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PEBBLE GUIDE

LEARNING ROCK NAMES

Louise Leslie

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ABOUT THIS GUIDE

Mostly everyone likes to collect pebbles as they stroll on the beach. What you might not know is what stories these pebbles tell.

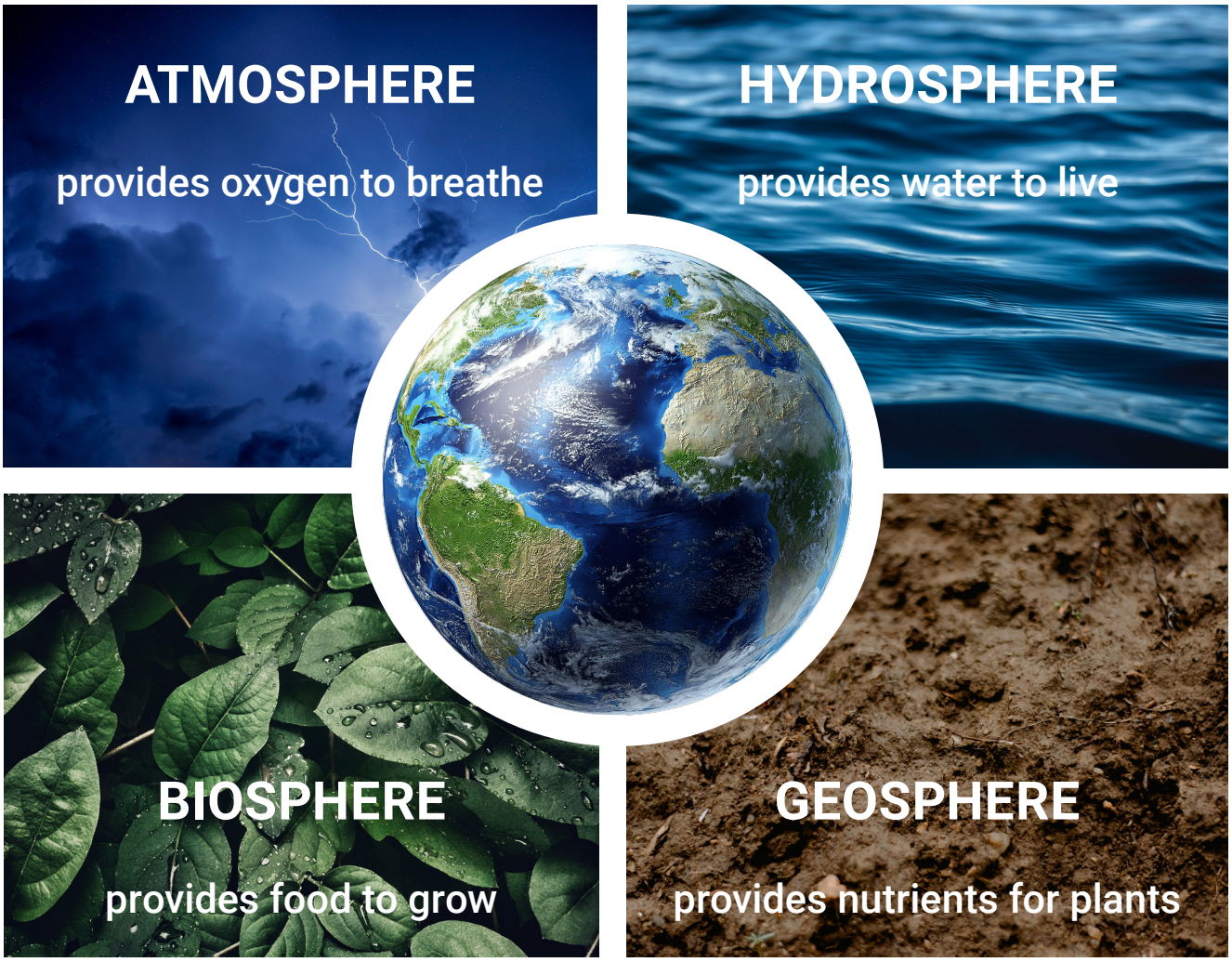
This guide has everything you'll need to go on your next pebble collecting adventure at a beach. You will learn facts about the composition of the Earth, some of the Earth's processes that take place and characteristics about the three different rock types. Most of the pebble photos you'll see in this guide were collected along the northern shore of the Minas Basin in Nova Scotia, Canada.

