



FOSSILS, ROCKS, AND TIME

By Lucy E. Edwards and
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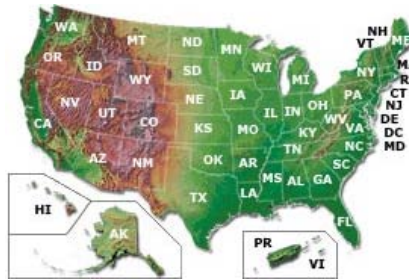
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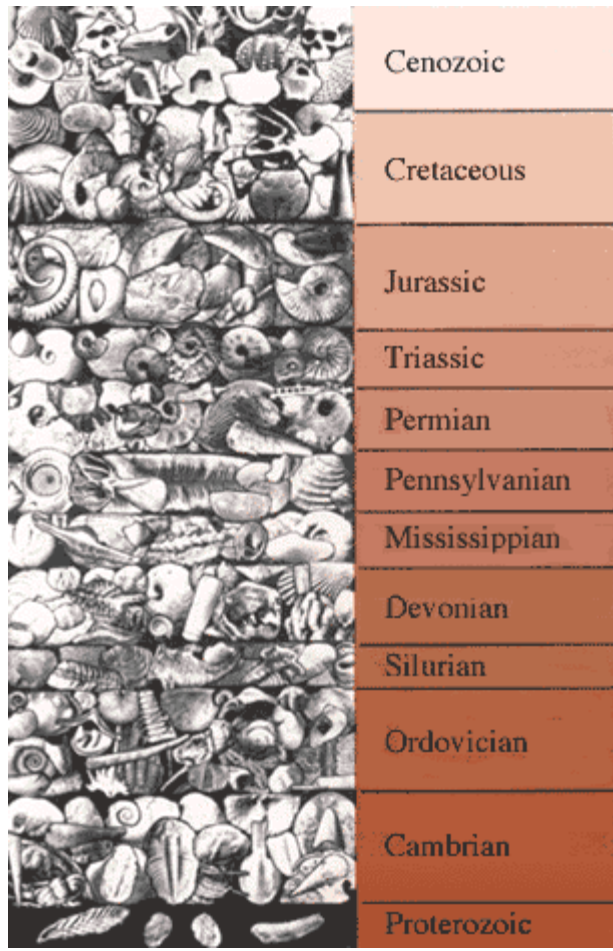
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INTRODUCTION



A photographic collage depicting the diversity and evolution of life on Earth through the last 600 million years. The oldest fossils are at the bottom and youngest at the top. The size of each time interval is proportional to its duration.

Cenozoic
Cretaceous
Jurassic
Triassic
Permian
Pennsylvanian
Mississippian
Devonian
Silurian
Ordovician
Cambrian
Proterozoic

We study our Earth for many reasons: to find water to drink or oil to run our cars or coal to heat our homes, to know where to expect earthquakes or landslides or floods, and to try to understand our natural surroundings. Earth is constantly changing--nothing on its surface is truly permanent. Rocks that are now on top of a mountain may once have been at the bottom of the sea. Thus, to understand the world we live on, we must add the dimension of time. We must study Earth's history.

When we talk about recorded history, time is measured in years, centuries, and tens of centuries. When we talk about Earth history, time is measured in millions and billions of years.

Time is an everyday part of our lives. We keep track of time with a marvelous invention, the calendar, which is based on the movements of Earth in space. One spin of Earth on its axis is a day, and one trip around the Sun is a year. The modern calendar is a great achievement, developed over many thousands of years as theory and technology improved.

People who study Earth's history also use a type of calendar, called the geologic time scale. It looks very different from the familiar calendar. In some ways, it is more like a book, and the rocks are its pages. Some of the pages are torn or missing, and the pages are not numbered, but geology gives us the tools to help us read this book.

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PUTTING EVENTS IN ORDER

Scientists who study the past try to put events in their proper order. When we discuss events that happened in historical times, we often use dates or numbers, but we do not have to do so.



In layered rocks like these at Saint Stephens, Alabama, geologists can easily determine the order in which the rocks were formed.

Consider six historical events: the Wright brothers' flight, the bicentennial of American independence, the First and Second World Wars, the first astronaut landing on the moon, and when television became common in homes. First, let's try to put these events in order. Our knowledge of the words *first* and *second* tells us that the First World War came before the Second World War. We may know or may have been told that the landing of Neil Armstrong on the moon was seen by many people on television, but there was no television around when the Wright brothers flew at Kitty Hawk. Thus, we can order these three events: first Wright brothers' flight, then television common in homes, then the landing on the moon. By a process of gathering evidence and making comparisons, we can eventually put all six events in the complete proper order: Wright brothers' flight, First World War, Second World War, television common in homes, landing on the moon, and American bicentennial.

Because we have written records of the time each of these events happened, we can also put them in order by using numbers. The Wright brothers' flight occurred in 1903, the First World War lasted from 1914 to 1918, and the Second World War lasted from 1939 to 1945. Televisions became part of our homes in the 1950's, Neil Armstrong

walked on the moon in 1969, and America celebrated 200 years of independence in 1976.

Written records are available for only a tiny fraction of the history of Earth. Understanding the rest of the history requires detective work: gathering the evidence and making comparisons.



American Bicentennial	1976
Neil Armstrong walks on the Moon	1969
Television common in homes	1950's
Second World War	1939-1945
First World War	1914-1918
Wright Brothers fly at Kitty Hawk	1903

The box at the top shows six events that occurred during the twentieth century. The bottom shows these events in relative order and numeric order.



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THE RELATIVE TIME SCALE

EON	ERA	PERIOD	EPOCH
Phanerozoic	Cenozoic	Quaternary	Holocene Pleistocene
		Tertiary	Pliocene Miocene Oligocene Eocene Paleocene
	Mesozoic	Cretaceous	Late Early
		Jurassic	Late Middle Early
		Triassic	Late Early
	Paleozoic	Permian	Late Early
		Pennsylvanian	Late Middle Early
		Mississippian	Late Early
		Devonian	Late Middle Early
		Silurian	Late Middle Early
		Ordovician	Late Middle Early
		Cambrian	Late Middle Early
Proterozoic	Late Proterozoic Middle Proterozoic Early Proterozoic		
Archean	Late Archean Middle Archean Early Archean		
pre-Archean			

Long before geologists had the means to recognize and express time in numbers of years before the present, they developed the geologic time scale. This time scale was developed gradually, mostly in Europe, over the eighteenth and nineteenth centuries. Earth's history is subdivided into eons, which are subdivided into eras, which are subdivided into periods, which are subdivided into epochs. The names of these subdivisions, like Paleozoic or Cenozoic, may look daunting, but to the geologist there are clues in some of the words. For example, **zoic** refers to animal life, and **paleo** means ancient, **meso** means middle, and **ceno** means recent. So the relative order of the three youngest eras, first **Paleozoic**, then **Mesozoic**, then **Cenozoic**, is straightforward.

Fossils are the recognizable remains, such as bones, shells, or leaves, or other evidence, such as tracks, burrows, or impressions, of past life on Earth. Scientists who study fossils are called **paleontologists**. Remember that **paleo** means ancient; so a paleontologist studies ancient forms of life. Fossils are fundamental to the geologic time scale. The names of most of the eons and eras end in **zoic**, because these time intervals are often recognized on the basis of animal life. Rocks formed during the Proterozoic Eon may have fossils of relative simple organisms, such as bacteria, algae, and wormlike animals. Rocks formed during the Phanerozoic Eon may have fossils of complex animals and plants such as dinosaurs, mammals, and trees.

The relative geologic time scale. The oldest time interval is at the bottom and the youngest is at the top.



This rock sample will be taken to the laboratory where tiny fossils will be extracted for further study.



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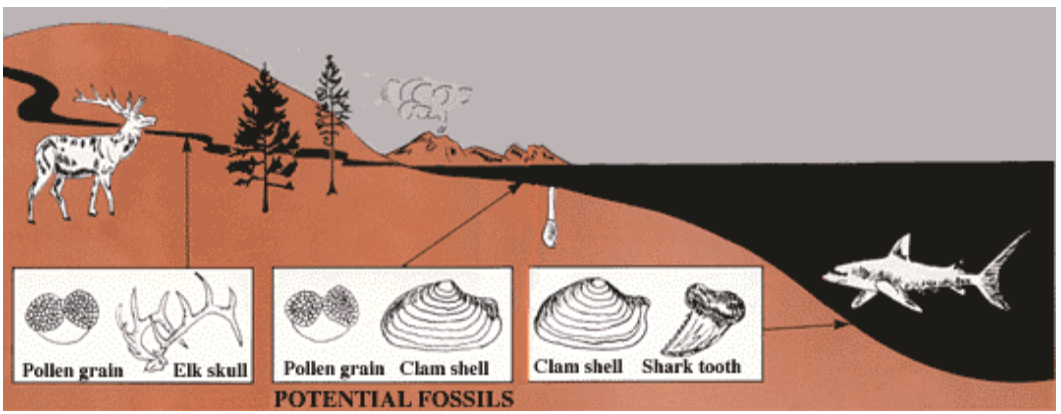
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ROCKS AND LAYERS

We study Earth's history by studying the record of past events that is preserved in the rocks. The layers of the rocks are the pages in our history book.

Most of the rocks exposed at the surface of Earth are *sedimentary*--formed from particles of older rocks that have been broken apart by water or wind. The gravel, sand, and mud settle to the bottom in rivers, lakes, and oceans. These sedimentary particles may bury living and dead animals and plants on the lake or sea bottom. With the passage of time and the accumulation of more particles, and often with chemical changes, the sediments at the bottom of the pile become rock. Gravel becomes a rock called conglomerate, sand becomes sandstone, mud becomes mudstone or shale, and the animal skeletons and plant pieces can become fossils.



An idealized view of a modern landscape and some of the plants and animals that could be preserved as fossils.

