Reading in Science

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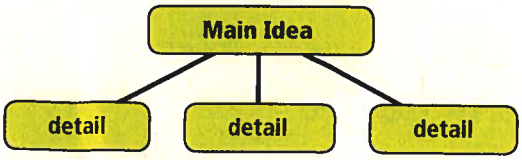
SCIENCE CONCEPTS
- how Earth is structured
- ways that Earth's surface changes

READING FOCUS SKILL
MAIN IDEA AND DETAILS Look for details about how Earth's surface changes.



Earth's Layers

Have you ever cut an onion? The outside is a thin, dry skin. But when you slice into the onion, you realize that there are many layers hidden under the skin. Just like an onion, Earth has many layers underneath its thin outer skin, or its **crust**. The crust includes both dry land and the ocean floor. No organism lives beneath the Earth's crust. In fact, the crust is the only layer of Earth that people have actually seen.

Scientists have had to learn about the layers beneath the crust through indirect evidence. For example, energy moves through objects of different densities at different speeds. Scientists have measured how fast energy waves move through Earth to calculate the densities and

Science Up Close

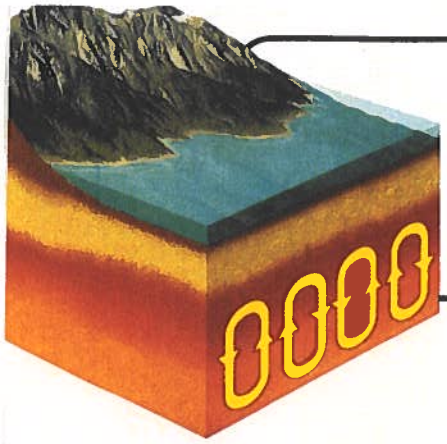
Earth's Layers

Within Earth's main layers lie several other layers that differ in their physical properties. The layers differ in temperature, pressure, and composition.

Outer Core (2200 km thick)
The outer core is made of very hot liquid iron and nickel. The movement of the outer core produces Earth's magnetic field.

Inner Core (1250 km thick)
The inner core is very hot, but it's been pressed into a solid metal ball by pressure from the layers around it.

Mantle (2900 km thick)
The upper part of the mantle consists of two layers. The upper layer is part of the lithosphere, with the asthenosphere lying below it. The lower mantle is made up of iron and magnesium silicate minerals.



The crust is much thicker under continents than under the ocean floor. The crust is thickest under tall mountain ranges, such as the Alps and Himalayas.

thicknesses of all of Earth's layers. Through their calculations, scientists have learned that the crust is the thinnest and least dense layer.

Underneath Earth's thin crust is a very thick layer of Earth called the **mantle**. Some of the upper mantle is partially melted, and the rest is solid.

Beneath the mantle is the last major layer of Earth, called the **core**. There are two parts to the core—a liquid outer core and a solid inner core. The core extends from the bottom of the mantle to Earth's center. Scientists think the core is made mostly of iron and nickel because of the core's density. Earth's iron-rich core also acts as a magnet, producing Earth's magnetic field. Like a magnet, Earth has a magnetic north pole and a magnetic south pole. This is why a compass works. The compass needle aligns itself with Earth's magnetic field and points toward the magnetic north pole.

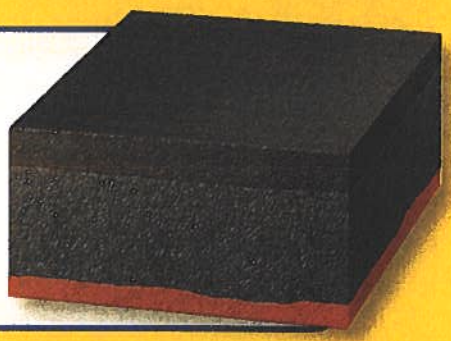
Focus Skill **MAIN IDEA AND DETAILS** **What are the three main layers of Earth?**

Crust (0–100 km thick)

Earth's crust is the thinnest of Earth's layers. It is thinner under the oceans than under the continents.

Lithosphere (averages 1.6–130 km thick)

The *lithosphere* (LITH•uh•sfir) is the crust and the upper, solid part of the mantle.



Asthenosphere (72–250 km thick)

The *asthenosphere* (as•THEN•uh•sfir) is the upper part of the mantle below the lithosphere. The rock is molten and taffy-like.

