The Rocks and Sediments of New Jersey

Some people may say a rock is just a rock, but what exactly *is a rock*?

Rocks vs. Minerals

Before we get into the fun and unique details about rocks, we need to understand what makes a rock an actual rock, and what the difference is between minerals and rocks. We also need to understand why they are associated with each other.

A **mineral** is a substance that is formed by natural and living processes. They form in several ways, such as by heat and pressure, organisms, water evaporation, or the cooling of molten rock. Amazingly, more than 3,000 minerals are formed worldwide. Some minerals are even essential for human health. Essential minerals are typically grouped into two different categories: macrominerals and microminerals. The difference between these two terms is that microminerals are needed in smaller amounts compared to macrominerals. Some examples of macrominerals are potassium, calcium, and magnesium and some examples of microminerals are iron, iodine, and selenium.

A **rock** is a naturally occurring solid mass. Both rocks and minerals are associated with each other since a rock consists of one or more minerals.

The Three Rock Types: Igneous, Sedimentary, and Metamorphic

Rocks are classified by three main rock types, and you may be asking why. This is because rocks have originated differently due to various processes. Let's take a closer look at these rock types individually to understand what makes a rock either igneous, sedimentary, or metamorphic.

Igneous Rocks:

When rocks are subjected to extreme temperatures and pressure deep within the Earth, the process of rocks melting into a hot fluid or semifluid material known as *magma* can take place. Believe it or not, there are two different types of igneous rocks! The way in which magma cools can determine whether an igneous rock is either intrusive or extrusive.

So, what is the difference between intrusive and extrusive rocks?

Intrusive rocks are formed when magma cools slowly and becomes a solid underneath the Earth's surface. **Diabase** is an example of an intrusive rock. **Extrusive rocks** are formed when magma comes to Earth's surface and cools rapidly. This typically happens when volcanoes erupt. **Basalt** is an example of an extrusive rock. The rocks diabase and basalt are discussed more specifically later on in this activity.

Sedimentary Rocks:

Over time, physical and chemical weathering contribute to the process of rocks being broken down into small particles or grains at Earth's surface. Such rocks can often be easily recognized by its distinctive layering or bedding.

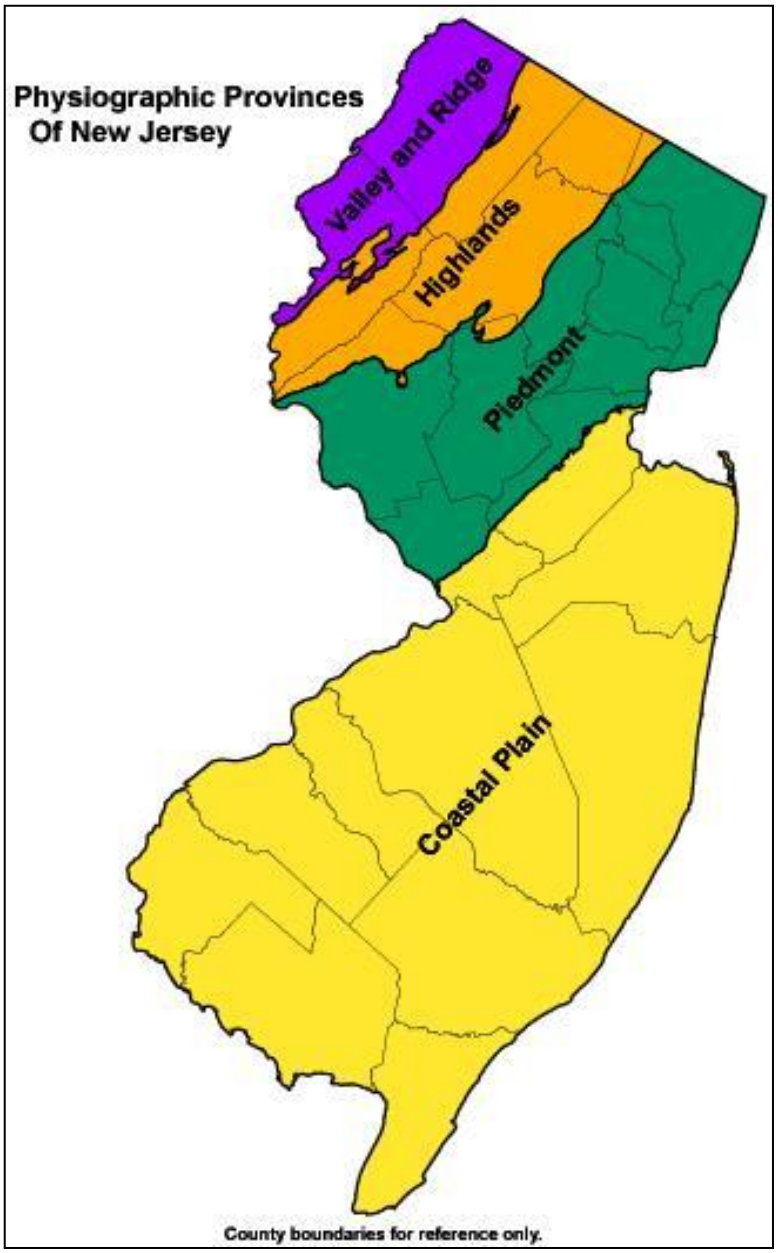
Metamorphic Rocks:

