Glossary

acid rain	rain or other precipitation that contains high amounts of sulfuric and nitric acid. It occurs when sulfur dioxide and nitrogen oxide react with water, oxygen, and other chemicals in the atmosphere to form these acidic compounds. Acid rain can cause damage to trees, soils, and entire ecosystems, as well as accelerating the decay of human works such as paint and building materials.
active plate boundary	the boundary between two plates of the Earth's crust that are colliding, pulling apart, or moving past each other. See also: convergent boundary, subduction, transform boundary
aeolian	pertaining to, caused by, or carried by the wind. Aeolian sediments are often polished, giving them a "frosty" appearance. The name comes from Aeolus, the Greek god of wind. See also: wind
aerosol	tiny solid or liquid particles in the air. Examples include dust, smoke, mist, and human-made substances such as particles emitted from factories and cars.
agate	a crystalline silicate rock with a colorful banded pattern. It is a variety of chalcedony. Agates usually occur as nodules in volcanic rock. See also: chalcedony, nodule, silica, volcanic
Alfisols	a soil order; these are highly fertile and productive agricultural soils in which clays often accumulate below the surface. They are found in humid and subhumid climates. See also: climate, soil, soil orders
alluvial, alluvium	a thick layer of river-deposited sediment.

amniotes	the group of tetrapods distinguished from amphibians by the development of an egg capable of maturing entirely out of water. Amniotes include the reptiles, birds, and mammals.
amphibole	a group of dark colored silicate minerals, or either igneous or metamorphic origin. See also: igneous rock, mineral, metamorphism, silica
anthracite	a dense, shiny coal that has a high carbon content and little volatile matter. Anthracite is as much as 95% carbon. Found in deformed rocks, anthracite is the cleanest burning of the three types of coal, because it contains the highest amount of pure carbon. See also: coal
anthropogenic	caused or created by human activity.
Appalachian Basin	an inland basin, formed by the Taconic and Acadian mountain-building events. The crust was downwarped as a result of the colliding plates, and the basin was later filled with an inland sea. See also: crust, inland basin, inland sea, plate tectonics
aquifer	a water-bearing formation of gravel, permeable rock, or sand that is capable of providing water, in usable quantities, to springs or wells. See also: permeable
Archean	a geologic time period that extends from 4 billion to 2.5 billion years ago. It is part of the Precambrian. See also: geologic time scale, Precambrian

Glossary

arthropod	an invertebrate animal, belonging to the Phylum Arthropoda, and posessing an external skeleton (exoskeleton), body segments, and jointed appendages. Arthropods include crustaceans, arachnids, and insects, and there are over a million described arthropod species living today. Trilobites are a major group of extinct arthropods. See also: extinction, trilobite
asthenosphere	a thin semifluid layer of the Earth, below the outer rigid lithosphere, forming the upper part of the mantle. The heat and pressure created by the overlying lithosphere make the solid rock of the asthenosphere bend and move like metal when heated. The layer is thought to flow vertically and horizontally with circular convection currents, enabling sections of lithosphere to subside, rise, and undergo lateral movement. See also convection, lithosphere, mantle.
atmosphere	a layer of gases surrounding a planet. Earth's atmosphere protects living organisms from damage by solar ultraviolet radiation, and it is mostly composed of nitrogen. Oxygen is used by most organisms for respiration. Carbon dioxide is used by plants, algae and cyanobacteria for photosynthesis.
Baltica	a late-Proterozoic, early-Paleozoic continent that included ancient Europe (northern Europe without Ireland and Scotland). Baltica began moving towards North America in the Ordovician, starting the Taconic Orogeny. North America fully collided with Baltica in the Devonian, resulting in the Acadian Orogeny on the eastern edge of the continent. See also: orogeny, Paleozoic, Proterozoic

banded iron formation	rocks with regular, alternating thin layers of iron oxides (e.g., hematite and magnetite) and either shale or silicate minerals (e.g. chert, jasper, and agate). They are a primary source of iron ore. See also: agate, chert, jasper, hematite, iron, magnetite, ore, shale
basalt	an extrusive igneous rock, and the most common rock type on the surface of the Earth. It forms the upper surface of all oceanic plates, and is the principal rock of ocean/seafloor ridges, oceanic islands, and high-volume continental eruptions. Basalt is fine-grained and mostly dark-colored, although it often weathers to reds and browns because of its high iron content. Basaltic magmas are produced by partial melting of the upper mantle. Materials melt when we increase their temperature, but a second way to melt a solid is to decrease the pressure. In the interior of the Earth this second mechanism – decompression – is far more important. When pressure on the mantle is released as it is forced up through the crust due to subduction, it becomes basaltic magma. See also: igneous, iron, magma, mantle, plate tectonics
basement rocks	the foundation that underlies the surface geology of an area, generally composed of igneous or metamorphic crystalline rock. In certain areas, basement rock is exposed at the surface because of uplift or erosion. See also: erosion, igneous rock, metamorphic rock, uplift
bentonite	a clay, formed from decomposed volcanic ash, with a high content of the mineral montmorillonite. See also clay, mineral.

Glossary

biodiversity	the number of kinds of organisms at any given time and place. Global changes in biodiversity through geologic time tells paleontologists that something is happening to the rate of extinction or the rate of origin of new species. Regional changes are influenced by migration, or the number of species supported by available food and space resources. See also: extinction, geologic time scale
biofuel	carbon-based fuel produced from renewable sources of biomass like plants and garbage. Energy is obtained through combustion, so greenhouse gases are still produced. Because plants get their carbon from the air, burning them for energy and re-releasing it into the air has less effect on climate than fossil fuels, whose carbon is otherwise sequestered away from the atmosphere. See also: biomass, fuel
biomass	organic material from one or more organisms.
biota	the organisms living in a given region, including plants, animals, fungi, protists, and bacteria.
bitumen	any of various flammable mixtures of hydrocarbons and other substances, occurring naturally or obtained by distillation from coal or petroleum, that are a component of asphalt and tar and are used for surfacing roads and for waterproofing. See also: coal, petroleum
bituminous coal	a relatively soft coal containing a tarlike substance called bitumen, which is usually formed as a result of high pressure on lignite. See also bitumen, coal, lignite.

bivalve	a marine or freshwater invertebrate animal belonging to the Class Bivalvia (or Pelecypoda) in the Phylum Mollusca. Bivalves are generally called “clams,” but they also include scallops, mussels, cockles, and oysters. Bivalves are characterized by right and left calcareous shells (valves) joined by a hinge. Most are filter feeders, collecting food particles from the water with their gills. During the Paleozoic, bivalves lived mostly on the surface of the ocean floor. In the Mesozoic, bivalves became extremely diverse and some evolved the ability to burrow into ocean floor sediments. See also: filter feeder, Mesozoic, mollusc, Paleozoic
body fossils	fossils that consist of an actual part of an organism, such as a bone, shell, or leaf. See also: fossil

Glossary

brachiopod	a marine invertebrate animal belonging to the Phylum Brachiopoda, and characterized by upper and lower calcareous shell valves joined by a hinge, and a crown of tentacles (lophophore) used for filter-feeding and respiration. Brachiopods are the most common fossil in Paleozoic sedimentary rocks. Brachiopods look somewhat similar to the clams that you find at the beach today. Brachiopods and bivalves both have a pair of hinged shells (valves) to protect themselves while feeding. However, the soft parts of modern brachiopods tell us that they are completely unrelated to bivalves. Brachiopods have a special structure formed by tissue with thousands of tiny hair-like tentacles stretched along a coiled piece of internal shell material. These tentacles catch and move small particles towards the mouth. This body plan is very different from that of bivalves, which have a larger fleshy body and collect particles with their gills. To tell the difference between a brachiopod and a bivalve, look for symmetry on the surface of the shell. Bivalve valves are of equal size and mirror image shapes. Brachiopods' bottom valves, however, are slightly bigger and often have a different shape. See also: filter feeder, bivalve, fossil, Paleozoic
braided stream	a stream consisting of multiple, small, shallow channels that divide and recombine numerous times, forming a pattern resembling strands of braided hair. A braided stream carries more sediment than a typical stream, causing the formation of sandbars and a network of crisscrossing streams.
brine	See hydrothermal solution

British Thermal Unit (BTU or Btu)	the most commonly used unit for heat energy. One Btu is approximately the amount of heat required to raise one pound of water by one degree Fahrenheit. A Btu is also about the amount of energy released by burning a single wooden match. See also: energy, heat
bryozoan	a marine or freshwater, colonial invertebrate animal belonging to the Phylum Bryozoa, and characterized by an encrusting or branching calcareous skeleton from which multiple individuals (zooids) extend from small pores to filter-feed using crowns of tentacles (lophophores). Bryozoans have a long and exemplary fossil record. One of the more common Paleozoic varieties looks like fine mesh cloth with numerous tiny holes in which the individual animals in the colony lived. Although they function somewhat like coral, and are often found in similar environments, bryozoans are more closely related to brachiopods. See also brachiopod, fossil
calcite	a carbonate mineral, consisting of calcium carbonate ($CaCO_3$). Calcite is a common constituent of sedimentary rocks, particularly limestone. See also: carbonate rocks, limestone, mineral, sedimentary rock
calyx	the head of a crinoid. See also: crinoid
Cambrian	a geologic time period lasting from 541 to 485 million years ago. During the Cambrian, multicellular marine organisms became increasingly diverse, as did their mineralized fossils. The Cambrian is part of the Paleozoic Era. See also: fossils, geologic time scale, Paleozoic

Glossary

Canadian Shield	the stable core of the North American continental landmass, containing some of the oldest rocks on Earth. The shield has experienced very little tectonic activity (faulting or folding) for millions of years. As the stable cores of all continents, shields are often covered by layers of younger material.
capstone, caprock	a harder, more resistant rock type that overlies a softer, less resistant rock. The harder rock typically helps to control the rate of erosion. See also: erosion
carbonate rocks	rocks formed by accumulation of calcium carbonate, often made of the skeletons of aquatic organisms such as corals, clams, snails, bryozoans, and brachiopods. These organisms thrive in warm, clear shallow waters common to tropical areas, therefore modern carbonate rocks are observed forming in places such as the Florida Keys and the Bahamas. They are also one of the dominant rock forms of the bottom of the ocean, where sediments form from the skeletons of planktonic organisms such as foraminifera. Carbonate rocks include limestone and dolostone. See also: brachiopod, bryozoan, dolostone, foraminifera, limestone
Carboniferous	a geologic time period that extends from 359 to 299 million years ago. It is divided into two subperiods, the Mississippian and the Pennsylvanian. By the Carboniferous, terrestrial life had become well established. The name Carboniferous means "coal-bearing," and it is during this time that many of today's coal beds were formed. The Carboniferous is part of the Paleozoic. See also: coal, geologic time scale, Mississippian, Pennsylvanian, Paleozoic

Cenozoic	the geologic time period spanning from 66 million years ago to the present. The Cenozoic is also known as the age of mammals, since extinction of the large reptiles at the end of the Mesozoic allowed mammals to diversify. The Cenozoic includes the Paleogene, Neogene, and Quaternary periods. See also: geologic time scale, Mesozoic, Neogene, Paleogene, Quaternary
cephalopod	a marine invertebrate animal belonging to the Class Cephalopoda in the Phylum Mollusca, and characterized by a prominent head, arms and tentacles with suckers, and jet propulsion locomotion. Cephalopods are swimming predators with beak-shaped mouthparts. The shells of cephalopods range from long straight cones to spirals, but some have internal shells or no significant shell at all, like the octopus. The group includes belemnites, ammonoids, nautilus, squid, and octopuses. A mass extinction between the Cretaceous and Paleogene eliminated many varieties of cephalopods. See also: Cretaceous, mass extinction, Paleogene
chalcedony	a crystalline silicate mineral that occurs in a wide range of varieties. See also: mineral, silica
chalk	a soft, fine-grained, easily pulverized, white-to-grayish variety of limestone, composed of the shells of minute planktonic single-celled algae. See also: limestone

