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Glossary

	Note: Words in bold font are also defined in this glossary.
<i>Acadian Orogeny</i>	a Devonian mountain-building event involving the collision of the eastern coast of North America and the accreted terrane of Avalon . The event caused metamorphism , folding, and faulting in an area from New York to Newfoundland; sediments eroded from the mountains accumulated in thick strata, the Catskill Delta, in the Appalachian Basin of New York and Pennsylvania. See also: orogeny
<i>accretion, accrete</i>	the process by which a body of rock increases in size due to the addition of further sedimentary particles or of large chunks of land, such as terranes .
<i>active plate boundary, active plate margin</i>	the boundary between two plates of the Earth's crust that are colliding, pulling apart, or moving past each other. See also: plate tectonics
<i>aeolian</i>	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.
<i>aerosol</i>	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.
<i>agate</i>	a crystalline silicate rock with a colorful banded pattern. It is a variety of chalcedony (quartz) . Agates usually occur as nodules in volcanic rock.
<i>aggregate</i>	crushed stone or naturally occurring unlithified sand and gravel, used for construction, agriculture, and industry. Aggregate properties depends on the properties of the component rock. Rock quarried for crushed stone includes, for example, granite and limestone .
<i>Alfisols</i>	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 .
<i>Alleghanian Orogeny</i>	a Carboniferous to Permian mountain-building event involving the collision of the eastern coast of North America and northwestern coast of Africa (then part of Gondwana). The event caused a combination of metamorphism , folding, and faulting in an area from Alabama to Newfoundland. The orogeny resulted in the Appalachian and Allegheny mountains, which are heavily eroded remnants of the original mountains formed by the event.
<i>alluvium, alluvial</i>	a layer of river-deposited sediment.
<i>aluminum</i>	a metallic chemical element (Al), and the most abundant metal in the Earth's crust. Aluminium has a low density and an excellent ability to resist corrosion. Structural components made from the metal and its alloys are commonly used in the aerospace industry, transportation, and household goods.
<i>amber</i>	a yellow or yellowish-brown hard translucent fossil resin that sometimes preserves small soft-bodied organisms inside.

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<i>ammonoid, ammonite</i>	a group of extinct cephalopods belonging to the Phylum Mollusca, and possessing a spiraling, tightly-coiled shell characterized by ridges, or septa.
<i>amphibole</i>	a group of dark-colored silicate minerals , or either igneous or metamorphic origin.
<i>Andisols</i>	a soil order ; these are highly productive soils often formed from volcanic materials. They possess very high water- and nutrient-holding capabilities, and are commonly found in cool areas with moderate to high levels of precipitation.
<i>anorthosite</i>	a plutonic igneous rock made mostly of plagioclase feldspar . Most anorthosite rocks were formed in the Proterozoic eon (Precambrian).
<i>anthracite</i>	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.
<i>anthropogenic</i>	caused or created by human activity.
<i>anticline</i>	a layer of rock folded (bent) along an axis, concave side down (i.e., in an upside down "U" or "V" shape). Thus rocks at the center of the anticline, along the fold (crest), are lifted up relative to the rest of the layer.
<i>Appalachian Basin</i>	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 .
<i>aquifer</i>	a water-bearing formation of gravel , permeable rock , or sand that is capable of providing water, in usable quantities, to springs or wells.
<i>archaeocete</i>	a member of a group of primitive whales that lived during the Eocene and Oligocene epochs. The earliest members of the group are from the Indo-Pakistan region and were only partially aquatic.
<i>archaeocyathid</i>	a vase-shaped organism with a carbonate skeleton, generally believed to be a sponge . Archaeocyathids were the first important animal reef builders, originating in the early Cambrian . They were very diverse, but went extinct by the end of the Cambrian. Archeocyathids are often easiest to recognize in limestones , by their distinctive cross-sections.
<i>Archean</i>	a geologic time interval that extends from 4 billion to 2.5 billion years ago. It is part of the Precambrian .
<i>Aridisols</i>	a soil order ; these are formed in very dry (arid) climates . The lack of moisture restricts weathering and leaching, resulting in both the accumulation of salts and limited subsurface development. They are commonly found in deserts.
<i>artesian</i>	a channel that releases pressure from an aquifer, allowing the aquifer's internal pressure to push the water up to the surface without the aid of a pump.
<i>arthropod</i>	<p>an invertebrate animal, belonging to the Phylum Arthropoda, and possessing an external skeleton (exoskeleton), body segments, and jointed appendages.</p> <p>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.</p>

<i>asbestos</i>	a fibrous silicate mineral that is resistant to heat, flames, and chemical action. As a very slow conductor of heat, asbestos was once commonly used as a fireproofing material and electrical insulation. Concerns over its health effects on the lungs have led to its removal from most common uses.
<i>asphalt</i>	a black, sticky, semi-solid, and viscous form of petroleum .
<i>asthenosphere</i>	a thin, semifluid layer of the Earth, below the outer rigid lithosphere , forming much of the upper 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.
<i>atmosphere</i>	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.
<i>Avalon</i>	an early Paleozoic microcontinent offshore of what is now the eastern coast of North America. Avalon collided with and became the eastern edge of North America during the Acadian Orogeny .
<i>badlands</i>	a type of eroded topography that forms in semi-arid areas experiencing occasional periods of heavy rainfall. Sloping ground composed of sandstones and calcareous sediments underlain by clay or other soft materials is eroded over time into an intricate series of gullies and ravines. Different layers of rock weather at different rates, resulting in a variety of sculpted spurs and buttresses, as well as tall pillars of softer rock with a hard capstone .
<i>Baltica</i>	a late- Proterozoic , early- Paleozoic continent that included ancient Europe (northern Europe without Ireland and Scotland). Baltica began moving toward 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.
<i>banded iron formation</i>	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 .
<i>barite</i>	a usually white, clear, or yellow mineral found in limestone , clay-rich rocks, and sandstones . Barite (BaSO_4) occurs as flattened blades or in a circular pattern of crystals that looks like a flower and, when colored red by iron stains, is called a "desert rose." Before federal laws were passed in 1906 to prevent the practice, finely ground barite was often added to flour and other foods to increase the weight.
<i>barrier island</i>	a long, thin island next to and parallel to a coastline.

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basalt	<p>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.</p> <p>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, it becomes basaltic magma.</p>
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 .
bauxite	a whitish, grayish, brown, yellow, or reddish-brown rock composed of hydrous aluminum oxides and aluminum hydroxides; the principal commercial source of aluminum.
bentonite	a clay , formed from decomposed volcanic ash, with a high content of the mineral montmorillonite.
beryl	a white, blue, yellow, green, or pink mineral , found in coarse granites and igneous rocks . It is a source of beryllium and used as a gemstone ; the green variety is called emerald, the blue is known as aquamarine.
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.
biofuel	carbon-based fuel produced from renewable sources of biomass such as 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 .
bioherm	a pile of lithified calcareous skeletal material formed on the sea floor from some variety of marine organisms, often including calcareous marine algae and marine invertebrates such as corals. Reefs are a form of bioherm in which organisms built the three-dimensional structure, while banks are bioherms in which skeletal material accumulated through transport.
biomass	organic material from one or more organisms.
biostratigraphy	the branch of geology that uses fossils to determine the relative age of sedimentary layers.
biota	the organisms living in a given region, including plants, animals, fungi, protists , and bacteria.
bioturbation	the displacement of sediment and soil by animals or plants.
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.

<i>bituminous coal</i>	a relatively soft coal containing a tar-like substance called bitumen , which is usually formed as a result of high pressure on lignite .
<i>bivalve</i>	<p>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.</p> <p>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.</p> <p>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.</p>
<i>blastoid</i>	an extinct form of stemmed echinoderm , similar to a crinoid . Blastoids possessed a nut-shaped body covered with interlocking plates, which was covered with fine hairlike structures for use in filter feeding . The body was held above the sea floor by a stalk of stacked disc-shaped plates.
<i>body fossils</i>	fossils that consist of an actual part of an organism, such as a bone, shell, or leaf.
<i>bolide</i>	an extraterrestrial object of any composition that forms a large crater upon impact with the Earth. In astronomy, bolides are bright meteors (also known as fireballs) that explode as they pass through the Earth's atmosphere .
<i>boreal</i>	a cold temperate region relating to or characteristic of the sub-Arctic climatic zone , often dominated by conifers , birch, and poplar.
<i>brachiopod</i>	<p>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.</p> <p>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 toward the mouth. This body plan is very different from that of bivalves, which have a larger, fleshy body and collect particles with their gills.</p> <p>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.</p>
<i>breccia</i>	a pyroclastic rock composed of volcanic fragments from an explosive eruption.
<i>brine</i>	See hydrothermal solution
<i>British Thermal Unit (BTU or Btu)</i>	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.

