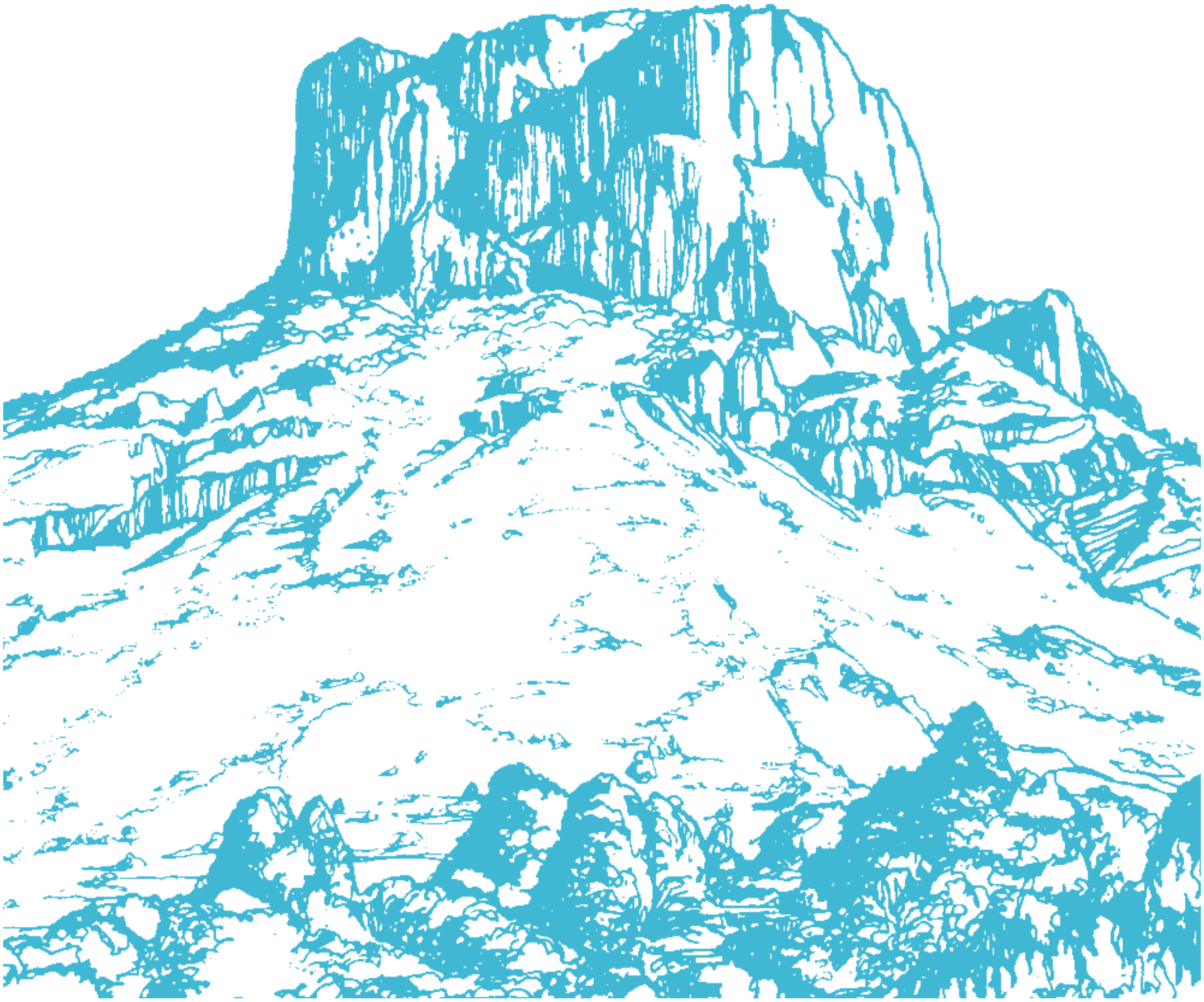


# Big Bend:
# A Land of Change

## An Educator's Guide to Big Bend National Park's Sixth Grade Outreach Education Programs

NATIONAL PARK SERVICE

PARKS AS CLASSROOMS®

"I hear and I forget.
I see and I remember.
I do and I understand."

## Parks as Classrooms

Boiled down to its purest essence, the National Park Service's *Parks as Classrooms* program is all about helping children understand their world. It is a concerted nationwide initiative to utilize the wonderful resources of the parks for teaching and learning purposes- in the process, education becomes active, experiential and fun.

The parks, after all, *are* classrooms. They are battlefields and Presidents' houses, where history was made. They are canyons and deserts, where geological processes have been played out for eons. They are historic trails, over which pioneers migrated and intermingled and resettled. They are monuments to civil rights leaders, where the lessons of cultural heritage are real and vivid. They are seashores and preserves, where a million forms of life offer daily lessons in biology, botany, evolution and survival amidst an endangered ecosystem. The national parks, in essence, help textbooks and lesson plans come to life. *Parks as Classrooms* is an idea whose time has come. Visit the National Park Service's homepage (http://www.nps.gov/) to explore these classrooms.

## Big Bend's Classroom

Big Bend National Park protects and preserves 801,000 acres of land in the State of Texas. The park, exhibiting the best Chihuahuan Desert expanse in the United States, shares a 118-mile border with the Mexican states of Coahuila and Chihuahua. Educating school children from the United States and Mexico on the importance of protecting this unique and fragile environment will encourage a sense of stewardship and ensure the protection of this ecosystem for future generations. The park preserves three distinct ecosystems; riparian, desert, and mountain. Differences in elevation, rainfall, and temperature throughout the park have created the biological diversity found here. There are 450 species of birds, 75 species of mammals, 3600 species of insects and more than 1500 species of plants protected within the park's boundaries.

Big Bend National Park has initiated an intensive environmental education outreach program, bringing to area classrooms programs designed to meet the Texas State Curriculum Guidelines. This guide, one in a series, was developed to help you prepare your students for an in-class program by park staff. Through preparation, a student benefits much more from this experience. This guide includes background information to help you, the educator, understand more about the subject matter being covered. The pre- and post-visit activities included in this guide are an important component of the program. We hope this program will encourage you to bring your students to the park to experience and utilize this valuable resource as part of your teaching curriculum.

## Visiting Your Classroom

We look forward to visiting your classroom and introducing your students to “Parks as Classrooms.”  Big Bend’s outreach program is designed to encourage students to become active owners of the National Park System and impart a sense of stewardship toward park resources. Through education, students will be inspired to learn more about the wonderful resources available in our national parks

Each program has incorporated a variety of learning styles so that students may assimilate information using their preferred learning style. Learning styles include hands-on, seeing, hearing, reading and group discovery. Before our visit to your classroom, please review the background information provided and work with your students to complete the pre-visit activity.  By preparing your students before our visit, students will have a greater understanding of the information presented.

Teachers are expected to participate with students during the presentation and provide discipline as needed.  It is helpful if the students have name tags or name plates. We have included a list of the Texas Essential Knowledge and Skills (TEKS)  covered in our programs. This list will help you meet the curriculum guidelines required by the state.  Each program will last approximately one hour.

# Texas Essential Knowledge and Skills (TEKS)

## Sixth Grade

**6.1 Scientific processes - Student will:**

(A) demonstrate safe practices during field and laboratory investigations.

(B) make wise choices in the use and conservation of resources and the disposal or recycling of materials.

**6.2 Scientific processes - Student will:**

(A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting and using equipment and technology.

(B) collect data by observing and measuring.

(C) analyze and interpret information to construct reasonable explanations from direct and indirect evidence.

(D) communicate valid conclusions.

**6.3 Scientific processes - Student will:**

(C) represent the natural world using models and identify their limitations.