Important information to help you identify your pebbles and to understand the stories they tell is included in this handy guide. Identifying pebbles is a skill that anyone can learn, if you take time to train your eyes to observe geologically. I'm sure you will come up with really amazing stories to tell about the pebbles you collect!

THE PLANET EARTH

All living things are able to live on our planet Earth because of its four interdependent systems.

The four systems of our planet Earth are the atmosphere, hydrosphere, biosphere and **geosphere**. The outermost layer of the geosphere is a solid **lithosphere**, which consists of continental and oceanic **crusts** and the upper part of the **mantle**. Under this layer is the **asthenosphere** which behaves like a **plastic** and allows the lithosphere to move continuously as several bodies called **tectonic plates**. Movement of the tectonic plates and processes in the **rock cycle** that form and transform rocks are what create continuous changes in the Earth's continents and oceans.



EARTH'S INTERIOR

The Earth's Interior is made up of layers defined by physical and chemical properties.

Knowing what makes up the Earth's interior helps us understand the origin of rocks and also how they are formed and transformed. Scientists use special tools to interpret what they believe are different layers in the Earth's interior. More than 6000 kilometres deep, at the centre of the Earth, is the **core**. It is composed mostly of iron and has a solid inner layer and a liquid outer layer. Around the core is the mantle. It is by far the thickest layer making up more than 80 percent of the Earth's interior. Between the upper and lower parts of the mantle is a layer called the asthenosphere. For many years scientists have debated about its properties but most believe it behaves like a plastic which helps to create magma, the origin of igneous rock. The outermost layer of the Earth is the solid lithosphere. This layer rests on the asthenosphere and contains the crust and the upper part of the mantle. The crust, which is the upper part of the lithosphere, is where all rocks are formed. It is divided into oceanic and continental crusts The rocks we can see in the mountain ranges and in cliffs along coastlines are only a very teeny-tiny fraction of the rocks that make up the Earth's crust.