As early as the mid-1600's, the Danish scientist Nicholas Steno studied the relative positions of sedimentary rocks. He found that solid particles settle from a fluid according to their relative weight or size. The largest, or heaviest, settle first, and the smallest, or lightest, settle last. Slight changes in particle size or composition result in the formation of layers, also called beds, in the rock. Layering, or bedding, is the most obvious feature of sedimentary rocks.

Sedimentary rocks are formed particle by particle and bed by bed, and the layers are piled one on top of the other. Thus, in any sequence of layered rocks, a given bed must be older than any bed on top of it. This **Law of Superposition** is fundamental to the interpretation of Earth history, because at any one location it indicates the relative ages of rock layers and the fossils in them.

EON	FORMS OF LIFE	
Phanerozoic	Animals with shells or bones; land animals and plants	
Proterozoic	Single and complex single-celled organisms, algae, wormlike organisms	
Archean	Microscopic single-celled or filament-shaped organisms	
pre-Archean	No record of life	

Originations of major life forms.

Layered rocks form when particles settle from water or air. Steno's **Law of Original Horizontality** states that most sediments, when originally formed, were laid down horizontally. However, many layered rocks are no longer horizontal. Because of the **Law of Original Horizontality**, we know that sedimentary rocks that are not horizontal

either were formed in special ways or, more often, were moved from their horizontal position by later events, such as tilting during episodes of mountain building.

Rock layers are also called **strata** (the plural form of the Latin word **stratum**), and stratigraphy is the science of strata. Stratigraphy deals with all the characteristics of layered rocks; it includes the study of how these rocks relate to time.



Outcrop of the Ordovician Lexington Limestone, which is rich in fossil shells, near Lexington, Kentucky. These horizontally layered beds were deposited about 450 million years ago. The dark stains on the rocks are formed by water seeping from springs. The vertical marks on the rocks are drill holes in which dynamite charges were exploded to remove the rock so that an interstate highway could be built. Photograph courtesy of O.L. Karlkins.



Nearly vertical limestone beds that were disturbed from their original horizontal position by mountain building. The men are collecting Silurian fossil shells. These rocks are in the Arbuckle Mountains, near Ardmore, Oklahoma. Photograph courtesy of J.E Repetski.



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FOSSILS AND ROCKS

To tell the age of most layered rocks, scientists study the fossils these rocks contain. Fossils provide important evidence to help determine what happened in Earth history and when it happened.

The word **fossil** makes many people think of dinosaurs. Dinosaurs are now featured in books, movies, and television programs, and the bones of some large dinosaurs are on display in many museums. These reptiles were dominant animals on Earth for well over 100 million years from the Late Triassic through the Late Cretaceous. Many dinosaurs were quite small, but by the middle of the Mesozoic Period, some species weighed as much as 80 tons. By around 65 million years ago all dinosaurs were extinct. The reasons for and the rapidity of their extinction are a matter of intense debate among scientists.

Editor's note: Many paleontologists consider birds to be surviving members of the theropod dinosaur lineage. Thus, it is correct to say "non-avian dinosaurs" here, rather than "dinosaurs." More information is available at <http://www.ucmp.berkeley.edu/diapsids/dinosaur.html>. March 25, 2010



Collecting samples from the bottom of the Mississippi Sound to look for the kinds of microorganisms that are preserved as fossils. The metal box is lowered overboard, scoops up bottom sediments, and then is raised onto the ship by a winch and pulleys.

In spite of all of the interest in dinosaurs, they form only a small fraction of the millions of species that live and have lived on Earth. The great bulk of the fossil record is dominated by fossils of animals with shells and microscopic remains of plants and animals, and these remains are widespread in sedimentary rocks. It is these fossils that are studied by most paleontologists.

In the late eighteenth and early nineteenth centuries, the English geologist and engineer William Smith and the French paleontologists Georges Cuvier and Alexandre Brongniart discovered that rocks of the same age may contain the same fossils even when the rocks are separated by long distances. They published the first geologic maps of large areas on which rocks containing similar fossils were shown. By careful observation of the rocks and their fossils, these men and other geologists were able to recognize rocks of the same age on opposite sides of the English Channel.

William Smith was able to apply his knowledge of fossils in a very practical way. He was an engineer building canals in England, which has lots of vegetation and few surface exposures of rock. He needed to know what rocks he could expect to find on the hills through which he had to build a canal. Often he could tell what kind of rock was likely to be below the surface by examining the fossils that had eroded from the rocks of the hillside or by digging a small hole to find fossils. Knowing what rocks to expect allowed Smith to estimate costs and determine what tools were needed for the job.

Smith and others knew that the succession of life forms preserved as fossils is useful for understanding how and when the rocks formed. Only later did scientists develop a theory to explain that succession.



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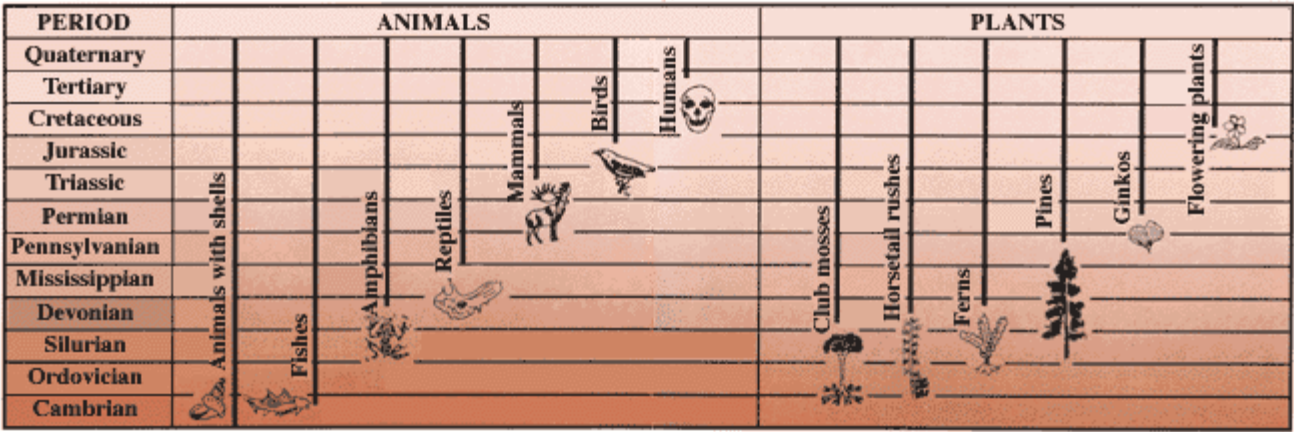
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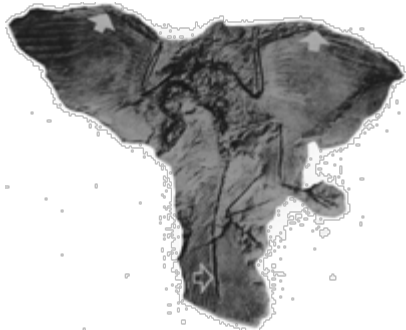
FOSSIL SUCCESSION

Three concepts are important in the study and use of fossils: (1) Fossils represent the remains of once-living organisms. (2) Most fossils are the remains of extinct organisms; that is, they belong to species that are no longer living anywhere on Earth. (3) The kinds of fossils found in rocks of different ages differ because life on Earth has changed through time.



Stratigraphic ranges and origins of some major groups of animals and plants.

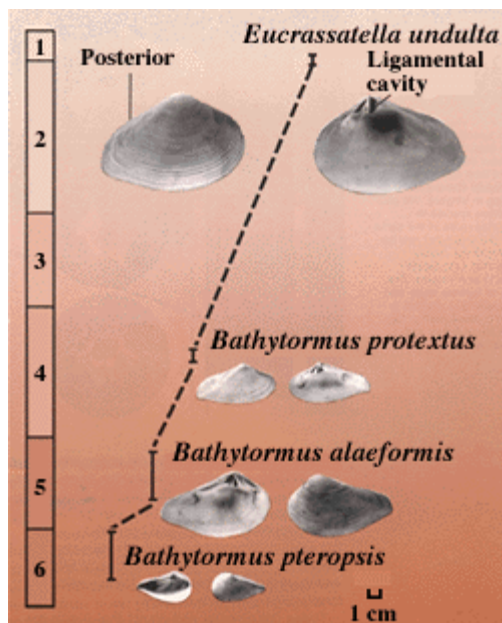
If we begin at the present and examine older and older layers of rock, we will come to a level where no fossils of humans are present. If we continue backwards in time, we will successively come to levels where no fossils of flowering plants are present, no birds, no mammals, no reptiles, no four-footed vertebrates, no land plants, no fishes, no shells, and no animals. The three concepts are summarized in the general principle called the **Law of Fossil Succession**: The kinds of animals and plants found as fossils change through time. When we find the same kinds of fossils in rocks from different places, we know that the rocks are the same age.



Scientists look for ancestors and descendants through geologic time. The fossil *Archaeopteryx lithographica* was a Jurassic animal with the skeleton of a reptile, including fingers with claws on the wings (solid arrows), backbone extending into the tail (open arrow), and teeth, but it was covered with feathers. We can see fossils of many other reptiles in rock of the same age and even older, but *Archaeopteryx lithographica* is the oldest known fossil to have feathers. We conclude that this animal is a link between reptiles and birds and that birds are descended from reptiles. The specimen is about 45 centimeters long. *Photograph courtesy of the National*

How do scientists explain the changes in life forms, which are obvious in the record of fossils in rocks? Early explanations were built around the idea of successive natural disasters or catastrophes that periodically destroyed life. After each catastrophe, life began anew. In the mid-nineteenth century, both Charles Darwin and Alfred Wallace proposed that older species of life give rise to younger ones. According to Darwin, this change or **evolution** is caused by four processes: variation, over-reproduction, competition, and survival of those best adapted to the environment in which they live. Darwin's theory accounts for all of the diversity of life, both living and fossil. His explanation gave scientific meaning to the observed succession of once-living species seen as fossils in the record of Earth's history preserved in the rocks.