(D) connect Grade 6 science concepts with the history of science and contributions of scientists.

**6.4 Scientific processes - Student will:**

(A) collect, analyze, and record information using tools including beakers, petri dishes, meter sticks, graduated cylinders, weather instruments, timing devices, hot plates, test tubes, safety goggles, spring scales, magnets, balances, microscope, telescopes, ther mometers, calculators, field equipment, compasses, computers and computer probes.

**6.6 Science concepts - Student will:**

(A) identify and describe the changes in position, direction of motion and speed of an object when acted upon by a force.

(B) demonstrate that changes in motion can be measured and graphically represented.

(C) identify forces that shape the features of the Earth including uplift, movement of water, and volcanic activity.

**6.7 Science concepts - Student will:**

(A) demonstrate that new substances can be made when two or more substances are chemically combined and compare the properties of the new substances to the original substances.

(B) classify substances by their physical and chemical properties.

**6.12 Science concepts - Student will:**

(C) identify components of an ecosystem to which organisms may respond.

## Background Information

### GEOLOGY REVIEW

**I. Introduction**

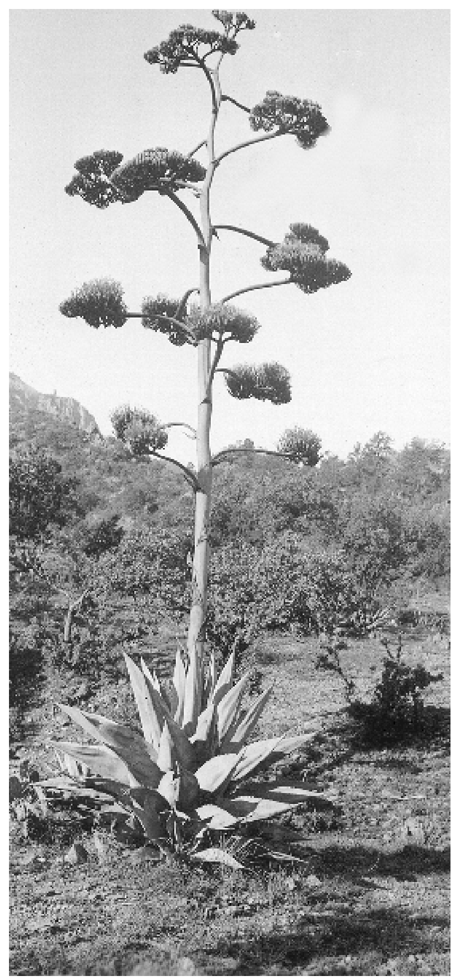
**II. Earth's Composition**
- A. Layers of the Earth
- B. Types of Rock

**III. Internal Processes**
- A. Crustal Rearrangement
  - 1. Continental Drift/Plate Tectonics
  - 2. Earthquakes
- B. Vulcanism
- C. Diastrophism
  - 1. Folding
  - 2. Faulting

**IV. External Processes**
- A. Weathering
  - 1. Physical
  - 2. Chemical
- B. Mass Movement
- C. Erosion/Deposition
  - 1. Running Water
  - 2. Ground Water
  - 3. Wind
  - 4. Ice (glaciers)
  - 5. Waves (currents)

**V. Conclusion**

**VI. Big Bend Geology Tidbits**



# Background Information

**GEOLOGY** is the branch of science that studies the history of the earth and the natural processes that act on it. Bit by bit we learn about the earth and the forces effecting it. The science of geology continues to evolve. What we know about the earth is from the information recorded in the rocks. Scientists now agree that the earth formed from a fiery ball of dust and gases about 41/2 billion years ago. This figure is based on radiometric dating of meteorites.

Geologists study the rocks on and in the earth. They use seismographs (that measure earthquakes) to obtain information about the layers of the earth. Seismic waves travel at different velocities depending on the nature of the layer they are passing through. We now know, that as the earth formed, the heaviest elements sank to the core. The lighter elements rose to the surface. Gases, clinging to the surface, over time made the atmosphere. Later oceans, soils, plants and animals evolved.

**THE EARTH'S COMPOSITION**

The outermost layer of the earth, the **crust**, is the layer we know the most about. The crust is five to fifty miles deep (the average is twenty miles deep). It is the shallowest under oceans and the deepest under mountains. Scientists have drilled down seven miles into the crust. It gets hotter the deeper they drill. At seven miles the crust is 350°F.

The underlying layer is called the **mantle**. It is 1,800 miles thick and contains a mixture of molten (liquid) rock and solid rock. The mantle rock is more dense than crustal rock. The mantle could be described as similar to silly putty in consistency. It is solid, but very plyable.

The innermost layer consists of two parts; the **outer core** is 1400 miles thick. It is a layer of dense molten rock. Geologist believe this layer is composed of iron, nickel and silicon.
The **inner core** is a ball of solid rock some 850 miles thick and 1540 miles across. It is composed of iron and nickel. The inner core is under such intense pressure from the other layers that the melting point of the rock is affected. The pressure allows the rock to remain solid, even at temperatures around 3700°C.

**TYPES OF ROCKS**

While studying the rocks on the earth's crust, geologists noticed that the rocks vary greatly in size, shape and mineral proportions. The texture influenced by the origin, helps geologists classify rocks into three main groups:

**Igneous** rocks have a "fiery inception". In the beginning all rocks are igneous. Most have been formed by magmatic cooling and are crystalline in structure. There are two ways igneous rocks appear on the earth's surface. They are either extrusive or intrusive in origin. **Extrusive** igneous rocks are spewed out (by volcanoes) onto the earth's surface while still molten. They solidify quickly in the open air. Basalt is an example. **Intrusive** igneous rocks cool and solidify beneath the earth's surface where surrounding, nonmagmatic material acts as insulation and slows the rate of cooling. Intrusive rocks may later be exposed by erosion or pushed upward to the surface. Granite is an example.

**Sedimentary** rocks are created when any pre-existing rocks go through mechanical and or chemical weathering processes. These processes reduce the rock to fragments. The fragments are then moved by an agent such as water, wind, ice, gravity or a combination. For example, water, the most common agent, picks up the sediments and deposits it in a quiet body or water (lake or ocean). Layers build up and the weight of the layers exerts pressure that causes the water to be squeezed out. Cementation of the interlocking particles occurs when silica, calcium carbonates and iron oxides fill the pores. Thus, the fragments are transformed into sedimentary rocks. The fragments are usually sorted by size with the smallest particles being carried the furthest and deposited horizontally. Sandstone forms from sand grains, shale from silt and clay sediments. Shale and sandstone are formed mechanically, where the large igneous rocks are broken down into smaller pieces. Their composition is the same as the original rock. Limestone is also a sedimentary rock but it is formed through chemical weathering. When water and carbon dioxide combine they form carbonic acid. This acid dissolves and chemically changes the original igneous rock. When the rock is redeposited, it is as the sedimentary rock limestone. Sedimentary rocks cover most of the ocean floor and 3/4 of the land. The presence of layers, fossils and ripple marks are good clues that the rock is sedimentary. Sedimentary rocks can also form from plant and animal remains.

**Metamorphic** rocks originate from any type of rock. These rocks were changed by massive forces of heat and/or pressure working on them from within the earth. The rock changes in structure, texture, composition and appearance. The metamorphism actually "cooks" the rock, melts it and causes recrystallization. Limestone changes into marble, sandstone becomes quartz, shale becomes slate and granite becomes gneiss. If a metamorphic rock melts it can be used again to form new igneous rock or be remetamorphosed.