CHARACTERISTICS OF THE EARTH'S INTERIOR

Earth's Interior

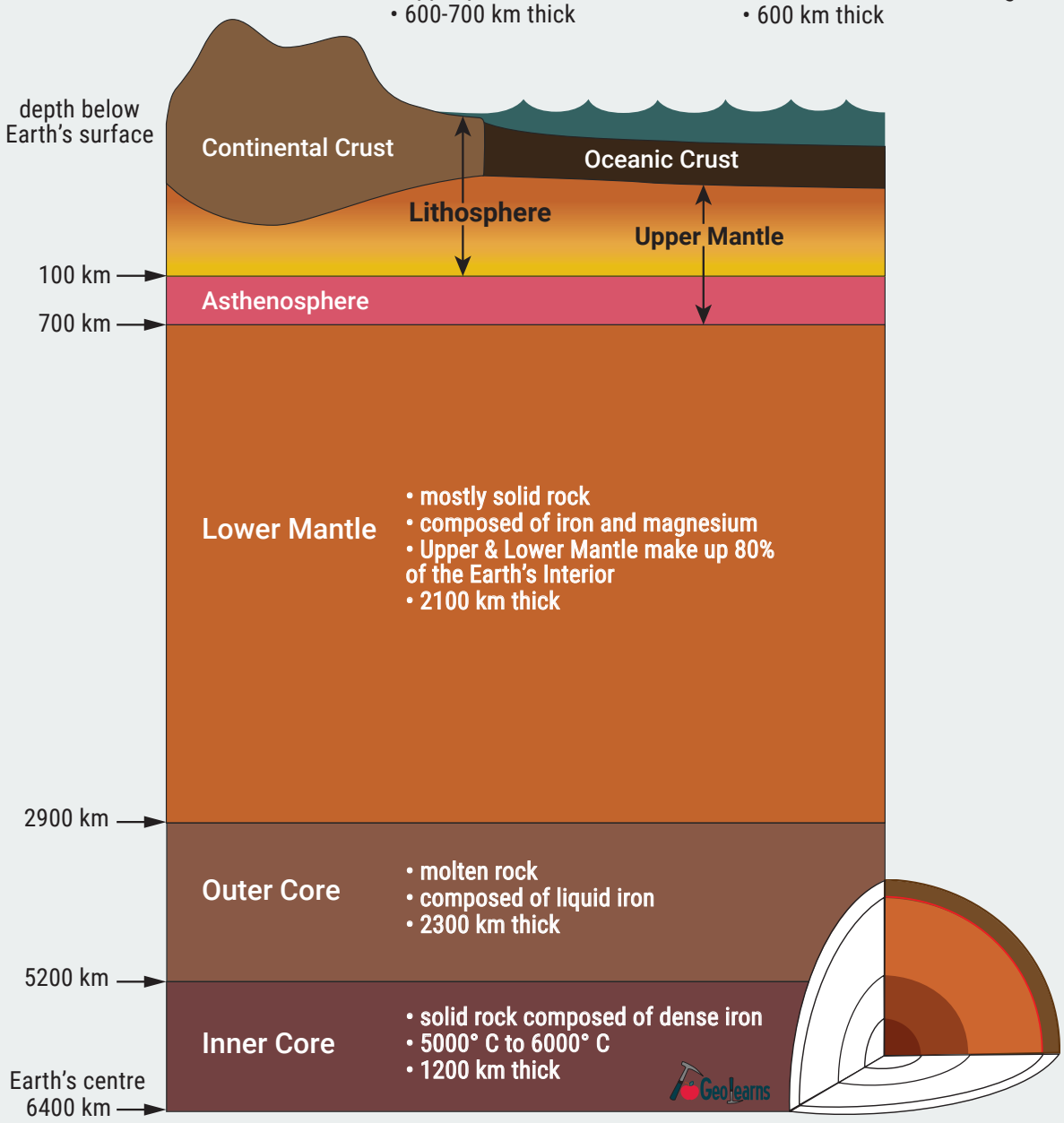
Continental Crust
- forms continents
- solid rock with lighter minerals
- 30 - 40 km thick

Lithosphere
- includes Crust & Upper Mantle
- solid rock cool zone
- 80 - 100 km thick