Scientific theories are continually being corrected and improved, because theory must always account for known facts and observations. Therefore, as new knowledge is gained, a theory may change. Application of theory allows us to develop new plants that resist disease, to transplant kidneys, to find oil, and to establish the age of our Earth. Darwin's theory of evolution has been refined and modified continuously as new information has accumulated. All of the new information has supported Darwin's basic concept--that living beings have changed through time and older species are ancestors of younger ones.



A species is the most basic unit of classification for living things. This group of fossil clams shows likely ancestor-descendant relationships at the species level. These fossils from the Mid-Atlantic States show the way species can change through time. Notice how the shape of the posterior (rear) end of these clams becomes more rounded in the younger species, and the area where the two shells are held together (ligamental cavity) gets larger. Paleontologists pay particular attention to the shape of the shells and the details of the anatomy preserved as markings on the shells.

Numbers in the left-hand column refer to the following geologic time segments: 1, Pliocene; 2, Miocene; 3, Oligocene; 4, Eocene; 5, Paleocene; 6, Late Cretaceous.

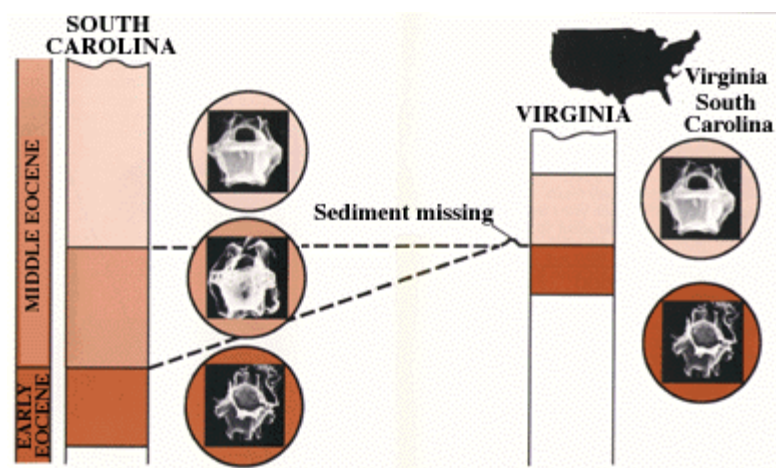
Figure courtesy of G. Lynn Wingard.

The **Law of Fossil Succession** is very important to geologists who need to know the ages of the rocks they are studying. The fossils present in a rock exposure or in a core hole can be used to determine the ages of rocks very precisely. Detailed studies of many rocks from many places reveal that some fossils have a short, well-known time of existence. These useful fossils are called **index fossils**.

Today the animals and plants that live in the ocean are very different from those that live on land, and the animals and plants that live in one part of the ocean or on one part of the land are very different from those in other parts. Similarly, fossil animals and plants from different environments are different. It becomes a challenge to recognize rocks of the same age when one rock was deposited on land and another was deposited in the deep ocean. Scientists

must study the fossils from a variety of environments to build a complete picture of the animals and plants that were living at a particular time in the past.

The study of fossils and the rocks that contain them occurs both out of doors and in the laboratory. The field work can take place anywhere in the world. In the laboratory, rock saws, dental drills, pneumatic chisels, inorganic and organic acids, and other mechanical and chemical procedures may be used to prepare samples for study. Preparation may take days, weeks, or months--large dinosaurs may take years to prepare. Once the fossils are freed from the rock, they can be studied and interpreted. In addition, the rock itself provides much useful information about the environment in which it and the fossils were formed.



Fossils can be used to recognize rocks of the same or different ages. The fossils in this figure are the remains of microscopic algae. The pictures shown were made with a scanning electron microscope and have been magnified about 250 times. In South Carolina, three species are found in a core of rock. In Virginia, only two of the species are found. We know from the species that do occur that the rock record from the early part of the middle Eocene is missing in Virginia. We also use these species to recognize rocks of the same ages (early Eocene and latter part of the middle Eocene) in both South Carolina and Virginia. The study of layered rocks and the fossils they contain is called biostratigraphy; the prefix bio is Greek and means life.



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THE NUMERIC TIME SCALE

Thus far we have been discussing the relative time scale. How can we add numbers to our time scale? How have geologists determined that:

- Earth is about 4.6 billion years old?
- The oldest known fossils are from rocks that were deposited about 3.5 billion years ago?
- The first abundant shelly fossils occur in rocks that are about 570 million years old?
- The last ice age ended about 10,000 ago?

EON	ERA	PERIOD	MILLIONS OF YEARS AGO
Phanerozoic	Cenozoic	Quaternary	1.6
		Tertiary	66
	Mesozoic	Cretaceous	138
		Jurassic	205
		Triassic	240
		Permian	290
	Paleozoic	Pennsylvanian	330
		Mississippian	360
		Devonian	410
		Silurian	435
		Ordovician	500
		Cambrian	570
Proterozoic	Late Proterozoic Middle Proterozoic Early Proterozoic		2500
Archean	Late Archean Middle Archean Early Archean		3800?
Pre-Archean			

Geologic time scale showing both relative and numeric ages.

Ages in millions of years are approximate

daughter atoms. Each radioactive isotope has its own unique half-life. Precise laboratory measurements of the number of remaining atoms of the parent and the number of atoms of the new daughter produced are used to compute the age of the rock. For dating geologic materials, four parent/daughter decay series are especially useful: carbon to nitrogen, potassium to argon, rubidium to strontium, and uranium to lead. Age determinations using radioactive isotopes are subject to relatively small errors in measurement--but errors that look small can mean many years or millions of years. If the measurements have an error of 1 percent, for example, an age determination of 100 million years could actually be wrong by a million years too low or too high.

Nineteenth-century geologists and paleontologists believed that Earth was quite old, but they had only crude ways of estimating just how old. The assignment of ages of rocks in thousands, millions, and billions of years was made possible by the discovery of radioactivity. Now we can use minerals that contain naturally occurring radioactive elements to calculate the numeric age of a rock in years.

The basic unit of each chemical element is the atom. An atom consists of a central nucleus, which contains protons and neutrons, surrounded by a cloud of electrons. **Isotopes** of an element are atoms that differ from one another only in the number of neutrons in the nucleus. For example, radioactive atoms of the element potassium have 19 protons and 21 neutrons in the nucleus (potassium 40); other atoms of potassium have 19 protons and 20 or 22 neutrons (potassium 39 and potassium 41). A radioactive isotope (the parent) of one chemical element naturally converts to a stable isotope (the daughter) of another chemical element by undergoing changes in the nucleus.

The change from parent to daughter happens at a constant rate, called the **half-life**. The half-life of a radioactive isotope is the length of time required for exactly one-half of the parent atoms to decay to

Isotopic techniques are used to measure the time at which a particular mineral within a rock was formed. To allow us to assign numeric ages to the geologic time scale, a rock that can be dated isotopically is found together with rocks that can be assigned relative ages because of their fossils. Many samples, usually from several different places, must be studied before assigning a numeric age to a boundary on the geologic time scale. [\[Sidebar\]](#)

The geologic time scale is the product of many years of detective work, as well as a variety of dating techniques not discussed here. The details will change as more and better information and tools become available. Many scientists have contributed and continue to contribute to the refinement of the geologic time scale as they study the fossils and the rocks, and the chemical and physical properties of the materials of which Earth is made. Just as in the time of William Smith, knowing what kinds of rocks are found below the soil can help people to make informed judgments about the uses of the resources of the planet.

Isotope		Half-life of parent (years)	Useful range (years)
Parent	Daughter		
Carbon 14	Nitrogen 14	5,730	100 - 30,000
Potassium 40	Argon 40	1.3 billion	100,000 - 4.5 billion
Rubidium 87	Strontium 87	47 billion	10 million - 4.5 billion
Uranium 238	Lead 206	4.5 billion	10 million - 4.6 billion
Uranium 235	Lead 207	710 million	

Parents and daughters for some isotopes commonly used to establish numeric ages of rocks.



Scientists compare the shapes of fossils on the computer screen



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FURTHER READING

For Younger Readers

- Bell, R.A., 1992, *Science Close-Up: Fossils*: Golden Books, New York, 24 p. Introduction to fossils for young people.
- Carrick, Carol, and Carrick, Donald, 1989, *Big Old Bones*: Clarion Books, New York, 32 p. The story of collecting and mounting dinosaur bones in the Old West.
- Elting, Mary, 1988, *The Big Golden Book of Dinosaurs*: Golden Books, New York, 61 p. Part of the Golden Book series dealing with natural history for young people.
- Horner, J.R., and Gorman, James, 1985, *Maia: A Dinosaur Grows Up*: Museum of the Rockies, Bozeman, Montana, 36 p. A nice story about dinosaur parenting.

For General Audience

- Arduini, Paolo and Teruzzi, Giorgio, 1986, *Simon & Schuster's Guide to Fossils*: Simon & Schuster, Inc., New York, 37 p. Beginner's guide to fossils.
- Czerkas, S.J., and Czerkas, S.A., 1991, *Dinosaurs: A Global View*: Mallard Press, New York, 247 p. This book deals with dinosaurs and the plants and animals that preceded them and followed them.
- Fenton, C.L., Fenton, M.A., Rich, P.V., and Rich, T.H., 1989, *The Fossil Book: A Record of Prehistoric Life*: Doubleday, New York, 740 p. Popular treatment of all major fossil groups--animals with and without backbones, plants, and microfossils. Revision of a book widely used by amateur paleontologists since 1958.
- Parker, Steve, and Benor, R.L., 1990, *The Practical Paleontologist*: Simon and Schuster/Fireside, New York, 160 p. Popular guide to all things paleontological, from collecting to displaying fossils

For Advanced Audience

- Benton, M.J., 1990, *Vertebrate Palaeontology*: Unwin Hyman, Boston, 377 p. Highly readable account of the history of animals with backbones.
- Boardman, R.S., Cheetham, A.H., and Rowell, A.J., editors, 1987, *Fossil Invertebrates*: Blackwell, Boston, 713 p. Basic college-level text from which to learn about fossils of animals without backbones.
- Lipps, J.H., editor, 1992, *Fossil Prokaryotes and Protists*: Blackwell Scientific Publications, Boston, 342 p. Introduction to the world of microfossils.
- Stanley, S.M., 1986, *Earth and Life Through Time*: Freeman, New York, 690 p. Well illustrated textbook dealing with our planet and its life through time.
- Stern C.W., and Carroll, R.L., 1989, *Paleontology: The Record of Life*: Wiley, New York, 453 p. Introduction to all fossil groups through time--plants, microfossils, invertebrates, and vertebrates.