Glossary

chemical fossils	chemicals produced by an organism that leave behind an identifiable record in the geologic record. Chemical fossils provide some of the oldest evidence for life on Earth. See also: fossil
chemical reaction	a process that involves changes in the structure and energy content of atoms, molecules, or ions but not their nuclei. See also: energy
chert	a sedimentary rock composed of microcrystaline quartz. It is often found as nodules or concretions in limestone and other marine sedimentary rocks. As these rocks form, water moving through them transports small amounts of silicon dioxide that accumulate into clumps of microscopic crystals. The resulting rocks are extremely hard and have no planes of weakness. For thousands of years, humans exploited these qualities, breaking chert nodules into blades and other tools See also: concretion, nodule, sedimentary rock, silica, quartz
chlorastrolite	a variety of pumpellyite with a distinctive “turtleback” pattern created by its interlocking green crystals. See also: pumpellyite
Cincinnati Arch	an uplifted region that existed between the Illinois Basin, the Michigan Basin, and the Appalachian Basin during the late Ordovician and Devonian. It stretched from southeastern Ontario all the way to northern Alabama. See also: Appalachian Basin, Devonian, Illinois Basin, Michigan Basin, Ordovician, uplift
clasper	an anatomical structure used by sharks for mating. See also: shark

clay	the common name for a number of very fine-grained, earthy materials that become plastic (flow or change shape) when wet. Chemically, clays are hydrous aluminum silicates. See also: silica
cleavage	a physical property of minerals. Cleavage occurs when a mineral breaks in a characteristic way along a specific plane of weakness. Mica and graphite have very strong cleavage, allowing them to easily break into thin sheets See also: graphite, mica, mineral
climate	a description of the average temperature, range of temperature, humidity, precipitation, and other atmospheric/ hydrospheric conditions a region experiences over a period of many years (usually more than 30). These factors interact with and are influenced by other parts of the Earth system, including geology, geography, insolation, currents, and living things. The climate of a region represents the average weather over a long period of time. See also: weather
climate change	See global warming
coal	a combustible, compact black or dark-brown carbonaceous rock formed by the compaction of layers of partially decomposed vegetation. By far the greatest abundance of coal is located in strata of Carboniferous age. See also: Carboniferous

Glossary

cold front	the boundary between the warm air and the cold air moving into a region. At this boundary, denser, colder air moves in, making the less dense, warm air rise. This displaced warm air cools as it rises because air pressure decreases with increasing height in the atmosphere. As the air cools, it becomes saturated with water vapor, and condensation begins to occur, eventually leading to dramatic rainstorms.
color (mineral)	a physical property of minerals. Color is determined by the presence and intensity of certain elements within the mineral. See also: mineral
color (soil)	a physical property of soils. Soil color is influenced by mineral content, the amount of organic material, and the amount of water it routinely holds. These colors are identified by a standard soil color chart called the Munsell chart. See also: soil
commodity	a good for which there is demand, but which is treated as equivalent across all markets, no matter who produces it.
compression, compressional force	a force acting on an object from all or most directions, resulting in compression (flattening or squeezing). Compressional forces occur by pushing objects together.
concretion	a hard, compact mass, usually of spherical or oval shape, found in sedimentary rock or soil. Concretions form when minerals precipitate around a particulate nucleus within the sediment. See also: mineral, sedimentary rock, soil

conglomerate	a sedimentary rock composed of multiple large and rounded fragments that have been cemented together in a fine-grained matrix. The fragments that make up a conglomeerate must be larger than grains of sand. See also: sand, matrix, sedimentary rock
conifer	a woody plant of the division Coniferophyta. Conifers bear cones that contain their seeds.
Conservation of Energy	a principle stating that energy is neither created nor destroyed, but can be altered from one form to another. See also: energy
contact metamorphism	a metamorphic rock that has been altered by direct contact with magma. Changes that occur due to contact metamorphism are greatest at the point of contact. The further away the rock is from the point of contact, the less pronounced the change. See also: magma, metamorphism
convection	the rise of buoyant material and the sinking of denser material. In the mantle, variations in density are commonly caused by the melting of subducting materials. See also: mantle, subduction
convergent boundary	an active plate boundary where two tectonic plates are colliding with one another. Subduction occurs when an oceanic plate collides with a continental plate or another oceanic plate. If two continental plates collide, mountain building occurs. See also: active plate boundary, plate tectonics, subduction
copper	a ductile, malleable, reddish-brown metallic element (Cu). Copper is used extensively as wiring in the electrical industry as well as in alloys such as brass and bronze.

Glossary

craton	the old, underlying portion of a continent that is geologically stable relative to surrounding areas. The portion of a craton exposed at the surface is termed a shield, while that overlain by younger layers is often referred to as a platform. A craton can be thought of as the heart of a continent—it is typically the oldest, thickest, and most stable part of the bedrock. It is also usually far from the margins of tectonic plates, where new rock is formed and old destroyed. This rock has usually been metamorphosed at some point during its history, making it resistant to erosion. See also: metamorphism
Cretaceous	a geologic time period spanning from 144 to 66 million years ago. It is the youngest period of the Mesozoic. The end of the Cretaceous bore witness to the mass extinction event that resulted in the demise of the dinosaurs. "Cretaceous" is derived from the Latin word, “creta” or “chalk.” The white (chalk) cliffs of Dover on the southeastern coast of England are a famous example of Cretaceous chalk deposits. See also: chalk, geologic time scale, mass extinction, Mesozoic
crevasse	a deep crack in an ice sheet or glacier, which forms as a result of shear stress between different sections of the moving ice. See also: glacier, ice sheet

crinoid	a marine invertebrate animal belonging to the Class Crinoidea of the Phylum Echinodermata, and characterized by a head (*calyx*) with a mouth on the top surface surrounded by feeding arms. Several groups of stemmed echinoderms appeared in the early Paleozoic, including crinoids, blastoids, and cystoids. Crinoids have 5-fold symmetry and feathery arms (sometimes held off the sea floor on a stem) that collect organic particles from the water. The stems, the most often preserved part, are made of a series of stacked discs. Upon death, these stems often fall apart and the individual discs are preserved separately in the rock. The crinoid's feathery arms make it look something like a flower on a stem. Thus, crinoids are commonly called “sea lilies,” although they are animals, not plants. See also: echinoderm
cross-bedding	layering within a bed in a series of rock strata that does not run parallel to the plane of stratification. Cross-beds form as flowing water or wind pushes sediment downcurrent, creating thin beds that slope gently in the direction of the flow as migrating ripples. The downstream slope of the ripple may be preserved as a thin layer dipping in the direction of the current, across the natural flat-lying repose of the beds. Another migrating ripple will form an additional layer on top of the previous one.

Glossary

crust	the uppermost, rigid outer layer of the Earth, composed of tectonic plates. Two types of crust make up the lithosphere. Oceanic crust is denser but significantly thinner than continental crust, while continental crust is much thicker but less dense (and therefore buoyant). When continental crust collides with oceanic crust, the denser oceanic crust will be dragged (subducted) under the buoyant continental crust. Although mountains are created by these oceanic/continental crust collisions due to the compression of the two plates, much taller ranges are produced by continental/continental collisions. When two buoyant continental crusts collide, there is nowhere for the crust to go but up! The modern Himalayas, at the collision site of the Asian and Indian plates, are a good example of very tall mountains formed by a collision between two continental crusts. See also: active plate boundary, compression, lithosphere, subduction
Cryogenian	a geologic period lasting from 850 to 635 million years ago, during the Precambrian. During this period, the Earth was subject to a 200-million-year-long ice age. See also: ice age, Precambrian
crystal form	a physical property of minerals, describing the shape of the mineral's crystal structure (not to be confused with cleavage). A mineral might be cubic, rhomboidal, hexagonal, or polyhedral. See also: cleavage, mineral
cyanobacteria	a group of bacteria, also called "blue-green algae," that obtain their energy through photosynthesis.
cyclothem	alternating sequences of marine and non-marine sedimentary rocks, usually including coal, and characterized by their light and dark colors. See also: coal

degrade (energy)	the transformation of energy into a form in which it is less available for doing work, such as heat. See also: energy
density	a physical property of minerals, describing the mineral's mass per volume. See also: mineral
derecho	a set of powerful straight-line winds that exceed 94 kph (58 mph) and can often approach 160 kph (100 mph). These powerful windstorms can travel over 400 kilometers (250 miles) and cause substantial wind damage, knocking down trees and causing widespread power outages. The lightning associated with these intense storms can cause both forest fires and house fires. *Derecho* is the Spanish word for "straight ahead." See also: wind
Devonian	a geologic time period spanning from 419 to 359 million years ago. The Devonian is also called the "age of fishes" due to the diversity of fish that radiated during this time. On land, seed-bearing plants appeared and terrestrial arthropods became established. The Devonian is part of the Paleozoic. See also: geologic time scale, Paleozoic
diamond	a mineral form of carbon, with the highest hardness of any material. Most natural diamonds are formed at high temperature and pressure deep in the Earth's mantle. See also: hardness, mantle, mineral

Glossary

dinosaurs	a group of terrestrial reptiles with a common ancestor and thus certain anatomical similarities, including long ankle bones and erect limbs. All of the large reptile groups , including the dinosaurs, disappeared at or before the mass extinction at the end of the Cretaceous. See also: Cretaceous, mass extinction
dolomite	a carbonate mineral, consisting of calcium magnesium carbonate ($CaMg(CO_3)_2$). Dolomite is an important reservoir rock for petroleum, and also commonly hosts large ore deposits. See also: mineral, ore, petroleum
dolostone	a rock (also known as dolomitic limestone and once called magnesian limestone) primarily composed of dolomite, a carbonate mineral. It is normally formed when magnesium bonds with calcium carbonate in limestone, forming dolomite. See also: dolomite, limestone
double refraction	the result of light passing through a material that splits it into two polarized sets of rays, doubling images viewed through that material. For example, a single line on a sheet of paper will appear as two parallel lines when viewed through a clear calcite crystal. See also: calcite, mineral

Driftless Area	a region that did not experience glaciation, located in parts of southwestern Wisconsin, eastern Minnesota, and northeastern Illinois and Iowa. This region is known as the Driftless Area since it lacks glacial deposits, which are collectively called drift. Glaciers are known to have reached all sides of the Driftless Area at various times throughout the Quaternary Ice Age, but are not known to have completely encompassed the area at any time. The Driftless Area is also called the Paleozoic Plateau. See also: glacier, ice age
drumlin	a teardrop-shaped hill of till that was trapped beneath a glacier and streamlined in the direction of the flow of the ice moving over it. The elongation of a drumlin is an excellent clue to the direction of flow during an ice sheet's most recent advance. See also: glacier, till
dynamic metamorphism	See regional metamorphism
earthquake	a sudden release of energy in the Earth's crust that creates seismic waves. Earthquakes are common at active plate boundaries. See also: active plate boundary, seismic waves
echinoderms	members of the Phylum Echinodermata, which includes starfish, sea urchins, and crinoids. Echinoderms have radial symmetry (which is usually five-fold), and a remarable ability to regenerate lost body parts, See also: crinoid
edrioasteroids	an extinct class of echinoderm that had a simple, cushion-shaped body and five arms. See also: echinoderm