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<i>bryozoan</i>	<p>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).</p> <p>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.</p>
<i>calcite</i>	a carbonate mineral , consisting of calcium carbonate (CaCO ₃). Calcite is a common constituent of sedimentary rocks , particularly limestone .
<i>calcium carbonate</i>	a chemical compound with the formula CaCO ₃ , commonly found in rocks in the mineral forms calcite and aragonite, as well as the shells and skeletons of marine organisms.
<i>caldera</i>	a collapsed, cauldron-like volcanic crater formed by the collapse of land following a volcanic eruption.
<i>calving</i>	the process by which ice breaks off from the end of a glacier (sometimes into a lake or ocean, sometimes over the edge of a cliff).
<i>calyx</i>	the head of a crinoid.
<i>Cambrian</i>	<p>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.</p> <p>The Cambrian is part of the Paleozoic era.</p>
<i>Canadian Shield</i>	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.
<i>capstone, caprock</i>	a harder, more resistant rock type that overlies a softer, less resistant rock. The harder rock typically helps to control the rate of erosion .
<i>carbonate rocks</i>	<p>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.</p> <p>Carbonate rocks include limestone, dolostone, and dolomite.</p>

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<i>Carboniferous</i>	<p>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.</p> <p>The name Carboniferous means "coal-bearing," and it is during this time that many of today's coal beds were formed.</p> <p>The Carboniferous is part of the Paleozoic.</p>
<i>cataclastic</i>	<p>pertaining to rocks made up of cemented fragments that originated from the mechanical breakdown of rock associated with plate tectonics. Cataclastic rocks form in regions that have undergone intense metamorphism and are associated with features such as folds and faults. They typically contain bent, broken, and granular minerals.</p>
<i>cementation</i>	<p>the precipitation of minerals, such as silica and calcite, that bind together particles of rock, bones, etc., to form a solid mass of sedimentary rock.</p>
<i>Cenozoic</i>	<p>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.</p> <p>The Cenozoic includes the Paleogene, Neogene, and Quaternary periods.</p>
<i>cephalopod</i>	<p>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.</p> <p>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, such as the octopus. The group includes belemnites, ammonoids, nautilus, squid, and octopuses.</p> <p>A mass extinction between the Cretaceous and Paleogene eliminated many varieties of cephalopods.</p>
<i>chalcedony</i>	<p>a crystalline silicate mineral that is a microcrystalline variety of quartz.</p>
<i>chalcopyrite</i>	<p>a yellow mineral consisting of a copper-iron sulfide (CuFeS_2). Chalcopyrite is the most common and important source of copper, and can also be called copper pyrite.</p>
<i>chalk</i>	<p>a soft, fine-grained, easily pulverized, white-to-grayish variety of limestone, composed of the shells of minute planktonic single-celled algae.</p>
<i>chemical fossils</i>	<p>chemicals produced by an organism that leave behind an identifiable trace in the geologic record. Chemical fossils provide some of the oldest evidence for life on Earth.</p>
<i>chemical reaction</i>	<p>a process that involves changes in the structure and energy content of atoms, molecules, or ions but not their nuclei.</p>

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<i>chert</i>	<p>a sedimentary rock composed of microcrystalline 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 strong and have no planes of weakness.</p> <p>For thousands of years, humans exploited these qualities, breaking chert nodules into blades and other tools.</p>
<i>chordate</i>	<p>an animal that possesses the following five traits during at least one stage of its development: a notochord (the flexible rod that, in vertebrates, becomes the backbone), a hollow dorsal nerve cord, pharyngeal gill slits, an endostyle (precursor to the thyroid gland), and a post-anal tail.</p>
<i>Cincinnati Arch</i>	<p>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.</p>
<i>cinder</i>	<p>a type of pyroclastic particle in the form of gas-rich lava droplets that cool as they fall.</p>
<i>clay</i>	<p>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.</p>
<i>cleavage</i>	<p>a physical property of minerals. Cleavage occurs when a mineral breaks in a characteristic way along a specific plane of weakness.</p> <p>Mica and graphite have very strong cleavage, allowing them to easily break into thin sheets.</p>
<i>climate</i>	<p>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.</p> <p>The climate of a region represents the average weather over a long period of time.</p>
<i>climate change</i>	<p>See global warming</p>
<i>coal</i>	<p>a combustible, compact black or dark-brown carbonaceous rock formed by the compaction of layers of partially decomposed vegetation.</p> <p>The greatest abundance of coal by far is located in strata of Carboniferous age.</p>
<i>coalification</i>	<p>the process by which coal is formed from plant materials through compression and heating over long periods of time.</p>
<i>coccolithophore</i>	<p>a marine phytoplankton with a skeleton made up of microscopic calcareous disks or rings, and forming much of the content of chalk rocks.</p>
<i>cold front</i>	<p>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.</p>

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<i>color (mineral)</i>	a physical property of minerals . Color is determined by the presence and intensity of certain elements within the mineral.
<i>color (soil)</i>	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.
<i>columnar joint</i>	five- or six-sided columns that form as cooling lava contracts and cracks. Columnar joints are often found in basalt flows, but can also form in ashflow tuffs as well as shallow intrusions . The columns are generally vertical, but may also be slightly curved.
<i>commodity</i>	a good for which there is demand, but which is treated as equivalent across all markets, no matter who produces it.
<i>compression, compressional force</i>	forces acting on an object from all or most directions, resulting in compression (flattening or squeezing). Compressional forces occur by pushing objects together.
<i>concretion</i>	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.
<i>conglomerate</i>	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 conglomerate must be larger than grains of sand .
<i>conifer</i>	a woody plant (tree) of the division Coniferophyta. Conifers bear cones that contain their seeds.
<i>Conservation of Energy</i>	a principle stating that energy is neither created nor destroyed, but can be altered from one form to another.
<i>contact metamorphism</i>	the process by which a metamorphic rock is formed through direct contact with magma . Changes that occur due to contact metamorphism are greatest at the point of contact. The farther away the rock is from the point of contact, the less pronounced the change.
<i>convection</i>	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.
<i>convergent boundary</i>	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: plate tectonics
<i>copper</i>	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.
<i>coquina</i>	a porous, sometimes crumbly limestone , composed of fragments of shells and coral, and used as a building material.

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<i>cordaite</i>	<p>a member of a group called the Cordaitales, which were closely related to early members of the conifers. The best known taxon is the eponymous Pennsylvanian genus <i>Cordaites</i>. The group was prominent in swampy habitats during the Carboniferous, but went extinct by the end of the Triassic.</p>
<i>corundum</i>	<p>an aluminum oxide mineral (Al_2O_3) that is, after diamond, the hardest known natural substance. Corundum is best known for its gem varieties, ruby (red), and sapphire (blue).</p>
<i>craton</i>	<p>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.</p> <p>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.</p>
<i>creep</i>	<p>the slow movement or deformation of a material under the influence of pressure or stress (such as gravity); the slow progression of rock and soil down a slope due to the interacting factors of gravity, vegetation, water absorption, and steepness.</p>
<i>Cretaceous</i>	<p>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.</p> <p>"Cretaceous" is derived from the Latin word <i>creta</i> meaning "chalk." The white (chalk) cliffs of Dover on the southeastern coast of England are a famous example of Cretaceous chalk deposits.</p>
<i>crinoid</i>	<p>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.</p> <p>Crinoids have five-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.</p> <p>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.</p>
<i>cross-bedding</i>	<p>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.</p>