**INTERNAL PROCESSES**

The earth appears to be a stable, steady and unchanging planet. However, since the beginning powerful forces have been at work steadily altering the surface. Both internal and external processes are effecting the earth. There are three internal processes; Crustal rearrangement (earthquakes and plate tectonics), Vulcanism (volcanoes) and Diastrophism (folding and faulting). Our planet's solid surface is actually a restless jigsaw of abutting, diverging and colliding slabs called tectonic plates. How the plates behave forms the subject known as **Plate Tectonics**.

In the early 1900's a german scientist named Alfred Wegener, first proposed the Continental Drift Theory. He believed that 300 million years ago the continents were all joined together. He called this land mass Pangaea (Pan JEE a) which means "all lands". He believed by 200 million years ago there were two land masses; Laurasia (North America, Europe and Asia) and Gondwanaland (India, South America, Australia, Africa and Antarctica). These two land masses further split into the seven separate continents of today. Wegener based his theory on geographical, geological, climatic, biological and paleomagnetic clues. Even with all this evidence Wegener's theory was not believed. He could find no plausible explanation for the mechanism of breakup and movement of the continents.

## Background Information

During World War II equipment was developed to locate submarines. After the war this same equipment was utilized to map and explore the ocean floor. Scientists discovered a mid-ocean ridge where lava was coming up and creating new sea floor. A half inch to one inch of new floor was being added each year, spreading the continents apart. Scientists began plotting earthquakes and a pattern emerged, showing the location of several plates. Today Wegener's theory of continental drift is accepted as fact and has been expanded by the theory of plate tectonics. We now know there are 7 major plates and 18 minor ones. Each plate is about 60 miles thick and made up of the crust and the upper solid part of the mantle. The Pacific Plate is 6000 miles wide. The plates are like giant rafts carrying the continents and ocean basins slowly over the mantle. The valleys on the ocean floor mark the edges of the plates. These plates cannot move without effecting other plates. There are three types of boundaries:

**Divergent boundary** occurs where 2 plates move away from each other. This movement creates valleys and is associated with shallow earthquakes and volcanoes.

**Convergent boundary** occurs where the plates are moving towards each other and meet. The older heavier plate usually slides under the younger lighter plate. These boundaries are associated with deep earthquakes and volcanoes and create mountains. It is believed that 40 million years ago the plate with India collided with the Asian plate and created the Himalayan Mountains along a convergent boundary.

**Transcurrent boundary** occurs where two plates slide pass each other laterally. The San Andreas fault in California is located at transcurrent boundary.

Studying plate tectonics suggests that 50 million years from now Africa will split in two and California will pull away from the minland and hit Alaska. Scientists also find that by studying plate tectonics and their boundaries we are learning more about earthquakes and volcanoes.

**EARTHQUAKES**

Early earthquakes and volcanos were blamed on the anger of the gods. Greek legends claimed earthquakes occurred because Atlas moved as he balanced the world on his shoulders. Today we know that along plate boundaries rocks are bent, compressed and stretched. The rocks give way by breaking or shifting position. This stress release occurs as vibrations or earthquakes. Earthquakes occur along plate boundaries and also at weak points in the crust called faults. When earthquakes occur the vibrations are in the form of waves - Seismic waves. Earthquakes are measured on a Richter Scale that determines magnitude. Quakes below 2.5 can't be felt by man. An 8.9 earthquake is the highest recorded to date. arthquakes can produce tsunami (Su NAM ee) or tidal waves in the ocean and trigger volcanoes. Today man is looking for ways to predict earth-quakes.

**VOLCANOES**

Over 850 volcanoes have erupted in the last 2000 years. Volcanoes can be one of nature's most destructive forces. Eruptions have wiped out entire civilizations, turned landscapes into wastelands and may have caused the ice ages. However, volcanic activity has also formed much of the earth's dry land and scientists believe the air we breathe and the water we drink may have first formed from gases given off by volcanoes. Volcanic ash and lava also enrich the soil.

Volcanoes do not erupt just anywhere. Nearly all volcanoes are formed at or near the edges of the 25 plates in the earth's crust. Here, the deep cracks and faults allow molten rock to rise to the earth's surface. A very active area known as the ring of fire circles the Pacific Ocean. Not all volcanoes in the Pacific fire zone erupt at the same time. They typically have brief active episodes and long periods of quiet. Most of the volcanoes in the ring are under the ocean. Over 10,000 of them are over 3000' high but not high enough to break the surface

.

They are called seamounts. Mount St. Helens and Mount Rainier are in the Cascade Volcano group in the ring of fire. Some volcanoes also form above a weak point in the crust called a hot spot. As the seafloor spreads, older volcanoes are moved away from the hot spot and new volcanoes form. Chains of islands like the Hawaiian Islands are created this way. This type of volcano is more predictable than those in the ring of fire.

Volcanoes are classified many ways. An **active** volcano is one with frequent activity. A **dormant** volcano has been quiet for a time but has erupted within recorded history and has the potential to erupt at any time. An **extinct** volcano is not known to have erupted since it was discovered.

Volcanoes form when lava and rocks, from eruptions, pile up on the earth's surface and form cones. At the top of each cone is a crater that formed when lava hardened around the vent. All volcanoes have **vents** or channels that connects the source of magma to the volcano opening. If the vent becomes blocked, a buildup of pressure occurs and the volcano may explode. **Calderas**, like Crater Lake in Oregon, form when an explosion blows off the top of the volcano or magma drains out of the crater.

Below ground volcanoes have two common features; A pool filled with magma and a passageway called a chimney or pipe that carries magma to the surface. The magma consists of melted rock and gases. The type of magma effects eruptions. A quiet eruption has thin magma and little gas. A violent eruption has thick magma and lots of gas. When magma reaches the surface it is called **lava**. The lava can reach 2100 degrees Fahrenheit. The hottest lava is yellow and flows quickly. This hot thin lava is called **pahoehoe** (Pah HOH ee hoh ee) and it hardens with a wrinkled surface. Cooler thicker lava that forms a rough block like surface is called **AA** (ah ah). Volcanoes release not only lava but also gases (water vapor, carbon dioxide, sulfuric acid and sulfur dioxide) and rocks. The rocks vary in size from volcanic dust to ash to cinders to bombs to blocks.

Predictions of volcanic eruptions are based on several factors. Scientists look at a volcano's eruption history, and for changes in behavior. Behavior changes could include changes in the types of gases released or increases in the temperature of the gases. Seismic activity (earthquakes) and physical changes in the volcano's appearance are also monitored. Today infrared photography and remote sensing are being used to help further predict volcanic eruptions.

**DIASTROPHISM**

The last internal process effecting the earth is Diastrophism or folding and faulting. The folding of rocks depends on pressure, temperature, strain rate and rock composition. Folding occurs along the edges of colliding continental plates. Here the steady stress, high temperatures and pressures make normally brittle rock bend instead of break.

While folding occurs deep in the earth, joints and faults are splits that form in stressed rock near the surface. **Faults** are breaks in the earth's crust that involve movement vertically, horizontally or both. Rock is forcefully broken and displaced along the faults. Faulting occurs along zones of weakness in the crust and is associated with earthquakes and volcanoes. **Joints** are cracks with little movement of the rock. They open as cooling igneous rocks contract or as other rocks are subjected to compression. They occur in parallel sets and often at right angles.

