Garden of the Gods Park
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NOTE: All field trips are suspended indefinitely. Program updates can be found at: https://gardenofgods.com/educational/edu-1/school-field-trips

Land Use Acknowledgement:

We gratefully acknowledge the native peoples on whose ancestral homeland we gather, as well as the diverse and vibrant Native communities of Colorado today.

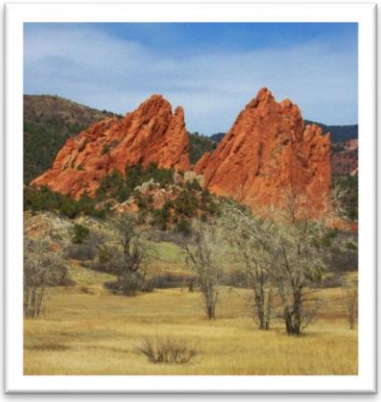
Geology of the Park Program

Welcome! We look forward to sharing the geological story of Garden of the Gods with your students.

We align with current Colorado Academic Standards for K-5 Earth and Space Science.

Goals:

- Students recognize the exceptional geological wonder of the Garden of the Gods.
- Students gain a broad understanding of the geological events that shaped the Pikes Peak region
- Students gain a broad understanding of and appreciation for the science of geology.
- Students identify the three rock types and the three geological processes.
- Students recognize the geological formations in the Park, their ages, and composition.



Teacher Reference Guide:

Basic Geology of Garden of the Gods

The Pike's Peak region has been shaped by millions of years of mountain building and erosion. There have been three different mountain building events in the geological history of this area:

1. *The Ancestral Rockies* (320-310 million years ago). The erosion of these first Rocky Mountains formed the sedimentary Fountain Formation and the Lyons Sandstone layers.

2. *The Laramide Orogeny* (70-65 million years ago). This process uplifted the Front Range. The layers seen in the Garden were forced upright as the land broke along the Rampart Range Fault.

3. *Late Tertiary Uplift* (5 million years ago). Ongoing erosion and uplift of Pikes Peak has spread Pikes Peak granite throughout western Colorado Springs. This granite has been dated at over 1 billion years in age using geologic radiometric dating methods. The erosion of this time period exposed the upright fins (hogbacks) seen in the Park today. The bowls on Pikes Peak were scoured out by glaciers during the last Ice Age that ended 11,700 years ago.

The Garden of the Gods Park is composed of sedimentary rock layers. They are geologically remarkable due to their vertical and in some cases beyond vertical positions. This allows study of rock that in other areas have been buried by miles of sediment. From youngest to oldest, the rock formations of the park include:

1. Mesa Gravels (2 million- 10,000 years ago): Loose red gravels atop the eastern ridges of the park and the mesa east of 30th street. Remains of regional glaciation from the last ice age. The freezing and thawing of these glaciers deposited layers of gravel that are now sedimentary rocks in the making.
2. Pierre Shale (73-70 million years ago): Much of Colorado Springs, the park's Visitor and Nature Center, and the Camp Creek valley on the east side of the park rest atop the 5,000-foot thick Pierre Shale. Formed of sea sediments (mud and clay) from when Colorado was under a deep ocean at the end of the Cretaceous period.
3. Niobrara Formation (88-70 million years ago): The pale ridges bisected by Gateway Road on the park's east side are made of the Niobrara Formation. This creamy buff layer is a mixture of shales and limestones. They are geological evidence of the shallow Cretaceous Seaway that once covered Colorado.
4. The Benton Group (100-88 million years ago): The small valley between the rise of the Niobrara Formation and the towering red hogbacks of the Central Garden was formed by the easily eroded Benton Group. Consisting mostly of black shales and limestones, this formation also contains thin lenses of volcanic ash clays. These layers were created as the Cretaceous Seaway began.

5. Dakota Group (112-100 million years ago): Dakota sandstone is visible to the north of the Benton Group valley. The grayish-tan ridge was formed in a coastal flood plain and beach sand environment during the Cretaceous time period. Due to its distinct color and tendency to erode into fins or hogbacks, Dakota sandstone is visible all along Colorado's Front Range.
6. Morrison Formation (155-148 million years ago): Between White Rock and Juniper Loop Road are the purple to gray shales and pale gypsum of the Morrison Formation. A swampy lowland created this environment and the resulting sediments. This rock layer formed during the late Jurassic period.
7. Lykins Formation (260-250 million years ago): A pale, Triassic period formation visible east of the red South Gateway Rock from the sidewalk connecting the Gateway Trail to the Perkins Central Garden Trail. This thin, light-colored outcrop was formed in a tidal environment that produced a mixture of shale, dolomite, and limestone. Lykins contains fossilized algae and cyanobacteria called stromatolites. Geologists have found evidence of a mass extinction event in the Lykins Formation. Called The Great Dying (or the Permian-Triassic Extinction), this event wiped out over 90% of all life on earth and paved the way for the emergence of dinosaurs.
8. Lyons Formation (300-260 million years ago): The great hogbacks of the Central Garden (save for rocks of Sentinel Plaza and Three Graces Plaza) are made from the Lyons Formation. The creamy white to gray sandstones of the easternmost rocks (White Rock and Gray Rock) are made of the Upper Member of the Lyons Formation. The reddish-orange rocks are made of the Lower Member of this formation. These weather resistant sandstones formed in an arid, dune environment. The missing Middle Member is composed of easily eroded shale and is no longer visible in our park.
9. Fountain Formation (320-300 million years ago): The rocks of Sentinel Plaza, Three Graces Plaza, and the western park are made of the sandstones, shales, and conglomerates of the Fountain Formation. As the Ancestral Rockies eroded away, their sediments were deposited in alluvial fans that built up over 4,500-feet thick.