<i>crust</i>	<p>the uppermost, rigid outer layer of the Earth. Two types of crust make up the lithosphere, which is broken into tectonic plates. Oceanic crust is denser but significantly thinner than continental crust, while continental crust is much thicker but less dense (and therefore buoyant).</p> <p>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.</p>
<i>Cryogenian</i>	a geologic time 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 .
<i>crystal form</i>	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.
<i>cyanobacteria</i>	a group of bacteria, also called "blue-green algae," that obtain their energy through photosynthesis.
<i>cycad</i>	a palm-like, terrestrial seed plant (tree) belonging to the Class Cycadopsida, and characterized by a woody trunk, a crown of stiff evergreen leaves, seeds without protective coatings, and no flowers. Cycads were very common in the Mesozoic , but are much reduced in diversity today, restricted to the tropical and subtropical regions of the planet.
<i>cyclothem</i>	alternating sequences of marine and non-marine sedimentary rocks , usually including coal , and characterized by their light and dark colors.
<i>cystoid</i>	extinct , stalked echinoderms related to crinoids , but with an ovoid body and triangular pore openings.
<i>debris flow</i>	a dangerous mixture of water, mud, rocks, trees , and other debris that can move quickly down valleys. Such flows can result from sudden rainstorms or snowmelt that create flash floods. Areas that have experienced a recent wildfire are particularly vulnerable to debris flows, since there is no vegetation to hold the soil .
<i>degrade (energy)</i>	the transformation of energy into a form in which it is less available for doing work, such as heat .
<i>delta, deltaic</i>	a typically wedge-shaped deposit formed as sediment is eroded from mountains and transported by streams across lower elevations. The Mississippi Delta is a modern delta containing sediment being transferred from the Mississippi River into the Gulf of Mexico.
<i>dendritic drainage</i>	a drainage pattern where many smaller streams join and contribute to ever larger streams. The pattern looks somewhat like a tree , in which smaller branches connect to progressively larger branches.
<i>density</i>	a physical property of minerals , describing the mineral's mass per volume.

Glossary

d–e

derecho	<p>a set of powerful straight-line winds that exceed 94 kilometers per hour (58 miles per hour) and can often approach 160 kilometers per hour (100 miles per hour). 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.</p> <p><i>Derecho</i> is the Spanish word for "straight ahead."</p>
derrick	<p>a lifting device in the form of a framework steel tower that is built over a deep drill hole, typically an oil well. An oil derrick is composed of machinery for hoisting and lowering tools required during the drilling process, and readying the well for extraction of petroleum.</p>
Devonian	<p>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.</p> <p>The Devonian is part of the Paleozoic.</p>
diabase	<p>a dark-gray to black, medium-grained, intrusive igneous rock consisting mainly of labradorite and pyroxene. The crystal size of diabase is medium, between that of a basalt (finely crystalline) and a gabbro (coarsely crystalline).</p>
diamond	<p>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.</p>
dike	<p>a sheet of intrusive igneous or sedimentary rock that fills a crack cutting across a pre-existing rock body.</p>
dimension stone	<p>the commercial term applied to quarried blocks of rock cut to specific dimensions and used for buildings, monuments, facing, and curbing.</p>
dinosaur	<p>a member of 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.</p>
divergent plate boundary	<p>an active plate boundary where two tectonic plates are pulling apart from one another, causing the mantle to well up at a rift. Mid-ocean ridges are the most common divergent boundary and are characterized by the eruption of bulbous pillow-shaped basalt lavas and hydrothermal fluids.</p>
dolomite	<p>a carbonate mineral, consisting of calcium magnesium carbonate ($\text{CaMg}(\text{CO}_3)_2$). Dolomite is an important reservoir rock for petroleum, and also commonly hosts large ore deposits.</p>
dolostone	<p>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.</p>
double refraction	<p>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.</p>
downwarp	<p>a segment of the Earth's crust that is broadly bent downward.</p>

<i>dynamic metamorphism</i>	See regional metamorphism
<i>earthquake</i>	a sudden release of energy in the Earth's crust that creates seismic waves . Earthquakes are common at active plate boundaries .
<i>echinoderm</i>	a member of the Phylum Echinodermata, which includes starfish, sea urchins, and crinoids . Echinoderms have radial symmetry (which is usually five-fold), and a remarkable ability to regenerate lost body parts.
<i>edestid</i>	a member of a group of primitive sharks from the Carboniferous period known for their “tooth-whorls,” unusual serrated teeth that grew in curved brackets and were used like the teeth in pinking shears.
<i>effervesce</i>	to foam or fizz while releasing gas. Carbonate minerals will effervesce when exposed to hydrochloric acid.
<i>efficiency</i>	the use of a relatively small amount of energy for a given task, purpose, or service; achieving a specific output with less energy input.
<i>embayment</i>	a bay, such as where the sea overflows a depression of land near the mouth of a river, or where there is a recess in a coastline.
<i>energy</i>	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.
<i>energy carrier</i>	a source of energy , such as electricity, that has been subject to human-induced energy transfers or transformations.
<i>Entisols</i>	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.
<i>Eocene</i>	a geologic time period extending from 56 to 33 million years ago. The Eocene is an epoch of the Paleogene period.
<i>erosion</i>	<p>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.</p> <p>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.</p>

Glossary

e–f

<i>erratic, glacial erratic</i>	<p>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.</p> <p>Erratics are often distinctive because they are a different type of rock than the bedrock in the area to which they have 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.</p>
<i>estuary</i>	a place where freshwater and saltwater mix, created when sea level rises to flood a river valley.
<i>eukaryotes</i>	organisms with complex cells containing a nucleus and organelles. Protists and all multicellular organisms are eukaryotes.
<i>evaporite</i>	a sedimentary rock created by the precipitation of minerals directly from seawater, including gypsum, calcite, dolomite, and halite .
<i>exfoliation</i>	a type of physical weathering . When overlying layers are weathered away, the reduction of downward pressure allows the underlying rock to expand toward the surface. This expansion causes joints , or cracks, to form parallel to the surface, producing slabs that resemble the curved layers of an onion.
<i>exhumation</i>	the erosional uncovering or exposing of a geological feature that had been previously covered by deposited sediments.
<i>exsolve</i>	to come out of solution and, in the case of a gas, form bubbles.
<i>extinction</i>	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 .
<i>extrusion, extrusive rock</i>	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 .
<i>fault</i>	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.
<i>feldspar</i>	<p>an extremely common group of rock-forming minerals found in igneous, metamorphic, and sedimentary rocks.</p> <p>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.</p> <p>Feldspars are commercially used in ceramics and scouring powders.</p>
<i>felsic</i>	igneous rocks with high silica content and low iron and magnesium content. They are light in color and are typically found in continental crust .

Glossary

<i>filter feeder</i>	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.
<i>flint</i>	a hard, high-quality form of chert that occurs mainly as nodules and masses in sedimentary rock . Due to its strength 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.
<i>floodplain</i>	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.
<i>fluorite, fluorspar</i>	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.
<i>fluvial</i>	See outwash plain
<i>flux (mineral extraction)</i>	a mineral added to the metals in a furnace to promote fusing or to prevent the formation of oxides .
<i>foliation</i>	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 sheet-like pattern.
<i>foraminifera</i>	a class of aquatic protists that possess a calcareous or siliceous exoskeleton. Foraminifera have an extensive fossil record.
<i>foreland bulge</i>	an area of uplift on the far side of an inland basin . Mountain building associated with plate convergence generally results in downwarping , that is, a basin associated with the load of mountains. Away from the area of maximum subsidence , the basin gradually shallows, followed by an area of uplift (the foreland bulge).
<i>fossil</i>	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 <i>fossilis</i> , meaning "dug up."