Glossary

effervesce	to foam or fizz while releasing gas. Carbonate minerals will effervesce when exposed to hydrochloric acid. See also: carbonate rock, mineral
efficiency	the use of a relatively small amount of energy for a given task, purpose, or service; achieving a specific output with less energy input. See also: energy
energy	the power derived from the use of physical or chemical resources. Everything we do depends upon energy - without it there would be no civilization, no sunlight, no food and no life. Energy moves people and goods, produces electricity, heats our homes and businesses, and is used in manufacturing and other industrial processes.
energy carrier	a source of energy, such as electricity, that has been subject to human-induced energy transfers or transformations. See also: energy
Entisols	a soil order; these are soils of relatively recent origin with little or no horizon development. They are commonly found in areas where erosion or deposition rates outstrip rates of soil development, such as floodplains, mountains, and badland areas. See also: erosion, horizon, soil, soil orders

erosion	the transport of weathered materials. Rocks are worn down and broken apart into finer grains by wind, rivers, wave action, freezing and thawing, and chemical breakdown. Over millions of years, weathering and erosion can reduce a mighty mountain range to low rolling hills. Some rocks wear down relatively quickly, while others can withstand the power of erosion for much longer. Softer, weaker rocks such as shale and poorly cemented sandstone and limestone are much more easily worn than hard, crystalline igneous and metamorphic rocks, or well-cemented sandstone and limestone. Harder rocks are often left standing as ridges because the surrounding softer, less resistant rocks were more quickly worn away. See also: igneous rock, metamorphic rock, sedimentary rock, weathering
erratic, glacial erratic	a piece of rock that differs from the type of rock native to the area in which it rests, carried there by glaciers often over long distances. Erratics are often distinctive because they are a different type of rock than the bedrock in the area to which they've been transported. For example, boulders and pebbles of igneous and metamorphic rocks are often found in areas where the bedrock is sedimentary; it is sometimes possible to locate the origin of an erratic if its composition and textures are highly distinctive. See also: glacier, igneous rock, metamorphic rock, sedimentary rock

Glossary

esker	a sinuous, elongated ridge of sand and gravel. Most eskers formed within ice-walled tunnels carved by streams flowing beneath a glacier. After the ice melted away, the stream deposits remained as long winding ridges. Eskers are sometimes mined for their well-sorted sand and gravel. See also: glacier, gravel, sand
eukaryotes	organisms with complex cells containing a nucleus and organelles. Protists and all multicellular organisms are eukaryotes. See also: protist
evaporite	a sedimentary rock created by the precipitation of minerals directly from seawater, including gypsum, carbonate, and halite. See also carbonate, gypsum, mineral, sedimentary rock
extinction	the end of species or other taxonomic groups, marked by death of the last living individual. Paleontologists estimate that over 99% of all species that have ever existed are now extinct. The species of modern animals that we study in biology today represent less than 1% of what has lived throughout geologic time.
extrusion, extrusive rock	an igneous rock formed by the cooling of lava after magma escapes onto the surface of the Earth through volcanic craters and cracks in the Earth's crust. See also crust, igneous rocks, magma.
fault	a fracture in the Earth's crust in which the rock on one side of the fracture moves measurably in relation to the rock on the other side. See also: crust

feldspar	an extremely common, rock-forming mineral found in igneous, metamorphic and sedimentary rocks. There are two groups of feldspar: alkali feldspar (which ranges from potassium-rich to sodium-rich) and plagioclase feldspar (which ranges from sodium-rich to calcium-rich). Potassium feldspars of the alkali group are commonly seen as pink crystals in igneous and metamorphic rocks, or pink grains in sedimentary rocks. Plagioclase feldspars are more abundant than the alkali feldspars, ranging in color from light to dark. Feldspars are commercially used in ceramics and scouring powders. See also: igneous rock, metamorphic rock, mineral, sedimentary rock
felsic	igneous rocks with high silica content and low iron and magnesium content. They are light in color and are typically found in continental crust. See also: crust, igneous rock, iron, silica
filter feeder	an animal that feeds by passing water through a filtering structure that traps food. The water may then be expelled and the food digested. This strategy is employed by a wide range of animals today, from clams and krill to flamingos and whales.
firn	compacted glacial ice, formed by the weight of snow on top. Individual flakes break down by melting, refreezing, and bonding to the snow around them, eventually forming compacted grains. See also: glacier

Glossary

flint	a hard, high-quality form of chert that occurs mainly as nodules and masses in sedimentary rock. Due to its hardness and the fact that it splits into thin, sharp flakes, flint was often used to make tools during the Stone Age. Flint will also create sparks when struck against steel, and has been used to ignite gunpowder in more modern times. See also: chert, sedimentary rock, nodule
floodplain	the land around a river that is prone to flooding. This area can be grassy, but the sediments under the surface are usually deposits from previous floods.
fluorite, fluorspar	the mineral form of calcium fluoride (CaF_2). Fluorite is used in a variety of commercial applications, including as lenses for microscopes, the production of some glass, and the chemical industry. Fluorite lent its name to the phenomenon of fluorescence, which occurs in some fluorites due to impurities in the crystal. See also: mineral
fluvial	See outwash plain
foliation	the arrangement of the constituents of a rock in leaflike layers, as in schists. During metamorphism, the weight of overlying rock can cause minerals to realign perpendicularly to the direction of pressure, layering them in a banded pattern. See also: metamorphism, schist
foraminifera	a class of aquatic protists that possess a calcareous or siliceous exoskeleton. Foraminifera have an extensive fossil record. See also: protist

fossil	preserved evidence of ancient life, including, for example, preserved skeletal or tissue material, molds or casts, and traces of behavior. Fossilization may alter biological material in a variety of ways, including permineralization, replacement, and compression. Remains are often classified as fossils when they are older than 10,000 years, the traditional start of the Holocene (recent) epoch. However, this date is only a practical guideline - scientists studying successions of plant or animal remains would not recognize any sudden change in the material at 10,000 years, and would typically refer to all material buried in sediments as fossil material. The word fossil is derived from the Latin word fossilis, meaning “dug up.” See also: compression, Holocene, permineralization, replacement
fossil fuels	fuel for human use that is made from the remains of ancient biomass, referring to any hydrocarbon fuel source formed by natural processes from anaerobically decomposed organisms, primarily coal, petroleum, and natural gas (methane). Fossil fuels are non-renewable, meaning that because they take thousands to millions of years to form, the rate of use is far greater than the rate of formation, and eventually we will run out. See also: biomass, coal, fuel, natural gas, petroleum
fracture	a physical property of minerals, formed when a mineral crystal breaks; also a crack in rocks, sometimes known as a joint. See also: mineral
frost wedging	weathering that occurs when water freezes and expands in cracks. See also: weathering

Glossary

fuel	a material substance that possesses internal energy that can be transferred to the surroundings for specific uses—included are petroleum, coal, and natural gas (the fossil fuels), and other materials, such as uranium, hydrogen, and biofuels. See also: biofuel, coal, energy, fossil fuel, natural gas, petroleum
gabbro	a usually coarse-grained, mafic and intrusive igneous rock. Most oceanic crust contains gabbro. See also: crust, igneous rock, intrusion, mafic
galena	an abundant sulfide mineral with cubic crystals. It is the most important ore of lead, as well as an important source of silver. See also: lead, mineral, ore, silver, sulfur
gastropod	a marine, freshwater, or terrestrial invertebrate animal belonging to the class Gastropoda of the phylum Mollusca, and characterized by a single, coiled, calcareous shell, a muscular foot for gliding, and internal asymmetry caused by an embryonic process (*torsion*). Gastropods include snails and slugs.
geode	a hollow, roughly spherical node of crystal that forms when minerals precipitate within hardened vesicles (gas bubbles) in volcanic rocks, or within dissolved nodules that leave openings within sedimentary rock. These geological structures occur in certain sedimentary and igneous rocks. See also: igneous rock, mineral, sedimentary rock, vesicular

geologic time scale	a standard timeline used to describe the age of rocks and fossils, and the events that formed them. It spans Earth's entire history, and is often subdivided into four major time periods: the Precambrian, Paleozoic, Mesozoic, and Cenozoic. See also: Cenozoic, Mesozoic, Paleozoic, Precambrian
glacier	a body of dense ice on land that does not melt away annually and has sufficient mass to move under its own weight. Glaciers form when snow accumulates faster than it melts over many years. As long as melt does not exceed accumulation, the ice and snow pile up and become a self-sustaining system. As glaciers slowly flow, they abrade and erode the landscape around them to create crevasses, moraines, and other distinguishing features. Glaciers form only on land, and are much thicker than ice that forms on the surface of water. 99% of Earth's glacial ice exists as vast polar ice sheets, but glaciers are also found high in the mountains of every continent except Australia. See also: crevasse, erosion, ice sheet, moraine
glassy rock	a volcanic rock that cooled almost instantaneously, resulting in a rock with tiny crystals or no crystals at all. Obsidian, tuff, and scoria are examples of glassy rocks. See also: igneous rock, obsidian, scoria, tuff, volcanic

Glossary

global warming	the current increase in the average temperature worldwide, caused by the buildup of greenhouse gases in the atmosphere. With the coming of the Industrial Age and exponential increases in human population, large amounts of gases have been released into the atmosphere (especially carbon dioxide) that give rise to global warming. The term "climate change" is preferred because warming contributes to other climatic changes such as precipitation and storm strength. See also: climate, greenhouse conditions, greenhouse gases
gneiss	a metamorphic rock that may form from granite or layered sedimentary rock such as sandstone or siltstone. Parallel bands of light and dark minerals give gneiss its striated texture. See also granite, metamorphic rock, mineral, sedimentary rock
gold	a soft, yellow, corrosion-resistant element (Au), which is the most malleable and ductile metal on Earth. Gold has an average abundance in the crust of only 0.004 parts per million. It can be profitably mined only where hydrothermal solutions have concentrated it. See also: crust, hydrothermal solution
Gondwana, Gondwanaland	the supercontinent of the Southern Hemisphere, composed of Africa, Australia, India, and South America. It combined with the North American continent to form Pangaea during the late Paleozoic. See also: Pangaea, Paleozoic
granite	a common and widely occurring type of igneous rock. Granite usually has a medium- to coarse-grained texture, and is at least 20% quartz by volume. See also: igneous

graphite	a mineral, and the most stable form of carbon. Graphite means "writing stone," a reference to its use as pencil lead. Graphite occurs in metamorphic rocks, igneous rocks, and meteorites. See also: igneous rock, metamorphic rock, mineral
graptolite	an extinct colonial invertebrate animal belonging to the Class Graptolithina of the Phylum Hemichordata, and characterized by individuals housed within a tubular or cup-like structure. The soft parts of a graptolite's body have never been clearly identified. See also: extinction
Great Lakes	the largest group of freshwater lakes on Earth (by total surface area and volume), located on the US-Canadian border, and consisting of Lakes Superior, Michigan, Huron, Erie, and Ontario. Prior to glaciation, the Great Lakes were river valleys that had been scoured and deepened repeatedly by the many ice advances during the Quaternary period. Many sizable glacial lakes were formed at the edge of the melting ice sheet that no longer exist today or have significantly shrunk in size. See also: ice sheet, Quaternary
greenhouse conditions	time periods when atmospheric greenhouse gas concnetrations are high and global temperatures are elevated. Sea levels are generally higher and glaciers diminish during these conditions. See also: glacier, global warming, greenhouse gases