- Taylor, T.N., and Taylor, E.L., 1993, The Biology and Evolution of Fossil Plants: Prentice Hall, New Jersey, 561 p. College-level text dealing with fossil plants.



Many fossils are too small to be studied without a microscope.



The rocks that seem to be coming out of the man's head, part of the Minaret Formation in the Ellsworth Mountains, Antarctica, are a 7.5-m-thick bed of limestone that stands vertically. The limestone is made up of the shells of Cambrian fossils.



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Unless otherwise credited, all photographs are by the authors.

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As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.



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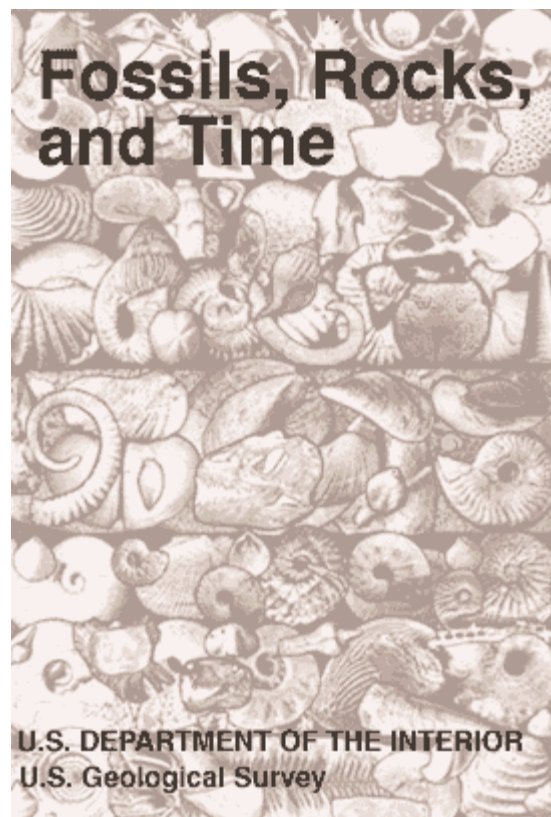


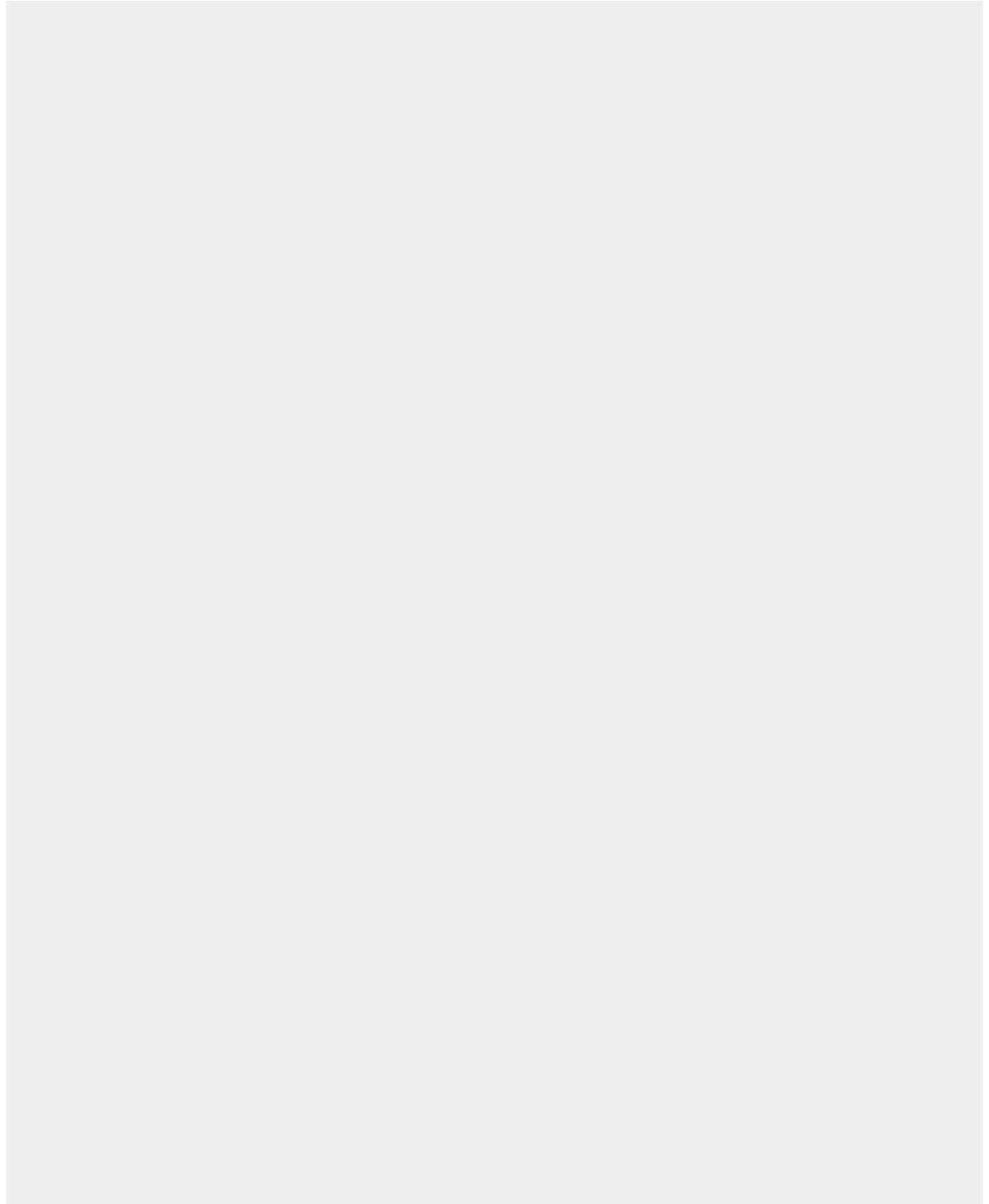
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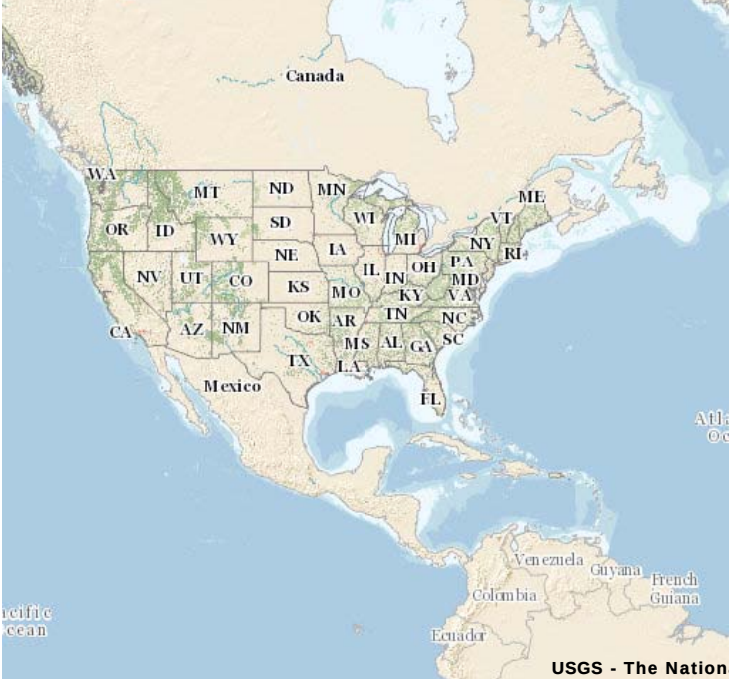
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A map of the United States showing state boundaries and abbreviations. The map is titled "USGS - The National Map". It includes labels for Canada, Mexico, and various countries in South America like Venezuela, Guyana, French Guiana, Colombia, and Ecuador. The Atlantic Ocean is also labeled.

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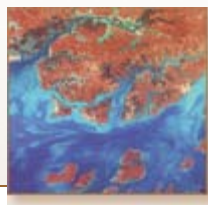
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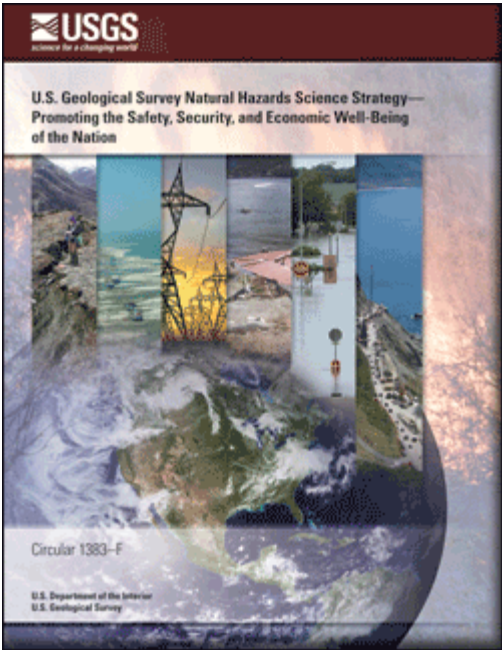
Natural Hazards

Every year in the United States, natural hazard events threaten lives and livelihoods, resulting in deaths and billions of dollars in damage. The USGS works with many partners to monitor, assess, and conduct targeted research on a wide range of natural hazards so that policymakers and the public have the understanding they need to enhance preparedness, response and resilience.