Glossary

f–g

<i>fossil fuels</i>	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 , natural gas (methane), and peat . 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.
<i>fracture (mineral)</i>	a physical property of minerals , formed when a mineral crystal breaks; also a crack in rocks, sometimes known as a joint . This process is separate from cleavage , which occurs when a mineral breaks in a characteristic way along a specific plane of weakness.
<i>frost wedging</i>	physical weathering that occurs when water freezes and expands in cracks.
<i>fuel</i>	a material substance possessing internal potential energy that can be transferred to the surroundings for specific uses—including are petroleum , coal , and natural gas (the fossil fuels), and other materials, such as uranium, hydrogen, and biofuels .
<i>gabbro</i>	a coarse-grained, mafic , and intrusive igneous rock . Most oceanic crust contains gabbro.
<i>galena</i>	an abundant sulfide mineral with cubic crystals. It is the most important ore of lead , as well as an important source of silver .
<i>gastropod</i>	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.
<i>Gelisols</i>	a soil order ; these are weakly weathered soils formed in areas that contain permafrost within the soil profile.
<i>gem, gemstone</i>	a mineral that has aesthetic value and is often cut and polished for use as an ornament.
<i>geologic time scale</i>	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 intervals: the Precambrian , Paleozoic , Mesozoic , and Cenozoic .
<i>ginkgo</i>	a terrestrial tree belonging to the plant division Ginkgophyta, and characterized by broad fan-shaped leaves, large seeds without protective coatings, and no flowers. Ginkgos were very common and diverse in the Mesozoic , but today only one species exists, <i>Ginkgo biloba</i> .
<i>glacier</i>	<p>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.</p> <p>As glaciers slowly flow, they abrade and erode the landscape around them to create grooves, scratches, moraines, and other distinguishing features. Glaciers form only on land, and are much thicker than ice that forms on the surface of water.</p> <p>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.</p>

<i>glassy rock</i>	a volcanic rock that cooled almost instantaneously, resulting in a rock with tiny crystals or no crystals at all. Obsidian , basalt glass, and pumice are examples of glassy rocks.
<i>global warming</i>	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.
<i>gneiss</i>	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 banded texture.
<i>gold</i>	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.
<i>Gondwana, Gondwanaland</i>	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 .
<i>gossan</i>	the near-surface, oxidized portion of a sulfide-rich ore body.
<i>granite</i>	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.
<i>graphite</i>	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.
<i>graptolite</i>	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.
<i>gravel</i>	unconsolidated, semi-rounded rock fragments larger than 2 millimeters (0.08 inches) and smaller than 75 millimeters (3 inches).
<i>greenhouse gas</i>	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.
<i>Grenville Orogeny</i>	a mountain-building event that took place over the interval of approximately 1.3 to 1 billion years ago, along the southeastern and eastern edges of North America from Mexico to Canada. The Grenville Orogeny played a role in the formation of the supercontinent Rodinia . See also: orogeny
<i>gypsum</i>	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.

Glossary

h

<i>halite</i>	See salt
<i>hardness</i>	<p>a physical property of minerals, specifying how hard the mineral is, and its resistance to scratching. Hardness helps us understand why some rocks are more or less resistant to weathering and erosion.</p> <p>See also: Moh's Scale of Hardness</p>
<i>heat</i>	<p>a form of energy transferred 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.</p>
<i>heat island effect</i>	<p>a phenomenon in which cities experience higher temperatures than do surrounding rural communities.</p>
<i>heat wave</i>	<p>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.</p> <p>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.</p>
<i>hectare</i>	<p>a metric unit of area defined as 10,000 square meters.</p>
<i>hematite</i>	<p>a mineral form of iron oxide (Fe₂O₃). The name hematite has its origins in the Greek word <i>haimatos</i>, meaning "blood." It is very common in Precambrian banded iron formations.</p> <p>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.</p>
<i>Histosols</i>	<p>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.</p>
<i>Holocene</i>	<p>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.</p> <p>The Holocene also encompasses the global growth and impact of the human species.</p>
<i>horizon (soil)</i>	<p>a layer in the soil, usually parallel to the surface, which has physical characteristics (usually color and texture) that are different from the layers above and below it. Each type of soil usually contains three or four horizons.</p>
<i>hornblende</i>	<p>a dark silicate mineral that can occur in a variety of forms. Hornblende is a common constituent of many igneous and metamorphic rocks.</p>
<i>horsetail</i>	see sphenopsid

<i>hot spot</i>	<p>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 hot material rising through the mantle. Magma from the hot spot pushes its way up through the crust, creating an igneous intrusion and sometimes a volcano.</p> <p>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.</p>
<i>humus</i>	the organic component of soil; a major part of the soil horizon containing organic matter.
<i>Huronian glaciation</i>	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.
<i>hurricane</i>	<p>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 kilometers per hour (74 miles per hour), such a storm is classified as a hurricane.</p> <p>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.</p>
<i>hydrothermal solution</i>	<p>hot, mineral-rich water moving through rocks. These solutions are often 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.</p> <p>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.</p>
<i>Iapetus Ocean</i>	<p>the proto-Atlantic Ocean, located against the eastern coast of North America's ancestral landmass before Pangaea formed.</p> <p>In Greek mythology, Iapetus was the father of Atlantis.</p>
<i>ice age</i>	a period of global cooling of the Earth's surface and atmosphere , resulting in the presence or expansion of ice sheets and alpine 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.
<i>ice cap</i>	an ice field that lies over the tops of mountains.
<i>ice field</i>	an extensive area of interconnected glaciers spanning less than 50,000 square kilometers (19,305 square miles). Ice fields are usually constrained by an area's topography . Ice fields that lie over the tops of mountains are called ice caps .

Glossary

<i>ice lobe</i>	a broad, rounded section of a continental glacier that flows out near the glacier's terminus, often through a broad trough.
<i>ice sheet</i>	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).
<i>iceberg</i>	a large chunk of ice, generally ranging in height from 1 to 75 meters (3 to 246 feet) above sea level, that has broken off of an ice sheet or glacier and floats freely in open water.
<i>igneous rocks</i>	<p>rocks derived from the cooling of magma underground or molten lava on the Earth's surface.</p> <p>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.</p> <p>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.</p>
<i>Illinois Basin</i>	<p>an inland basin centered in the state of Illinois, which formed when Baltica approached North America in the Ordovician.</p> <p>More than four billion barrels of petroleum have been extracted from the Illinois Basin.</p>
<i>ilmenite</i>	an ore of titanium , produced for use as a white pigment in paint.
<i>Inceptisols</i>	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.
<i>index fossil</i>	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.
<i>inland basin</i>	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.
<i>inland sea</i>	<p>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.</p> <p>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.</p>
<i>intensity (earthquake)</i>	a subjective measurement that classifies the amount of shaking and damage done by an earthquake in a particular area.
<i>interglacial</i>	a period of geologic time between two successive glacial stages.

<i>intertidal</i>	areas that are above water during low tide and below water during high tide.
<i>intrusion, intrusive rock</i>	a plutonic igneous rock formed when magma from within the Earth's crust escapes into 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.
<i>iron</i>	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.
<i>isotope</i>	a form of an element that contains a specific number of neutrons. For example, the isotope of carbon with six neutrons is known as carbon-12 (¹² C) and the isotope of carbon with eight neutrons is carbon-14 (¹⁴ C).
<i>jade</i>	a word applied to two green minerals that look similar and have similar properties: jadeite (a kind of pyroxene) and nephrite (a kind of amphibole). Both minerals are formed during metamorphism and are found primarily near subduction zones , which explains why jade is abundant in a variety of locations along active plate boundaries .
<i>jasper</i>	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.
<i>joint</i>	a surface or plane of fracture within a rock.
<i>joule (J)</i>	the energy expended (or work done) to apply a force of one newton over a distance of one meter.
<i>Jurassic</i>	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 .
<i>kaolinite</i>	a silicate clay mineral , also known as "china clay." Kaolinite is the main ingredient in fine china dishes such as Wedgwood.
<i>karst topography</i>	a kind of landscape defined by bedrock that has been weathered by dissolution in water, forming features like sinkholes, caves, and cliffs. Karst topography primarily forms in limestone bedrock.
<i>kinetic energy</i>	the energy of a body in motion (e.g., via friction).

Glossary

k–l

<i>Köppen system</i>	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.
<i>lacustrine</i>	of or associated with lakes.
<i>Lagerstätte (pl. Lagerstätten)</i>	fossil deposit containing animals or plants that are preserved unusually well, sometimes even including the soft organic tissues. Lagerstätten 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. Lagerstätten are important for the information they provide about soft-bodied organisms that we otherwise would know nothing about.
<i>landslide</i>	the rapid slipping of a mass of earth or rock from a higher elevation to a lower level under the influence of gravity and water lubrication. Landslides include rock falls, avalanches, debris flows , mudflows, and the slumping of rock layers or sediment. See also: mass wasting
<i>last glacial maximum</i>	the most recent time the ice sheets reached their largest size and extended farthest toward 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.
<i>lava</i>	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.
<i>Law of Superposition</i>	the geologic 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: stratigraphy
<i>lead</i>	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.
<i>levee</i>	a deposit of sediment built up along and sloping away from the sides of a river's floodplain ; also, an artificial embankment along a waterway to prevent flooding, especially from a river.
<i>lignite</i>	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 .
<i>lime</i>	an inorganic white or grayish white compound made by roasting limestone (calcium carbonate, CaCO₃) until all the carbon dioxide (CO ₂) is driven off. Originating from limestone, dolomite , or marble , lime is very important to agriculture, in which it is regularly applied to make soils "sweeter" (less acidic).

