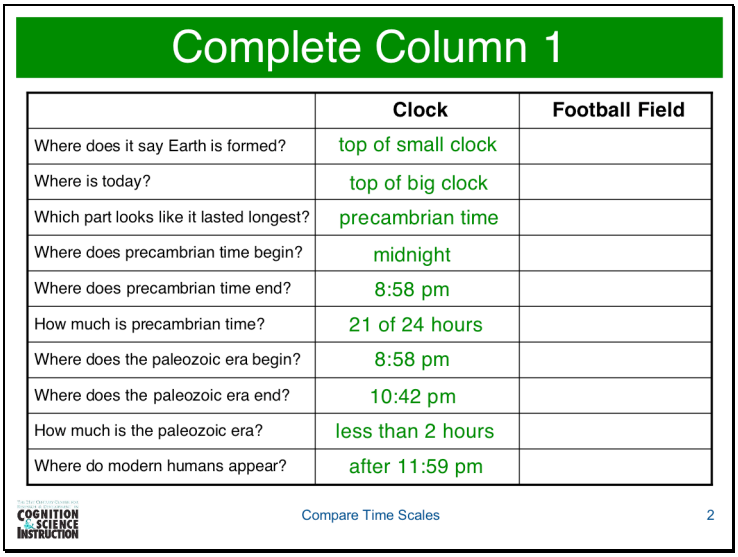
Distribute the clock and football field (worksheets 3 & 4). You may need to help students understand the clock diagram. The diagram represents one 24-hour day. It starts at midnight and ends the following midnight. The small clock shows the first half of Earth's history, and the large clock shows the second.

If students need more help with the diagram, have them find the time they usually get up in the morning, the time they usually leave for school, the time they usually eat lunch, the time they usually get home, and so forth. Once they understand the diagram as it relates to a typical day in their own lives, have them relate Earth's history to that same typical day. Some teachers have students color all of precambrian time the same color.

Distribute the proportional comparison table (worksheet 6), and have students complete the first column.

Day 2 – Compare Time Scales, Part 2

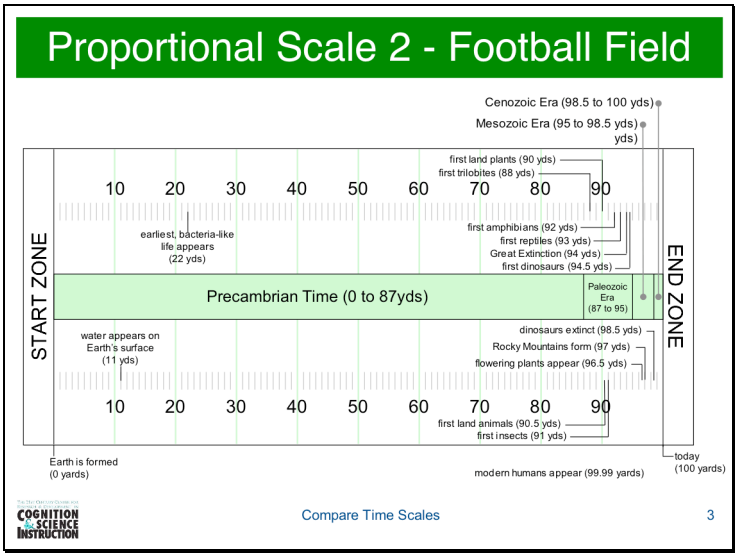
Compare Time Scales, part 2 (cont.)



Answers will appear on keypress.

Day 2 – Compare Time Scales, Part 2

Compare Time Scales, part 2 (cont.)

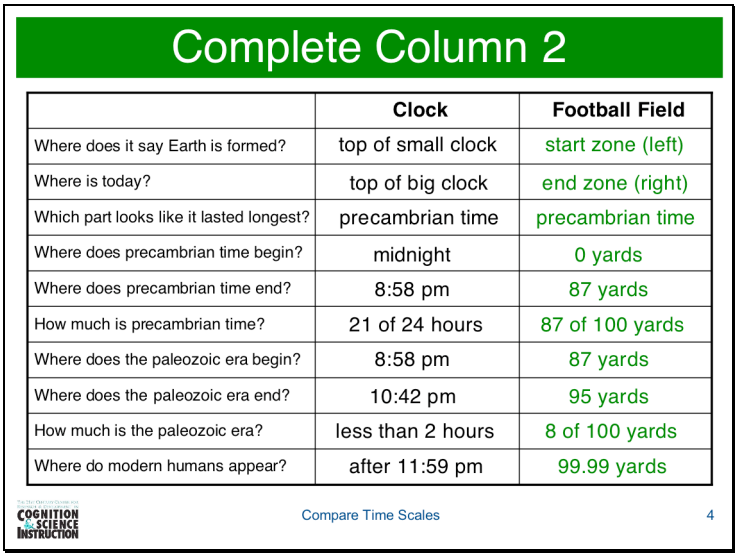


Have students examine the football field. Use questions to elicit the idea that both of these scales show that Precambrian time makes up a huge part of Earth's history. In comparison, the Cenozoic era's part is small, and human history's is miniscule.

Have students complete the second column of the comparison table.

Day 2 – Compare Time Scales, Part 2

Compare Time Scales, part 2 (cont.)



Complete Column 2

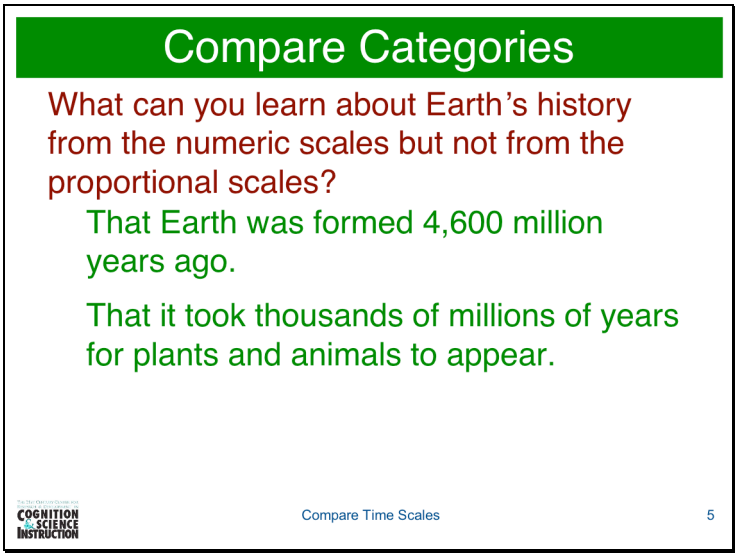
	Clock	Football Field
Where does it say Earth is formed?	top of small clock	start zone (left)
Where is today?	top of big clock	end zone (right)
Which part looks like it lasted longest?	precambrian time	precambrian time
Where does precambrian time begin?	midnight	0 yards
Where does precambrian time end?	8:58 pm	87 yards
How much is precambrian time?	21 of 24 hours	87 of 100 yards
Where does the paleozoic era begin?	8:58 pm	87 yards
Where does the paleozoic era end?	10:42 pm	95 yards
How much is the paleozoic era?	less than 2 hours	8 of 100 yards
Where do modern humans appear?	after 11:59 pm	99.99 yards

Compare Time Scales 4

Answers will appear on keypress.

Day 2 – Compare Time Scales, Part 2

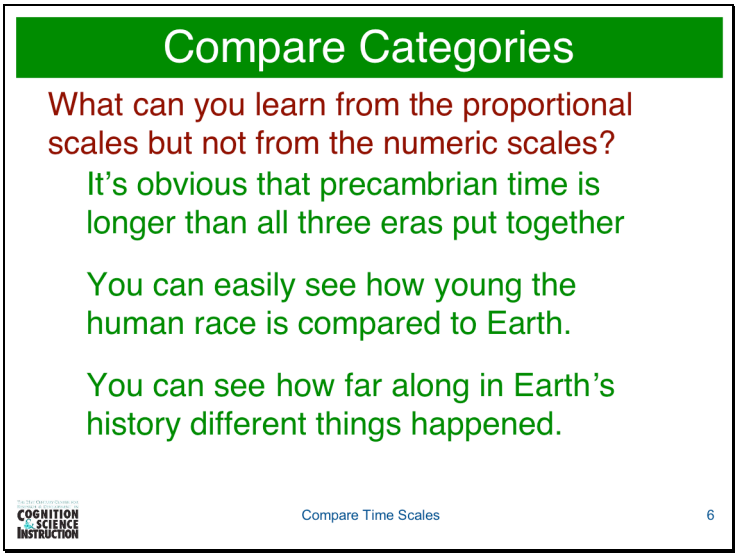
Compare Time Scales, part 2 (cont.)



Because they use numbers, numeric scales can show how many years ago things happened, and you can figure out how long things lasted or how long they took.

Day 2 – Compare Time Scales, Part 2

Compare Time Scales, part 2 (cont.)



Tell your students that a proportion involves relating a part to the whole. Proportional scales make it easy to see how things compare. With the numeric scales, you can subtract and compare numbers, but it's difficult to see how everything fits together.

Day 2 – Compare Time Scales, Part 2

Compare Time Scales, part 2 (cont.)

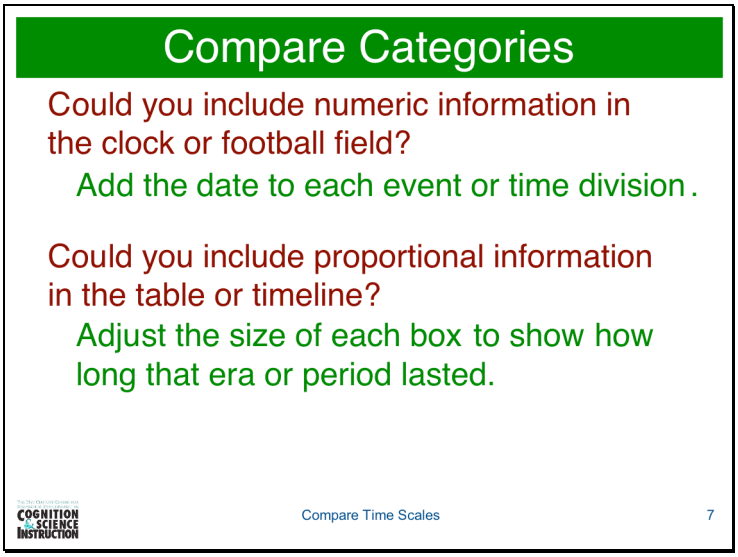
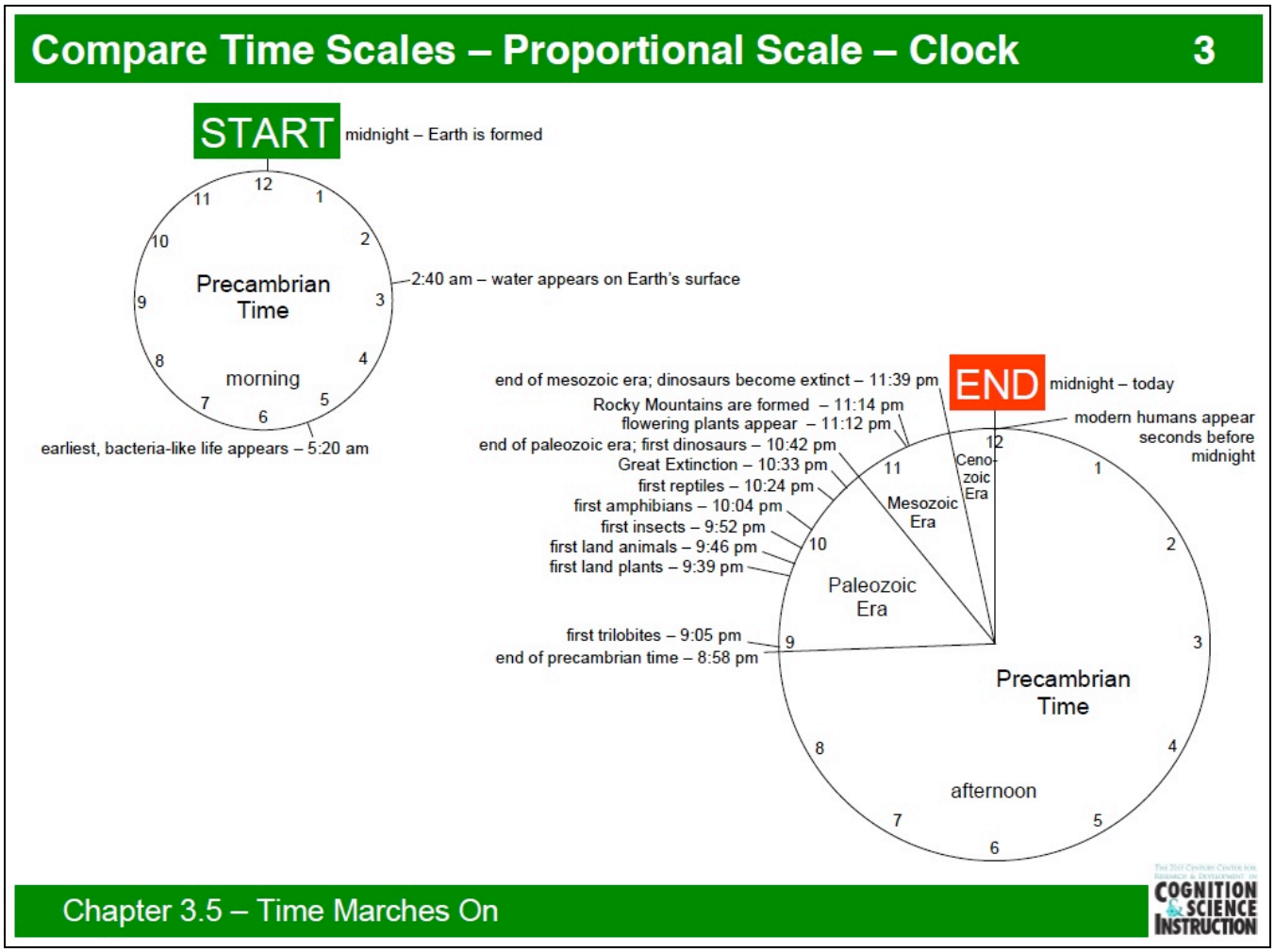


Figure 3 on page 82 of the textbook is another example of a numeric scale. The section review on page 85 contains a proportional scale that is very similar to the clock on slide 8, except it uses only 12 hours rather than a full day to depict Earth's history.

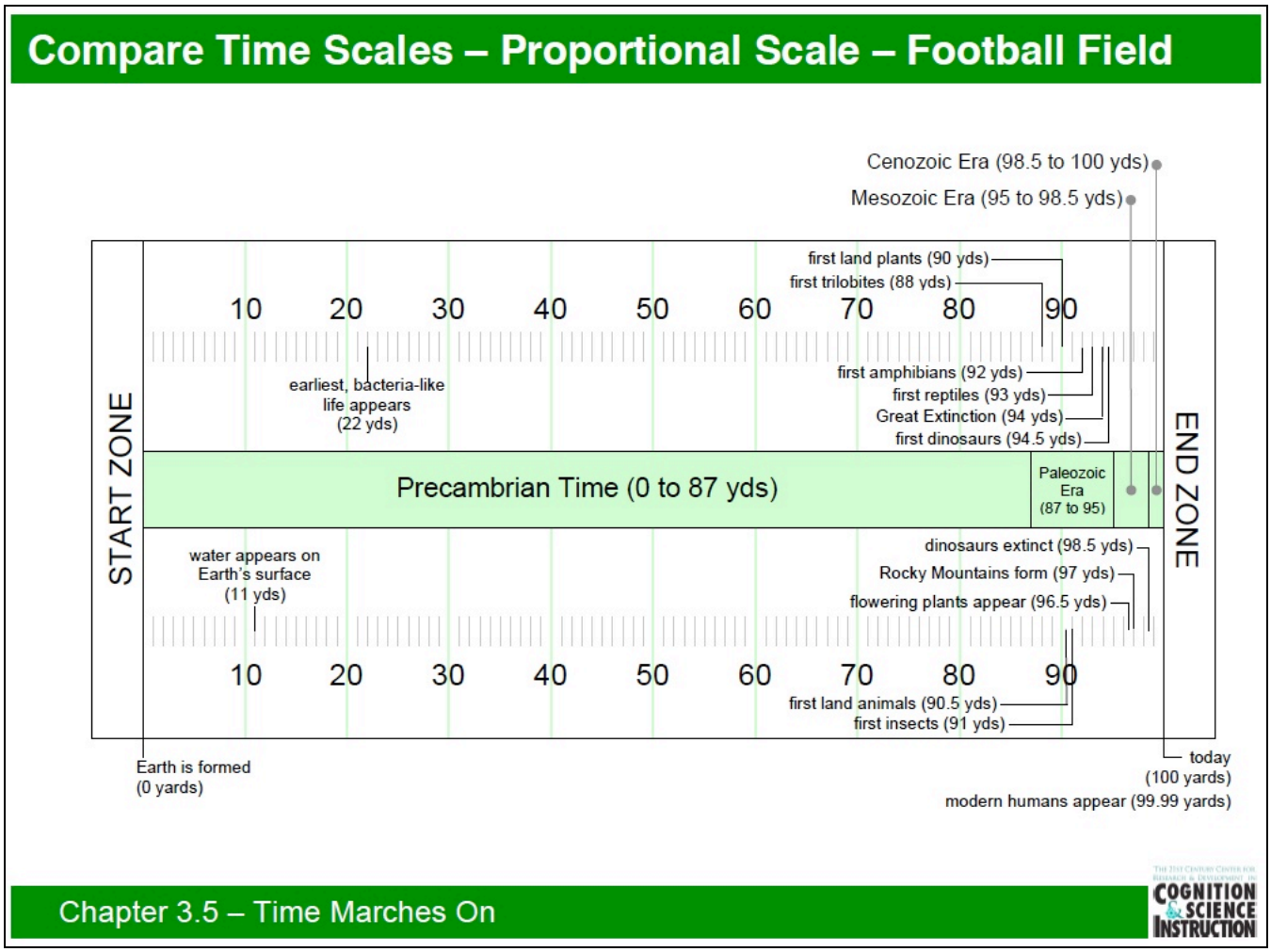
Day 2 – Compare Time Scales, Part 2

Worksheet 3



Day 2 – Compare Time Scales, Part 2

Worksheet 4



Day 2 – Compare Time Scales, Part 2

Worksheet 6

Compare Proportional Time Scales

	Clock	Football Field
Where in the diagram does it say Earth is formed?		
Where in the diagram is today?		
Look at the three eras and precambrian time. At first glance, which looks like it lasted longest?		
At what point does precambrian time begin?		
At what point does precambrian time end?		
How much of the diagram is precambrian time?		
At what point does the paleozoic era begin?		
At what point does the paleozoic era end?		
How much of the diagram is the paleozoic era?		
At what point do modern humans appear?		

Chapter 3.5 – Time Marches On

DAY 3

Geologic Time

This lesson covers the first part of section 3.5 (pages 80-81).

Big Ideas

- The world we live in gradually emerged over about 4.6 billion years.
- The Grand Canyon only formed about 10 million years ago, but its rocks reveal geologic events that happened as many as 1.7 billion years ago.
- Earth's history is also recorded in fossils.

Materials

Teacher:

1. visualization exercises – day03.ppt

Students:

none

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
5 minutes – visualization 3.5a – Zoom
30 minutes – chapter 3.5, part 1

Chapter 3.5, part 1

Part 1 points out that dinosaurs lived in Utah about 150 million years ago, which seems like a very long time. But 150 million years is just a little more than 3% of the time Earth has existed. To help your students understand what this means, ask questions to elicit that 3% is 3 out of 100. So if Earth's history were crammed into 100 years instead of 4.6 billion, dinosaurs would have lived in Utah 3 years ago. The Bellringer on page 80 says that if Earth's history were equal to just one year, humans would have appeared yesterday.

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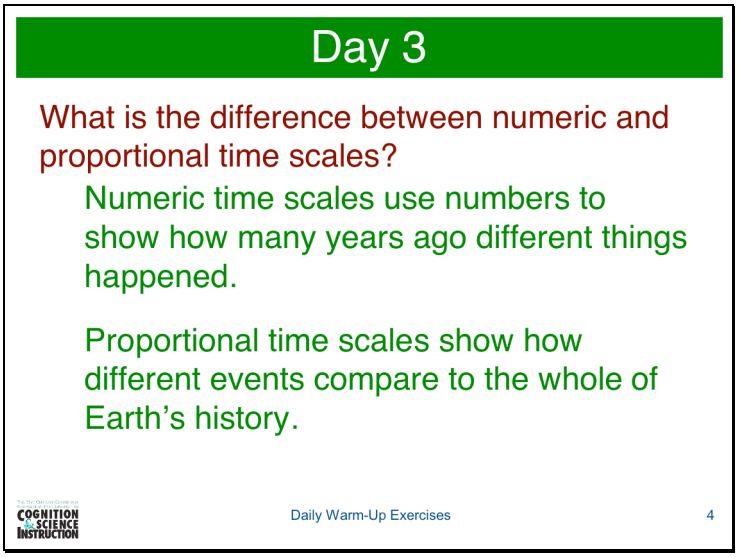
Day 3 – Geologic Time

Warm-Up Activity



Which type makes it easy to see that humans have only been around for a tiny fraction of Earth's history?

proportional, like the clock and football-field diagrams

Day 3 – Geologic Time

Visualization Exercise 3.5a – Zoom

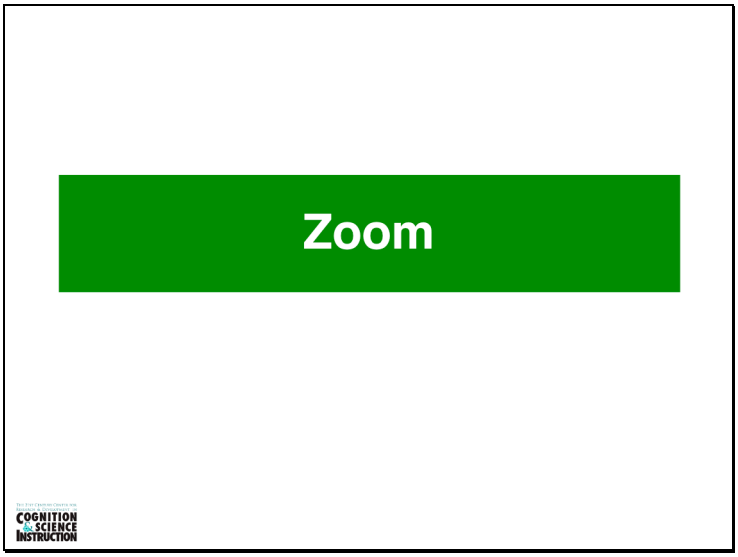


Image Comprehension Focus: Zoom

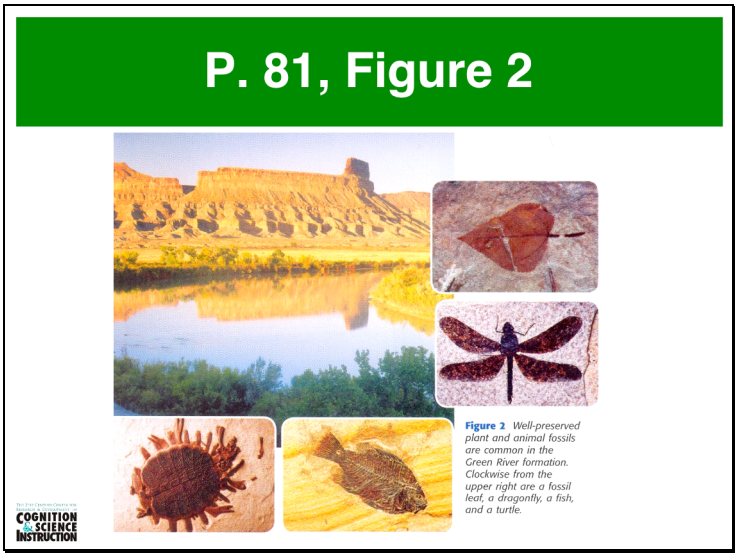
Goal: To reinforce the understanding of what a "zoom" convention illustrates

Type of Activity: Teacher Guided Student Activity

Overview: This activity is designed to reinforce students' understanding of the "zoom" convention by explicitly discussing how zoom can make things visible which may otherwise be difficult to see.

(Continue to the next slide)

Visualization Exercise 3.5a – Zoom (cont.)

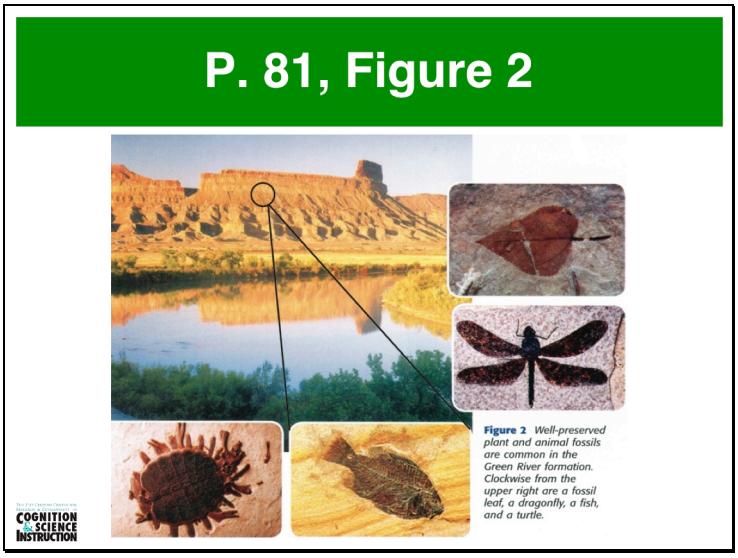


Procedure: The teacher has the students open their textbooks to pg. 81 and look at Figure 2. The teacher can also project this image on the slide shown above. The teacher asks students what the connection is between each smaller fossil picture and the main picture. The teacher can then assist students in pointing out that these are fossils that were found in the rocks of the larger picture.

The teacher then asks, out of all the conventions learned (e.g. captions, zoom, arrows, color, etc.,) which diagram convention could the author have used in order to show that the smaller fossil pictures are actually a part of the main picture?

(Continue to the next slide)

Visualization Exercise 3.5a – Zoom (cont.)



Procedure Cont: After the students have had a chance to answer, the teacher can project the above image and confirm/explain that the zoom convention would be very valuable in showing the relationship between the smaller fossil pictures and the larger picture. The teacher can then reinforce the importance of zoom in being able to point out details that otherwise are not seen.

(End of Activity)

DAY 4

The Geologic Time Scale

This lesson covers the last part of section 3.5 (pages 82-85).

Big Idea

- Earth's history is divided into eons, eras, and periods based on major changes that occurred at those times.

Materials

Teacher:

1. visualization exercises – day04.ppt

Students:

1. time scales from Days 1 & 2 – worksheets 1-4

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
5 minutes – visualization 3.5b – Relative Scale & Magnification
5 minutes – visualization 3.5c – Captions
25 minutes – chapter 3.5, part 2

Chapter 3.5, part 2

Begin the lesson by having students compare their time scales from the contrasting case activity with the one on page 82. They should recognize the scale in the book as a numeric scale. They will probably notice that, instead of Precambrian Time, the book shows three **eons**, but they may not notice the fourth eon, which includes all the eras and periods listed in the cc scales.

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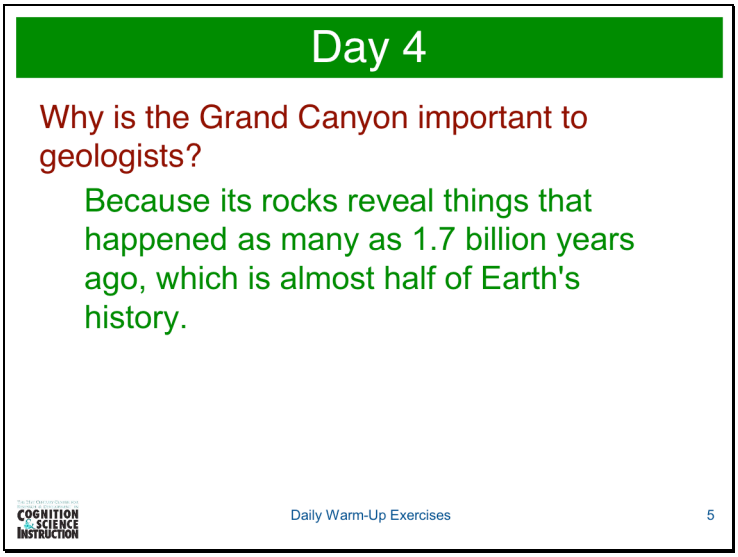
Day 4 – The Geologic Time Scale

Warm-Up Activity



How old is Earth?
4.6 billion years

According to fossils found in Utah, how long ago did dinosaurs live in that area?
about 150 million years ago

How does that compare with the age of Earth?
4.6 billion is 4,600 million; 150 mya is much shorter than 4,600 mya

Day 4 – The Geologic Time Scale

Visualization Exercise 3.5b – Relative Scale & Magnification

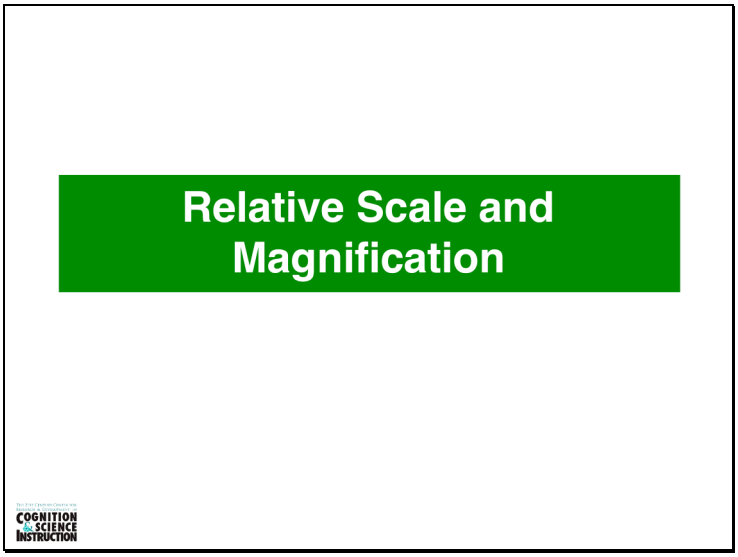


Image comprehension focus: Relative Scale and Magnification

Goal: Expand understanding of scale that visual cues may not accurately reflect relative size

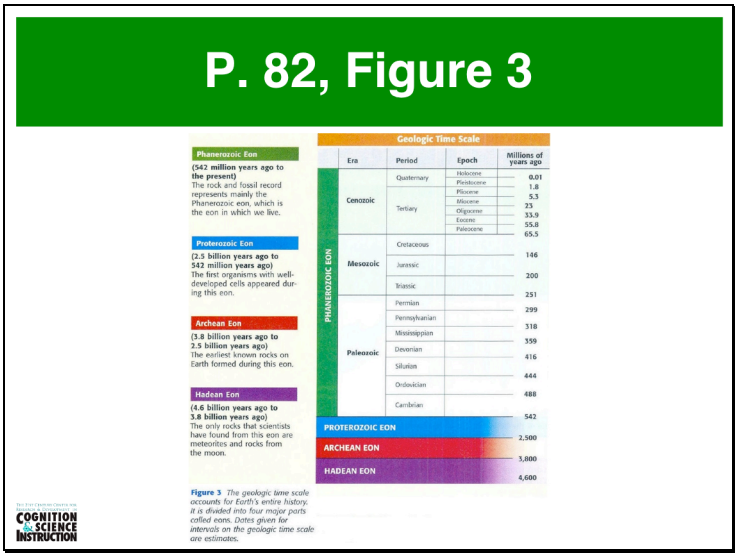
Type of Activity: Teacher comment

Objective: The purpose of this activity is to help students appreciate that sometimes the visual cues in an image do not reflect the relationships between parts of the image. In this case, the visual conveyed by the timeline does not match the relative size of each time period.

(Continue to the next slide)

Day 4 – The Geologic Time Scale

Visualization Exercise 3.5b – Relative Scale & Magnification (cont.)



Procedure: The key goal of this activity is for students to appreciate that the visual impression of this time line does not match the actual relative time line.

First the teacher should direct the students to look at fig 3 on page 82 (shown above if the teacher wants to project it). Explain that there is an extremely long measure of time called an 'Eon' which was not covered during the contrasting case on geologic time.

Next, he/she should direct the students to describe the size of each of the time eons as drawn in the image [the Proterozoic, Archean, and Hadean are all about the same size, the Phanerozoic is much larger].

The teacher should then ask the students to estimate the length of each time period. [The Phanerozoic is 542 million years long, the Proterozoic is roughly 2450 million years long, the Archean is 1300 million years long and the Hadean is 800 million years long. These numbers were obtained by looking at when each eon started and ended]

(End of Activity)

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Day 4 – The Geologic Time Scale

Visualization Exercise 3.5c – Captions

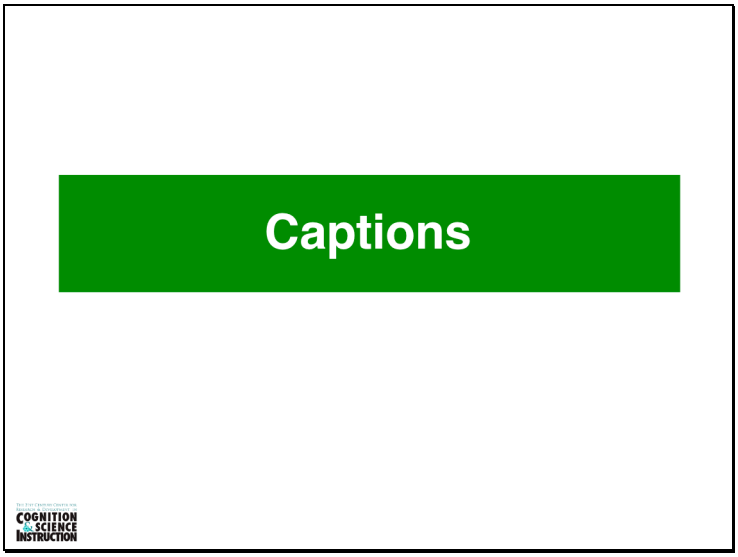
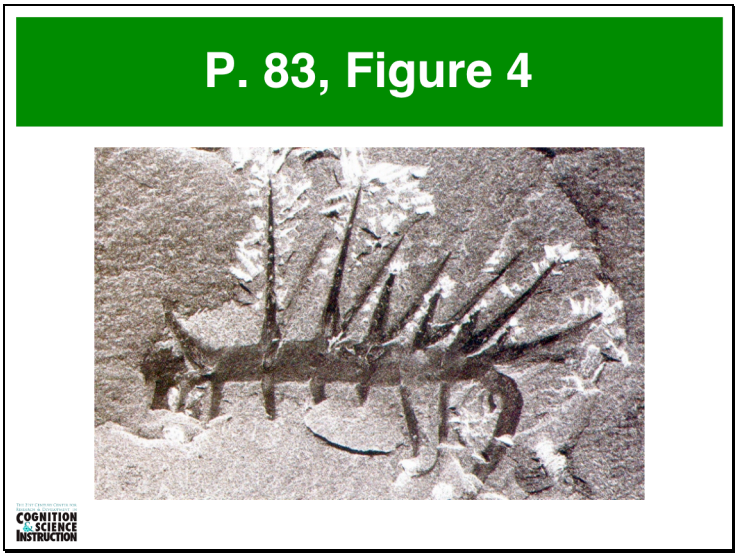


Image comprehension focus: Captions

Goal: Reinforce the idea that captions can contain critical information that may not be known by the diagram alone

(Continue to the next slide)

Visualization Exercise 3.5c – Captions (cont.)



Procedure: The teacher will have the students turn to p. 83 in the textbook and read the paragraph underneath the heading 'The Appearance and Disappearance of Species.'

The teacher will then have students close their textbooks and get into small groups. The teacher then asks each group to write a caption for Figure 4 (shown above for the teacher to project)

The teacher can then have each group share their caption. After each group has shared their caption, the teacher has students open their textbooks again to page 83 and look at the caption for Figure 4.

The teacher can ask about similarities and differences between the caption in the textbook and the caption(s) written by the students, which can lead to a discussion on what makes a good caption. The teacher should emphasize the importance of a good caption, and being sure to read the caption, as the image alone may not contain enough information.

(End of Activity)

DAY 5

Quiz 1/Reteach/Review

This lesson provides an opportunity for students to review what they've learned about Earth to this point. For some, it may be an opportunity to understand an idea they didn't fully grasp the first time around.

Big Idea
See list of big ideas, Days 1-4.

Materials

Teacher:

1. vocabulary list – RE word list.doc
2. list of big ideas – RE big ideas.pdf

Students:

1. Quiz 1

Activities & Allotted Time (40 minutes total)

10 minutes – quiz
10 minutes – go over quiz
20 minutes – reteach/review chapter 3.5

Reteach/Review Chapter 3.5
After going over the quiz and reviewing the meanings of vocabulary words and the big ideas from days 1-4, use the section review questions on page 85 to identify areas that need additional attention.

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Day 5 – Quiz 1/Reteach/Review

Quiz 1 – Page 1

1. Which of the following appeared earliest (closest to when Earth was formed)?
   a. dinosaurs
   b. humans
   (c.) insects

2. Which of the following appeared most recently (closest to today)?
   a. dinosaurs
   (b.) humans
   c. insects

3. When was Earth formed?
   a. about 200 thousand years ago
   b. about 150 million years ago
   (c.) about 4.6 billion years ago

4. When did humans first appear?
   (a.) about 200 thousand years ago
   b. about 150 million years ago
   c. about 4.6 billion years ago

5. A geologic time scale shows _____.
   a. the dates when different fossils were formed
   (b.) when major changes occurred during Earth's history
   c. the ages and locations of different layers of rocks

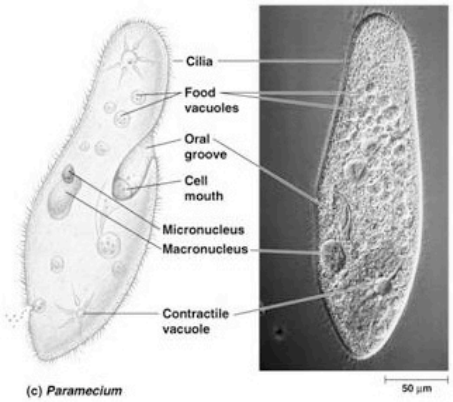
6. Which of the following is the correct order from largest to smallest division of geologic time?
   a. eras, periods, epochs, eons
   (b.) eons, eras, periods, epochs
   c. epochs, eons, eras, periods

Inside the Restless Earth

Day 5 – Quiz 1/Reteach/Review

Quiz 1 – Page 2

7. **Note to student:** We know you didn't learn this, but we want you to try to answer the question based on the information in the diagram.



(c) *Paramecium*

The image on the left is _____.

a. a magnified version of the object on the right
(b) a drawing of the object on the right
c. a miniature version of the object on the right
d. a different object than the object on the right

8. What is extinction, and what can cause it to happen?

Extinction is the death of every member of a species. It can be caused by major changes in global climate or ocean currents. Such changes could result from a sudden event like an asteroid impact or a huge volcanic eruption.

Inside the Restless Earth

End-of-Section Survey – 3.5

Directions for Completing Survey Forms
These forms are designed to provide us with information about how teachers are implementing the module and how specific activities are working in classrooms. The three middle columns are intended as checkboxes. We'd like you to check one of the three for each activity. You would check "did as described" if you did that activity as described in the pages listed in the activity column. Those page numbers usually refer to the overview, which includes suggestions for modifying or supplementing many Holt passages. So "did as described" would mean you followed our suggestions. If we don't have any suggestions, the activity column will say "Holt page." For those, you would check "did as described" if you presented the material as described in the textbook.

The "modified" column is for when you change an activity. This would include activities that you do as Holt describes instead of following our suggestions. For example, on Day 4, we suggest you begin the lesson by having students compare their time scales from the contrasting case activity with the one on page 82. If you decide to teach the section the way you normally do, you would check "modified" and, under comments, indicate that you followed the text.

activity	did as described	modified	didn't do	comments
Day 1 Warm-Up (page 2)				
cc 3.5–Compare Time Scales, part 1 (pages 2-12)				
Day 2 Warm-Up (page 14)				
cc 3.5–Compare Time Scales, part 2 (pages 13-24)				

End-of-Section Survey – 3.5

activity	did as described	modified	didn't do	comments
Day 3 Warm-Up (page 26)				
vis 3.5a–Zoom (pages 27-29)				
chp 3.5, part 1–*Geologic Time* (page 25 & Holt, pages 80-81)				
Day 4 Warm-Up (page 31)				
vis 3.5b–Relative Scale (pages 32-33)				
vis 3.5c–Captions (pages 34-35)				
chp 3.5, part 2–*Geologic Time Scale* (page 30 & Holt, pages 82-85)				
Quiz 1 (pages 37-38)				
Reteach/Review Chapter 3.5 (page 36)				

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DAY 6

Compare Rocks & Minerals

This lesson is contrasting case activity 1.1, in which students compare three pairs of cards. Each pair includes a mineral and a rock that contains that mineral. This is the first lesson of chapter 1, *Minerals of the Earth's Crust.*

Big Ideas

- Both rocks and minerals are naturally formed solids.
- Minerals are elements or compounds.
- Rocks are mixtures that usually contain minerals.