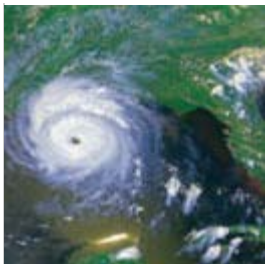
In 2010, the USGS realigned its organizational structure around the missions identified in the [USGS Science Strategy](#). The Natural Hazards Mission Area includes six science programs: [Coastal & Marine Geology](#), [Earthquake Hazards](#), [Geomagnetism](#), [Global Seismographic Network](#), [Landslide Hazards](#), and [Volcano Hazards](#). Through these programs, the USGS provides alerts and warnings of geologic hazards and supports the warning responsibilities of the National Oceanic and Atmospheric Administration (NOAA) for geomagnetic storms and tsunamis. The Coastal and Marine Geology Program supports all the missions of the USGS, characterizing and assessing coastal and marine processes, conditions, change and vulnerability.

The Natural Hazards Mission Area is responsible for coordinating USGS response following disasters and overseeing the bureau's [emergency management](#) activities. The mission area coordinates long-term planning across the full USGS hazards science portfolio, including activities funded through many other programs across the bureau, including floods, hurricanes and severe storms, and wildfires.

The future direction of the USGS hazards mission is guided by the recently released [USGS Natural Hazards Science Strategy](#), which was developed by a team of USGS scientists with considerable input from partners and the public. This document is part of a broader USGS [science strategy](#) planning process across all our missions.



Natural Hazards Mission Area Programs & Activities	
Coastal and Marine Geology	Earthquake Hazards
CMGP conducts research on the changes to the coastal and marine environment that	The Earthquake Hazards Program is part of the National Earthquake Hazards Reduction Program

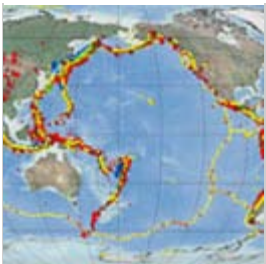


impact lands, lives and livelihoods, and vulnerable ecosystems;

providing science to inform decisions that ensure safe and resilient coastal communities and sustainable use and protection of marine resources. Supporting the Natural Hazards mission, CMGP conducts research on marine geohazards including earthquakes, tsunami, and submarine landslides and on coastal change hazards from erosion, hurricanes and other extreme storms, and sea-level rise.

- [Coastal Change](#)
- [Tsunamis](#)

[Monthly Newsletter - Soundwaves](#)



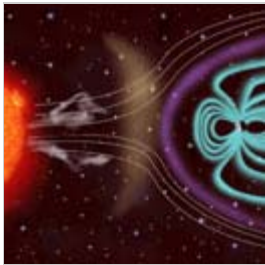
(NEHRP), a four-agency partnership led by the National Institute of

Standards and Technology (NIST). Earthquakes pose significant risk to 75 million Americans in 39 States. The USGS provides research and information products for earthquake loss reduction, including hazard and risk assessments, comprehensive real-time earthquake monitoring, and public outreach.

- [Earthquake Map](#)
- [Real-time RSS Feeds](#)
- [Earthquake Notification Service](#)
- [Did You Feel It?](#)

["Earthquake Hazards – A National Threat" Fact Sheet](#)

[Geomagnetism](#)



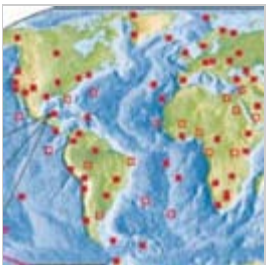
The mission of the Geomagnetism Program is to monitor the Earth's magnetic field. Using ground-based observatories, the Program provides continuous records of

magnetic field variations covering long timescales; disseminates magnetic data to various governmental, academic, and private institutions; and conducts research into the nature of geomagnetic variations for purposes of scientific understanding and hazard mitigation.

- [Real-time Data](#)

["Monitoring the Earth's Magnetic Field" Fact Sheet](#)

[Global Seismographic Network](#)



The Global Seismographic Network (GSN) is a permanent digital network of state-of-the-art seismological and geophysical sensors connected by a

telecommunications network. The GSN provides near-uniform, worldwide monitoring of the Earth, with over 150 modern seismic stations distributed globally. The GSN was formed in partnership among the USGS, the National Science Foundation (NSF) and the Incorporated Research Institutions for Seismology (IRIS).

- [Station Status](#)

[The Global Seismographic Network Fact Sheet](#)

[Landslide Hazards](#)

The mission of the Landslide Hazards Program is to

[Volcano Hazards](#)

The Volcano Hazards Program advances the scientific



provide information that leads to the reduction of losses from landslides and increase in public safety through improved understanding of landslide hazards and strategies for hazard mitigation. The USGS conducts landslide hazard assessments, pursues landslide investigations and forecasts, provides technical assistance to respond to landslide emergencies, and engages in outreach activities.

- [Advisories](#)
- [Real-time Monitoring](#)

["Landslide Hazards – A National Threat" Fact Sheet](#)
["Wildfire Hazards – A National Threat" Fact Sheet](#)



understanding of volcanic processes in order to lessen the harmful impacts of volcanic activity. The USGS monitors active and potentially active volcanoes, assesses their hazards, responds to volcanic crises, and conducts research on how volcanoes work. The USGS also issues warnings of potential volcanic hazards to responsible emergency-management authorities and to the populace affected.

- [Current Alerts for U.S. Volcanoes](#)

["Volcano Hazards – A National Threat" Fact Sheet](#)

[Science Applications for Risk Reductions \(SAFRR\) Project](#)



The SAFRR project focuses on building partnerships to improve the use of natural hazards information from the USGS, to identify needs and gaps, and to develop new products that increase the use of USGS science by emergency managers and community decisionmakers in order to promote greater resilience to natural hazards. SAFRR evolved from the Multi-Hazards Demonstration Project in Southern California, which has developed interdisciplinary, science-based products that deliver information that starts with the hazard and carries through to impacts on the community.

- [USGS Natural Hazards Risk Reduction Project Goes National](#)

[USGS Emergency Management](#)



The USGS Natural Hazards Mission Area has been given responsibility for overseeing the bureau's emergency management activities. This function includes the USGS Hazard Response Executive Committee, which provides executive direction, oversight, and support to USGS managers in responding to major hazard events. During incidents of national significance, the USGS provides support to certain National Response Framework emergency support functions.

- [USGS Emergency Management](#)

Additional USGS Hazards Science Activities

[Astrogeology](#)



The Astrogeology Science Center serves the nation, the international science community, and the general public in the pursuit of new knowledge about our Solar

System. The program has participated in analyzing data from numerous missions to planetary bodies, assisting in finding potential landing sites for exploration vehicles, mapping our neighboring planets, moons, and asteroids, and conducting research to better understand the geologic processes operating on these bodies.

- [Gazetteer of Planetary Nomenclature](#)
- [PILOT - Planetary Image Locator Tool](#)

[Floods and Droughts](#)



The USGS is the Nation's primary provider of information on water. The bulk of the USGS activities related to floods and droughts are carried out through

programs within the Water Mission Area. Web portals make it possible to view current water conditions and where floods and droughts are occurring.

- [USGS Flood Information](#)
- [Current Conditions](#)
- [FloodWatch](#) | [DroughtWatch](#)
- [Interactive Flood Map](#)

["Flood Hazards – A National Threat" Fact Sheet](#)

[Wildfire Hazards](#)



The USGS carries out a wide range of wildfire-related science activities that span multiple USGS mission areas, including landscape ecology studies, geospatial support

for fire response, burned area hydrology, and post-fire debris flow warnings.

- [GEOMAC](#)
- [EROS Fire Science Activities](#)
- [Satellite Data Applications for Fire Science](#)
- [LANDFIRE](#)
- [Post-wildfire Debris Flow Hazards](#)
- [Fire Ecology](#)
- [Ash Contamination from Wildland-Urban Interface](#)
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["Wildfire Hazards – A National Threat" Fact Sheet](#)

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State/Local Release:

New Maps of Afghanistan Provide "Fingerprint" of Natural Resources

Released: 3/10/2014 10:00:00 AM

A coalition of scientists from the United States and Afghanistan today released 60 high-tech maps that will help Afghanistan chart a course for future economic development.

2011 Oklahoma Induced Earthquake May Have Triggered Larger Quake

Released: 3/6/2014 5:00:00 PM

In a new study involving researchers at the U.S. Geological Survey, scientists observed that a human-induced magnitude 5.0 earthquake near Prague, Oklahoma in November 2011 may have triggered the larger M5.7 earthquake less than a day later.

Global Undiscovered Copper Resources Estimated at 3.5 Billion Metric Tons

Released: 3/6/2014 11:30:00 AM

The first-ever, geologically-based global assessment of undiscovered copper resources estimates that 3.5 billion metric tons of copper may exist worldwide.

President's 2015 Budget Proposes \$1.1 Billion for the USGS

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[USGS Researcher Honored for Helping Managers Save Desert Fish from Extinction](#)

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Released: 3/4/2014 3:21:16 PM

The President's fiscal year (FY) 2015 budget request for the U.S. Geological Survey is \$1.1 billion, an increase of \$41.3 million above the FY 2014 enacted level. The FY 2015 Budget reflects the President's ongoing commitment to scientific discovery and innovation to support decision making in addressing critical societal needs and to support a robust economy, while protecting the health and environment of the Nation.

25 Years After the Exxon Valdez, Sea Otter Population at Pre-Spill Levels

Released: 2/28/2014 11:00:00 AM

Nearly 25 years after the Exxon Valdez oil spill injured wildlife off the coast of Alaska, a new report issued today by the U.S. Geological Survey indicates that sea otters have returned to pre-spill numbers within the most heavily oiled areas of Prince William Sound.

The National Map and National Atlas Merge

Released: 2/28/2014 11:00:00 AM

During this year, National Atlas of the United States and The National Map will transition into a combined single source for geospatial and cartographic information.