Glossary

greenhouse gas	a gas in the atmosphere that absorbs and emits heat. The primary greenhouse gases in the Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone. See also: atmosphere, heat
gypsum	a soft sulfate mineral that is widely mined for its use as fertilizer and as a constituent of plaster. Alabaster, a fine-grained light colored variety of gypsum, has been used for sculpture making by many cultures since ancient times. See also: mineral, sulfur
halite	See salt
hardness	a physical property of minerals, specifying how hard the mineral is. Hardness helps us understand why some rocks are more or less resistant to weathering and erosion See also: erosion, mineral, Moh's Scale of Hardness, weathering
heat	the transfer of energy from one body to another as a result of a difference in temperature or a change in phase. Heat is transmitted through solids and fluids by conduction, through fluids by convection, and through empty space by radiation. See also: convection, energy
heat island effect	a phenomenon in which cities experience higher temperatures than surrounding rural communities do.

heat wave	a period of excessively hot weather that may also accompany high humidity. Temperatures of just 3°C (6°F) to 6°C (11°F) above normal are enough to reclassify a warm period as a heat wave. Under high humidity, the mechanism of sweating does little to cool people down because the humidity prevents sweat from evaporating and cooling off the skin. See also: weather
hematite	a mineral form of iron oxide (Fe_2O_3). The name hematite has its origins in the Greek word *haimatos*, meaning blood. It is very common in Precambrian banded iron formations. Iron from hematite is used in the manufacture of steel. The vivid red pigments that iron lends to the mineral also makes it valuable as a commercial pigment. See also: iron, Precambrian
Histosols	a soil order; these are organic-rich soils found along lake coastal areas where poor drainage creates conditions of slow decomposition and peat (or muck) accumulates. See also: peat, soil, soil orders
Holocene	the most recent portion of the Quaternary, beginning about 11,700 years ago and continuing to the present. It is the most recent (and current) interglacial, an interval of glacial retreat. The Holocene also encompasses the global growth and impact of the human species. See also: interglacial, Quaternary

Glossary

horizon (soil)	a layer in the soil, usually parallel to the surface, which has physical characteristcs (usually color and texture) that are different from the layers above and below it. Each type of soil usually contains three or four horizons. See also soil
hornblende	a dark silicate mineral that can occur in a variety of forms. Hornblende is a common constituent of many igneous and metamorphic rocks. See also: igneous rock, metamorphic rock
hot spot	a volcanic region thought to be fed by underlying mantle that is anomalously hot compared with the mantle elsewhere. Hot spots form from plumes of magma rising off the mantle. Magma from the hot spot pushes its way up through the crust, creating an igneous intrusion and sometimes a volcano. Although the hot spot remains fixed, the plates of the lithosphere continue to move above it. As a plate continues to move over the hot spot, the original volcano shifts off of the hot spot and a new intrusion or volcano is formed. This gradually produces a chain of volcanic islands such as the Hawaiian Islands. Erosion of volcanoes may eventually wear down the crust to reveal the igneous intrusions that formed the volcano's magma chamber. See also: crust, erosion, igneous rocks, intrusion, lithosphere, magma, mantle, volcanic islands
Huronian glaciation	a glaciation beginning about 2.4 billion years ago, that covered the entire surface of the Earth in ice for as long as 300 million years. See also: glacier, ice age

hurricane	a rapidly rotating storm system with heavy winds, a low-pressure center, and a spiral arrangement of thunderstorms. These storms tend to form over large, warm bodies of water. Once winds have reached 119 kph (74 mph), such a storm is classified as a hurricane. Hurricanes usually develop an eye, which is visible as a small, round, cloud-free area at the center of the storm. The eye is an area of relative calm and low atmospheric pressure. The strongest thunderstorms and winds circulate just outside the eye, in the eyewall. See also: wind
hydrothermal solution	hot, salty water moving through rocks.These solutions are always enriched in salts (such as sodium chloride, potassium chloride, and calcium chloride) and thus are called “brines.” The brine is as salty or even saltier than seawater. Salty water can contain minute amounts of dissolved minerals such as gold, lead, copper, and zinc. The presence of salt in the water suppresses the precipitation of the metallic minerals from the brine because the chlorides in the salt preferentially bond with metals. Additionally, because the brine is hot, minerals are more easily dissolved, just as hot tea dissolves sugar more easily than cold tea. See also: copper, gold, lead, mineral, salt, zinc
hyolith	animals with cone-shaped shells that existed throughout the Paleozoic. Their affinities to other animals are uncertain, with some scientists classifying them as mollusks and others placing them in their own phylum. See also: Paleozoic

Glossary

Iapetus Ocean	the proto-Atlantic Ocean, located against the eastern coast of North America's ancestral landmass before Pangaea formed. In Greek mythology, Iapetus was the father of Atlantis. See also: Pangaea
ice age	a period of global cooling of the Earth's surface and atmosphere, resulting in the presence or expansion of ice sheets and glaciers. Throughout the Earth's history, it has been periodically plunged into ice ages, dependent upon the climate and position of the continents. Over the past 2.6 million years, North America has experienced about 50 glacial advances and retreats. The most recent ice age ended about 12,000 years ago. See also: atmosphere, climate, ice sheet, glacier
ice dome	the spreading center of an ice sheet. Glacial ice flows outward from the ice dome, where snow continues to accumulate, like like the pouring of pancake batter onto a griddle. See also: glacier, ice sheet
ice sheet	a mass of glacial ice that covers part of a continent and has an area greater than 50,000 square kilometers (19,000 square miles). See also: glacier
ichthyosaurs	extinct Mesozoic marine reptiles that were probably similar in size and habitat to the toothed whales, dolphins, and large sharks of today. See also: extinction, Mesozoic

Glossary

igneous rocks	rocks derived from the cooling of magma underground or molten lava on the Earth's surface. Igneous rocks differ not only in their cooling rates and subsequent crystal sizes, but also in their chemical compositions. Rocks found in continental crust, such as granite, have high silica content and low iron and magnesium content. They are light in color and are called felsic. Rocks found in oceanic crust, like basalt, are low in silica and high in iron and magnesium. They are dark in color and are called mafic. Although the composition of magma can be the same as lava, the texture of the rocks will be quite different due to different rates of cooling. It is because of this difference in genesis that geologists are able to make the distinction between extrusive and intrusive igneous rocks when encountered at an outcrop at the Earth's surface. See also: extrusion, felsic, intrusion, mafic, magma, lava
Illinoian glaciation	a period of glaciation that occurred during the Pleistocene, 191 to 131 thousand years ago. See also: glacier, Pleistocene
Illinois Basin	an inland basin centered in the state of Illinois, which formed when Baltica approached North America in the Ordovician. More than four billion barrels of petroleum have been extracted from the Illinois Basin. See also: inland basin, Ordovician, petroleum
Inceptisols	a soil order; these are soils that exhibit only moderate weathering and development. They are often found on steep (relatively young) topography and overlying erosion-resistant bedrock. See also: soil, soil orders, topography, weathering

Glossary

index fossil	a fossil used to determine the relative age of sedimentary deposits. An ideal index fossil lived during a short period of time, was geographically and environmentally widespread, and is easy to identify. Some of the most useful index fossils are hard-shelled organisms that were once part of the marine plankton. See also: fossil, sedimentary rock
inland basin	a depression located inland from the mountains, and formed by the buckling (downwarping) of the Earth's crust. Basins naturally preserve thick sediment layers because they accumulate eroded sediment and commonly continue to subside under the weight of the sediment. See also: crust
inland sea	a shallow sea covering the central area of a continent during periods of high sea level. An inland sea is located on continental crust, while other seas are located on oceanic crust. An inland sea may or may not be connected to the ocean. For example, Hudson Bay is on the North American plate and connects to the Atlantic and Arctic Oceans, while the Caspian Sea is on the European plate but does not drain into any ocean at all. See also: crust
interglacial	a period of geologic time between two successive glacial stages. See also: glacier

intrusion, intrusive rock	a plutonic igneous rock formed when magma from within the Earth's crust escapes into spaces in the overlying strata. As the magma rises, pushing through overlying layers of rock, it begins to cool. The cooling magma can crystallize and harden to become intrusive igneous rock, locked within layers of older rock. See also: crust, igneous, magma, pluton
iron	a metallic chemical element (Fe). Iron is most often found in combination with other elements, such as oxygen and sulfur, to form ores like hematite, magnetite, siderite, and pyrite. The ready availability of iron at Earth's surface made it one of the earliest mined mineral resources in the US. See also: hematite, magnetite, ore, pyrite, sulfur
isostasy	an equilibrium between the weight of the crust and the buoyancy of the mantle. See also: crust, mantle
jasper	a speckled or patterned silicate stone that appears in a wide range of colors. It is a variety of chalcedony. Jasper forms when silica precipitates in a fine particulate material such as soft sediment or volcanic ash. The particulates give the stone its color and patterns. See also: chalcedony, sedimentary rock, silica
joule (J)	the energy expended (or work done) to apply a force of one newton over a distance of one meter. See also: energy

Glossary

Jurassic	the geologic time period lasting from 201 to 145 million years ago. During the Jurassic, dinosaurs dominated the landscape and the first birds appeared. The Jurassic is the middle period of the Mesozoic. See also: geologic time scale, Mesozoic
kame	an irregularly shaped mound made up of sediment that accumulated in a depression on a retreating glacier. The mound-like deposits of sorted sediment are then deposited on the land after the glacier retreats. See also: glacier
karst topography	a kind of landscape defined by bedrock that has been weathered by dissolution in water, forming features like sinkholes, caves, and cliffs. Karst primarily forms in limestone bedrock. See also: limestone, topography, weathering
kettle	a lake formed where a large, isolated block of ice became separated from the retreating ice sheet. The weight of the ice leaves a shallow depression in the landscape that persists as a small lake. See also: ice sheet
kinetic energy	the energy of a body in motion (e.g., via friction). See also: energy

Köppen system	a commonly used system of climate categorization developed by Russian climatologist Wladimir Köppen. It is based on the kinds of vegetation that areas sustain, and defines 12 climate types: rainforest, monsoon, tropical savanna, humid subtropical, humid continental, oceanic, Mediterranean, steppe, subarctic, tundra, polar ice cap, and desert. Updated by Rudolf Geiger, it has been refined to five groups each with two to four subgroups. See also: climate
lagerstätte (pl. lagerstätten)	fossil deposit containing animals or plants that are preserved unusually well, sometimes even including the soft organic tissues. Lagerstatten form in chemical environments that slow decay of organic tissues or enhance preservation through mineralization. Also, quick burial of the organism leaves no opportunity for disturbance of the fossils. Lagerstatten are important for the information they provide about soft-bodied organisms that we otherwise would know nothing about. See also: fossil
Lake Superior agate	the Minnesota state gemstone. This stone formed in magma containing bubbles created by water and carbon dioxide that had been trapped in the magma. After the magma cooled, these bubbles were slowly filled by mineral-rich water, depositing layers of fine quartz crystals and enough iron to color the resulting rocks red. See also: iron, magma, quartz
last glacial maximum	the most recent time the ice sheets reached their largest size and extended farthest towards the equator, about 26,000 to 19,000 years ago. Ice sheets over North America melted back until about 10,000 years ago—they have been relatively stable since that time. See also: ice sheet