**EXTERNAL PROCESSES**

Plate tectonics, continental drift and earthquakes are types of crustal rearrangement. Folding, faulting and jointing are types of diastrophism. These processes along with vulcanism are the internal processes effecting our earth. The internal processes are major events but it is the external forces that are most effective in changing the earth. Their cumulative effect is awesome. External forces are capable of wearing down anything the internal forces erect. There are three types of external processes:

**Weathering** is the breakdown of rock into smaller components by atmospheric and biotic agents. It is a slow process, the rate is not constant and depends on the type of rock and climate. All rock exposed at the surface will be weathered. Weathering is fastest in warm, humid climates. Continual weathering produces soil. Weathering occurs through physical (mechanical) or chemical means. **Physical weathering** destroys the rock but leaves it chemically unchanged. Physical weathering is prominent in cold or dry climates. Methods include sharp temperature changes, frost, drought, crystallizing salts and biotic agents. Biotic agents include growing plant roots or burrowing animals. The freeze/thaw action of water is the most important means of physical weathering. **Chemical weathering** is most active in humid climates. The weathering process attacks the chemical ingredients of the rock. Rainwater and the chemicals it contains can dissolve some rocks or rot the natural cements. Examples include **carbonation** where water and carbon dioxide bond to create carbonic acid. The acid can eat away at some rocks especially limestone. This process is important in cave formation. **Hydration** occurs where water combines with minerals in the rocks. **Oxidation** occurs when oxygen combines with minerals. Rust is an example of oxidation. Acid rain and other pollutants also influence weathering.

**Mass movement** is caused by gravity. Gravity causes rocks to move downhill wherever there is a slope. Talus (piles of loose rocks) forms at the base of the slope. Wind and water can increase the action of mass movement. Landslides and mudflows are examples of mass movement.

**Erosion/deposition.** Erosion s the removal of fragments of rock and soil from its original position. **Deposition** is the relocation of the erosional materials. The two work together. The main agents of erosion are water, wind, ice (glaciers) and waves (currents). The various characteristics of the rocks and the underlying geologic structures influence the effectiveness of erosion. Erosional agents change the materials they erode. Many of our western national park units were set aside to preserve unique landforms created through erosion.

**RUNNING WATER**

Running water rounds and smoothes the rock materials it carries. Stream erosion is an important external geological process. It sculptures slopes and valleys and carves canyons. The Grand Canyon in Arizona is a prime example of stream erosion curtesy of the Colorado River. Running water causes most of the erosion on earth. It dissolves rock through carbonation, abrades the rock or just wears it away through force. Rivers drain 70% of the dry land and each year dump 20 billion tons of eroded material into the seas and valleys.

# Background Information

## GROUND WATER

Beneath the earth's surface lies most of the world's fresh water. The amount of water stored under the surface is 30 times the amount stored in all the rivers and lakes combined. More than half of the population of the USA depends on ground water for drinking. Today man is often using the ground water faster than it can be replaced. When this happens the ground above may lose the support the water once provided. The land may collapse into a sinkhole. Ground water also often provides the water necessary for carbonation. Carbonation can lead to the formation of caverns. Carlsbad Caverns, NM and Mammoth Cave, KY were set aside to protect an example of ground water action.

## WIND

Wind is moving air. Wind is nature's attempt to balance out the uneven distribution of air pressure over the earth. Wind spreads heat more evenly across the world. Wind can make you feel comfortable on a hot day and cold on a winter day. Wind has a drying affect. In cold regions wind increases the loss of body temperature. Wind, however, also helps by carrying pollen, seeds, lightweight organisms and flying creatures. Wind is also used as a source of energy. The wind can be used to move the blades of a windmill to draw water up from a well or to run a generator to produce electricity.

Wind is not an effective agent of erosion on its own. It is not dense enough to carry much material. Wind is most effective in dry areas with limited vegetation to hold soil and rocks in place. Exposed areas such as deserts, beaches and plowed fields are vulnerable to wind deflation. Deflation creates desert pavement. **Desert pavement** is the layer of rocks and pebbles left after the connecting sand, clays and silts are blown away. The pavement eventually forms a protective covering from further deflation.

Abrasion occurs when the wind picks up loose materials and sandblasts objects in its path. The finer particles like sand and dust can travel several feet above ground. The larger particles remain closer to the surface and are bounced and rolled along. Wind abrasion does not construct or shape a landform. It sculptures those already in existence. Wind abrasion pits, etches, facets and polishes rock surfaces and further fragments rocks. How effective wind erosion is depends on the size of particles being moved, the speed and duration of the wind and also the amount of resistance offered by the object being eroded. Wind erosion is a gradual process. Wind erosion helps sculpt such landforms as arches, hoodoos and dunes.

Wind affects the Earth's landscape by:

**Deflation**-*the blowing away of of loose materials*

**Abrasion**- *the wearing away of material by friction*

When the wind encounters a barrier, it slows down. As the wind slows down it can carry less material. The wind then drops its load at the base of the barrier. People take advantage of this process and erect **windbreaks**, like fences or plants, to the stop the wind and protect their crops and buildings. In nature, plants and rocks act as a windbreak. The wind drops its load at the foot of the windbreak. Each time this is done, the deposit builds up. Finally, the deposits themselves, slow the wind. The deposits build up into mounds or small hills to form **dunes**. Sand dunes vary in size and shape. Usually the windward side (side facing the wind) has a gentle slope. Wind blows along this slope to the crest or top of the dunes. At the top, the sand is deposited on the leeward side (side facing away from the wind). Deposits slide down the back side and create a steep slope. This side is the slipface of the dune. Dunes are not fixed features. They move in the direction the wind blows. Often several feet a year, more if the wind is strong and steady. Dunes have been known to cover roads and structures. Dunes provide little nourishment or moisture for plant growth. Where vegetation does manage to gain a foothold, it may anchor the dunes so they move less or are stable. There is one area of unbroken dunes in the Sahara desert of Africa that is the size of Colorado.

Sand dunes are one type of wind deposit. The other is **loess** (luhss). Loess is a fine grained wind deposited silt, found in extensive deposits in the mid - latitudes of the USA, China, Argentina and the former USSR. It is believed to have come from silt produced in association with Pleistocene glaciers. Loess provides fertile soil for agriculture.

**ICE - GLACIERS**

Ice moved rocks tend to keep their irregular shape. Ice covers 10% of the land and 12% of the oceans, mostly in the form of sea ice, polar ice sheets and caps and glaciers. 20,000 years ago 1/3 of the land was covered by ice. It caused the sea level to drop 100 meters and created many land bridges. There have been 10 ice ages in the last 2 million years. One-fourth of North America and one-eighth of the world's land surface is cloaked in debris shed by ice or its melt water. **Glaciers** are formed by snow that under pressure becomes ice. When the ice is thick enough, its weight will cause it to move downhill (gravity). When the glacier moves downhill, heat caused by the ice scraping against rock causes some of the ice to melt. The layer of water under the glacier allows the glacier to slide easier over rock. Continental glaciers like those in Greenland and Antarctica cover large areas. When chunks of these glaciers reach the sea and break off, **icebergs** are created. Valley glaciers form in the mountains and move down toward the valleys. The hollow where the glacier begins to form, and carves deeper as it grows is called the **cirque**. Frost from the glacier shatters rocks and the stones fall to the flanks or are pushed in front of the glacier creating **moraines**. A glacier can fill a mountain valley. As it moves it shoves the loose material ahead and plucks rocks from the valley sides. Thus a glacier deepens, widens and straightens a V shaped valley into a U shaped trough. Several Alaskan parks and Glacier N.P., MT have active glaciers in them.

**WAVES**

The final external process in erosion/deposition is the action of waves in oceans and currents in rivers and streams. **Waves** are curving swells of water caused by wind, tides or earthquakes. They move along the surface of the water. Strong winds create large waves. Waves reshape the shoreline where the water meets the land. The rate of erosion depends on the size and force of the wave, and the type of rock at the shore. The action of the waves can grind the rocks into sand and silt. **Beaches** form where these eroded materials are deposited parallel to the shore.