Rocks that have changed form, or "metamorphosed", define metamorphic rocks. This occurs when rocks are subjected to extreme temperatures and pressure. Igneous, sedimentary, and even metamorphic rocks can all be metamorphosed.

How did the rocks of New Jersey originate?

The rocks of New Jersey have formed in many ways and much of the state's beauty comes from various geologic formations. Some of these rocks formed when continents drifted apart, allowing lake and river sediments to be deposited in narrow rift valleys that unfolded. Continental collisions allowed some rocks to be uplifted and formed ancient mountains. Other rocks formed from mud and sand of ancient shorelines. It truly is amazing how rocks play such an important role in shaping New Jersey for what it is today, as well as the Earth itself.

The map to the right shows the physiographic provinces of New Jersey. The separation of each province establishes a major difference in topography and geology. Four physiographic provinces make up New Jersey: The Valley and Ridge, Highlands, Piedmont, and Coastal Plain.



New Jersey's Rocks and Sediments

Now that you are finally on your way toward becoming a rock expert, it is time to talk about the specific rocks and sediments that can be found in New Jersey!

Sediments:

1). Peat

In wetlands such as swamps and bogs, partially decomposed plant material, known as peat, are formed in such environments. In New Jersey, most peat accumulated over time in low-lying and undrained areas for about 17,000 years following the end of the last ice age. Peat can transform into coal, which requires deep burial as well as a lot of time. The spongy material that makes up peat is responsible for its high water-holding capacity and this is beneficial for the purpose of improving soil conditions and retaining moisture for lawns and gardens.

A peat sample that comes from a bog in Lafayette Meadows, located in Sussex County.

2). Clay

When compared to other sediments, clay consists of the smallest particle size. Clay's particles are so small that it cannot be seen with the naked eye. One would need to do X-ray analyses or use special equipment such as high-powered microscopes to see it. Back in the day, hundreds of thousands of tons of clay dug in Central New Jersey was used to make bricks, pottery, roofing tile, and other useful products. Most of the clay that is currently mined in New Jersey is used to seal the tops of landfills in a process known as "capping". Landfills are sites that are used to dispose waste materials. Clay is used to cap landfills because it is essentially watertight and prevents rain from seeping into the landfill, which would mix with the polluted material if not capped.

This sample of clay from New Jersey was specifically dug to be used for the "capping" of a landfill.

3). Glass Sand

This sediment originates from common beach sand and is used to make glass, hence its name. Glass sand is made up almost entirely of quartz. Some of the highest-grade glass sand (more than 99 percent pure quartz) comes from two counties of South Jersey: Cumberland and Salem. Not only is glass sand used as a raw supply, but the pure quartz sands of New Jersey are used for other purposes such as making molds, silica gel (a drying agent), and silica flour, which is used for cosmetics (makeup).

New Jersey glass sand

4). Lime Sand

This specific sediment is unique because it is made up of one mineral known as calcite, and unlike most minerals, can fizz in a weak acid such as vinegar. In lime sand, it is quite common to see fossil fragments of clams, snails, and sea urchins. With a magnifying glass, hand lens, or low magnification microscope you can often see tiny fossils such as single-celled animals called foraminifera.