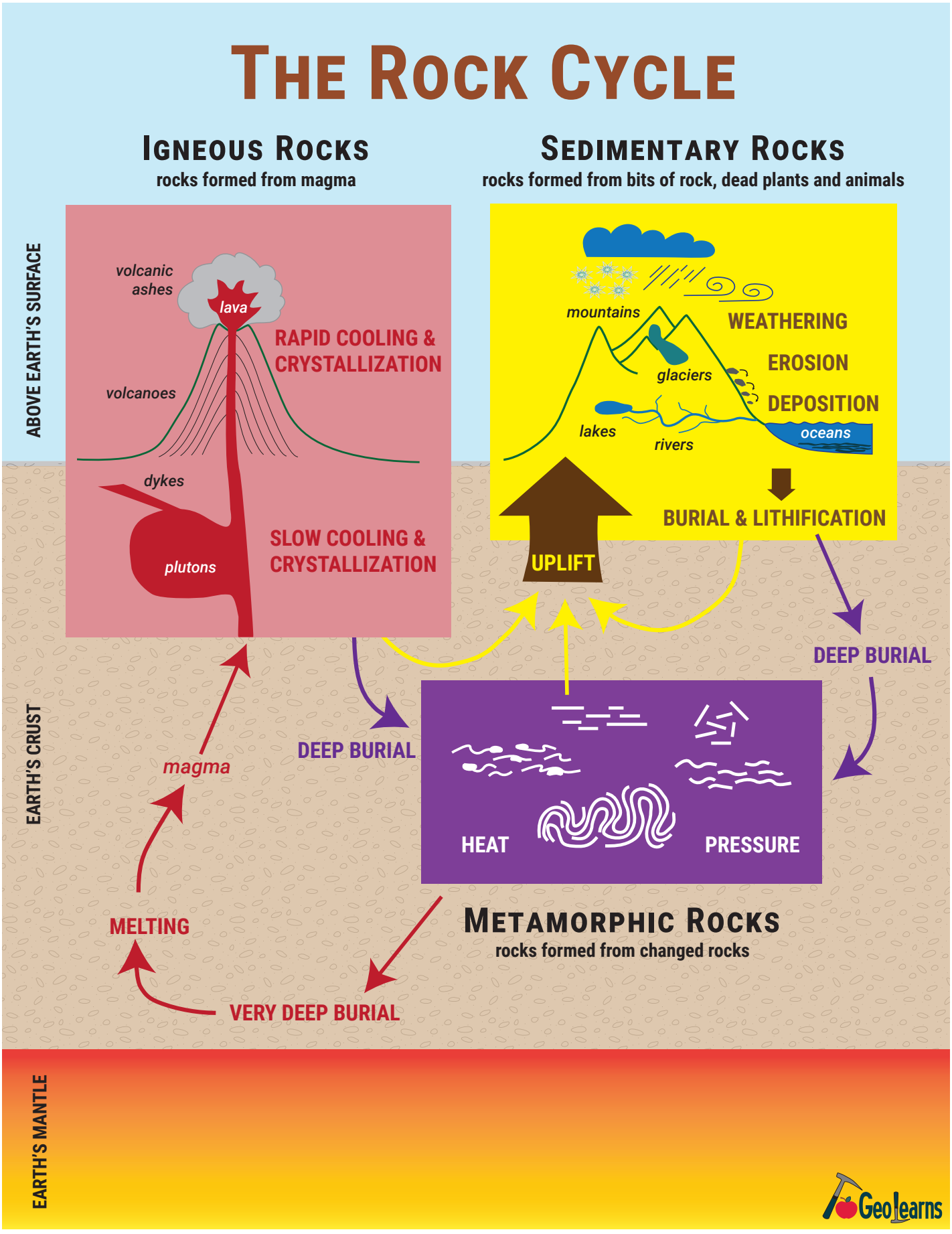
Oceanic Crust
- found under the oceans
- solid rock with darker minerals
- 5 -10 km thick

Upper Mantle
- includes Asthenosphere
- upper part is solid rock
- 600-700 km thick

Asthenosphere
- behaves like a plastic
- hot zone that creates magma
- 600 km thick



The Rock Cycle



THE ROCK CYCLE

The Rock Cycle represents how materials in the Earth's crust are continuously recycled to form and transform rocks.

The formation of different rocks are categorized into three types: **IGNEOUS**, **SEDIMENTARY** and **METAMORPHIC**.

IGNEOUS rocks begin to form in the Earth's crust by very deep **burial**. The temperatures are so hot that solid rock is transformed by **melting** which then creates **magma**. As magma rises upwards, solid rock is formed by the processes of cooling and **crystallization**. Slow cooling and crystallization takes place when magma gets trapped in **plutons** and **intrusions** such as **dykes**, to form **INTRUSIVE IGNEOUS** rocks. Rapid cooling and crystallization takes place when magma transforms into **lava** as it rises close to the Earth's surface and erupts from a volcano to form **EXTRUSIVE IGNEOUS** rocks.

SEDIMENTARY rocks begin to form by the process of **uplift.** This is created by movements in the lithosphere that push rocks upward. Once rocks are uplifted above the Earth's surface they become exposed to the processes of **weathering**, **erosion** and **deposition** to produce clastic **sediments**. In bodies of water, like lakes and oceans, **mineral matter** can be precipitated into **solutions** to produce chemical sediments. These sediments will then come to rest by a process called deposition. This is then followed by the processes of burial and **lithification** where layers of sediment at shallow depths in the Earth's crust form into **CLASTIC** and **CHEMICAL SEDIMENTARY** rocks.

All rocks that become buried deep in the Earth's crust are transformed by processes of heat and pressure to form **METAMORPHIC** rocks. Even a metamorphic rock can be transformed into another metamorphic rock. When rocks are buried very deep in the Earth's crust they will melt completely to create magma and then the rock cycle begins all over again.