Glossary

Laurentide Ice Sheet	an ice sheet that covered most of Canada during the last major glaciation. In its prime, the Laurentide was more than 5 kilometers (3.1 miles) thick at its thickest point on what is now the Hudson Bay. The sheet began to melt about 13,000 years ago. See also: glacier, ice sheet
lava	molten rock located on the Earth's surface. When magma rises to the surface, typically through a volcano or rift, it becomes lava. Lava cools much more quickly than magma because it is at the surface, exposed to the atmosphere or ocean water where temperatures are much cooler. Such rocks, with little time to crystallize, have small or no crystals. See also: magma, rift, volcanism
Law of Superposition	the geological principle that states that unless rock layers have been overturned or intruded, older rocks are found at the bottom and younger rocks are found at the top of a sedimentary sequence. See also: intrusion, stratigraphy
lead	a metallic chemical element (Pb). Lead was one of the first metals mined in North America, where it was sought after especially for making shot. It is used in batteries, communication systems, and building construction.
lignite	a soft, brownish-black coal in which the alteration of plant matter has proceeded farther than in peat but not as far as in bituminous coal. See also: bituminous coal, coal, peat

limestone	a sedimentary rock composed of calcium carbonate ($CaCO_3$). Most limestones are formed by the deposition and consolidation of the skeletons of marine invertebrates; a few originate in chemical precipitation from solution. Limestone is ordinarily white but can be colored by impurities such as iron oxide (making it brown, yellow, or red), or organic carbon (making it blue, black, or gray). The rock's texture varies from coarse to fine. See also: iron, sedimentary rock
lithification	the process of creating sedimentary rock through the compaction or sementation of soft sediment. The word comes from the Greek *lithos*, meaning “rock.” See also: sedimentary rock
lithosphere	the outermost layer of the Earth, comprising a rigid crust and upper mantle broken up into many plates. The plates of the lithosphere move with the underlying asthenosphere, on average about 5 centimeters (2 inches) per year and as much as 18 centimeters (7 inches) per year. See also asthenosphere, crust, mantle
loam	a soil containing equal amounts of clay, silt, and sand. See also: clay, soil, sand, silt
loess	very fine grained, wind-blown sediment, usually rock flour left behind by the grinding action of flowing glaciers. See also: rock flour
luminescence	to give off light.

Glossary

luster	a physical property of minerals, describing the appearance of the mineral's surface in reflected light, and how brilliant or dull it is. Luster can range from metallic and reflective to opaque, vitreous like glass, translucent, or dull and earthy. See also: mineral
lycopod	an extinct, terrestrial tree belonging to the plant division Lycopodiophyta, and characterized by a tall, thick trunk covered with a pattern of diamond-shaped leaf scars, and a crown of branches with simple leaves. Lycopods, or "scale trees," grew up to 98 feet (30 meters) high in Mississippian and Pennsylvanian forests. The plant division Lycopodiophyta survives today but only as very small plants on the forest floor, sometimes called “ground pines.” See also: Mississippian, Pennsylvanian, tree
mafic	igneous rocks that contain a group of dark-colored minerals, with relatively high concentrations of magnesium and iron compared to felsic igneous rocks. See also: felsic, igneous rock
magma	molten rock located below the surface of the Earth. Magma can cool beneath the surface to form intrusive igneous rocks. However, if magma rises to the surface without cooling enough to crystallize, it might break through the crust at the surface to form lava. See also: crust, igneous, intrusive rock, lava
magnetic	affected by or capable of producing a magnetic field.

magnetite	a mineral form of iron oxide (Fe_3O_4). It is the most magnetic naturally occurring mineral. The molecules in magnetite align with the North and South Poles when rocks containing magnetite ore are formed. By examining the alignment today, scientists can reconstruct how the rocks have moved since their formation, giving them clues about the previous arrangement of the continents. Magnetite lodestones were used as an early form of compass. Huge deposits of magnetite have been found in Precambrian banded iron formations. See also: banded iron formations, iron, mineral, ore, Precambrian
mammoth	an extinct terrestrial vertebrate animal belonging to the Order Proboscidea of the Class Mammalia. Mammoths are from the same line of proboscideans that gave rise to African and Asian elephants. They had tall bodies with a rather high "domed" skull, and teeth with numerous parallel rows of ridges. Mammoths are among the most common Pleistocene vertebrate fossils in North America, Europe, and Asia. See also: extinction, fossil, Pleistocene
mantle	the layer of the Earth between the crust and core. It consists of solid silicate rocks that, over long intervals of time, flow like a highly viscous liquid. Convection currents within the mantle drive the motion of plate tectonics. See also: convection, magma, plate tectonics, silica
marble	a metamorphic rock composed of recrystallized carbonate minerals, most commonly calcite or dolomite. Not everything commercially called a marble is "true marble," which lacks fossils and is recrystallized from limestone. See also: calcite, dolomite, limestone, metamorphic, mineral

Glossary

mass extinction	the extinction of a large percentage of the Earth's species over a relatively short span of geologic time. Unfortunately, this is not just a phenomenon of the past: it is estimated that the extinction rate on Earth right now may be as much as 1000 times higher than normal, and that we are currently experiencing a mass extinction event. See also: geologic time scale, extinction
mass wasting	a process in which soil and rock move down a slope in a large mass. This can occur both on land (such as a landslide) or underwater (such as a turbidity current). See also: turbidity current
mastodon	an extinct terrestrial vertebrate animal belonging to the Order Proboscidea of the Class Mammalia, and characterized by an elephant-like shape and size, and massive molar teeth with conical projections. Mastodons are among the most common Pleistocene vertebrate fossils in North America. See also: extinction, fossil, Pleistocene
matrix	a fine-grained mass of material around and embedding larger grains or crystals. The term matrix can also describe sediment or rock in which a fossil is embedded. See also: fossil

Mesozoic	a geologic time period that spans from 252 to 66 million years ago. This period is also called the “age of reptiles” since dinosaurs and other reptiles dominated both marine and terrestrial ecosystems. During this time, the last of the Earth’s major supercontinents, Pangaea, formed and later broke up, producing the Earth’s current geography. The Mesozoic contains the Triassic, Jurassic, and Cretaceous periods. See also: Cretaceous, geologic time scale, Jurassic, Pangaea, Triassic
metamorphism, metamorphic rocks	rocks formed by the recrystallization and realignment of minerals in pre-existing sedimentary, igneous, and metamorphic rocks when exposed to high enough temperature and/or pressure. This can be a result of plate movements, very deep burial, or contact with molten rock or superheated water. This process destroys many features in the rock that would have revealed its previous history, transforming it into an entirely new form. Tectonic forces can cause minerals to realign perpendicularly to the direction of pressure, layering them in a pattern called foliation, as exemplified in gneiss and schist. Recrystallization, as seen in marble and quartzite, results as rock is heated to high temperatures, and individual grains reform as interlocking crystals, making the resulting metamorphic rock harder than its parent rock. See also: gneiss, igneous rock, marble, quartzite, schist, sedimentary rock
mica	a large group of sheetlike silicate minerals. See also: mineral

Glossary

Michigan Basin	an inland basin centered on Michigan's Lower Peninsula, which formed when Baltica approached North America in the Ordovician. The rocks of the Michigan Basin are a commercial source of petroleum. See also: Baltica, inland basin, petroleum
Michigan Formation	a ring-like stratum in the rock of the Michigan Basin, where most of the state's gypsum is mined. It can be found in a nearly continuous band around the center of the Lower Peninsula. See also: gypsum, Michigan Basin
Milankovitch Cycles	cyclical changes in the amount of heat received from the sun, associated with how the Earth's orbit, tilt, and wobble alter its position with respect to the sun. These changes affect the global climate, most notably alterations of glacial and interglacial intervals. See also: climate
mineral	a naturally occurring solid with a specific chemical composition and crystalline structure. Minerals are identified based on their physical properties, including hardness, luster, color, crystal form, cleavage, density, and streak. There are over 4,900 identified minerals. However, the number of common rock-forming minerals is much smaller. The most common minerals that form igneous, metamorphic, and sedimentary rocks include quartz, feldspar, mica, pyroxenes, and amphiboles. See also: amphibole, color (mineral), cleavage, crystal form, density, feldspar, igneous rock, luster, metamorphic rock, mica, pyroxene, quartz, sedimentary rock, streak

mineralogy	The branch of geology that studies the chemical and physical properties and formation of minerals. See also: mineral
Mississippian	a subperiod of the Carboniferous, spanning from 359 to 323 million years ago. See also: Carboniferous
Mohs Scale of Hardness	the scale of relative hardness of minerals, developed by the Austrian mineralogist, Frederich Mohs, in 1824. The scale is very useful as a means for identifying minerals or quickly determining hardness. A piece of glass has a hardness of approximately 5 on the scale; our fingernails are just over 2; a knife blade is just over 5. Diamond ranks at 10 as the hardest mineral. See also: hardness, mineral
Mollisols	a soil order; these are agricultural soils made highly productive due to a very fertile, organic-rich surface layer. See also: soil, soil orders
moraine	an accumulation of unconsolidated glacial debris (soil and rock) that can occur in currently glaciated and formerly glaciated regions, such as those areas acted upon by a past ice age. The debris is scraped from the ground and pushed forward by the glacier, to be left behind when the ice melts. Thus, many moraines mark the terminus or edge of a glacier. Lateral moraines can also occur in between and at the sides of glaciers or ice lobes. See also: glacier, ice age, soil
Morton Gneiss	the oldest rock in the United States. It was formed 3.6 billion years ago, during the Archean. See also: Archean, gneiss

Glossary

mosasaurs	extinct, carnivorous, marine vertebrate reptiles. Mosasaurs were characterized by a streamlined body for swimming, a powerful fluked tail, and reduced, paddle-like limbs. They were common in Cretaceous seas and were were powerful swimmers, reaching 40-59 feet (12-18 meters) in length. See also: Cretaceous, extinction
natural gas	a hydrocarbon gas mixture composed primarily of methane (CH_4), but also small quantites of hydrocarbons such as ethane and propane. See also: fossil fuel
natural hazard	events that result from natural processes and that have significant impacts on human beings.
Neogene	the geologic time period extending from 23 to 2.6 million years ago. During the Neogene, global climate cooled, the continents moved close to their current positions, mammals and birds continued to evolve, and the first hominins appeared. The Neogene is a portion of the Cenozoic. See also: Cenozoic
nickel	a ductile, silvery-white metallic element (Ni). Nickel in its pure form is rarely found on Earth's surface; large quantites of nickel are typically found in meteorites. On Earth, nickel is generally found in combination with iron. Nickel is resistant to corrosion and is commonly used to plate metals, coat chemistry equipment, and manufacture alloys such as electrum. See also: iron

nodule	a small, irregular or rounded mineral deposit that has a different composition from the sedimentary rock that encloses it. Nodules typically form when minerals precipitate from a supersaturated solution within or around features such as biotic remains. See also: mineral, sedimentary rock
nuclear	a reaction, as in fission, fusion, or radioactive decay, that alters the energy, composition, or structure of an atomic nucleus. See also: radioactive
obsidian	a glassy volcanic rock, formed when felsic lava cools rapidly. Although obsidian is dark in color, it is composed mainly of silicon dioxide (SiO_2), and its dark color is a result of the rapid cooling process. Obsidian is extremely brittle and breaks with very sharp edges. It was valuable to Stone Age cultures for its use as cutting implements or arrowheads. See also: felsic, glassy, lava, volcanic
oil	See petroleum
Ordovician	a geologic time period spanning from 485 to 443 million years ago. During the Ordovician, invertebrates dominated the oceans and fish began to diversify. The Ordovician is part of the Paleozoic. See also: geologic time scale, Paleozoic
ore	a type of rock that contains minerals with valuable elements, including metals, that are economically viable to extract. See also: mineral

