Polar Rock Repository

Polar Rock Box

For a digital version of this content, visit:

prr.osu.edu

The Ohio State University

Byrd Polar and Climate Research Center

Attention Teachers!

We understand learning about rocks and minerals can be difficult, let alone having to teach it!

We hope that you find the following information (along with the rock box samples) helpful in understanding some of the basics. All samples labeled with a “PRR” number are from Antarctica. Any samples with a “UN” number have an unknown (or non-Antarctic) origin.

Visit our website for activities, games, background information, and other helpful websites on Antarctica and general geology. The contents of this binder are also available in pdf form on our website in the Additional Resources under the Education tab.

Helpful links:

Rocks and Minerals Lecture
(with geoscience careers discussion at time 1:15:00)
go.osu.edu/rocks_and_minerals

Real-Time Polar Weather
fluid-earth.byrd.osu.edu

Virtual Field Trips to Antarctica:

McMurdo Dry Valleys
virtualice.byrd.osu.edu/DryValleys

South Pole Station
virtualice.byrd.osu.edu/southpoleVR

Please do not hesitate to contact us if you have any questions!

Website: prr.osu.edu

Email: curator@bprc.mps.ohio-state.edu

Virtual Rock Box
go.osu.edu/virtual_rock_box

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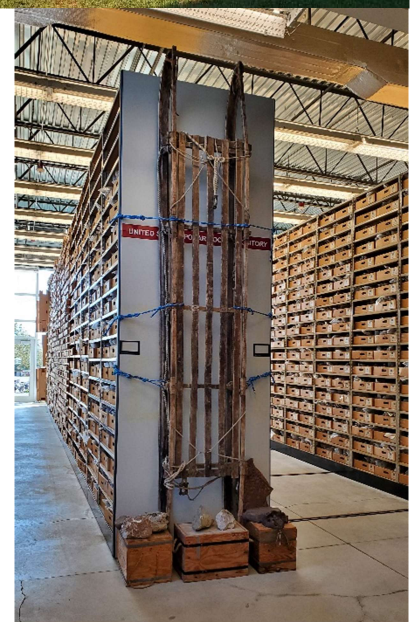
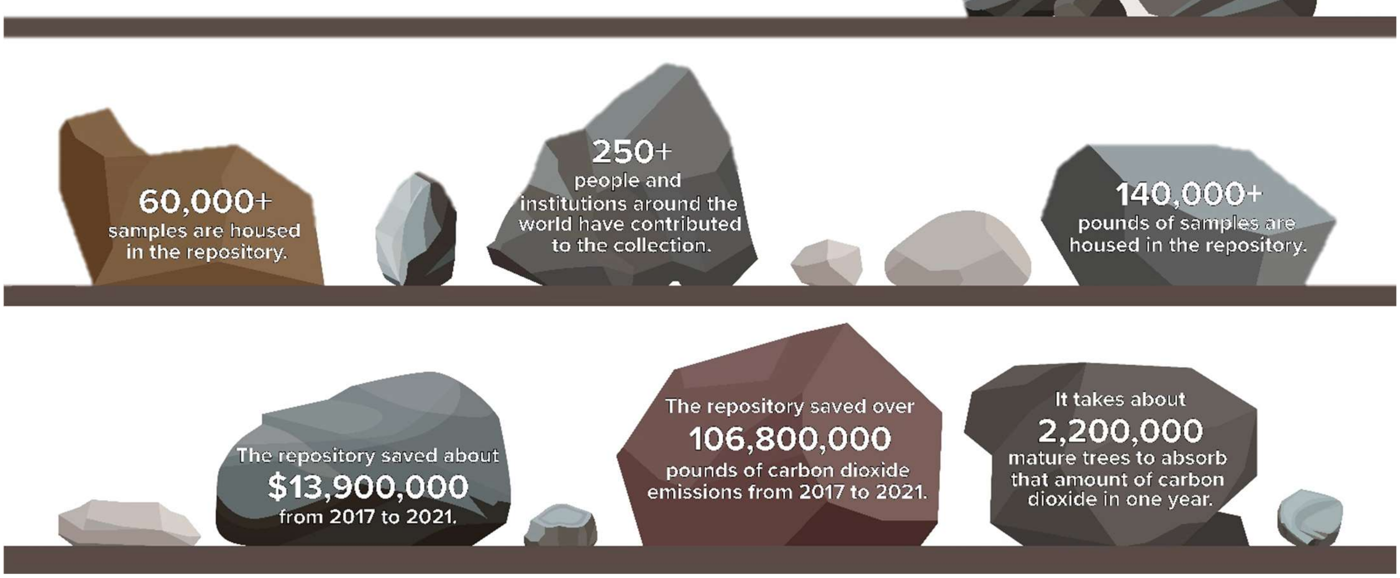
About the Polar Rock Repository (PRR)



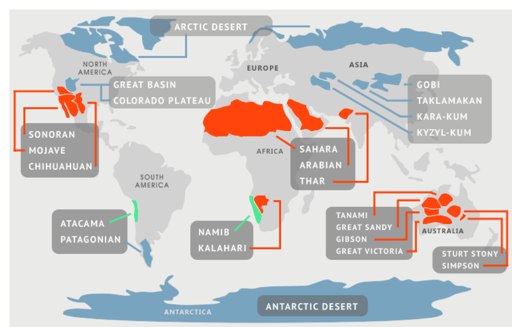
- **What is the PRR?**
  - The PRR was established in 2003 by the National Science Foundation Office of Polar Programs to preserve and freely provide scientific access to rock samples from Antarctica with some minor collections from the Southern Ocean (and other southern continents).
  - The PRR is like a library, but we loan out Antarctic rocks instead of books!
- **Why was the PRR created?**
  - In the past, rock samples were discarded after they were studied. The PRR allows samples to be reused and reexamined. Using the repository instead of recollecting samples saves carbon emissions and saves money!
- **What kind of rocks do you have?**
  - All kinds! Antarctica is home to all 3 rock types (igneous, sedimentary, and metamorphic), along with some minerals and even fossils.
  - Samples can include solid rock, unconsolidated (loose) samples, core, and dredges.
- **Where is the PRR?**
  - The PRR is with the Byrd Polar and Climate Research Center at The Ohio State University in Columbus, OH. Byrd is also home to Ohio State's ice core facility, where thousands of meters of ice cores from all over the world are stored.
- **Can we come visit?**
  - Byrd Polar and Climate Research Center hosts regular tours and events! Visit https://byrd.osu.edu/engage to find an event or schedule a tour.



Antarctica FAQ

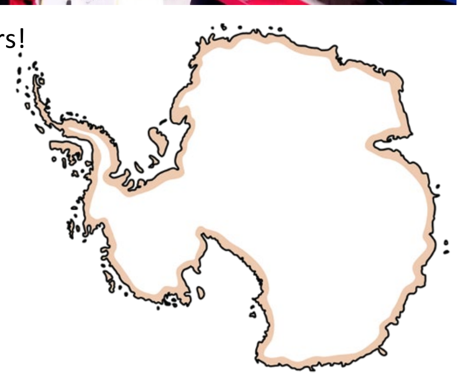
- **Why are so many meteorites found in Antarctica?**
  - Meteorites are easily seen against the ice and are often protected from corrosion by being quickly frozen into the icepack.
  - Ice sheets both transport and concentrate meteorites as they slip off the plateaus and churn against the mountains.
- **Are rocks in Antarctica different from other places?**
  - Rocks around the world are pretty much the same (a granite in the USA will be very similar to an Antarctic granite). However, where you find different rocks can tell you about the history of that area, which can be very different from place to place.