Materials

Teacher:

1. slides – day06.ppt

Students:

1. description cards – worksheets 7-9
2. data table & Venn diagram – worksheets 10-11

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
35 minutes – cc activity – compare rocks & minerals

Compare Rocks & Minerals

In this activity, students compare three pairs of cards. Each pair shows a mineral and a rock that contains that mineral or another form of the same substance. The first pair includes diamond, which is made entirely of carbon, and coal, which contains organic carbon. The other pairs are calcite-and-limestone and quartz-and-granite. Students work in groups to enter information from the cards into a table. The whole class uses the table to compare the three minerals, and they do the same for the three rocks. The class then completes a Venn diagram to depict similarities and differences between rocks and minerals.

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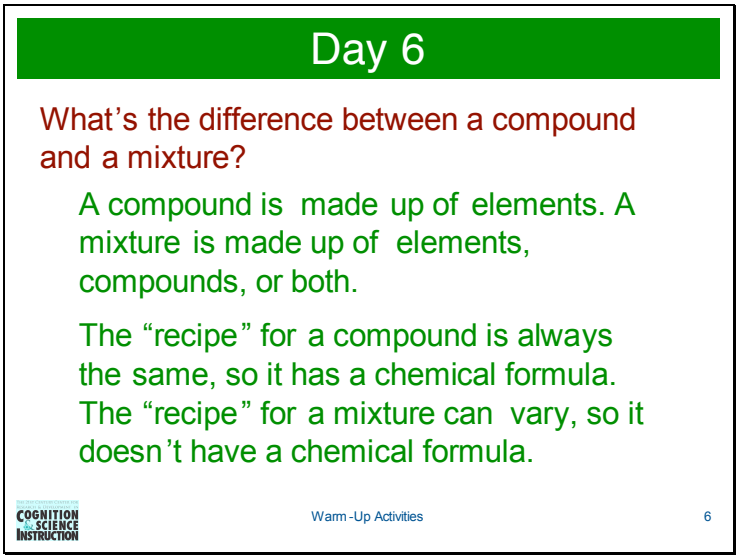
Day 6 – Compare Rocks & Minerals

Warm-Up Activity

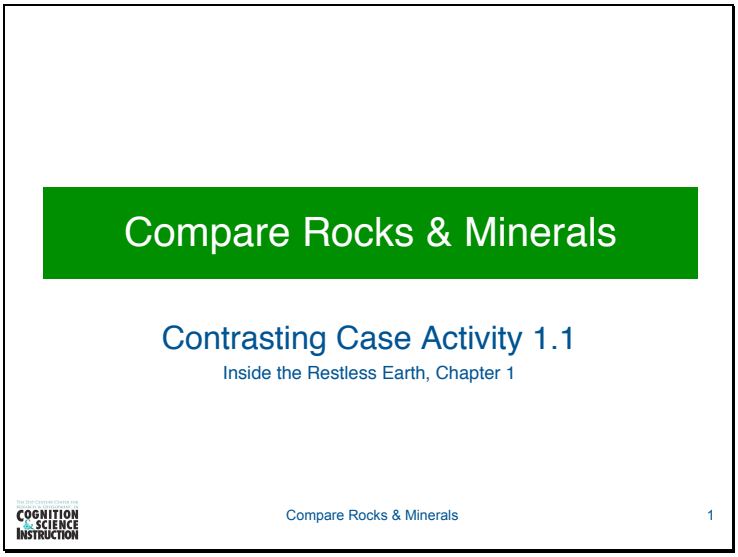


This is a review of key ideas from Introduction to Matter that will come into play in today's activity. Based on a written description, students will need to decide whether a rock or mineral is an element, compound, or mixture. This warm-up is designed to help students recognize that, if a description includes a chemical formula, that item is a compound. If an item is made up of "varying amounts" of something, it's a mixture.

There are additional differences that students may identify (e.g., compounds are chemically combined; mixtures aren't), but the answer on the slide contains the ideas students will need for today's activity.

Day 6 – Compare Rocks & Minerals

Compare Rocks & Minerals (cont.)

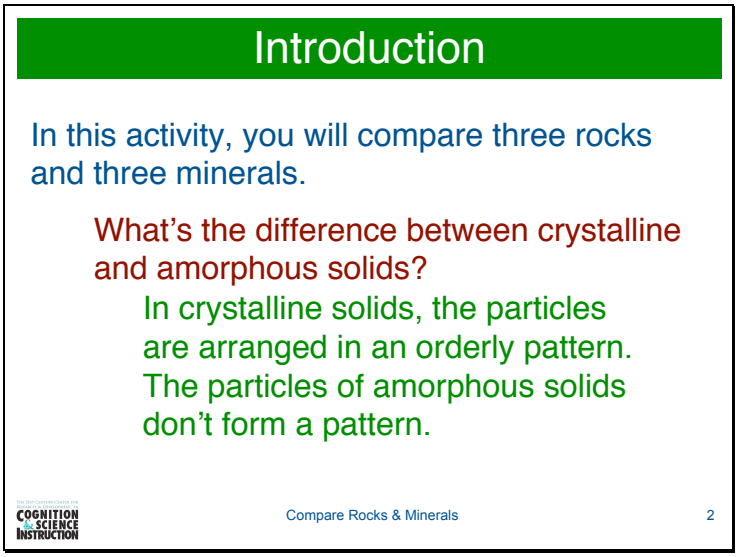


Materials needed:

- cards (worksheets 7-9)
- data table & Venn Diagram (worksheets 10-11)

Day 6 – Compare Rocks & Minerals

Compare Rocks & Minerals (cont.)

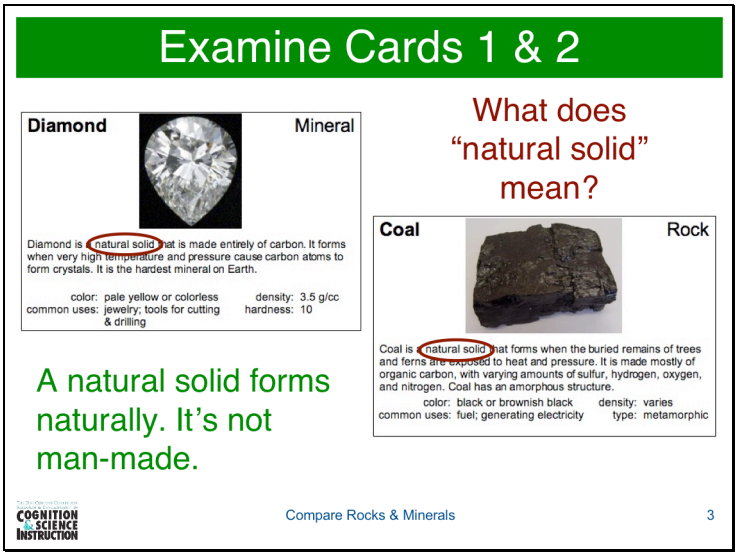


Students may remember this from Introduction to Matter. If your students seem uncertain about the difference, you might draw particle models to show the two kinds – one with circles arranged in neat rows, and the other with circles bunched together in an unorganized blob.

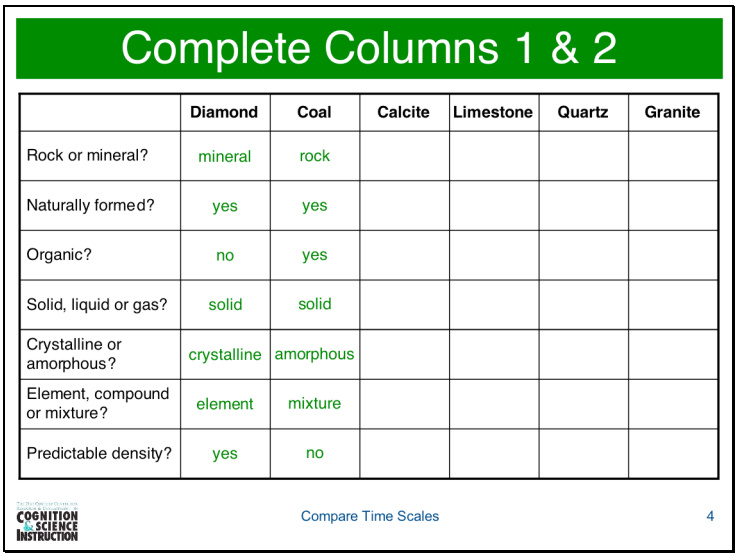
When students complete the data table, they will need to decide whether each case has a crystalline or amorphous structure. With actual rocks, they could look for properties like crystal symmetry and cleavage (splits along smooth surfaces), but those may not be observable in the photographs. Point out that the particles that make up crystals are arranged in an orderly pattern. So if a card talks about crystals, students should identify that rock or mineral as crystalline.

Day 6 – Compare Rocks & Minerals

Compare Rocks & Minerals (cont.)



Distribute the case descriptions (worksheets 7-9) and ask students to examine the first two (Diamond & Coal). The circles, question, and answer will appear on keypress.



	Diamond	Coal	Calcite	Limestone	Quartz	Granite
Rock or mineral?	mineral	rock				
Naturally formed?	yes	yes				
Organic?	no	yes				
Solid, liquid or gas?	solid	solid				
Crystalline or amorphous?	crystalline	amorphous				
Element, compound or mixture?	element	mixture				
Predictable density?	yes	no				

Distribute the data table (worksheet 10) and have students work in pairs to complete the first two columns. Answers will appear on keypress. Tell your students that some diamonds are organic in origin.

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Day 6 – Compare Rocks & Minerals

Compare Rocks & Minerals (cont.)

Examine Cards 3 & 4

Calcite Mineral

Calcite is a natural solid that is made of calcium carbonate. The chemical formula for calcium carbonate is $CaCO_3$. Calcite is an inorganic solid that is noted for its almost perfect cleavage, which means that it splits along smooth surfaces.

color: colorless or white to tan
common uses: cement; building materials; soil treatment
density: 2.7 g/cc
hardness: 3

Limestone Rock

Limestone is a natural solid that forms when the shells of sea creatures are pressed tightly together. It is made mostly of calcite, with varying amounts of other minerals like quartz and aragonite. Limestone has a crystalline structure.

color: white to tan or gray
common uses: crushed stone; cement; building materials
density: varies
type: sedimentary

COGNITION & SCIENCE INSTRUCTION

Compare Rocks & Minerals 5

Ask students to examine the next two cards (Calcite & Limestone), then work in pairs to complete the next two columns of the data table.

Complete Columns 3 & 4

	Diamond	Coal	Calcite	Limestone	Quartz	Granite
Rock or mineral?	mineral	rock	mineral	rock		
Naturally formed?	yes	yes	yes	yes		
Organic?	no	yes	no	yes		
Solid, liquid or gas?	solid	solid	solid	solid		
Crystalline or amorphous?	crystalline	amorphous	crystalline	crystalline		
Element, compound or mixture?	element	mixture	compound	mixture		
Predictable density?	yes	no	yes	no		

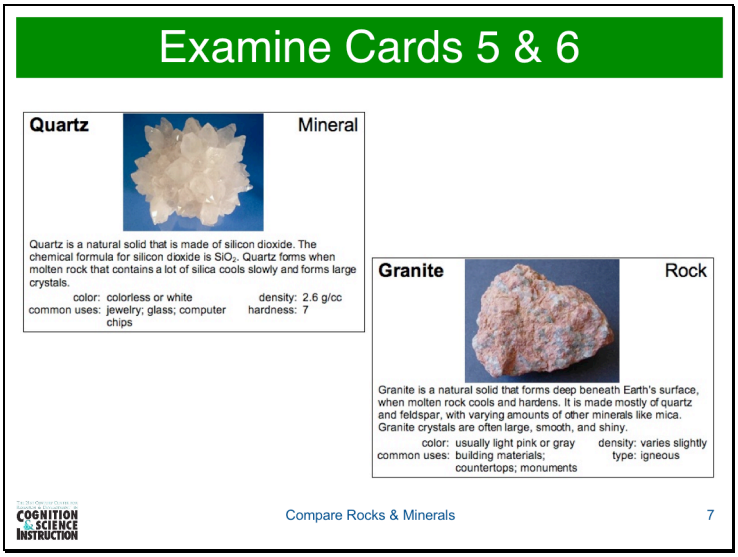
COGNITION & SCIENCE INSTRUCTION

Compare Time Scales 6

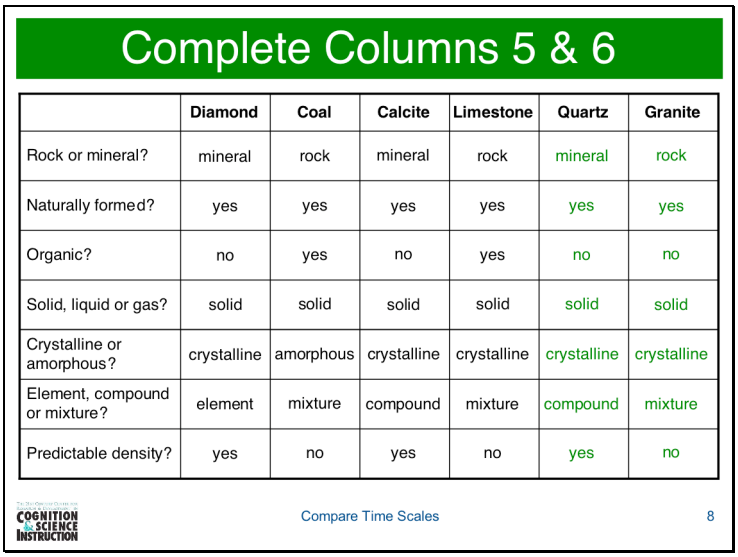
Answers will appear on keypress.

Day 6 – Compare Rocks & Minerals

Compare Rocks & Minerals (cont.)



Ask students to examine the last two cards (Quartz & Granite), then work in pairs to finish the data table.

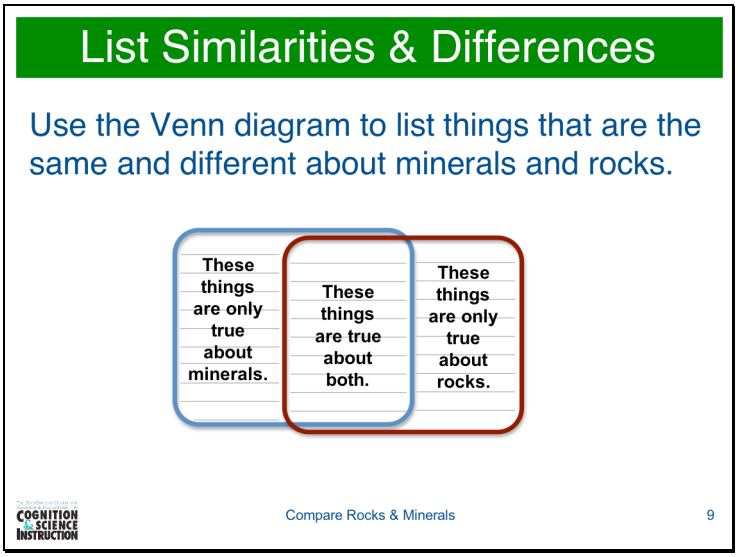


	Diamond	Coal	Calcite	Limestone	Quartz	Granite
Rock or mineral?	mineral	rock	mineral	rock	mineral	rock
Naturally formed?	yes	yes	yes	yes	yes	yes
Organic?	no	yes	no	yes	no	no
Solid, liquid or gas?	solid	solid	solid	solid	solid	solid
Crystalline or amorphous?	crystalline	amorphous	crystalline	crystalline	crystalline	crystalline
Element, compound or mixture?	element	mixture	compound	mixture	compound	mixture
Predictable density?	yes	no	yes	no	yes	no

Answers will appear on keypress.

Day 6 – Compare Rocks & Minerals

Compare Rocks & Minerals (cont.)

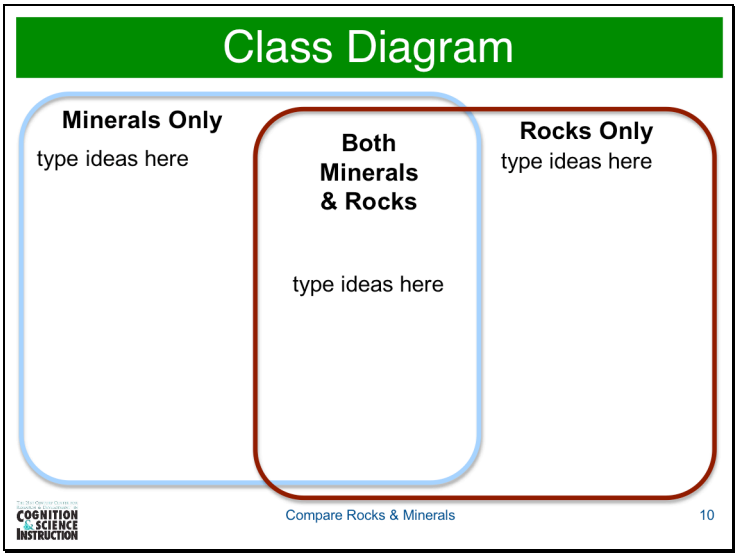


Distribute the Venn diagram (worksheet 11). Have students work in groups, then share their ideas with the class.

The next slide contains a blank diagram you can use to record ideas your students all agree on.

Day 6 – Compare Rocks & Minerals

Compare Rocks & Minerals (cont.)



(Click Escape to stop the slide show. After typing in their ideas, click the slide show icon at the bottom of the window to display the diagram.)

Some ideas your students may come up with:

Same

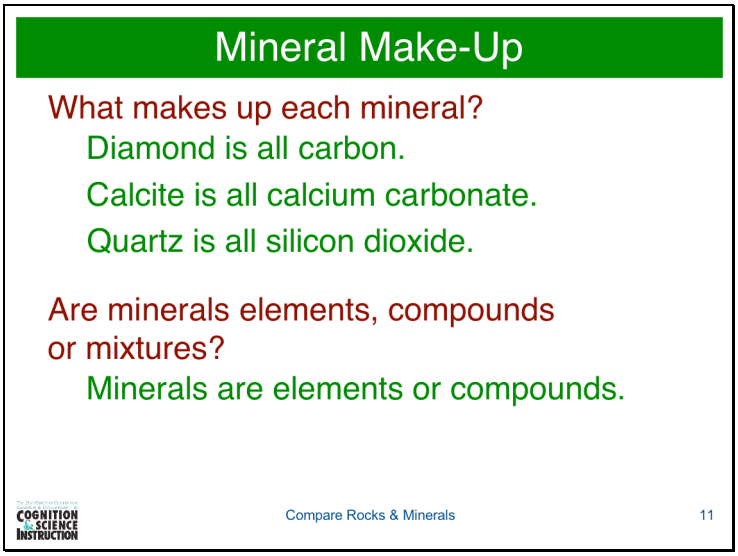
- both are naturally formed
- both are solids

Different

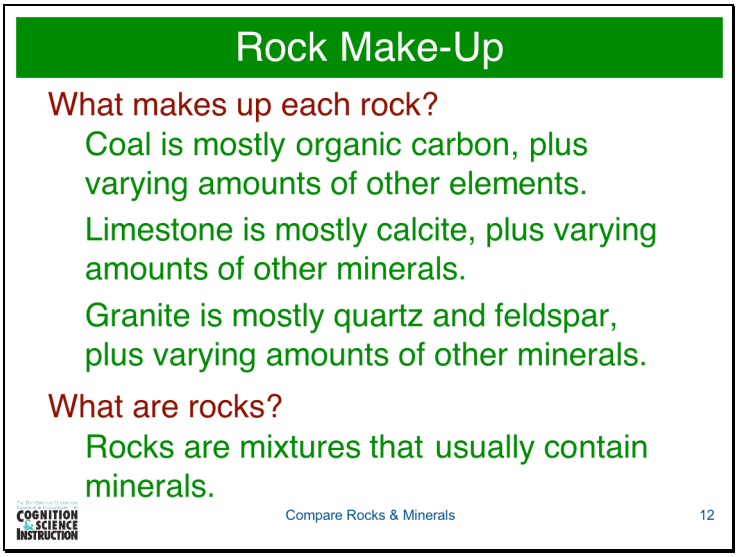
- minerals are not organic; rocks can be organic or not organic
- minerals are crystalline; rocks can be crystalline or amorphous
- minerals are elements or compounds; rocks are mixtures
- minerals have a predictable density; rocks don't

Day 6 – Compare Rocks & Minerals

Compare Rocks & Minerals (cont.)



Diamond is an element, and calcite and quartz are compounds.



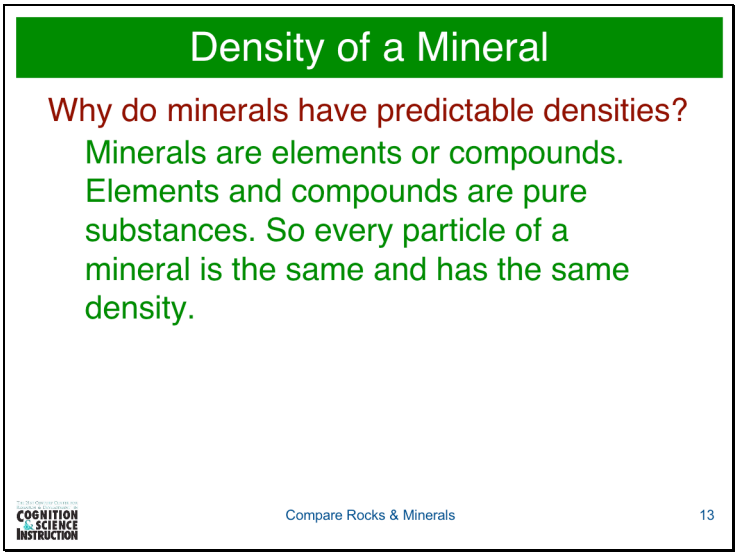
At this point, use questions to elicit something like the following:

ROCK -- a naturally formed solid that contains one or more minerals or other Earth materials; rocks are mixtures

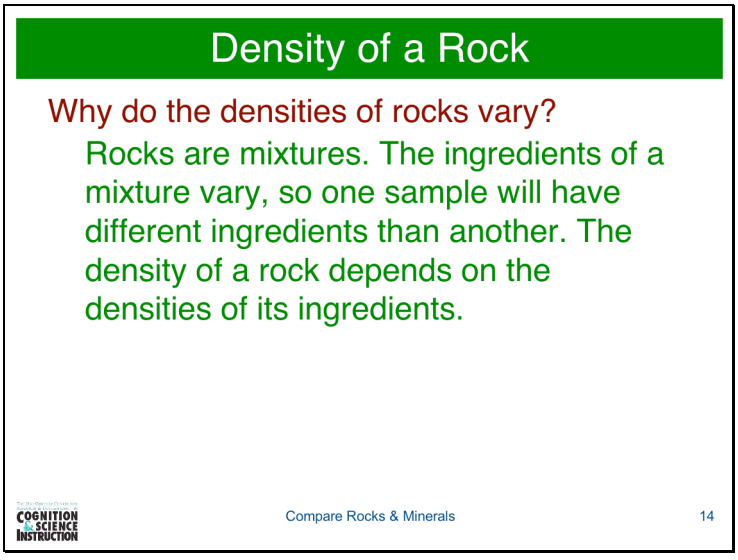
MINERAL -- a naturally formed, inorganic solid with a crystalline structure; minerals are elements or compounds

Day 6 – Compare Rocks & Minerals

Compare Rocks & Minerals (cont.)



Use questions to elicit that density is a characteristic property of a material, which means that it does not change with sample size (volume).



Tell students that rocks are like chocolate-chip cookies. Some have more chocolate chips than others. Some have nuts, and others don't. The density of a cookie depends on its ingredients.

Day 6 – Compare Rocks & Minerals

Worksheet 7

Compare Rocks & Minerals 7

Diamond — Mineral

Diamond is a natural solid that is made entirely of carbon. It forms when very high temperature and pressure cause carbon atoms to form crystals. It is the hardest mineral on Earth.

color: pale yellow or colorless
common uses: jewelry; tools for cutting & drilling
density: 3.5 g/cc
hardness: 10

Coal — Rock

Coal is a natural solid that forms when the buried remains of trees and ferns are exposed to heat and pressure. It is made mostly of organic carbon, with varying amounts of sulfur, hydrogen, oxygen, and nitrogen. Coal has an amorphous structure.

color: black or brownish black
common uses: fuel; generating electricity
density: varies
type: metamorphic

Chapter 1 – Minerals of the Earth's Crust

Day 6 – Compare Rocks & Minerals

Worksheet 8

Compare Rocks & Minerals 8

Calcite — Mineral

Calcite is a natural solid that is made of calcium carbonate. The chemical formula for calcium carbonate is $CaCO_3$. Calcite is an inorganic solid that is noted for its almost perfect cleavage, which means that it splits along smooth surfaces.

color: colorless or white to tan
common uses: cement; building materials; soil treatment
density: 2.7 g/cc
hardness: 3

Limestone — Rock

Limestone is a natural solid that forms when the shells of sea creatures are pressed tightly together. It is made mostly of calcite, with varying amounts of other minerals like quartz and aragonite. Limestone has a crystalline structure.

color: white to tan or gray
common uses: crushed stone; cement; building materials
density: varies
type: sedimentary

Chapter 1 – Minerals of the Earth's Crust

Day 6 – Compare Rocks & Minerals

Worksheet 9

Compare Rocks & Minerals 9

Quartz — Mineral

Quartz is a natural solid that is made of silicon dioxide. The chemical formula for silicon dioxide is SiO_2. Quartz forms when molten rock that contains a lot of silica cools slowly and forms large crystals.

color: colorless or white
common uses: jewelry; glass; computer chips
density: 2.6 g/cc
hardness: 7

Granite — Rock

Granite is a natural solid that forms deep beneath Earth's surface, when molten rock cools and hardens. It is made mostly of quartz and feldspar, with varying amounts of other minerals like mica. Granite crystals are often large, smooth, and shiny.

color: usually light pink or gray
common uses: building materials; countertops; monuments
density: varies slightly
type: igneous

Chapter 1 – Minerals of the Earth's Crust

Day 6 – Compare Rocks & Minerals

Worksheet 10

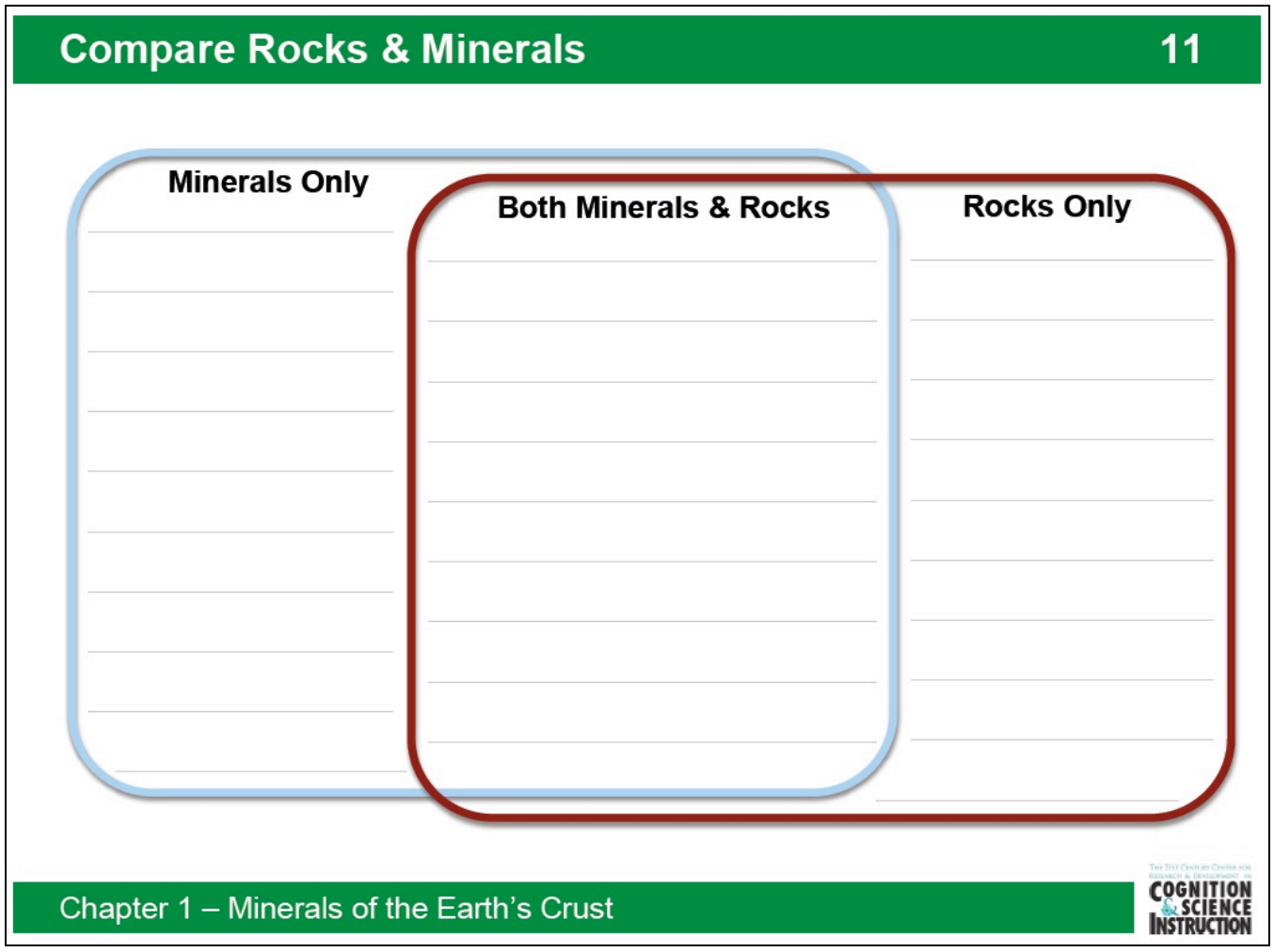
Compare Rocks & Minerals 10

	Diamond	Coal	Calcite	Limestone	Quartz	Granite
What is it? (rock or mineral)						
Is it naturally formed? (i.e., not man-made)						
Is it organic? (i.e., comes from living things)						
What is its state? (solid, liquid, or gas)						
What kind of structure does it have? (crystalline or amorphous)						
What kind of substance is it? (element, compound, or mixture)						
Does it have a predictable density?						

Chapter 1 – Minerals of the Earth's Crust

Day 6 – Compare Rocks & Minerals

Worksheet 11



DAY 7

What is a Mineral?

This lesson covers the first section of chapter 1 (pages 4-7).

Big Idea

- A mineral is a naturally formed, inorganic solid that has a definite crystalline structure.

Materials

Teacher:

1. visualization exercises – day07.ppt

Students:

1. mineral cards from cc 1.1 – worksheets 7-9

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
3 minutes – visualization 1.1a – Color
2 minutes – visualization 1.1b – Relative Scale
3 minutes – visualization 1.1c – Arrows
2 minutes – visualization 1.1d – Labels
5 minutes – visualization 1.1e – Labels
20 minutes – chapter 1.1 – *What is a Mineral?*

Chapter 1.1

Page 4 defines **mineral** as a naturally formed, inorganic solid that has a definite crystalline structure. Write that definition on the board and ask students to explain each segment in their own words. For example:

naturally formed – not man-made
inorganic – doesn't come from living things
solid – not liquid or gas
crystalline – particles are arranged in a pattern

Use questions to help students understand that, if a mineral changes state, it is no longer a mineral. For example, gold is an element whether it is solid, liquid, or gas. But it is only a mineral when it is solid. Similarly, liquid water, ice, and water vapor are all compounds, but only ice is a mineral.

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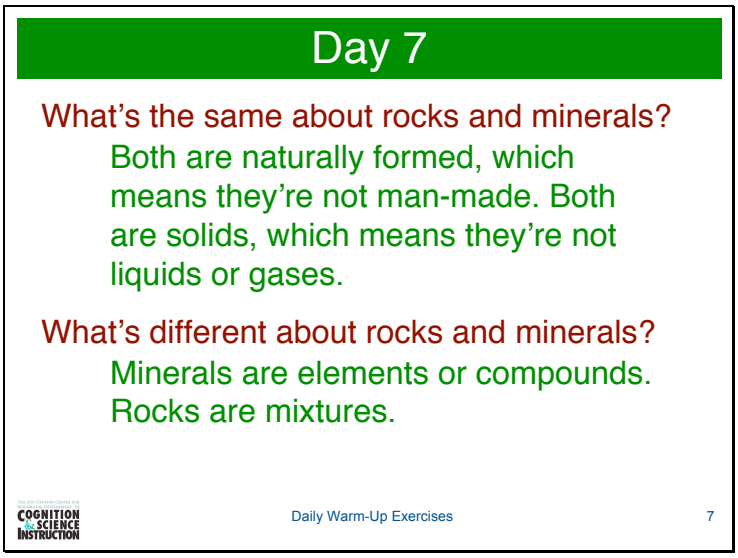
Day 7 – What is a Mineral?

Chapter 1.1 (cont.)
Page 5 defines a **native element** as a mineral that is composed of only one element. Have students examine their mineral cards (worksheets 7-9) and see if they can locate a native element. [Diamond]

Page 6 explains that **silicate minerals** contain both silicon and oxygen. They usually contain other elements as well. All other minerals are classified as nonsilicate minerals. Tell your students that the chemical symbol for silicon is Si, and ask them to examine their mineral cards and classify each as silicate or nonsilicate. Diamond contains only carbon, so it's nonsilicate. Calcite ($CaCO_3$) is also nonsilicate because it contains oxygen but not silicon. Quartz (SiO_2) contains both silicon and oxygen, so it's a silicate.

Warm-Up Activity



Additional differences:

- minerals are not organic; rocks can be organic
- minerals are crystalline; rocks can be crystalline or amorphous
- minerals have a predictable density; rocks don't

Day 7 – What is a Mineral?

Visualization Exercise 1.1a – Color

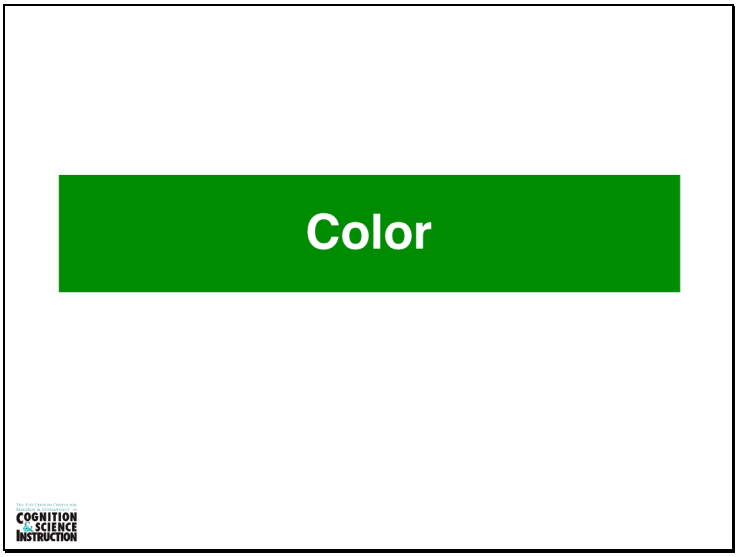


Image Comprehension Focus: Color

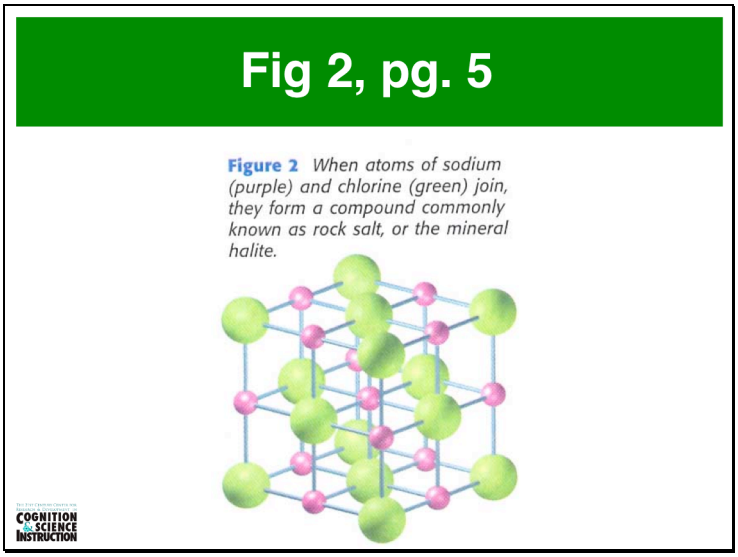
Goal: To understand the role that colors may play in diagrams

Type of Activity: Teacher Guided Student Activity

Overview: The purpose of this activity is to emphasize the point that many times the different colors being used in diagrams can indicate different pieces of information that may be critical when trying to understand the diagram.

(Continue to the next slide)

Visualization Exercise 1.1a – Color (cont.)



Procedure: The teacher has students look at Figure 2 on page 5 (also shown on the above slide if the teacher wants to project it).

The teacher asks students (either individually or in small groups):

Why are some of the atoms shown in one color (purple) and some are another color (green) [to show the difference between the sodium atoms and the chlorine atoms]

How is the color blue used in this diagram? (aside from the words 'Figure 2' being in blue) [blue is being used to show the way in which the atoms are joined to form the compound]

The teacher should then ask students to share their answers and gives the correct answers if needed. The teacher should explain that while sodium and chlorine atoms are not actually purple and green, the author has chosen to use different colors in order to distinguish between the

Visualization Exercise 1.1a – Color (cont.)

different types of atoms. Additionally, the teacher needs to explain that there are not actually blue lines in between the atoms, but that this convention has been used in order to illustrate the point of the atoms being joined to form the compound. The teacher should emphasize that sometimes different colors in diagrams are used to show different pieces of information that can be important when trying to understand the diagram overall.

(End of Activity)

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Day 7 – What is a Mineral?

Visualization Exercise 1.1b – Relative Scale

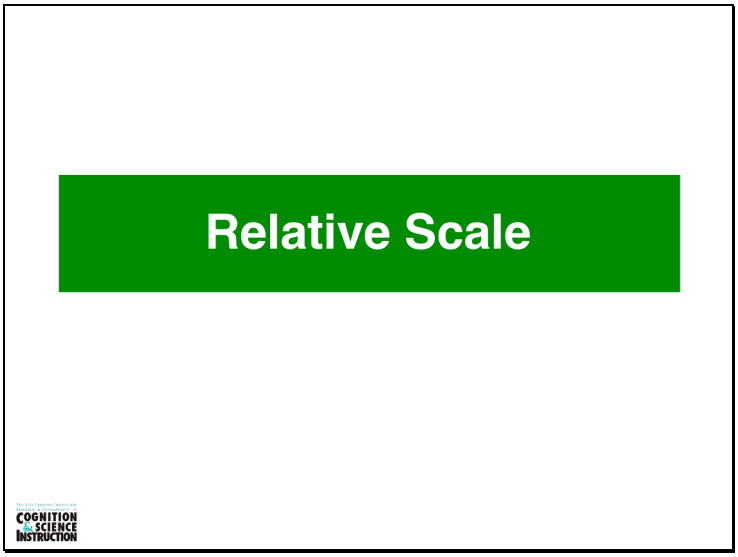


Image Comprehension Focus: Relative Scale

Goal: To reinforce the understanding of relative scale

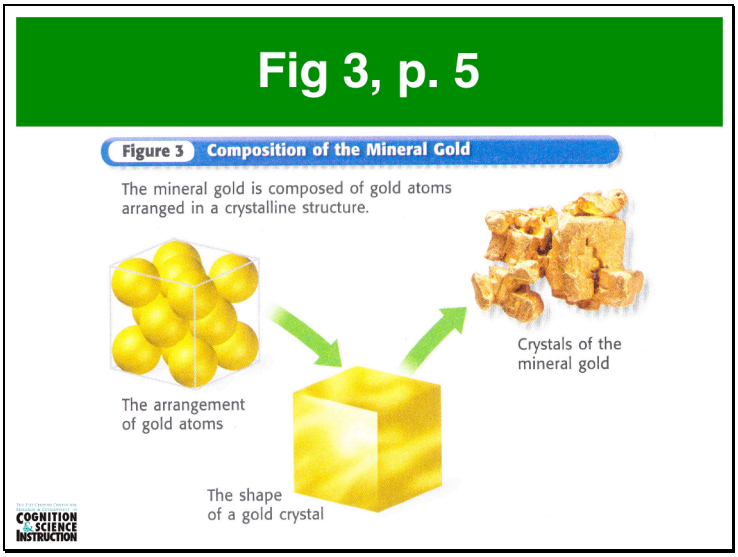
Type of Activity: Teacher Guided Student Activity

Overview: This activity is designed to reinforce students' understanding of relative scale and that sometimes images depicted in diagrams are shown as much larger than they actually appear in real life in order to show detail that would otherwise be difficult to see.