Burmese Pythons Pose Little Risk to People in Everglades

Released: 2/27/2014 2:30:00 PM

The estimated tens of thousands of Burmese pythons now populating the Everglades present a low risk to people in the park, according to a new assessment by U.S. Geological Survey and National Park Service scientists.

Pollutants Pose Threat to Mekong River Residents

Released: 2/27/2014 11:30:00 AM

Portions of the Mekong River Basin contain hotspots of persistent organic pollutants that pose a significant threat to the residents and wildlife of the Mekong Basin, according to a new U.S. Geological Survey study.

Barred Owls Ousting Spotted Owls in the Pacific Northwest

Released: 2/24/2014 11:25:09 AM

An increase in the barred owl population is contributing to the decline of threatened Northern spotted owls, according to models developed by U.S. Geological Survey and U.S. Forest Service scientists.

Media Advisory: USGS to Host Congressional Briefing: Earthquake Science and Remaining Mysteries

Released: 2/20/2014 11:20:00 AM

Come learn about the great leaps in research over the last 50 years, and the research still underway to understand the remaining mysteries of earthquake hazards.

Linking U.S. and Canadian Border Waters

Released: 2/19/2014 9:00:00 AM

Clearer views of waters along the U.S. and Canadian border are now possible with new seamless digital maps. These maps make it easier to solve complex water issues that require a thorough understanding of drainage systems on both sides of the International Boundary.

First Global Geologic Map of Largest Moon in the Solar System Details an Icy World

Released: 2/12/2014 12:00:00 PM

More than 400 years after its discovery by Galileo, the largest moon in the Solar System – Ganymede – has finally claimed a spot on the map.

Identifying Bats By Sound

Released: 2/12/2014 9:30:00 AM

Recording bats' echolocation "calls" is the most efficient and least intrusive way of identifying different species of bats in a given area, providing insight into some populations that have been decimated by white-nose syndrome.

National Scenic Trails Added to Washington State Maps

Released: 2/12/2014 9:00:00 AM

Newly released US Topo maps for Washington now feature segments of the Pacific Crest and Pacific Northwest National Scenic Trails. Several of the 1,446 new US Topo quadrangles for the state now display parts of the Trails along with other improved layers.

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Featured Topic

Online Lecture: The 1964 Great Alaska Earthquake



March 27 marks the the 50th anniversary of the magnitude 9.2 Great Alaska Earthquake and Tsunami. Watch a new, [online public lecture](#) about the major effects of the earthquake, which provided a key that helped unlock one of the critical mysteries of plate tectonics. A new [fact sheet](#) about the earthquake and a [11-minute video](#) are excellent supplements.

More resources, including photographs and additional videos, are on [our website](#) for the earthquake.

[Featured Topics Archive](#)

What's New and Interesting

Land Subsidence and Sea-Level Rise in Chesapeake Bay

A [new publication](#) written for a general audience explains why the southern Chesapeake Bay region has the

Education Resources

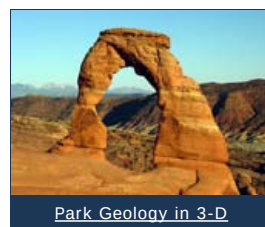
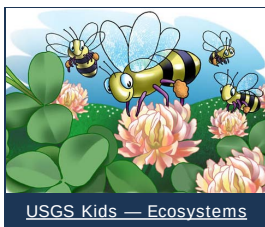
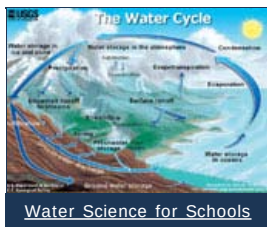
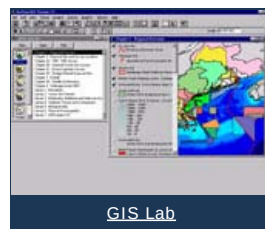
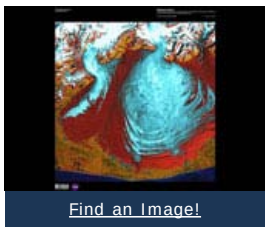
Biology, Geography, Geology, Water, and much more...

[Grades K-6](#)

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Frequently Visited Resources



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[Search USGS Fact Sheets](#)

Search thousands of informative Fact Sheets and publications written for a non-technical audience. Be sure to check the "Not a Scientist?" box.

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highest rates of
sea-level rise on
the Atlantic Coast.

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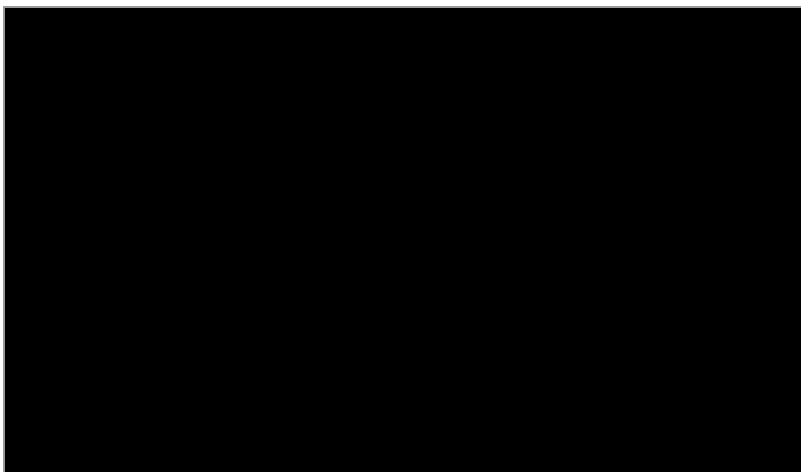
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Jobs at the USGS



[Travis Gibson](#)

Hydrological Technician

“Working as a student for the USGS is an excellent way for anybody interested in working in a science field to “get their foot in the door”

Be our future...join the USGS

* Video above: [DOI](#) and [USGS](#) link policies apply.

Be a Part of the USGS

[Volunteer Jobs](#)

Get your toes wet at the USGS by becoming a volunteer. ([Volunteer.gov](#))

[Student Jobs](#)

Current [student job openings](#) at the USGS. ([USAJobs.gov](#))

[Full-Time Jobs](#)

Make USGS your big career move!

Search for full-time openings today. ([USAJobs.gov](#))

[Mendenhall Postdoctoral Jobs](#)

Looking for a postdoctoral fellowship? Take a look at our postdoctoral research options.

Need [some tips on how to interview](#)—what to do and what not to do? ([USAJobs.gov](#))

Employee & Career Development

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Pay, Leave, Calculators, Insurance, Retirement, Worklife Benefits, and more.

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Training, Mentoring, Consulting, DOI Learn, Science & Technical, and more.

[Organizational Development](#)

Improving the overall organization through strategic planning and teambuilding.

...

Visit the [USGS Human Capital site](#) for more information related to USGS human resources.

Building a Diverse Workforce and Inclusive Work Environment

USGS Non-Discrimination Policy

The U.S. Geological Survey (USGS) is committed to the principles of Equal Employment Opportunity (EEO). All employees, former employees, applicants for employment, and members of the public who seek to participate in USGS programs, activities, and services will not be discriminated against.

USGS Diversity Statement

U.S. Geological Survey (USGS) recognizes its talented and diverse workforce as a key asset. Our success as an agency is a reflection of the quality and skill of our people. The USGS is committed to seeking out and retaining a highly skilled and diverse workforce to ensure we accomplish our mission in the most effective, efficient, and robust way possible.

USGS Anti-Harassment Policy

The U.S. Geological Survey (USGS) is committed to creating and maintaining a work environment where all employees have a fair and equitable opportunity to succeed.

USGS Diversity and Inclusion Plan

Leveraging diversity makes the USGS a more effective organization by helping us attract and retain a highly skilled workforce. The USGS Diversity Statement also recognizes the importance of the "people" aspect of diversity—"All employees bring their own unique capabilities, experiences, and characteristics to their work."

Diversity Council Fact Sheet

The Diversity Council strives to achieve a USGS workforce that reflects the demographics of our Nation, and an environment which is open and accepting of individual differences.

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Science Partnerships and Opportunities

Welcome to the USGS Partnerships Portal of the U.S. Geological Survey, a Federal bureau located within the Department of the Interior. The USGS serves the Nation as an independent fact-finding agency that collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems. The USGS leverages its resources and expertise in partnership with more than 2,000 agencies of State, local and tribal government, the academic community, other Federal allies, non-governmental organizations, and the private sector.

- [Biology Partnerships](#)
- [Connections: Partnerships in Science](#)
- [Contract and Grants Information](#)
- [Partnerships - Working Together to Build the National Map](#)
- [Domestic Memorandums of Understanding with other Federal Agencies or Entities](#)
- [Technology Transfer Information](#)
- [USGS Activities Related to American Indians and Alaska Natives](#)

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USGS Libraries

Welcome to the largest earth science library in the world! Established in 1879 to build and organize a collection of scientific materials in the earth sciences, the U.S. Geological Survey Library is now the largest library for earth sciences in the world. The Libraries Program includes four central libraries and is part of Core Science Systems within the USGS.

Featured Stories



[Research Services at the USGS Denver Library](#)
By Emily C. Wild and Keith J. Van Cleave The U.S. Geological Survey (USGS) was established March 3, 1879, by the Organic Act (20 Stat. 394; 43 U.S.C. 31), which included creation of a USGS Library. In 1946, the USGS ... [Continue reading →](#)

New USGS Publications



Genetic variation in bacterial kidney disease (BKD) susceptibility in Lake Michigan Chinook Salmon and its progenitor population from the Puget Sound

Hyperspectral surface materials map of quadrangle 3468, Chak-e Wardak-Siyahgird (509) and Kabul (510) quadrangles, Afghanistan, showing carbonates, phyllosilicates, sulfates, altered minerals, and other materials

Hyperspectral surface materials map of quadrangle 3468, Chak-e Wardak-Siyahgird (509) and Kabul (510) quadrangles, Afghanistan, showing iron-bearing minerals and other materials

Hyperspectral surface materials map of quadrangles 3664 and 3764, Char Shengo (123), Shibirghan (124), Jalajin (117), and Kham-Ab (118) quadrangles, Afghanistan, showing carbonates, phyllosilicates, sulfates, altered minerals, and other materials

Hyperspectral surface materials map of quadrangles 3664 and 3764, Char Shengo (123), Shibirghan (124), Jalajin (117), and Kham-Ab (118) quadrangles, Afghanistan, showing iron-bearing minerals and other materials

Download if needed: [Excel Viewer](#) | [PDF Reader](#) | [Powerpoint Viewer](#) | [Word Viewer](#)



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About USGS

The USGS is a science organization that provides impartial information on the health of our ecosystems and environment, the natural hazards that threaten us, the natural resources we rely on, the impacts of climate and land-use change, and the core science systems that help us provide timely, relevant, and useable information.