<i>limestone</i>	<p>a sedimentary rock composed of calcium carbonate (CaCO₃). Most limestones are formed by the deposition and consolidation of the skeletons of marine invertebrates; a few originate in chemical precipitation from solution.</p> <p>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.</p>
<i>liquefaction</i>	a process by which water-saturated unconsolidated sediment temporarily loses strength and behaves as a fluid when vibrated.
<i>lithification</i>	the process of creating sedimentary rock through the compaction or cementation of soft sediment. The word comes from the Greek <i>lithos</i> , meaning "rock."
<i>lithium</i>	a metallic chemical element (Li) used in the manufacture of ceramics, glass, greases, and batteries.
<i>lithosphere</i>	<p>the outermost layer of the Earth, comprising a rigid crust and upper mantle broken up into many plates.</p> <p>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.</p>
<i>loam</i>	a soil containing equal amounts of clay , silt , and sand .
<i>lode</i>	an ore deposit that fills a fissure or crack in a rock formation; alternately, an ore vein that is embedded between layers of rock.
<i>loess</i>	very fine-grained, wind-blown sediment, usually rock flour left behind by the grinding action of flowing glaciers .
<i>luminescence</i>	the emission of light.
<i>luster</i>	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.
<i>lycopod</i>	<p>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.</p> <p>The plant division Lycopodiophyta survives today but only as very small plants on the forest floor, sometimes called "ground pines."</p>
<i>mafic</i>	igneous rocks that contain a group of dark-colored minerals , with relatively high concentrations of magnesium and iron compared to felsic igneous rocks.
<i>magma</i>	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 .

Glossary

m

<i>magnetic</i>	affected by or capable of producing a magnetic field.
<i>magnetite</i>	<p>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.</p> <p>Magnetite lodestones were used as an early form of compass. Huge deposits of magnetite have been found in Precambrian banded iron formations.</p>
<i>magnitude (earthquake)</i>	a logarithmic scale used to measure the seismic energy released by an earthquake . Magnitudes follow a numerical scale, with M1 earthquakes classified as micro, M2 earthquakes classed as minor, and earthquakes of M8 or greater being classified as great.
<i>mammoth</i>	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.
<i>mantle</i>	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 .
<i>marble</i>	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 or dolostone .
<i>marl</i>	a fine-grained sedimentary rock consisting of clay minerals , calcite and/or aragonite, and silt .
<i>mass extinction</i>	<p>the extinction of a large percentage of the Earth's species over a relatively short span of geologic time.</p> <p>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.</p>
<i>mass wasting</i>	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).
<i>mastodon</i>	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.
<i>matrix</i>	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.

<i>Mesozoic</i>	<p>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.</p> <p>The Mesozoic contains the Triassic, Jurassic, and Cretaceous periods.</p>
<i>metamorphism, metamorphic rocks</i>	<p>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.</p> <p>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.</p>
<i>meteorite</i>	a stony or metallic mass of matter that has fallen to the Earth's surface from outer space.
<i>mica</i>	a large group of sheet-like silicate minerals .
<i>Michigan Basin</i>	<p>an inland basin centered on Michigan's Lower Peninsula, which formed when Baltica approached North America in the Ordovician.</p> <p>The rocks of the Michigan Basin are a commercial source of petroleum.</p>
<i>microcontinent</i>	a piece of continental crust , usually rifted away from a larger continent. Microcontinents and other smaller fragments of continental crust (terranes) each had their own, often complex, geologic history before they were tacked onto the margin of another continent.
<i>Milankovitch Cycles</i>	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.
<i>mineral</i>	<p>a naturally occurring, inorganic solid with a specific chemical composition and a well-developed crystalline structure. Minerals are identified based on their physical properties, including hardness, luster, color, crystal form, cleavage, density, and streak.</p> <p>There are over 4900 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, feldspars, micas, pyroxenes, and amphiboles.</p>
<i>mineralogy</i>	the branch of geology that includes study of the chemical and physical properties and formation of minerals .
<i>Miocene</i>	a geologic time unit extending from 23 to 5 million years ago. During the Miocene, the Earth experienced a series of ice ages , and hominid species diversified. The Miocene is the first epoch of the Neogene period.

<p><i>Mississippi Embayment</i></p>	<p>a topographically low-lying basin in the south-central United States, stretching from Illinois to Louisiana. The Mississippi Embayment originated as far back as the Precambrian, during the breakup of Rodinia. During this time, many smaller rifts in the crust formed adjacent to the major rift that split away North America—one of these smaller rifts is located beneath the modern day Mississippi Embayment.</p> <p>During the breakup of Pangaea, the area subsided, forming a trough that was flooded during the Cretaceous. When sea level fell, the Mississippi River was born. Thousands of meters of Cretaceous to Recent sediment were deposited in the river valley. Recurrent activity along faults associated with the deeply buried ancient rifts beneath the embayment caused the 1811–1812 New Madrid Earthquakes, one of the largest earthquakes ever recorded in North America.</p>
<p><i>Mississippian</i></p>	<p>a subperiod of the Carboniferous, spanning from 359 to 323 million years ago.</p>
<p><i>Mohs Scale of Hardness</i></p>	<p>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.</p>
<p><i>Mollisols</i></p>	<p>a soil order; these are agricultural soils made highly productive due to a very fertile, organic-rich surface layer.</p>
<p><i>monadnock</i></p>	<p>an isolated hill or small mountain on a plain, formed from rock more resistant to erosion than that of the rest of the surrounding landscape. These features are named after Mount Monadnock (New Hampshire), which is made of schist and quartzite.</p>
<p><i>moraine</i></p>	<p>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 between and at the sides of glaciers or ice lobes.</p>
<p><i>mosasaur</i></p>	<p>an extinct, carnivorous, marine vertebrate reptile. 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 powerful swimmers, reaching 12–18 meters (40–59 feet) in length.</p>
<p><i>mysticete</i></p>	<p>a member of the group of whales (cetaceans), such as finback and humpback whales, which have baleen for feeding upon some combination of plankton, krill, and small fish. The earliest mysticetes occur in the late Eocene.</p>
<p><i>natural gas</i></p>	<p>a hydrocarbon gas mixture composed primarily of methane (CH₄), but also small quantities of hydrocarbons such as ethane and propane.</p> <p>See also: fossil fuel</p>
<p><i>natural hazards</i></p>	<p>events that result from natural processes and that have significant impacts on human beings.</p>

Neogene	<p>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.</p> <p>The Neogene is a portion of the Cenozoic.</p>
Newark Supergroup	<p>a sequence of nonmarine sedimentary rocks that accumulated in rift basins along what is now eastern North America (North Carolina to Newfoundland) in the late Triassic to early Jurassic periods. The rifts formed as Pangaea split apart. In some places the strata contain well-preserved fish fossils or dinosaur tracks.</p>
nodule	<p>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.</p>
nuclear	<p>pertaining to a reaction, as in fission, fusion, or radioactive decay, that alters the energy, composition, or structure of an atomic nucleus.</p>
obsidian	<p>a glassy volcanic rock, formed when felsic lava cools rapidly. Although obsidian is dark in color, it is composed mainly of silicon dioxide (SiO₂), and its dark color is a result of impurities such as iron and magnesium.</p> <p>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.</p>
odontocete	<p>a member of the group of whales (cetaceans) such as sperm whales and killer whales, which have baleen for feeding upon some combination of fish, squid, and mammals. The earliest odontocetes occur in the Oligocene.</p>
oil	<p>See petroleum</p>
Oligocene	<p>a geologic time interval spanning from about 34 to 23 million years ago. It is an epoch of the Paleogene.</p>
olivine	<p>an iron-magnesium silicate mineral ((Mg,Fe)₂SiO₄) that is a common constituent of magnesium-rich, silica-poor igneous rocks.</p>
oolite (adj. oolitic)	<p>a sedimentary rock, especially limestone, consisting of tiny (< 2 millimeters [0.787 inches]), spherical grains made of concentric layers of calcium carbonate (ooids), sometimes preserved within a limy mud matrix. Ooids typically grow when calcium carbonate precipitates as the ooids roll around in <i>intertidal</i> supersaturated seawater.</p>
ophiolite	<p>a section of the Earth's oceanic crust and the underlying upper mantle that has been uplifted and exposed above sea level and often thrust onto continental crustal rocks. Ophiolites are often formed during subduction—as oceanic crust is subducted, some of the deep-sea sediments overlying the crust, the oceanic crust itself, and sometimes rock from the upper mantle, can be scraped off the descending plate and accreted to the continental crust.</p>
Ordovician	<p>a geologic time period spanning from 485 to 443 million years ago. During the Ordovician, invertebrates dominated the oceans and fish began to diversify.</p> <p>The Ordovician is part of the Paleozoic.</p>