- **Why study geology in Antarctica?**
  - There are tons of reasons to study Antarctica! Examples:
  - Glaciologists look for glacial features that provide evidence of major changes in ice sheet extent/global sea level.
  - Paleontologists look for fossils which can tell us about the environments they lived in.
  - Volcanologists study Antarctica's ~150 known volcanoes (many of which are under the ice sheets)
  - Geophysicists study earthquakes and take advantage of Antarctica's ideal conditions to study the effects of solar radiation of Earth's magnetic field.



- **How can Antarctica be a desert when there is so much snow and ice?**
  - Antarctica is considered a desert because of how little precipitation it receives (deserts get <10 inches of rain each year). Not much evaporation occurs, so snow can accumulate over many years to form the vast glaciers that cover the continent.

- **What is an ice core and why do scientists study them?**
  - Ice cores are cylinders of ice drilled from ice sheets and glaciers.
  - Glaciers form as layers of snow accumulate on top of each other. Over time, the buried snow compresses under the weight of the snow above it, forming ice. Particulates and dissolved chemicals that were captured by the falling snow become a part of the ice, as do bubbles of trapped air. Layers of ice accumulate over seasons and years, creating a record of the climate conditions at the time of formation, including snow accumulation, local temperature, the chemical composition of the atmosphere.
  - By studying ice cores, scientists can directly measure past climate conditions. The oldest measurements from ice cores go back 800,000 years!
  - For some videos on how ice cores are collected and used, please visit wosu.org/ice-cores



Antarctic Fun Facts

- There is no capital of Antarctica – countries that study this continent must sign an international treaty that states that no country can ‘own’ it.
  - As stated in the Antarctic Treaty, wildlife may not be touched or harmed in any way. There are also strict guidelines on commercial fishing, sealing, and a total ban on mining and mineral exploration.

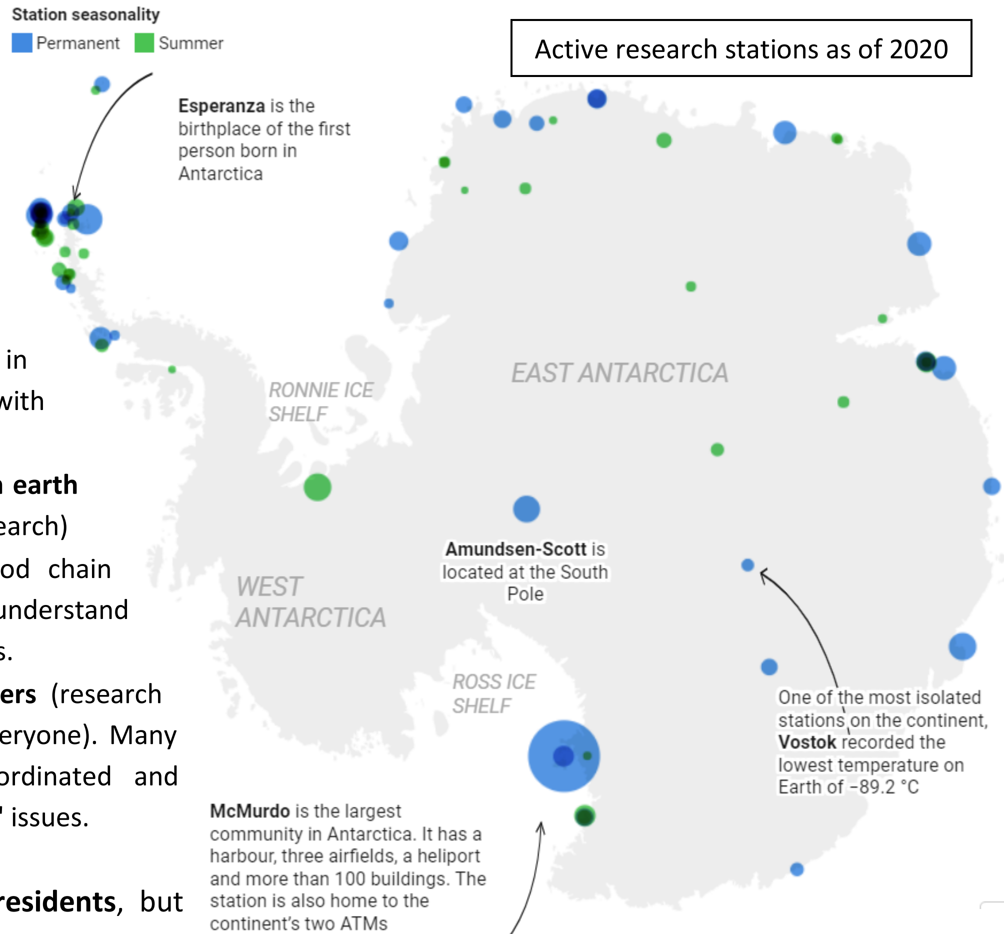
- Antarctica is ~5.4 million mi^2- roughly 1.5 times the size of the continental U.S.
  - ~98% of the continent is covered in ice!
- Antarctica’s ice cap contains 90% of all the ice on the planet and between 60-70% of all the world’s fresh water. If the ice sheets melted, oceans would rise by 200-210 feet (60-65 meters).
- The coldest temperature ever recorded at ground level on Earth was -89.2°C (-128.6°F) at Vostok Station (East Antarctica). The coldest temperature measured by satellite was -93.2°C (-135.8°F) near Dome Fuji Station (East Antarctica).
- The main countries involved with research in Antarctica are New Zealand, Australia, France, Great Britain, Chile, Norway, Russia, and the USA.
  - The United States has explored more Antarctic territory than any other country.

- American Admiral Richard Byrd was the first man to fly over the South Pole (his pilot was Bernt Balchen) in 1929.
- Antarctica is the largest desert on Earth (almost twice the size of the Sahara). Its annual precipitation is less than two inches per year.
  - Fire is a real concern in Antarctica due to the lack of humidity in the air and not having liquid water (since everything is frozen)

- Meteorites are more easily found in Antarctica because their dark color is easily seen on the white snow and ice.
- Blood Falls is nearly 5 stories high and sourced from a subglacial lake high in salt and iron. When the water comes in contact with oxygen, the iron in the water rusts and gives the water its striking red shade.

- There are ~150 known volcanoes in Antarctica- most of which are buried under glaciers. Two active volcanos include Deception Island and Mt. Erebus.
  - Deception Island (South Shetland Islands) once had a thriving whaling station and later a research station but was abandoned after an eruption in 1969.
  - Mt. Erebus, on Ross Island, is the southernmost active volcano on earth and has a lava lake in its crater.
- An insect called the wingless midge, (Belgica Antarctica), is the largest native land creature at ~1cm (~½in) long. They hop like fleas instead of flying (since the extreme winds would blow them away).
  - While there are many larger animals in Antarctica like penguins and seals, they are considered marine animals as they feed and live largely in the ocean.