Highlights

- [Directory of Key Officials](#)
- [Employee Directory](#) 
- [Professional Pages](#)
- [USGS Science Strategy](#)
- [Visitors Center](#)
- [USGS Museum](#)
- [Budget Information](#)
- [USGS IT Strategic Plan](#)
- [DOI Strategic Plan](#)
- [USGS Library](#)
- [Customer Listening Sessions](#)

Mission

The USGS serves the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.

Who We Are

The USGS employs the best and the brightest experts who bring a range of earth and life science disciplines to bear on problems. By integrating our diverse scientific expertise, the USGS is able to understand complex natural science phenomena and provide scientific products that lead to solutions. Every day the 10,000 scientists, technicians, and support staff of the USGS are working for you in more than [400 locations throughout the United States](#).

What We Do

As the Nation's largest water, earth, and biological science and civilian mapping agency, the U.S. Geological Survey (USGS) collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems. The diversity of our scientific expertise enables us to carry out large-scale, multi-disciplinary investigations and provide impartial scientific information to resource managers, planners,

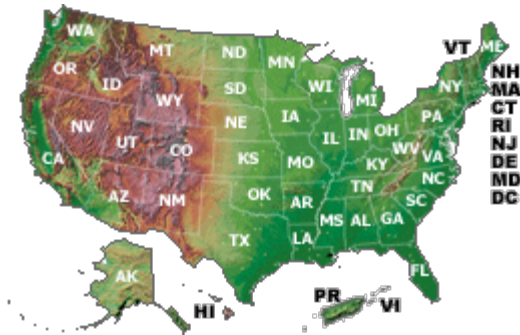


and other customers.

- [Our Programs](#) and [Science Topics](#)
- [Strategic Plan](#)
- [Laws, Policies & Guidelines governing USGS activities](#)

How We Are Organized

The USGS is organized with a Headquarters in Reston, Virginia. Thousands of USGS employees are working in every State in the Nation, with Regional Executives located in the Southeast, South Central region, Northeast, Midwest, Rocky Mountains, Northwest, Southwest and Alaska.



The following links provide information about our senior leadership, how we are structured, where we are located, and how to contact USGS employees:

- [Acting Director, Suzette Kimball](#)
- [Directory of Key Officials](#)
- [Organization Chart](#)
- [USGS State Offices](#)
- [Directory of USGS Employees](#) (Electronic Phonebook)
- [Professional Pages](#)

Our Budget and Performance

Access primary [budget](#) documents, information about performance measures, and other various management reports.

Working With Us

There are a variety of ways to interact with the USGS and its science. We invite you to explore the following information about doing business with us, partnering with our science programs, and being part of the USGS workforce.

Business Opportunities: The USGS is interested in forming cooperative partnerships with organizations from all levels of government and industry. The following links provide information about doing business and partnering with USGS.

- [Contracts and Grants Information](#)



Science Partnerships and Opportunities: Explore the collaborative work the USGS is doing with other Federal agencies, non-government organizations, State/local and tribal governments and the private sector as well as additional opportunities to partner with us and further our science mission. [Learn more.](#)

Cooperative Agreements: The USGS works with many other Federal agencies and the private sector to accomplish its science mission through formal memorandums of understanding and memorandums of agreement. [Learn more.](#)

International Activities: The USGS carries out international activities as a complement to its domestic programs. Learn more about the scientific and technical assistance being provided in more than 100 countries. [Learn more.](#)

Activities Related to Native Americans: Learn more about the work USGS does in cooperation with American Indian and Alaska Native governments—including research on water and mineral resources; animals and plants important to subsistence the environment, or the economy; natural hazards; and geologic resources. [Learn more.](#)

Employment Opportunities: Your one source for information on job openings, including senior management positions, student employment, Postdoctoral and Upward Mobility Programs, and volunteering.

- [Careers](#)
- [Volunteer](#)

News & Events

USGS uses a variety of traditional and new media tools, including social media, to share information and help the public understand how science addresses some of our Nation's most pressing issues. We invite you to stay up-to-date with events and news using our [Newsroom](#) and various [social media tools](#), and to join our community, tell us what you think, and let us know how we can better serve you!



Our History

The United States Geological Survey was established on March 3, 1879, just a few hours before the mandatory close of the final session of the 45th Congress, when President Rutherford B. Hayes signed the bill appropriating money for sundry civil expenses of the Federal Government for the fiscal year beginning July 1, 1879. [Learn more.](#)





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Social Media at the USGS

The USGS has several social media presences*. The sites listed below are those that are considered official USGS presences. Any site found that is not listed is considered a non-USGS presence.

- [DOI Social Media Policy](#)
- [USGS Easy Guidelines for Employee Use of Social Media](#) (March 2013) 
- [GSA's Social Media Registry](#)

Bureau-Level

USGS								
USGS Science In Action Public Flickr Group for anyone to contribute their fantastic photos to related to USGS science.								
USGS News: Everything We've Got This is every single news item we post. If you want it all, here it is. One-way only.								
USGS News: Biology News about ecosystems, plants, animals, and wildlife health. One-way only.								
USGS News: Climate Change News about global warming, carbon storage, and sea level rise. One-way only.								
USGS News: Data, Tools and Technology News about new data sets, websites, hardware and software advancements, etc. One-way only.								
USGS News: Energy News about energy. One-way only.								
USGS News: Environmental Health News about contaminants, and toxics. One-way only.								
USGS News: Mapping News about topographic maps, The National Map, remote sensing, geography, and GIS. One-way only.								
USGS News: Minerals News about minerals. One-way only.								
USGS News: Natural Hazards News about earthquakes, landslides, volcanoes, etc. One-way only.								
USGS News: Planetary Science News about astrogeology, geomagnetism, etc. One-way only.								

USGS News: Water News about floods, droughts, water quality, and oceans. One-way only.	  
USGS Live Live-tweeting only	
USGS Store Products created and distributed by USGS Store to promote natural sciences and outdoorsmanship.	
Libraries Provides support for scientific research in earth and natural sciences.	
USGS Ethics	
USGS Podcasts	

Climate Change and Land Use

Land Cover Institute The USGS Land Cover Institute (LCI) is a focal point for advancing the science, knowledge, and application of land use and land cover information.	
Land Cover Analysis Tool Updates made to the Land Cover Analysis Tool (LCAT) which is used to access the USGS's National Land Cover Database.	
Arctic This feed follows the USGS scientific team on the USCG Healy in the Arctic Ocean from Aug 15 to Sept 28, 2011.	

Ecosystems

Aquatic Life Explore the science of aquatic life without getting your feet wet. USGS research findings, news, and the general science of life in the nation's waterscapes.	
Nonindigenous Aquatic Species A central repository for spatially referenced biogeographic accounts of introduced aquatic species .	
Wetlands Follow USGS as we explore the science of wetlands: the unsung heroes of the world's ecosystems!	
Wildlife Advancing wildlife and ecosystems health.	
DISCOVRE Researching the biology, ecology, and connectivity of deep-sea coral environments to provide the science necessary for their effective conservation and management.	
Bee Inventory and Monitoring Laboratory Designs and develops large and small scale surveys for native bees. Identifies tools and keys for native bee species.	 

Energy and Minerals

Energy News and information related to energy resources (coal, oil, natural gas, geothermal) and assessments from the USGS		
Minerals Information on mineral resource potential, production, consumption, and the environment.		
Mining USGS mining-related science and activities.		
Environmental Health		
Mercury in the Environment		
Silverlake Nutrient Study Information, news, and observations from the USGS Silver Lake nutrient study.		
Maps, Products, and Services		
The National Map News and information related to The National Map , the National Geospatial Program and general geospatial issues.		
The National Map Research Project A research project about the usability of geographic information in support of USGS's The National Map		
National Hydrography Dataset The National Hydrography Dataset (NHD) is the surface water component of The National Map.		
National Atlas Delivers products and services that make it easier to find, get, and use authoritative maps, geographic information, and data about America.		
Landsat The Landsat operational mission, future missions, and the Landsat Science Team are co-managed by USGS and NASA.		
Publications The Publications Warehouse provides access to recent and historic publications written by USGS scientists.		
Hydrologic Instrumentation Services Providing hydrologic instrumentation support to the USGS.		
Hydrologic Instrumentation Services — Local Internal HIF account for communication among HIF Employees Only.		
Natural Hazards		
Big Quakes USGS earthquake alerts for M 5.5 and higher.		
Tweet Earthquake Dispatch USGS Twitter Earthquake Dispatch (TED): Distributes notifications for earthquakes worldwide with magnitudes of 5.5 and above.		

Coastal and Marine Geology			
Hazards Data Distribution Hazards Data Distribution System (HDDS) provides access to aerial and satellite imagery for emergency response.			
Scientific Advancement			
Powell Center The Powell Center supports collaborative research to explore complex earth system and natural resource questions.			
ScienceBase An open-source project creating data and information cataloging capabilities for scientists.			
Geo Data Portal Product updates related to the Geo Data Portal data mapping application.			
Location-Specific			
California			
Colorado USGS sciences related events happening in Colorado. A forum for sharing outdoor experiences in Colorado and learning about our world!			
Idaho			
Illinois			
Indiana			
Iowa			
Kentucky			
Maine			
Minnesota			
Montana			
Nevada			
Oregon			

Nebraska		
North Carolina		
North Dakota		
South Carolina		
Washington		
Wyoming		
Event-Specific		
9th Annual National Monitoring Conference		

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* [DOI](#) and [USGS](#) link policies apply.



