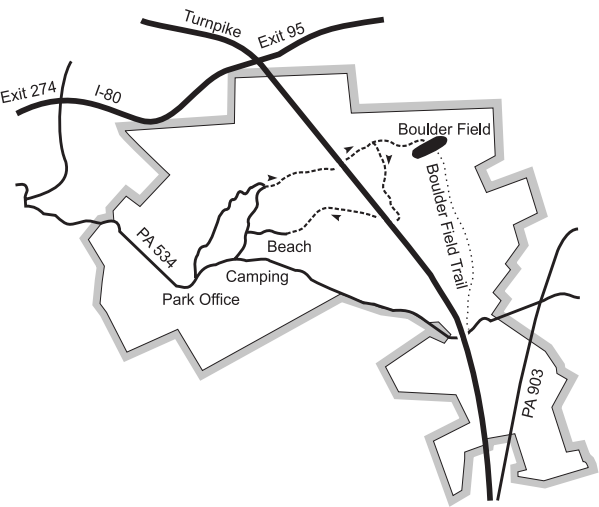


Explore

People have been exploring Boulder Field for centuries. Watch your step since some of the boulders move. Try these activities:

- Examine the different textures of rocks.
- Try to find the largest boulder.
- Try to find the smallest rock.
- Look for water moving under the boulders.
- Look for natural depressions in the field, but be sure not to move the boulders.
- Search for animals and plants that find a way to live in the barren area.
- Attend an educational program. Check at the park office for a program listing. Or, arrange a program for a school or organized group by contacting the park office.

Map to Hickory Run State Park and Boulder Field



Hickory Run State Park
3613 State Route 534
White Haven, PA 18661
570-443-0400
email: hickoryrunsp@pa.gov
www.visitPAparks.com
5/18



The Mild, Modern Climate Halted the Formation of Boulder Field

A Warming Trend

For an unknown reason, the climate began to warm about 15,000 years ago. The glacier melted farther and farther back each year, releasing large amounts of water and debris. Animals and plants slowly returned to their former ranges. About 11,000 years ago, humans arrived in the Poconos to find dark spruce forests, bogs and many boulder fields.

When the yearly average temperature rose above freezing, the permafrost thawed and Boulder Field stopped forming. As the climate continued to warm, pines and hemlocks replaced most of the spruce trees. Many boulder fields and other glacial features were covered or destroyed by soil and forests. Possibly due to its location, Boulder Field survived.

Experts debate the lack of sand or other debris between the boulders. Some say that there never was any of this *interstitial material*, while others hold that the sand and mud washed away, or settled under the stones. The stream Hickory Run starts in a bog just east of Boulder Field. The water flows under the field and emerges west of the field and there is officially called Hickory Run. It is unknown how long this water flow existed or if it helped form Boulder Field or removed the interstitial material.

Boulder Field has grown smaller. Trees lining the edge of the field drop leaves and plant material onto the boulders. After enough leaves accumulate, it becomes soil for shrubs and trees to grow, shrinking the field.

Help Preserve this Scenic Wonder

In 1967, Boulder Field was declared a National Natural Landmark by the U.S. Department of the Interior. To receive this designation, an area must be deemed unique to the region and be of scientific significance.

In 1993, Boulder Field was declared a State Park Natural Area and will be preserved with a minimum of human intervention.

To preserve the beauty and wonder of Boulder Field:

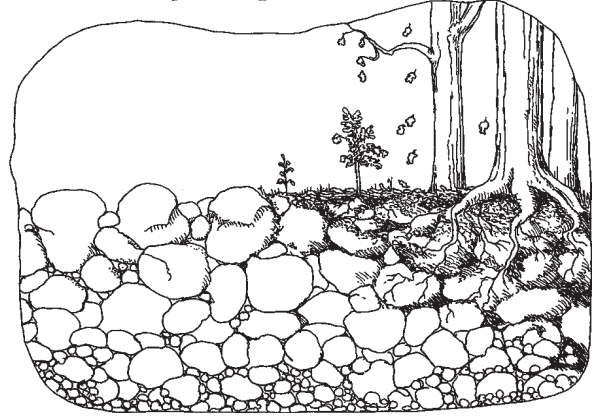
- ◆ Please explore Boulder Field and enjoy its natural beauty.
- ◆ Please take only pictures.
- ◆ Please do not paint or vandalize the boulders.

The Future is Uncertain

The future of Boulder Field is uncertain. As more visitors see the field, vandalism is increasing. Painting and moving rocks is destroying this ancient landscape. With minimal human intervention, two futures are possible.

1. Trees continue to encroach on the field and eventually might cover all of Boulder Field.
2. The earth is still in the ice age. It just happens to be a warm period. Scientists figure that in about 5,000 years, the climate will begin to cool and ice sheets will grow at the poles. If a new continental glacier nears Hickory Run, the ground will freeze and Boulder Field will grow to be an even more spectacular landscape for future generations.