The forces of nature have created some of the most beautiful landforms in the world. Many of these landforms (arches, canyons, hoodoos, glaciers, beaches, etc.) are now preserved in our National Park System. The landforms these processes have created greatly effect our life as well as the lives of plants and animals living near them. For instance, man rarely builds under an active volcano or moving glacier or on top of sand dunes. Plants and animals have evolved to be able to survive in those regions influenced by landforms. For instance, a cactus could not live near a glacier but a polar bear could.

The spectular landforms of the Big Bend are one reason this park was set aside. Big Bend has canyons, mountains, volcanoes (extinct), and hoodoos and this is just a few geologic features found here.

# Background Information

Running water in streams and rivers causes the most erosion on the earth's surface.

rain is absorbed by vegetation or some other protective covering, the direct collision of raindrops with the ground is strong enough to blast fine soil particles upward and outward. The water, that doesn't sink in, proceeds to flow across the surface in a thin sheet transporting the materials loosened by the drops. As this sheet is broken into narrow streams of water by obstacles in its path, the water carves out channels called **rills**. With more water the rills form **gullies**. Gullies become **streams** with even more water.

Streams sort the debris they transport. The finer, lighter materials move more rapidly than the coarser and heavier materials. Some minerals, largely salts are dissolved in the water and carried in solution. Fine particles of silt and clay are carried in suspension and move along with the flow, without touching the steambed. The sand, gravel and rock fragments or bed load move along in a series of jumps and bounces, rolling and sliding along the channel. Eventually, deposition or the settling of the rocks happens, usually in a response to a decrease in velocity or volume of flow. Most water borne debris is dumped into a quiet body of water where massive deposits may develop. These deposits are usually sorted by size. Rivers drain 70% of the dry land and each year dump 20 billion tons of eroded material into the seas and valleys. When a river enters another body of water and leaves its deposits behind a **delta** forms. When a mountain stream slows as it enters a valley and deposits its eroded material an **alluvial fan** is formed.

Stream erosion is an important external geological process. It sculptures slopes and valleys and carves canyons. The erosional and depositional properties of running water create many different landforms. The Grand Canyon in Arizona is a prime example of stream erosion curtesy of the Colorado River. The Rio Grande has carved Santa Elena, Mariscal, and Boquillas Canyons in Big Bend National Park. Many other national parks preserve features created by running water.

*Water wears away rock three ways:*

By dissolving rocks. Water combines with carbon dioxide from the air and a weak acid forms that eats away some rocks, especially limestone.

By force. The force of the water widens cracks and removes pieces of rock from the channel.

By abrasion. Rocks scrape against the rockbed of the channel, chipping away rocks that then bounce along in the stream with the water.

## PARKS WITH CAVES:

Carlsbad Caverns National Park, New Mexico
Great Basin National Park, Nevada (former Lehman Caves N. M.)
Jewel Cave National Monument, South Dakota
Mammoth Cave National Park, Kentucky
Oregon Caves National Monument, Oregon
Russell Cave National Monument, Alabama
Timpanogos Cave National Monument, Utah
Wind Cave National Park, South Dakota

## PARKS WITH GLACIERS OR EVIDENCE OF GLACIERS:

Denali National Park and Preserve, Alaska
Gates of the Arctic National Park and Preserve, Alaska
Glacier National Park, Montana
Glacier Bay National Park and Preserve, Alaska
Great Basin National Park, Nevada
Ice Age National Scenic Trail, Alaska
Isle Royale National Park, Michigan
Kenai Fjords National Park, Alaska
Kobuk Valley National Park, Alaska
Mount Rainier National Park, Washington
Olympic National Park, Washington
North Cascades National Park, Washington
Rocky Mountain National Park, Colorado
Wrangell- St. Elias National Park and Preserve, Alaska
Yosemite National Park, California

# Background Information

## PARKS WITH EVIDENCE OF WATER EROSION:

Arches National Park, Utah
Badlands National Park, South Dakota
Big Bend National Park, Texas
Big Horn Canyon National Recreation Area, Montana
Black Canyon of the Gunnison, Colorado
Bryce Canyon National Park, Utah
Canyonlands National Park, Utah
Capitol Reef National Park, Utah
Cedar Breaks National Monument, Utah
Chiricahua National Monument, Arizona
Colorado National Monument, Colorado
Dinosaur National Monument, Utah
Grand Canyon National Park, Arizona
Grand Tetons National Park, Wyoming
Natural Bridges National Monument, Utah
Rainbow Bridge National Monument, Utah
Yellowstone National Park, Wyoming
Zion National Park, Utah

## PARKS WITH HOODOOS:

Arches National Park, Utah
Badland National Park, South Dakota
Big Bend National Park, Texas
Chiricahua National Monument, Arizona
Zion National Park, Utah

# Background Information

## PARKS WITH VOLCANOES AND EVIDENCE OF VOLCANOES:

Anaikchak National Monument and Preserve, Alaska
Big Bend National Park, Texas
Capulin Volcano National Monument, New Mexico
Crater Lake National Park, Oregon
Craters of the Moon National Monument, Idaho
Devil's Postpile National Monument, California
Devil's Tower national Monument, Wyoming
El Malpais National Monument, New Mexico
Haleakala National Park, Hawaii
Hawaii Volcanoes National Park, Hawaii
Hot Springs National Park, Arkansas
Katmai National Park and Preserve, Alaska
Lake Clark National Park and Preserve, Alaska
Lassen Volcanic National Park, California
Lava Beds National Monument, California
Mount Rainier National Park, Washington
Sunset Crater Volcano National Monument, Arizona
Yellowstone National Park, Wyoming

## NATIONAL LAKESHORES, SEASHORES & PARKS WITH SAND DUNES:

Acadia National Park, Maine
Apostle Islands National Lakeshore, Wisconsin
Assateague Island National Seashore, Maryland & Virginia
Biscayne National Park, Florida
Cape Cod National Seashore, Massachusetts
Cape Hatteras National Seashore, North Carolina
Cape Lookout National Seashore, North Carolina
Cumberland Island National Seashore, Georgia
Great Sand Dunes National Monument, Colorado
Gulf Islands National Seashore, Florida
Indiana Dunes National Lakeshore, Indiana
Kenai Fjords National Park, Alaska
Kobuk Valley National Park, Alaska
Padre Island National Seashore, Texas
Pictured Rocks National Lakeshore, Michigan
Point Reyes National Seashore, California
Sleeping Bear Dunes National Lake Shore, Michigan
White Sands National Monument, New Mexico

## Background Information

### National Park Service History

The United States of America was the very first country in the world to develop the idea of national parks. It is an idea that has been copied today throughout the world. Artist, George Catlin is credited with the original idea. In 1832, in the Dakotas he worried about the effects of westward expansion on the American Indians, wildlife and wilderness. He suggested preserving them "by some great protecting policy of government...in a magnificent park...a nation's park, containing man and beast in all the wildness and freshness of their nature's beauty!"

In 1864, Congress donated the land in Yosemite Valley and the Mariposa Big Tree Grove to California for a state park. In 1872, after the encouragement of several explorers and surveyors, Congress preserved the Yellowstone area. President Grant signed the Yellowstone Park Act which preserved the watershed of the Yellowstone River "for the benefit and enjoyment of the people." Since this area was still a territory and there was no state government to which the area could be entrusted, Yellowstone was placed in the custody of the federal government, as a national park - the world's first area so designated. This land was put under the control of the Secretary of the Interior. The act required the secretary to "make and publish such rules and regulations that would provide for the preservation...wonders within said park and their retention in there natural condition." Congress followed by creating Sequoia, Mount Rainier, Crater Lake, and Glacier National Parks. Yosemite was returned from the state of California to also become a national park. The idea to preserve nature was also connected with the idea of enjoying it. Tourism began to be promoted and railroads and hotels were brought into the parks. Campgrounds, trails and roads began to be built.