For more links and activities, go to www.hspscience.com

Wind, Water, and Gravity Change Earth's Surface

Earth's crust is constantly changing. Some of these changes are caused by the movements of the asthenosphere. Other changes are caused by conditions on Earth's surface. For example, suppose a large boulder is sitting in a meadow. On a windy day, wind carrying small bits of sand blows against the boulder. The sand hits the boulder at high speeds and breaks off tiny bits of rock. The boulder is undergoing **weathering**, or the process of being broken down into smaller pieces.

Of course, wind is not the only force that can weather Earth's surface. Water is another powerful weathering agent. Suppose it rains on the same boulder in the meadow. In a process known as **erosion**, or the removal and transportation of weathered material, the pieces of rock are carried away.

Gravity is a very powerful agent of erosion. Think how a large boulder could have ended up in a meadow in the first place. If there's a nearby hill or mountain, you have your answer. Gravity probably caused the boulder to roll down the mountain. Gravity also carries away bits of rock by causing rock slides and mudflows. As rocks move downward during a rock slide, they collide with one another. This causes the rocks to break into smaller pieces, leading to further weathering and erosion.

The amount of weathering and erosion that takes place depends on many factors. A soft rock erodes much faster than a hard rock. And stronger forces cause more weathering and erosion than weaker forces. For example, suppose that the

This sea cave was formed as ocean waves crashed against a rock cliff. Over time, the waves produced a pocket in the rock, forming a cave.

These sand dunes have been formed by wind deposition. When the wind hits an obstacle, the wind slows down. Heavy material, such as sand, carried by the wind then falls to the ground and builds up.

The Cuckmere River in Sussex, England, has meanders, or bends. They form when eroded material from one meander is deposited on the inside of the next meander as the speed of the water decreases.

boulder in the meadow were in a fast-moving river. The water in the river would quickly weather and erode the surface of the boulder. Instead of having jagged edges, the boulder would become rounded and smooth.

What happens to the small pieces of rock that are weathered and eroded? These small pieces, called *sediment,* are carried by wind and water. Eventually, the wind and water lose energy and slow down. When this happens, the sediment drops out of the air or water, and deposition occurs. **Deposition** is the dropping or settling of eroded material.