A sample of lime sand from New Jersey (Vincetown, Burlington County) that is comprised almost entirely of fossil fragments.

5). Greensand

This sediment gets its green color from a mineral known as glauconite. The sandy mixture not only consists of glauconite, but also clay and quartz sand. Greensand is important because it contains chemicals that are vital for plant growth, including potassium, phosphorus, and lime. In New Jersey, it was mined and used as a fertilizer starting as early as the 1700's. Even though greensand is still being used for soil improvement, by the 1900's, artificial fertilizers put most greensand producers out of business. Greensand also can be used to soften water. Softening water can reduce high levels of mainly calcium and magnesium ions. Hard water can be problematic because it prevents soap from lathering and can cause staining. In comparison to fertilizers, most artificial compounds have replaced greensand for the purpose of softening water.

A sample of greensand from the Inversand Pit in Sewell, Gloucester County. For many years, this pit was the only place in North America where greensand was produced.

Sedimentary Rocks:

6). Shale

Shale is known as the most common sedimentary rock and it is formed from the compaction of mud or clay. Shale is considered the most common type of sedimentary rock because most sediments produced from the weathering of rocks become mud. In many parts of central and northeastern New Jersey, red soil derived from the weathering of shale can be recognized. The red coloration of shale comes from oxygen-rich iron minerals. When shale is soft enough to be ground into a clay-like material, then

This shale sample was formed on the bottom of a shallow lake that produced little to no oxygen. Iron materials and organic debris contribute to its dark coloration.

bricks and terra cotta can be produced. Terra cotta is used to make products such as tiles, flowerpots, and ceramic piping.

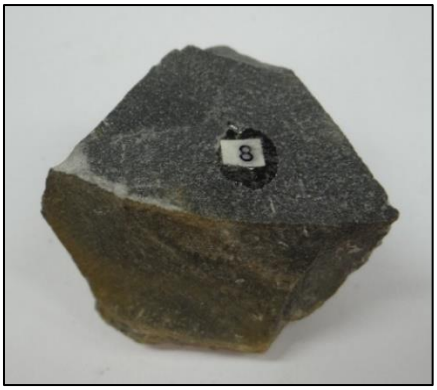
7). Sandstone

Sandstone is formed by groundwater depositing minerals between the sand/gravel grains. This process causes sand grains to cement together. High temperatures and pressure that occur thousands of feet underground are responsible for creating most of New Jersey's sandstone formations.

This sandstone was formed about 210 million years ago, dating back to the Late Triassic Period (when dinosaurs were around). It was formed in a desert environment from sand deposited by rivers.

8). Limestone, 9). Dolomite

Both limestone and dolomite are comparable because they are chemically similar, form from minerals dissolved in water, and form mostly in warm climates. Although they are both formed from minerals dissolved in water, they are not comprised of the same minerals. Limestone is primarily composed of the mineral calcite whereas dolomite is primarily composed of the mineral dolomite (the same as its rock name). Another distinction between these two rocks is that they dissolve differently. Limestone tends to break down at a faster rate because the calcite within it dissolves more easily than dolomite does in water. Limestone and dolomite are widely extracted for producing cement and agricultural lime (reduces soil acidity and provides calcium for plant growth). A lot of limestone today is used for road building materials and other construction purposes.



The minerals in these rock samples were precipitated from sea water, mainly by the one-celled plants known as algae.

Metamorphic Rocks:

10). Slate

In a marine environment about 450 million years ago, the slate in the above image was first deposited as clay and mud. Eventually these sediments were buried and formed into shale. High temperatures and pressure changed the shale to slate.

Shale forms into slate at extremely high temperatures and pressure deep underground. Slate can be viewed in North Jersey along the base of Kittatinny Mountain in Sussex and Warren counties. Typically, slate can be made to produce blackboards, but New Jersey's slate consists of sand layers that does not allow it to break into large, flat pieces.

11). Quartzite

When quartz grains have become tightly bound together from silica precipitated out of solution, or recrystallized under intense heat and pressure, the rock quartzite is formed. Quartzite is unique because unlike many rocks, it is tough and more resistant to erosion. At the two ends of Kittatinny Mountain lie High Point (the highest spot in New Jersey) and Mount Tammany. This 35-mile long mountain that is about 1,000 feet high is made up of quartzite.