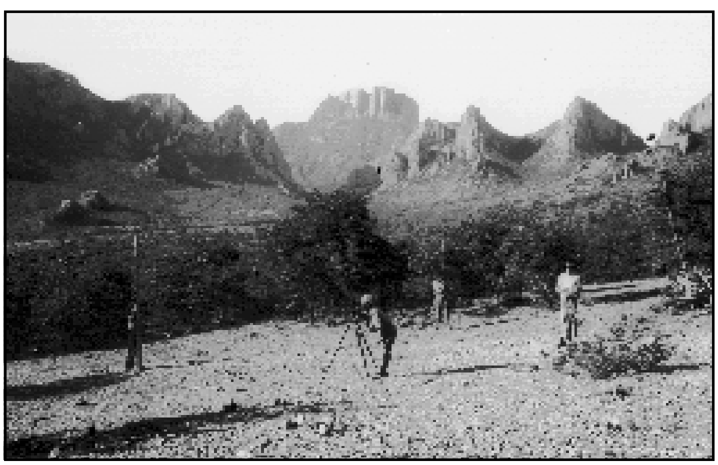
In 1906, the Antiquities Act was passed by Congress. This law established the federal policy for protection and preservation of historic and prehistoric ruins, archeological sites and other scientific resources located on land owned by the federal government. This law established criminal penalties for looting and a permit system to explore and excavate archeological sites. Finally, it authorized the President to establish National Monuments for lands of historic or scientific interest. Teddy Roosevelt took advantage of this act to proclaim 18 national monuments before he left office. Many monuments like Petrified Forest and the Grand Canyon were later converted into national parks. In fact, 100 monuments have been proclaimed through this act to date. Over half are still national monuments (58), 34 were converted into national parks, national battlefields, historic sites, etc. Only 8 have been abolished. Many of the Alaskan parks were set aside in 1978 when President Carter used this law. In 1996, President Clinton used this law to create the Grand Staircase-Escalante national monument in Utah. It will be operated by the BLM. Monument designation does not require Congress's approval like a National Park does.

# Background Information

> **To conserve the scenery and the natural and historic objects and the wildlife therin and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations**
>
> National Park Service Organic Act, 1916

By 1916, the national parks and monuments numbered 33. The parks were being run without true organization capable of caring for the parks. The Secretary of Interior was forced pre-1916 to ask the US Army to help care for the parks. The army influence is still felt today in the National Park Service uniform and organizational structure. Stephen Mather and Horace Albright had been campaigning for an organization to operate the parks. On August 25, 1916, President Wilson signed the Organic Act which established the National Park Service (NPS). It mandated the NPS to "conserve the scenery, the natural and historic objects and wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The act also stated museums, exhibits and other educational activities would be promoted. Further expansion of the park system was recommended. The act stated "In studying new park projects, seek to find scenery of supreme and distinctive quality of some natural feature so extraordinary or unique as to be of national interest or importance.

Before 1925 the parks established were all west of the Mississippi River. In 1926, Shenandoah, Great Smokies, and Mammoth Cave were designated national parks, provided the land was donated. In 1933, a reorganization occurred within the government. The war department turned over its parks, monuments and battlefields to the NPS. Fifteen national monuments operated by the US Forest Service and all of the capitol parks were also now included in the NPS. In total, 53 units in whole or part were added. The new historical areas introduced more diversity into the system. Now the National Park Service was truly national.



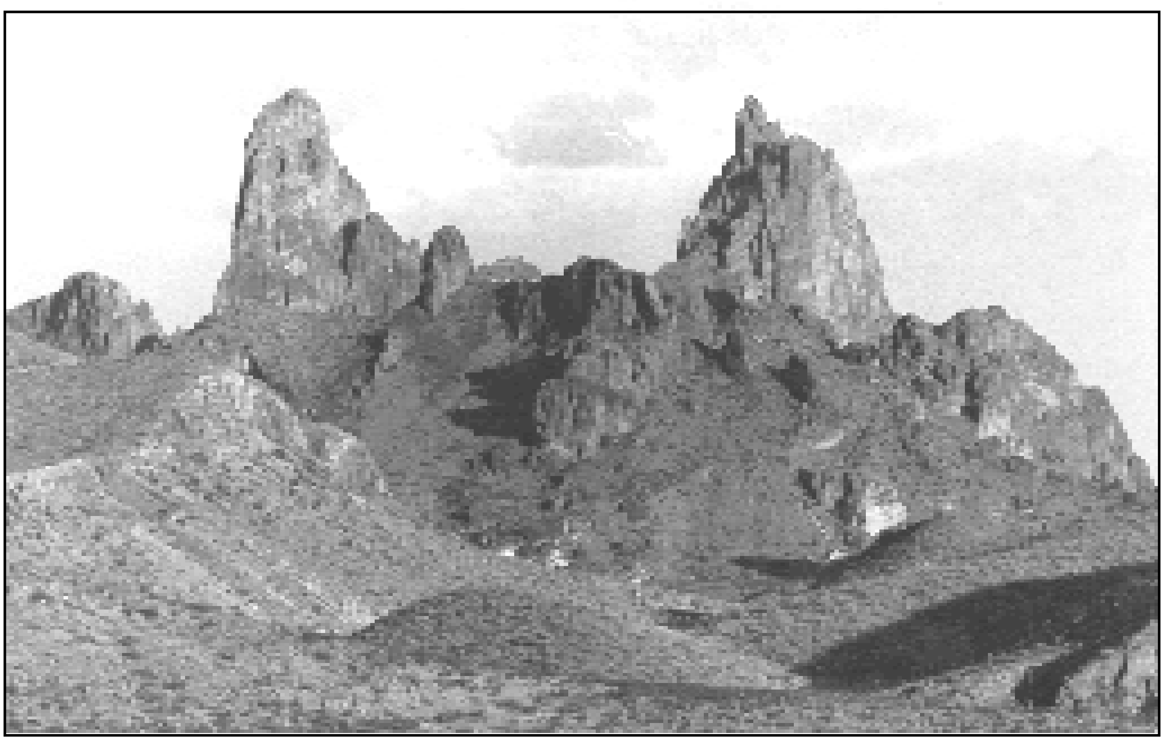
In the 1930's the Civilian Conservation Corp (CCC) was established. The CCC made vast improvements in the park structures, roads and etc. After World War II, there was a big tourism boom, the parks needed help. The Mission 66 program helped upgrade facilities, staff and resource management throughout the system. Many visitor centers, exhibits and other public services were established. The Mather and Albright training centers were created to provide educational and training opportunities for park employees. In the 1970's the first national lakeshores, national recreation areas, national riverways and national trails were created. Through the 1980s and 1990s few parks were added. By 1997, 376 national park service units existed. Over 270 million people visited the parks in 1996.

# Background Information

The national parks today face many challenges. There are numerous rules and regulation that the parks must follow to help preserve and protect these special areas and yet still provide a means of enjoyment. The first law the parks' answer to is the Organic Act of 1916. This legislation, although amended a few times, is the bible for the NPS. The parks must also follow NPS 9 (law enforcement regulations) and the Code of Federal Regulations (CFR) in protecting the parks. Each park also has a superintendent's compendium that gives special rules for that particular park. For instance, Big Bend's superintendent's compendium allows the park to close trails, roads and parts of the river to help protect the peregrine falcon.