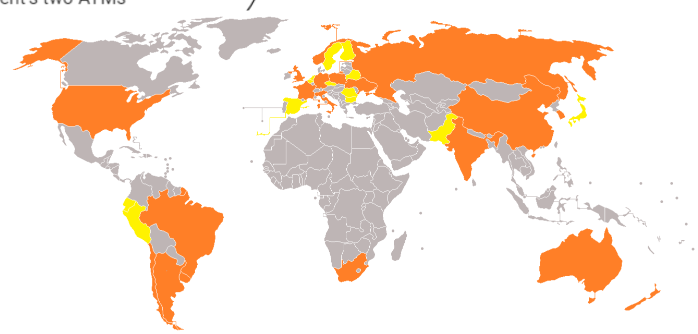
Antarctic Research Stations



Remote, isolated, and frozen year-round, **Antarctica is arguably the most untouched and undisturbed region on the planet**. There are many advantages to studying science in Antarctica over anywhere else on earth. For example:

- Antarctica has the **cleanest air** in the world (air quality monitoring with a reliable baseline)
- Antarctica is the **darkest place on earth** (ideal setting for astronomical research)
- Studying the bottom of the food chain allows scientists to better understand environmental impacts on humans.
- Antarctica has **no national borders** (research findings be freely available to everyone). Many projects are internationally coordinated and supported without any 'home turf' issues.

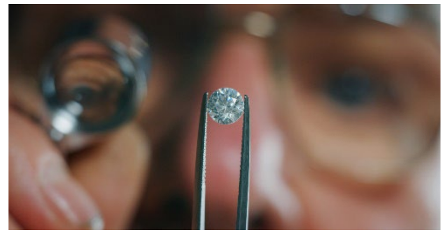
Antarctica has no permanent residents, but there are several thousand people there at any given time (up to 5,000 in the summer). Most researchers generally come and work for a few months to a year or two. There are ~50 permanent active research stations representing 32 countries (colored on map to the right) from all the continents. Some notable stations:



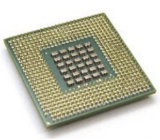
- **<u>Oldest research station</u>**: *Orcadas*; established in 1904 (by Argentina) on Laurie Island (~600km NE of the tip of the Antarctic Peninsula, ~840km SW of South Georgia Island). Population 11 (Winter) to 45 (Summer). Average annual temperature -3.0°C (26.6°F)
- **<u>Largest research station</u>**: *McMurdo*; established in 1956 (USA) on Ross Island (in the Ross Sea). Population 250 (Winter) to 1,258 (Summer). Average annual temperature -19.7°C (-3.5°F)
- **<u>Coldest research station</u>**: *Vostok*; established in 1957 (Russia) in East Antarctica. Population up to 25. Average annual temperature -55.2°C (-67.4°F)
- **<u>Southernmost research station</u>**: *Amundsen-Scott South Pole*; established in 1956 (USA) at the south pole. Population 45 (Winter) to 150 (Summer). Average annual temperature -49.5°C (-57.1°F)
- **<u>First person born in Antarctica</u>** (1978) at *Esperanza*; established in 1953 (Argentina) on the tip of the Antarctic Peninsula. Population 55 (Winter), but hosts ~1,100 tourists each year. Average annual temperature -4.6°C (23.7°F)

Mineral Uses

Why should anyone care about rocks and minerals? Because we use a ton of them daily! We've listed some examples here, but there are many more.



- **Cinnabar**: mercury ore; electronics, paint, thermometers
- **Diamond**: a gemstone, but also a wide range of industrial uses because of their extreme hardness
- **Galena**: lead ore; used in batteries, gasoline additives, ammunition, construction, nuclear shielding
- **Graphite**: dry lubricant, steel hardener, pencils
- **Gypsum**: building plaster/drywall
- **Halite**: also known as sodium chloride. This is table salt! Also makes a great lamp
- **Kyanite**: used in processing metals, glass, and ceramics
- **Mica**: used in electronic insulators, paints, well-drilling mud, plastics, roofing, and rubber
- **Olivine**: used in metallurgical processes. Also used as the gemstone peridot
- **Pyrite**: "fool's gold" used to manufacture sulfur, sulfuric acid, and sulfur dioxide
- **Quartz**: semiprecious gemstone (some varieties include amethyst, citrine, rose quartz, smoky quartz). Also used for pressure gauges and in manufacturing glass, paints, abrasives, computer chips, ceramics, and precision instruments
- **Sulfur**: drugs, fertilizers
- **Talc**: paper production, used as a filler in ceramics, paint, paper, roofing, plastics, cosmetics, and agriculture. In many household products like baby (talcum) powder, deodorant, and makeup.
- **Sphalerite**: zinc ore; used as protective coating on steel, an alloying metal with copper (makes brass), and used in rubber and paint. Used in automotive parts, electrical fuses, electroplating, dry cell batteries, nutrition, organ pipes, and pennies. Zinc oxide used in medicine, paints, vulcanizing rubber, and sunblock

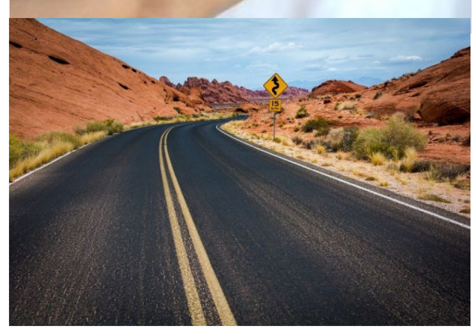


Rock Uses

Why should anyone care about rocks and minerals? Because we use a ton of them daily! We've listed some examples here, but there are many more.





- **Basalt**: railroad ballast, for asphalt, and road aggregate in highway construction. Also good for building stone (monuments, headstones, statues, etc.)

- **Coal**: a "fossil fuel" like petroleum and natural gas

- **Dolomite**: agriculture, chemical, and industrial applications; cement construction, refractories, and environmental industries. Very similar rock to limestone

- **Granite**: can be cut into large blocks and used as building stone (similar to basalt). Most commonly known as a countertop material

- **Limestone:** (lime) composed of calcium carbonate; a basic building block in the construction industry. Also used as aggregate, cement, abrasives, soil conditioners, and as an ingredient in a host of chemical processes.

- **Pumice:** abrasive in cleaning, polishing, and scouring compounds

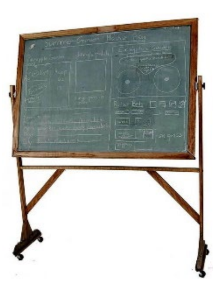
- **Quartzite:** typically a very hard rock, making it useful for building stone material

- **Sandstone:** concrete for highways, bridges, dams, waterworks, and airports; road bases and coverings, construction fill, aggregates, railroad ballast, snow and ice control. Also a common reservoir rock where oil can be found

- **Scoria:** used in landscaping and drainage works

- **Shale:** often a source of petroleum (used in plastics, synthetic fabrics, lubricants, etc.); common component in bricks and cement

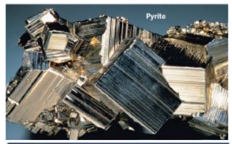
- **Slate:** breaks into thin sheets, useful for chalkboards

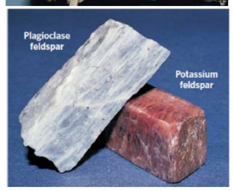


Minerals

<u>Mineral</u>: naturally occurring, inorganic solid with a definite chemical composition and crystal structure