Quartzite from New Jersey

Mount Tammany

12). Marble

The rock marble can be seen in several belts located in the New Jersey Highlands. It is formed from the recrystallization of limestone or dolomite. Marble is used for several purposes. In New Jersey, marble is usually mined and used for landscaping. It can also be used as grit for chickens to eat and for agricultural lime.

Marble can frequently be found throughout the Northeastern United States around trees, bushes, and along walks.

13). Gneiss

A fun fact about this rock is that it is pronounced as “nice”! A typical characteristic specific to gneiss is that it has an irregular layered appearance consisting of light and dark mineral bands that may become more visible when the rock is wet. Gneiss has been through so many changes that it is difficult to know what rock it has been formed from. Some of the rocks that gneiss is originated from include slate, sandstone, and other igneous and metamorphic rocks. Gneiss is used for construction purposes such as chipped rock used in road surfaces (known as road metal).

In this gneiss sample, you can see the light-colored crystals, which include quartz and feldspar. You can also see the dark-colored crystals, which include amphibole or biotite mica (iron and magnesium responsible for dark coloration).

Igneous Rocks:

14). Diabase, 15). Basalt

Both diabase and basalt are both remarkably similar rocks, for they are both formed from molten rock material (magma), but they do have differences! Basalt is classified as an extrusive igneous rock while diabase is classified as an intrusive igneous rock. They are classified this way based on their formations. Basalt reached Earth’s surface from lava that erupted from volcanoes and fissures and cooled rapidly at the Earth’s surface. Basalt does not have visible crystals that can be seen with the naked eye since it formed very quickly. With a microscope, you may be able to see the crystals in basalt. Unlike basalt, diabase did not reach Earth’s surface and it took thousands of years for the magma to cool and harden. Diabase crystals are visible with the naked eye because of its long, cooling process. Because diabase and basalt are harder compared to many of other rocks, they resist erosion and remain as mountains and boulder fields.

If you look closely at this image of diabase above, you can see the crystals that have formed because of the slow cooling process. The dark specks represent a mineral called pyroxene and the white speaks represent the minerals feldspar or plagioclase.

Basalt does not have any visible crystals because of its formation under rapid cooling conditions.

Ores and Economic Minerals:

What is an ore?

Ores are rocks that consist of one or more minerals that can be extracted for valuable profit.

16). Ironstone

Although ironstone is not an ore because it contains too much sand and too little iron, we mention it here because it is common throughout the Coastal Plain of New Jersey. If ironstone consisted of more iron, it would be considered a bog iron ore. Ironstone is made up mainly of quartz sand cemented together by iron minerals. Chemical and bacterial processes allow these minerals to form when iron dissolved in acidic water is deposited.

In this ironstone, you can see that it mainly consists of quartz sand with its yellow-white coloration.