J. Horace McFarland stated in 1916 to Congress "The parks are the nation's pleasure grounds, the nation's restoring places, recreation grounds...The national parks are an American idea...Each one of these national parks is the result of some great man's thought of service to his fellow citizens.  These parks did not just happen...These great parks are a sheer expression of democracy." McFarland  was and is correct, the National Park System is among America's proudest and best loved creations.

Today, the parks are increasingly besieged by development and problems outside their park boundaries. The NPS can no longer shoulder the burden of protecting the land without cooperation and partnerships with others outside the system. Today the parks look  more and more to wildlife organizations, friends groups and educational organizations for grants and other means of support to continue to provide top rated services to the visitors.



## OTHER LAWS OF IMPORTANCE TO THE N.P.S.

**Historic Sites, Buildings and Antiquities Act 1935**
Creates a national policy to preserve for public use historic sites, buildings and objects of national significance. Establishes National Historic Landmarks.

**Wilderness Act 1964**
Established the National Wilderness Preservation System and the rules and regulations regarding wilderness use.

**Land and Water Conservation Act 1965**
Established a fund to assist states and federal agencies in meeting present and future outdoor recreation demands and needs of American people. 40% of the funds are to go to land purchases.

**Endangered Species Act 1966**
Provides for the protection, monitoring and recovery plans for species considered threatened or endangered.

**National Historic Preservation Act 1966**
NPS required to assume responsibility for preservation of historic properties.

**National Environmental Policy Act (NEPA) 1969**
Requires environmental impact statements prior to any building. Includes categorical exclusions, environmental assessments, and environmental impact statements.

**Clean Air Act**
Provides the framework to preserve and protect air quality.

**Clean Water Act**
Provides framework to restore and maintain chemical, physical and biological integrity of Nation's water.

**Archeological Resource Protection Act (ARPA) 1979**
Addressed the weakness of the 1906 Antiquities Act. Provided protection of archeological resources on public and American Indian lands. Offered increased protection for historic and prehistoric resources of 100+ years. Stiffened the criminal penalties for looting and damaging sites. Required surveys of the land to locate sites and provided an exemption to the Public Information laws. (Do not have to disclose location of cultural sites).

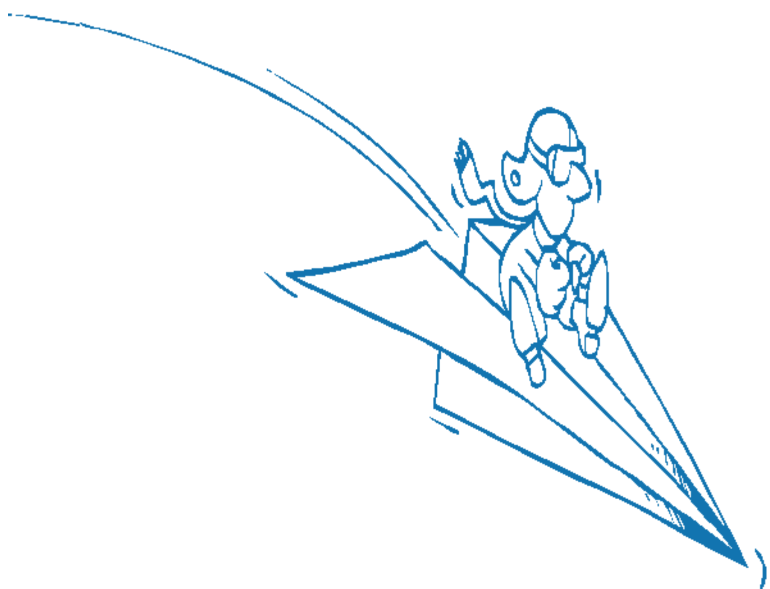
**Federal Insecticide, Fungicide and Rodenticide Act 1988**
Regulates the manufacturing, labeling, sale and use of pesticides. Restricts their use and application.

# Visiting Your Classroom

The pre- and post-visit activites are an important component of the Educator's Guide. Students will retain more information during the in-class program if they have completed the pre-visit activity. After the program, the post-visit activity will reinforce concepts and ideas presented by the Ranger.  Please insure your students have completed the pre-visit activities **before** the inclass visit.