3 Ps MAKE A ROCK

All rocks have two stories to tell, where they have travelled (place) and how they formed (process).

Rock characteristics, such as **texture** and patterns, are important clues that tell the stories hidden in the rocks. An easy way to unravel the stories in the rocks is by relating the clues to the "three Ps".

PLACE + PROCESS = PRODUCT

PLACE tells us where the rock has travelled. Some examples of places above the Earth's surface can be mountains, rivers, lakes and oceans. Places below the Earth's surface can be described as shallow, deep and very deep in the Earth's crust. **PROCESS** tells us how the rock is formed by understanding the mechanisms that happened, such as melting; cooling and crystallization; uplift; erosion; and heat and pressure. The two stories together will then lead you to the type of rock (Igneous, Sedimentary and Metamorphic) which is the **PRODUCT**.

THE 3 Ps FOR ROCK NAMES

PLACE	+	PROCESS	=	PRODUCT
Above the Earth's surface		RAPID COOLING and CRYSTALLIZATION		IGNEOUS ROCKS
Shallow in the Earth's crust		SLOW COOLING and CRYSTALLIZATION		
Geographic locations such as mountains, rivers, lakes, and oceans		UPLIFT followed by EROSION, WEATHERING, and DEPOSITION of sediments		SEDIMENTARY ROCKS
Shallow in the Earth's crust		BURIAL & LITHIFICATION of sediments		
Deep in the Earth's crust		HEAT and PRESSURE that changes rocks		METAMORPHIC ROCKS
Very deep in the Earth's crust		MELTING to form magma		origin of IGNEOUS ROCKS

ROCKS and MINERALS

Minerals are the ingredients that make up a rock.

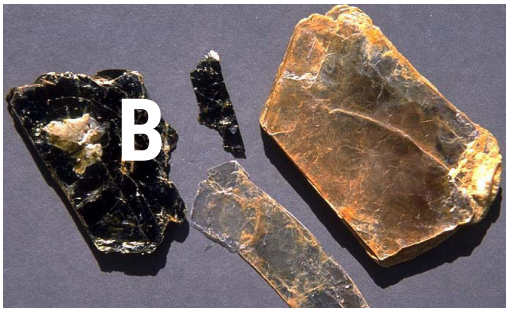
To tell your stories it's important to identify the characters in the story, such as the rocks and minerals. **Minerals** are non-living substances that occur naturally to form **crystals.** They each have specific chemical compositions that determine their physical characteristic properties. So far, scientists have discovered over 2,000 minerals.

Rocks can be composed of one or more of three materials: minerals, fragments of rock and organic material such as **fossils**. Below are four common minerals in rocks.

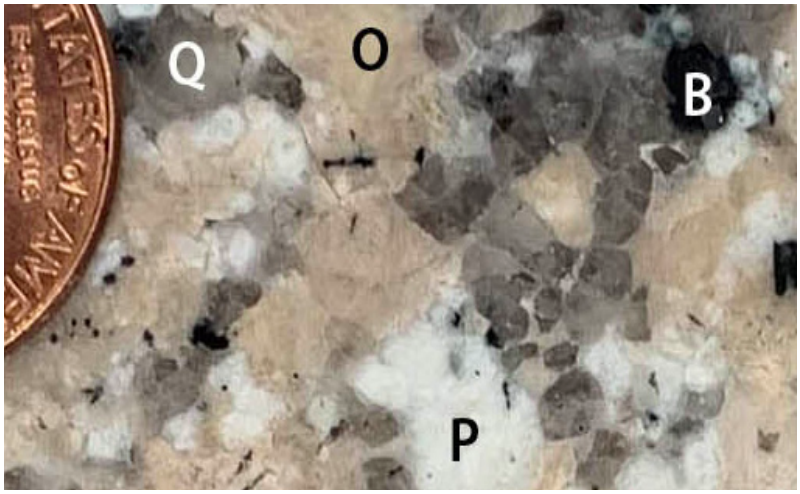
Plagioclase Feldspar (P)