<u>Mineral Properties</u>





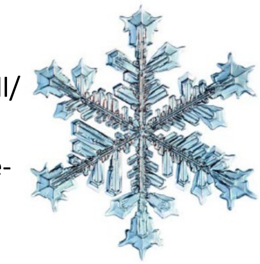

Olivine

- **Luster**: the overall "sheen" on a mineral's surface
  - Metallic (like polished or unpolished metal)
  - Nonmetallic (waxy, earthy, glassy, etc.)
- **Color**
  - Tricky! Some minerals have a distinct color (olivine- green), others can be many colors (quartz)
- **Streak**: a mineral's "true" color
  - The color of a mineral when powdered. Even if a mineral's color varies, the streak color will be the same!
- **Hardness**: a mineral's relative resistance to scratching
  - Mohs Hardness scale- minerals with a higher number will scratch minerals with a lower number. Scale is from 1 (talc) to 10 (diamond)
  - Easy to test minerals against common objects like fingernails (2.5), a copper penny (3.5), or glass (5.5)
- **Crystal Habit**: a mineral's geometric shape
  - When two minerals have the same chemical composition but different crystal habits, they are called "polymorphs" (like diamond and graphite, both of which are pure carbon)
    - Can have wildly different mineral properties despite having the same chemical composition
- **Cleavage**: breakage of a mineral into fragments across planes of weakness
  - Minerals with 1 cleavage plane often break into "sheets" (mica)
  - Minerals with 2+ cleavage planes often look like they have "steps" (halite, calcite)
- **Many more!**
  - Magnetism, taste, smell, reaction to acid, fluorescence, specific gravity, radioactivity, etc.

<u>Mineral example: quartz</u>

- Naturally occurring (not man-made)
- Inorganic (not made of once-living organisms)
- Solid
- Definite chemical composition (SiO_2)
- Specific crystal structure (hexagonal)

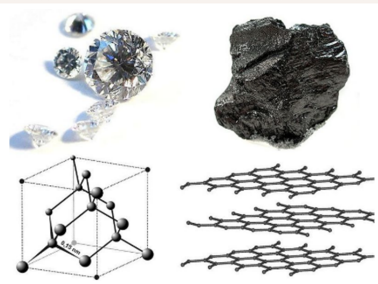
<u>Mineral example: ice</u>



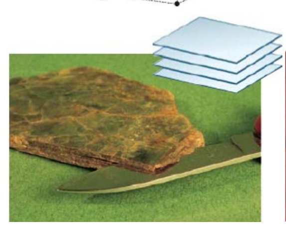
- Naturally occurring (snowfall/ glaciers)
- Inorganic (not made of once-living organisms)
- Solid (ice, not water)
- Definite chemical composition (H_2O)
- Specific crystal structure (hexagonal)

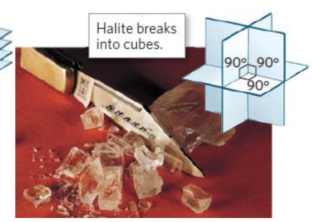
MOHS SCALE OF HARDNESS

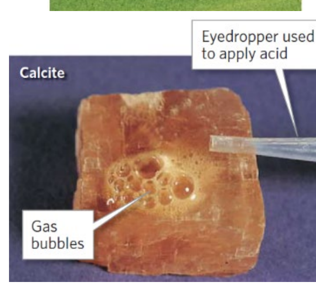
<u>Diamond</u>
- C
- Isometric
- H: 10
- Used as abrasive, gemstone



<u>Graphite</u>
- C
- Hexagonal
- H: 1-2
- Used as pencil "lead"







Minerals

The following minerals are included in the rock box. Here are some key characteristics that help you identify them.

Anorthoclase: "flattened" crystal habit. Despite being a rare mineral globally, this is an extremely common mineral at Mt. Erebus (the southernmost active volcano in the world)

Calcite: low hardness (scratched with a knife) and reaction with HCl, breaks into rhombuses

Halite: taste of salt, greasy feel when rubbed with finger, breaks into cubes

Hematite: streak is reddish-brownish color; either metallic silver or rusty brown

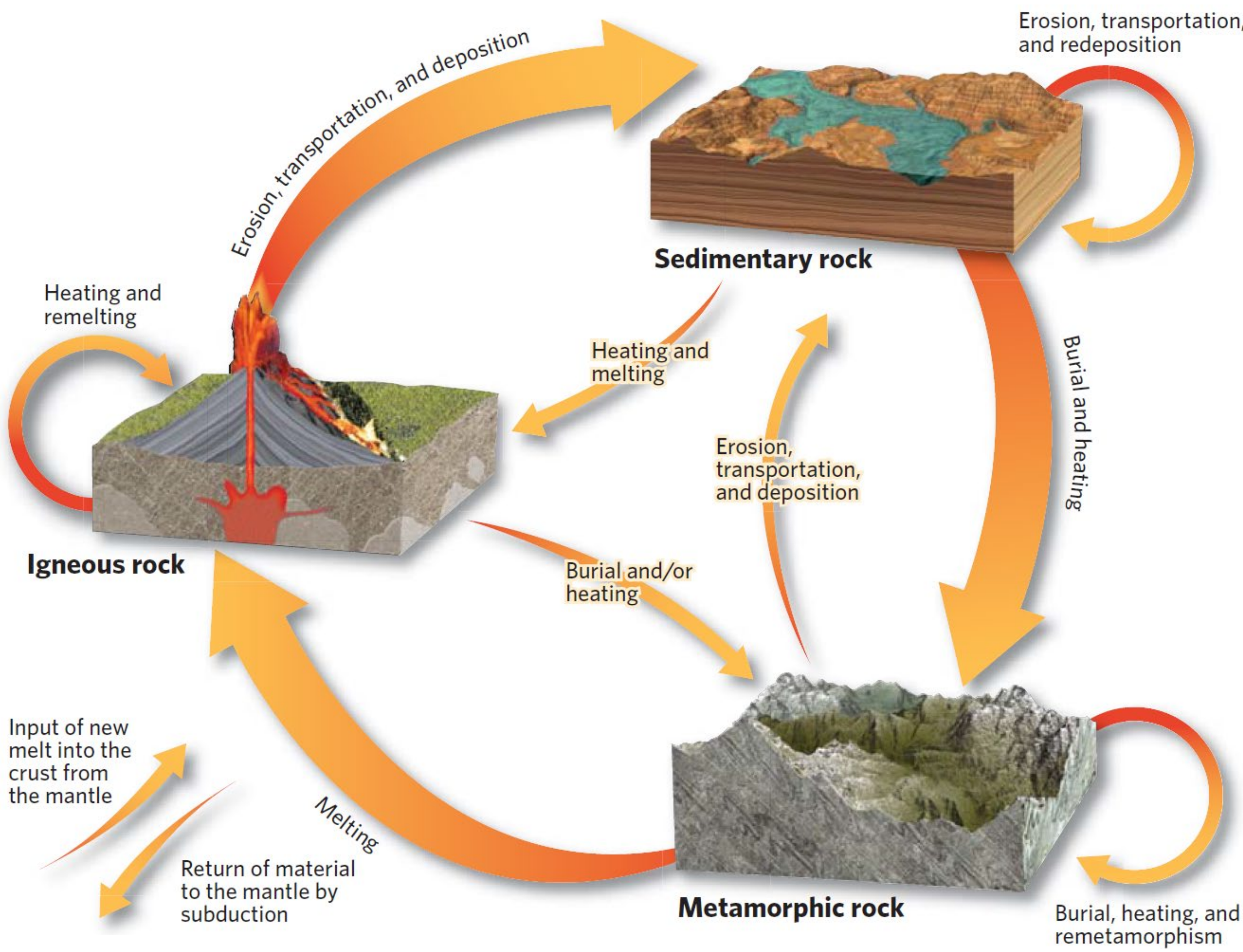
Gypsum: easily scratched with a fingernail