Glossary

orogeny	a mountain-building event generally caused by colliding plates and compression of the edge of the continents. Orogeny is derived from the Greek word *oro*, meaning mountain. See also: compression, plate tectonics
outwash plain	large sandy flats created by sediment-laden water deposited when a glacier melts. Outwash sediments are also called fluvial material. See also: glacier, sand
paleoecology	the study of the relationships of fossil organisms to one another and their environment. See also: fossil
Paleogene	the geologic time period extending from 66 to 23 million years ago. During the Paleogene, mammals and birds diversified into many of the niches that had previously been held by dinosaurs. The Paleogene is the first part of the Cenozoic. See also: dinosaur, geologic time scale, Cenozoic
Paleozoic	a geologic time period that extends from 541 to 252 million years ago. Fossil evidence shows that during this time period, life evolved in the oceans and gradually colonized the land. The Paleozoic includes the Cambrian, Ordovician, Silurian, Devonian, Carboniferous, and Permian periods. See also: Cambrian, Carboniferous, Devonian, geologic time scale, Ordovician, Permian, Silurian

Pangaea	supercontinent, meaning “all Earth,” which formed over 250 million years ago and lasted for almost 100 million years. All of the Earth’s continents were joined in a giant supercontinent. Pangaea eventually rifted apart and separated into the continents in their current configuration.
parent material	the original geologic material from which soil formed. This can be bedrock, preexisting soils, or other materials such as till or loess. See also: loess, soil, till
patterned ground	patterns and sorting in the soil caused by repeated freezing and thawing, which causes repeated heaving upwards and settling of the rocks and pebbles in the soil. See also: soil
peat	an accumulation of partially decayed plant matter. Under proper heat and pressure, it will turn into lignite coal over geologic periods of time. As much as 30 feet (9 meters) of peat might need to accumulate to produce an economically profitable coal seam. By the time that a peat bed has been turned into a layer of anthracite, the layer is one-tenth its original thickness. See also: anthracite, coal, lignite
peds	clumps of soil, identified by their shape, which may take the form of balls, blocks, columns, and plates. These structures are easiest to see in recently plowed fields, where the soil is often granular and loose or lumpy. See also: soil
Pennsylvanian	a subperiod of the Carboniferous, spanning from 323 to 299 million years ago. See also: Carboniferous

Glossary

periglacial zone	a region directly next to an ice sheet, which, although it was never covered or scoured by ice, has its own distinctive landscape and features because it was next to the ice margin. The average annual air temperature in a periglacial area is between -12° and 3°C (10° and 37°F). Though the surface of the ground may melt in the summer, it refreezes in the winter. See also: ice sheet
permafrost	a layer of soil below the surface that remains frozen all year round. Its thickness can range from tens of centimeters to a few meters. See also: soil
permeable, permeability	a capacity for fluids and gas (such as water, oil and natural gas) to move through fractures within a rock, or the spaces between its grains. Sandstone, limestone, and fractured rocks of any kind generally are permeable. Shale, on the other hand, is usually impermeable because the small, flat clay particles that make up the rock are tightly packed into a dense rock with very little space between particles. Poorly sorted sedimentary rocks can also be impermeable because smaller grains fill in the spaces between the bigger grains, restricting the movement of fluids. See also: clay, limestone, petroleum, sandstone, sedimentary rocks, shale

Permian	the geologic time period lasting from 299 to 252 million years ago. During the Permian, the world's landmass was combined into the supercontinent Pangaea. The Permian is the last period of the Paleozoic. It ended with the largest mass extinction in Earth's history, which wiped out 70% of terrestrialanimal species and 90% of all marine animal species. See also: geologic time scale, mass extinction, Paleozoic, Pangaea
permineralization	a fossilization method where empty spaces (such as in a bone or shell) are filled by minerals. See also: fossil
petroleum	a naturally occurring, flammable liquid found in geologic formations beneath the Earth's surface and consisting primarily of hydrocarbons. Petroleum, also called oil, is a fossil fuel, formed when large masses of dead organisms (usually algae or plankton) are buried underneath sediments and subjected to intense heat and pressure. Today, petroleum is used to manufacture a wide variety of materials, and it is commonly refined into various types of fuels. It is estimated that 90 million barrels are consumed globally every day. See also: fossil fuel
Phanerozoic	a generalized term used to describe the entirety of geological history after the Precambrian, from 541 million years ago to the present. See also: geologic time scale
placoderms	an extinct class of heavily armored fishes. Placoderms lived from the Silurian to the Devonian. See also: Devonian, extinction, Silurian

Glossary

plate tectonics	the way by which the plates of the Earth's crust move and interact with one another at their boundaries. The Earth is dynamic, consisting of constantly moving plates that are made of rigid continental and oceanic lithosphere overlying a churning, plastically flowing asthenosphere. These plates are slowly pulling apart, colliding, or sliding past one another with great force, creating strings of volcanic islands, new ocean floor, earthquakes, and mountains. See also: asthenosphere, crust, earthquake, lithosphere, volcanic islands
plates	large, rigid pieces of the Earth's crust and upper mantle, which move and interact with one another at their boundaries. See also: crust, mantle, plate tectonics
platform	See craton
Pleistocene	a subset of the Quaternary, lasting from 2.5 million to about 11,700 years ago. During the Pleistocene, continental ice sheets advanced south and retreated north several dozen times. See also: ice age, ice sheet, Quaternary
plesiosaurs	a group of extinct long-necked Mesozoic marine reptiles. See also: dinosaur, extinction, Mesozoic
plucking	process in which a glacier "plucks" sediments and larger chunks of rock from the bedrock. The flowing ice cracks and breaks rock as it passes over, pieces of which become incorporated into the sheet or bulldozed forward, in front of the glacier's margin. See also: glacier
plunge pool	a stream pool, lake, or pond that is small in diameter, but deep.

pluton, plutonic rock	a large body of intrusive igneous rock that formed under the Earth's surface through the slow crystallization of magma. The term comes from the name of Pluto, Roman god of the underworld. See also: igneous rock, intrusion, magma
polar vortex	a regularly occurring area of low pressure that circulates in the highest levels of the upper atmosphere. Typically, the polar vortex hovers above Canada. However, a pocket of the counter-clockwise rotating low-pressure center can break off and shift southward at a lower altitude. The jet stream then shifts to a more southward flow than usual. A polar vortex can lock the jet stream in this new pattern for several days to more than a week
potash	a name used for a variety of salts containing potassium, with mined potash being primarily potassium chloride (KCl). The majority of potash is used as fertilizer, but an increasing amount is being used in a variety of other ways: water softening, snow melting, a variety of industrial processes, as a medicine, and to produce potassium carbonate (K_2CO_3). See also: carbonate, salt
pothole	a shallow, rounded depression eroded in bedrock by a glacier. See also: erosion, glacier
power	the rate at which energy is transferred, usually measured in watts or, less frequently, horsepower. See also: energy, watt
Pre-Illinoian glaciation	a grouping of the Midwestern glacial periods that occurred before the Wisconsinian and Illinoian glaciations. See also: glacier, Illinoian glaciation, Wisconsinian glaciation

Glossary

Precambrian	a geologic time period that spans from the formation of Earth (4.6 billion years ago) to the beginning of the Cambrian (541 million years ago). Relatively little is known about this time period since very few fossils or unaltered rocks have survived. What few clues exist indicate that life first appeared on the planet as long as 3.9 billion years ago in the form of single-celled organisms. The Precambrian contains the Hadean, Archean and Proterozoic eons. See also: Archean, geologic time scale, Proterozoic
primary energy source	a source of energy found in nature, that has not been subject to any human-induced energy transfers or transformations (like conversion to electricity). Examples include fossil fuels, solar, wind, and hydropower. See also: energy, fossil fuel
prokaryotes	single-celled organisms, with simple cells containing no nucleus or organelles.
Proterozoic	a geologic time interval that extends from 2.5 billion to 541 million years ago. It is part of the Precambrian. During this eon, the Earth transitioned to an oxygenated atmosphere and eukaryotic cells, including fungi, plants, and animals, originated. See also: geologic time scale, Precambrian
protists	a diverse group of single-celled eukaryotes. See also: eukaryote
pterosaurs	extinct flying reptiles with wingspans of up to 15 meters. They lived during the same time as the dinosaurs. See also: dinosaur, extinction

pumpellyite	a group of metamorphic silicate minerals that produce translucent green crystals with a fibrous texture. See also: metamorphic rock, mineral, silica
pyrite	the iron sulfide mineral (FeS_2). Pyrite's superficial resemblance to gold has led to the common nickname "fool's gold." See also: iron, mineral, sulfur
pyroclastic	rocks that form during explosive volcanic eruptions, and are composed from a variety of different volcanic ejecta. The term comes from Greek, and means “broken fire.” Pyroclastic debris of all types is known as tephra. See also: volcanism
pyroxene	dark-colored rock-forming silicate minerals containing iron and magnesium, found in many igneous and metamorphic rocks. They are often present in volcanic rocks. See also: igneous rock, iron, metamorphic rock, silica, volcanic

Glossary

quartz	the second most abundant mineral in the Earth's continental crust (after feldspar), made up of silicon and oxygen (SiO_2). It makes up more than 10% of the crust by mass. There are a wide variety of types of quartz: onyx, agate, and petrified wood are fibrous, microcrystalline varieties collectively known as chalcedony. Although agate is naturally banded with layers of different colors and porosity, commercial varieties of agate are often artificially colored. Flint, chert and jasper are granular microcrystalline varieties of quartz, with the bright red color of jasper due to the inclusion of small amounts of iron within the mineral structure. The most common, coarsely crystalline varieties include massive quartz veins, the distinct, well formed crystals of "rock crystal", and an array of colored quartz, including amethyst (purple), rose quartz (pink), smoky quartz (gray), citrine (orange), and milky quartz (white). See also: chalcedony, chert, crust, flint, iron, jasper, mineral
quartzite	a hard metamorphic rock that was originally sandstone. Quartzite usually forms from sandstone that was metamorphosed through tectonic compression within orogenic belts. Quartzite is quarried for use as a building and decorative stone. See also: compression, metamorphism, orogeny, sandstone
Quaternary	a geologic time period that extends from 2.6 million years ago to the present. This period is largely defined by the periodic advance and retreat of continental glaciers. The Quaternary is part of the Cenozoic. See also: Cenozoic, geologic time scale, glacier

radioactive	when an unstable atom loses energy by emitting radiation.
radon	a naturally occurring radioactive, colorless, odorless gas. It is one of the products of decay from the breakdown of radioactive elements in soil, rock, and water, released by weathering. See also: radioactive, weathering
recrystallization	the change in structure of mineral crystals that make up rocks, or the formation of new mineral crystals within the rock. Recrystallization commonly occurs during metamorphism. When rocks are metamorphosed, individual grains that make up the original rock are melted slightly and recrystallize. The pressure allows crystals to grow into a tighter, interlocking arrangement than in an unmetamorphosed rock. See also: metamorphism, mineral
recurrence interval	the time elapsed between major events, such as floods.
reef	a feature lying beneath the surface of the water, which is a buildup of sediment or other material built by organisms, and which has positive relief from the sea floor. While some reefs result from abiotic processes such as deposition or wave action, the best-known reefs are built by corals and other marine organisms.
regional metamorphism	a metamorphic rock that has been altered due to deep burial and great pressure. This type of metamorphic rock tends to occur in long belts at the center of mountain ranges. Different types of metamorphic rock are created depending on the gradients of heat and pressure applied. See also: metamorphism
regression	a drop in sea level.