(Continue to the next slide)

Day 7 – What is a Mineral?

Visualization Exercise 1.1b – Relative Scale (cont.)



Procedure: The teacher asks students to look at Figure 3 on page 5 of their textbooks (shown above if the teacher wants to project it). The teacher asks students about how large they believe the gold atoms to be?

The teacher explains that the gold atoms are actually very small in relation to the actual crystals of the mineral gold shown in the image on the right.

(If students have already completed the Introduction to Matter unit, the teacher may remind students about the relative scale exercises about atoms).

(End of Activity)

Day 7 – What is a Mineral?

Visualization Exercise 1.1c – Arrows

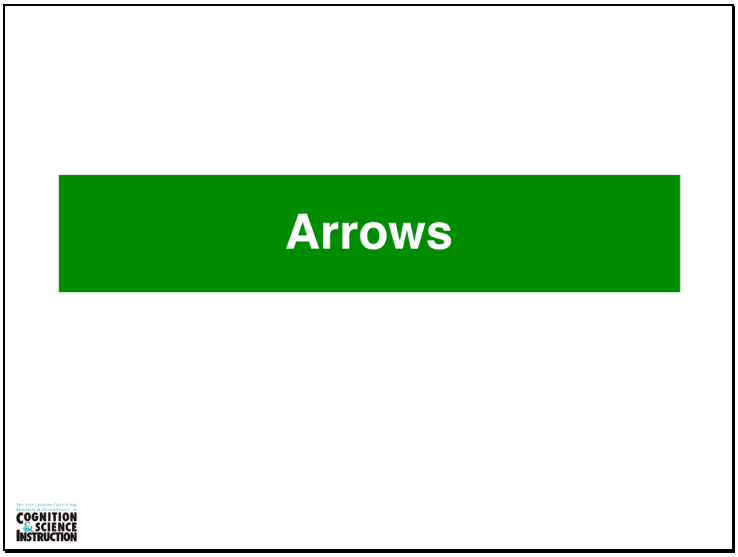


Image Comprehension Focus: Arrows

Goal: To show one of the ways in which arrows may be used in a diagram

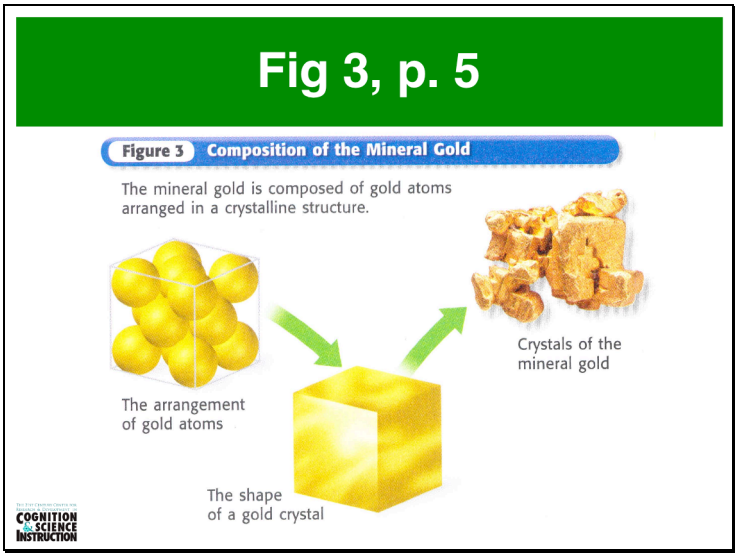
Type of Activity: Teacher Guided Student Activity

Overview: This activity is designed to show students one way in which arrows are used in diagrams. In this case, it is emphasized that the way this diagram uses arrows is not typical, and may therefore be unfamiliar and even confusing to students.

(Continue to the next slide)

Day 7 – What is a Mineral?

Visualization Exercise 1.1c – Arrows (cont.)



Procedure: The teacher asks students to again look at Figure 3 on p. 5 of their textbooks (again shown above if the teacher wants to project it). The teacher asks students to pay particular attention to the arrows. The teacher then asks the students, what role do the arrows play in the diagram? [That there is a relationship between the three images.]

This may be difficult to answer as students may be more familiar with arrows being used to show a process. They may guess that the images show a change from one state to another. The teacher should emphasize the point that while arrows are often used to show a process, this is not necessarily the case, and that assumptions should not be made when arrows are seen as a part of a diagram.

The teacher may then ask students, rather than having arrows, what diagram convention might the author have used to show that the pictures on the left are a very small piece of the picture on the right? [zoom]

(Continue to next slide)

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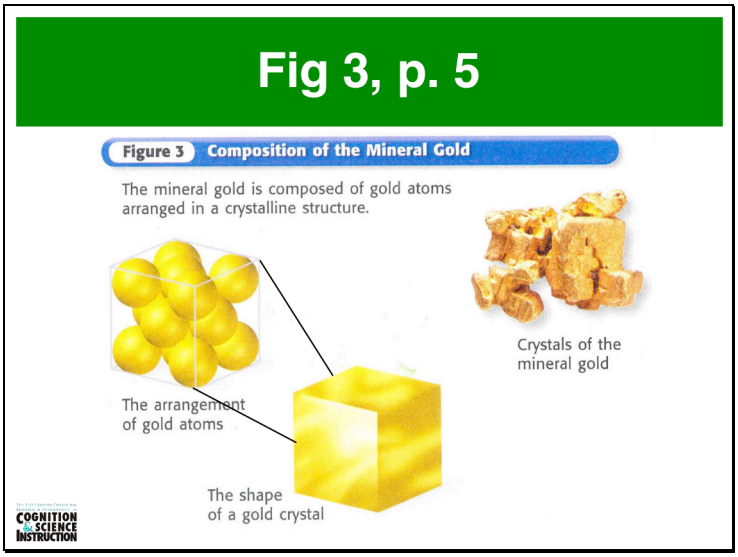
Day 7 – What is a Mineral?

Visualization Exercise 1.1c – Arrows (cont.)



Procedure: The teacher can then project the above slide that illustrates how the author may have used the zoom convention to show that the picture of the gold crystals on the right are made up of the other pictures and that the arrows are not showing an actual process, but rather a relationship.

(End of Activity)

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Day 7 – What is a Mineral?

Visualization Exercise 1.1d – Labels

Image comprehension focus: Labels

Goal: To illustrate and explain two types of labels that are common in diagrams.

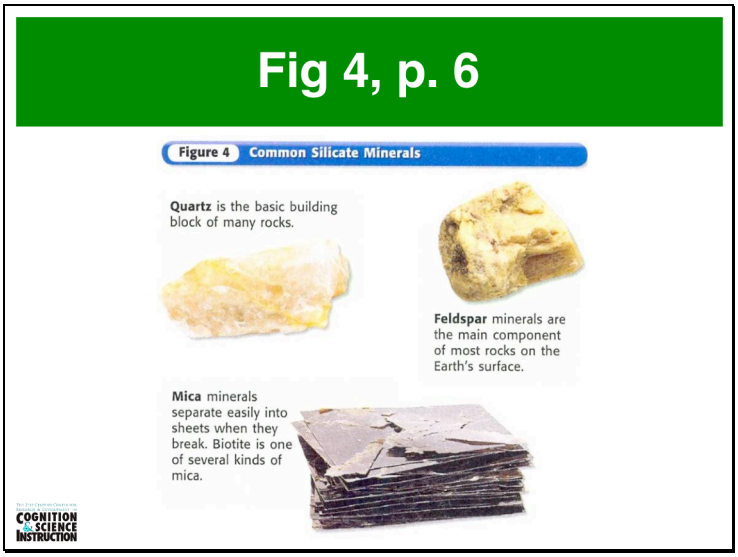
Type of Activity: Teacher guided student activity

Objective: The point of this activity is to illustrate two types of labels, (naming and explanatory), that students may come across in diagrams and the purpose of each type of label.

(Continue to the next slide)

Day 7 – What is a Mineral?

Visualization Exercise 1.1d – Labels (cont.)



Procedure: First, the teacher should have students take a look at Figure 4 on page 6 of their textbooks. The teacher first tells the students to pay close attention to the words in bold (Quartz, Feldspar, and Mica). The teacher explains that these words are naming labels, as they indicate what each image is, or the name of each individual mineral.

The teacher then has the students look at the rest of the words next to each naming label and explains that these are explanatory labels because they explain something about the image.

The teacher can then ask the students: What do these minerals have in common? [they are all silicate minerals] How do you know? [the information is in the title]

The teacher should then emphasize the importance of paying close attention to all three pieces of information (naming labels, explanatory labels, and title) when looking at diagrams, and the way in which each can convey important details about the image.

(End of Activity)

Day 7 – What is a Mineral?

Visualization Exercise 1.1e – Labels

Image comprehension focus: Labels

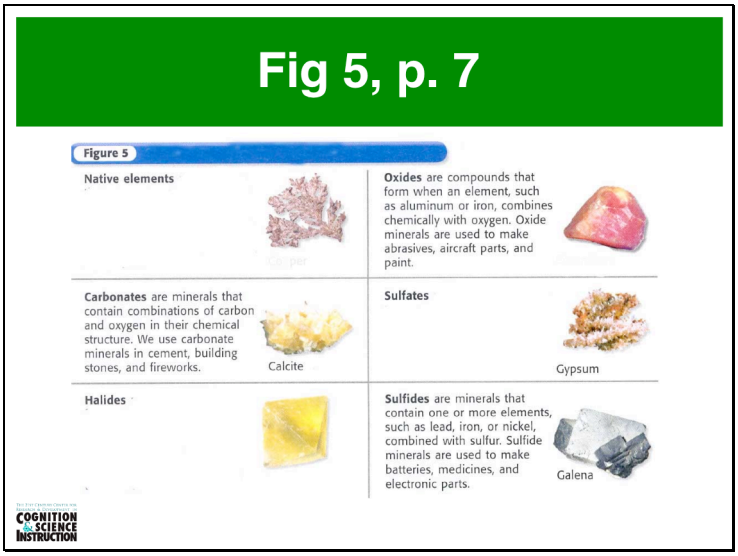
Goal: Reinforce the idea that different types of labels can contain different pieces of critical information that may not be known by the diagram alone

Type of Activity: Teacher guided student activity

(Continue to the next slide)

Day 7 – What is a Mineral?

Visualization Exercise 1.1e – Labels (cont.)



Procedure: The teacher should first have students open their textbooks and take two minutes to look at Figure 5 on page 7. Students should then close their textbooks and the teacher can project the altered Fig 5 shown above. Then, either individually or in small groups, answer the following questions (which should be difficult to do because of the missing information):

- Native elements are minerals that are _____. [composed of only one element]
- Sulfates are minerals that contain ____ and ____. [sulfur and oxygen]
- The example of the oxide shown in Fig 5 is called _____. [Corundum]
- Fluorite, which is shown above, is part of the class of nonsilicate materials known as _____. [Halides]
- What do all of the minerals above have in common? [They are all examples of nonsilicate minerals]

The teacher then has students open their books again to Fig 5 on page 7 and again try to answer the questions. The teacher reviews the correct answers and emphasizes the importance of different types of labels.

(End of Activity)

DAY 8

Identifying Minerals

This lesson covers the first half of section 1.2 (pages 8-9).

Big Idea

- Properties like luster, streak, cleavage, and fracture can be used to identify minerals.

Materials

Teacher:

1. visualization exercises – day08.ppt

Students:

1. mineral samples & streak plates from Holt materials kit

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
5 minutes – visualization 1.2a – Labels
5 minutes – visualization 1.2b – Captions
25 minutes – chapter 1.2, parts 1 through 4

Chapter 1.2, parts 1 through 4

Distribute the mineral samples from the Holt kit and encourage students to identify properties of the samples as they work through this section. When they learn about luster, for example, they can see that galena and pyrite are both metallic, and calcite and feldspar are vitreous.

Distribute the streak plates when students reach that section. When you get to the section on cleavage and fracture, rather than having students break up their mineral samples, have them compare each sample with the cleavage and fracture descriptions in the table on pages 210 and 211.

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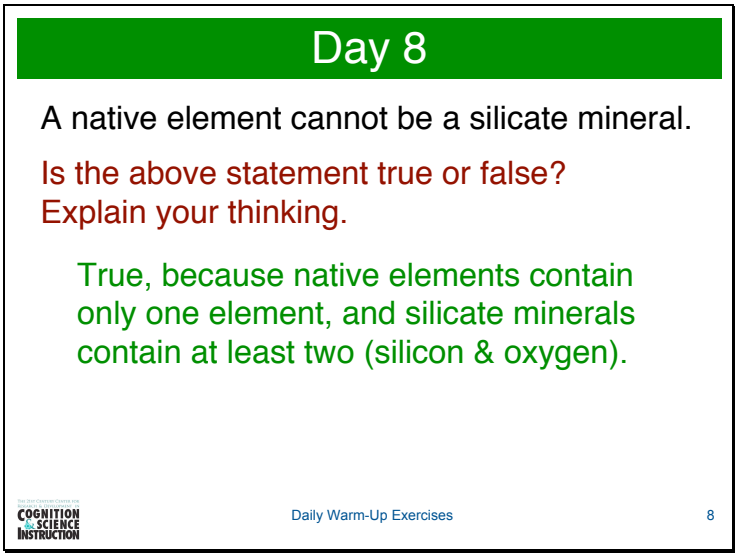
Day 8 – Identifying Minerals

Warm-Up Activity



What is a mineral?

a naturally formed, inorganic solid that has a definite crystalline structure

Is the compound H_2O a mineral?

It depends. Ice is a mineral, but liquid water and water vapor aren't minerals.

Day 8 – Identifying Minerals

Visualization Exercise 1.2a – Labels

Image Comprehension Focus: Labels

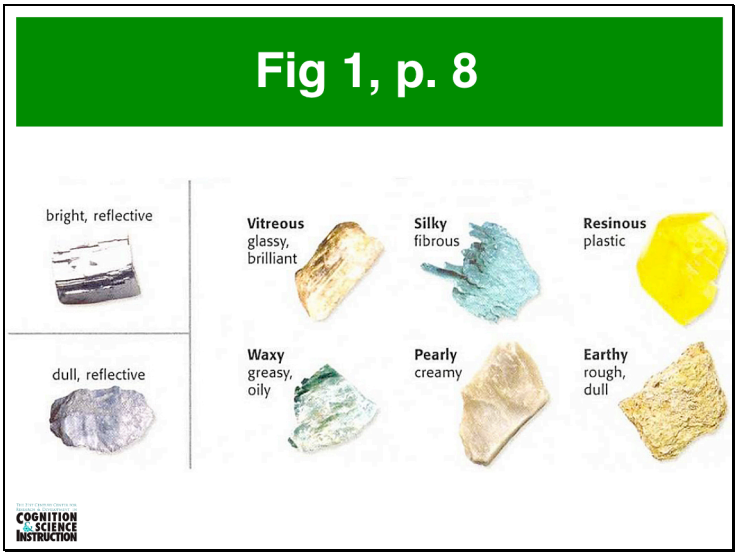
Goal: To understand the importance of reading naming labels when looking at a diagram.

Type of Activity: Teacher Guided Student Activity

Overview: The purpose of this activity is to emphasize the importance of naming labels in diagrams.

(Continue to the next slide)

Visualization Exercise 1.2a – Labels (cont.)



Procedure: The teacher has students open their textbooks and take two minutes to look over Figure 1 on page 8. The teacher then has the students close their textbooks, and projects the above image of Figure 1, page 8 (with certain labels missing). The teacher then asks students to categorize each type of luster as being either Metallic, Submetallic, or Nonmetallic. This may be difficult to do as this information is missing from the above version of Figure 1.

After reviewing the students' answers, the teacher has the students open their textbooks again to Figure 1 on page 8 and again categorize the types of luster. The teacher then reviews the correct answers, emphasizing the importance and usefulness of reading the labels when looking at a diagram.

Additional Teacher Comment: The teacher can ask the students why some of the words (labels) are in bold and others are not. The teacher can explain that the words in bold are the terms that would normally be used by the geologists, while the other words are used to describe those terms to people who may not be familiar with such terms.

(End of Activity)

Day 8 – Identifying Minerals

Visualization Exercise 1.2b – Captions

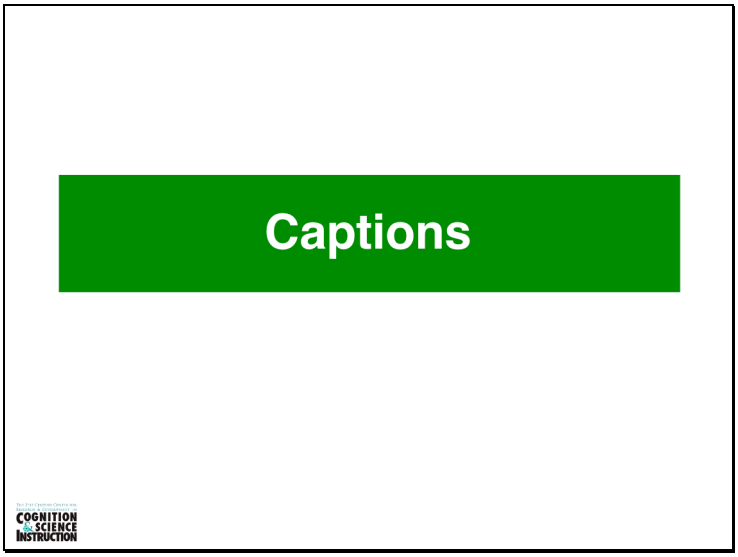


Image Comprehension Focus: Captions

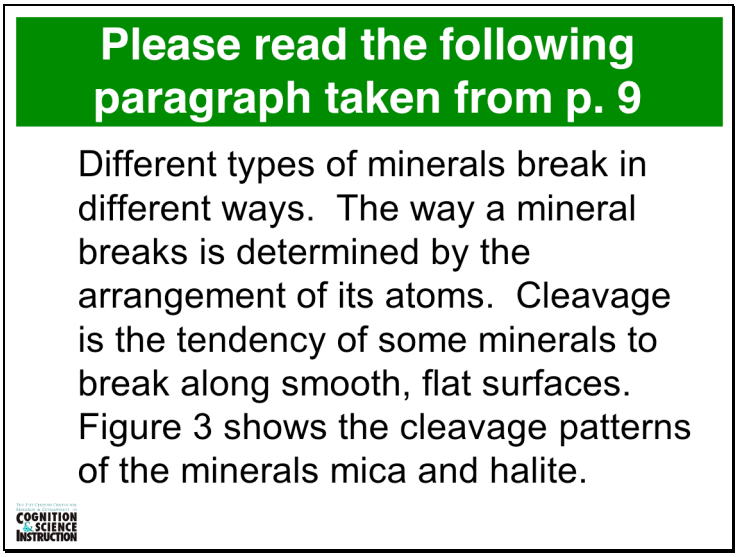
Goal: To reinforce the importance of captions.

Type of Activity: Teacher Guided Student Activity

Overview: This activity is designed to emphasize the importance of reading captions when looking at diagrams and how captions often contain critical information that otherwise may be missed when not reading the caption.

(Continue to the next slide)

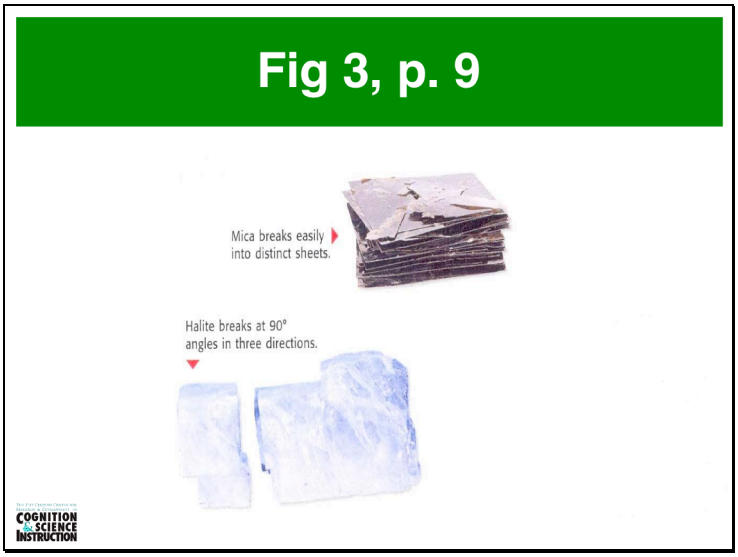
Visualization Exercise 1.2b – Captions (cont.)



Procedure: The teacher projects the above slide of a paragraph taken from page 9 of the textbook and gives students a couple of minutes to read the paragraph.

(Continue to the next slide)

Visualization Exercise 1.2b – Captions (cont.)



After the students have read the paragraph, the teacher projects the above image of Figure 3 from p. 9 (without a caption).

The teacher then has students (either individually or in small groups), write what they believe to be a good caption for Figure 3.

After the students have shared their own captions, the teacher then has students open their textbooks to page 9 in order to see the caption used by the author for Figure 3.

The teacher can then lead a discussion about the similarities and differences between the caption used by the author and the captions created by the students, emphasizing the point that captions often will contain information that is critical in being able to understand a diagram and should not be overlooked.

(End of Activity)

DAY 9

More Properties of Minerals

This lesson covers the rest of section 1.2 (pages 10-11) and includes a quick lab.

Big Idea

- Properties like hardness and density, and special properties like magnetism and radioactivity can be used to identify minerals.

Materials

Teacher:

1. visualization exercises – day09.ppt

Students:

1. penny
2. pencil
3. mineral samples from Holt materials kit

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
5 minutes – visualization 1.2c – Captions
10 minutes – quick lab – Scratch Test – page 10
20 minutes – chapter 1.2, parts 5 through 7

Chapter 1.2, parts 5 through 7

From their study of *Introduction to Matter*, students should recall density as heaviness-for-size, or the ratio of mass to volume. They should also remember that density is a characteristic property of a material, which means it does not change with sample size. In other words, if we were to determine the density of one of the galena samples in the Holt kit, we should get roughly the same number for all the other galena samples.

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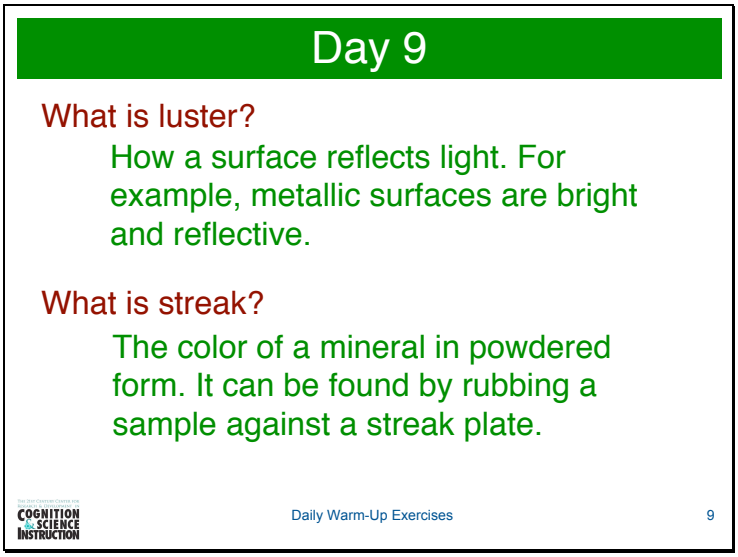
Day 9 – More Properties of Minerals

Warm-Up Activity



Why are properties like luster and streak useful?
They can be used to identify minerals.

After students complete today's scratch-test quick lab, ask:

What would happen if the sample were harder than the streak plate?
It would scratch the streak plate and leave a white streak of powdered porcelain.

Day 9 – More Properties of Minerals

Visualization Exercise 1.2c – Captions

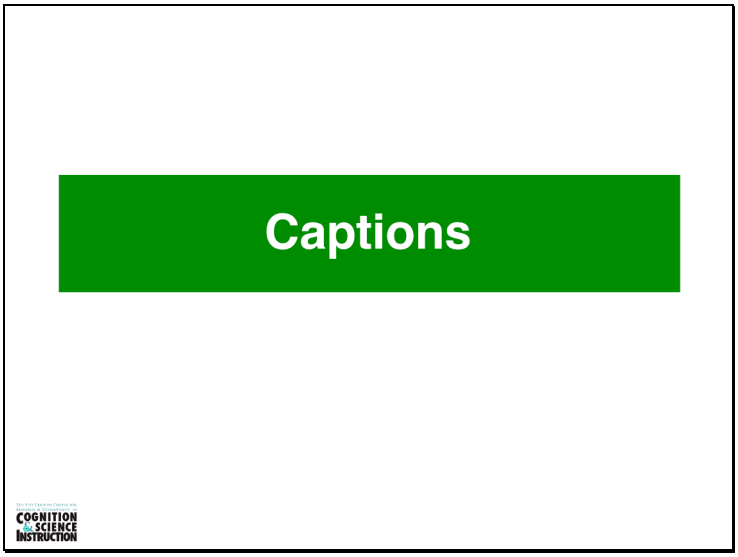


Image Comprehension Focus: Captions

Goal: To show how captions may be used to convey important information in a diagram.

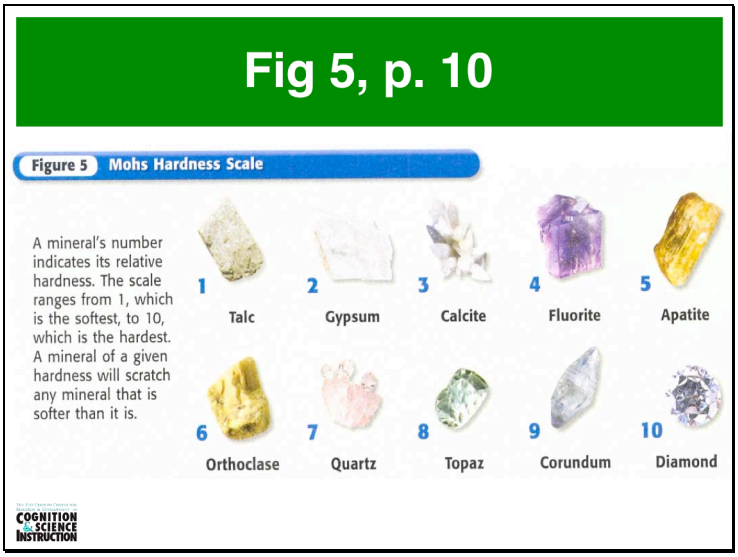
Type of Activity: Teacher Guided Student Activity

Overview: This activity is designed to show students how captions can be used to convey important information in diagrams.

(Continue to the next slide)

Day 9 – More Properties of Minerals

Visualization Exercise 1.2c – Captions (cont.)



Procedure: The teacher asks students to open their textbooks to page 10 and look at Figure 5 (shown above if the teachers wants to project it). Note – students can read along in their books if the projected text is difficult to read.

- The teacher then asks the following questions:
- The softest mineral shown in Figure 5 is _____ [Talc]
- The hardest mineral shown in Figure 5 is _____ [Diamond]
- Quartz is softer/harder than Orthoclase. [harder]
- True or False? Apatite is harder than Fluorite, but not as hard as Topaz. [True]

The teacher reviews the answers with students, asking what pieces of information they used from the diagram in order to answer the questions. The teacher points out that without the caption, it would be difficult to tell what role the numbers play in this particular diagram. Likewise, without the numbers, it would be difficult to understand the scale.

(End of Activity)

DAY 10

Quiz 2/Reteach/Review

This lesson provides an opportunity for students to review what they've learned so far. For some, it may be an opportunity to understand an idea they didn't fully grasp the first time around.

Big Ideas
See list of big ideas, Days 1-9.

Materials

Teacher:

1. vocabulary list – RE word list.doc
2. list of big ideas – RE big ideas.pdf

Students:

1. Quiz 2

Activities & Allotted Time (40 minutes total)

10 minutes – quiz
10 minutes – go over quiz
20 minutes – re-teach/review chapter 1.1 and 1.2

Reteach/Review Chapter 1.1 and 1.2
After going over the quiz and reviewing the meanings of vocabulary words and the big ideas from days 1-9, use the section review questions on pages 7 and 11 to identify areas that need additional attention.

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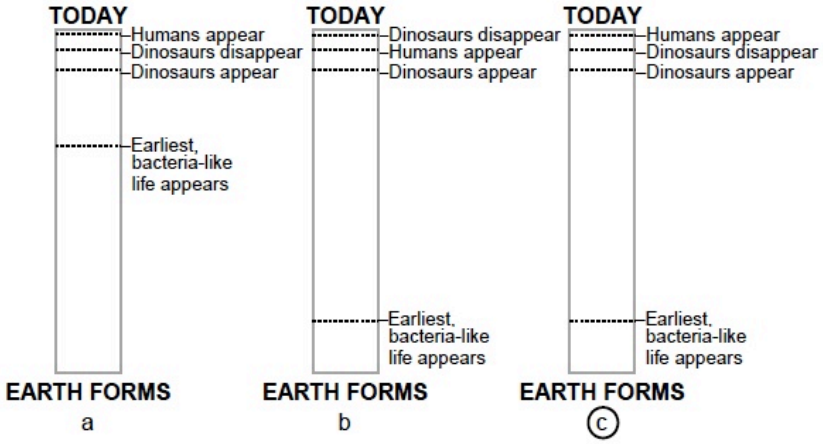
Day 10 – Quiz 2/Reteach/Review

Quiz 2 – Page 1

1. What does a proportional time scale show?
   a. How many years ago different events occurred.
   b. The locations at which different events occurred.
   (c.) How different parts of Earth's history compare to the whole.

2. Which of the figures below most closely represents changes in life on earth over time?



3. Which of the following is true about both rocks and minerals?
   a. Both can be elements or compounds.
   (b.) Both are solids, and neither is man-made.
   c. Both can be organic or inorganic.

4. What type of structure does a mineral have?
   (a.) crystalline
   b. amorphous
   c. can be crystalline or amorphous

5. What type of structure does a rock have?
   a. crystalline
   b. amorphous
   (c.) can be crystalline or amorphous

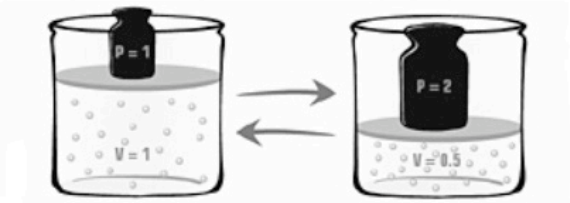
Inside the Restless Earth

Day 10 – Quiz 2/Reteach/Review

Quiz 2 – Page 2

6. Which property measures the ability of a mineral to resist scratching?
   a. density
   (b) hardness
   c. luster

7. **Note to student:** We know you didn't study this recently, but we want you to try to answer the question based on the information in the diagram.



Boyle's Law: The volume of a gas is inversely proportional to its pressure. That is, if the pressure increases, the volume decreases. Similarly, the volume would increase if the pressure decreased.

According to the above model of Boyle's Law, if one were to increase the volume of a gas, the pressure of the gas would _____.
   (a) decrease
   b. increase
   c. remain the same
   d. increase, then decrease

8. Name and describe two properties that can be used to identify minerals.

Streak is the color of a mineral in powdered form. Luster is how the surface reflects light. Hardness is the ability to resist scratching. Density is heaviness-for-size, or the ratio of mass to volume.

Inside the Restless Earth

DAY 11

Mineral Formation

This lesson covers part 1 of section 1.3 (pages 12-13).

Big Idea

- A mineral's properties are determined by how it forms and what it is made of.

Materials

Teacher:

1. visualization exercises – day11.ppt

Students:

1. mineral samples from Holt materials kit

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
5 minutes – visualization 1.3a – Zoom and Labels
30 minutes – chapter 1.3, part 1 – *The Formation of Minerals*

Chapter 1.3, part 1

Most of the information in part 1 is conveyed through the figure that spans pages 12 and 13. Distribute the sample minerals and have students find each sample in the figure. Biotite is a form of mica, which is listed in two places, under metamorphic rocks and plutons. Calcite also has two listings, under metamorphic rocks and limestones. To help students begin to understand the connection between formation and properties, encourage them to speculate about how each environment may have resulted in the properties of the samples. Accept all ideas at this point, and tell students they'll learn more about formation processes in chapter 2.

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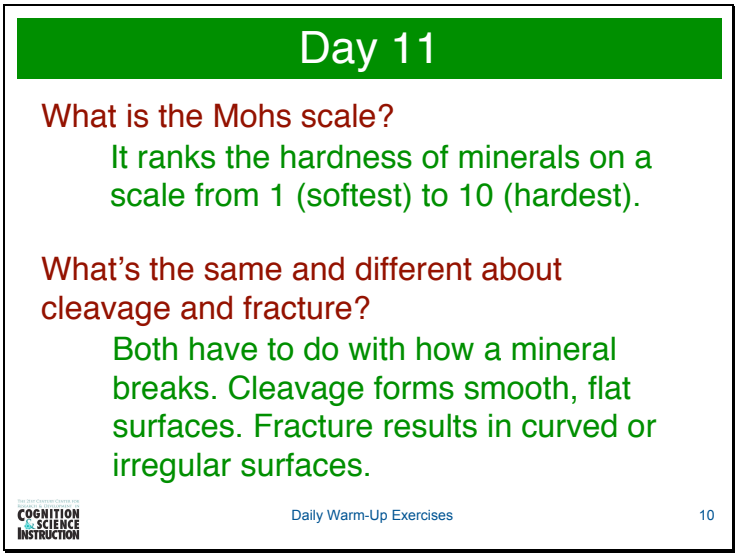
Day 11 – Mineral Formation

Warm-Up Activity



How can you tell if one mineral is harder than another?

Try to scratch one with the other. The one that leaves a mark is harder.

What determines how a mineral will break?

the arrangement of its atoms or molecules

Day 11 – Mineral Formation

Visualization Exercise 1.3a – Zoom and Labels

Image Comprehension Focus: Zoom and Labels

Goal: To understand the use of the zoom convention and the importance of labels in diagrams

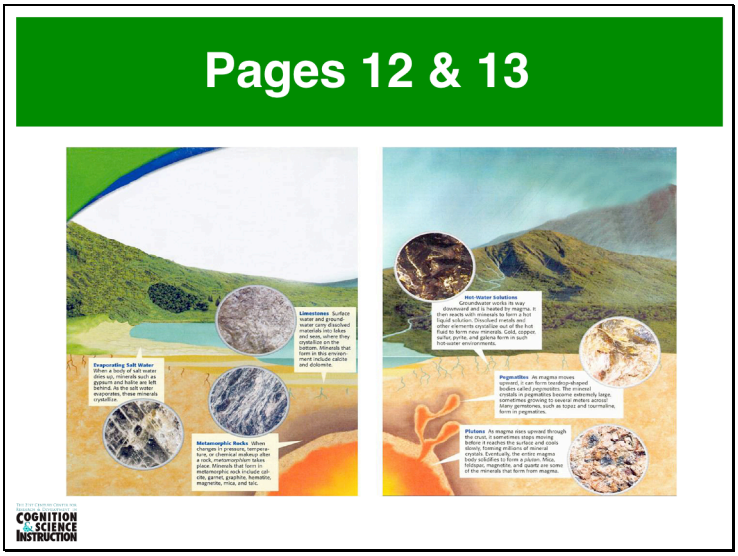
Type of Activity: Teacher guided student activity

Overview: This exercise is designed to show students one way in which the zoom convention can be used, as well as illustrate how labels can contain important information that otherwise would be missed when looking at a diagram.

(Continue to the next slide)

Day 11 – Mineral Formation

Visualization Exercise 1.3a – Zoom and Labels (cont.)



Procedure: The teacher asks students to open their textbooks to pages 12 and 13 (shown above so that the teacher can also project it). Next, the teacher asks students, either individually or in small groups, to point out the following conventions in the above diagram:

- Examples of naming labels [e.g. Metamorphic Rocks, Limestones, Plutons]
- Examples of the zoom convention [The six circles or bubbles shown]
- Examples of explanatory labels [The words under the naming labels]

The teacher asks the students to share their answers and provides the correct answers/additional examples as necessary.

The teacher should then ask the students about the relationship(s) between the naming label, zoom bubble and explanatory labels. That is, the zoom bubble can illustrate by use of a picture the thing being described which otherwise is unable to be seen. The explanatory label may explain something about this picture and it is given a name by the naming label. More specifically, Metamorphic Rock is naming the type of rock, while the words underneath are explaining the process that leads to this type of rock. The zoom bubble involved is showing a picture of a metamorphic rock that is otherwise unable to be seen in the diagram.

(End of Activity)

DAY 12

Mining & Use of Minerals

This lesson covers the rest of section 1.3 (pages 14-17).

Big Ideas

- Reclamation reduces the harmful effects of mining by returning land to its original condition after mining is completed.

Materials

Teacher:

1. visualization exercises – day12.ppt

Students:

none

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
5 minutes – visualization 1.3b – Cut-Away and Zoom
5 minutes – visualization 1.3c – Labels
25 minutes – chapter 1.3, parts 2 through 4

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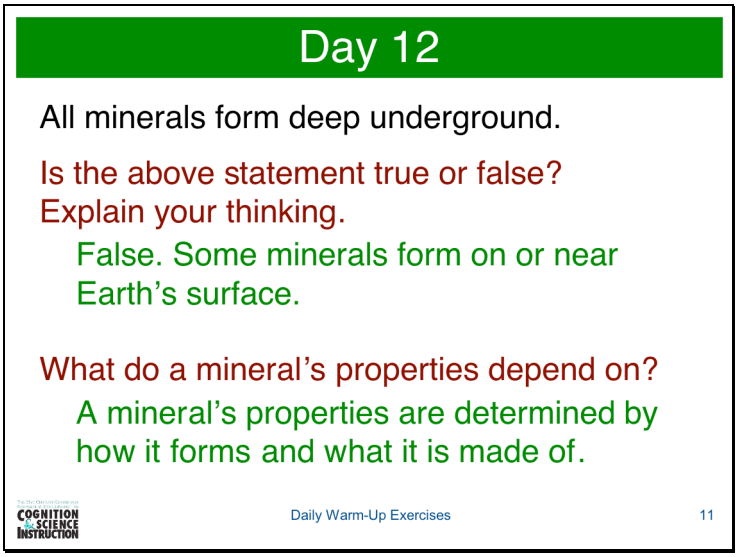
Day 12 – Mining & Use of Minerals

Warm-Up Activity



What is density?

heaviness-for-size; the ratio of mass to volume; a characteristic property of a material

Day 12 – Mining & Use of Minerals

Visualization Exercise 1.3b – Cut-Away and Zoom

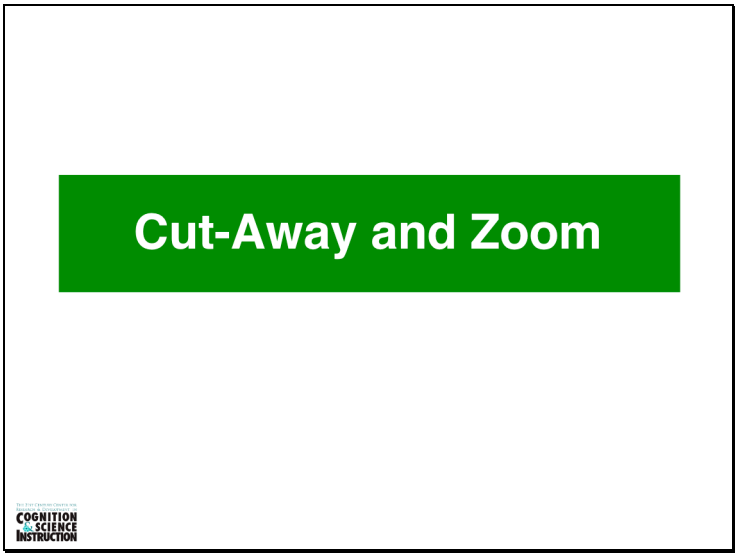


Image Comprehension Focus: Cut-Away and Zoom

Goal: 1) To understand the use of the cut-away convention when looking at certain diagrams, and 2) to further understand the use of zoom

Type of Activity: Teacher Guided Student Activity

Overview: This activity is designed to show students how the cut-away convention can be helpful to use in certain diagrams as well as reinforce understanding of the zoom convention.

(Continue to the next slide)

Day 12 – Mining & Use of Minerals

Visualization Exercise 1.3b – Cut-Away and Zoom (cont.)