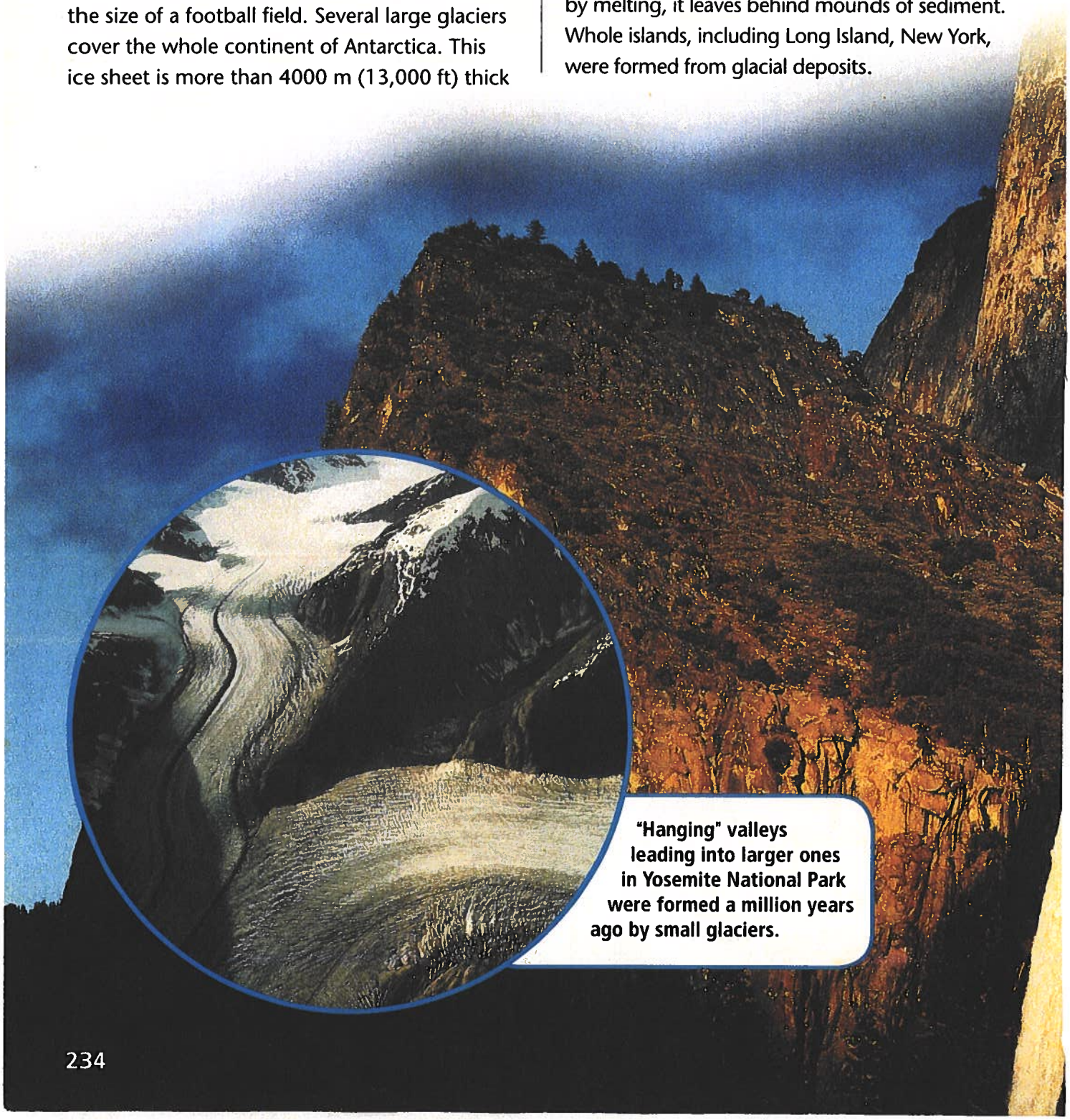
Deposition can occur very close to where the sediment was originally produced. This happens often when gravity is the weathering agent. For example, if gravity causes a rock slide or a mudflow, the materials usually don't move very far before settling. However, sediment from weathering can sometimes travel very far. For example, sediment that is picked up at the beginning of the Nile River, in Africa, may travel more than 6600 km (4100 mi) before being deposited at the river's mouth!

Focus Skill **MAIN IDEA AND DETAILS** **How do wind, water, and gravity change Earth's surface?**

Ice Changes Earth's Surface

You've already learned that liquid water changes Earth's surface. Frozen water does this, too. In some areas of the world, the environment is cold enough for huge sheets of ice to form and stay frozen year-round. These immense ice sheets are called **glaciers**. They do not stand still but flow as slow-moving rivers of ice. Glaciers vary in size. A small one might be found in a mountain valley and be about the size of a football field. Several large glaciers cover the whole continent of Antarctica. This ice sheet is more than 4000 m (13,000 ft) thick and spreads over an area of 13 million sq km (5 million sq mi)! That's about one and a half times the size of the United States.

Now just imagine what might happen to the land underneath a glacier as the huge, heavy sheet of ice moves. The glacier carries rocks, debris, and sediment along with it as it flows forward. This smoothes out the landscape as the glacier erodes small hills and other sharp features. When the glacier stops moving forward or retreats by melting, it leaves behind mounds of sediment. Whole islands, including Long Island, New York, were formed from glacial deposits.



"Hanging" valleys leading into larger ones in Yosemite National Park were formed a million years ago by small glaciers.