Mica: pearly luster and 1 cleavage plane (flakes off into sheets)

Quartz: hardness (scratches glass); hexagonal (6-sided) prism

Zeolite: "fibers" span out in a fan-shape

The Rock Cycle



<u>Rock</u>: coherent, naturally occurring solid made of a collection of minerals or (less commonly) a mass of glass

Solid mass- not loose grains

Formed during geologic processes (not manufactured materials)

<u>The Three Rock Types</u>

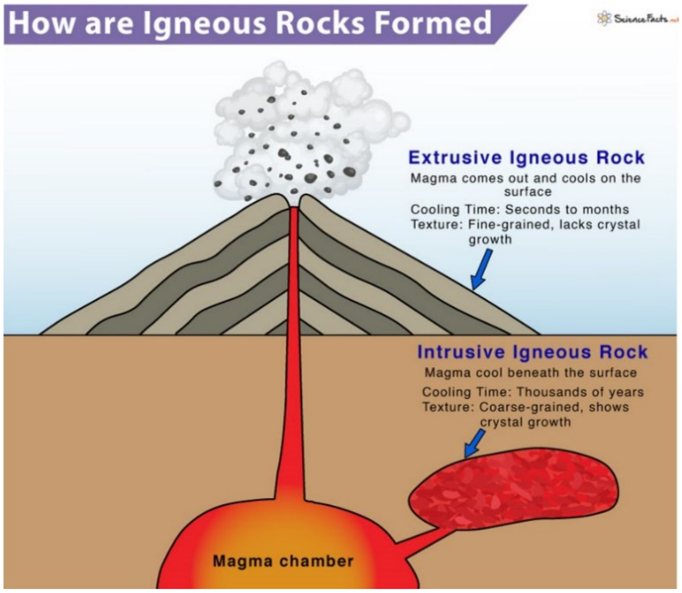
<u>Igneous rocks</u>: form when molten hot material (magma/lava) cools and solidifies

<u>Sedimentary rocks</u>: form from pre-existing rocks or pieces of once-living organisms

<u>Metamorphic rocks</u>: form when high temperatures and pressure act on a rock to alter its physical and chemical properties

Any rock type can transform into any other rock type!

Igneous Rocks



Two main types of igneous rocks:

Extrusive igneous rocks form from lava (molten rock above ground) and *tend to have smaller crystals*. Because lava is exposed to air, the molten rock cools quickly, therefore the crystals do not have much time to grow.

Intrusive igneous rocks from underground. Because the magma (molten rock) is not exposed to air, it cools slowly, therefore mineral crystals have time to grow.

Extra textural terms:

Equigranular: all crystals are (roughly) equal size

Porphyritic: (por-fuh-*ri*-tic) some crystals are drastically bigger than others in the same rock

Extrusive rocks

Rhyolite: (*rai*-oh-lite) usually light (pink or gray) in color and is a relatively common volcanic rock. Contains many light-colored minerals (quartz, mica, etc.). It is the chemical equivalent of granite (just with smaller crystals). Although the two rock types have the same chemistry, rhyolite is extrusive, and granite is intrusive.

Basalt: (buh-*salt*) the most common rock in Earth's crust (composes most oceanic crust). Generally dark (black) in color because it contains mostly dark minerals, and a green mineral (olivine) is sometimes present. It is the chemical equivalent of gabbro (intrusive).

Andesite: (*an*-di-site) contains roughly 50% light minerals and 50% dark minerals. Color is often a medium/charcoal gray. It is the chemical equivalent of diorite (intrusive). Andesite gets its name from the Andes Mountains of South America.

Obsidian: (uhb-*si*-dee-uhn) usually dark (black or brown) in color with a very smooth, glassy texture. Closely resembles flint. Formed when lava cools instantly so that minerals have no time to grow.

Pumice: (*puh*-miss) very lightweight and has many holes where air bubbles used to be. It is usually light gray in color. This rock floats on water!

Volcanic Breccia: (*breh*-chee-uh) formed during an explosive volcanic eruption and includes many angular volcanic fragments. In Antarctica, hyaloclastites (hai-al-oh-*class*-tite, a type of volcanic breccia) are common, and form when lava explosively interacts with ice.

Intrusive rocks

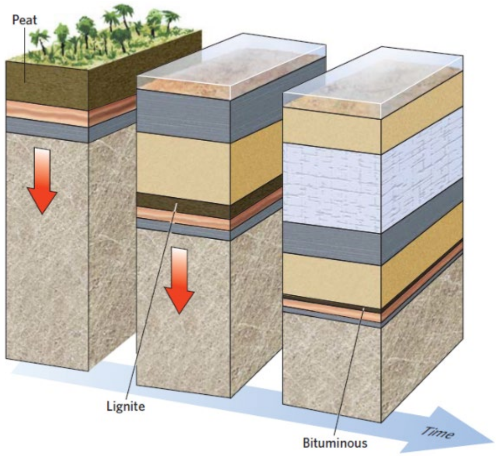
Granite: (*gran*-it) most common igneous rock known to the general public and makes up much of the continental crust. Composed of many light-colored minerals (quartz, feldspars, mica, etc.).

Gabbro: (*gab*-roh) dark gray to black with the same mineral composition as basalt, only coarser grained.

Diorite: (*dai*-ur-ite) gray to dark gray and may have a blue or green tint. It can have a "salt and pepper" appearance with the same mineral composition as andesite.

Peridotite: (per-*i*-doh-tite) this rock type is what the mantle is made of. Mostly green because of the mineral olivine (*all*-uh-veen), with some darker minerals. Olivine's gem form is more commonly known as peridot!