Fig 2, pg. 15

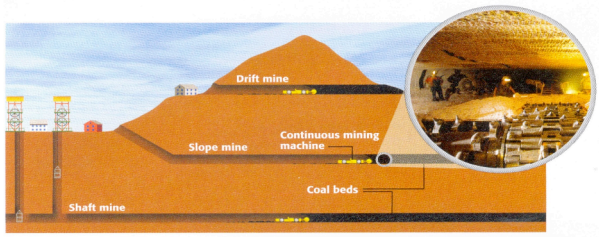


Figure 2 *Subsurface mining is the removal of minerals or other materials from deep within the Earth. Passageways must be dug underground to reach the ore. Machines such as continuous mining machines (inset) are used to mine ore in subsurface mines.*

Procedure: The teacher has the students open their textbooks to page 15 and has them look at Figure 2 (shown above if the teacher wants to project it).

The teacher asks the students what type of perspective they believe this diagram to be and what this type of perspective is trying to represent. The teacher then discusses how this is a cut-away (2D) perspective and that this perspective is being used in order to show the different types of passageways that are used for subsurface mining (that otherwise would be difficult to see). It is important for the teacher to emphasize that this type of perspective is a representation of what these passageways may look like and that diagrams can often represent complex features in a more simplified manner by using certain conventions such as this type of cut-away.

(Continue to the next slide)

Visualization Exercise 1.3b – Cut-Away and Zoom (cont.)

Fig 2, pg. 15

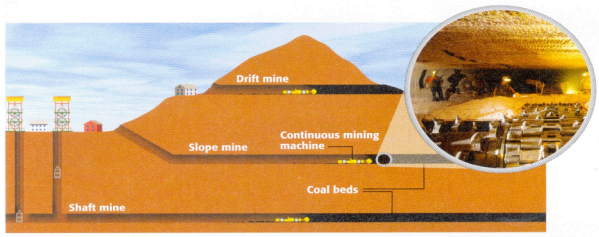


Figure 2 *Subsurface mining is the removal of minerals or other materials from deep within the Earth. Passageways must be dug underground to reach the ore. Machines such as continuous mining machines (inset) are used to mine ore in subsurface mines.*

The teacher then has students pay particular attention to the picture in the circle on the right hand side of the diagram.

The teacher asks the students why the author has chosen to use that bigger circle as part of the diagram. Then, depending on students' answers, the teacher can explain that the author has chosen to use this type of zoom feature in order to show something that would otherwise be difficult to see. In this case, the zoom bubble shows the actual miners and the machinery being used inside the passageways depicted in Figure 2.

The teacher can also point out that the zoom convention used in this particular diagram allows the students to actually see the type of information being given from the caption.

(End of Activity)

Day 12 – Mining & Use of Minerals

Visualization Exercise 1.3c – Labels

Image Comprehension Focus: Labels

Goal: To further emphasize the importance of labels in diagrams

Type of Activity: Teacher Guided Student Activity

Overview: This exercise is designed to reinforce the point that labels should not be skipped when looking at a diagram because they often contain critical information which may not be known by simply looking at the picture.

(Continue to the next slide)

Day 12 – Mining & Use of Minerals

Visualization Exercise 1.3c – Labels (cont.)

Procedure: The teacher shows students the above (altered) image of Figure 3 from page 16. The teacher advises students, either individually or in small groups, to use information from the diagram in order to answer the following questions (which should be difficult to do because of the missing labels):

- Titanium from ilmenite was used in order to make the _____ on the bike. [handlebars]
- The spokes are made out of _____ from _____. [iron, magnetite]
- The pedals are made of beryllium from _____. [beryl]
- The _____ is made of aluminum from _____. [frame, bauxite]

The teacher then asks students by show of hands if anyone was able to answer the above questions.

(Continue to the next slide)

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Visualization Exercise 1.3c – Labels (cont.)

The teacher then projects the original image of Figure 3, pg. 16 (or has students turn to page 16 in their textbooks) and now has students answer the same questions.

The teacher then reviews the correct answers, emphasizing, as in previous exercises, that labels can contain critical information that otherwise would not be known simply by looking at the picture.

(End of Activity)

End-of-Section Survey – Chapter 1

activity	did as des-cribed	modi-fied	didn't do	comments
Day 6 Warm-Up (page 42)				
cc 1.1–Compare Rocks & Minerals (pages 41-56)				
Day 7 Warm-Up (page 58)				
vis 1.1a–Color (pages 59-61)				
vis 1.1b–Relative Scale (pages 62-63)				
vis 1.1c–Arrows (pages 64-66)				
vis 1.1d–Labels (pages 67-68)				
vis 1.1e–Labels (pages 69-70)				
chp 1.1–*What is a Mineral?* (page 57-58 & Holt, pages 4-7)				
Day 8 Warm-Up (page 72)				
vis 1.2a–Labels (pages 73-74)				
vis 1.2b–Captions (pages 75-77)				
chp 1.2, parts 1-4 (page 71 & Holt, pages 8-9)				

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End-of-Section Survey – Chapter 1

activity	did as described	modified	didn't do	comments
Day 9 Warm-Up (page 79)				
vis 1.2c–Captions (pages 80-81)				
quick lab – *Scratch Test* (Holt page 10)				
chp 1.2, parts 5-7 (page 78 & Holt, pages 10-11)				
Quiz 2 (pages 83-84)				
Reteach/Review Chp. 1.1 & 1.2 (page 82)				
Day 11 Warm-Up (page 86)				
vis 1.3a–Zoom & Labels (pages 87-88)				
chp 1.3, part 1 (page 85 & Holt, pages 12-13)				
Day 12 Warm-Up (page 90)				
vis 1.3b–Cut-Away & Zoom (pages 91-93)				
vis 1.3c–Labels (pages 94-96)				
chp 1.3, parts 2-4 (page 89 & Holt, pages 14-17)				

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DAY 13

Trilobite Hunter

This lesson is the first half of contrasting case activity 2.2, in which students compare the formation of two igneous rocks. The activity opens with a brief description of Earth's interior and a story/video about hunting trilobite fossils in the Grand Canyon.

Big Ideas

- There is heat and pressure inside the Earth, and they get more and more extreme the deeper you go.
- The Grand Canyon only formed about 10 million years ago, but its rocks reveal geologic events that happened as many as 1.7 billion years ago.
- Igneous rocks form when molten rock cools and hardens.

Materials

Teacher:

1. slides – day13.ppt
2. Grand Canyon Video, part 1

Students:

1. story – worksheet 12
2. igneous cards & comparison table – worksheets 13 & 14
3. granite & pumice samples from the Holt kit
4. hand lenses

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
35 minutes – cc activity – compare rock formation, part 1a

Compare Rock Formation, part 1a

In today's activity, students will compare the formation of two igneous rocks. On Day 14, they will compare the formation of two sedimentary rocks. On Day 23, they will compare the formation of two metamorphic rocks, and on Day 24, they will use the comparison tables for all three rock types to investigate and depict the rock cycle.

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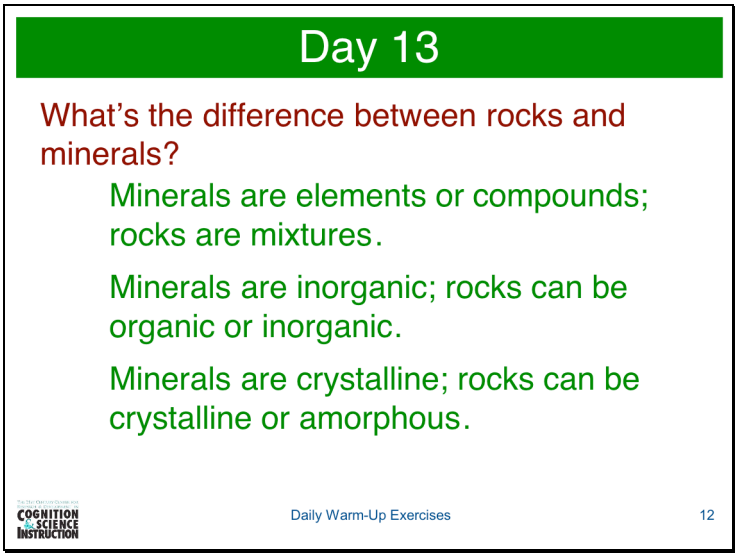
Day 13 – Trilobite Hunter

Warm-Up Activity



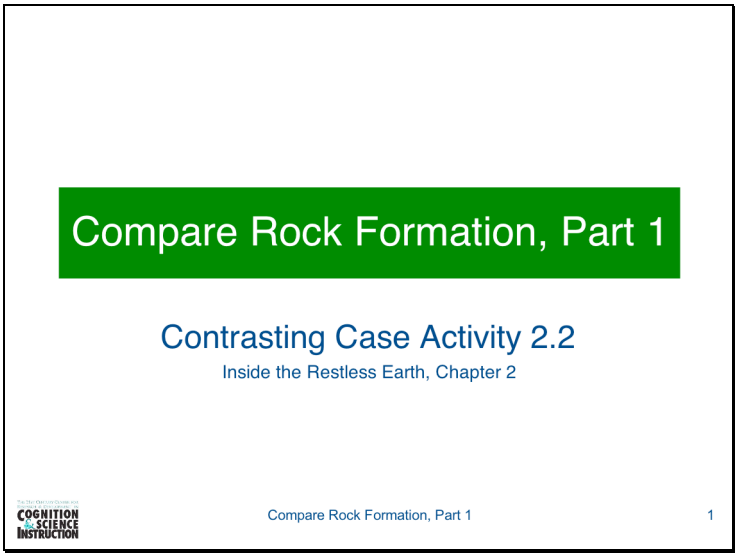
Answers will appear separately on keypress.

Can you name the three rock types?
igneous, metamorphic, & sedimentary

Tell students that, for the next few days, they will be focusing on igneous & sedimentary rocks.

Day 13 – Trilobite Hunter

Compare Rock Formation, part 1a (cont.)



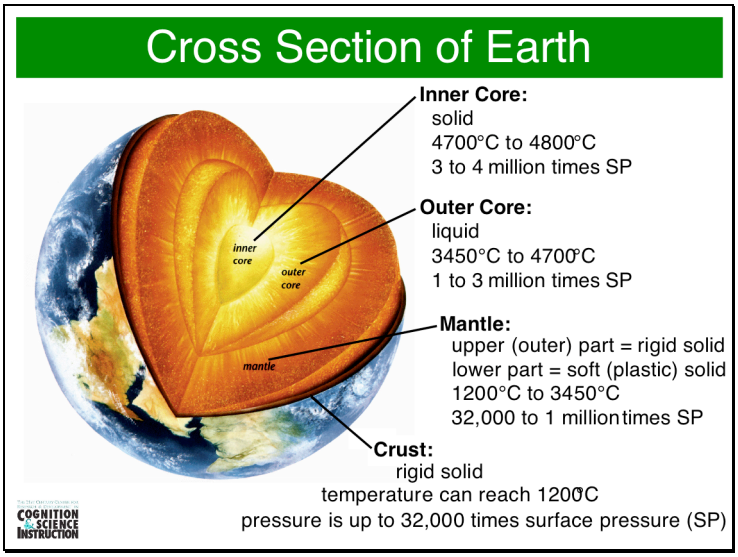
Materials needed:

- Trilobite Hunter story (worksheet 12)
- Grand Canyon Videos, parts 1 & 2
- granite & pumice samples from the Holt kit
- sandstone & limestone samples, if you have them
- hand lenses
- rock formation cards (worksheet 13 & 15)
- comparison tables (worksheets 14 & 16)

STUDENTS WILL NEED THESE TABLES FOR CONTRASTING CASE ACTIVITY 2.4 ON DAY 24.

Day 13 – Trilobite Hunter

Compare Rock Formation, part 1a (cont.)



The purpose of this slide is to help students begin to appreciate the conditions of extreme heat and pressure that exist deep underground. The information will appear line-by-line on keypress, starting with the crust and moving toward the center of the Earth. At each level, ask your students to make predictions about state of matter, temperature, and pressure.

The upper part of the mantle is rigidly solid like the crust. The lower part is a soft solid that flows very slowly. It's called a plastic solid, and it behaves a lot like Silly Putty.

Students don't need to memorize the numbers, but they need to understand that there is heat and pressure inside the Earth, and they get more and more extreme the deeper you go. They will learn more about the inside of Earth in chapter 4.

Day 13 – Trilobite Hunter

Compare Rock Formation, part 1a (cont.)

Distribute the Trilobite Hunter story (worksheet 12) and have students read it. [A longer version of the story is displayed in slides 4 through 9, in case you want to go through the text as a group.]

Your students may recall that trilobites were listed in the time scales they worked with in cc 3.5. Tell them trilobites were hard-shelled creatures similar to lobsters and crabs. They first appeared more than 500 million years ago and are now extinct. There were thousands of different kinds of trilobites, and they ranged in size from really tiny to over two feet long. Most were about an inch long.

Tell students that there are some places where it's easy to find lots of different kinds of rocks. The Grand Canyon is one of those places, because you can see rock layers there that are over a billion years old. Tell them that, in the story, the friend's rock is called pumice. We're going to go find some pumice in the Grand Canyon and try to figure out why the friend's rock doesn't have a trilobite fossil.

At this time, show Grand Canyon Video, part 1, then proceed to slide 10 to begin the hands-on portion of the activity.

Day 13 – Trilobite Hunter

Compare Rock Formation, part 1a (cont.)
The next six slides provide a slightly longer version of the Trilobite Hunter story, in case you want to go through the text as a group. If you use the printed version, skip to slide 10 to begin the hands-on portion of the activity.

Rock Hunt

Imagine you are on a field trip to a local quarry with your school. The teacher asks everybody to find the coolest rock they can and bring it back to her.

You and your friend go to opposite sides of the quarry. You both find rocks at the same time and you wave to each other.

Compare Rock Formation, Part 1 4

Two Rocks

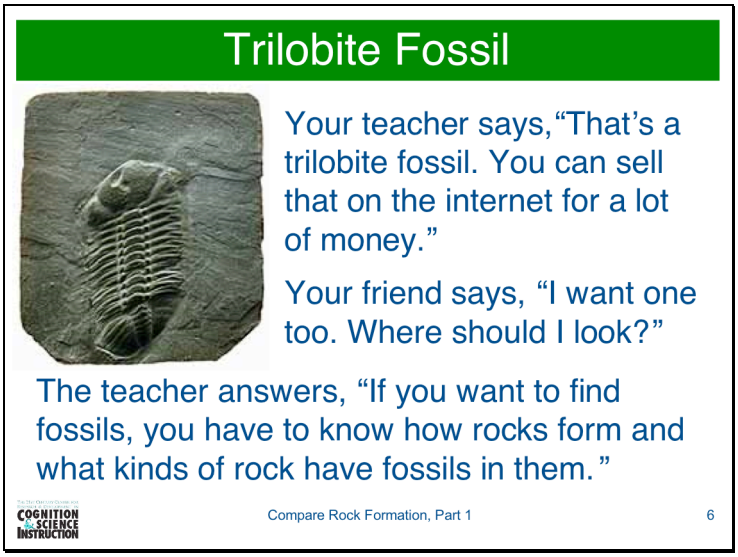
Your friend brings back a rock that is really light and has a lot of tiny holes.

You bring back a grey rock marked with what looks like a picture of a bug.

5

Day 13 – Trilobite Hunter

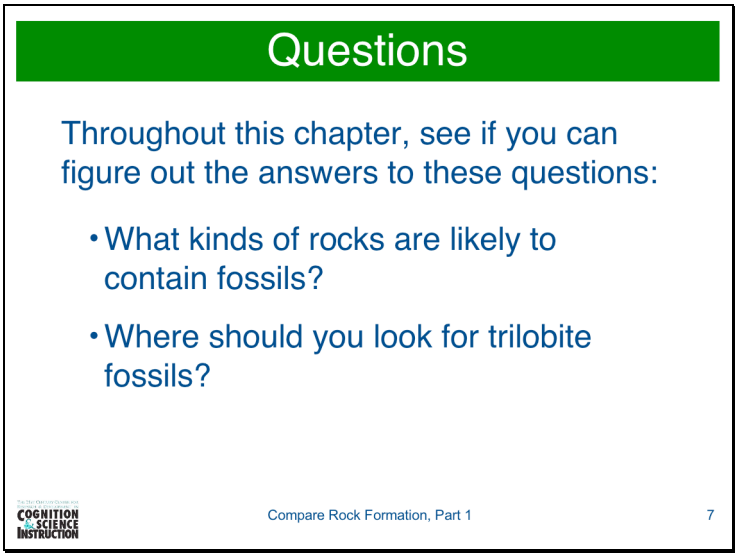
Compare Rock Formation, part 1a (cont.)

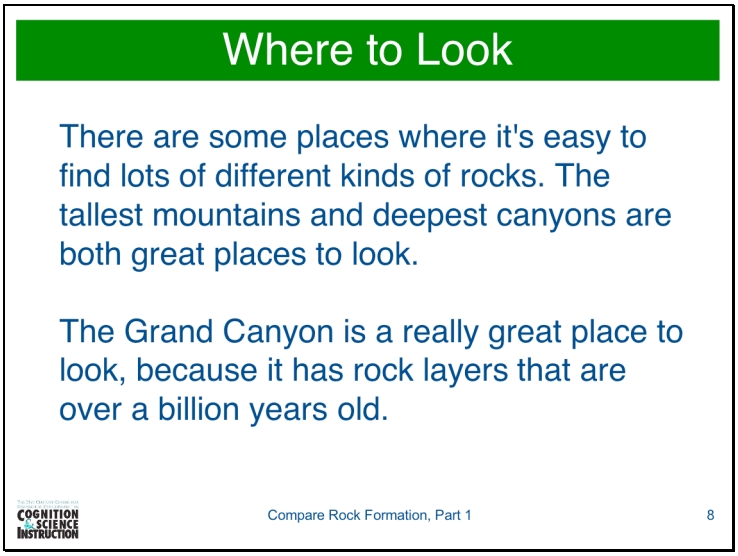


Your students may recall that trilobites were listed in the time scales they worked with in cc 3.5. Tell them trilobites were hard-shelled creatures similar to lobsters and crabs. They first appeared more than 500 million years ago and are now extinct. There were thousands of different kinds of trilobites, and they ranged in size from really tiny to over two feet long. Most were about an inch long.

Day 13 – Trilobite Hunter

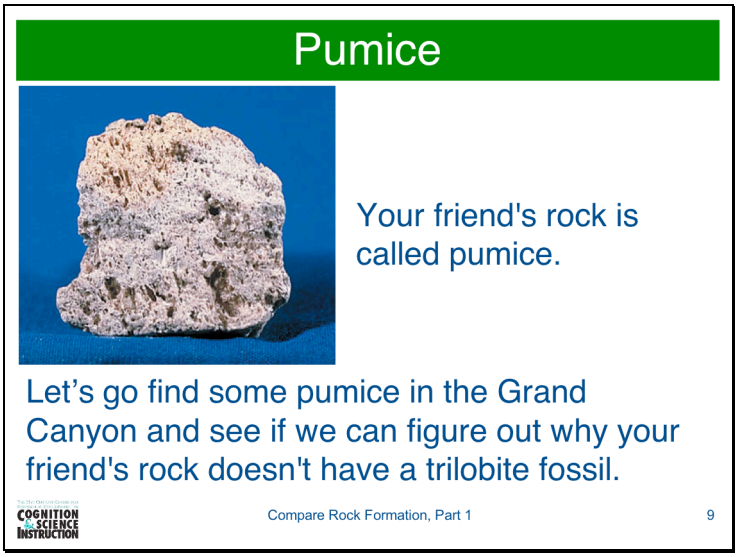
Compare Rock Formation, part 1a (cont.)





Day 13 – Trilobite Hunter

Compare Rock Formation, part 1a (cont.)

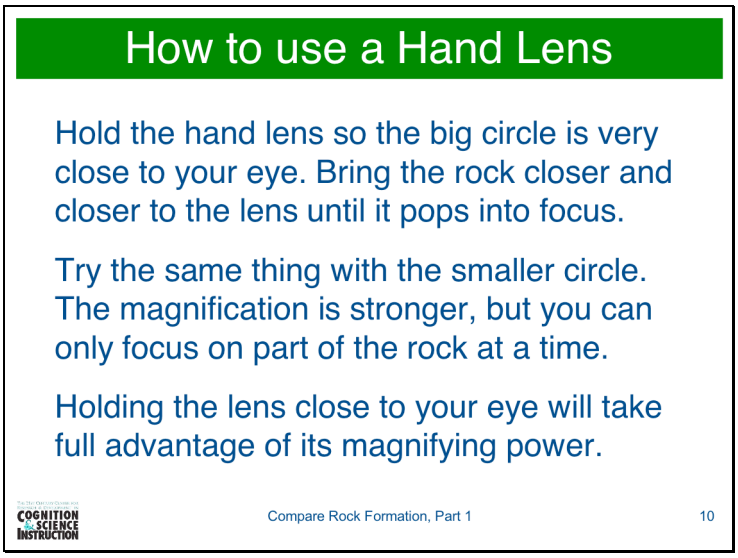


At this time, show the Grand Canyon Video, part 1.

When the video is finished, proceed to the next slide to begin the hands-on portion of the activity.

Day 13 – Trilobite Hunter

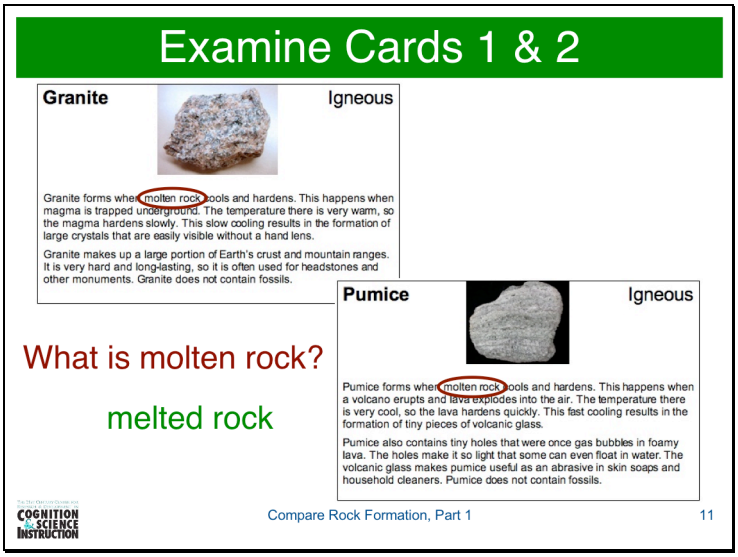
Compare Rock Formation, part 1a (cont.)
After reading the story, students watch a video that introduces the Grand Canyon as an ideal place for finding all kinds of rocks. The video ends by introducing two igneous rocks commonly found in the Grand Canyon, pumice and granite. At this point, students begin the hands-on portion of the activity.



Distribute the hand lenses and rock samples. Demonstrate how to use a hand lens and give your students a few minutes to practice.

Day 13 – Trilobite Hunter

Compare Rock Formation, part 1a (cont.)

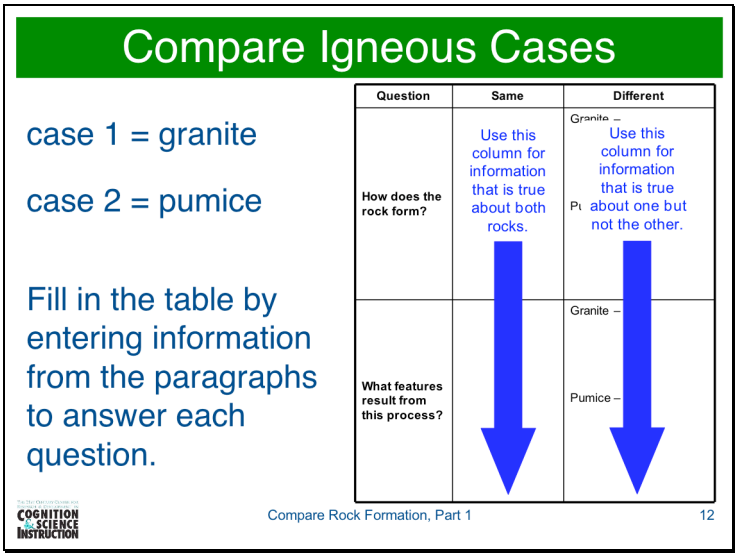


Distribute the igneous formation cards (Granite & Pumice, worksheet 13). The circles, question, and answer will appear on keypress.

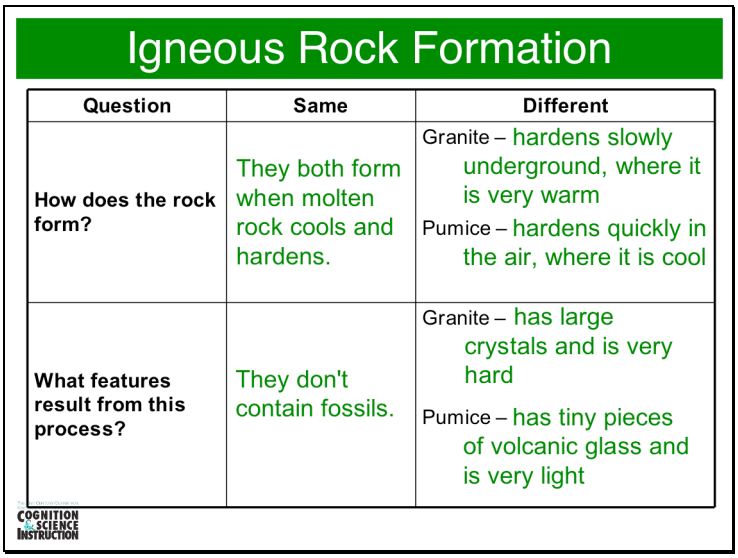
Encourage students to compare their rock samples with the pictures and descriptions on the cards.

Day 13 – Trilobite Hunter

Compare Rock Formation, part 1a (cont.)



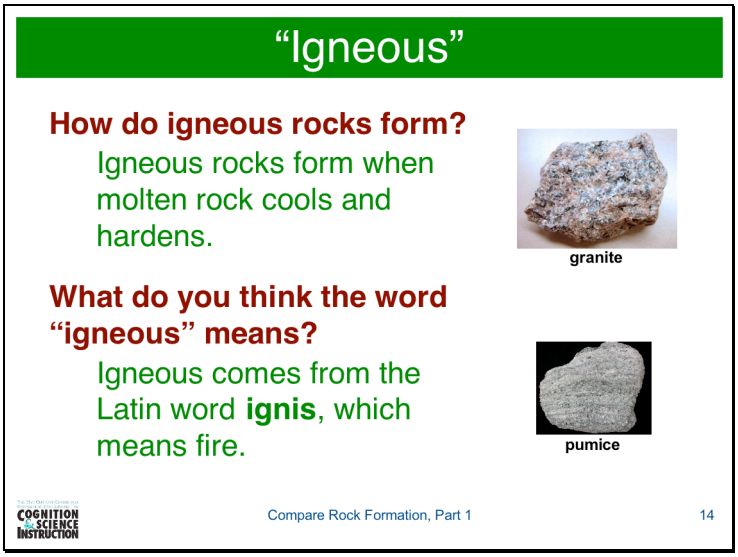
Distribute the igneous comparison table (worksheet 14). Have students work in groups, then share ideas with the class. The next slide shows the completed table for the two igneous rocks.



Answers will appear separately on keypress.

Day 13 – Trilobite Hunter

Compare Rock Formation, part 1a (cont.)



If your students need help with the second question, ask if they can think of any words that are similar, then ask what those words mean. For example, ignite means to light a fire. Ignition is the system that provides the spark in an internal-combustion engine.

Tell your students that igneous rocks got their name because people used to think volcanoes were caused by fire inside the Earth.

Day 13 – Trilobite Hunter

Worksheet 12

Compare Rock Formation, Part 1 — 12

Trilobite Hunter

Imagine your class is on a field trip to a local quarry. The teacher asks everybody to find the coolest rock you can and bring it back to her. You and your friend go to opposite sides of the quarry.

Your friend brings back a rock that hardly weighs anything and is full of tiny holes. You bring back a gray rock marked with what looks like a picture of a bug.

Your teacher says, "That's a trilobite fossil. You can sell that rock on the internet for a lot of money."

Your friend says, "Where can I find a trilobite fossil?"

The teacher answers, "if you want to find fossils, you have to know about how rocks form and where rocks that contain fossils are likely to be found."

Throughout this chapter, see if you can figure out the answers to these questions:

- What kinds of rocks are likely to contain fossils?
- Where should you look for trilobite fossils?

Chapter 2 – Rocks: Mineral Mixtures

Day 13 – Trilobite Hunter

Worksheet 13

Compare Rock Formation, Part 1 — 13

Granite — Igneous

Granite forms when molten rock cools and hardens. This happens when magma is trapped underground. The temperature there is very warm, so the magma hardens slowly. This slow cooling results in the formation of large crystals that are easily visible without a hand lens.

Granite makes up a large portion of Earth's crust and mountain ranges. It is very hard and long-lasting, so it is often used for headstones and other monuments. Granite does not contain fossils.

Pumice — Igneous

Pumice forms when molten rock cools and hardens. This happens when a volcano erupts and lava explodes into the air. The temperature there is very cool, so the lava hardens quickly. This fast cooling results in the formation of tiny pieces of volcanic glass.

Pumice also contains tiny holes that were once gas bubbles in foamy lava. The holes make it so light that some can even float in water. The volcanic glass makes pumice useful as an abrasive in skin soaps and household cleaners. Pumice does not contain fossils.

Chapter 2 – Rocks: Mineral Mixtures

Day 13 – Trilobite Hunter

Worksheet 14

Compare Rock Formation, Part 1 — 14

Igneous – Granite & Pumice

Question	Same	Different
How does the rock form?		Granite – Pumice –
What features result from this process?		Granite – Pumice –

Chapter 2 – Rocks: Mineral Mixtures

DAY 14

Compare Formation

This lesson is the second half of contrasting case activity 2.2. The activity opens with a brief return to the Trilobite Hunter story, and students watch a video segment that introduces the two sedimentary rocks they will compare today.

Big Ideas

- There is heat and pressure inside the Earth, and they get more and more extreme the deeper you go.
- The Grand Canyon only formed about 10 million years ago, but its rocks reveal geologic events that happened as many as 1.7 billion years ago.
- Igneous rocks form when molten rock cools and hardens.
- Sedimentary rocks form when particles settle and get compacted and cemented together.

Materials

Teacher:

1. slides – day14.ppt
2. Grand Canyon Video, part 2

Students:

1. sedimentary cards & comparison table – worksheets 15 & 16
2. sandstone & limestone samples, if you have them
3. hand lenses

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
35 minutes – cc activity – compare rock formation, part 1b

Compare Rock Formation, part 1b

On Day 13, students compared the formation of two igneous rocks. In today's activity, they will compare the formation of two sedimentary rocks. On Day 23, they will compare the formation of two metamorphic rocks, and on Day 24, they will use the comparison tables for all three rock types to investigate and depict the rock cycle.

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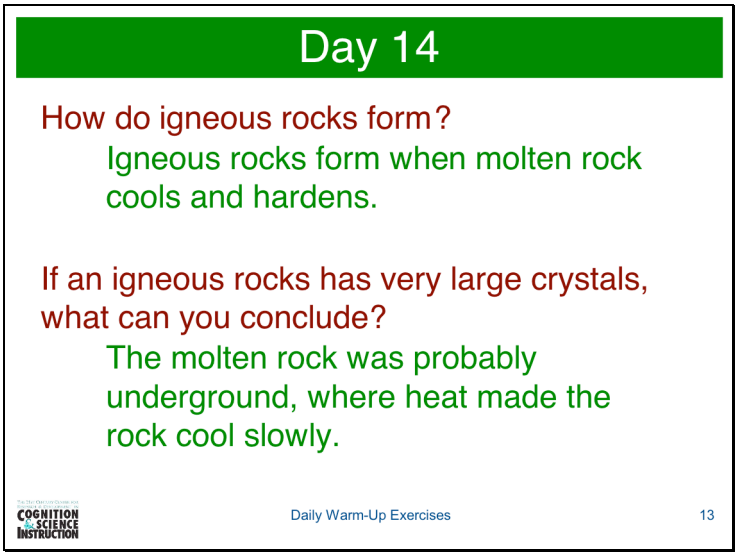
Day 14 – Compare Formation

Warm-Up Activity



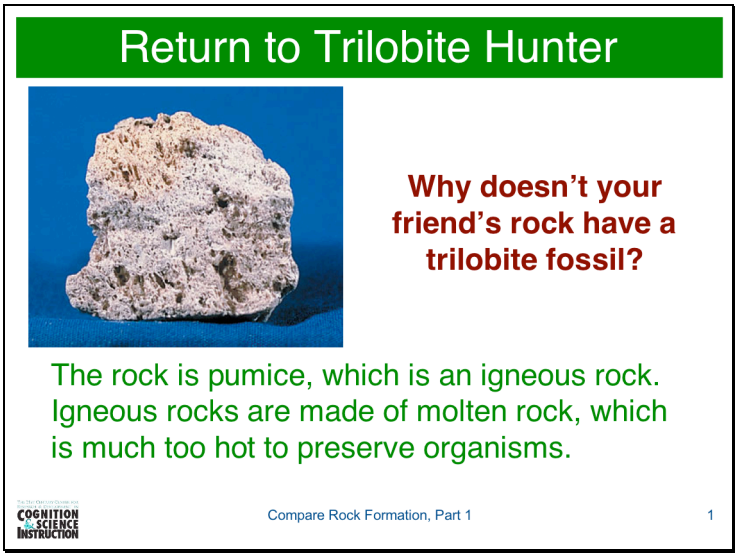
If you could tunnel deep underground, what would you find?
There is heat and pressure inside the Earth, and they get more and more extreme the deeper you go.

What is magma?
molten rock when it is underground

What is lava?
molten rock when it comes to the surface

Day 14 – Compare Formation

Compare Rock Formation, part 1b

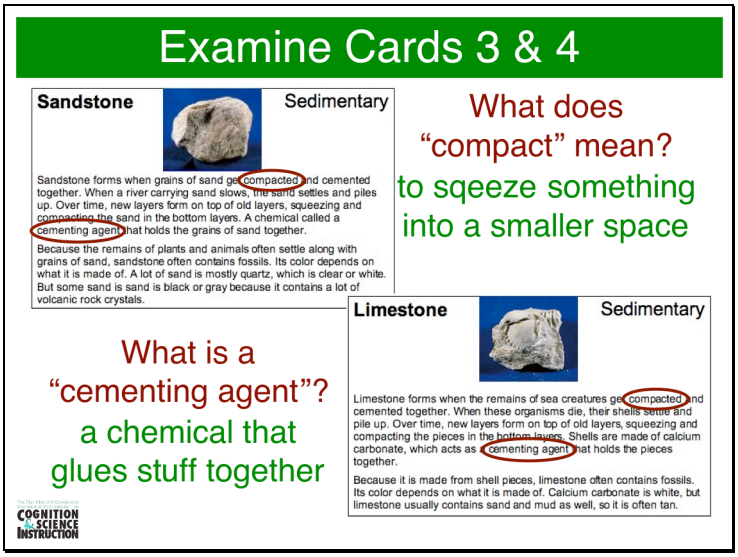


Tell your students that we're now going to look at another type of rock, called sedimentary.

At this time, show the Grand Canyon Video, part 2.

Day 14 – Compare Formation

Compare Rock Formation, part 1b (cont.)

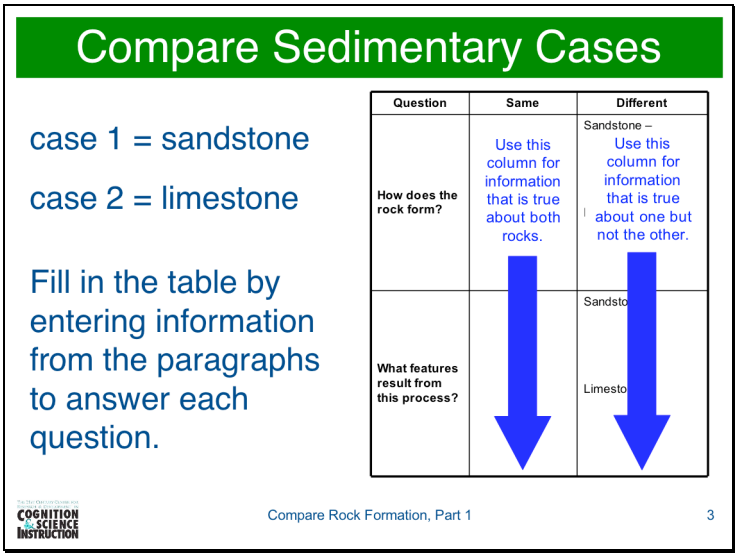


Ask students to examine the next two rock formation cards (Sandstone & Limestone, worksheet 13). The circles, questions and answers will appear on keypress.

If you have samples of sandstone and limestone, encourage students to compare them with the pictures and descriptions on the cards.

Day 14 – Compare Formation

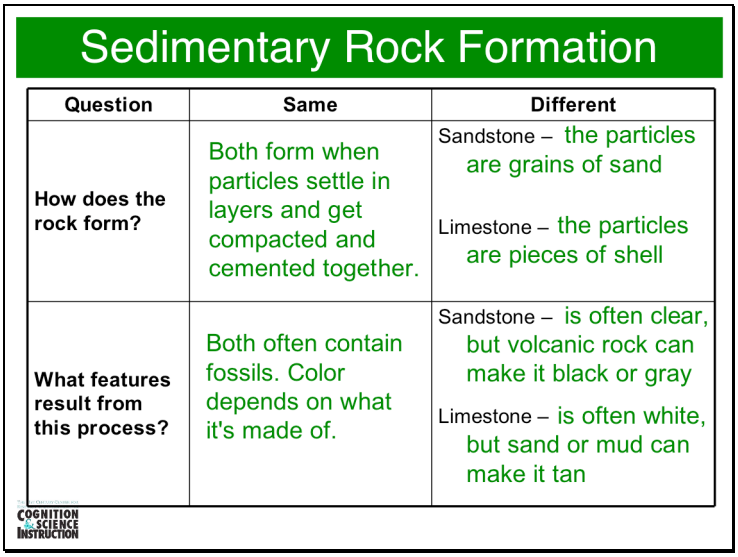
Compare Rock Formation, part 1b (cont.)



Distribute the sedimentary comparison table (worksheet 16). Have students work in groups, then share ideas with the class. The next slide shows the completed table for the two sedimentary rocks.

Day 14 – Compare Formation

Compare Rock Formation, part 1b (cont.)



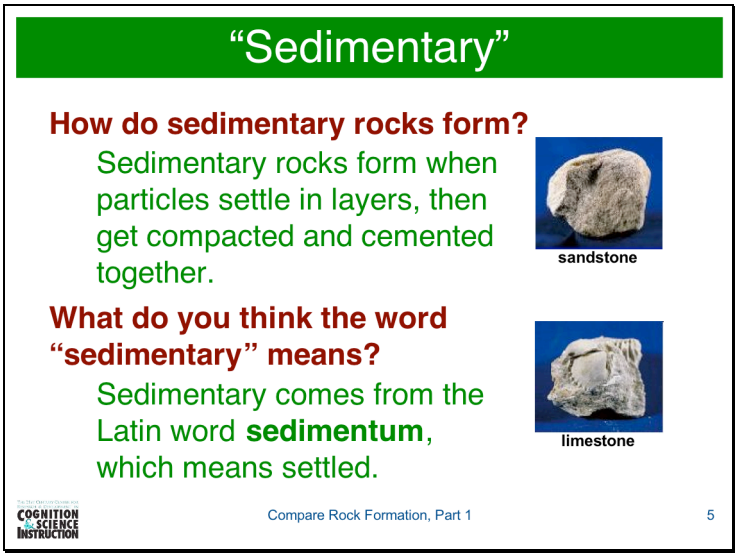
Sedimentary Rock Formation

Question	Same	Different
How does the rock form?	Both form when particles settle in layers and get compacted and cemented together.	Sandstone – the particles are grains of sand Limestone – the particles are pieces of shell
What features result from this process?	Both often contain fossils. Color depends on what it's made of.	Sandstone – is often clear, but volcanic rock can make it black or gray Limestone – is often white, but sand or mud can make it tan

Answers will appear separately on keypress.

Day 14 – Compare Formation

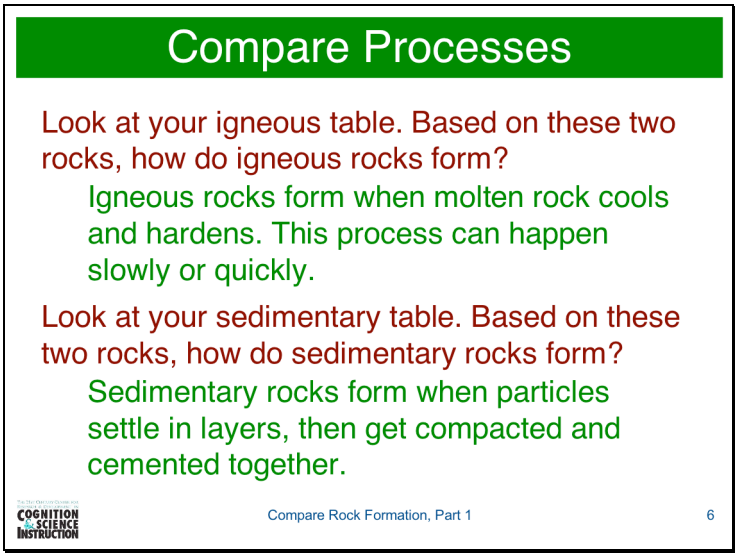
Compare Rock Formation, part 1b (cont.)