17). Magnetite

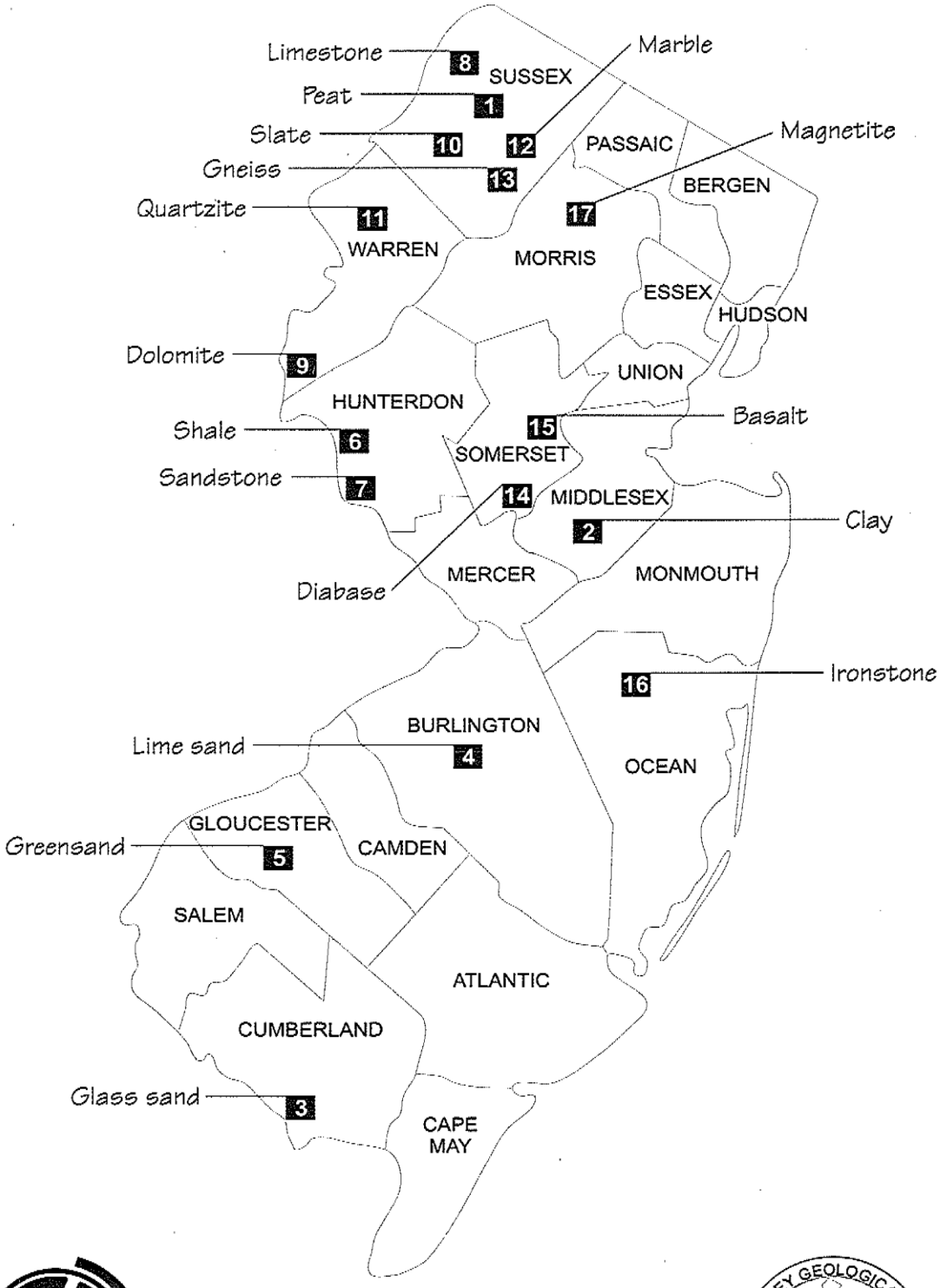
The rock magnetite, unlike ironstone, is an ore because of its high iron concentration; for this reason, it can even be picked up by a magnet. Magnetite can be found in northern Jersey where gneiss is located.

The gray-black coloration in magnetite shows its abundant iron concentration.

Specimen	Geologic Source	Township	County
1 Peat	Peat bog	Lafayette	Sussex
2 Clay	Woodbury Clay	Monroe	Middlesex
3 Glass sand	Cohansey Sand	Downe	Cumberland
4 Lime sand	Vincentown Formation	Southampton	Burlington
5 Greensand	Hornerstown Formation	Mantua	Gloucester
6 Shale	Stockton Formation	Kingwood	Hunterdon
7 Sandstone	Stockton Formation	Delaware	Hunterdon
8 Limestone	Glenerie Formation	Sandyston	Sussex
9 Dolomite	Allentown Dolomite	Pohatcong	Warren
10 Slate	Martinburg Formation	Newton[1]	Sussex
11 Quartzite	Shawangunk Formation	Blairstown	Warren
12 Marble	Franklin Marble	Sparta	Sussex
13 Gneiss	Microcline gneiss	Sparta	Sussex
14 Diabase	Rocky Hill diabase	Franklin	Somerset
15 Basalt	Orange Mountain basalt	Bound Brook[1]	Somerset
16 Ironstone	Cohansey Sand	Jackson	Ocean
17 Magnetite	Biotite-quartz-oligoclase gneiss	Rockaway	Morris

The table to the left categorizes where each sediment and rock specimen was collected geologically and geographically.