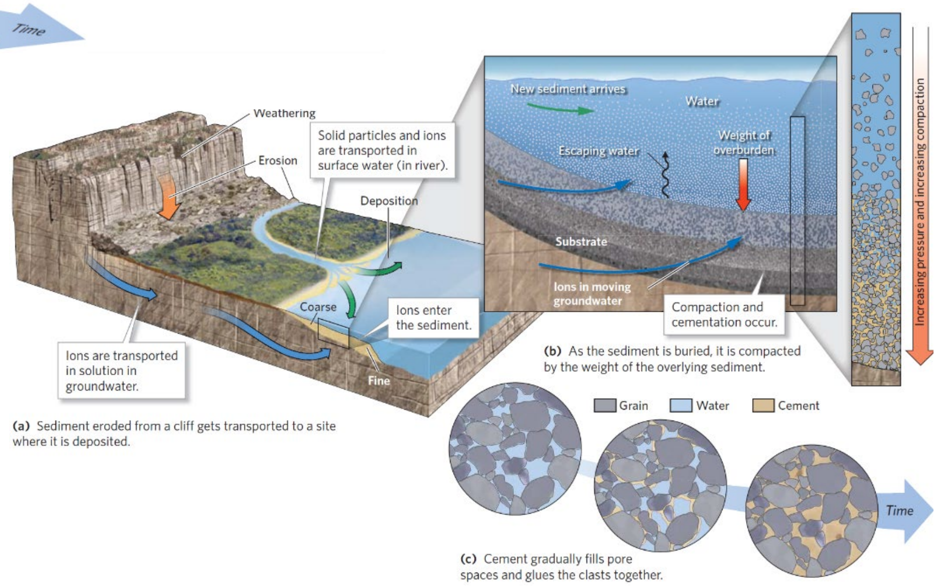
Sedimentary Rocks

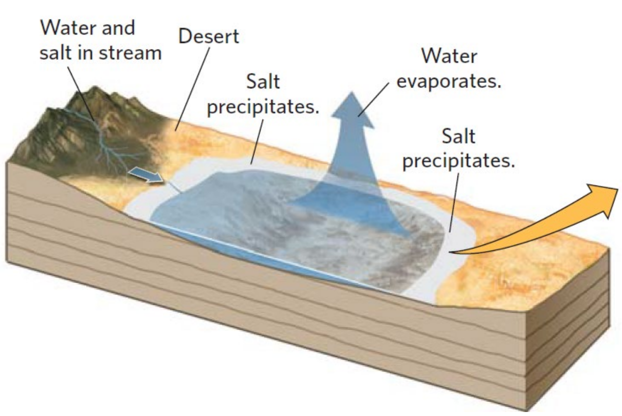


Organic/biochemical rocks form from organic processes and requires living organisms to produce the sediments.

Examples: Animals like clams, snails, or coral produce calcium carbonate shells/"houses" that, when compacted and buried, form **limestone**. In swampy environments, plants/organic debris can get buried and compressed, eventually forming **coal**. **Anthracitic coal** has just been buried deeper/"cooked" more than **bituminous coal**.

Clastic rocks are composed of sediments/ fragments from other rocks (also called clasts). Generally defined by clast size, which can range from boulders/pebbles (>2mm) in **conglomerates**, to sand in **sandstone**, all the way down to very fine clay sized grains (<0.004mm) in rocks like **shale**.

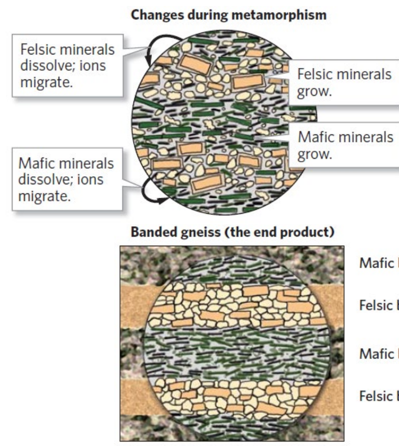




Chemical rocks: often called evaporites as they form when water evaporates, and dissolved materials precipitate out of the water. The most common precipitated minerals that compose chemical rocks are **halite** and **gypsum**.

Example experiment: Take a glass of water and pour some salt (halite) into it. The salt will dissolve into the water. If you set the water in a hot and dry place (like Arizona, but you can also simulate this with a stove or hot plate), the water (but not the salt) will evaporate away. The concentration of salt gets higher as the water evaporates, and the water will eventually not be able to dissolve any more salt. At this point, as the water continues to evaporate, the salt will come out of solution and will be precipitated in the glass.

Metamorphic Rocks



Two main types of metamorphism:

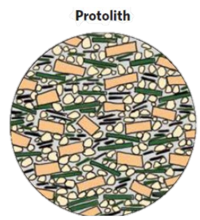
Contact metamorphism: local, thermal metamorphism caused by the intrusion and extrusion of magma. Think of the hot magma "cooking" the surrounding rocks.

Regional metamorphism occurs in mountain belts (like the Appalachians or the Rockies) and affects an extensive region with both heat and pressure. The resulting rocks are always deformed because of the extreme pressure, exhibiting parallel minerals or layers ("foliation").

Extra terms:

Protolith/parent rock: the original rock that underwent metamorphism (can be any rock type).

Grade: how metamorphosed a rock is. A low-grade metamorphic rock (like slate) has been less "cooked" or "squeezed" than a high-grade metamorphic rock (like gneiss).



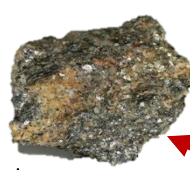
Regional metamorphism

Slate: very thin flat layers/sheets (chalkboards are typically made of slate!). Example protolith- shale

Schist: (rhymes with "list") medium to coarse grained with aligned mica grains. Typically glittery/shimmery, can resemble fish scales. Example protolith- granite

Gneiss: (pronounced "nice") alternating bands of dark and light layers. This is a high-grade metamorphic rock, that has been "squeezed" so much that the minerals have sorted themselves to reduce the amount of stress as much as possible. Example protolith- granite

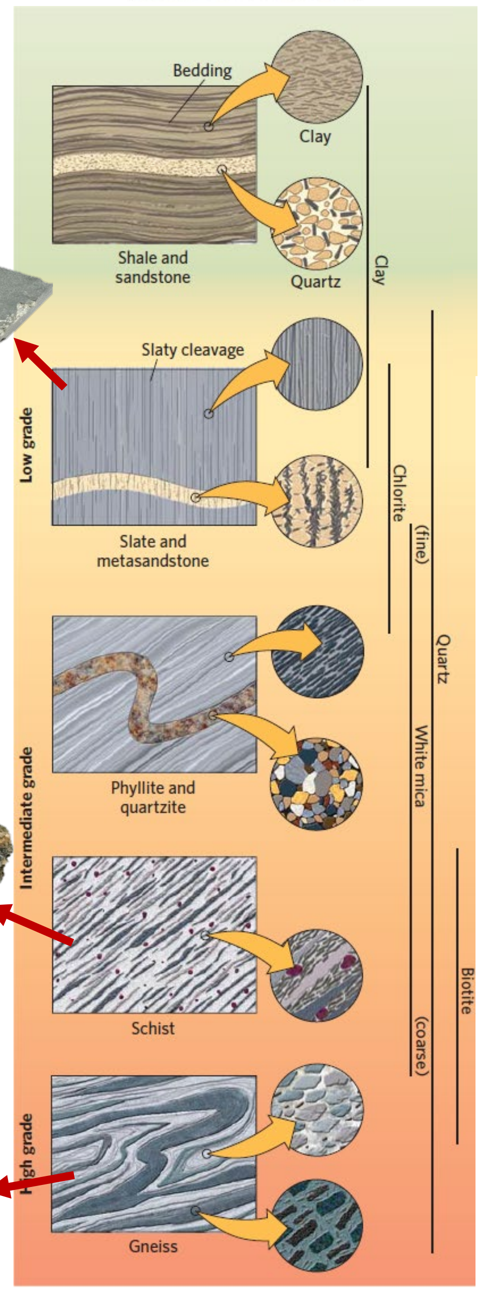
Mylonite: (*my*-loh-nite) a fine-grained, partially recrystallized rock with a pronounced "foliation" (layering) as a result of intense shearing/stress. Example protoliths- sandstone or granite