Quartz (Q)

Orthoclase Feldspar (O)



Biotite (B)



This is a close up of a polished rock containing four common minerals

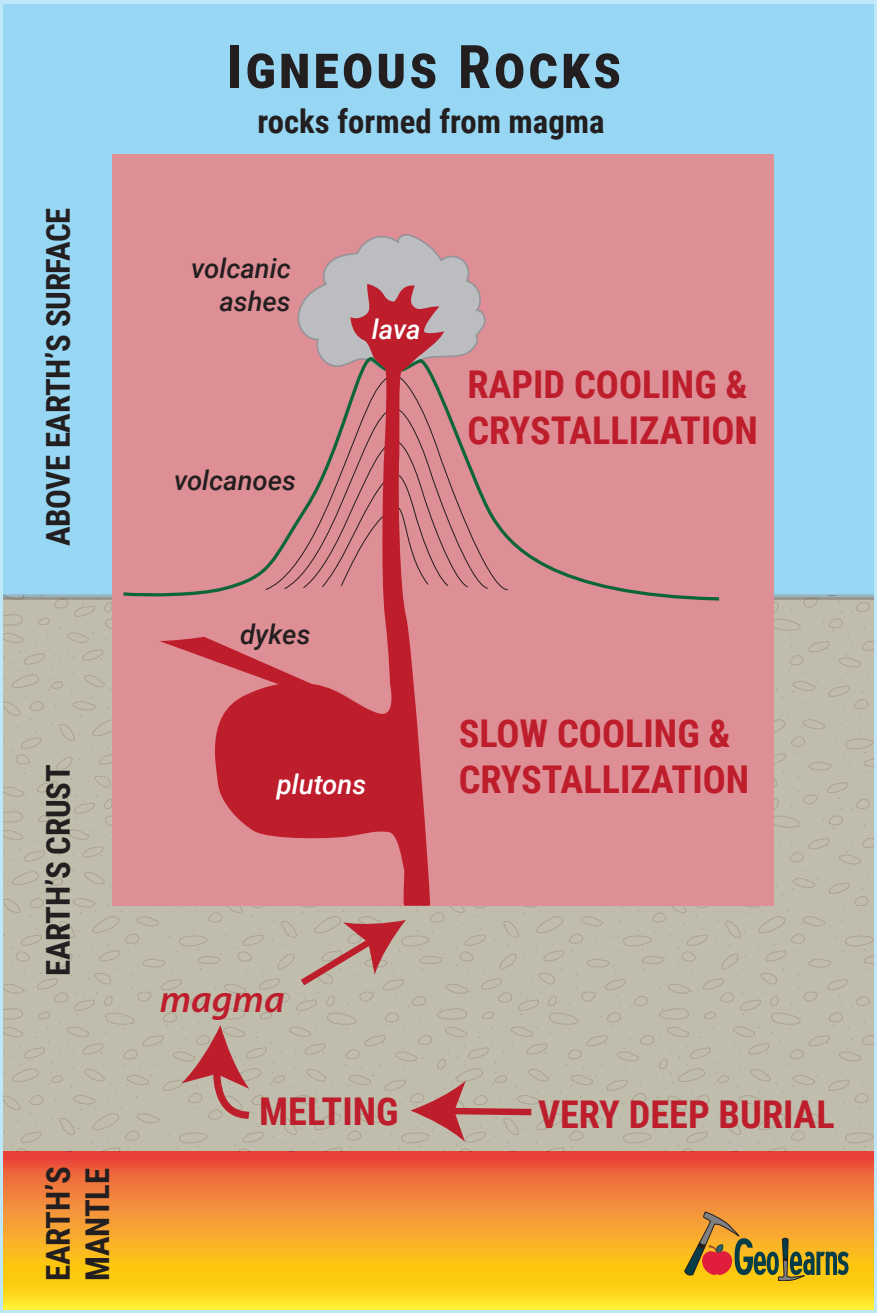
IGNEOUS ROCKS

The word “igneous” comes from the Latin word “ignis”, meaning “fire” which is known as molten (or melted) rock called magma.