Glossary

renewable energy, renewable resource	energy obtained from sources that are virtually inexhaustible (defined in terms of comparison to the lifetime of the Sun) and replenish naturally over small time scales relative to human life spans. See also: energy
replacement	a fossilization method by which the original material is chemically replaced by a more stable mineral. See also: fossil
rhyolite, rhyolitic	a felsic volcanic rock high in abundance of quartz and feldspar. See also: feldspar, felsic, quartz, volcanic
rift	a break or crack in the crust that can be caused by tensional stress as a landmass breaks apart into separate plates. See also: crust, plate tectonics
rift basin	a topographic depression caused by subsidence within a rift; the basin, since it is at a relatively low evelation, usually contains freshwater bodies such as rivers and lakes. See also: rift
ripple marks	surface features created when sediment deposits are agitated, typically by water currents or wind. The crests and troughs formed by this agitation are occasionally preserved, providing information about the flow of water or wind in the paleoenvironment. See also: lithification, sedimentary rock
rock flour	very fine sediments and clay resulting from the grinding action of glaciers. See also clay, glacier.

Rodinia	a supercontinent that contained most or all of Earth's landmass, between 1.1 billion and 750 million years ago, during the Precambrian. Geologists are not sure of the exact size and shape of Rodinia. It was analagous to but not the same supercontinent as Pangaea, which formed was assembled several hundred million years later during the Permian. See also: Pangaea, Permian, Precambrian
salt	a mineral composed primarily of sodium chloride (NaCl). In its natural form, it is called rock salt or halite. Salt is essential for animal life, and is a necessary part of the diet. In addition, salt is used for de-icing roads in winter and is also an important part of the chemical industry. See also: mineral
sand	rock material in the form of loose, rounded, or angular grains, and formed as a result of the weathering and decomposition of rocks. Particles of sand are between 0.05-2 millimeters in diameter. See also: weathering
sandstone	sedimentary rock formed by cementing together grains of sand. See also: sand, sedimentary rocks
schist	a medium grade metamorphic rock with sheet-like crystals flattened in one plane. The flattened crystals are often muscovite or biotite mica, but they can also be talc, graphite, or hornblende. See also: graphite, hornblende, metamorphism, mica, talc

Glossary

scleractinian coral	a modern "stony" coral; a colonial or solitary marine invertebrate animal belonging to the Order Scleractinia in the Class Anthozoa of the Phylum Cnidaria, and characterized by an encrusting calcareous skeleton from which multiple individuals (*polyps*) extend from small pores to capture prey with small tentacles equipped with stinging cells (*nematocysts*). Although scleractinians look somewhat similar to extinct rugose and tabulate corals, each group possesses distinctive features in the shape of the skeletal cup holding the individual polyps. Modern scleractinians host commensal algae (*zooxanthellae*) whose photosynthetic activities supply the coral with energy.
scoria	a highly vesicular form of basalt. It tends to form as cinders in the early stages of a volcanic eruption, when gas bubbles are still caught up in the frothy erupting magma. Once the gas has escaped, the remaining magma can flow out, creating basalt lava flows that spread out over the landscape. See also: basalt, magma, vesicular, volcanic
scour, scouring	erosion resulting from glacial abrasion on the landscape. See also: erosion, glacier

sedimentary rocks	rocks formed through the accumulation and consolidation of grains of broken rock, crystals, skeletal fragments, and organic matter. Sediment that forms from weathering is transported by wind or water to a depositional environment such as a lakebed or ocean floor; here they build up, burying and compacting lower layers. As water permeates the sediment, dissolved minerals may precipitate out, filling the spaces between particles and cementing them together. Sedimentary rocks may also accrete from fragments of the shells or skeletal material of marine organisms like clams and coral. Sedimentary rocks are classified by their sediment size or their mineral content. Each one reveals the story of the depositional environment where its sediments accumulated and the history of its lithification. See also: erosion, lithification, mineral, weathering
seed fern	an extinct terrestrial plant belonging to the plant division Pteridospermatophyta, and characterized by a fern-like appearance, but bearing seeds instead of spores. Seed ferns lived from the Mississippian to the Jurassic. See also: Jurassic, Mississippian
seismic waves	the shock waves or vibrations radiating in all directions from the center of an earthquake or other tectonic event. See also: earthquake
seismic zone	a regional zone that encompasses areas prone to seismic hazards, such as earthquakes or landslides.

Glossary

seismometer	an instrument that measures seismic waves (movements) within the ground. These measurements help us map the interior of the Earth, as well as locate the areas where earthquakes and other seismic events begin. See also: seismic waves
shale	a dark, fine-grained, laminated sedimentary rock formed by the compression of successive layers of silt- and clay-rich sediment. Shale is weak and often breaks along thin layers. Shale that is especially rich in unoxidized carbon is dark grey or black. These organic-rich black shales are often source rocks for petroleum and natural gas. See also: clay, compression, natural gas, petroleum, sedimentary rock, silt
shark	a large fish characterized by a cartilaginous skeleton and five to seven gill slits on the side of the head. Sharks first appeared 420 million years ago, and have since diversified to over 470 species.
shield	See craton
silica	a chemical compound also known as silicon dioxide (SiO_2). Silica is most commonly found as quartz, and is also secreted as skeletal material in various organisms. It is one of the most abundant materials in the crust. See also: quartz
silt	granular sediment most commonly composed of quartz and feldspar crystals. Particles of silt have diameters of less than 0.074 millimeters. See also: feldspar, quartz

Silurian	a geologic time period spanning from 443 to 419 million years ago. During the Silurian, jawed and bony fish diversified, and life first began to appear on land. The Silurian is part of the Paleozoic. See also: geologic time scale, Paleozoic
silver	a metallic chemical element (Ag). Silver is used in photographic film emulsions, utensils and other tableware, and electronic equipment.
snail	see gastropod
soil	the collection of natural materials that collect on Earth's surface, above the bedrock. Soil consists of layers (horizons) of two key ingredients: plant litter, such as dead grasses, leaves, and fallen debris, and sediment derived from the weathering of rock. Both of these components can influence the texture and consistency of the soil, as well as the minerals available for consumption by plants. The word is derived from the Latin "*solum*," which means “floor” or “ground." See also: horizon (soil), mineral, weathering
soil orders	the twelve major units of soil taxonomy, which are defined by diagnostic horizons, composition, soil structures, and other characteristics. Soil orders depend mainly on climate and the organisms within the soil. These orders are further broken down into 64 suborders based on properties that influence soil development and plant growth, with the most important property being how wet the soil is throughout the year. See also soil, soil taxonomy
soil taxonomy	The system used to classify soils based on their properties. See also: soil

Glossary

solifluction	a type of mass wasting where waterlogged sediment moves slowly downslope, over impermeable material. Solifluction is similar to a landslide or mudslide. See also: mass wasting
sphenopsid	a terrestrial plant belonging to the Family Equisetaceae in the plant division Pteridophyta, and characterized by hollow, jointed stems with reduced, unbranched leaves at the nodes. Sphenopsids, or horsetails, reached over 33 feet (10 meters) high during the Pennsylvanian. See also: Pennsylvanian
Spodosols	a soil order; these are acidic soils in which aluminum and iron oxides accumulate below the surface. They typically form under pine vegetation and sandy parent material. See also: iron, sand, soil, soil orders
St. Peter Sandstone	a pure, quartz-rich sandstone that covers much of the Midwest and was deposited during the Ordovician. It is an enduring enigma to geologists because it is not clear how all the non-quartz minerals could have been removed. See also: Ordovician, quartz, sandstone
stratigraphy, stratigraphic	the branch of geology specifically concerned with the arrangement and age of rock units. See also: Law of Superposition
streak	a physical property of minerals, obtained by dragging the mineral across a porcelain plate and effectively powdering it. During identification, the color of the powder eliminates the conflating variables of external weathering, crystal form, or impurities. See also: crystal form, mineral, weathering

striations	long, parallel scratch marks that are the result of the grinding of sediments in glacial ice sliding across a rock surface. See also: glacier
stromatolite	regularly banded accumulations of sediment created by the trapping and cementation of sediment grains in bacterial mats (especially photosynthetic cyanobacteria). Cyanobacteria emit a sticky substance that binds settling clay grains and creates a chemical environment leading to the precipitation of calcium carbonate. The calcium carbonate then hardens the underlying layers of bacterial mats, while the living bacteria move upward so that they are not buried. Over time, this cycle of growth combined with sediment capture creates a rounded structure filled with banded layers. Stromatolites peaked in abundance around 1.25 billion years ago, and likely declined due to the evolution of grazing organisms. Today, stromatolites exist in only a few locations worldwide, such as Shark Bay, Australia. Modern stromatolites form thick layers only in stressful environments, such as very salty water, that exclude animal grazers. Even though there are still modern stromatolites, the term is often used to refer specifically to fossils. See also: fossil
stromatoporoid	a type of calcareous sponge that acted as an important reef-builder throughout the Paleozoic and the late Mesozoic. See also: Mesozoic, Paleozoic, reef
subduction	the process by which one plate moves under another, sinking into the mantle. This usually occurs at convergent plate boundaries. Denser plates are more likely to subduct under more buoyant plates, as when oceanic crust sinks beneath continental crust. See also: active plate boundary, convergent boundary, crust, mantle

Glossary

sulfur	a bright yellow chemical element (S) that is essential to life. It acts as an oxidizing or reducing agent, and occurs commonly in raw form as well as in minerals. See also: mineral
sustainable	able to be maintained at a steady level without exhausting natural resources or causing severe ecological damage, as in a behavior or practice.
suture	the area where two continental plates have joined together through continental collision. See also: convergent boundary, plate tectonics
system	a set of connected things or parts forming a complex whole - in particular, a set of things working together as parts of a mechanism or an interconnecting network.
talc	hydrated magnesium silicate, formed during hydrothermal alteration accompanying metamorphism. Talc can be formed from calcite, dolomite, silica, and some ultramafic rocks. See also: calcite, dolomite, mafic, metamorphism, silica
talus	debris fields found on the sides of steep slopes, common in periglacial environments. See also: periglacial
terrane	a piece of crustal material that has broken off from its parent continent and become attached to another plate. Due to their disparate origins, terranes have distinctly different geologic characteristics than the surrounding rocks. Florida is a good example of an exotic terrane, originating as part of the supercontinent Gondwana. Parts of the western coast of North America (including Alaska and the Northeastern US) are also terranes that have been sutured onto the coast. See also crust, plate tectonics, suture

Tertiary	an unoffical but still commonly used term for the time period spanning from 66 million to 2.5 million years ago, incluidng the Paleogene, Neogene, and part of the Pleistocene. Although the Tertiary period was officially phased out in 2008 by the International Commission on Stratigraphy, it can still be found in scientific literature. (In contrast, the Carboniferous and Pennsylvanian & Mississippian periods all enjoy official status, with the latter pair being more commonly used in the US.) See also: Carboniferous, Mississippian, Neogene, Paleogene, Pennsylvanian, Pleistocene, stratigraphy
till	unconsolidated sediment that is eroded from the bedrock, then carried and eventually depositied by glaciers as they recede. Till may include a mixture of clay, sand, gravel, and even boulders. The term originated with farmers living in glaciated areas who were constantly removing rocks from their fields while breaking the soil for planting, a process known as tilling. See also: clay, erosion, glacier, sand
topography	the landscape of an area, including the presence or absence of hills and the slopes between high and low areas. These changes in elevation over a particular area are generally the result of a combination of deposition, erosion, uplift and subsidence. These processes that can happen over an enormous range of timescales. See also: erosion, uplift
tornado	a vertical funnel-shaped storm with a visible horizontal rotation. The word tornado has its roots in the Spanish word *tonar*, which means "to turn."