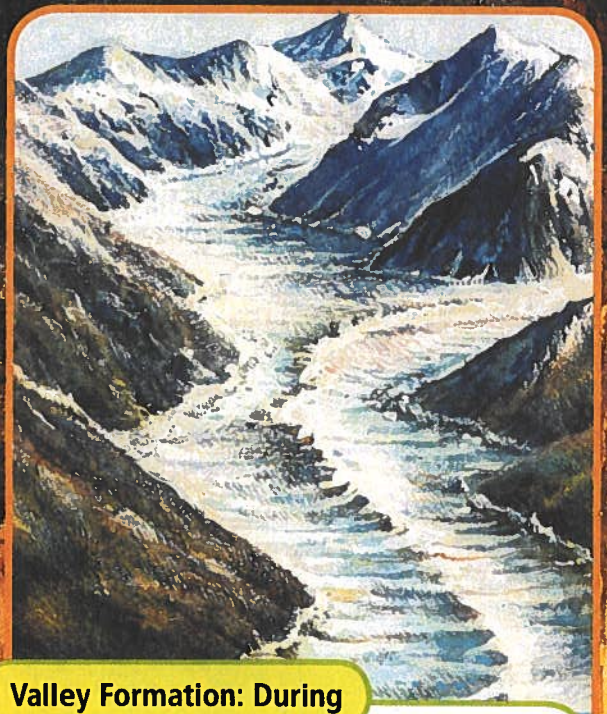
Sometimes a glacier is so heavy that it pushes down the land it flows over. When the glacier retreats, the land rises back up in a process called *uplift*. In fact, the retreat of the same group of large glaciers that formed Long Island also caused uplift along much of the northeast coast of the United States. This produced many of the sea cliffs that are found in that region today.

Focus Skill **MAIN IDEA AND DETAILS** **What are three ways that glaciers can change the landscape?**

Insta-Lab

Modeling Glaciers

Half-fill two paper cups with water. Pour 2 tablespoons of sand into one cup. Put both cups in a freezer overnight. The next day, take the two pieces of ice out of the cups and rub each piece across a sheet of aluminum foil, representing Earth's surface. Describe what happens to the foil when you rub it with each piece of ice. Let the ice with sand in it melt over the foil. Describe what happens.



Valley Formation: During

As a glacier advances down a mountain valley, it erodes the sides of the valley.

Valley Formation: After

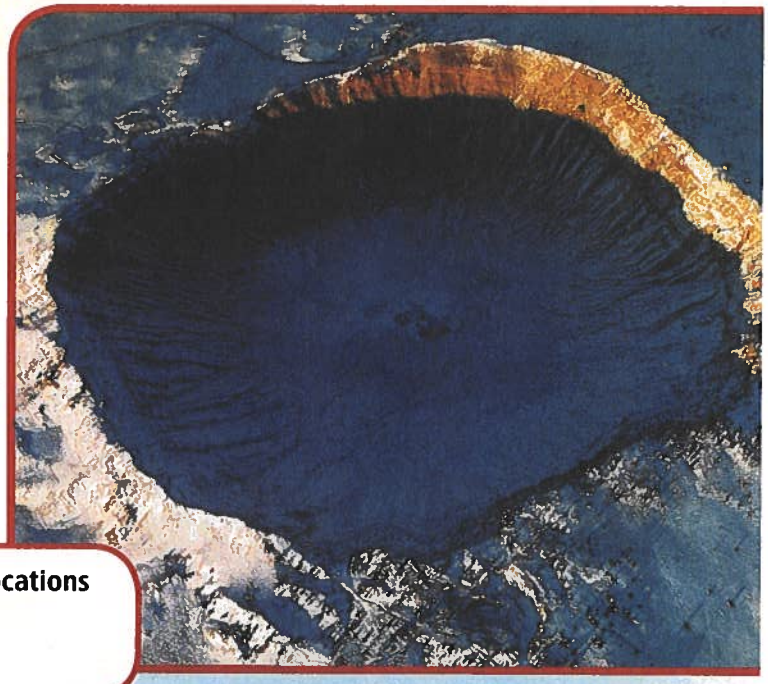
When the glacier retreats, it reveals a U-shaped valley. A broad valley like this is called a *glacial trough*.

Impacts Change Earth's Surface

Have you ever seen pictures of the surface of the moon? It is pockmarked with hundreds of craters. The craters formed when rocks from space, known as **meteorites**, collided with the moon. Meteorites have also struck Earth. However, Earth has experienced fewer meteorite impacts than the moon because Earth's atmosphere is much thicker. The atmosphere causes many of the falling objects to burn up before they reach Earth's surface.