Students may have heard of sediments, although they may not know exactly what they are. Sediments are particles that settle and pile up over time. Settle means come to rest. If you stir sugar into iced tea, the sugar that doesn't dissolve will gradually settle at the bottom of the glass. Sedimentary rocks got their name because most are made from particles that settle.

Day 14 – Compare Formation

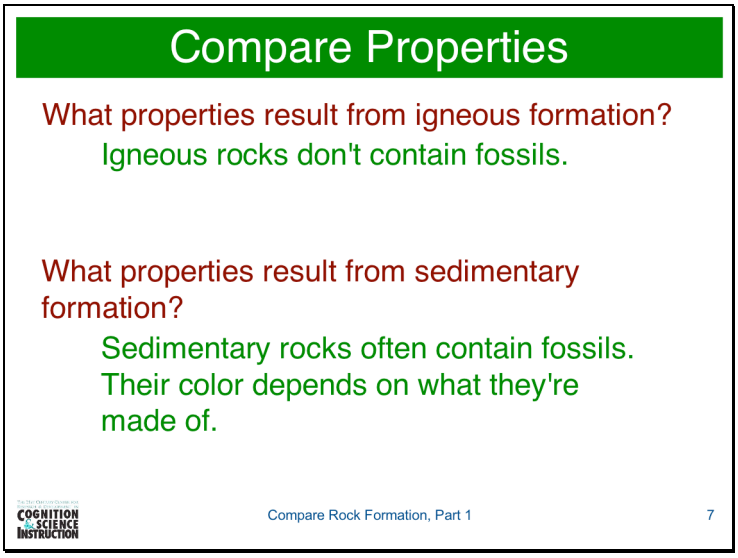
Compare Rock Formation, part 1b (cont.)



Make sure your students understand that sedimentary layers pile up over time, and that the squeezing and compacting that turns particles into rock is caused by the weight of all the layers pressing down on the oldest particles at the bottom.

Day 14 – Compare Formation

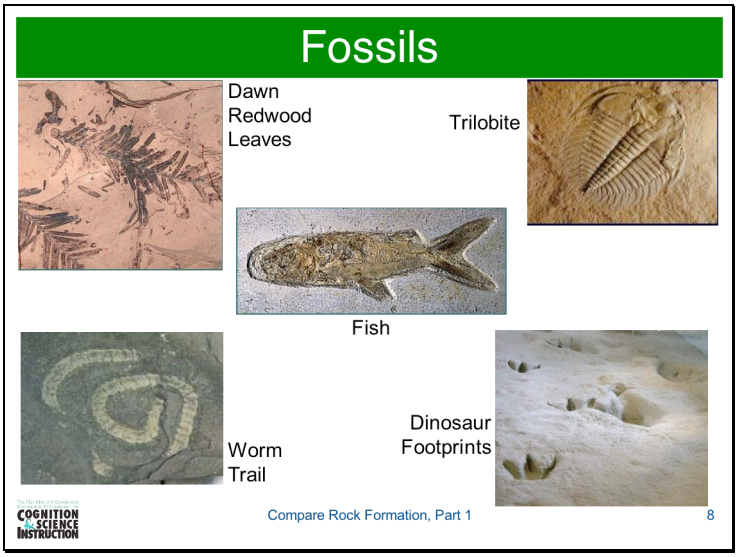
Compare Rock Formation, part 1b (cont.)



The next slide provides some pictures of different kinds of fossils.

Day 14 – Compare Formation

Compare Rock Formation, part 1b (cont.)



A fossil is a remnant or trace of an organism that is embedded and preserved in a rock. The top three examples are body fossils, which are the preserved remains of organisms. The bottom two are trace fossils, which are the preserved impressions an organism made on its environment. Body fossils tell us about an organism itself. Trace fossils tell us about an organism's behavior.

Additional information:

- Dawn Redwood -- a cone-bearing tree that lived about 30 million years ago
- Trilobite -- a hard-shelled marine organism that lived about 550 million years ago; there were thousands of different kinds of trilobites
- Fish -- a fish that lived about 140 million years ago
- Worm Trail -- trace left by a worm crawling in mud
- Dinosaur -- trace left by a dinosaur near a tropical seashore, between 112 and 100 million years ago

Day 14 – Compare Formation

Worksheet 15

Compare Rock Formation, Part 1 — 15

Sandstone — Sedimentary

Sandstone forms when grains of sand get compacted and cemented together. When a river carrying sand slows, the sand settles and piles up. Over time, new layers form on top of old layers, squeezing and compacting the sand in the bottom layers. A chemical called a cementing agent that holds the grains of sand together.

Because the remains of plants and animals often settle along with grains of sand, sandstone often contains fossils. Its color depends on what it is made of. A lot of sand is mostly quartz, which is clear or white. But some sand is sand is black or gray because it contains a lot of volcanic rock crystals.

Limestone — Sedimentary

Limestone forms when the remains of sea creatures get compacted and cemented together. When these organisms die, their shells settle and pile up. Over time, new layers form on top of old layers, squeezing and compacting the pieces in the bottom layers. Shells are made of calcium carbonate, which acts as a cementing agent that holds the pieces together.

Because it is made from shell pieces, limestone often contains fossils. Its color depends on what it is made of. Calcium carbonate is white, but limestone usually contains sand and mud as well, so it is often tan.

Chapter 2 – Rocks: Mineral Mixtures

Day 14 – Compare Formation

Worksheet 16

Compare Rock Formation, Part 1 — 16

Sedimentary – Sandstone & Limestone

Question	Same	Different
How does the rock form?		Sandstone – Limestone –
What features result from this process?		Sandstone – Limestone –

Chapter 2 – Rocks: Mineral Mixtures

DAY 15

Quiz 3/Reteach/Review

This lesson provides an opportunity for students to review what they've learned so far. For some, it may be an opportunity to understand an idea they didn't fully grasp the first time around.

Big Ideas
See list of big ideas, Days 1-14.

Materials

Teacher:

1. vocabulary list – RE word list.doc
2. list of big ideas – RE big ideas.pdf

Students:

1. Quiz 3

Activities & Allotted Time (40 minutes total)

10 minutes – quiz
10 minutes – go over quiz
20 minutes – reteach/review chapter 1.3

Reteach/Review Chapter 1.3
After going over the quiz and reviewing the meanings of vocabulary words and the big ideas from days 1-14, use the section review questions on page 17 and the chapter review questions on pages 20-21 to identify areas that need additional attention.

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Day 15 – Quiz 3/Reteach/Review

Quiz 3 – Page 1

1. Which substance is the same type of matter (element, compound, or mixture) as a rock?
   a. oxygen
   b. carbon dioxide
   (c.) air

2. Which property can be used to identify a mineral?
   a. size
   b. weight
   (c.) heaviness-for-size

3. A mineral's properties are determined by _____.
   (a.) how it forms and what it is made of
   b. whether it is organic or inorganic
   c. how pure it is

4. Returning the land to its original condition after mining is completed is called _____.
   a. excavation
   b. surface mining
   (c.) reclamation

5. Minerals are _____.
   a. elements only
   b. compounds only
   (c.) either elements or compounds

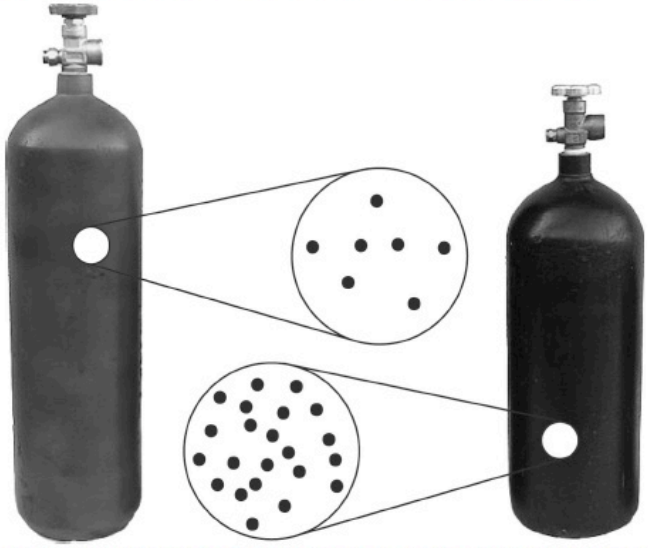
6. Minerals that have shiny surfaces, do not let light pass through them, and are good conductors of heat and electricity are called _____.
   (a.) metallic minerals
   b. nonmetallic minerals
   c. gemstones

Inside the Restless Earth

Day 15 – Quiz 3/Reteach/Review

Quiz 3 – Page 2

7. **Note to student:** We know you didn't learn this, but we want you to try to answer the question based on the information in the diagram.



In the above diagram of air tanks, what does the image inside the larger circle represent?

a. a magnified version of the tank's contents
b. a view of objects that are not part of the tank's contents
c. a life-size view of the tank's contents
d. a miniature view of the tank's contents

8. How do igneous rocks form?

Igneous rocks form when molten rock cools and hardens. This process happens slowly when magma hardens deep underground and quickly when lava hardens on Earth's surface.

Inside the Restless Earth

DAY 16 Origins & Properties of Igneous Rock

Because students will better understand the significance of the rock cycle after learning about the processes that form igneous, sedimentary, and metamorphic rocks, we are postponing the first section until the end of the chapter. This lesson covers the first two parts of section 2.2 (pages 36-37).

Big Ideas

- Igneous rocks form when molten rock cools and hardens.
- Magma forms when solid rock melts.

Materials

Teacher:

1. visualization exercises – day16.ppt

Students:

none

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
5 minutes – visualization 2.2a – Arrows & Color
5 minutes – visualization 2.2b – Cut-Away, Arrows & Captions
25 minutes – chapter 2.2, parts 1 & 2

Chapter 2.2, parts 1 & 2

Page 36 explains that magma forms when a rock melts, and that this can happen when temperature rises, when pressure drops, or when the composition of the rock changes. To help students understand this, today's warm-up includes a question about melting point and reviews the Introduction to Matter quick lab in which students found that reducing pressure lowers the boiling point of water. Similarly, increasing the pressure increases the boiling point. Tell your students that the same is true for melting point. Decreasing the pressure decreases the melting point and increasing the pressure increases the melting point. This is true for rocks as well as for water. [Note to teacher: The relationship between melting point and pressure also depends on how much water a rock contains.]

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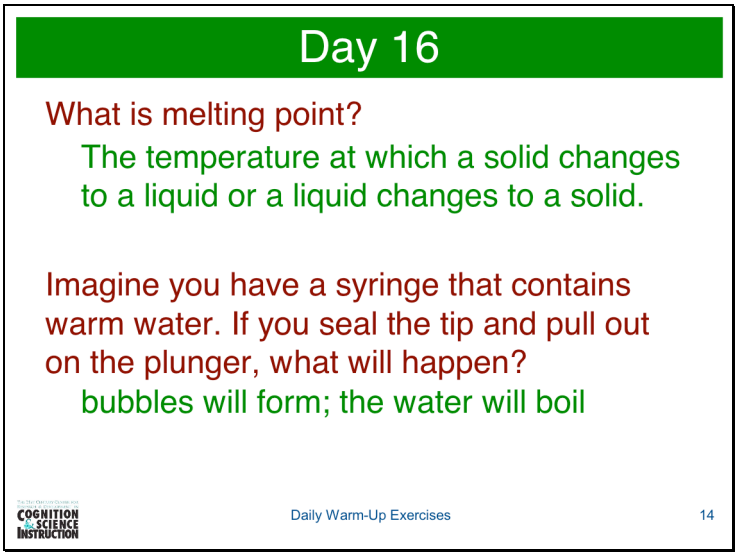
Day 16 – Origins & Properties of Igneous Rock

Chapter 2.2, parts 1 & 2 (cont.)
Point out that rocks don't have a single melting point. There is a temperature at which they begin to melt, but they must reach a higher temperature before they completely change to liquid. Ask your students to describe the conditions that exist deep underground. They should recall that the inside of Earth is characterized by extreme heat and pressure that get more extreme the deeper you go. Use questions to elicit the idea that extreme pressure can keep a rock from melting, but if it gets moved to a shallower depth, the pressure will decrease, which will lower the melting point and causes it to begin to melt.

Warm-Up Activity



What makes the water boil?
Pulling out on the plunger reduces the pressure inside the syringe. Reducing pressure lowers the water's boiling point, so it boils at a lower temperature.

Day 16 – Origins & Properties of Igneous Rock

Visualization Exercise 2.2a – Arrows & Color

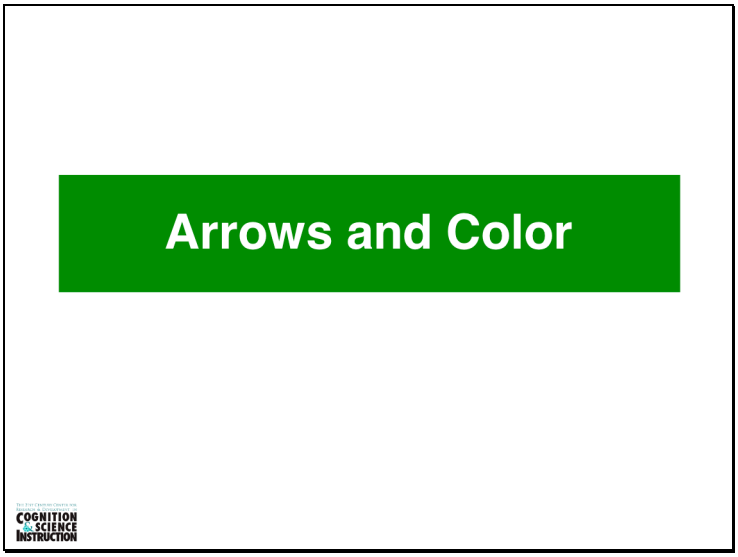


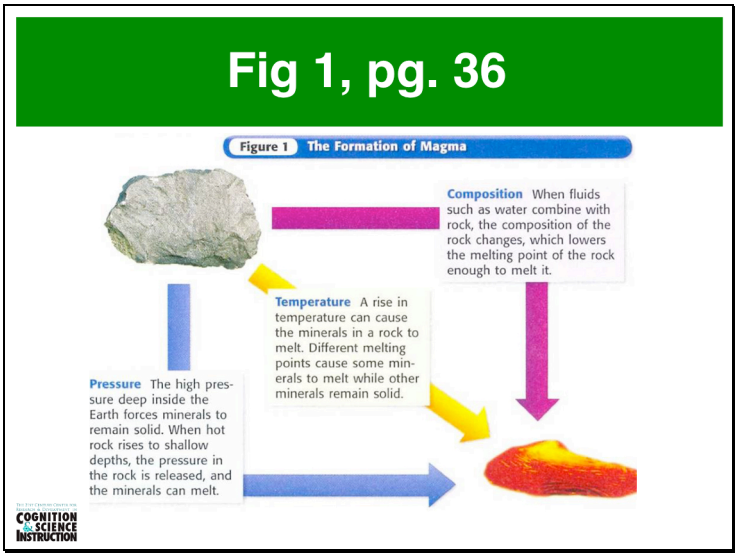
Image Comprehension Focus: Arrows and Color

Goals: 1) To illustrate one way in which arrows can be used in a diagram, and 2) To illustrate one way in which color can be used in a diagram

Type of Activity: Teacher Guided Student Activity

Overview: This activity is designed to show one way in which arrows and colors can be used to depict certain information in diagrams, and that it is important to pay attention to conventions such as arrows and colors, as these conventions can illustrate ideas that would not otherwise be understood.

Visualization Exercise 2.2a – Arrows & Color (cont.)



Procedure: The teacher has students turn to Figure 1 on page 36 of their textbooks (shown above if the teacher wants to project it).

The teacher asks students: What do the arrows represent in the diagram? [The arrows represent the change of state during the formation of magma.] Note: The teacher may also want to emphasize that in this particular diagram, it is not enough to look only at the arrows, but that the explanatory labels are of particular importance as well. For example, with Temperature, the label talks about a "rise in temperature" even though the arrow is pointed downwards which could be confusing to students unless they read the label.

Why is each arrow a different color? [Each arrow is a different color in order to illustrate the three distinct factors that are part of the magma formation.] The teacher can emphasize that it is not the actual color that is of particular importance, but the fact that there are different colors, representing three different factors.

(End of Activity)

Visualization Exercise 2.2b – Cut-Away, Arrows & Captions

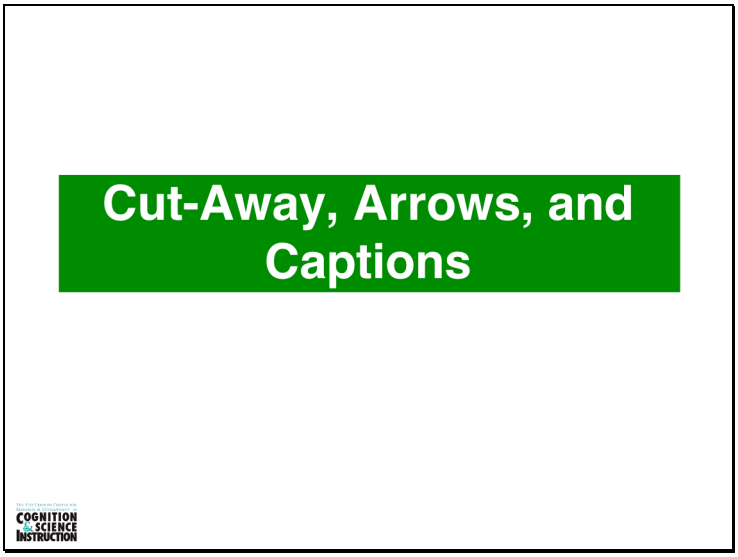


Image Comprehension Focus: Cut-Away, Arrows and Captions

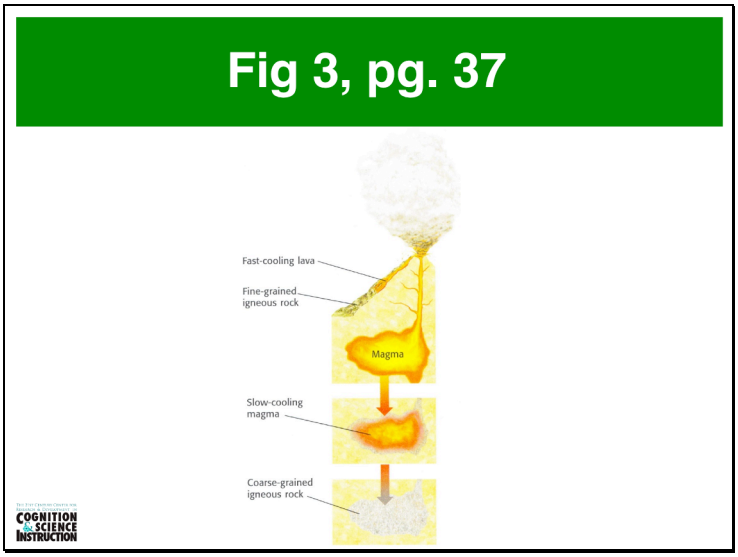
Goal: 1) To reinforce understanding of the cut-away and arrows, 2) To reinforce the importance of captions

Type of Activity: Teacher Guided Student Activity

Overview: This exercise is designed to reinforce the students' understanding of the cut-away as well as one way in which arrows can be used in diagrams. This exercise will also help to emphasize the importance of not skipping the caption when looking at a diagram.

(Continue to the next slide)

Visualization Exercise 2.2b – Cut-Away, Arrows & Captions (cont.)



Procedure: The teacher has students open their textbooks to Figure 3 on pg. 37 (shown above if the teacher wants to project it).

The teacher asks students what perspective this diagram is shown from, and what is the perspective trying to show? [The perspective is a cut-away (2D) and is an illustration of what happens to magma when it cools at different rates as seen inside of the earth]

The teacher then asks students, what role do the arrows play in this diagram? [The process of the magma cooling slowly and then turning into the coarse-grained igneous rock]. The teacher emphasizes that arrows are sometimes used to illustrate a process.

After going over the cut-away convention and arrows, the teacher can then ask the students, in small groups, to write their own caption for the diagram.

(Continue to the next slide)

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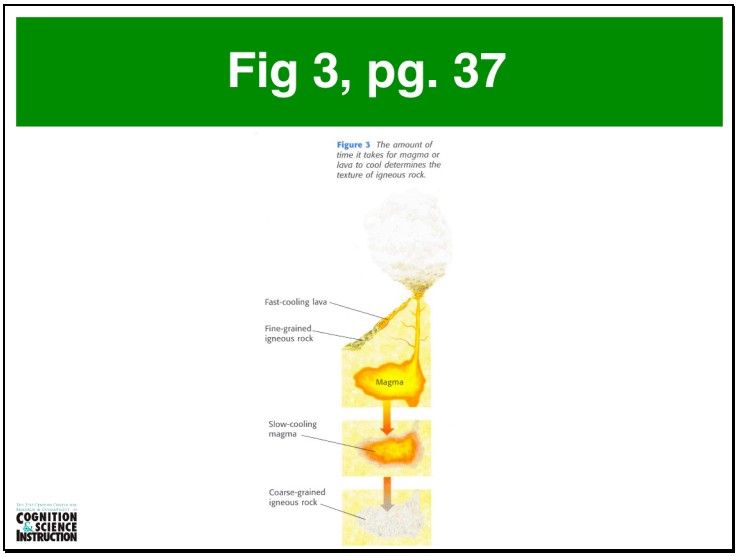
Visualization Exercise 2.2b – Cut-Away, Arrows & Captions (cont.)



After each group shares their caption, the teacher can then have students open their textbooks to Figure 3 on pg 37 (or project the above image).

The teacher can then lead a discussion about the similarities and differences between their own captions and the caption in the textbook, emphasizing the importance of always reading the caption because it often contains information necessary to understand the diagram.

Note to teacher: This diagram can be easily misinterpreted, leaving students with the impression that magma sinks down as it cools and becomes more dense, which is not the case. Make sure your students understand that the magma does not actually sink down.

(End of Activity)

DAY 17

Igneous Rock Formations

This lesson covers the rest of section 2.2 (pages 38-39).

Big Ideas

- Intrusive igneous rock forms beneath Earth's surface, where the temperature is hot and cooling is slow.
- Extrusive igneous rock forms at or near Earth's surface, where the temperature is cooler and cooling is fast.

Materials

Teacher:

1. visualization exercises – day17.ppt

Students:

none

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
5 minutes – visualization 2.2c – Cut-Away & Labels
30 minutes – chapter 2.2, part 3

Chapter 2.2, part 3

From their study of *Introduction to Matter*, students should recall density as heaviness-for-size, or the ratio of mass to volume. They should also remember that density is a characteristic property of a material, which means it does not change with sample size. In other words, if we were to determine the density of one of the galena samples in the Holt kit, we should get roughly the same number for all the other galena samples.

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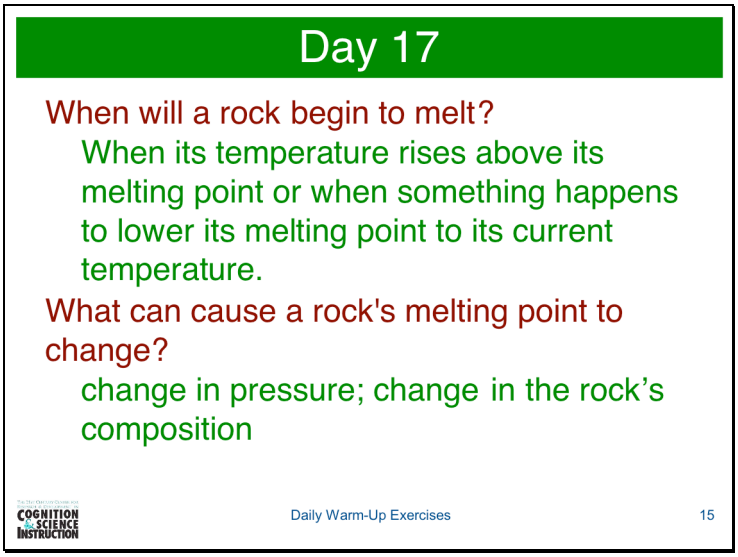
Day 17 – Igneous Rock Formations

Warm-Up Activity



Remind students that rocks have one temperature at which they start to melt, but they must reach a higher temperature before they will melt completely. When we say "melting point," we're talking about the starting temperature.

If pressure decreases, will melting point increase or decrease?
decrease (substance will melt at a lower temperature)

Note to teacher: If the change in composition involves the addition of water, the relationship between melting and pressure may change. If a rock contains enough water, its melting point will decrease as pressure increases.

Day 17 – Igneous Rock Formations

Visualization Exercise 2.2c – Cut-Away & Labels

Image Comprehension Focus: Cut-Away and Labels

Goal: 1) To promote understanding of one way that cut-away can be used in diagrams, 2) the importance of labels in diagrams

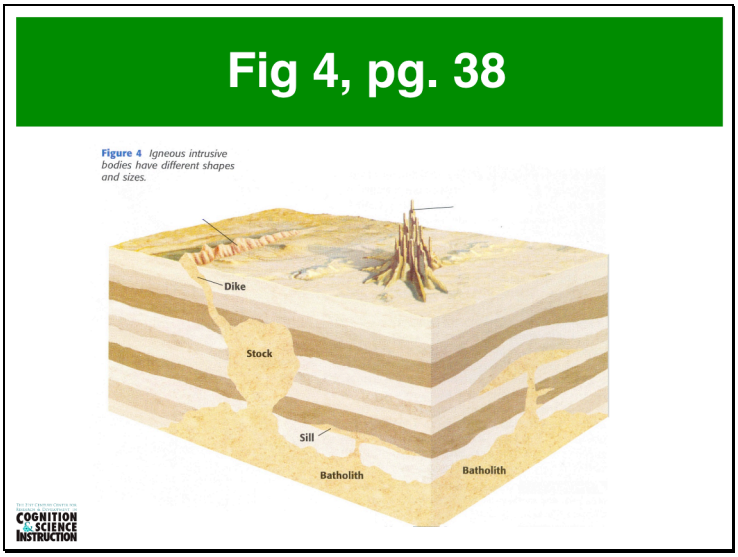
Type of Activity: Teacher Guided Study Activity

Overview: This activity is designed to illustrate another way that the cut-away convention can be used to illustrate points in diagrams that otherwise would be difficult to see. Additionally, this exercise reinforces the importance and function of labels.

(Continue to the next slide)

Day 17 – Igneous Rock Formations

Visualization Exercise 2.2c – Cut-Away & Labels (cont.)



Procedure: The teacher has students look at the altered image of Figure 4 from page 38 (shown above for the teacher to project).

The teacher first asks students what type of perspective is being shown by the diagram and what the perspective is trying to represent. [This is a cut-away (3D) that is trying to show the different shapes of common intrusive bodies and their sizes relative to each other.] The teacher can also ask the students why they think the author chose to use a 3D cut-away as apposed to a 2D cut-away [Some students may simply responds that it "looks cool" or it is more interesting to look at. However, there are some other, more intentional reasons the author may have made this choice. Some examples might be that the larger span of the batholith is more easily seen in the 3D perspective; to emphasize that the horizontal stripes represent continuous layers; this perspective shows the underground source of the dike and also its long, ridge-like above ground structure.]

Visualization Exercise 2.2c – Cut-Away & Labels (cont.)

The teacher then asks students to fill in the 2 missing labels [this should be difficult to do].

The teacher asks if anyone was able to fill in the 2 missing labels. The teacher has students turn to Figure 4 on page 38 of their textbooks and use the information to fill in the missing two labels [Dike and Volcanic neck]. The teacher again reinforces the importance of labels and how it would be difficult to tell what these pieces of the diagram are without the labels.

(End of Activity)

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DAY 18

Comprehensive Review

This lesson provides an opportunity for students to prepare for quiz 4, which is a full-period quiz that will cover everything they've learned so far (section 5 of chapter 3, all of chapter 1, and the first section of chapter 2).

Big Ideas

- See list of big ideas, Days 1-17.

Materials

Teacher:

1. vocabulary list – RE word list.doc
2. list of big ideas – RE big ideas.pdf

Students:

none

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
35 minutes – review chapter 1 and sections 3.5 & 2.2

Review Chapter 1 and Sections 3.5 & 2.2

After reviewing the meanings of vocabulary words and the big ideas from days 1-17, use the Chapter 1 review on pages 20 and 21 and the section review questions on pages 85 and 39 to identify areas that need additional attention.

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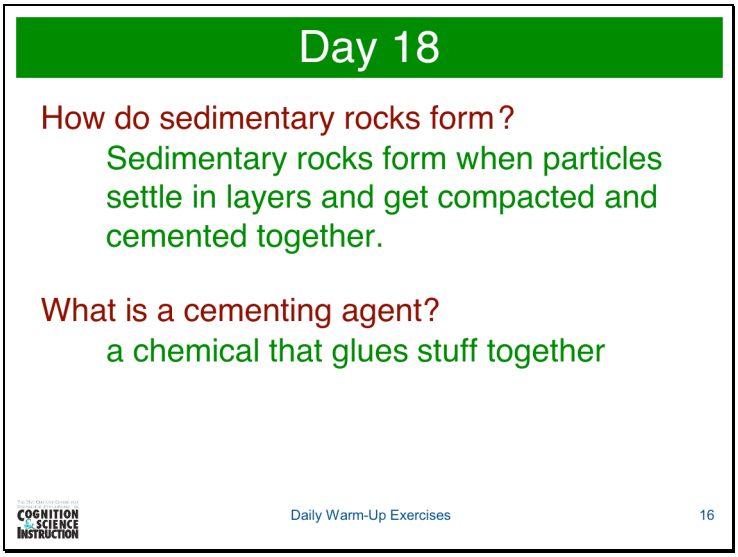
Day 18 – Comprehensive Review

Warm-Up Activity



What happens when sediments are compacted?
they get squeezed into a smaller space

What squeezes the sediments?
the weight of all the layers that are on top of the sediments

DAY 19

Quiz 4

Quiz 4 is a comprehensive assessment that covers section 3.5, chapter 1, and section 2.2.

Big Ideas
See list of big ideas, Days 1-17.

Materials

Teacher:
none

Students:
1. Quiz 4

Activities & Allotted Time (40 minutes total)

40 minutes – quiz

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Day 19 – Quiz 4

Quiz 4 – Page 1

1. What does a numeric time scale show?
   (a) How many years ago different events happened.
   b. The locations at which different events happened.
   c. How different parts of Earth's history compare to the whole.

2. If you could travel back in time to when the Earth was first formed as a planet, how many years back in time would you have to travel?
   a. about 4.6 thousand years
   b. about 4.6 million years
   (c) about 4.6 billion years

3. Which of the following correctly lists the organisms in the fossil record from most recent to earliest?
   a. reptiles, mammals, plants
   (b) mammals, reptiles, plants
   c. plants, reptiles, mammals

4. What type of minerals make up most of Earth's crust?
   (a) silicate minerals
   b. nonsilicate minerals
   c. native elements

5. One difference between rocks and minerals is _____.
   a. all minerals are elements and all rocks are compounds
   b. all minerals are compounds and all rocks are mixtures
   (c) all minerals are pure substances and all rocks are mixtures

6. A mineral that is composed of only one element is called a _____.
   a. gemstone
   b. silicate mineral
   (c) native element

7. Which of the following is not a property of minerals?
   a. naturally formed
   (b) organic
   c. crystalline

Inside the Restless Earth

Day 19 – Quiz 4

Quiz 4 – Page 2

8. Mrs. Smith's class tested three minerals (A, B, C) for hardness. This table shows their results:

Mineral	Scratched by fingernail?	Scratched by penny?
A	yes	yes
B	no	yes
C	no	no

Which mineral is the softest?

(a) A
b. B
c. C

9. Suppose you found a new mineral (X). Which test would show whether X is harder than all three of the minerals in question 8?

a. scratch X with A
b. scratch X with B
(c.) scratch X with C

10. Which of the following best describes what you would find if you could tunnel deep down inside the Earth?

a. The mantle is rigidly solid because the extreme pressure prevents solid rock from melting.
b. The mantle is completely liquid because the extreme heat melts any solid rock that moves below the crust.
(c.) The upper mantle is rigid and the lower mantle is soft because heat and pressure get more extreme the deeper you go.

11. What type of rock is formed when molten rock cools and hardens?

(a.) igneous
b. metamorphic
c. sedimentary

12. What type of rock is formed when particles settle and get compacted and cemented together?

a. igneous
b. metamorphic
(c.) sedimentary

Inside the Restless Earth

Day 19 – Quiz 4

Quiz 4 – Page 3

13. Granite forms deep below Earth's surface, from slowly cooling magma. What feature results from this process?
    a. Granite has small crystals.
    (b) Granite has large crystals.
    c. Granite has no crystals.

14. Based on the description in item 13, what type of igneous rock is granite?
    a. extrusive
    (b) intrusive
    c. could be extrusive or intrusive

15. When solid rock melts, it forms _____.
    a. lava
    (b) magma
    c. sediments

16. What's the difference between rocks and minerals?

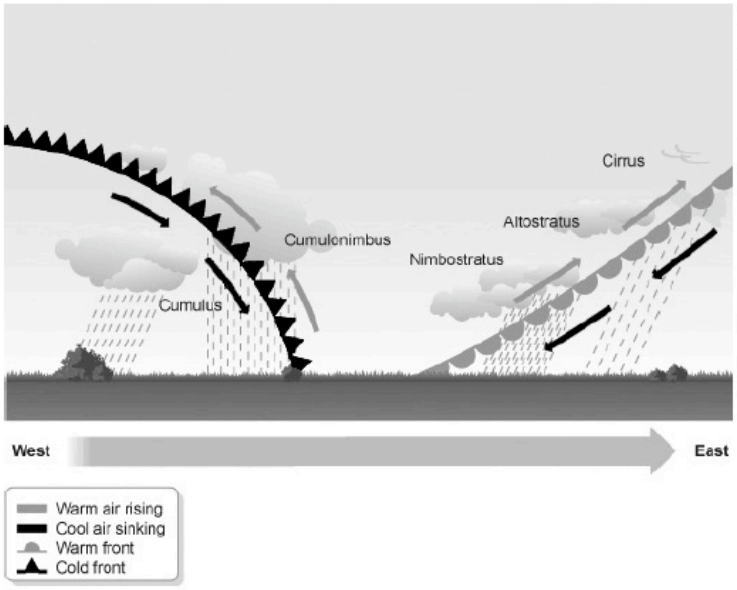
Minerals are elements or compounds; rocks are mixtures. Minerals are inorganic; rocks can be organic or inorganic. Minerals are crystalline; rocks can be crystalline or amorphous.

Inside the Restless Earth

Day 19 – Quiz 4

Quiz 4 – Page 4

17. **Note to student:** We know you didn't learn this, but we want you to try to answer the question based on the information in the diagram.



As indicated in the diagram above, the weather fronts are moving from the _____ to the _____ .

a. north to south
b. west to east
c. east to west
d. south to north

Inside the Restless Earth

DAY 20

Sedimentary Rock

This lesson covers parts 1 and 2 of section 2.3 (pages 40-42).

Big Ideas

- Sedimentary rocks form when particles settle and get compacted and cemented together.
- Sedimentary rocks form at or near Earth's surface.
- The particles that make up sedimentary rocks can be fragments of other rocks, minerals that are dissolved in water, or the remains of organisms.

Materials

Teacher:

1. visualization exercises – day20.ppt

Students:

none

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
5 minutes – visualization 2.3a – Arrows & Labels
5 minutes – visualization 2.3b – Zoom & Captions
25 minutes – chapter 2.3, parts 1 & 2

Chapter 2.3, parts 1 & 2

Most of the information in part 1 is a review of things students learned in the Compare Rock Formation activity, so you should be able to elicit most of the information from your students. The major new idea is that sedimentary rocks form at or near Earth's surface, and that they form without the heat and pressure that are involved in the formation of igneous and metamorphic rocks. You might qualify that last statement, saying that sedimentary rocks form without extreme heat and pressure. When layers of sediment accumulate, older layers get compacted because of the pressure that results from the weight of the newer layers pressing down on the older layers beneath them. So pressure is involved, but it's not as extreme as the pressure found deep beneath Earth's surface.

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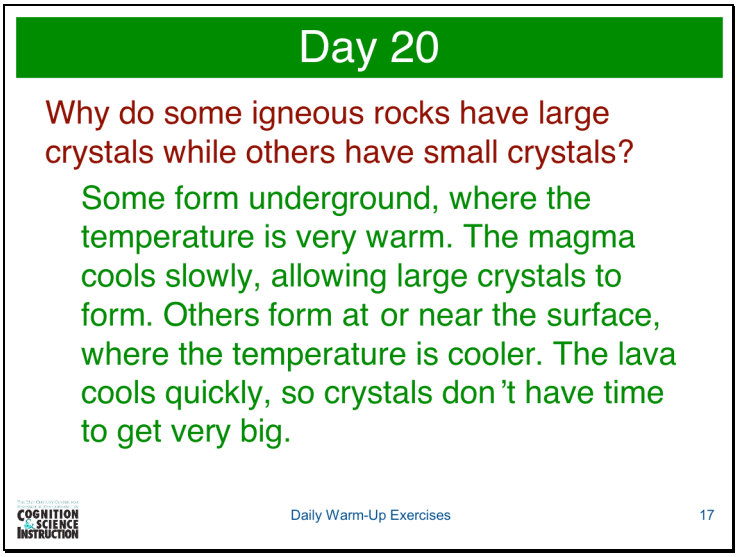
Day 20 – Sedimentary Rock

Warm-Up Activity



What's the difference between magma and lava?
Melted (molten) rock is called magma when it's underground and lava when it flows out onto Earth's surface.

What type of igneous rock forms underground?
intrusive

What type of igneous rock forms at or near Earth's surface?
extrusive

Day 20 – Sedimentary Rock

Visualization Exercise 2.3a – Arrows & Labels

Image Comprehension Focus: Arrows & Labels

Goal: 1) To illustrate one way arrows may be used to illustrate information in a diagram, and 2) Re-emphasize the importance of labels

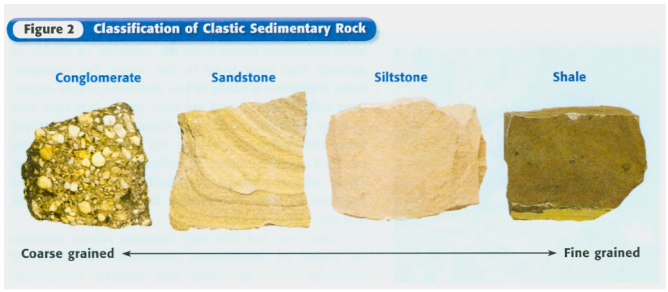
Type of Activity: Teacher Guided Student Activity

Overview: The purpose of this activity is to illustrate one way in which arrows can be used to show information as well as emphasize, again, the importance and purpose of labels in a diagram.

(Continue to the next slide)

Visualization Exercise 2.3a – Arrows & Labels (cont.)

Fig 2, pg. 41



Procedure: The teacher has the students turn to Figure 2 on page 41 of their textbooks. The teacher asks the students, what role do the arrows play in this diagram? [These particular arrows help to show direction as part of a scale.] The teacher emphasizes the point that arrows do not always play the same role in diagrams and that students need to pay attention to the particular role that the arrows play in each diagram that they see.

The teacher then has students answer the following questions:
According to Figure 2, which of the following statements is correct?

- Conglomerate is more 'coarse grained' than Shale (True)
- Shale is more 'coarse grained' than Conglomerate (False)
- Shale is less 'fine grained' than Siltstone (False)
- Conglomerate is less 'coarse grained' than Sandstone (False)

The most 'fine grained' sedimentary rock is _____. [Shale]
The most 'course grained' sedimentary rock is _____. [Conglomerate]
What is the correct order of clastic sedimentary rocks from finest grained to coarsest grained? [Shale, Siltstone, Sandstone, Conglomerate]

Visualization Exercise 2.3a – Arrows & Labels (cont.)

The teacher reviews the correct answers as necessary, emphasizing again the specific role of the arrows in this diagram as well as the importance of the labels, as well as the importance of having both the labels and the arrows in this diagram.