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Glossary

trace fossils	fossils that record the actions of organisms, such as footprints, trails, trackways, and burrows. Trace fossils cannot always be associated at least with a group of organisms or way of life. The first trace fossils appear a couple hundred million years before the first animal (body) fossils. See also: fossil
transform boundary	an active plate boundary in which the crustal plates move sideways past one another. See also: active plate boundary
transgression	a relative rise in sea level in a particular area, through global sea level rise or subsidence of land.
tree	any woody perennial plant with a central trunk. Not all trees are closely related; different kinds of plants have evolved the tree form through geological time. The trees of the Paleozoic were more closely related to club mosses or ferns than they were to today's trees. See also: Paleozoic
Triassic	a geologic time period that spans from 252 to 201 million years ago. During this period, dinosaurs, pterosaurs, and the first mammals appear and begin to diversify. The Triassic begins directly after the Permian-Triassic mass extinction event, and is the first period of the Mesozoic. See also: geologic time scale, mass extinction, Mesozoic

trilobite	an extinct marine invertebrate animal belonging to the Class Trilobita of the Phylum Arthropoda, and characterized by a three-part body and a chitinous exoskeleton divided longitudinally into three lobes. Trilobites have been extinct since the end of the Paleozoic. Trilobites were primitive arthropods distantly related to horseshoe crabs. As bottom dwellers, they were present in a variety of environments. Like crabs and lobsters, trilobites molted their exoskeletons when they grew. Most fossils of trilobites are actually molts, broken as they were shed off the trilobite. Thus, it is common to find only parts of trilobites, such as the head, mid-section, or tail. See also: extinction, Paleozoic
tropical depression	an organized, rotating system of clouds and thunderstorms. A tropical storm has wind speeds of less than 63 kph (39 mph). It has no eye, and lacks the shape and organization of a more powerful hurricane. See also: hurricane
tuff	a pyroclastic rock made of consolidated volcanic ash. Tuff is the result of pyroclastic flows, in which the violent expansion of hot gas shreds the erupting magma into tiny particles that cool in the air to form dense clouds of volcanic ash. The tremendous explosions that are necessary to create ash-flow tuffs are caused by rhyolitic magma, which is felsic. High silica content makes the magma quite viscous, preventing gas bubbles from easily escaping, thus leading to pressure build-ups that are released by explosive eruptions. The ash flows from these violent explosions tend to hug the ground, eventually solidifying into tuffs. Tuffs and other pyroclastic materials are vesicular (porous) due to gases expanding within the material as it cools. See also: felsic, magma, pyroclastic, rhyolitic, silica, vesicular

Glossary

turbidity current	a submarine sediment avalanche. These fast-moving currents of sediment are often caused by earthquakes or other geological disturbances that loosen sediment on a continental shelf. These massive sediment flows have extreme erosive potential, and often carve out underwater canyons. Turbidity currents deposit huge amounts of sediment during flow; such deposits are called turbidites. Because of the rate at which turbidity currents deposit dense sediments, they are often responsible for the effective preservation of many fossil organisms, which are swept up from shallow marine environments and buried in the deep sea. See also: fossil
uplift	upward movement of the crust due to compression, subduction, or mountain building. Uplift can also occur as a rebounding effect after the removal of an ice sheet reduces the amount of weight pressing on the crust. See also: compression, crust, ice sheet, subduction
Utica Formation	an organic-rich black shale from the Middle Ordovician. It is found throughout New York, Pennsylvania, Ohio, West Virginia, and other portions of eastern North America. The Utica Formation is an extremely rich source rock for oil and natural gas. See also: natural gas, petroleum, shale
vesicular	porous or pitted with vesicles (cavities). Some extrusive igneous rocks have a vesicular texture. See also: extrusive, igneous rock

volcanic islands	a string of islands created when molten rock rises upwards through oceanic crust. Volcanic islands are common in several contexts, including at subduction zones between colliding oceanic plates, above oceanic hot spots, and along mid-ocean ridges. At subduction zones, the friction between the plates generates enough heat and pressure to melt some of the crust. In the case of hot spots, islands form as magma from the mantle breaks through the sea floor. See also: crust, hot spot, magma, mantle, plate tectonics, subduction, volcanism
volcanic, volcanism	the eruption of molten rock onto the surface of the crust. Most volcanic eruptions occur along tectonic plate boundaries, but may also occur at hot spots. Rocks that form from molten rock on the surface are also called volcanic. Prior to eruption, magma ascends from the mantle to a relatively shallow (1-10 km / 0.5-6 mi) magma chamber. Upward movement reduces the pressure on the magma until it is low enough to permit dissolved gas to exsolve (come out of solution and form bubbles). All eruptions are driven by the exsolution of dissolved gas. As the gas forms bubbles, it expands in volume and forces the magma out of the vent/chamber system onto the surface. The combination of magma viscosity and gas content can produce a range of eruptive styles, from gentle, effusive eruptions to violent explosions. see also: hot spot, magma, mantle, plate tectonics
water table	the upper surface of groundwater, that is, the underground level at which groundwater is accessible.

Glossary

watt	a unit of power measuring the rate of energy conversion or transfer designated by the International System of Units as one joule per second. See also: energy, joule, power
weather	the measure of short-term conditions of the atmosphere such as temperature, wind speed, and humidity. These conditions vary with the time of day, the season, and yearly or multi-year cycles.
weathering	the breakdown of rocks by physical or chemical means. Rocks are constantly being worn down and broken apart into finer and finer grains by wind, rivers, wave action, freezing and thawing, and chemical breakdown. Over millions of years, weathering and erosion can reduce a mighty mountain range to low rolling hills. Some rocks wear down relatively quickly, while others can withstand the power of erosion for much longer. Softer, weaker rocks such as shale and poorly cemented sandstone and limestone are much more easily worn away than hard, crystalline igneous and metamorphic rocks, or well-cemented sandstone and limestone. Harder rocks are often left standing alone as ridges because surrounding softer, less resistant rocks were more quickly worn away. See also: erosion, igneous rock, metamorphic rock, sedimentary rock
wind	the movement of air from areas of high pressure to areas of low pressure. The greater the temperature difference, the greater the air pressure difference and, consequently, the greater the speed at which the air will move.

wind shear	when wind speed and/or direction changes with increasing height in the atmosphere. Wind shear can happen when a cold front moves rapidly into an area with very warm air. There, the condensing water droplets mix with the cooler, drier air in the upper atmosphere to cause a downdraft. See also: wind
Wisconsinian glaciation	the most recent interval of glaciation, which occurred during the Pleistocene, 85,000 to 11,000 years ago. See also: glacier, Pleistocene
zinc	a metallic chemical element (Zn, atomic number 30). Zinc is typically used in metal alloys and galvanized steel.

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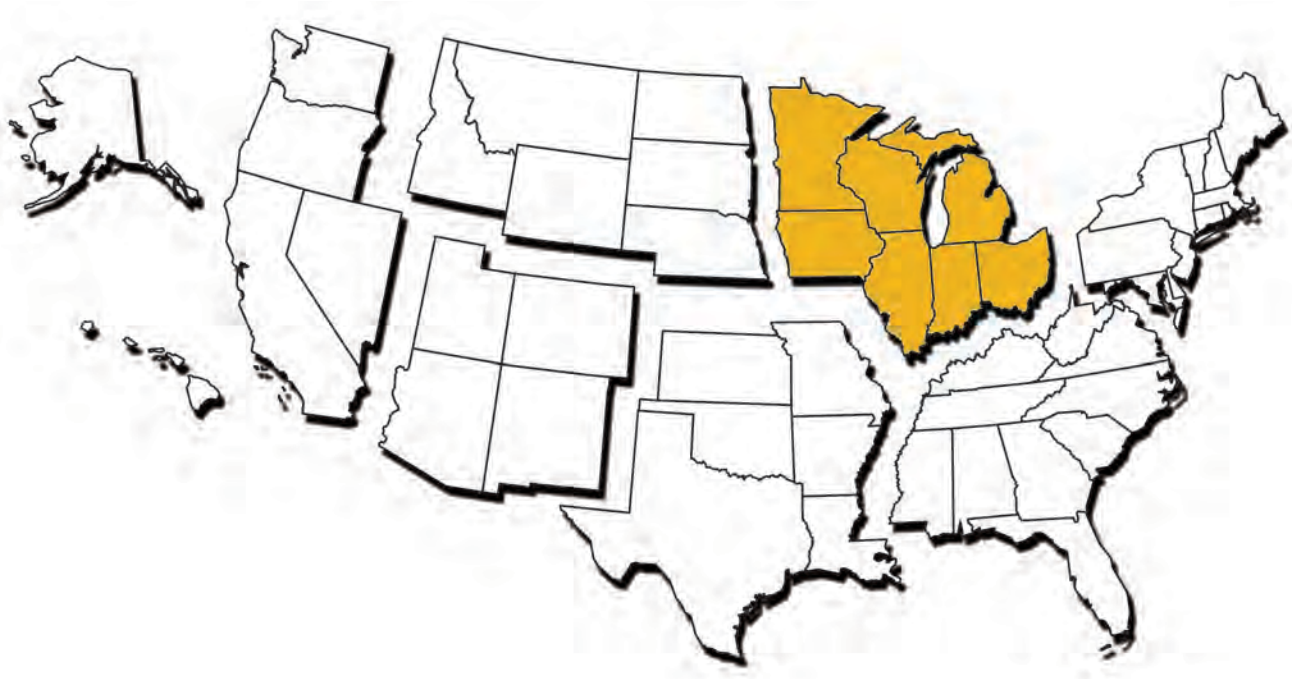

Edited by Mark D. Lucas, Robert M. Ross, & Andrielle N. Swaby

Paleontological Research Institution
2014

ISBN 978-0-87710-507-7
Library of Congress no. 2014953666
PRI Special Publication no. 46

1259 Trumansburg Road
Ithaca, New York 14850 USA
priweb.org

First printing October 2014

This material is based upon work supported by the National Science Foundation under grant DRL-0733303. Any opinions, findings, and conclusions or recommendations are those of the author(s) and do not necessarily reflect the views of the National Science Foundation. The publication also draws from work funded by the Arthur Vining Davis Foundations and The Atlantic Philanthropies.

The interactive online version of this *Teacher-Friendly Guide*™ (including downloadable pdfs) can be found at http://teacherfriendlyguide.org. Web version by Brian Gollands.

The Teacher-Friendly Guide™ series was originally conceived by Robert M. Ross and Warren D. Allmon. Original illustrations in this volume are mostly by Jim Houghton (The Graphic Touch, Ithaca), Wade Greenberg-Brand, and Christi A. Sobel.

Layout and design by Paula M. Mikkelsen, Elizabeth Stricker, Wade Greenberg-Brand, and Katherine Peck.

Cite this book as:
Lucas, M. D., R. M. Ross, & A. N. Swaby (eds.), 2014, *The Teacher-Friendly Guide to the Earth Science of the Midwestern US.* Paleontological Research Institution, Ithaca, New York, 316 pp.

Cite one chapter as (example):
Wall, A. F., and W. D. Allmon, 2014, Fossils of the Midwestern US. Pages 57–83, in: M. D. Lucas, R. M. Ross, & A. N. Swaby (eds.). *The Teacher-Friendly Guide to the Earth Science of the Midwestern US.* Paleontological Research Institution, Ithaca, New York.

On the back cover: Blended geologic and digital elevation map of the Midwest. Each color represents the age of the bedrock at the surface. Adapted from Barton, K.E., Howell, D.G., Vigil, J.F., *The North America Tapestry of Time and Terrain*, US Geological Survey Geologic Investigations Series I-2781, http://pubs.usgs.gov/imap/i2781.