Pre-activity 1: Word Search
Post-activity 1: Cross word

Pre-activity 2: Create a Park
Post-activity 2: Word Search



Take a closer LOOK

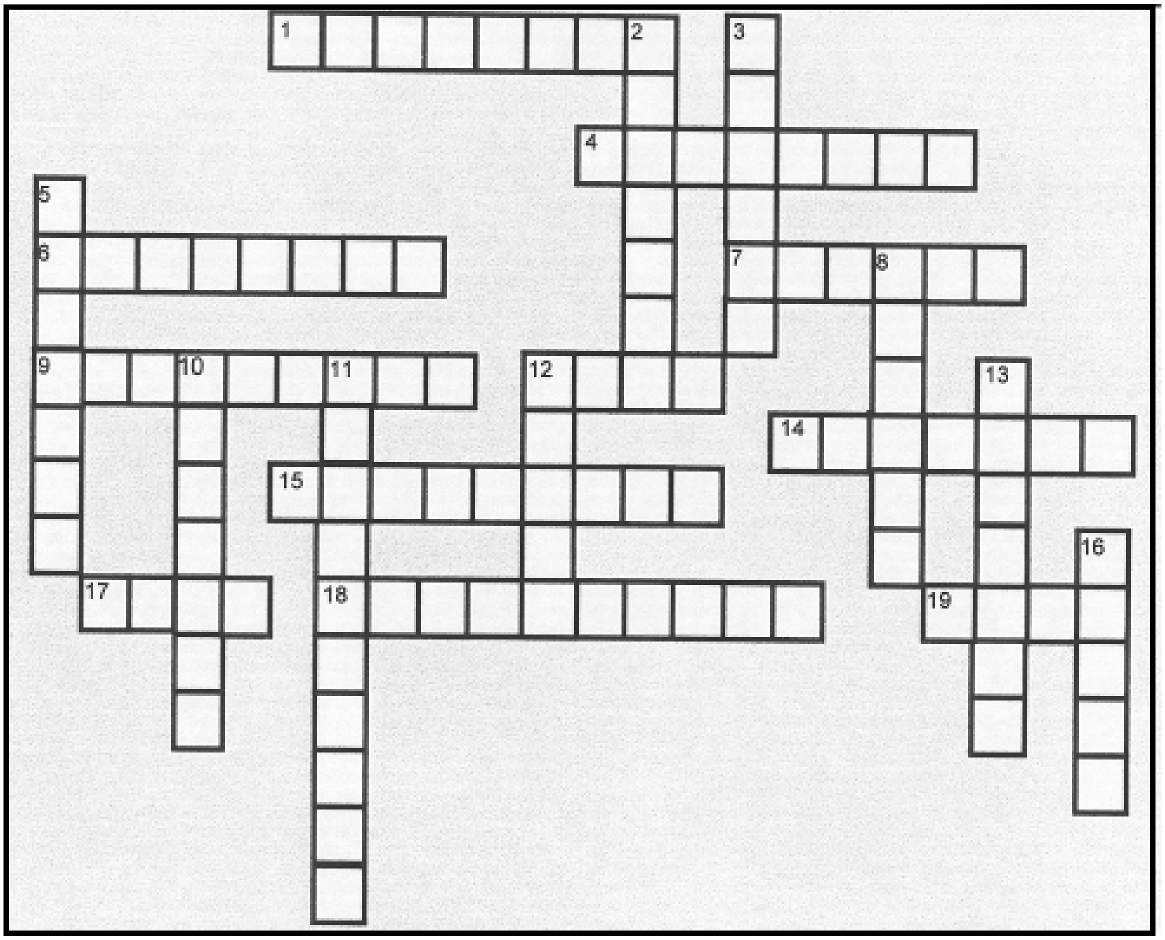
# WORD SEARCH

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| J | L | T | V | S | C | A | S | U | S | A | T | L | E | D |
| J | F | E | E | S | N | X | M | G | L | V | F | I | X | A |
| N | U | N | N | E | G | G | U | L | L | I | E | S | C | T |
| E | U | Z | T | O | M | G | U | M | I | N | K | A | X | N |
| D | R | O | S | L | I | V | Z | X | R | A | L | F | U | D |
| O | N | O | I | T | I | S | O | P | E | D | F | Z | I | S |
| N | O | I | S | A | R | B | A | R | E | O | X | F | P | R |
| X | I | K | L | I | S | E | B | R | N | R | L | U | R | T |
| T | T | F | Z | I | O | D | A | U | B | M | E | U | O | O |
| C | A | N | B | K | N | N | R | M | L | A | V | A | U | N |
| N | L | D | J | I | K | X | O | Z | S | N | C | O | V | A |
| I | F | C | W | W | U | M | J | X | V | T | L | K | R | C |
| T | E | Y | U | H | G | P | P | D | I | U | U | K | J | L |
| X | D | T | O | S | W | R | A | V | E | A | E | P | X | O |
| E | W | B | F | G | M | G | E | Q | X | M | W | X | A | V |

ABRASION
ACTIVE
ALLUVIAL FAN
CALDERA
DEFLATION
DELTA
DEPOSITION
DORMANT
DUNES
EROSION
EXTINCT
GULLIES
LAVA
LOESS
RILLS
RUNOFF
STREAMS
VENTS
WINDBREAKS
VOLCANO

## *Geology and Landforms*

# Geology Crossword




**ACROSS**

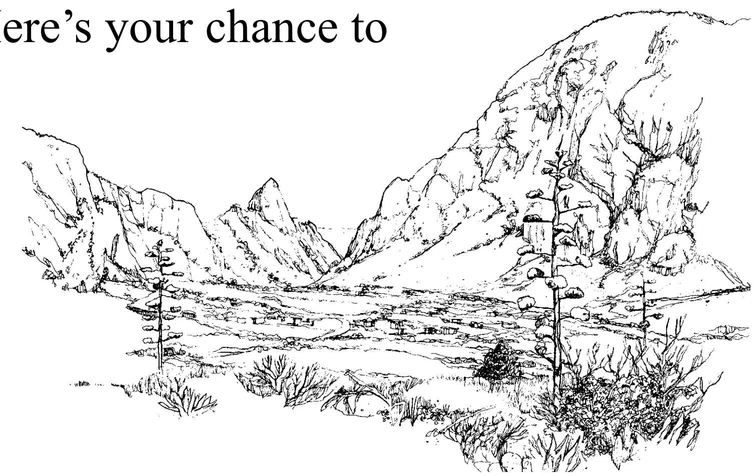
1. A mound, ridge, or low hill of loose windblown sand.
4. A landmass that projects conspicuously above its surroundings.
6. The ejection of molten rock, water, and ash.
7. The whole body of salt water that covers nearly three-fourths of the surface of the Earth.
9. An individual topographical region.
12. A current of air, especially a natural one that moves parallel to the ground.
14. A rock pillar or pedestal of unusual shape, formed by erosion.
15. A person who studies physical or natural sciences.
17. Land set aside for recreation.
18. A test, trial, or procedure for the purpose of discovering the unknown or testing a theory.
19. Melted rock which flows from an erupting volcano.

**DOWN**

2. The process by which the earth's surface is worn away.
3. A deep, narrow valley with steep sides and often with a stream flowing through it.
5. The science that deals with physical history and physical changes of the Earth.
8. The dry beds of intermittent streams found in deserts.
10. An arid landscape that usually receives less than ten inches of rainfall per year.
11. A means of diversion, a hobby.
12. Composed of two molecules of hydrogen and one molecule of oxygen.
13. An opening in the Earth's surface where magmatic gasses and lava are erupted.
16. All of the animals in the world.

# Create a National Park

National parks are special places. Parks conserve the scenery, the plants, and the animals that call them home. Parks provide a place for us to play. Future generations will be able to enjoy parks just as we do today. Here's your chance to create a national park.



Look up different national parks on the internet. Just go to www.nps.gov

Choose the location of your park in the world.

Choose a name for your park.

Pick the landforms and the cultural features in your park.

Decide what rules and regulations you need to protect your park and the people who visit it.

Draw a map of your park and include campgrounds, hiking trails, roads, visitor centers, restrooms, restaurants, and any other facilities that might be appropriate.

Take a closer LOOK

# WORD SEARCH

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | H | I | S | T | O | R | I | C | T | A | S | O | T | W |
| O | S | B | L | D | I | E | V | A | C | V | M | S | O | H |
| I | T | B | P | D | H | C | C | M | C | Z | T | Z | U | Y |
| T | T | C | E | T | O | R | P | P | Z | C | E | O | R | V |
| A | G | A | C | S | S | E | R | G | N | O | C | Z | I | O |
| V | A | P | R | G | W | A | Y | R | E | N | E | C | S | N |
| R | E | G | U | L | A | T | I | O | N | S | L | P | M | Z |
| E | F | I | L | D | L | I | W | U | B | E | D | J | S | W |
| S | T | N | E | M | Y | O | J | N | E | R | H | W | O | S |
| E | X | T | S | W | J | N | N | D | N | V | K | E | L | V |
| R | B | Y | W | V | J | M | F | W | E | E | R | I | E | F |
| P | H | X | G | B | V | S | E | H | F | O | A | G | G | P |
| J | A | O | H | Z | K | Q | W | K | I | R | P | J | C | R |
| E | T | M | T | F | W | O | Y | X | T | O | V | L | G | M |

| | | |
|---|---|---|
| BENEFIT | LAWS | REGULATIONS |
| CAMPGROUND | MAP | RULES |
| CONGRESS | PARK | SCENERY |
| CONSERVE | PRESERVATION | TOURISM |
| ENJOYMENT | PROTECT | TRAILS |
| HISTORIC | RECREATION | WILDLIFE |
| IDEA | | |

*National Park Service*

# Suggested Reading

### *Sixth Grade*

Alessandrello, Anna. **The Earth: Origins and Evolution.**
Raintree/Steck Vaughn; ISBN: 0811433315. Published 1994

Brooks, Susan. **The Geography of Earth.**
Oxford University Press; ISBN: 0195212320. Published 1996.

Field, Nancy. **Discovering Volcanoes.**
Dog Eared Publications; ISBN: 0941042030. Published 1996.

Gallant, Roy A. **Sand on the Move: The Story of Dunes (First Books-Earth and Sky Science).** Franklin Watts, Inc.; ISBN 0531158896. Published 1998.

Grimshaw, Caroline. **Earth (Connections).**
World Book, Inc.; ISBN 15684745339. Published 1995.

Pope, Joyce. **Earthquakes (A Closer Look At).**
Copper Beach Books; ISBN: 0761308067. Published 1998.

Redfern, Martin. **The Kingfisher Book of Planet Earth.**
Kingfisher Books; ISBN: 0753451808. Published 1999

Richardson, Hazel. **Water (Against the Elements).**
Copper Beach Books; ISBN: 0761308016. Published 1998.

Stotsky, Sandra. **Geology, The Active Earth (Ranger Rick's Nature Scope).**
Chelsea House Publications; ISBN:0791048349. Published 1998.

Steedman, Scott. **Our Planet (Worldwise).**
Franklin Watts, Inc.; ISBN: 0531153169. Published 1998.

Winner, Cherie. **Erosion (Earthwatch).**
Carolrhoda Books; ISBN: 1575052237. Published 1999.