(End of Activity)

Visualization Exercise 2.3b – Zoom & Captions

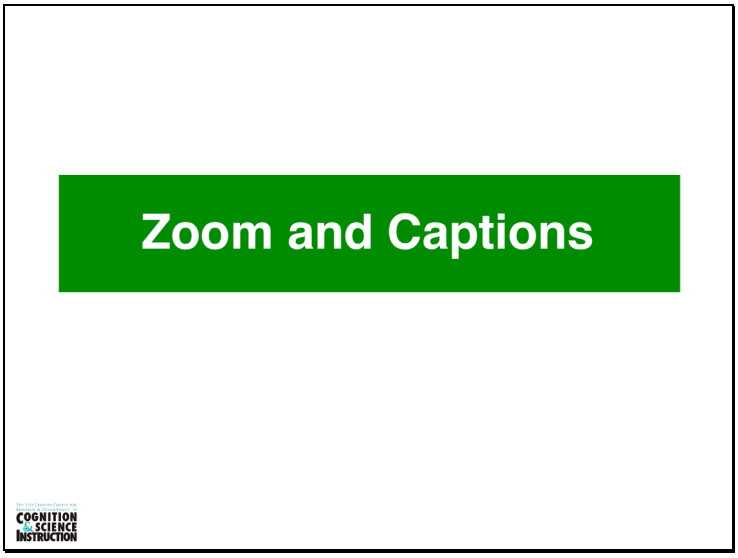


Image Comprehension Focus: Zoom & Captions

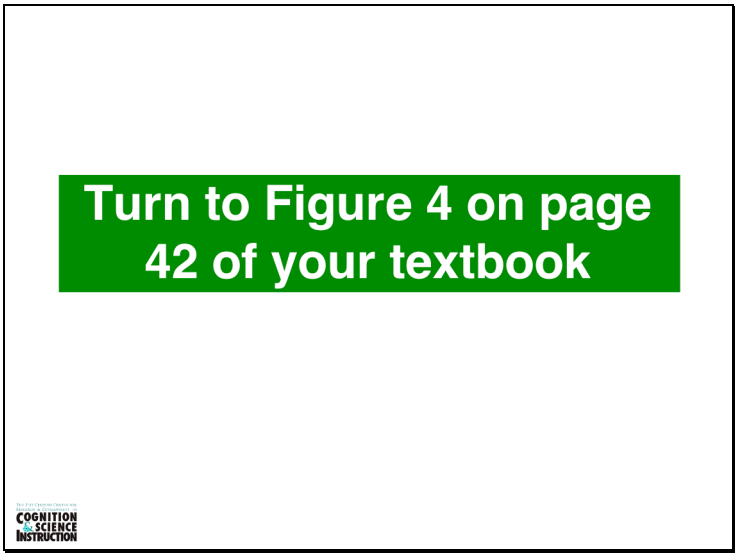
Goal: 1) To again illustrate and ensure understanding of the zoom convention, and 2) To re-emphasize the importance of captions

Type of Activity: Teacher Guided Student Activity

Overview: The purpose of this activity is to promote students' understand of the zoom convention as well as to re-emphasize the role and importance of captions when looking at a diagram.

(Continue to the next slide)

Visualization Exercise 2.3b – Zoom & Captions (cont.)



Procedure: The teacher has the students turn to page 42 of the textbook and has them take a few minutes to look at Figure 4, after which the students should close their textbooks.

Next, the teacher has the students answer the following question:

- When organisms such as brachiopods die, their shells collect on the floor of the ocean and form _____. [fossiliferous limestone]

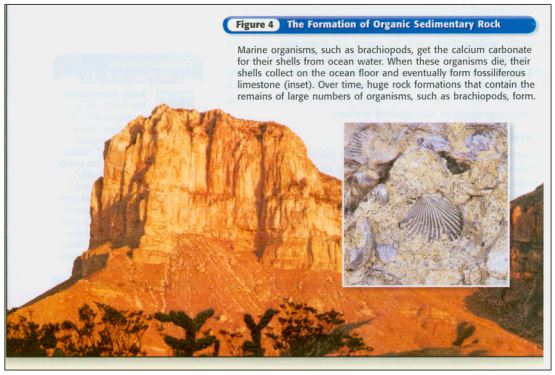
The teacher asks students, either out loud or by show of hands, who was able to answer the question. The teacher then has students turn back to page 42 (shown on the next slide if the teacher wants to project it), and points out that unless one had read the caption, it would have been very difficult to answer this question. The teacher emphasizes again the point that reading the caption can be crucial when trying to understand a diagram.

(Continue to the next slide)

Day 20 – Sedimentary Rock

Visualization Exercise 2.3b – Zoom & Captions (cont.)

Fig 4, pg. 42

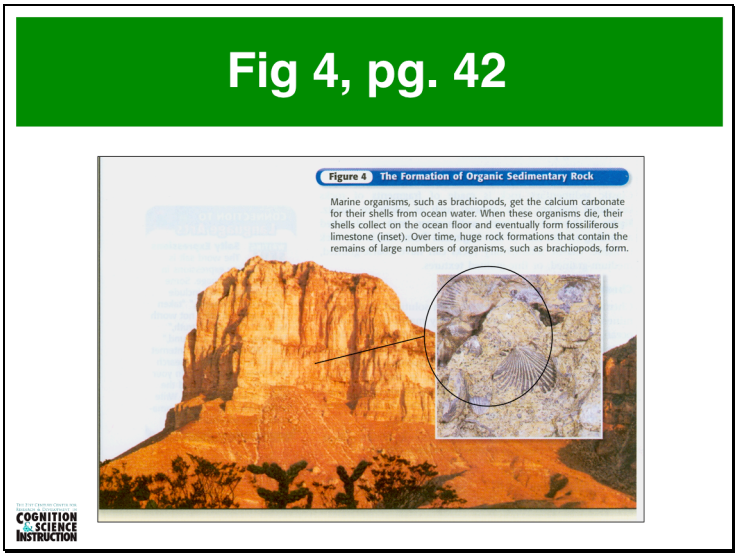


The teacher asks the students to look at the picture in the box below the caption and asks students what they think the author was trying to do by showing this smaller picture in the box. [The author was trying to show something up close that otherwise would be very difficult to see.]

The teacher then can ask students to think about the conventions they have learned so far (e.g. arrows, captions, zoom, cut-away, etc.), and asks the students what convention would fit most with what the author has used here by putting this picture in the box?

(Continue to the next slide)

Visualization Exercise 2.3b – Zoom & Captions (cont.)



After hearing the students' answers, the teacher can project the above slide to illustrate how the zoom feature could be used in order to show the fossiliferous limestone that otherwise would be very difficult to see.

Next, the teacher can ask "what is being shown in the zoomed area? [a fossil of a marine organism]

Ask "what part of the caption goes with the zoomed image? [The first two sentences refer to the relationship between marine organisms and the formation of fossiliferous limestone. They also end with the term "inset," which refers directly to the zoomed image]

Finally, the teacher can draw the students' attention to the large-scale photograph. Ask "what part of the caption goes with the photograph of the mountain?" [the last sentence, which talks about the formation of huge rock formations over time]

(End of Activity)

DAY 21

Stratification

This lesson covers the last part of section 2.3 (page 43).

Big Ideas

- Sedimentary rock formations contain layers, or strata, which form through a process called stratification.

Materials

Teacher:

1. visualization exercises – day21.ppt

Students:

1. sandstone cards – worksheet 13

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
5 minutes – visualization 2.3c – Captions
30 minutes – chapter 2.3, part 3 – *Sedimentary Rock Structures*

Chapter 2.3, part 3

Part 3 defines **stratification** as the process in which sedimentary rocks are arranged in layers. Encourage your students to use the description cards from the contrasting case activity to explain what that means and why it occurs. They should recognize that the layers form because particles settle and form a layer, just like undissolved sugar forms a layer at the bottom of a glass. Over time, new layers form on top of old layers. The layers that form are called strata, and the process that forms them is called stratification.

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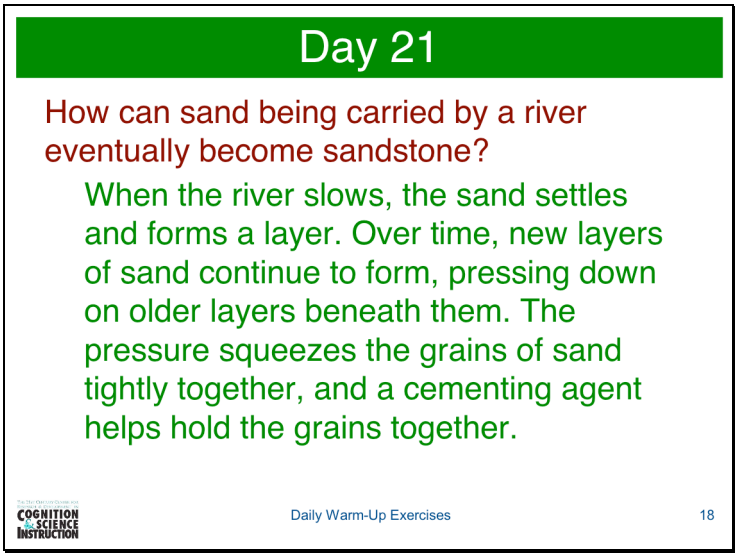
Day 21 – Stratification

Warm-Up Activity



What is a cementing agent?
a chemical that glues stuff together

Where do sedimentary rocks form?
on or near Earth's surface

What kinds of particles can become sedimentary rocks?
fragments of other rocks, minerals that are dissolved in water, or the remains of organisms

Day 21 – Stratification

Visualization Exercise 2.3c – Captions

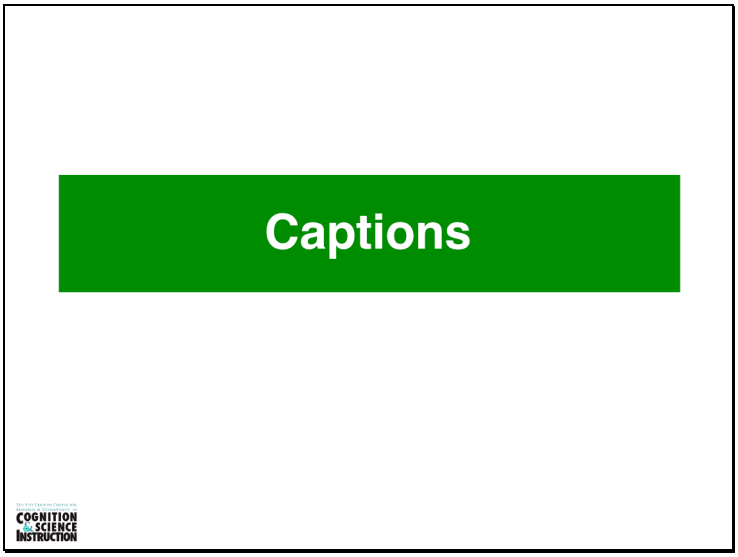


Image Comprehension Focus: Captions

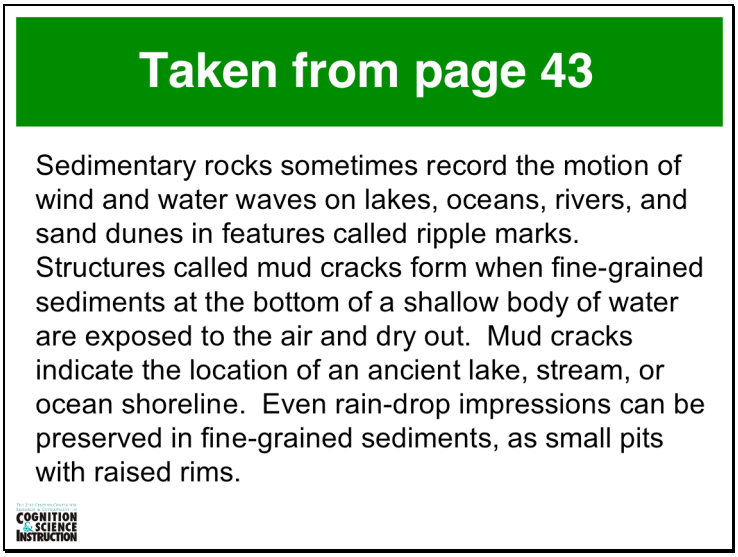
Goal: To understand the importance of captions as well as understanding the features of a good caption.

Type of Activity: Teacher Guided Student Activity

Overview: The purpose of this activity is to help students understand the importance of never skipping over captions when looking at diagrams as well as understanding important features of captions.

(Continue to the next slide)

Visualization Exercise 2.3c – Captions (cont.)

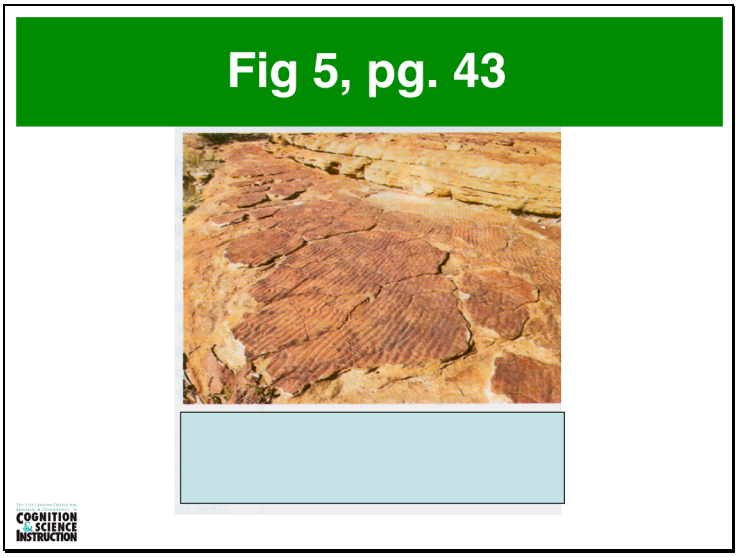


Procedure: The teacher has students take several minutes to read the paragraph taken from page 43 of their textbooks that is shown on the above slide for the teacher to project.

The teacher advises students that they should take notes on what they believe to be the important points from the paragraph.

(Continue to the next slide)

Visualization Exercise 2.3c – Captions (cont.)



The teacher then projects the above slide of Figure 5 from page 43 that is missing the caption.

The teacher then asks students, either individually or in groups, to imagine that they are the authors of the textbook and to write a caption for the image, using the information they have just read.

The teacher then asks students to share the captions they have written. After students have shared their own captions, the teacher can have the students turn to page 43 of their textbooks to look at the caption written by the actual author of the textbook (shown on the next slide).

The teacher can have students compare/contrast their captions with that of the caption in the textbook, emphasizing the importance of captions, and that captions should never be skipped when looking at diagrams as they often contain information that otherwise could not be obtained from looking at the diagram alone.

(Continue to the next slide)

Visualization Exercise 2.3c – Captions (cont.)

Fig 5, pg. 43

Figure 5 *These ripple marks were made by flowing water and were preserved when the sediments became sedimentary rock. Ripple marks can also form from the action of wind.*

(End of Activity)

DAY 22

Skills Practice Lab

In this lesson, students complete the chapter lab described on pages 50-51.

Big Idea

- When particles settle, the heaviest particles tend to settle first, and the lightest particles tend to settle last.

Materials

Teacher:

none

Students:

1. clay soil
2. fine sand
3. pebble gravel
4. clear plastic bottle with cap
5. water

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
35 minutes – skills lab – *Let's Get Sedimental* – pages 50-51

Skills Lab – *Let's Get Sedimental*

In this activity, students mix gravel, sand, and clay particles in a clear plastic bottle. They add water and shake the bottle until all the particles are mixed in the rapidly moving water. They then place the bottle on a table top. The book says to cut the top off the bottle and, in steps 5 through 8, to allow the water to evaporate and the sediments to dry and harden. We suggest you omit this portion of the activity. Instead, after shaking the bottle, have students set the bottle down and immediately observe what happens. They may need to repeat this part several times to enable everyone to see that the gravel tends to settle first and the clay particles tend to settle last.

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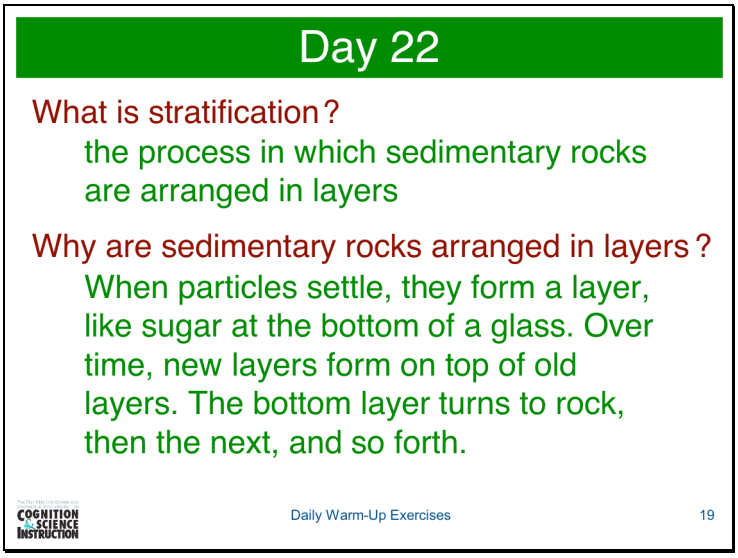
Day 22 – Skills Practice Lab

Skills Lab – *Let's Get Sedimental*

Use questions to help your students transfer this idea to a real-world situation. For example, when a river is flooded because of heavy rains, it will turn brown because the fast moving water picks up and carries all kinds of particles. As the water slows, the heaviest particles will settle out, but the other particles are carried further. As the water continues to slow, lighter and lighter particles settle out.

Warm-Up Activity



Why does the bottom layer turn to rock?

The weight of all the layers above pushing down compacts the particles, and a cementing agent helps hold them together.

End-of-Section Survey – 2.2 & 2.3

activity	did as described	modified	didn't do	comments
Day 13 Warm-Up (page 100)				
cc 2.1–Compare Rock Formation, part 1a (pages 99-114)				
Day 14 Warm-Up (page 116)				
cc 2.1–Compare Rock Formation, part 1b (pages 115-126)				
Quiz 3 (pages 128-129)				
Reteach/Review Chp. 1.3 (page 127)				
Day 16 Warm-Up (page 131)				
vis 2.2a–Arrows & Colors (pages 132-133)				
vis 2.2b – Cut-Away, Arrows & Captions (pages 134-136)				
chp 2.2, parts 1-2 (page 130-131 & Holt, pages 36-37)				
Day 17 Warm-Up (page 138)				
vis 2.2c–Cut-Away & Labels (pages 139-141)				
chp 2.2, part 3 (page 137 & Holt, pages 38-39)				

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End-of-Section Survey – 2.2 & 2.3

activity	did as described	modified	didn't do	comments
Day 18 Warm-Up (page 143)				
Comprehensive Review (page 142)				
Quiz 4 (pages 145-148)				
Day 20 Warm-Up (page 150)				
vis 2.3a – Arrows & Labels (pages 151-153)				
vis 2.3b – Zoom & Captions (pages 153-156)				
chp 2.3, parts 1-2 (page 149 & Holt, pages 40-42)				
Day 21 Warm-Up (page 158)				
vis 2.3c – Captions (pages 159-162)				
chp 2.3, part 3 (page 157 & Holt, page 43)				
Day 22 Warm-Up (page 164)				
skills lab–*Let's Get Sedimental* (page 163-164 & Holt, pages 50-51)				

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DAY 23

Compare Formation 2

This lesson is the first half of contrasting case activity 2.4, which is called Compare Rock Formation, Part 2.

Big Ideas

- Metamorphic rocks form when an existing rock changes because of heat and/or pressure.
- Metamorphic rocks form deep beneath Earth's surface, where heat and pressure get more and more extreme the deeper you go.

Materials

Teacher:

1. slides – day23.ppt
2. Grand Canyon Video, part 3

Students:

1. metamorphic cards – worksheet 17
2. metamorphic comparison tables – worksheets 18-19
3. shale, slate, & schist samples, if you have them
4. hand lenses

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
35 minutes – cc activity – compare rock formation, part 2a

Compare Rock Formation, part 2a

In part 1, (Days 13 and 14), students compared the formation of two igneous and two sedimentary rocks, and they completed a comparison table for each pair of rocks. In today's activity, they will compare and complete a table for two metamorphic rocks. In part 2b (Day 24), students will use the comparison tables for all three rock types to investigate and depict the rock cycle.

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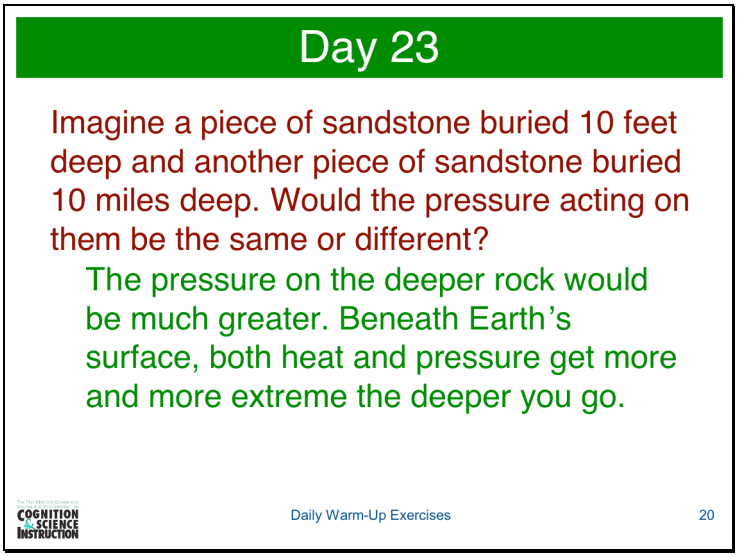
Day 23 – Compare Formation 2

Warm-Up Activity



What is pressure?

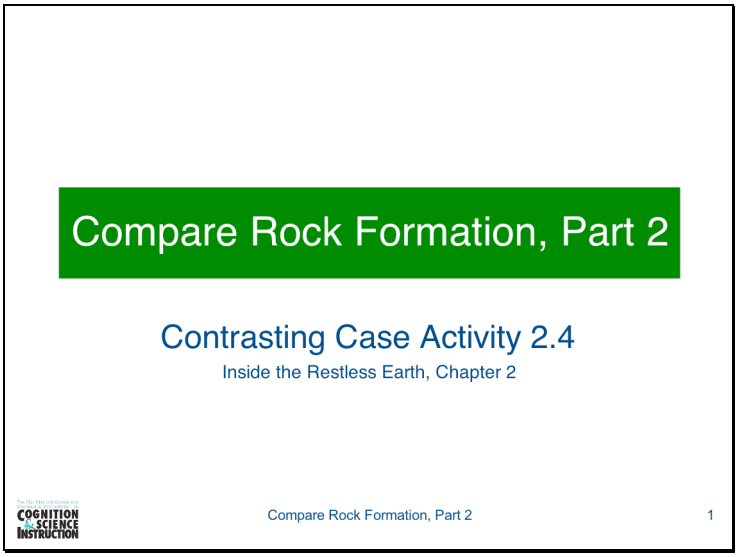
a force or set of forces that is spread out over a surface; when something is squeezing or pressing on something else

Why does pressure increase with depth?

The pressure is caused by the weight of everything above you. The deeper you go, the more there is above you.

Day 23 – Compare Formation 2

Compare Rock Formation, part 2a (cont.)



Materials needed:

- Grand Canyon Video, part 3
- metamorphic cards (worksheet 17)
- metamorphic comparison tables (worksheets 18-19)
- completed igneous & sedimentary comparison tables from cc 2.2 (worksheets 15-16)
- rock cycle diagram & cut-outs (worksheets 20-21)
- shale, slate, & schist samples, if you have them
- hand lenses

Day 23 – Compare Formation 2

Compare Rock Formation, part 2a (cont.)

Return to Trilobite Hunter

Are igneous rocks good for finding trilobite fossils?

granite

pumice

No, because they are made of molten rock, which is much too hot to preserve organisms.

Compare Rock Formation, Part 2 2

Return to Trilobite Hunter

Are sedimentary rocks good for finding trilobite fossils?

sandstone

limestone

Yes, sedimentary rocks often contain fossils.

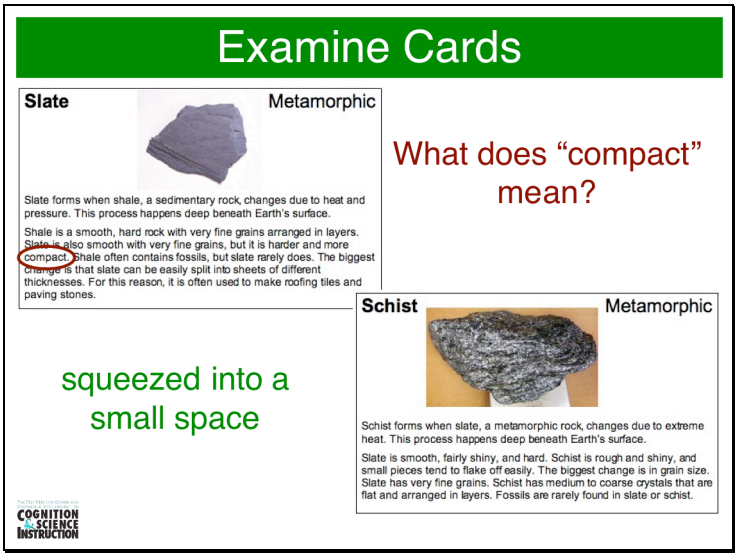
We have one more rock type to look at. This type is found in some of the deepest layers of the Grand Canyon.

Compare Rock Formation, Part 2 3

At this time, show Grand Canyon Video, part 3.

Day 23 – Compare Formation 2

Compare Rock Formation, part 2a (cont.)



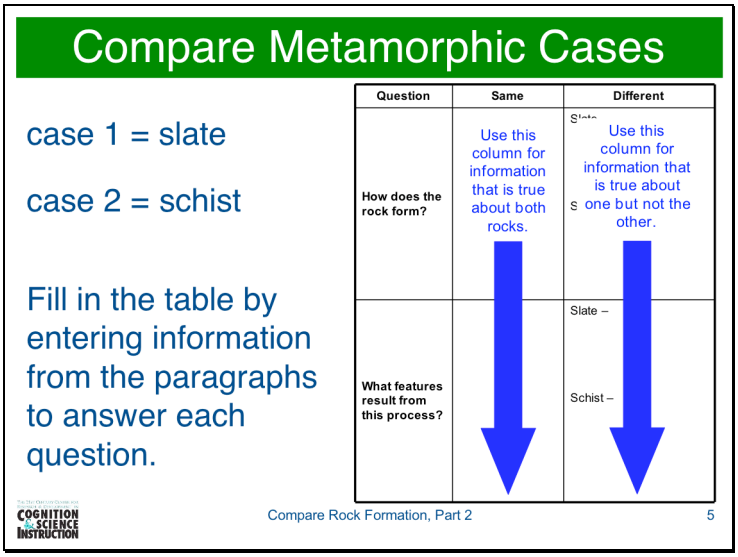
Distribute the metamorphic cards (worksheet 17) and ask students to examine them. The circles and question will appear on keypress. Press a key to display the answer.

Encourage students to compare their rock samples with the pictures and descriptions on the cards.

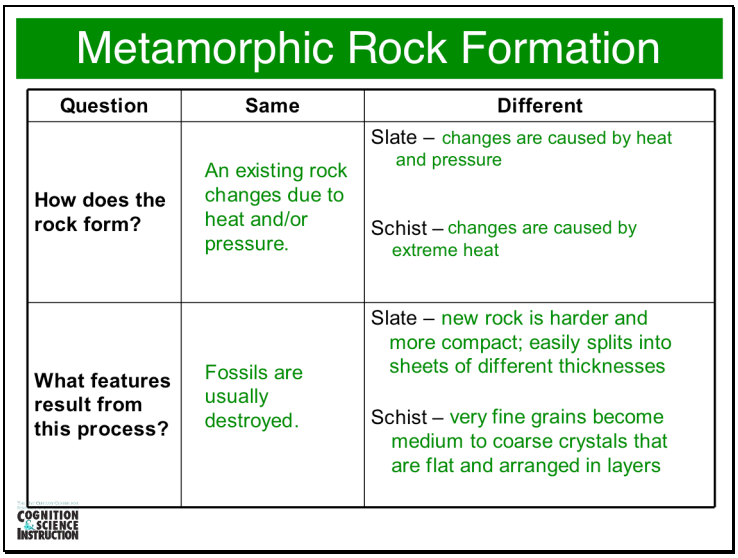
Distribute the Compare Properties table (worksheet 18), and have students work in groups to record the properties of the original rocks (shale and slate) and the properties of the new rocks that are the same and different.

Day 23 – Compare Formation 2

Compare Rock Formation, part 2a (cont.)



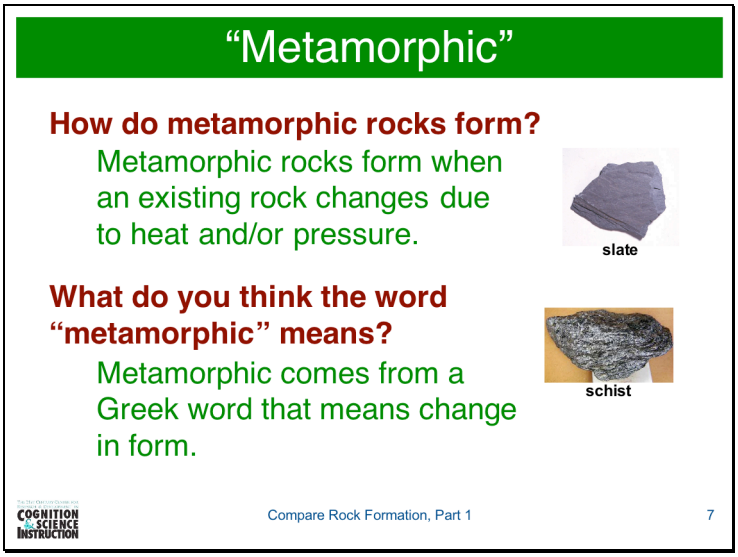
Distribute the comparison table (worksheet 19). As students work, ask them to explain why metamorphic rocks rarely contain fossils. [fossils are usually destroyed by the heat and/or pressure that change the rocks]



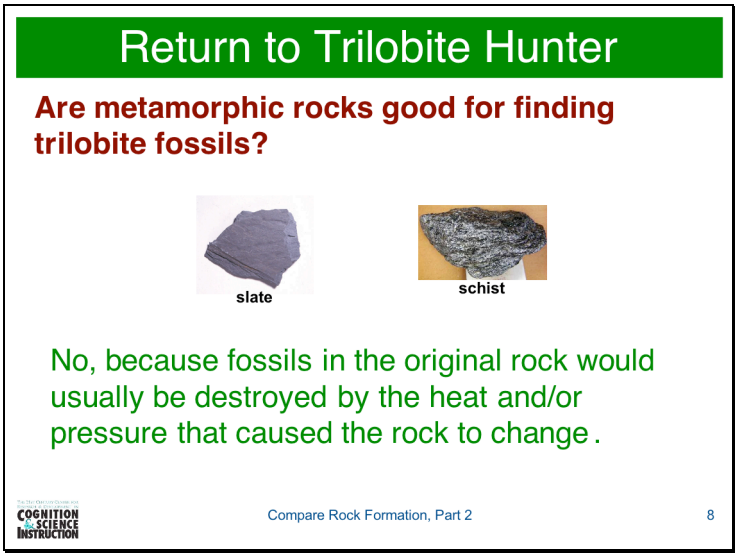
Answers will appear separately on keypress.

Day 23 – Compare Formation 2

Compare Rock Formation, part 2a (cont.)



If your students need help with the second question, ask if they ever learned about metamorphosis, in which caterpillars change into butterflies. Or they may have heard the word morph in connection with computer animations that change faces to other faces or science fiction characters that can change from one form to another.



Day 23 – Compare Formation 2

Worksheet 17

Compare Rock Formation, Part 2 17

Slate — Metamorphic

Slate forms when shale, a sedimentary rock, changes due to heat and pressure. This process happens deep beneath Earth's surface.

Shale is a smooth, hard rock with very fine grains arranged in layers. Slate is also smooth with very fine grains, but it is harder and more compact. Shale often contains fossils, but slate rarely does. The biggest change is that slate can be easily split into sheets of different thicknesses. For this reason, it is often used to make roofing tiles and paving stones.

Schist — Metamorphic

Schist forms when slate, a metamorphic rock, changes due to extreme heat. This process happens deep beneath Earth's surface.

Slate is smooth, fairly shiny, and hard. Schist is rough and shiny, and small pieces tend to flake off easily. The biggest change is in grain size. Slate has very fine grains. Schist has medium to coarse crystals that are flat and arranged in layers. Fossils are rarely found in slate or schist.

Chapter 2 – Rocks: Mineral Mixtures

Day 23 – Compare Formation 2

Worksheet 18 – With Sample Answers

Compare Rock Formation, Part 2 — 18

Compare Properties

Properties of SHALE (original)	smooth & hard very fine grains grains are arranged in layers often contains fossils
Properties of SLATE that are the same	smooth very fine grains
Properties of SLATE that are different	harder & more compact rarely contains fossils easily splits into sheets
Properties of SLATE (original)	smooth; fairly shiny; hard very fine grains rarely contains fossils
Properties of SCHIST that are the same	shiny rarely contains fossils
Properties of SCHIST that are different	rough; small pieces flake off easily medium to coarse crystals crystals are flat & arranged in layers

Chapter 2 – Rocks: Mineral Mixtures

Day 23 – Compare Formation 2

Worksheet 19

Compare Rock Formation, Part 2 19

Metamorphic – Slate & Schist

Question	Same	Different
How does the rock form?		Slate – Schist –
What features result from this process?		Slate – Schist –

Chapter 2 – Rocks: Mineral Mixtures

DAY 24

The Rock Cycle

This lesson is the last part of the *Compare Rock Formation* contrasting case activities.

Big Ideas

- Igneous rocks form when molten rock cools and hardens.
- Sedimentary rocks form when particles settle and get compacted and cemented together.
- Metamorphic rocks form when an existing rock changes because of heat and/or pressure.
- Weathering is when rocks break apart to form small pieces or bits.
- Erosion is when something like water or wind picks up loose bits of rock.
- Transport is when the water or wind carries the bits of rock to another place.
- Deposition is when the water or wind slows down and the loose bits settle.
- The rock cycle is a series of processes that cause rocks to change from one type to another.
- Depending on what happens to it, any type of rock can change into any other type of rock.

Materials

Teacher:

1. slides – day24.ppt

Students:

1. three comparison tables – worksheets 15, 16 & 19
2. rock cycle diagram & cut-outs – worksheets 20-21

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
35 minutes – cc activity – compare rock formation, part 2b

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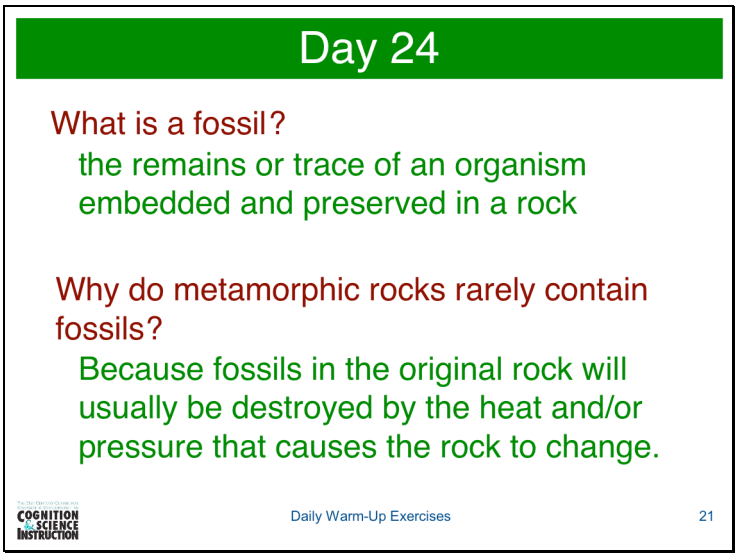
Day 24 – The Rock Cycle

Compare Rock Formation, part 2b
In part 1, (Days 13 and 14), students compared the formation of two igneous and two sedimentary rocks, and they completed a comparison table for each pair of rocks. In part 2a, they compared and completed a table for two metamorphic rocks. In today's activity, they use all three comparison tables to investigate and depict the rock cycle.

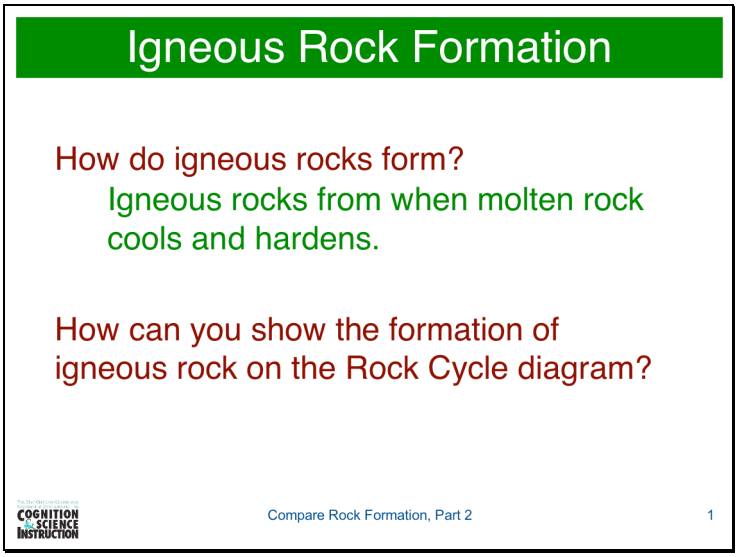
Warm-Up Activity



When particles settle, which ones tend to settle first?
The heaviest particles tend to settle first, and the lightest tend to settle last.

Day 24 – The Rock Cycle

Compare Rock Formation, part 2b (cont.)

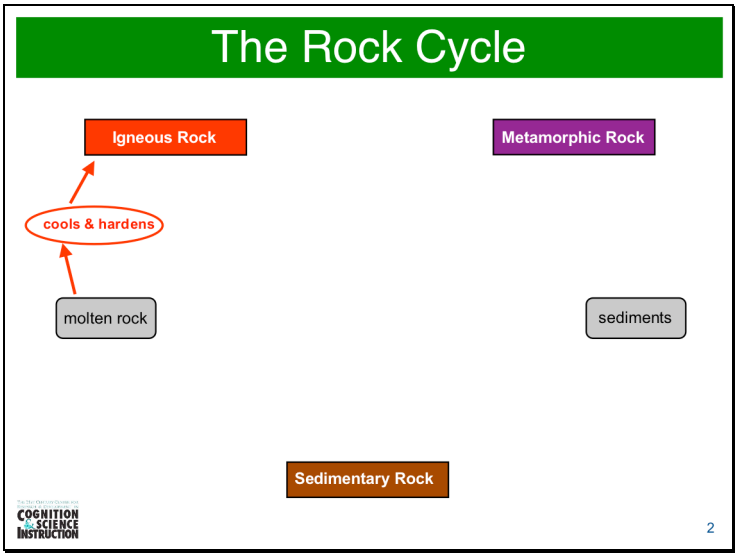


Distribute the Rock Cycle diagram and cut-outs (worksheets 20-21). Have students get out their igneous and metamorphic comparison tables from part 1 (worksheets 15-16).

Tell students they will use the worksheets to create a diagram of the rock cycle. Have them cut out the ovals from the cut-out sheet, then find the one that shows how igneous rocks form and position it in the diagram.

Day 24 – The Rock Cycle

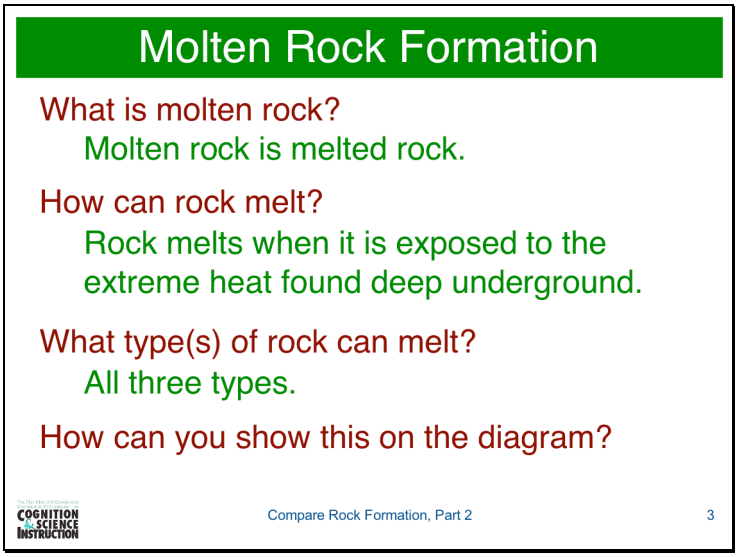
Compare Rock Formation, part 2b (cont.)



Molten rock cools and hardens to form Igneous Rock.

Day 24 – The Rock Cycle

Compare Rock Formation, part 2b (cont.)