On page 11, there is a map of New Jersey and its counties. The numbers that are shown in specific counties represent the location where the sediment or rock specimen was collected. The images of sediments and rocks that were shown with each description in this activity correspond to this table as well as the map of New Jersey (pg. 11).



Department of Environmental Protection
Land Use Management
New Jersey Geological Survey

Multiple Choice: Put your sediment and rock knowledge to the test!

(Answer key available on page 22)

1. **What main rock type is formed by physical and chemical weathering?**

   a) Igneous rocks

   b) Sedimentary rocks

   c) Metamorphic rocks

2. **Rocks that change their form under extreme temperatures and pressure are:**

   a) Igneous rocks

   b) Sedimentary rocks

   c) Metamorphic rocks

3. **Which rocks have formed as a result of cooling magma?**

   a) Igneous rocks

   b) Sedimentary rocks

   c) Metamorphic rocks

4. **New Jersey is made up of how many physiographic provinces?**

   a) 3

   b) 4

   c) 5

   d) 6

   Name the physiographic provinces that make up New Jersey: _____

   _____

5. **A sediment that is used to make glass is:**

    a) Lime Sand

    b) Glass Sand

    c) Greensand

    d) Clay

6. **Which sediment consists of the smallest particle size?**

    a) Clay

    b) Peat

    c) Lime Sand

    d) Glass Sand

7. **It is common to see fossil fragments in:**

    a) Peat

    b) Lime sand

    c) Clay

    d) Greensand

8. **A sediment made up of partially decomposed plant material is:**

    a) Greensand

    b) Clay

    c) Lime sand

    d) Peat

9. **Glauconite is a mineral that contributes to the green coloration of this sediment:**

    a) Greensand

    b) Clay

c) Lime sand

d) Peat

10. What rock is formed from sand grains that are cemented together?

a) Limestone

b) Lime sand

c) Sandstone

d) Marble

11. An irregular layered appearance consisting of both light and dark mineral bands is characteristic of:

a) Marble

b) Gneiss

c) Dolomite

d) Limestone

12. What rock has a high iron concentration classifies it to be an ore?

a) Ironstone

b) Slate

c) Shale

d) Magnetite

13. In which rock are sand grains and silica tightly bound together by recrystallization?

a) Limestone

b) Quartzite

c) Gneiss

d) Dolomite

14. Which rock is formed from the compaction of mud or clay and is also known as the most common type of sedimentary rock?

a) Shale

b) Slate

c) Basalt

d) Diabase

15. What specific rock is not considered an ore since it consists of too much sand and too little iron?

a) Slate

b) Magnetite

c) Basalt

d) Ironstone

16. A sedimentary rock that is composed primarily of calcite is:

a) Limestone

b) Dolomite

c) Quartzite

d) Sandstone

17. An extrusive igneous rock that does not have visible crystals that can be seen with the naked eye is:

a) Gneiss

b) Quartzite

c) Basalt

d) Diabase

18. When exposed to extreme temperatures and pressure deep underground, shale forms into:

a) Diabase

b) Marble

c) Sandstone

d) Slate

19. What rock is formed from the recrystallization of limestone or dolomite?

a) Gneiss

b) Quartzite

c) Marble

d) Limestone

20. An intrusive igneous rock that has visible crystals that can be seen with the naked eye is:

a) Diabase

b) Marble

c) Quartzite

d) Basalt

Index Card Practice Instructions:

1. **After reading and completing the multiple choice, print out these index card pages.**
2. **Cut out the index cards carefully. Do not cut the dashed line. The dashed line is where you will fold your index card horizontally.**
3. **When you fold the index cards, glue the blank sides of the index card together.**
4. **Finally, put your knowledge to the test and see if you can guess whether the photo is a rock or sediment. If you think it is a sediment, name the sediment type, geologic source, and geologic location. If you think it is a rock, name the main rock type, specific rock type, geologic source, and geologic location.**
5. **If you want to become a rock expert, remember *practice* makes *perfect*!** 😊