All the various sedimentary layers were gradually compacted and cemented into rock. Beginning about 70 million years ago these layers were broken and tilted upright. Erosion has exposed the ridges and carved out the valleys to what we see today. Our rocks get their red color from the iron-oxide (rust) trapped within them.

Fossil evidence of dinosaurs and ancient marine animals has been found in the Park. The skull of a dinosaur named *Theiophytalia kerri*, a type of iguanodon, was found in the Garden of the Gods in 1878 by Colorado College Professor James Kerr. The fossil dates to the early Cretaceous period and is the only evidence this species found anywhere in the world.

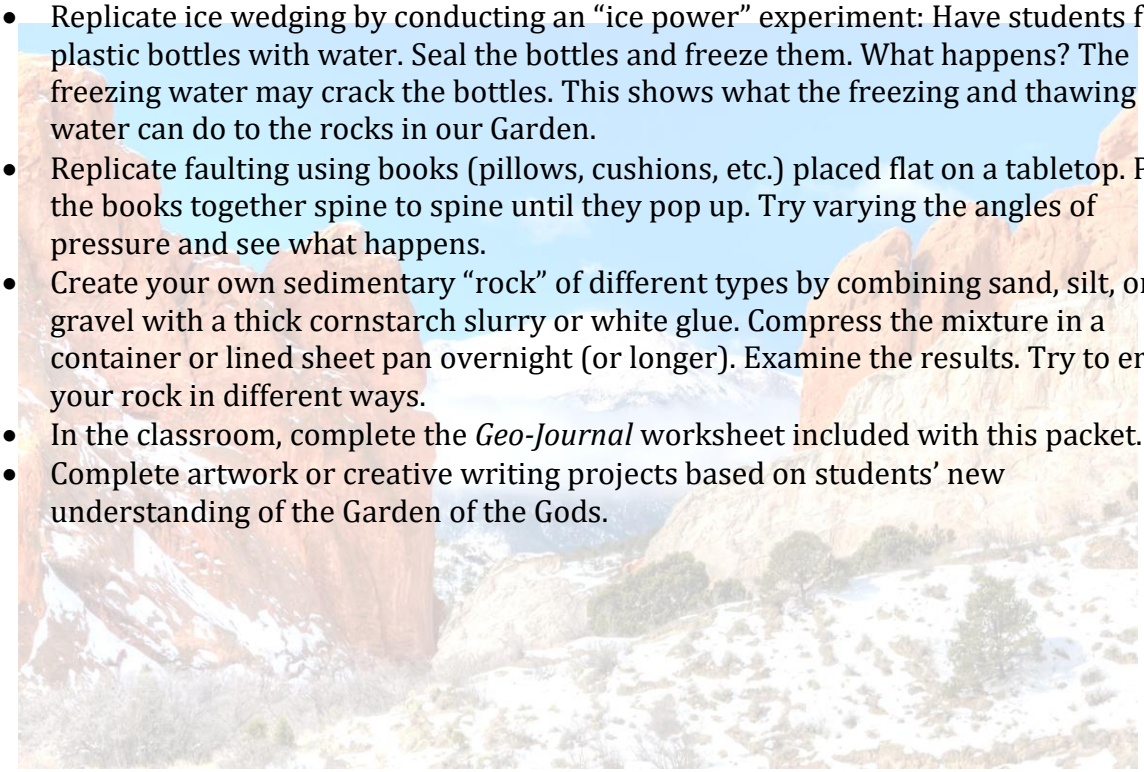
Faulting is evident throughout the Central Garden. A fault is a crack in the earth's surface where movement occurs. Typical faulting occurs along the boundary of tectonic plates—the big, thin pieces of our planet's crust that drift and move on the viscous layer beneath them, bumping and grinding into each other. There is no plate boundary here in Colorado, but there is a crack in the North American tectonic plate itself.