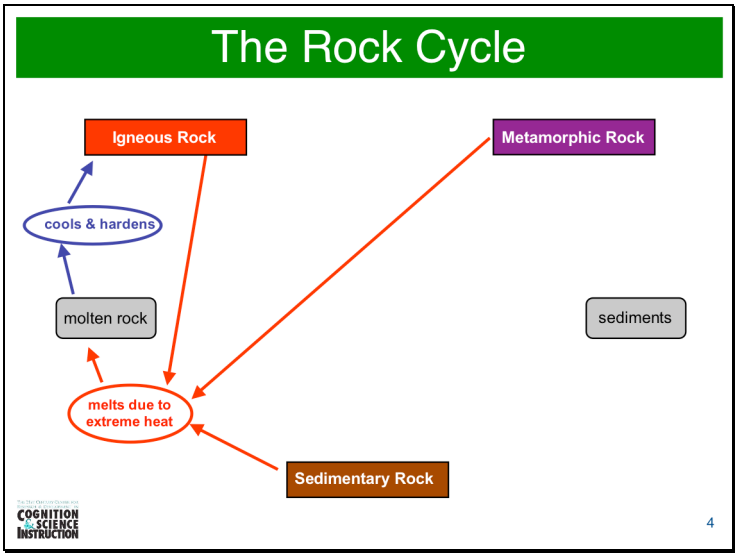


Point out that rock usually melts between 600ºC and 1600ºC. When we talked about the cross section of Earth, we learned that pressure and temperature increase as you move toward the center of the Earth. Near the border between the crust and mantle, the temperature is usually between 800ºC and 1200ºC.

Have students find the appropriate oval and position it in the diagram.

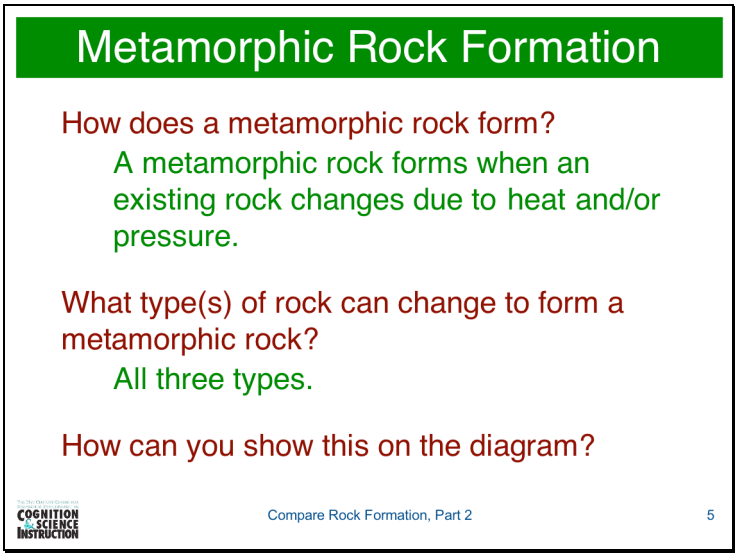
Day 24 – The Rock Cycle

Compare Rock Formation, part 2b (cont.)



Molten rock is formed when a rock melts due to extreme heat. The rock that melts can be igneous, metamorphic, or sedimentary.

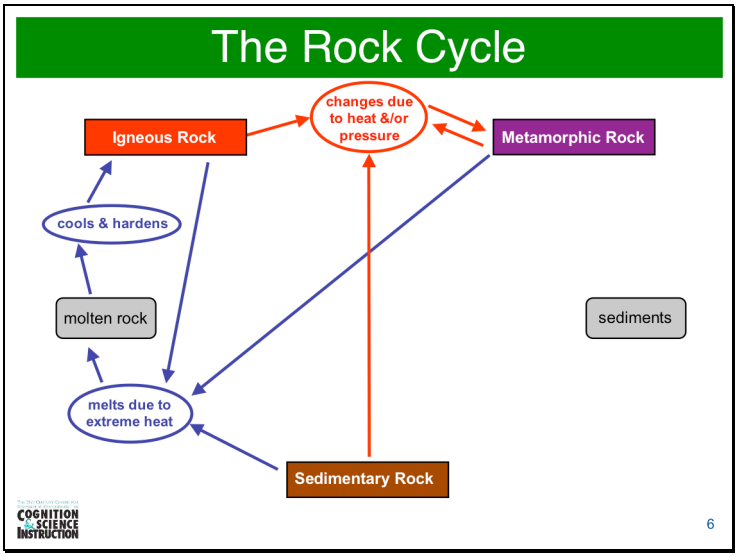
Compare Rock Formation, part 2b (cont.)



Have students find the appropriate oval and position it in the diagram.

Day 24 – The Rock Cycle

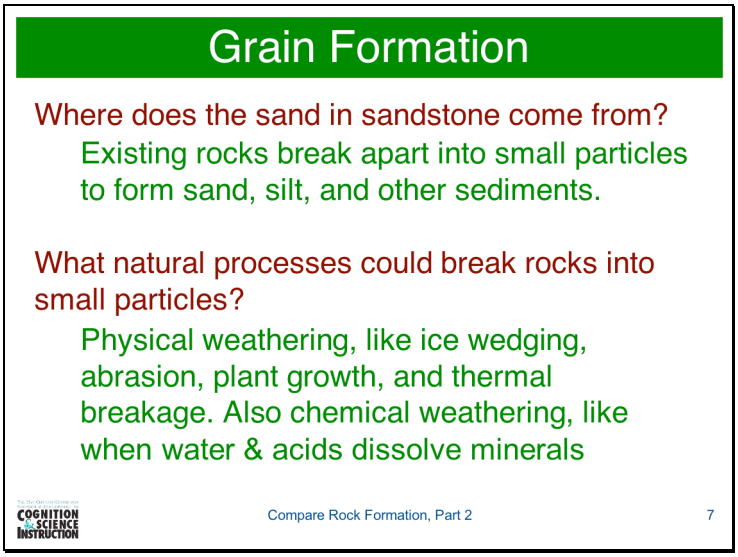
Compare Rock Formation, part 2b (cont.)



A metamorphic rock forms when an existing rock changes due to heat and/or pressure. The rock that changes can be igneous, metamorphic, or sedimentary.

Day 24 – The Rock Cycle

Compare Rock Formation, part 2b (cont.)



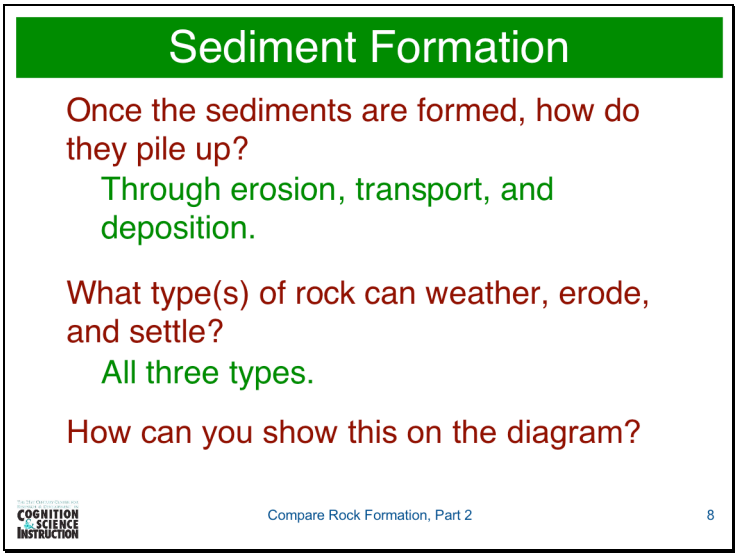
You may need to offer some hints to help students answer the questions on this screen and the next. For example, you could ask what happens when you put a full bottle of water in the freezer. Most students will know that the bottle will break because water expands as it freezes. Ask if something similar could break rocks. To help them understand thermal breakage, you might compare it to potholes that form in the spring, when days are warm and nights are cold.

After revealing the answer to the second question, use questions to elicit a description of each process:

- Ice wedging happens when water seeps into cracks, freezes, and expands, creating a wedge that breaks the rock apart.
- Plant growth can break rocks when roots grow in cracks, exerting pressure that breaks the rock apart.
- Thermal breakage happens because a rock will expand when warm and contract when cool. When this happens over and over, the rock breaks apart.
- In chemical weathering, water and acids dissolve or change the minerals that make up rocks, causing them to break apart.

Day 24 – The Rock Cycle

Compare Rock Formation, part 2b (cont.)



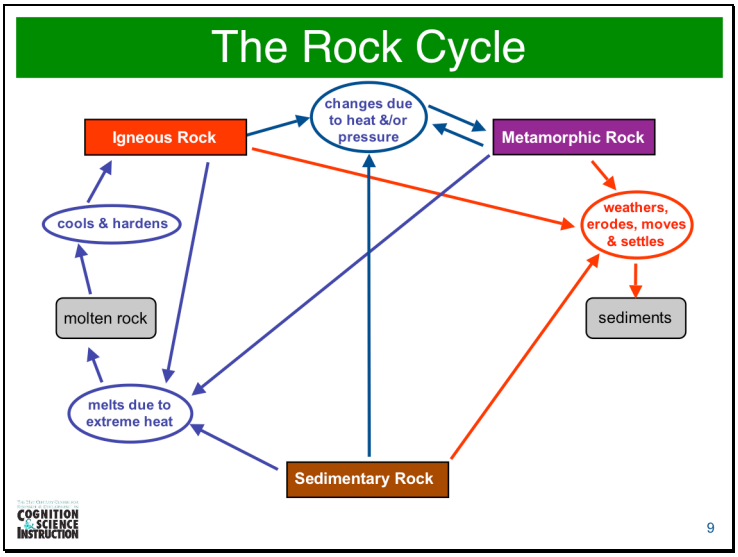
What is EROSION?
When something like water or wind picks up loose bits of rock.

What is TRANSPORT?
When the water or wind carries the bits of rock to another place.

What is DEPOSITION?
When the water or wind slows down, it releases or lets go of the particles it is carrying. This is also called settling or sedimentation.

Day 24 – The Rock Cycle

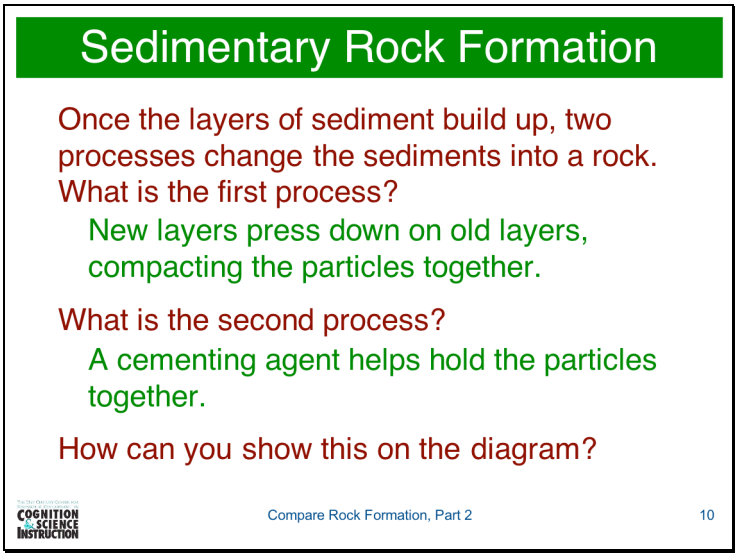
Compare Rock Formation, part 2b (cont.)



Sediments form when an existing rock weathers, erodes, moves, and settles. The rock that weathers can be igneous, metamorphic, or sedimentary.

Day 24 – The Rock Cycle

Compare Rock Formation, part 2b (cont.)



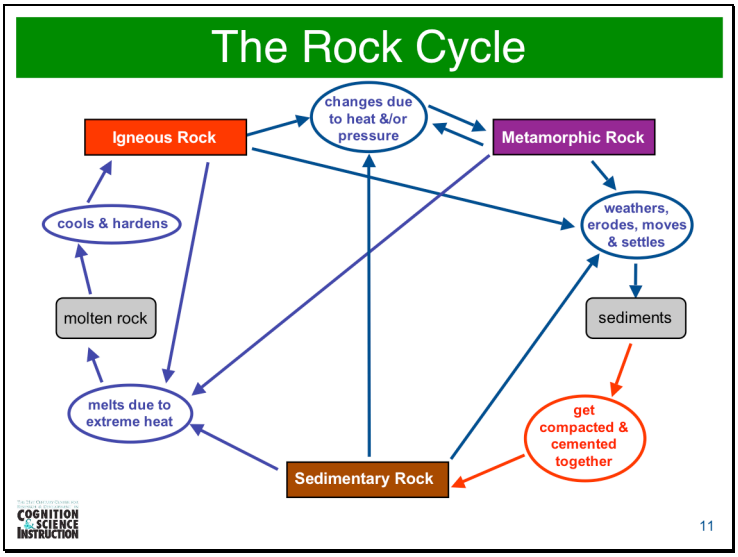
What does COMPACT mean?
To squeeze or pack something together so it takes up less space.

What is a CEMENTING AGENT?
A chemical that glues stuff together.

Have students find the appropriate oval and position it in the diagram.

Day 24 – The Rock Cycle

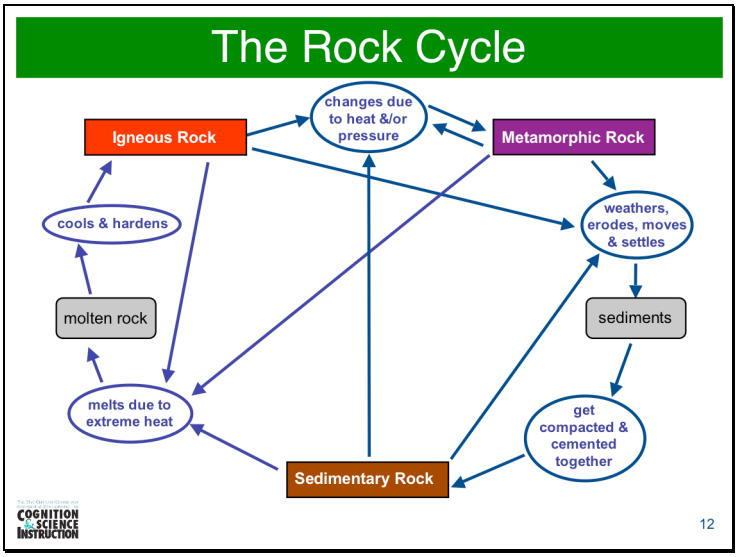
Compare Rock Formation, part 2b (cont.)



Sediments get compacted and cemented together to form Sedimentary Rock.

Day 24 – The Rock Cycle

Compare Rock Formation, part 2b (cont.)



Once your students complete their diagrams, ask, "What is the ROCK CYCLE?" [a series of processes that cause rocks to change from one type to another]

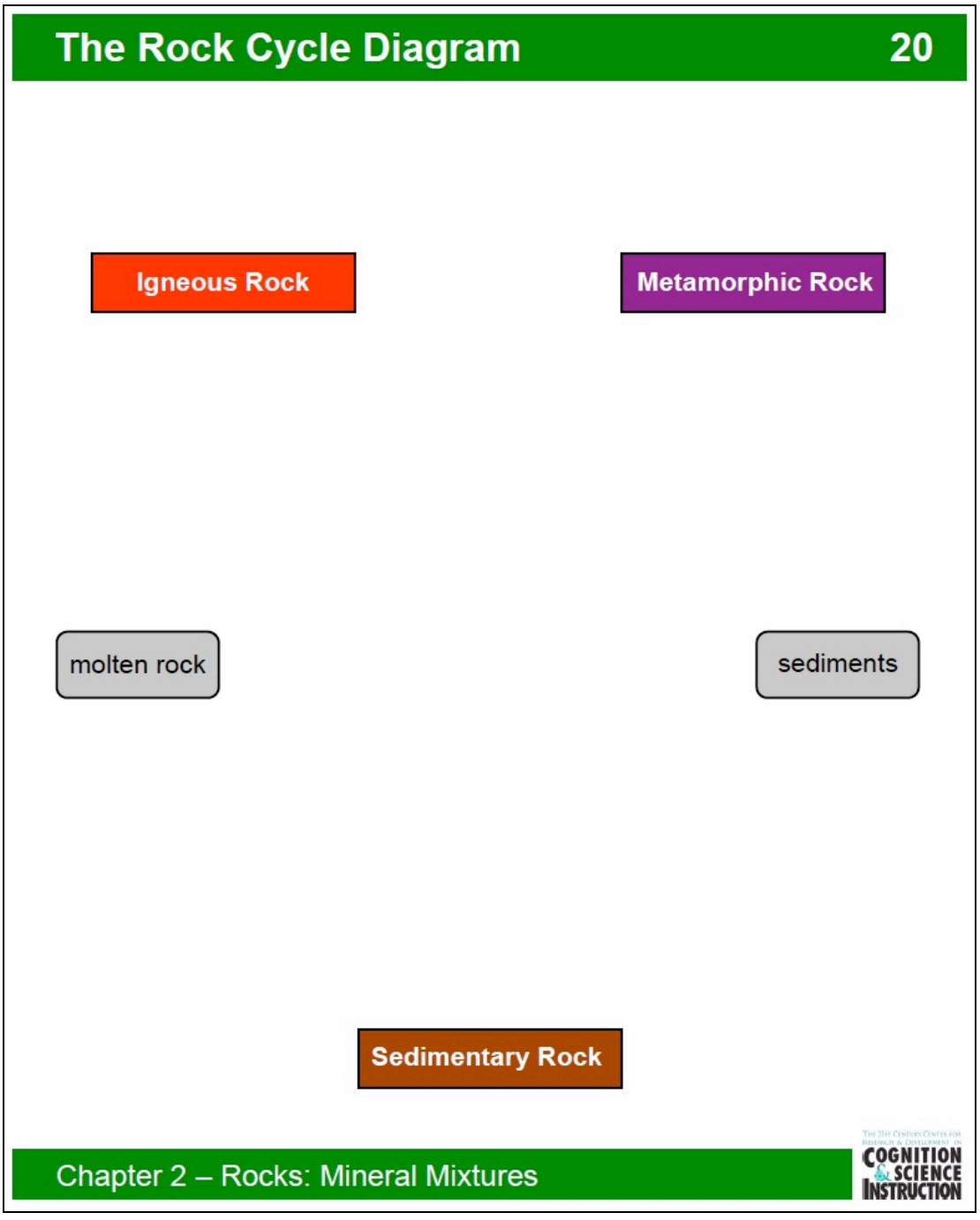
Encourage them to think about the rocks they've examined and how they might fit into the diagram. For example, sandstone could melt due to extreme heat, forming molten rock that could cool and harden to form an igneous rock. If the sandstone were exposed to heat and pressure, it would change into quartzite, a metamorphic rock. On the other hand, if it were to undergo weathering, erosion, and settling, it could change into another piece of sandstone.

Similarly, granite could weather to form sand. The sand could erode and settle, then get compacted and cemented together to form sandstone. Or the granite could change due to heat and pressure to form the metamorphic rock gneiss. Or it could melt, then cool and harden to form another igneous rock.

In other words, rocks can and do change from one type to another over time.

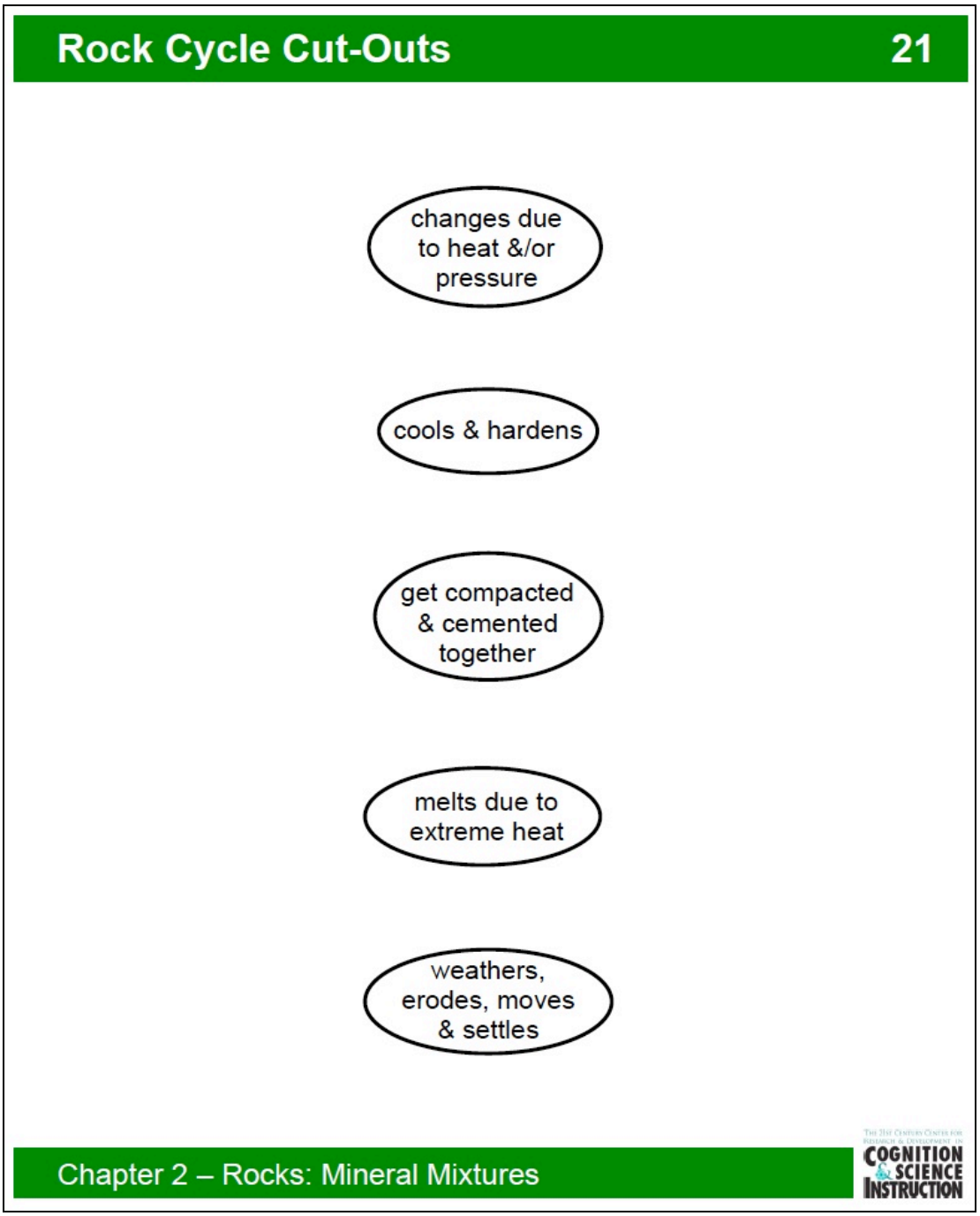
Day 24 – The Rock Cycle

Worksheet 20



Day 24 – The Rock Cycle

Worksheet 21



DAY 25

Quiz 5/Reteach/Review

This lesson provides an opportunity for students to review what they've learned so far. For some, it may be an opportunity to understand an idea they didn't fully grasp the first time around.

Big Ideas
See list of big ideas, Days 1-24.

Materials

Teacher:

1. vocabulary list – RE word list.doc
2. list of big ideas – RE big ideas.pdf

Students:

1. Quiz 5

Activities & Allotted Time (40 minutes total)

10 minutes – quiz
10 minutes – go over quiz
20 minutes – reteach/review chapter 2.2 & 2.3

Reteach/Review Chapter 2.2 & 2.3
After going over the quiz and reviewing the meanings of vocabulary words and the big ideas from days 1-24, use the section review questions on pages 39 and 43 to identify areas that need additional attention.

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Day 25 – Quiz 5/Reteach/Review

Quiz 5 – Page 1

1. What type of rock can form at or near earth's surface?
   a. igneous
   b. sedimentary
   (c.) both igneous and sedimentary

2. The tiny holes in igneous rocks like pumice were formed by _____.
   (a.) bubbles of gas that escaped when lava hardened
   b. tiny worms crawling in mud that later hardened
   c. extreme heat and pressure deep beneath Earth's surface

3. What type of rock can be made up of rock fragments, dissolved minerals, or the remains of plants or animals?
   a. igneous
   (b.) sedimentary
   c. metamorphic

4. Ripple marks in rocks are formed by _____.
   (a.) flowing water and wind
   b. heating and cooling
   c. drying and cracking

5. The formation of layers in sedimentary rock formations is called _____.
   a. cementation
   b. solidification
   (c.) stratification

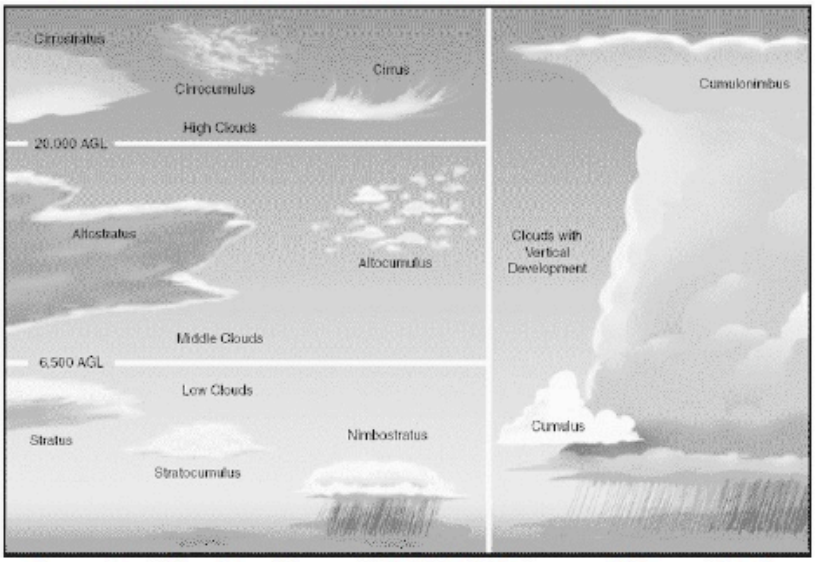
6. Weathering is when _____.
   (a.) rocks break apart to form small pieces or bits
   b. loose bits of rock are carried from one place to another
   c. loose bits of rock settle and pile up

Inside the Restless Earth

Day 25 – Quiz 5/Reteach/Review

Quiz 5 – Page 2

7. **Note to student:** We know you didn't learn this, but we want you to try to answer the question based on the information in the figure.



According to the above figure, which of the following would be considered a "high cloud?"

a. altocumulus
(b) cirrocumulus
c. stratocumulus
d. cumulus

8. What is the rock cycle?

The rock cycle is a series of processes that cause rocks to change from one type to another. Any type of rock can change into any other type of rock.

Inside the Restless Earth

DAY 26

Origins of Metamorphic Rock

This lesson covers the first part of section 2.4 (pages 44-45).

Big Ideas

- Metamorphic rocks form when an existing rock changes because of heat and/or pressure.
- When metamorphic rocks are forming, increased pressure can prevent them from melting.

Materials

Teacher:

1. visualization exercises – day26.ppt

Students:

none

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
5 minutes – visualization 2.4a – Cut-Away
30 minutes – chapter 2.4, part 1 – *Origins of Metamorphic Rock*

Chapter 2.4, part 1

This section explains why metamorphic rocks don't melt even though they are exposed to extreme heat. Today's warm-up is designed to help students understand the relationship between heat and pressure. To provide further support, you might have one group of students model the molecules of a rock and another group model the pressure exerted on the rock by surrounding rocks (form a circle around the rock and push inward). The rock particles vibrate in place, like the particles of any solid. As the temperature rises, the particles vibrate faster. They would move apart and change to liquid, but the pressure holds them together. This explains why Earth's inner core is solid, even though the temperature is nearly 5000°C. The extreme pressure at the center of the Earth prevents the inner core from melting.

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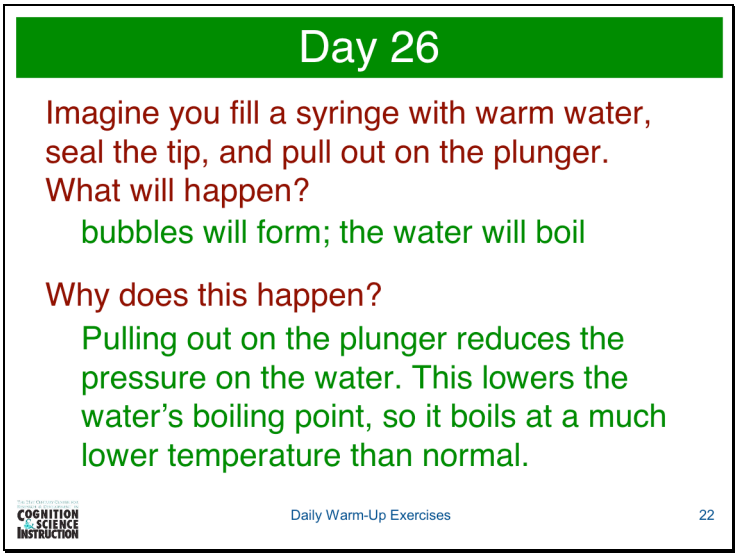
Day 26 – Origins of Metamorphic Rock

Warm-Up Activity



This warm-up is very similar to the warm-up for Day 16 in that it asks students to recall and explain an activity from Introduction to Matter. On Day 16, students learned that the relationship between pressure and melting point is true for rocks, and that the opposite is also true: raising the pressure raises a rock's melting point.

We are returning to this idea today because it will help students understand how metamorphic rocks can get hot enough to change and still not melt. The extreme pressure acting on a rock deep underground raises its melting point, so it remains solid. Remind students that rocks have one temperature at which they start to melt and a higher temperature at which they finish.

[Reminder to teacher: The relationship between melting point and pressure also depends on how much water a rock contains.]

Day 26 – Origins of Metamorphic Rock

Visualization Exercise 2.4a – Cut-Away

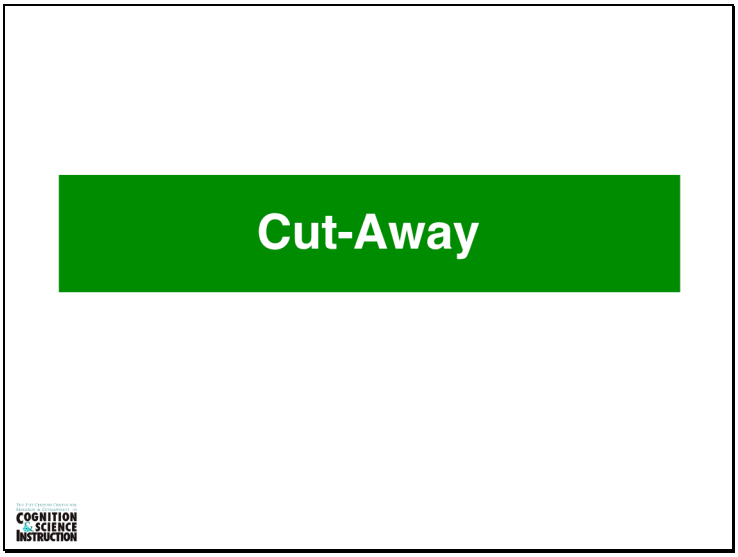


Image Comprehension Focus: Cut-Away

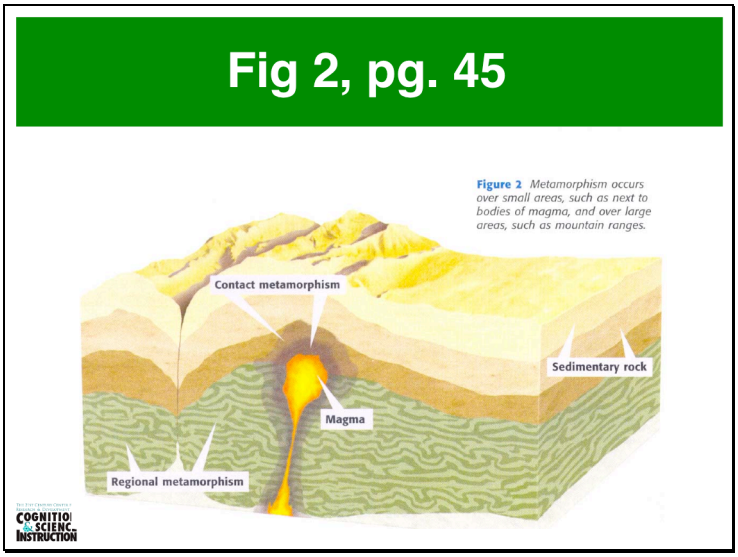
Goal: To quickly review students' understanding of the cut-away convention.

Type of Activity: Teacher-Guided Student Activity

Overview: This activity is designed to review and reinforce the use of the cut-away convention.

(Continue to the next slide)

Visualization Exercise 2.4a – Cut-Away (cont.)



Procedure: The teacher projects Figure 2 from page 45 (shown above).

The teacher then asks students, what type of perspective is this diagram showing, and what is this perspective trying to illustrate? [This perspective is a cut-away, specifically 3D. This perspective is trying to illustrate an area of the earth's crust where contact metamorphism can occur.]

The teacher can ask the students, what advantage(s) does using the 3D perspective have as opposed to using a 2D perspective? [Students may recall the recent, similar image, and come up with several answers to this. The teacher should talk about how using this 3D perspective allows more to be seen or illustrated (such as the extension of the layers as well as the mountain ranges on the top).]

(End of Activity)

DAY 27

Properties of Metamorphic Rock

This lesson covers parts 2 and 3a of section 2.4 (pages 46-47) and includes a quick lab.

Big Ideas

- Metamorphic rocks form when an existing rock changes because of heat and/or pressure.
- Sometimes heat and pressure will cause the minerals in a rock to combine and form new minerals.

Materials

Teacher:

1. visualization exercises – day27.ppt

Students:

1. black pen
2. paper
3. Silly Putty

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
5 minutes – visualization 2.4b – Symbols, Labels & Captions
3 minutes – visualization 2.4c – Labels & Captions
2 minutes – visualization 2.4d – Arrows & Captions
5 minutes – quick lab – *Stretching Out* – page 45
20 minutes – chapter 2.4, parts 2 & 3a

Chapter 2.4, parts 2 & 3a

Some teachers say the Silly Putty activity works better with pencil than black pen. After the lab, tell students the putty is a pretty good model of very hot rock. It maintains its shape, but if you let it sit for awhile, it will gradually take the shape of its container, like a liquid. If you stretch it quickly, it will break. But if you stretch it slowly, you can make it long and thin. If the temperature rises higher or if the pressure on the rock is lowered, the rock will become more and more like a liquid and less and less like a solid.

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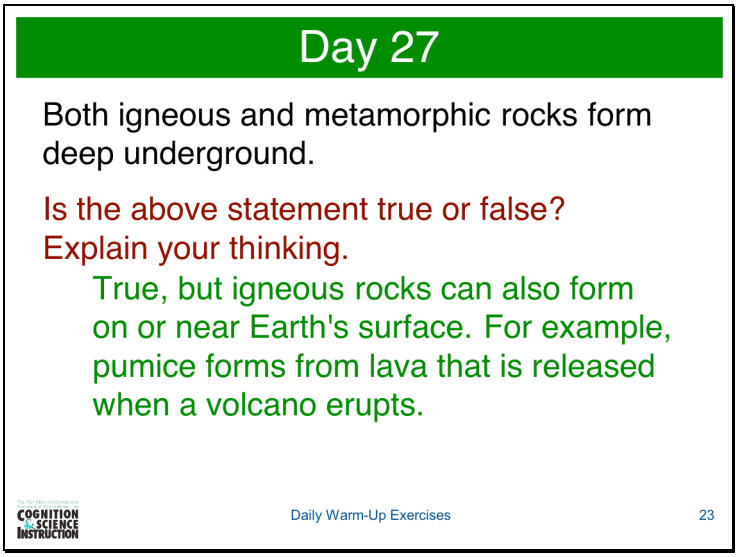
Day 27 – Properties of Metamorphic Rock

Warm-Up Activity



When an igneous rock forms deep underground, is it likely to harden slowly or quickly?

slowly because it is extremely warm deep underground

Day 27 – Properties of Metamorphic Rock

Visualization Exercise 2.4b – Symbols, Labels & Captions

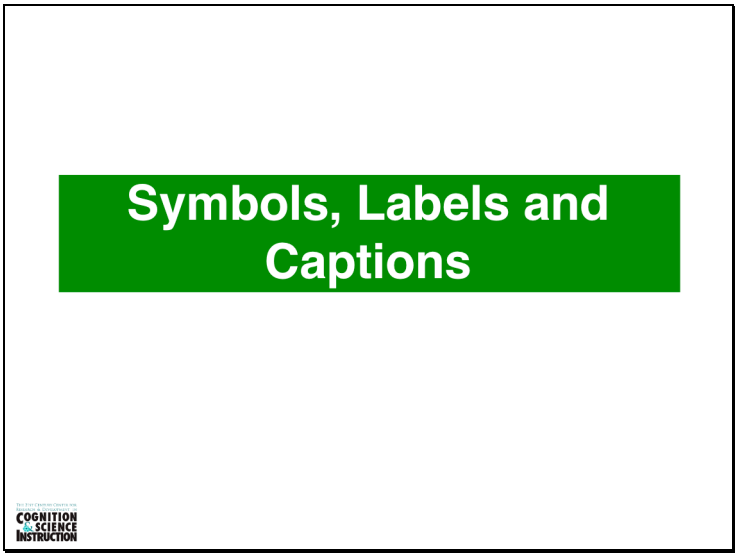


Image Comprehension Focus: Symbols, Labels, and Captions

Goal: 1) To understand the role/importance of symbols in diagrams, 2) Further emphasize the importance of labels and captions

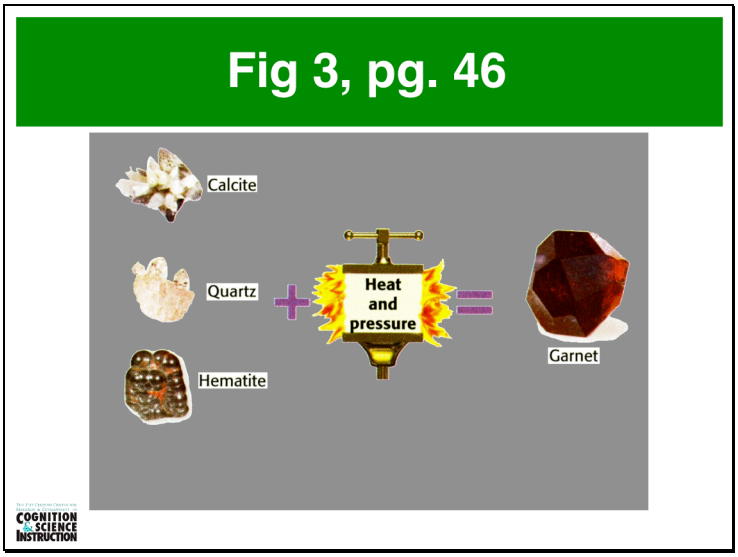
Type of Activity: Teacher Guided Student Activity

Overview: The exercise will help students to understand how symbols may be used in diagrams. In addition, this exercise will further emphasize the importance of reading labels and captions when trying to understand a certain diagram.

(Continue to the next slide)

Day 27 – Properties of Metamorphic Rock

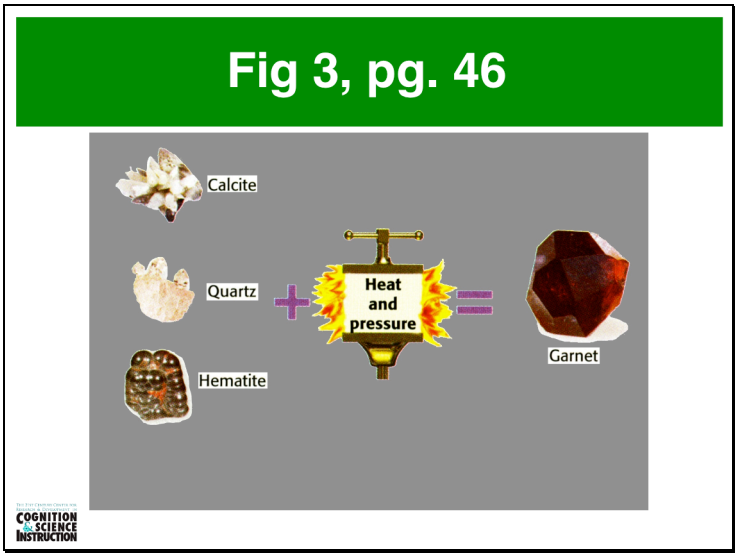
Visualization Exercise 2.4b – Symbols, Labels & Captions (cont.)



Procedure: The teacher projects Figure 3 on page 46 from the above slide. Next, the teacher asks students to look at the diagram and answer the following questions:

- What familiar mathematical symbols has the author used? [The "+" and "=" symbols]
- Why does the author use these symbols? After all, there are no numbers here to "do math" with. [The author expects students to know how to combine two numbers through addition in order to get a new number. The author is using this familiar idea to show how minerals can be "combined" with heat and pressure to produce a new substance. The author is making an analogy – a comparison of something unfamiliar and new, to something else that is already well understood and is similar in some important way.]
- What image does the author use to indicate 'heat?' [the flames – again, the author is using something that is already familiar to the reader]

Visualization Exercise 2.4b – Symbols, Labels & Captions (cont.)