Boulder Field is slowly shrinking.



- ◆ Please do not move the boulders.
- ◆ Please do not litter.



Boulder Field
at Hickory Run State Park



Boulder Field is a fossil, a relict, a leftover. However, it is not the remains or impression of an ancient animal or a plant, but a small piece of a landscape left over from the last ice advance. About 15,000 years ago, this type of landscape was common throughout Pennsylvania and the northern part of North America. But since then, the climate has warmed, and plants, soil and weathering have covered or removed boulder fields. Only in unique places do they remain, like at Hickory Run State Park.

The field is a jumbled assortment of loosely packed boulders which range in size from 25 feet to several inches in length. Most boulders are under four feet in length. The field is 400 feet wide, 1,800 feet long, about ten feet deep, and surprisingly flat. The boulders are predominantly red sandstone but there are also some quartz conglomerate. The boulders trend from angular shapes in the east side to more rounded shapes in the west side.

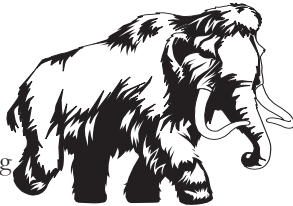
Hickory Run State Park is in northern Carbon County, Pennsylvania. Boulder Field is easily reached by following Boulder Field Road, but this dirt road is closed in the winter. The field can also be reached by Boulder Field Trail, a three-mile hike, one way. Consult the map on the back of this brochure to help you find Boulder Field.

A Harsh Climate Very Different from the Modern Climate Created Boulder Field

An Ice Advance Begins

For unknown reasons, about 80,000 years ago, the climate began to cool. More snow fell on the north and south poles than melted each year. The extreme buildup of ice caused the most recent ice advance, sometimes called the ice age.

As the yearly temperature cooled, animals migrated farther south. Plants and trees changed as cold-tolerant species replaced the dying warm-loving species.



Out of the north crept a giant sheet of ice--a *glacier*. Several miles thick and as wide as North America, the Laurentide Continental Glacier was a frozen blanket that eventually covered two-thirds of North America.

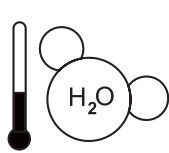
Like a giant bulldozer, the glacier scraped the land, removing vegetation and soil, and flattening hills and ridges. Rocks, sand, mud and debris were pushed and carried by the glacier.

Eventually, the glacier moved so far south that in the summer, it melted back as far as it advanced the previous winter. The glacier stopped near, but never reached Boulder Field.

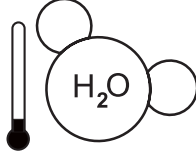
The Power of Water

Water has a unique property that helped create Boulder Field. Most chemicals shrink as they cool, but water briefly enlarges when it nears freezing.

Water expands when it nears freezing.



Liquid Water



Frozen Water

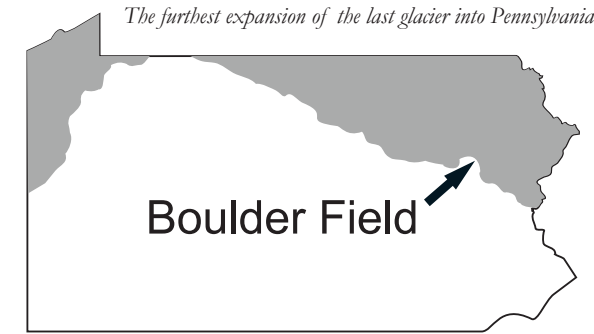
Liquid water can enter very small cracks in rock. When the temperature drops below freezing, the liquid water briefly enlarges, widening the crack in the rock. If the temperature rises, the ice thaws and the liquid water sinks deeper into the crack. This is called *freeze-thaw*. Potholes in roads begin this way.

A similar process is *frost-heave*, which takes place in wet soil or sand. Freezing water expands, lifting objects above it. Freezing water attracts more water and the molecules stack themselves. Objects can be lifted up almost two inches. Frost-heave lifts rocks, and shallowly buried fence posts and mail box posts.

Location, Location, Location

Landscape and topography also affected the formation of Boulder Field. Although it appears perfectly flat, the area is slightly inclined. This one degree slope is enough for materials to move when pulled by gravity.

The entire area encompassing Boulder Field is a highland. Consult the map below to see the extent of the last glacier in Pennsylvania. The glacier was at its terminal point and could not surmount the 1800-foot ridges. The glacier moved south of Boulder Field to the east and west, but did not cover or reach Boulder Field. The area was surrounded by ice and this certainly cooled the temperature further.



The furthest expansion of the last glacier into Pennsylvania.