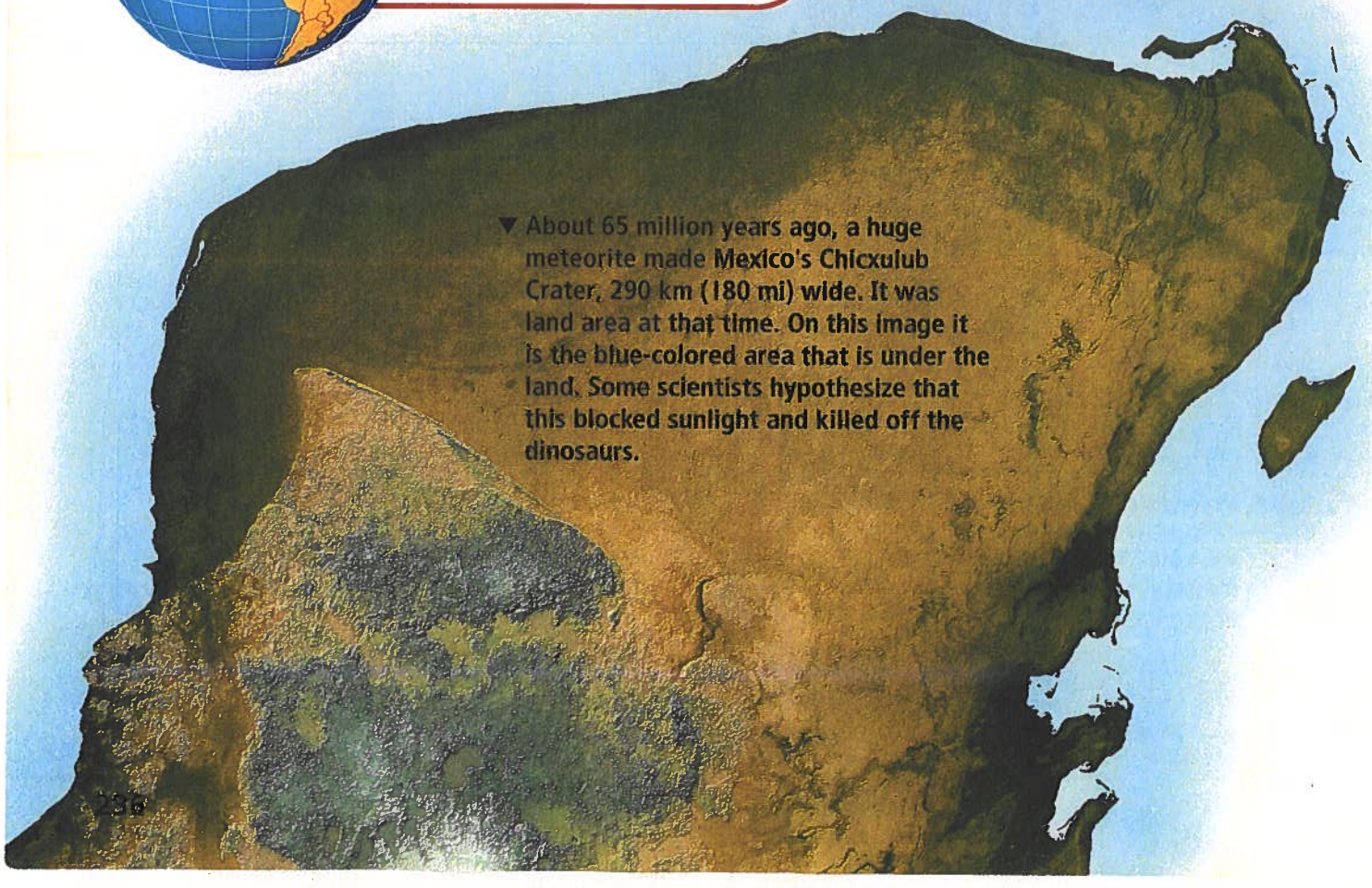
If an object is large enough to survive entry through Earth's atmosphere, it may form a crater when it hits the surface. Many craters have been found around the world, including in the United States.

Focus Skill **MAIN IDEA AND DETAILS** **What causes craters to form?**



Meteor Crater, in Arizona, was formed by a meteorite that hit Earth about 20,000 years ago. The meteorite made a hole about 1.2 km (0.7 mi) across. ▶

This map shows the locations of Meteor Crater and Chicxulub Crater.



▼ About 65 million years ago, a huge meteorite made Mexico's Chicxulub Crater, 290 km (180 mi) wide. It was land area at that time. On this image it is the blue-colored area that is under the land. Some scientists hypothesize that this blocked sunlight and killed off the dinosaurs.