Some faulting occurs in sudden, dramatic spurts, causing earthquakes. The faulting in the Garden occurs very slowly.

The biggest fault in the Garden is the Rampart Range Fault. It trends north and south, parallel to the Front Range. This fault is caused by mountain building and connects to another fault to the south by Cheyenne Mountain and to the north just south of Denver. Smaller faults radiate from the Rampart Range Fault throughout the park. It's these faults that cause the offset position of some of our rocks. For example, both Grey Rock and White Rock are part of the same rock layer, but due to faulting, are no longer aligned. White Rock rests much further east than Grey Rock.

Supplemental Activities:

- Replicate ice wedging by conducting an "ice power" experiment: Have students fill plastic bottles with water. Seal the bottles and freeze them. What happens? The freezing water may crack the bottles. This shows what the freezing and thawing of water can do to the rocks in our Garden.
- Replicate faulting using books (pillows, cushions, etc.) placed flat on a tabletop. Push the books together spine to spine until they pop up. Try varying the angles of pressure and see what happens.
- Create your own sedimentary "rock" of different types by combining sand, silt, or gravel with a thick cornstarch slurry or white glue. Compress the mixture in a container or lined sheet pan overnight (or longer). Examine the results. Try to erode your rock in different ways.
- In the classroom, complete the *Geo-Journal* worksheet included with this packet.
- Complete artwork or creative writing projects based on students' new understanding of the Garden of the Gods.



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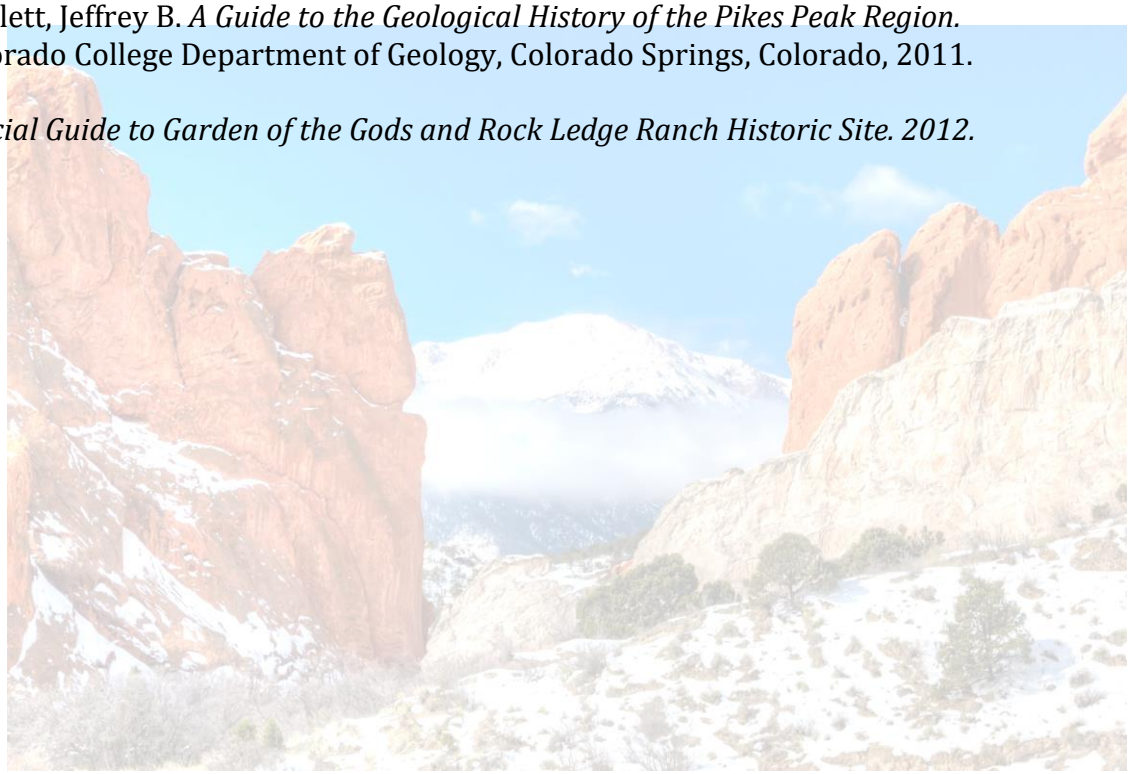