RSS and Data Feeds

The USGS provides a variety of [RSS](#), [CAP](#), [MediaRSS](#), [KMZ](#), and other feeds and data content.

Newsroom	
News Releases (full story)	
News Releases (summary only)	
State Releases	Get local news
Technical Announcements	
Frequently Asked Questions	
Latest FAQs	
Multimedia Gallery	
Latest 50 Photography and Images	 
Latest 50 Videos and Animations	 
Latest 50 Audio and Podcasts	 
Earthquakes	
Hazards Data Distribution System (HDDS)	
Remote Sensing	
Remote Sensing news items	

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Landsat	
Latest Headline	
Recent Imagery	
Landsat Imagery (GeoRSS) - Recent Terrain-Corrected Images	
Landsat 7 Scenes (GeoRSS) - Newest available Landsat 7 scenes	
Landslides	
Landslides	
Mineral Resources	
Minerals Periodicals	
National Cooperative Geologic Mapping Program (NCGMP)	
Latest Program News	
National Wildlife Health Center (NWHC)	
Avian Influenza Updates	
Publications Warehouse	
Latest publications (last 7 days)	
Volcano Hazards Program	
Last 7 days—Volcano Updates (includes Mariana Islands)	
Water Related	
Groundwater Software Updates	
Project Alerts — USGS field activities in response to floods, droughts, chemical spills, and hurricanes.	

[View USGS catalogs on Data.gov](#) 

	Latest Earthquakes: Feeds & Data Include items such as: Google Earth KML, RSS, CSV, Cube catalogs, ShakeMaps, 1906 virtual tour, weekly seismic reports, and much more.
	WaterWatch Site includes Google Earth (KMZ), real-time streamflow, and regional streamflow data all in KML format.

Start with Science

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How do we make smart decisions
about a changing world?

Start with Science

There are 7 billion people on Earth, and that number is increasing every day — human influence on our planet is ever more apparent. Changes to the natural world combined with growing human demands threaten our health and safety, our national security, our economy, and our quality of life.



**Thank you to those that participated in helping
us shape the future of USGS science!**

Click on the mission areas to the right to read the strategies

The USGS is focused on some of the most significant issues society faces, in which natural science can make a substantial contribution to the well-being of the Nation and the world. The USGS Science Strategy outlines the major societal issues that USGS science is poised to address. We've also created specific strategies for each of those areas to expand and advance the actions we can take in the next decade. *Thank you to all who offered input!* 

Core Science Systems

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Land Use Change](#)

[Energy and Minerals](#)

[Environmental Health](#)

[Ecosystems](#)

[Natural Hazards](#)

[Water](#)

Learn more about what we are doing.

[The Science Strategy Planning Process](#)

[Our Science Strategy](#)

[Our Mission Areas](#)

In 2010, the USGS aligned itself with the broad science themes outlined in our 10-year Bureau-level Science Strategy. *Teams of USGS scientists* also led the creation of 10-year science strategies for each of the USGS Mission Areas:

- [Climate and Land Use Change](#)
- [Core Science Systems](#)
- [Ecosystems](#)
- [Energy and Minerals](#)
- [Environmental Health](#)

Send other questions, comments, or ideas to sciencestrategy@usgs.gov.

Natural Hazards

- Water

USGS employees, external partners and stakeholders, Indian Tribes, and the public are being asked to weigh in on these strategies and major questions informing their creation.

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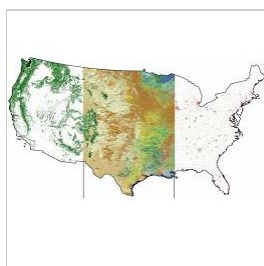
[Our Contacts](#)

Climate and Land Use Change

The USGS undertakes scientific research, monitoring, remote sensing, modeling, synthesis, and forecasting to address the effects of climate and land use change on the Nation's resources. The resulting research and products are provided as the scientific foundation upon which policymakers, natural resource managers, and the public make informed decisions about the management of natural resources on which they and others depend.

Climate and Land Use Change Programs

[Land Change Science \(LCS\)](#)



The goal of the USGS Land Change Science (LCS) Program, formerly Geographic Analysis and Monitoring, is to understand the patterns, processes, and consequences of

changes in land use, land condition, and land cover at multiple spatial and temporal scales, resulting from the interactions between human activities and natural systems.

[Land Remote Sensing \(LRS\)](#)



The Land Remote Sensing Program operates the Landsat satellites and provides the Nation's portal to the largest archive of remotely sensed land data in the world, supplying

access to current and historical images. These images serve many purposes from assessing the impact of natural disasters to monitoring global agricultural production.

[National Climate Change and Wildlife Science Center \(NCCWSC\)](#)



The National Climate Change and Wildlife Science Center responds to the research and management needs of partners and provides science and technical support

regarding the impacts of climate change on fish, wildlife and ecological process. The Center is taking the lead on establishing the Department of the Interior regional Climate Science Centers.

[Research and Development Program \(R&D\)](#)



The USGS Climate and Land Use Change Research and Development Program supports fundamental scientific research to: 1) understand processes controlling

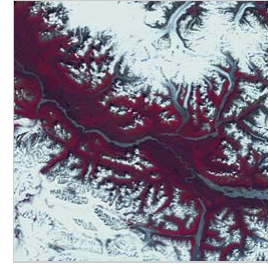
Earth system responses to global change over broad temporal and spatial scales; and 2) understand and model impacts of climate and land-cover change on ecosystems and other natural resources.

[Carbon Sequestration](#)



Scientists at the U.S. Geological Survey (USGS) are working to assess both the potential capacities and the potential limitations of the various forms of carbon sequestration and to evaluate their geologic, hydrologic, and ecological consequences. In accordance with the Energy Independence and Security Act of 2007, the USGS has developed scientifically based methods for assessment of biologic and geologic carbon sequestration.

[Earth Resources Observation and Science Center \(EROS\)](#)



The USGS Earth Resources Observation and Science Center (EROS) contributes to the Climate and Land Use Change Mission Area through research and operational activities that enable the understanding of local to global land change. The EROS multidisciplinary staff uses their unique expertise in remote sensing-based science and technologies to carry out basic and applied research, data acquisition, systems engineering, information access and management, and archive preservation to address the Nation's most critical needs.

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URL: http://www.usgs.gov/climate_landuse/default.asp

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Core Science Systems

Data about Earth and its resources are only useful if available in a format that is understandable and accessible. The U.S. Geological Survey (USGS) provides the Nation with ready access to natural science information that supports smart decisions about how to respond to natural risks and manage natural resources. Core Science Systems includes the following programs: [Core Science Analytics and Synthesis](#), [National Geospatial Program](#), [Libraries](#), [National Cooperative Geologic Mapping Program](#), and [National Geological and Geophysical Data Preservation Program](#).

- [Mission Overview](#) (Fact Sheet 2012-3009)
- [CSS Access Newsletter](#)
- [USGS Core Science Systems Strategy—Characterizing, Synthesizing, and Understanding the Critical Zone through a Modular Science Framework](#)

Core Science Systems

[Core Science Analytics and Synthesis](#)



With expertise in technology, informatics, and science, CSAS leads the management and delivery of scientific data and information for the USGS. CSAS

implements and promotes standards and best practices to enable efficient, data-driven science for decision making at multiple scales. Critical relationships are established and fostered to identify and access data, and to develop and deploy appropriate technological solutions that support rapid response to emerging natural resource issues. CSAS facilitates the [USGS Community for Data Integration](#) (CDI) and supports the [John Wesley Powell Center for Analysis and Synthesis](#), which allows USGS researchers and their colleagues to address complex earth system and natural resource questions in intensive, short-term research focus groups.

[National Geospatial Program](#)



The National Geospatial Program (NGP) organizes, maintains, and publishes the geospatial baseline of the Nation's topography, natural landscape, and built

environment. The baseline is [The National Map](#), a set of databases of map data and information from which customers can download data and derived map products and use web-based map services. Through the [Geospatial Liaison Network](#), the NGP works with cooperators to share the costs of acquiring and maintaining these geospatial data. [The National Atlas of the United States of America®](#), the small-scale component of *The National Map*, fosters an understanding of broad geographic patterns, trends, and conditions useful for national assessments. The [Federal Geographic Data Committee](#) promotes consistent data and metadata standards, system

interoperability, and cross-government best business practices for geospatial resources, policies, standards, and technology as part of the [National Spatial Data Infrastructure](#).

[Libraries](#)



The USGS Library program supports all of the fundamental scientific research conducted within the USGS. The library serves both internal and external users with comprehensive access to the literature, data, and information necessary to understand the mission areas of the USGS and make critical decisions about how to proceed with research initiatives and investigations in the earth and natural sciences.

[National Cooperative Geologic Mapping Program](#)



The National Cooperative Geologic Mapping Program (NCGMP) produces accurate geologic maps and 3-D geologic frameworks that provide critical data for sustaining and improving the quality of life and economic vitality of the Nation. [Geologic maps](#) are indispensable to understanding earth surface processes and ground-water availability and quality, supporting DOI land management decisions, mitigating hazards, assisting in ecological and climatic monitoring and modeling, and understanding onshore-offshore sediment processes. NCGMP is unique in the Federal Government as it supports the production of most geologic maps in the United States through a successful [Federal-State-university](#) partnership.

[National Geological and Geophysical Data Preservation Program](#)



The Energy Policy Act of 2005 ([Public Law 109-58](#), Sec. 351) established the National Geological and Geophysical Data Preservation Program in the USGS and outlined the following goals:

- Archive geological, geophysical, and engineering data, maps, well logs, and samples
- Provide a national catalog of archived materials
- Provide technical and financial assistance to State geological

	surveys and relevant Department of the Interior bureaus for archived materials
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