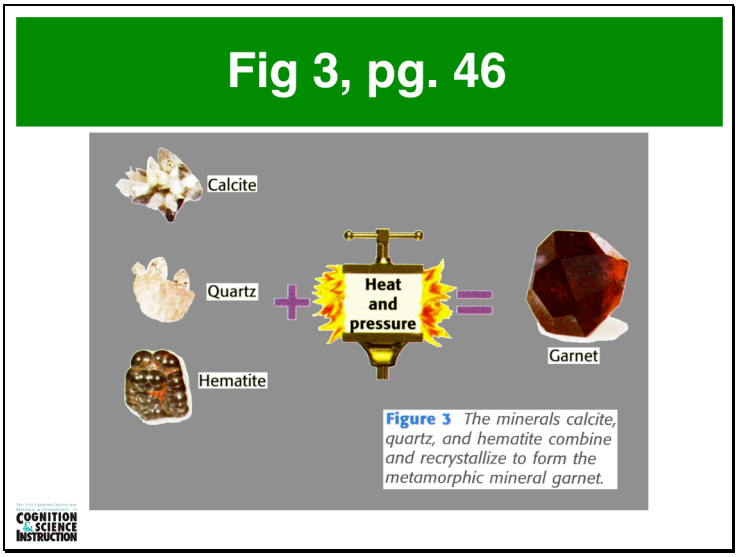
- What image does the author use to indicate 'pressure?' [The vice, which may be a problem. The author probably assumes that the vice will be familiar to students, but students may or may not know what a vice is. The teacher should explain that a vice is something that is used to apply pressure or squeeze something. The teacher may want to use examples of vices that some students may be familiar with, such as using a vice in woodworking or metalworking.

Note: While students will most likely understand that there is not an actual vice under the ground and that this is merely symbolic, they should be made aware that things inside the earth are not actually burning or on fire, which is a common misconception.

Next, the teacher will direct students, either individually or in small groups, using information from the labels and symbols, write a caption to go with the above image of Figure 3.

(Continue to the next slide)

Visualization Exercise 2.4b – Symbols, Labels & Captions (cont.)



After having students share their own captions, the teacher can project the above image of Figure 3 with the original caption. The teacher can then emphasize the importance of the symbols, such as the flames, vice, as well as the plus and minus symbols, in addition to the labels, in being able to understand the diagram.

(End of Activity)

Day 27 – Properties of Metamorphic Rock

Visualization Exercise 2.4c – Labels & Captions

Image Comprehension Focus: Labels and Captions

Goal: To further emphasize the role/importance of labels and captions

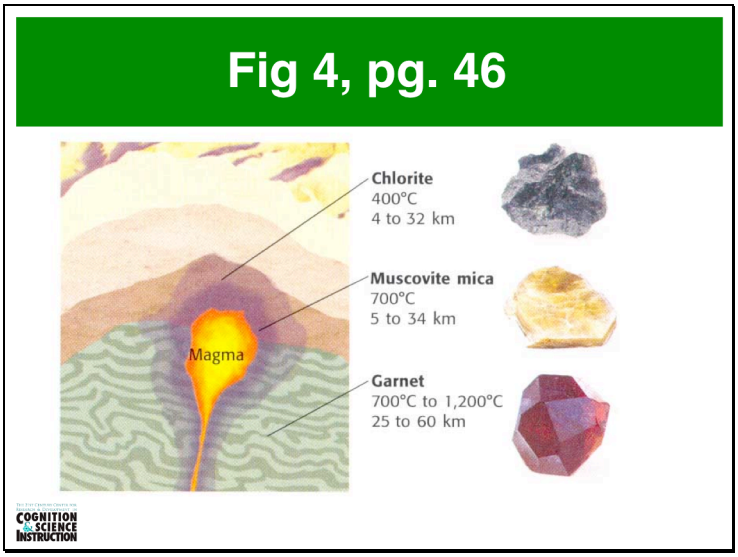
Type of Activity: Teacher Guided Student Activity

Overview: This exercise is designed to further emphasize the important role of labels and captions in diagrams, and that captions usually contain important information about the diagram that otherwise would be missed.

(Continue to the next slide)

Day 27 – Properties of Metamorphic Rock

Visualization Exercise 2.4c – Labels & Captions (cont.)



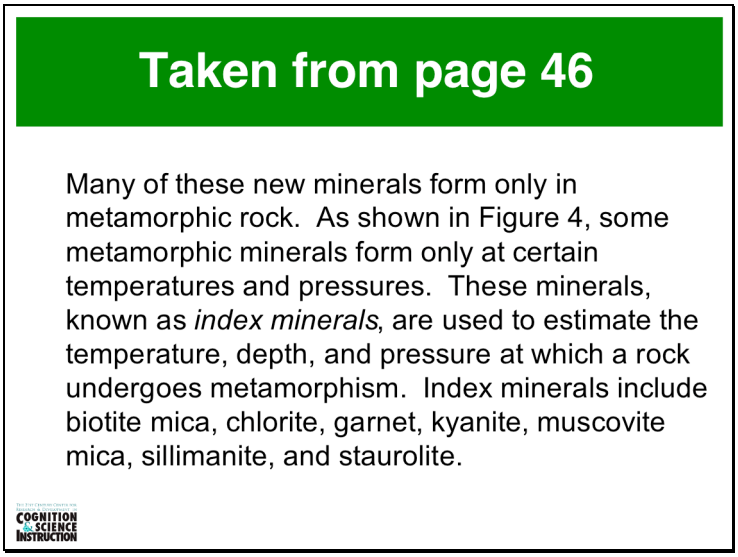
Procedure: The teacher projects the above image of Figure 4 from page 46 and asks students the following questions:

- What type of labels are the words in bold (Chlorite, Muscovite mica, Garnet)? [Naming labels]
- What do the labels 400ºC**, 700ºC, and 700ºC to 1,200ºC have to do with the diagram? [These are explanatory labels that are explaining the temperatures at which these particular index minerals are formed.]
- What do the labels 4 to 32km**, 5 to 34 km, and 25 to 60 km have to do with the diagram? [These are explanatory labels that are explaining the depth at which these particular index minerals are formed.]

**Note to teacher: The teacher should be mindful that students may or may not be familiar with metric abbreviations (Celsius and Kilometer), and so further explanation/assistance with such terms may be necessary.

(Continue to the next slide)

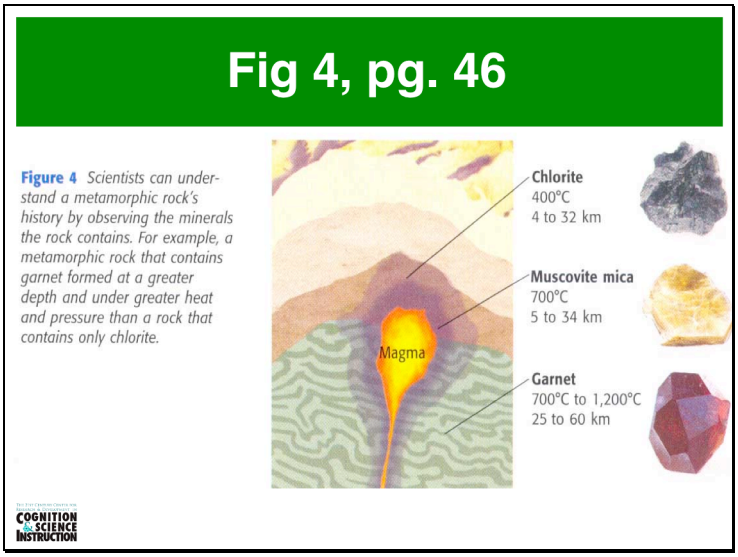
Visualization Exercise 2.4c – Labels & Captions (cont.)



The teacher has students read the above paragraph from page 46. If necessary, the students will again try and answer the questions from the previous slide, and the teacher can review the correct answers.

(Continue to the next slide)

Visualization Exercise 2.4c – Labels & Captions (cont.)



Next, either individually or in small groups, the teacher has students read the caption for Figure 4 shown on page 46 (shown above if the teacher wants to project it). The teacher asks students, either individually or in small groups, to add information to the caption written by the author that would make clear the purpose of the labels from the diagram.

The teacher can then lead a discussion which emphasizes not only the importance of reading captions, which can contain information crucial to understanding the diagram, but also emphasizes the idea of reading the surrounding text that can accompany the diagram when one is unable to understand the diagram alone.

(End of Activity)

Day 27 – Properties of Metamorphic Rock

Visualization Exercise 2.4d – Arrows & Captions

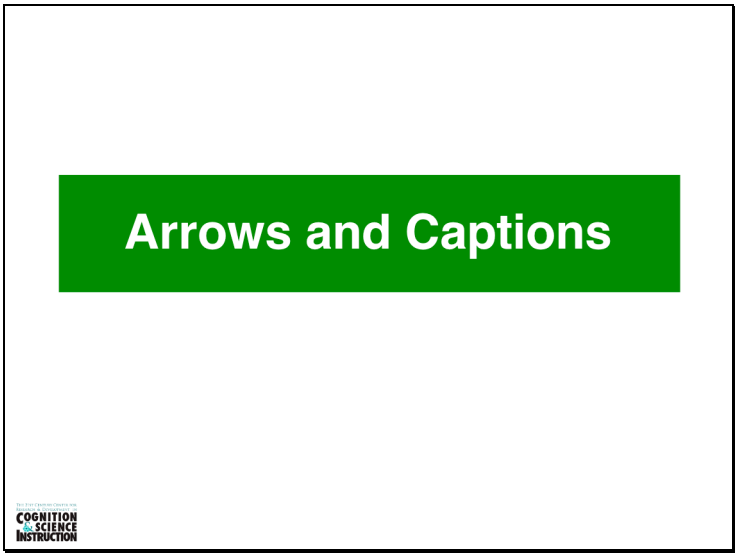


Image Comprehension Focus: Arrows and Captions

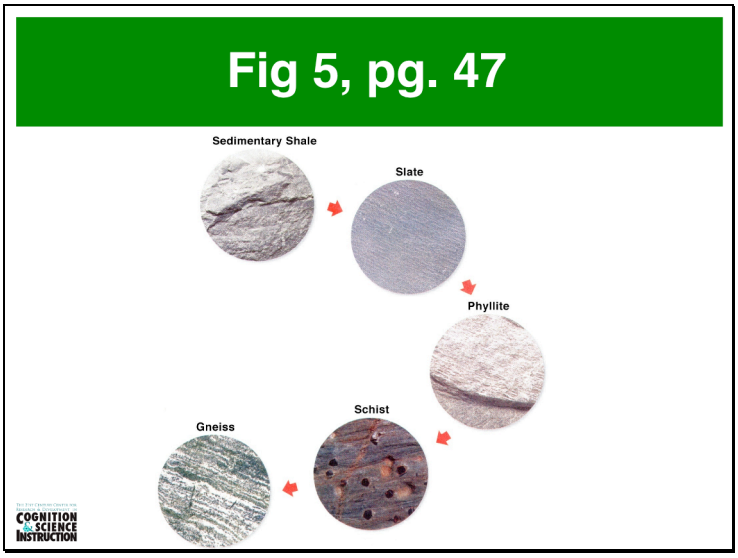
Goal: 1) To illustrate one way in which arrows are used, and 2) Further emphasize the importance/role of captions

Type of Activity: Teacher Guided Student Activity

Overview: This exercise will further students' understanding of one way in which arrows can be used in diagrams, as well as re-emphasize the importance of always reading the caption when trying to understand a diagram.

(Continue to the next slide)

Visualization Exercise 2.4d – Arrows & Captions (cont.)



Procedure: The teacher has students look at the above altered image of Figure 5 from page 47 and asks the students:

What role do the arrows play in the diagram? [This may be difficult to answer without being able to see the caption. The arrows are showing a change of rock type.]

(Continue to the next slide)

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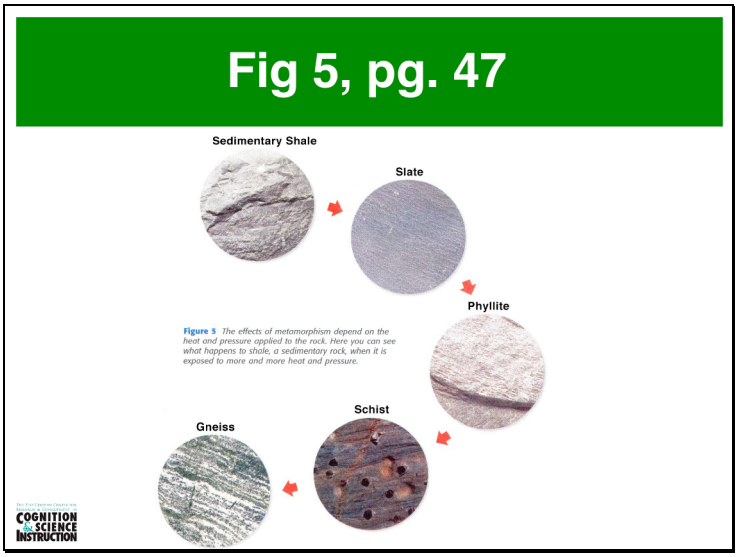
Visualization Exercise 2.4d – Arrows & Captions (cont.)



After hearing student answers, the teacher has them turn to Figure 5 on page 47, pointing out that it would be difficult to tell the role of the arrows without the information from the caption. After students have been given a chance to read* the caption, the teacher reviews the role of the arrows in this particular diagram. [*Note: Students should be directed to read the caption using their textbook, as the above image of the caption may be too difficult to see.]

The teacher should emphasize, as in previous exercises, that arrows can play different roles according to the diagram (e.g. change of state, motion, a process, a relationship, etc.), and that it is important to focus on the specific role of the arrows in a particular diagram, rather than assuming that arrows function in only one way. Often, there will be clues that will make the function of the arrows clear. In this case, the caption provides the necessary information. But in other cases it may be in explanatory labels, or the surrounding text, or made clear through use of color. Emphasize that it is important to identify exactly what the arrows are showing each time you come across a new diagram.

(End of Activity)

DAY 28

Metamorphic Structures

This lesson covers the rest of section 2.4 (pages 48-49).

Big Idea

- Deformation is a change in shape that happens when heat and pressure cause a rock formation to fold, bend, or twist.

Materials

Teacher:

none

Students:

none

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
35 minutes – chapter 2.4, parts 3b & 4

Chapter 2.4, parts 3b & 4

You might begin this lesson by reviewing all the changes in a rock that can be caused by extreme heat and pressure. Middle school students often have trouble accepting the idea that rocks can change, so the more examples you can show them, the more likely they are to understand the conditions and outcomes that are described in this section.

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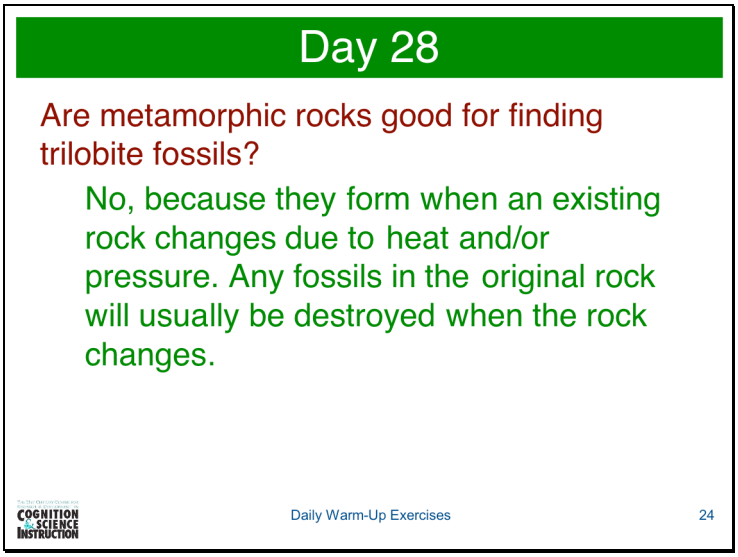
Day 28 – Metamorphic Structures

Warm-Up Activity



What is a fossil?

a remnant or trace of an organism that is embedded and preserved in a rock

What's the difference between body fossils and trace fossils?

Body fossils are preserved remains of organisms. Trace fossils are preserved impressions an organism made on its environment.
Body fossils tell us about an organism itself. Trace fossils tell us about its behavior.

DAY 29

Metamorphic Mash

In this lesson, students complete the modeling lab described on page 185.

Big Idea

- When a rock is changing because of pressure, its grains tend to line up with each other.

Materials

Teacher:

none

Students:

1. stiff cardboard
2. modeling clay
3. plastic knife
4. sequins

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
35 minutes – modeling lab – *Metamorphic Mash* – page 185

Note to teacher: The textbook says grains tend to line up perpendicular to the strongest pressure or stress. This is incorrect because minerals respond to strain, not stress. They actually line up perpendicular to the direction of maximum shortening, which is not always perpendicular to the strongest pressure.

For sequins, you could make little rectangles by cutting up a few disposable plastic plates. Before applying pressure, the rectangles will be at random angles. After applying pressure, the rectangles will all be horizontal.

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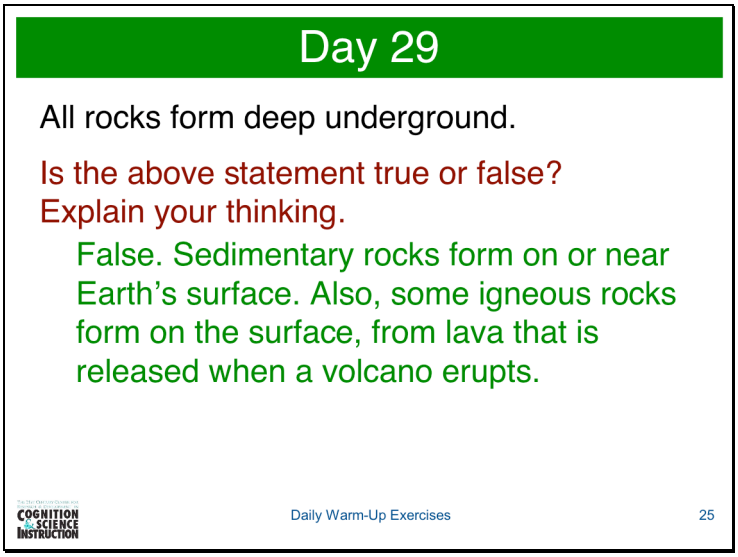
Day 29 – Metamorphic Mash

Warm-Up Activity



What's the difference between intrusive and extrusive igneous rock?

Intrusive forms beneath Earth's surface, where the temperature is very warm. Extrusive forms at or near the surface, where the temperature is cooler.

Which would have larger crystals?

Intrusive, because cooling is slow, so crystals have more time to grow.

DAY 30

Quiz 6/Reteach/Review

This lesson provides an opportunity for students to review what they've learned so far. For some, it may be an opportunity to understand an idea they didn't fully grasp the first time around.

Big Ideas
See list of big ideas, Days 1-29.

Materials

Teacher:

1. vocabulary list – RE word list.doc
2. list of big ideas – RE big ideas.pdf

Students:

1. Quiz 6

Activities & Allotted Time (40 minutes total)

10 minutes – quiz
10 minutes – go over quiz
20 minutes – reteach/review chapter 2.4

Reteach/Review Chapter 2.4
After going over the quiz and reviewing the meanings of vocabulary words and the big ideas from days 1-29, use the section review questions on page 49 to identify areas that need additional attention.

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Day 30 – Quiz 6/Reteach/Review

Quiz 6 – Page 1

1. Which statement best describes how sediments settle?
   - (a) The heaviest particles tend to settle first, and the lightest particles tend to settle last.
   - b. The smallest particles tend to settle first, and the largest particles tend to settle last.
   - c. All the particles settle at approximately the same time, regardless of weight or size.

2. In which type of rock is the fossil imprint of a fern leaf most likely to be found?
   - a. igneous
   - b. metamorphic
   - (c) sedimentary

3. What type of rock is formed when an existing rock changes because of heat and/or pressure?
   - a. igneous
   - (b) metamorphic
   - c. sedimentary

4. When a metamorphic rock is forming, why doesn't the rock melt and become magma?
   - a. The minerals that make up the rock do not have a melting point.
   - (b) The increased pressure raises the rock's melting point.
   - c. A cementing agent keeps the rock from changing to a liquid.

5. Which statement is true?
   - a. Sedimentary rocks form on, near, or deep below Earth's surface.
   - (b) Metamorphic rocks only form below Earth's surface.
   - c. Igneous rocks only form on or near Earth's surface.

6. Metamorphic rocks with mineral crystals arranged in parallel layers or bands are called _____ .
   - (a) foliated
   - b. nonfoliated
   - c. stratified

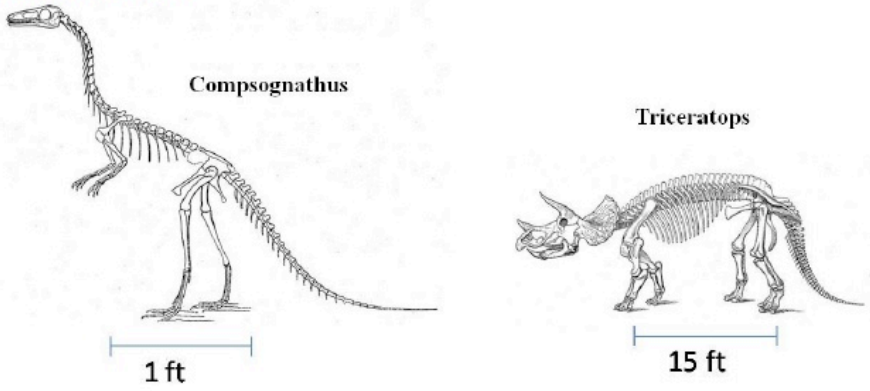
Inside the Restless Earth

Day 30 – Quiz 6/Reteach/Review

Quiz 6 – Page 2

7. **Note to student:** We know you didn't learn this, but we want you to try to answer the question based on the information in the diagram.

Dinosaur Skeletons



According to the diagram above _____.

a. compsognathus was 1 foot long
b. triceratops was 1 foot long
c. compsognathus was larger than triceratops
(d.) triceratops was larger than compsognathus

8. What changes can happen to a rock because of heat and pressure?

Heat and pressure can cause the minerals in a rock to combine and form new minerals. They can also cause a rock formation to fold, bend, or twist. This change in shape is called deformation.

Inside the Restless Earth

DAY 31

Earth Processes

This lesson covers parts 1 and 2 of section 2.1 (pages 28-29).

Big Ideas

- Weathering is when rocks break apart to form small pieces or bits.
- Erosion is when something like water or wind picks up loose bits of rock.
- Transport is when the water or wind carries the bits of rock to another place.
- Deposition is when the water or wind slows down and the loose bits settle.
- Uplift is when movements inside the Earth push rocks to the surface.
- The rock cycle is a series of processes that cause rocks to change from one type to another.
- Depending on what happens to it, any type of rock can change into any other type of rock.

Materials

Teacher:
none

Students:
none

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
35 minutes – chapter 2.1, parts 1 & 2

Chapter 2.1, parts 1 & 2

Parts 1 and 2 are essentially a review of the rock cycle activity from Day 24, so you should be able to use questions to elicit most of this information from your students.

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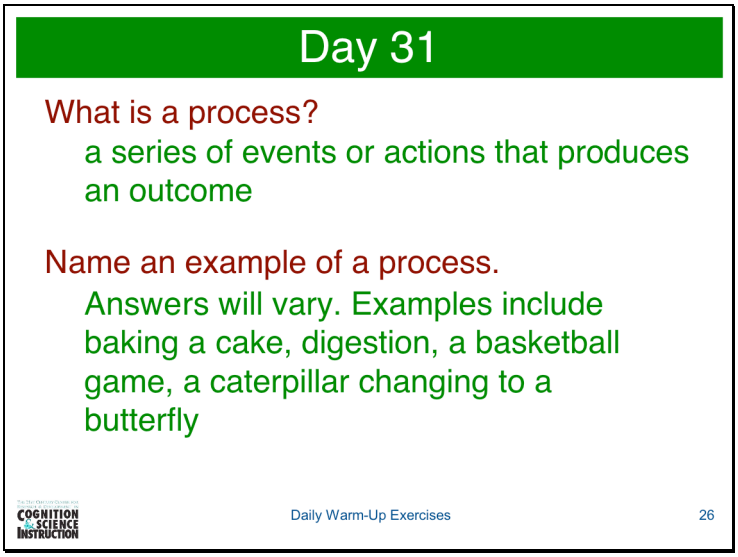
Day 31 – Earth Processes

Warm-Up Activity



Process is a key word in today's lesson, so it's important that students understand what it means.

DAY 32

Compare Rock Cycle Diagrams

This lesson covers parts 3 and 4 of section 2.1 (pages 30-32).

Big Ideas

- The rock cycle is a series of processes that cause rocks to change from one type to another.
- Depending on what happens to it, any type of rock can change into any other type of rock.

Materials

Teacher:

1. visualization exercises – day32.ppt
2. rock cycle slide – included in day32.ppt (last slide)

Students:

1. rock cycle diagram – worksheet 20

Activities & Allotted Time (40 minutes total)

5 minutes – warm-up activity
5 minutes – visualization 2.1a – Labels & Color
5 minutes – visualization 2.1b – Arrows, Labels & Color
25 minutes – chapter 2.1, parts 3 & 4

Chapter 2.1, parts 3 & 4

Have students compare the rock cycle diagram from cc 2.4 (worksheet 20; last slide of day32.ppt.) with the diagram on pages 30 and 31 of the textbook. In the cc diagram, the rock cycle processes are in ovals. In the book, the processes are on arrows, and some of the processes are different. For example, the book shows three separate arrows for weathering, erosion, and deposition, and the cc diagram has all three in one oval. The book also has pictures that show what the products look like and where the processes occur.

The biggest difference is that the book diagram makes it look like there is only one way to move through the cycle. The cc diagram shows that the order can

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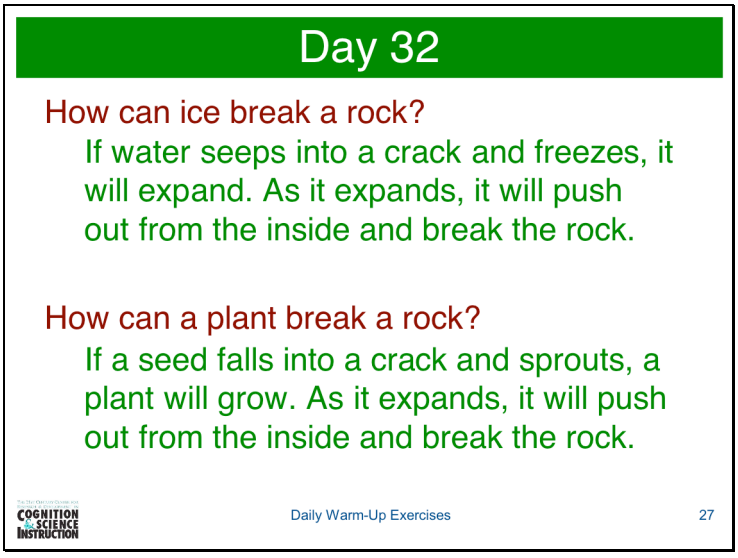
Day 32 – Compare Rock Cycle Diagrams

Chapter 2.1, parts 3 & 4
vary. A sedimentary rock can change to a metamorphic rock, as the book shows, but it can also melt to form magma or weather, erode, and settle to form sediments. The paragraph at the top of page 30 says that the diagram shows one way sand grains can change as different processes act on them, but it is important that students understand that any type of rock can change into any other type of rock.

Have students compare the diagram on page 32 with the other two diagrams. The paragraphs say that rocks can follow different pathways and that each type can change into any of the other three but, as students learned in the second visualization exercise, the diagram doesn't quite show this. The igneous rock has paths that lead to all three rock types. But there is no path for a sedimentary rock to become another sedimentary rock or for metamorphic to become another metamorphic rock. Ask your students how they could revise the diagram to include those pathways.

Warm-Up Activity



What is the process called that breaks rocks into pieces?
weathering

Day 32 – Compare Rock Cycle Diagrams

Visualization Exercise 2.1a – Labels & Color

Image Comprehension Focus: Labels and Color

Goal: 1) To re-emphasize the importance of labels in diagrams, and
2) Show one way in which color can be used in diagrams

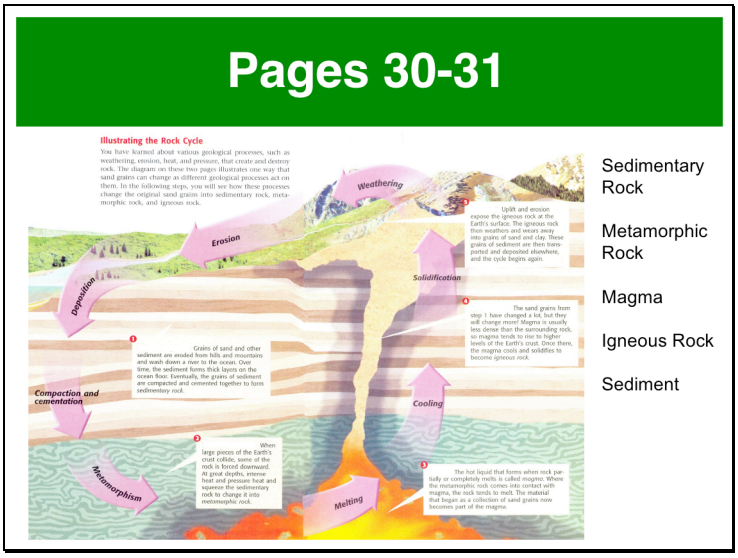
Type of Activity: Teacher-Guided Student Activity/Teacher Comment

Overview: The purpose of this activity is to again emphasize the role/importance of labels in diagrams as well as to show students one way in which color can be used to show information in a diagram.

(Continue to the next slide)

Day 32 – Compare Rock Cycle Diagrams

Visualization Exercise 2.1a – Labels & Color (cont.)



Procedure: The teacher projects the above image from pages 30-31.

The teacher then asks students to pay particular attention to the numbered boxes*, pointing out that these boxes contain explanatory labels, as each label explains a particular aspect of the diagram.

The teacher then points out the list of naming labels to the right of the diagram, and asks students, (either individually or in small groups), to match the naming label to the appropriate explanatory label.

*Note: If it is difficult for students to read the explanatory labels from the screen, the teacher should read each box aloud, then have students select a naming label. This should be done one at a time for each box.

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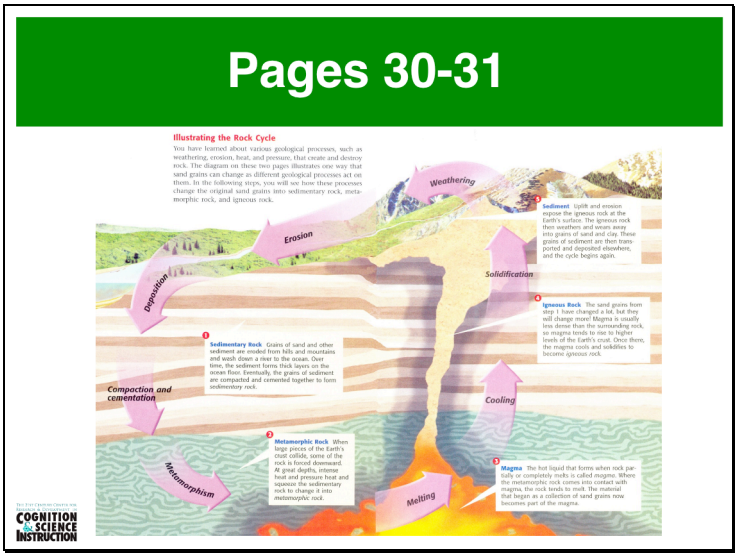
Day 32 – Compare Rock Cycle Diagrams

Visualization Exercise 2.1a – Labels & Color (cont.)

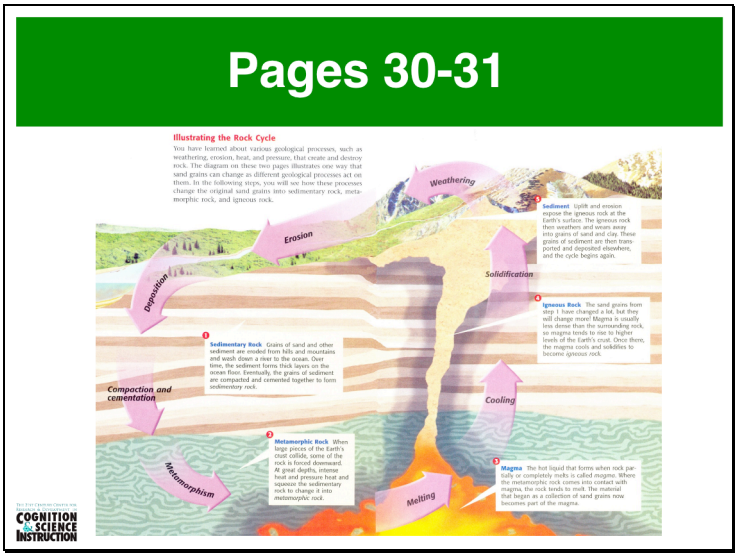


The teacher then has the students turn to pages 30-31 in their textbooks, (and/or projects the above image), and has students check their answers. The teacher makes the point that sometimes labels can make it easier to talk about/point out pieces of a diagram, and that it could be difficult to talk about specific pieces of this diagram without the naming labels.

(Continue to the next slide)

Day 32 – Compare Rock Cycle Diagrams

Visualization Exercise 2.1a – Labels & Color (cont.)



While still on the above image from pages 30-31, the teacher asks the students, if there were no labels, how else might they be able to identify the magma? [Students may have different answers to this. Here the teacher would want to emphasize the use of color, and that if there were no label, one could identify the magma because of the orange, red, and yellow "fire" colors the author has chosen.]

Additionally the teacher can point out that the author has also chosen different color tones for the Sedimentary Rock in order to illustrate different layers. Another color/pattern has also been used to illustrate the Metamorphic Rock.

The teacher can point out that it may be useful to take note of certain color schemes as the author may choose to use the same scheme more than once, thereby helping the student to understand similar points in different diagrams. [To illustrate this, the teacher can have students turn to Figure 2 on page 45 of their textbooks, which uses similar color schemes as the above image.]

(End of Activity)

Day 32 – Compare Rock Cycle Diagrams

Visualization Exercise 2.1b – Arrows, Labels & Color

Image Comprehension Focus: Arrows, Labels and Color

Goal: 1) To enhance students' understanding of how arrows can be used in diagrams, 2) To re-emphasize the importance of labels, and 3) Show how color can be used to illustrate certain types of information

Type of Activity: Teacher-Guided Student Activity/Teacher Comment

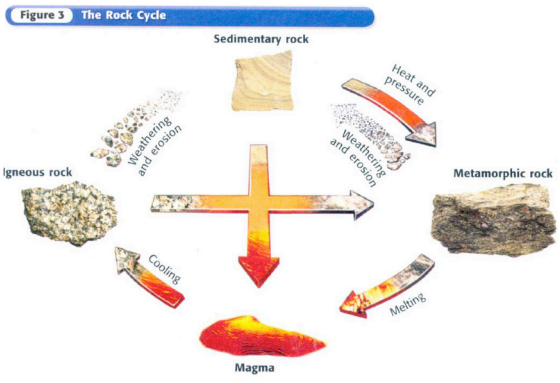
Overview: The purpose of this activity is to illustrate different roles that arrows can play in diagrams, and that arrows can show important information that can enhance one's understanding of the diagram. Additionally the teacher can use this exercise to reinforce the importance of labels as well as ways in which color could be used to point out useful pieces of information.

(Continue to the next slide)

Day 32 – Compare Rock Cycle Diagrams

Visualization Exercise 2.1b – Arrows, Labels & Color (cont.)

Fig 3, pg. 32



Procedure: The teacher has students turn to Figure 3 on page 32 (shown above if the teacher wants to project it). The teacher asks students, what is the role of the arrows that are labeled (e.g. the arrows labeled 'heat and pressure,' 'melting,' 'cooling,' 'weathering and erosion')? [These arrows are being used to illustrate a change.]

The teacher then asks students, what is the role of the two arrows in the middle of the diagram? [These arrows are also being used to illustrate a change. For example, igneous rock can change into metamorphic Rock.]

The teacher should then take the opportunity to point out certain characteristics of the different labeled arrows. For example, the teacher can point out that the 'weathering and erosion' arrow actually appears to weather as the pieces that make up the arrow are getting smaller. Likewise, the arrow labeled 'melting' starts to become more red and orange (like fire) as the metamorphic rock 'melts' into magma. The opposite is true for the 'cooling' arrow which starts off as a red, but then "cools down" into igneous rock.

Day 32 – Compare Rock Cycle Diagrams

Visualization Exercise 2.1b – Arrows, Labels & Color (cont.)

After pointing out these characteristics, the teacher can ask students if they see any connections between these characteristics and the two arrows in the middle. [If students have trouble with this, the teacher can point out that the vertical arrow is turning from an orange to a red, which could indicate melting. Additionally, the horizontal arrow appears to turn from igneous rock into metamorphic rock.]

(Continue to the next slide)

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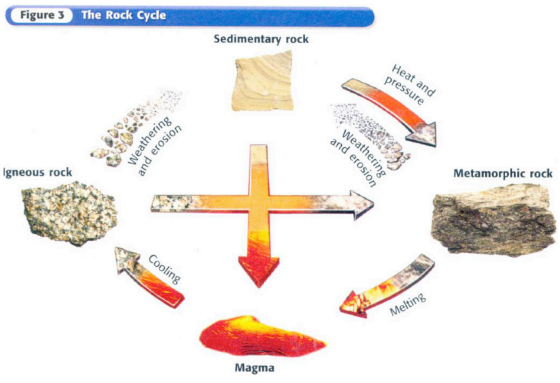
Day 32 – Compare Rock Cycle Diagrams

Visualization Exercise 2.1b – Arrows, Labels & Color (cont.)

Fig 3, pg. 32



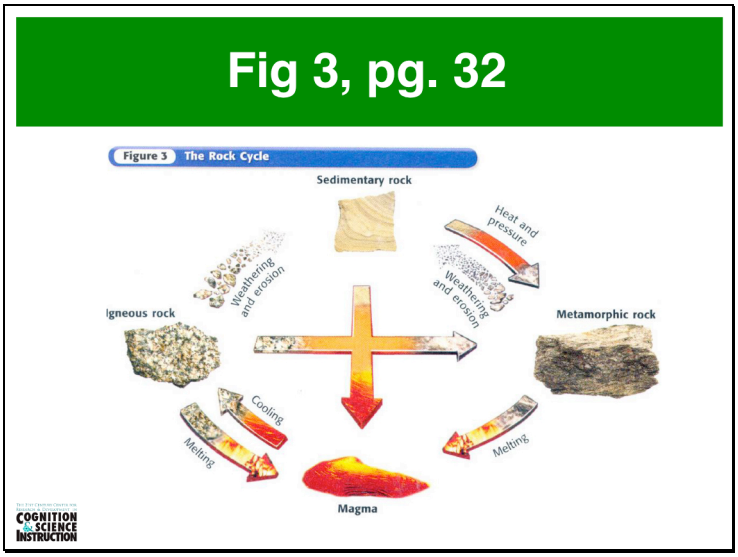
After the students have become familiar with the arrows in the diagram, the teacher can ask the students, can you think of any arrows that the author could have added to the diagram, or that are missing from the diagram? [Students may have difficulty answering this or may have several different answers. For now, you are looking for students to notice that there could be an additional arrow going from the igneous rock into magma. Later you will discuss arrows that loop from sedimentary straight back to sedimentary, and a similar looping arrow for metamorphic rock.]

Once students have recognized that there should be an igneous-to-magma arrow (either on their own, or with teacher prompting) ask them what this arrow should look like. That is, if the author were to draw this new arrow, using the same strategies they used for all of the other arrows, what would it look like?

(Continue to the next slide)

Day 32 – Compare Rock Cycle Diagrams

Visualization Exercise 2.1b – Arrows, Labels & Color (cont.)



The teacher should indicate (shown above) how an arrow can easily be added to demonstrate that igneous rock can change into magma. The teacher should also point out that, while not shown in the above slide, in order for the diagram to really be complete, there should be an arrow going from the sedimentary rock back into itself, as well as an arrow from the metamorphic rock back into itself.

After the teacher has pointed out how these arrows can be added, the teacher should have students look at the heading, 'Round and Round It Goes.' The teacher should ask students in what way the heading could be misleading. [It seems to imply that the cycle goes in only one direction. However, as explained earlier, this is not the case.]

(End of Activity)

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