Glossary

o–p

ore	a type of rock that contains minerals with valuable elements, including metals, that are economically viable to extract.
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 <i>oro</i> , meaning "mountain."
outwash plain	large sandy flats created by sediment-laden water deposited when a glacier melts. Outwash sediments are also called "fluvial material."
oxbow	a stream meander in the shape of a "U," named after the U-shaped collar of an ox yoke. An oxbow may curve sufficiently to bend back and connect with itself; in this case the stream will straighten and the curved bow may become isolated as an "oxbow lake."
oxidation, oxide	a chemical reaction involving the loss of at least one electron when two substances interact; most often used to describe the interaction between oxygen molecules and the substances they come into contact with. Oxidation causes effects such as rust and cut apples turning brown.
Oxisols	a soil order ; these are very old, extremely leached and weathered soils with a subsurface accumulation of iron and aluminum oxides . Commonly found in humid, tropical environments.
Paleocene	a geologic time interval spanning from about 66 to 56 million years ago. It is an epoch of the Paleogene period.
paleoecology	the study of the relationships of fossil organisms to one another and their environment.
Paleogene	the geologic time interval 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 .
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.
Pangaea	a supercontinent, meaning "all Earth," which formed over 300 million years ago and lasted for almost 150 million years, during which 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 transported sediment such as till or loess .
passive margin	a tectonically quiet continental edge, such as the eastern margin of North America, where crustal collision or rifting is not occurring.

p

Glossary

<i>peat</i>	<p>an accumulation of partially decayed plant matter. Under proper heat and pressure, it will turn into lignite coal over geologic periods of time.</p> <p>As much as 9 meters (30 feet) 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.</p>
<i>peds</i>	<p>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.</p>
<i>pegmatite</i>	<p>a very coarse-grained igneous rock that formed below the surface, usually rich in quartz, feldspars, and micas. Pegmatite magmas are very rich in water, carbon dioxide, silicon, aluminum, and potassium, and form as the last fluids to crystallize from magma or the first minerals to melt at high temperatures during metamorphism.</p>
<i>Pennsylvanian</i>	<p>a subperiod of the Carboniferous, spanning from 323 to 299 million years ago.</p>
<i>perennial</i>	<p>continuous; year-round or occurring on a yearly basis.</p>
<i>peridotite</i>	<p>a coarse-grained plutonic rock containing minerals, such as olivine, which make up the Earth's mantle.</p>
<i>periglacial zone</i>	<p>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.</p> <p>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.</p>
<i>permafrost</i>	<p>a layer of soil below the surface that remains frozen all year round. Its thickness can range from tens of centimeters (inches) to a few meters (yards). Permafrost is typically defined as any soil that has remained at a temperature below the freezing point of water for at least two years.</p>
<i>permeable, permeability</i>	<p>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.</p> <p>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.</p>
<i>Permian</i>	<p>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.</p> <p>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 terrestrial animal species and 90% of all marine animal species.</p>
<i>permineralization</i>	<p>a fossilization method in which empty spaces (such as in a bone or shell) are filled by minerals.</p>

Glossary

p

<i>petroleum</i>	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.
<i>phosphate</i>	an inorganic salt of phosphoric acid, and a nutrient vital to biological life.
<i>phyllite</i>	a metamorphic rock that is intermediate in grade between slate and schist .
<i>physiography</i>	a subfield of geography that studies the Earth's physical processes and patterns, including consideration of the shape (not just the height) of land forms, as well as the bedrock, soil, water, vegetation, and climate of an area, and how they interacted in the past to form the landscape we see today.
<i>pillow basalt</i>	basaltic lava that forms in a characteristic "pillow" shape due to its extrusion underwater.
<i>placer deposit</i>	a mineral deposit occurring in rivers and streams where less dense sediment has been carried downstream but denser minerals such as gold have been left behind.
<i>placoderms</i>	an extinct class of heavily armored fishes. Placoderms lived from the Silurian to the Devonian .
<i>plate tectonics</i>	the process 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.
<i>plates</i>	large, rigid pieces of the Earth's crust and upper mantle , which move and interact with one another at their boundaries. See also: plate tectonics
<i>Pleistocene</i>	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.
<i>plesiosaur</i>	a member of a group of extinct , long-necked, Mesozoic marine reptiles.
<i>Pliocene</i>	a geologic time interval extending from roughly 5 to 2.5 million years ago. The Pliocene epoch is a subdivision of the Neogene period, and is the time period directly preceding the onset of Pleistocene glaciations .
<i>pluton, plutonic rock</i>	a 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.
<i>porosity</i>	the percentage of openings in a body of rock such as pores, joints , channels, and other cavities, in which gases or liquids may be trapped or migrate through.

p

Glossary

<i>potash</i>	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 ₂ CO ₃).
<i>power (energy)</i>	the rate at which energy is transferred, usually measured in watts or, less frequently, horsepower.
<i>Precambrian</i>	a geologic time interval 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.
<i>primary energy source</i>	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.
<i>progradation</i>	outward building of strata toward the sea in the form of a beach, fan, or delta , caused by continuous deposition of sediment by rivers, or by the progressive accumulation of material thrown up by waves or other shoreline processes.
<i>Proterozoic</i>	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.
<i>protists</i>	a diverse group of single-celled eukaryotes .
<i>protolith</i>	the original parent rock from which a metamorphosed rock is formed.
<i>pterosaurs</i>	extinct flying reptiles with wingspans of up to 15 meters (49 feet). They lived during the same time as the dinosaurs .
<i>pumice</i>	a pyroclastic rock that forms as frothing and sputtering magmatic foam cools and solidifies. It is so vesicular that it can float. Pumice is a common product of explosive eruptions. Today it is used in a variety of mediums, including construction materials and abrasives.
<i>pyrite</i>	an iron sulfide mineral (FeS ₂). Pyrite's superficial resemblance to gold has led to the common nickname "fool's gold."
<i>pyroclastic rocks</i>	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 .
<i>pyroxene</i>	dark-colored, rock-forming silicate minerals containing iron and magnesium, found in many igneous and metamorphic rocks . They are often present in volcanic rocks.

Glossary

q–r

<i>quartz</i>	<p>the second most abundant mineral in the Earth's continental crust (after the feldspars), made up of silicon and oxygen (SiO_2). It makes up more than 10% of the crust by mass.</p> <p>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.</p> <p>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.</p> <p>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).</p>
<i>quartzite</i>	<p>a hard metamorphic rock that was originally sandstone. Quartzite usually forms from sandstone that was metamorphosed through tectonic compression within orogenic belts.</p> <p>Quartzite is quarried for use as a building and decorative stone.</p>
<i>Quaternary</i>	<p>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.</p> <p>The Quaternary is part of the Cenozoic.</p>
<i>radioactivity</i>	<p>The emission of radiation (energy) by an unstable atom.</p>
<i>radiocarbon dating</i>	<p>a method of determining the age of a biological object by measuring the ratio of carbon isotopes ^{14}C and ^{12}C. Because the decay rate of ^{14}C is 5000 years, it is useful for numerical dating as far back as 50,000 years. Beyond this point, nearly all of the ^{14}C has decayed.</p>
<i>radon</i>	<p>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.</p>
<i>rare earth elements</i>	<p>a set of 17 heavy, lustrous elements with similar properties, some of which have technological applications. Although they are relatively common in the crust, these metals are not usually found concentrated in economically viable ore deposits.</p>
<i>recrystallization</i>	<p>the change in structure of mineral crystals that make up rocks, or the formation of new mineral crystals within the rock.</p> <p>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.</p>
<i>recurrence interval</i>	<p>the time elapsed between major events, such as floods.</p>