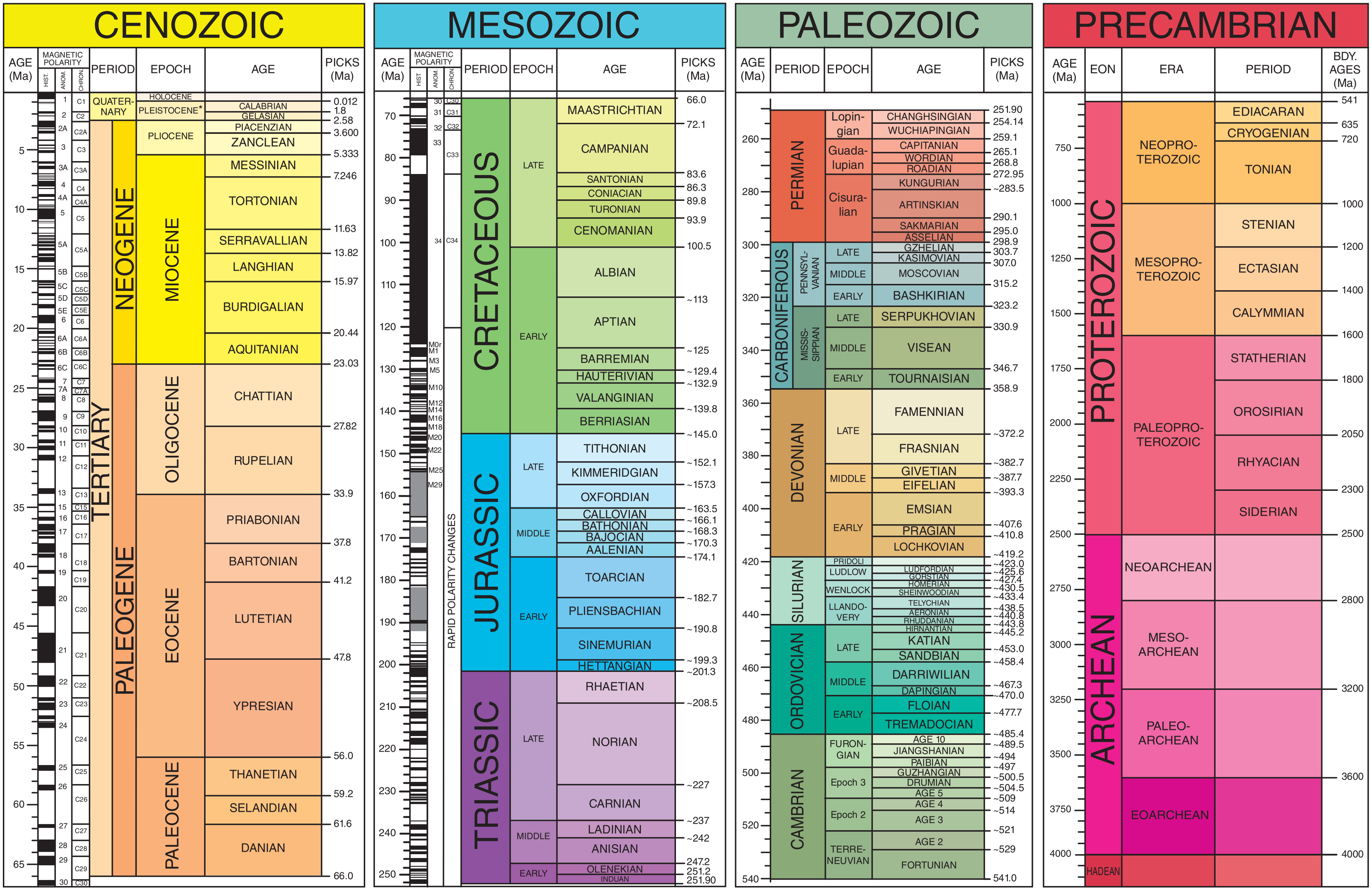
Contact metamorphism

Marble: recrystallized carbonate minerals under the influence of heat and/or pressure. Example protolith- limestone

Quartzite: extremely hard, granular rock almost entirely composed of quartz. Typically a sandstone (protolith) heated to the point where the quartz grains get so hot that they fuse together.



GSA GEOLOGIC TIME SCALE v. 5.0



Walker, J.D., Geissman, J.W., Bowring, S.A., and Babcock, L.E., compilers, 2018, Geologic Time Scale v. 5.0: Geological Society of America, https://doi.org/10.1130/2018.CTS005R3C.

*The Pleistocene is divided into four ages, but only two are shown here. What is shown as Calabrian is actually three ages—Calabrian from 1.80 to 0.781 Ma, Middle from 0.781 to 0.126 Ma, and Late from 0.126 to 0.0117 Ma.

The Cenozoic, Mesozoic, and Paleozoic are the Eras of the Phanerozoic Eon. Names of units and age boundaries usually follow the Gradstein et al. (2012), Cohen et al. (2012) , and Cohen et al. (2013, updated) compilations. Numerical age estimates and picks of boundaries usually follow the Cohen et al. (2013, updated) compilation. The numbered epochs and ages of the Cambrian are provisional. A "~" before a numerical age estimate typically indicates an associated error of ±0.4 to over 1.6 Ma.

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Cohen, K.M., Finney, S., and Gibbard, P.L., 2012, International Chronostratigraphic Chart: International Commission on Stratigraphy, www.stratigraphy.org (accessed May 2012). (Chart reproduced for the 34th International Geological Congress, Brisbane, Australia, 5–10 August 2012.)

Cohen, K.M., Finney, S.C., Gibbard, P.L., and Fan, J.-X., 2013, The ICS International Chronostratigraphic Chart: Episodes v. 36, no. 3, p. 199–204 (updated 2017, v. 2, http://www.stratigraphy.org/index.php/ics-chart-timescale; accessed May 2018).

Gradstein, F.M, Ogg, J.G., Schmitz, M.D., et al., 2012, The Geologic Time Scale 2012: Boston, USA, Elsevier, https://doi.org/10.1016/B978-0-444-59425-9.00004-4.

Previous versions of the time scale and previously published papers about the time scale and its evolution are posted to http://www.geosociety.org/timescale.

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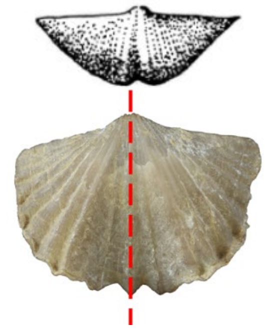
Fossils

Fossils are the remains of impression of a prehistoric organism. All time periods mentioned are in the geologic time scale on the previous page. Here are some examples that could be in your rock box:

Ammonites were a type of ocean-dwelling cephalopod (mollusk) with tightly wound/"coiled up" shells with chambers that they used for buoyancy. They are related to squid and octopus, with the nautilus being their closest living relative. Ammonites lived all over the world in shallow seas. Typically, only the shell is preserved in the fossil record.

Time extent: Devonian to late Cretaceous (most abundant in Jurassic and Cretaceous

Size: few millimeters to almost 2 meters in diameter

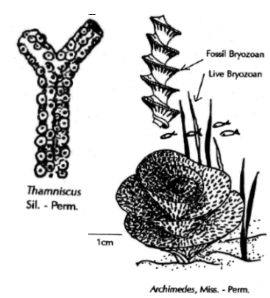


Brachiopods are bivalves (marine animal with 2 shells) that live in shallow marine environments. Brachiopods have a plane of symmetry that cuts across the two valves. Because brachiopods are sensitive to water conditions (depth, salinity, oxygen levels, etc.), paleontologists often use these to deduce the position of ancient shorelines.