Boulder Field

The Perfect Temperature

The average temperature today in the Poconos is 41 F. During the last ice advance, the climate was much colder. Winter lasted for six months and the annual temperature was 20 to 25 F cooler, which made the average temperature below freezing. It was the perfect temperature to freeze the ground.

Permanently frozen ground is called *permafrost*. The surface two to three feet of permafrost is called the *active zone*. This layer of frozen mud and soil can thaw, but the deeper ground remains frozen. The watery nature of the active zone is perfect for freeze-thaw and frost-heave.

Few plants can grow on permafrost soil. Without the plants, much of the soil washes away, exposing the underlying rock, which is called *bedrock*. This makes it harder for plants to grow.

The temperature was cold enough to freeze the ground, but fluctuated enough that in the summer and part of spring and autumn, the temperature rose above freezing in the day, then refroze at night. It was the perfect temperature for freeze-thaw and frost-heave.

The Landscape Moved in a Process Called Gelifluction

Location kept Boulder Field from being under the glacier and allowed a very cold climate. The climate was cold enough to expose bedrock and create permafrost, yet was warm enough for the temperature to go above and below freezing. The temperature fluctuations caused freeze-thaw and frost-heave that *eroded* (broke-up) bedrock and moved the rock downslope on the permafrost in a slurry of ice, mud, sand, water and boulders. This movement is called *gelifluction*.

Abundant water worked down into cracks in the bedrock, usually during the day, then froze at night, widening the cracks. Large sections of rock, about the size of a school bus, broke off of the intact bedrock. Pulled by gravity, the rock moved downslope, moving from east to west.

The rocks moved on the one degree slope because the active layer of permafrost melted, and the entire mass slid on the still frozen permafrost underneath. Boulders,

mud, sand, water and ice were a thick stew that slowly crept downslope. The speed of movement is not known, but it is assumed that it was extremely slow.

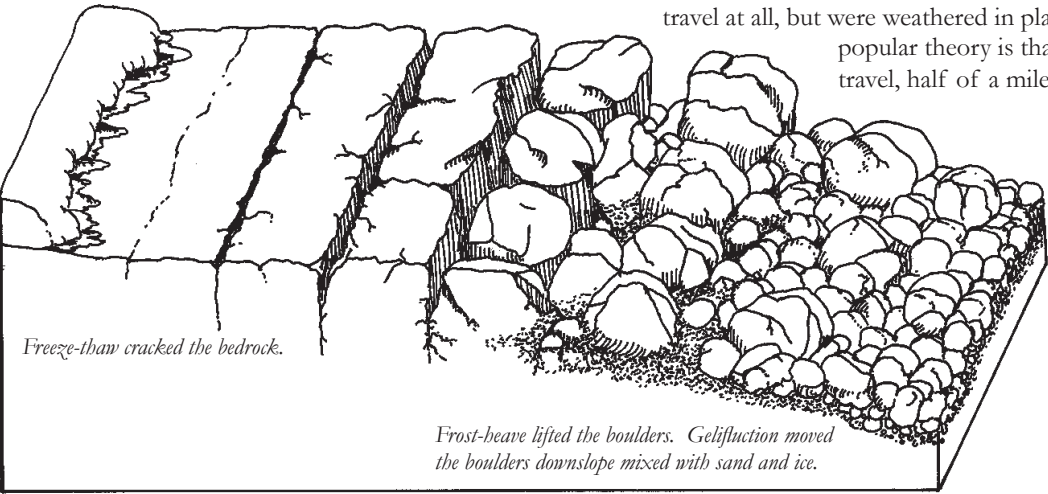
As the large boulders moved, they slowly rolled, exposing more cracks that were widened by freeze-thaw. The boulders slowly broke into smaller and smaller pieces and crept downslope. As they moved, the boulders ground against each other, rounding the edges. Streams of rock can be traced the length of the field to their origin in the bedrock at the head of the field in the east.

The boulders also moved vertically. Constant ice formation at the bottom of the field heaved upward, lifting the boulders. Larger boulders were lifted higher because they have greater surface area. Slowly the larger boulders were heaved to the top of Boulder Field and the smaller rocks worked to the bottom. This upward movement rounded the boulders even more, and created stone circles. Some of these circles can still be seen in

the field. Look for indentations in the field that have large stones on the edges.

There is debate about how far the boulders moved. Some scientists say the boulders traveled great distances, about one mile, while others say the boulders did not travel at all, but were weathered in place. The most popular theory is that there was some travel, half of a mile or less.

Scientists continue to visit Boulder Field to resolve the mysteries of its formation and continued existence.



Freeze-thaw cracked the bedrock.

Frost-heave lifted the boulders. Gelifluction moved the boulders downslope mixed with sand and ice.