<i>reef</i>	<p>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.</p> <p>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.</p>
<i>regional metamorphism</i>	<p>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.</p>
<i>relief (topography)</i>	<p>the change in elevation over a distance.</p>
<i>renewable energy, renewable resource</i>	<p>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.</p>
<i>replacement</i>	<p>a fossilization method by which the original material is chemically replaced by a more stable mineral.</p>
<i>residual weathering deposit</i>	<p>a mineral deposit formed through the concentration of a weathering-resistant mineral, in which the other minerals around it have been eroded away.</p>
<i>rhyolite, rhyolitic</i>	<p>a felsic volcanic rock high in abundance of quartz and feldspar.</p>
<i>rift</i>	<p>a break or crack in the crust that can be caused by tensional stress as a landmass breaks apart into separate plates.</p>
<i>rift basin</i>	<p>a topographic depression caused by subsidence within a rift; the basin, since it is at a relatively low elevation, usually contains freshwater bodies such as rivers and lakes.</p>
<i>ripple marks</i>	<p>surface features created when sediment deposits are agitated, typically by water currents or wind. The crests and troughs formed by this agitation are occasionally lithified and preserved, providing information about the flow of water or wind in the paleoenvironment.</p>
<i>rock flour</i>	<p>very fine sediments and clay resulting from the grinding action of glaciers.</p>
<i>Rodinia</i>	<p>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 analogous to but not the same supercontinent as Pangaea, which formed was assembled several hundred million years later during the Permian.</p>
<i>rugose coral</i>	<p>an extinct group of corals that were prevalent from the Ordovician through the Permian. Solitary forms were most common; these were horn-shaped, leading to their common name, "horn corals."</p>
<i>rutile</i>	<p>a typically reddish brown mineral formed of TiO_2. It is an ore of titanium.</p>
<i>salt</i>	<p>a mineral composed primarily of sodium chloride (NaCl). In its natural form, it is called "rock salt" or "halite."</p> <p>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.</p>

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<i>salt dome</i>	a largely subsurface geologic structure, consisting of a vertical cylinder of salt embedded in horizontal or inclined sedimentary strata. Salt buried under thousands of feet of overlying sediment often deforms plastically. Because it is less dense than the rocks above it, it flows upward toward areas of lower pressure, forming geological structures named for their shapes (e.g., domes, canopies, tables, and lenses).
<i>salt lick</i>	a naturally occurring salt deposit that animals regularly lick, providing the sodium, calcium, iron , phosphorus, and zinc required for bone, muscle, and other growth.
<i>sand</i>	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 and 2 millimeters (0.00016 and 0.0065 inches) in diameter.
<i>sandstone</i>	sedimentary rock formed by cementing together grains of sand .
<i>schist</i>	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 .
<i>scleractinian coral</i>	<p>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.</p> <p>Modern scleractinians host commensal algae (zooxanthellae) whose photosynthetic activities supply the coral with energy.</p>
<i>scoria</i>	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.
<i>scour, scouring</i>	erosion resulting from glacial abrasion on the landscape.
<i>sedimentary rocks</i>	<p>rocks formed through the accumulation and consolidation of grains of broken rock, crystals, skeletal fragments, and organic matter.</p> <p>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 such as clams and coral.</p> <p>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.</p>
<i>seismic waves</i>	the shock waves or vibrations radiating in all directions from the center of an earthquake or other tectonic event.

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<i>seismic zone</i>	a regional zone that encompasses areas prone to seismic hazards, such as earthquakes or landslides .
<i>serpentinite</i>	a metamorphic rock formed when peridotite from a subducting plate reacts with water, producing a light, slippery, green rock.
<i>sessile</i>	unable to move, as in an organism that is permanently attached to its substrate.
<i>shale</i>	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 .
<i>shark</i>	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.
<i>shearing, shear</i>	the process by which compressive stress causes the fracturing and faulting of brittle rocks.
<i>silica, silicon, silicate</i>	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 .
<i>siliciclastic</i>	pertaining to rocks that are mostly or entirely made of silicon-bearing clastic grains such as quartz , feldspar , and clays that were weathered from silicate rocks.
<i>silt</i>	granular sediment most commonly composed of quartz and feldspar crystals. Particles of silt have diameters of less than 0.074 millimeters.
<i>Silurian</i>	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 .
<i>silver</i>	a metallic chemical element (Ag). Silver is used in photographic film emulsions, utensils and other tableware, and electronic equipment.
<i>sirenian</i>	a sea cow, including dugongs and manatees. These aquatic herbivorous mammals live in various nearshore and freshwater habitats. Sirenians appeared during the Eocene epoch.
<i>slate</i>	a fine-grained, foliated metamorphic rock derived from a shale composed of volcanic ash or clay .
<i>slump</i>	a slow-moving landslide in which loosely consolidated rock or soil layers move a short distance down a slope. See also: mass wasting
<i>snail</i>	See gastropod

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soapstone	a metamorphic schistose rock composed mostly of talca . Soapstone has a flaky texture and a greasy or soapy feel, and is an effective medium for carving.
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. Each 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 <i>solum</i> , which means "floor" or "ground."
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.
soil taxonomy	the system used to classify soils based on their properties.
solution mining	the extraction of soluble minerals from subsurface strata by the injection of fluids, and the controlled removal of mineral-laden solutions.
sphalerite	zinc sulfide (ZnS), the chief ore mineral of zinc.
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 .
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.
spodumene	a translucent pyroxene mineral (lithium aluminum inosilicate) occurring in prismatic crystals, and a primary source of lithium . Some varieties of spodumene are also prized as gems .
sponge	a marine invertebrate belonging to the Phylum Porifera, and characterized by a soft shape with many pores and channels for water flow. Because they have no nervous, digestive, or circulatory systems, some consider them to be colonies of specialized single cells. Sponges come in a variety of shapes and body forms, and have been around at least since the Cambrian . Entire sponges are rarely preserved, but their tiny skeletal pieces (spicules) are common in sedimentary rocks . See also: archaeocyathid
stratigraphy, stratigraphic	the branch of geology specifically concerned with the arrangement and age of rock units. See also: Law of Superposition

<i>stratovolcano</i>	a conical volcano made up of many lava flows as well as layers of volcanic ash and breccia from explosive eruptions. Stratovolcanoes are often characterized by their periodic violent eruptions, which occur due to their presence at subduction zones. While young stratovolcanoes tend to have steep cone shapes, the symmetrical conical shape is readily disfigured by massive eruptions. Many older stratovolcanoes contain collapsed craters called calderas .
<i>streak</i>	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 confounding variables of external weathering , crystal form , or impurities.
<i>stromatoporoid</i>	a type of calcareous sponge that acted as an important reef-builder throughout the Paleozoic and the late Mesozoic .
<i>subduction</i>	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.
<i>subsidence</i>	the sinking of an area of the land surface.
<i>subsoil</i>	the layer of soil beneath the topsoil , composed of sand , silt , and/or clay . Subsoil lacks the organic matter and humus content of topsoil.
<i>sulfur, sulfate</i>	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 .
<i>sustainable</i>	able to be maintained at a steady level without exhausting natural resources or causing severe ecological damage, as in a behavior or practice.
<i>suture</i>	the area where two continental plates have joined together through continental collision. See also: convergent boundary , plate tectonics
<i>system</i>	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.
<i>tabulate coral</i>	an extinct form of colonial coral that often formed honeycomb-shaped colonies of hexagonal cells.
<i>Taconic Orogeny</i>	a late Ordovician mountain-building event involving the collision and accretion of a volcanic island arc along the eastern coast of North America, from New England to eastern Canada. Sediments eroded from the resulting mountains accumulated in thick strata, the Queenston Delta, in the Appalachian Basin from New York to Quebec. See also: orogeny
<i>talc</i>	hydrated magnesium silicate, formed during hydrothermal alteration accompanying metamorphism . Talc can be formed from calcite , dolomite , silica , and some ultramafic rocks.
<i>tektite</i>	gravel-sized glass formed when melted rock from the Earth's surface is ejected during meteorite impacts. Tektites differ chemically and texturally from volcanic glass.