	***Can transition into coal if buried deep enough and is composed of partially decomposed plants***	**Sediment Type: Peat** **Geologic Source: Peat bog** **Geologic Location (County): Sussex**
	***Consists of minerals that cannot be seen by the naked eye and can be used for roofing tile, pottery, and ceramic pipe***	**Sediment Type: Clay** **Geologic Source: Woodbury Clay** **Geologic Location (County): Middlesex**

	*Comprised almost entirely of quartz and it is used for making glass*	**Sediment Type: Glass Sand** **Geologic Source: Cohansey Sand** **Geologic Location (County): Cumberland**
	*Is made up of the mineral calcite and can consist of tiny fossils that can be seen with a hand lens, magnifying glass, or low magnification microscope*	**Sediment Type: Lime Sand** **Geologic Source: Vincentown Formation** **Geologic Location (County): Burlington**
	*Includes chemicals (potassium and phosphorus) essential for plant growth was used in the past to soften water*	**Sediment Type: Greensand** **Geologic Source: Hornerstown Formation** **Geologic Location (County): Gloucester**
	*Is formed by the compaction of mud or clay and if soft enough can be used to make bricks and terra cotta*	**Main Rock Type: Sedimentary** **Specific Rock Type: Shale** **Geologic Source: Stockton Formation** **Geologic Location (County): Hunterdon**

	*Forms when groundwater deposits minerals between sand/gravel grains*	**Main Rock Type: Sedimentary** **Specific Rock Type: Sandstone** **Geologic Source: Stockton Formation** **Geologic Location (County): Hunterdon**
	*Made up primarily of the mineral calcite and forms from warm climates and minerals dissolved in water*	**Main Rock Type: Sedimentary** **Specific Rock Type: Limestone** **Geologic Source: Glenerie Formation** **Geologic Location (County): Sussex**
	*Forms from warm climates and minerals dissolved in water (hint: the mineral that makes up this rock gives it its name)*	**Main Rock Type: Sedimentary** **Specific Rock Type: Dolomite** **Geologic Source: Allentown Dolomite** **Geologic Location (County): Warren**
	*Formed by the rock shale when subjected to high temperatures and pressure*	**Main Rock Type: Metamorphic** **Specific Rock Type: Slate** **Geologic Source: Martinburg Formation** **Geologic Location (County): Sussex**

	*More resistant to erosion compared to other rocks, recrystallized under intense heat and pressure*	**Main Rock Type: Metamorphic** **Specific Rock Type: Quartzite** **Geologic Source: Shawangunk Formation** **Geologic Location (County): Warren**
	*Can be used as grit for chicken feed and agricultural lime and is exposed in many belts in the New Jersey Highlands*	**Main Rock Type: Metamorphic** **Specific Rock Type: Marble** **Geologic Source: Franklin Marble** **Geologic Location (County): Sussex**
	*Has an irregular layered appearance caused by dark and light mineral bands and forms hills 500 - 1,000 feet high in New Jersey Highlands*	**Main Rock Type: Metamorphic** **Specific Rock Type: Gneiss** **Geologic Source: Microcline Gneiss** **Geologic Location (County): Sussex**
	*Formed from magma that did not reach Earth's surface to cool and has crystals that can be seen by the naked eye*	**Main Rock Type: Igneous** **Specific Rock Type: Diabase** **Geologic Source: Rocky Hill Diabase** **Geologic Location (County): Somerset**

Formed from magma and visible crystals can only be seen under microscope because of rapidly cooled magma

Main Rock Type: Igneous

Specific Rock Type: Basalt

Geologic Source: Orange Mountain Basalt

Geologic Location (County): Somerset

Commonly found in many parts of the Coastal Plain and could have been considered an ore if the iron concentration were higher

Main Rock Type: Sedimentary

Specific Rock Type: Ironstone

Geologic Source: Cohansey Sand

Geologic Location (County): Ocean

Has enough iron to be picked up by a magnet (hint: think about the word "magnet")

Ore Type: Magnetite

Geologic Source: Biotite-Quartz-oligoclase gneiss

Geologic Location: Morris

Multiple Choice Answer Key

1. b.

2. c.

3. a.

4. b.

5. b.

6. a.

7. b.

8. d.

9. a.

10. c.

11. b.

12. d.

13. b.

14. a.

15. d.

16. a.

17. c.

18. d.

19. c.

20. a.