Geo-Journal

Name _____

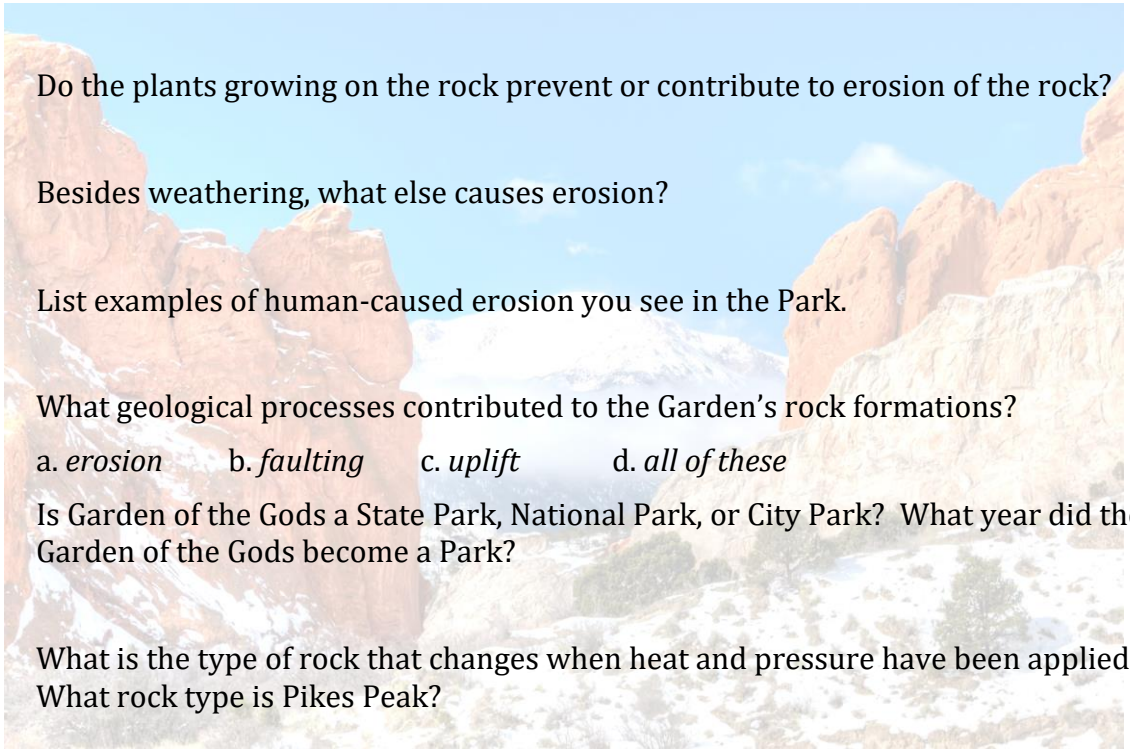
Garden of the Gods

Geology of the Park

1. Name the three rock types. Garden of the Gods rock layers are which rock type?

2. What causes holes to form in the rock formations?

3. Which is older, Lyons sandstone or the Fountain Formation?



4. Do the plants growing on the rock prevent or contribute to erosion of the rock?

5. Besides weathering, what else causes erosion?

6. List examples of human-caused erosion you see in the Park.

7. What geological processes contributed to the Garden's rock formations?

   a. *erosion* b. *faulting* c. *uplift* d. *all of these*

8. Is Garden of the Gods a State Park, National Park, or City Park? What year did the Garden of the Gods become a Park?

9. What is the type of rock that changes when heat and pressure have been applied? What rock type is Pikes Peak?

10. What do we call a break in the earth's crust along which movement has occurred?

11. What unique dinosaur was found in the Garden of the Gods Park?

    a. *Rockasaurus redikus* b. *Theiophytalia kerri* c. *Stegosaurus*

12. What caused our horizontal sedimentary rock to become vertical?

On the back, draw your favorite rock, plant, or animal from the Garden of the Gods.

Geo-Journal Answer Key

Garden of the Gods

Geology of the Park

1. Name the three rock types. Garden of the Gods rocks are which rock type?
   Sedimentary, igneous, metamorphic. GOTG rocks are sedimentary
2. What causes holes to form in the rock formations?
   Water seeps into the rock, freezes, cracks inside, repeats this, and eventually begins dripping out of a soft place (ice wedging)
3. Which is older, Lyons sandstone or Fountain conglomerate?
   Fountain conglomerate
4. Do plants growing on the rock prevent or contribute to erosion of the rock?
   Contribute
5. Besides weathering, what else causes erosion?
   People, animals, plants, pollution
6. List examples of human-caused erosion you see in the park.

   Walking off a designated trail, carving on the rocks
7. What geological processes contributed to the Garden's rock formations?

   d. all of the above
8. Is Garden of the Gods a State Park, National Park, or City Park? What year did the Garden of the Gods become a Park?

   City Park, dedicated in 1909
9. What is the type of rock that changes when heat and pressure have been applied? What rock type is Pikes Peak made of?

   Metamorphic. Igneous (granite)
10. What do we call a break in the earth's crust along which movement has occurred?

    Fault
11. What unique dinosaur was found in the Garden of the Gods Park?

    b. Theiophytalia kerri
12. What caused horizontal sedimentary rock to become vertical?

    Uplift and faulting