Time extent: early Cambrian to present-day (most abundant in Paleozoic Era)

Size: 1 mm (millimeter) to 38 cm (centimeters) (most ~2.5 cm)

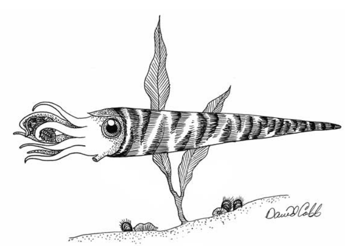
Bryozoans were tiny colonial animals that filtered seawater for microscopic organisms. The fossils were their tiny homes, where each "pit" was the home of one bryozoan.



Time extent: Ordovician to present-day

Size: 0.5 mm (individual animal); 1 cm to over 1 m (meter) (colonies)

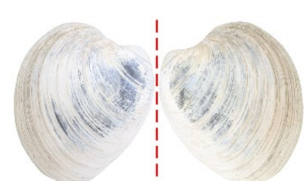
Cephalopods include squid, octopus, and ammonites. The fossils in your rock box lived in shells with individual chambers that were filled with gas to regulate their buoyancy.



Time extent: Cambrian to present-day

Size: 1 cm to over 10 m

Clams are bivalved mollusks (like the brachiopods). Clams have a plane of symmetry that cuts between their two valves. If you were to separate their two halves, each side perfectly mirrors the other, even though the shell shape might not be symmetrical.



Time extent: Cambrian to present-day

Size: 1 cm to 140 cm (giant clam); typically ~4 cm

Fossils

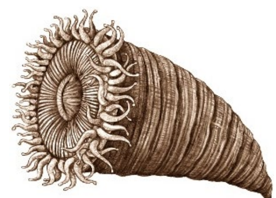
Colonial corals lived in reef-like communities in warm, clear tropical seas. Many coral species were colonial, living together in a mass of individual skeletons of lime resembling a honeycomb.

<u>Time extent</u>: Cambrian to present-day (most abundant in Devonian and Silurian)
<u>Size</u>: 1-3 mm (individual); colonies extremely variable (mms to over 4 m)

<u>Fossil leaves</u> are less common than animal fossils since leaves and other plant parts break down quickly under normal conditions. They can be preserved if they are quickly buried in the sediment of a lake or pond.

<u>Time extent</u>: Ordovician to present-day
<u>Size</u>: extremely variable depending on species (1 mm^2 to over 1 m^2)

Horn corals are from an extinct order of corals (Rugosa). These grow in a long cone shape like a bull's horn and have a wrinkled outside appearance. The animal lived at the top of the cone and had many tentacles sticking out to gather food.



<u>Time extent</u>: Ordovician to Permian
<u>Size</u>: up to 75 cm

<u>Petrified wood</u> is another name for fossilized wood. Trees can fossilize if they are buried before they rot. Petrification occurs when the organic matter is completely replaced by minerals and the fossil is turned to stone. This generally occurs by filling the pores of the tissue with minerals, then dissolving the organic matter and replacing it with minerals.

<u>Time extent</u>: Devonian to present-day
<u>Size</u>: extremely variable (millimeters to tens of meters)

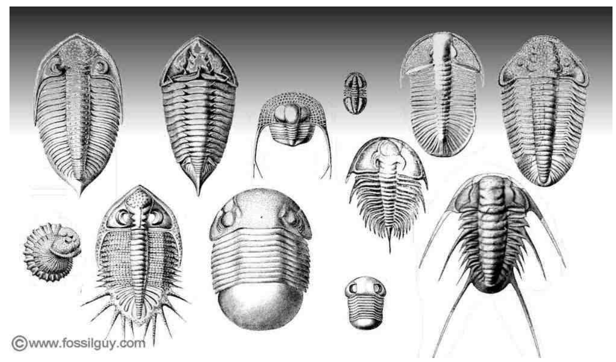
<u>Rotularia</u> are a type of annelid (or ringed worm) that were common in shallow marine environments from Seymour Island, Antarctica. Since annelids are soft-bodied, their fossils are rare- mostly jaws and the mineralized tubes that some species secreted.

<u>Time extent</u>: late Jurassic to Eocene
<u>Size</u>: up to a few centimeters

Fossils

<u>Snails</u>, or gastropods (meaning “stomach foot”), are sluggish, bottom-dwelling mollusks that scavenged or grazed the ancient seafloor. Snails move on a flat muscular foot and could withdraw inside its shell for protection.

<u>Time extent</u>: Cambrian to present-day
<u>Size</u>: 1 mm to over 1 m (usually a few centimeters)



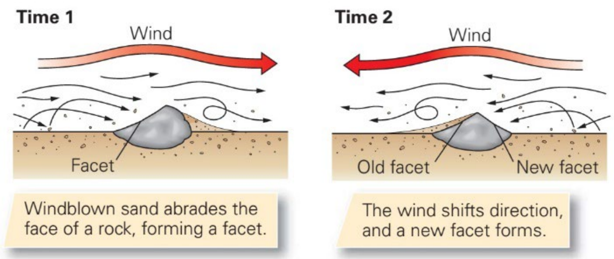
<u>Trilobites</u> are an ancient variety of arthropods. Trilobites were extremely diversified and geographically dispersed, with different species evolving to fit many lifestyles including predators, scavengers, and filter feeders. Their hard exoskeleton was easily fossilized, leaving an extensive fossil record.

<u>Time extent</u>: Cambrian to Permian
<u>Size</u>: up to 60 cm (typically 3-6 cm)

Other Rocks

Included in your rock box are a couple of "other" rocks that are common in Antarctica and the Southern Ocean.

Ventifacts are rocks that have been shaped and/or polished by the wind. Antarctica is the windiest place on Earth, and any sand and ice carried by the wind can hit the exposed rock. Over time, the rocks become pitted, polished, and smoothed out.



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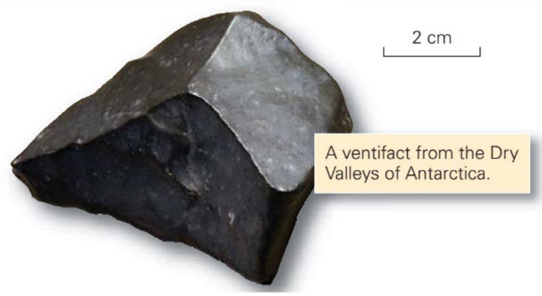

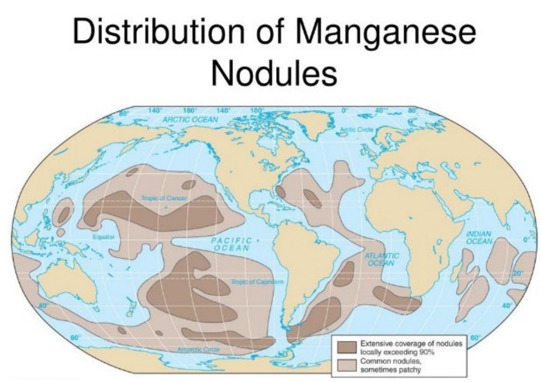

Manganese nodules are rock concretions on the seafloor, made of concentric layers of iron and manganese around a core. The core can be a small shell, fossil, rock fragment, and other solid things. These form when metal in seawater or hot springs on the ocean floor precipitate and coat the starting material. Manganese nodules vary in size from microscopic to over 20cm across, though most are between 3 and 10cm in diameter. It can take millions of years for a nodule to grow by just a few millimeters! While manganese is the most abundant metal in these nodules, they also contain fair amounts of nickel, copper, cobalt, and smaller amounts of platinum and other precious metals.

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