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<i>tephra</i>	fragmented material produced by a volcanic eruption. Airborne tephra fragments are called pyroclastic .
<i>terrace</i>	a flat or gently sloped embankment or ridge occurring on a hillside, and often along the margin of (or slightly above) a body of water, representing a previous water level.
<i>terrane</i>	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.
<i>Tertiary</i>	an unofficial but still commonly used term for the time period spanning from 66 million to 2.5 million years ago, including 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.)
<i>thorium</i>	a radioactive rare earth element, with potential applications in next-generation nuclear reactors that could be safer and more environmentally friendly than current uranium reactors.
<i>till</i>	unconsolidated sediment that is eroded from the bedrock, then carried and eventually deposited 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.
<i>titanium</i>	a metallic chemical element (Ti). Titanium is important because of its lightweight nature, strength, and resistance to corrosion.
<i>topographic inversion</i>	a landscape with features that have reversed their elevation relative to other features, most often occurring when low areas become filled with lava or sediment that hardens into material more resistant to erosion than the material that surrounds it.
<i>topography</i>	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.
<i>topsoil</i>	the surface or upper layer of soil , as distinct from the subsoil, and usually containing organic matter.
<i>tornado</i>	a vertical funnel-shaped storm with a visible horizontal rotation. The word tornado has its roots in the Spanish word <i>tonar</i> , which means "to turn."
<i>trace fossils</i>	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.

<i>trackway</i>	a set of impressions in soft sediment, usually a set of footprints, left by an animal. Trackways preserved as fossils are known as trace fossils .
<i>transform boundary</i>	an active plate boundary in which the lithospheric plates move sideways past one another.
<i>transgression</i>	a relative rise in sea level in a particular area, through global sea level rise or subsidence of land.
<i>tree</i>	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.
<i>trellis drainage</i>	a drainage pattern in which roughly parallel main streams are intersected by tributaries that are at nearly right angles. The name refers to the similarity of the pattern to a garden trellis, or the vines that grow along it.
<i>Triassic</i>	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 .
<i>trilobite</i>	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.
<i>tropical depression</i>	an organized, rotating system of clouds and thunderstorms. A tropical storm has wind speeds of less than 63 kilometers per hour (39 miles per hour). It has no eye, and lacks the shape and organization of a more powerful hurricane .
<i>tsunami</i>	a series of ocean waves that are generated by sudden displacement of water, usually caused by an earthquake , landslide , or volcanic explosions (but also from other sources such as meteor impacts, nuclear explosions, and glacier calving). Unlike a wind-generated sea wave, a tsunami wave has an extremely long wavelength. A very large wind wave could have a wavelength of 200 meters (650 feet), while a typical tsunami has a wavelength of 200 kilometers (120 miles). Tsunamis can travel at 800 kilometers per hour (500 miles per hour) in the open ocean. While at sea, a tsunami has a long wavelength, but a small wave height—ships in the open ocean may never notice the passing of a tsunami wave. As the wave approaches shore, however, the wavelength decreases and the wave height (amplitude) increases.

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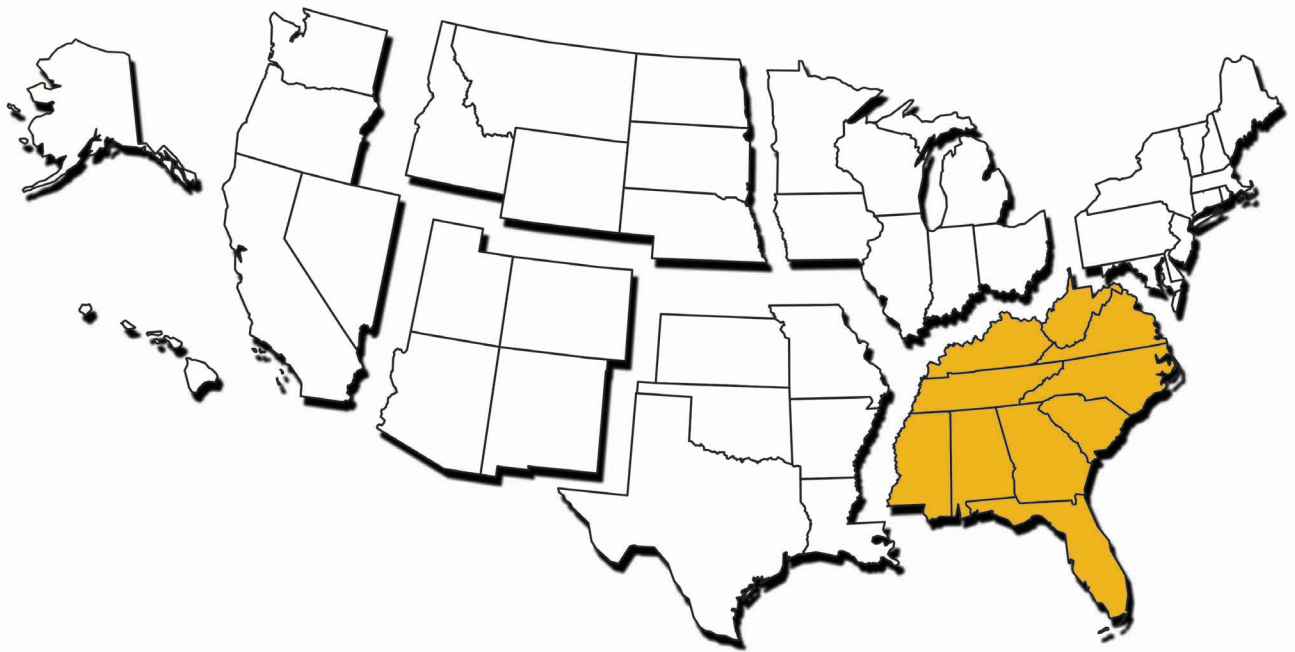
t–v

<i>tuff</i>	<p>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.</p> <p>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 buildups 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.</p>
<i>turbidity current</i>	<p>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.</p> <p>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.</p>
<i>Ultisols</i>	<p>a soil order; these are soils with subsurface clay accumulations that possess low native fertility and are often red hued (due to the presence of iron oxides). They are found in humid tropical and subtropical climates.</p>
<i>ultramafic rocks</i>	<p>igneous rocks with very low silica content (< 45%), which are composed of usually greater than 90% mafic minerals. The Earth's mantle is composed of ultramafic rocks, which are dark green to black in color due to their high magnesium and iron content.</p>
<i>unconformity</i>	<p>the relation between adjacent rock strata for which the time of deposition was separated by a period of nondeposition or erosion; a break in a stratigraphic sequence.</p>
<i>uplift</i>	<p>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.</p>
<i>Vertisols</i>	<p>a soil order; these are clayey soils with a high moisture capacity. During dry periods, these soils shrink and develop wide cracks; during wet periods, they swell with moisture.</p>
<i>vesicular</i>	<p>porous or pitted with vesicles (cavities). Some extrusive igneous rocks have a vesicular texture.</p>
<i>volcanic ash</i>	<p>fine, unconsolidated pyroclastic grains under 2 millimeters (0.08 inches) in diameter. Consolidated ash becomes tuff.</p>
<i>volcanic islands</i>	<p>a string of islands created when molten rock rises upward 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.</p> <p>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.</p>

<i>volcanic, volcanism</i>	<p>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.</p> <p>Prior to eruption, magma ascends from the mantle to a relatively shallow (1–10 kilometers / 0.5–6 miles) 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.</p>
<i>water table</i>	the upper surface of groundwater, that is, the underground level at which groundwater is accessible.
<i>watershed</i>	an area of land from which all water under or on it drains to the same location.
<i>waterspout</i>	a spinning, funnel-shaped cloud over a body of water. "Tornadic" waterspouts are simply tornados that originated on land during severe thunderstorms and moved over water. "Fair weather" waterspouts develop near the surface of the water and grow upward; they form in low wind conditions and may move little, but do become tornados if they move to land.
<i>watt</i>	a unit of power measuring the rate of energy conversion or transfer designated by the International System of Units as one joule per second.
<i>weather</i>	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.
<i>weathering</i>	<p>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.</p> <p>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.</p>
<i>wind</i>	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.
<i>wind shear</i>	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.
<i>zinc</i>	a metallic chemical element (Zn). Zinc is typically used in metal alloys and galvanized steel.

The
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On the back cover: Blended geologic and digital elevation map of the Southeastern US. 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>.