PLACE: The origin of all igneous rocks is from magma. It is formed beneath the surface at very deep depths in the Earth’s crust. This is where temperatures and pressures are hot enough to transform solid rock into liquid or **molten** rock. Magma will rise upwards and form igneous rocks both below and above the Earth’s surface.

PROCESS: One of the main processes in igneous rocks is how much time it takes magma to cool and transform into a solid rock. Magma that transforms below the Earth’s surface will cool slowly to form an intrusive (or *Plutonic*) igneous rock. Slow cooling allows time for crystals to form large enough for the naked eye to see. Magma that continues upwards will transform into lava. When this lava erupts from a volcano it transforms into a solid rock by rapid cooling to form an extrusive (or *Volcanic*) igneous rock. Rapid cooling forms very tiny crystals that can only be seen through a microscope. Crystallization also happens as the magma cools to form crystals that interlock together so there are no spaces between the crystals.

PRODUCT: Classification of igneous rocks is based on the composition of the rock and size of the crystals. A **GRANITE** and **RHYOLITE** have similar compositions, but have different crystal sizes because of their different rates of cooling and crystallization. The table on the next page explains important igneous rock properties.



CHARACTERISTICS OF IGNEOUS ROCKS

PROPERTY	INTRUSIVE ROCKS	EXTRUSIVE ROCKS
rate of cooling and crystallization	slow	rapid
crystal sizes	visible with the naked eye	not visible with the naked eye
composed of light-coloured minerals	GRANITE	RHYOLITE
composed of dark-coloured minerals	GABBRO	BASALT

EXTRUSIVE (VOLCANIC) IGNEOUS ROCKS

RHYOLITE (RYE - o - LIGHT)

Each one of the bands in this rhyolite represents a separate lava flow which cooled very rapidly. The different colours in the bands represent different compositions in the lava. Not all rhyolites have bands like this one, some have no pattern and contain some crystals that are big enough to see.

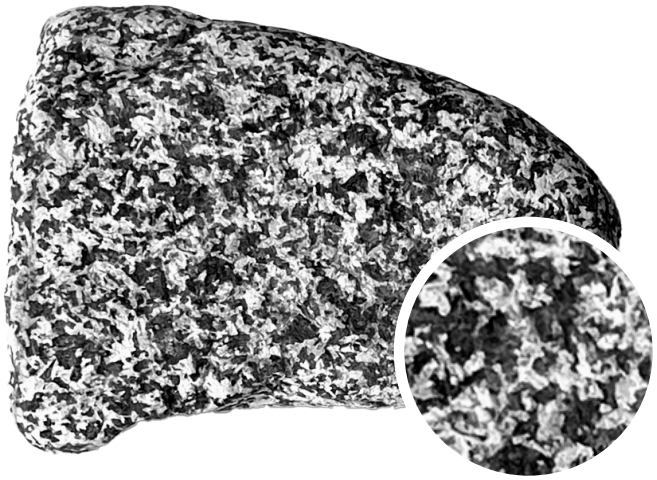
BASALT (bah - SALT)

A unique characteristic found only in a basalt rock are **vesicles**. These rounded holes were formed by trapped gas bubbles in the lava when the rock was cooling. The vesicles often have minerals inside them, like this one. Vesicles are only found in igneous extrusive rocks.

INTRUSIVE (PLUTONIC) IGNEOUS ROCKS

GRANITE (gran - IT)

Granite is composed mostly of feldspar (orange crystals in this sample), quartz (grey crystals) and biotite (black crystals). Feldspar has shiny, flat, repeating surfaces with square corners. Quartz looks like melted glass and biotite is a flaky mineral. Feldspars can also be white coloured.



DIORITE (DIE - o - RIGHT)

Diorite often has a salt-and-pepper texture made up of mostly hornblende (black crystals) and plagioclase (white crystals). There is always a bit more darker minerals than lighter minerals, which includes a tiny amount of quartz (grey crystals).

GABBRO (GAB - ROW)

Gabbro is composed mostly of darker coloured minerals and can have a tiny amount of quartz (grey crystals). The pits in this pebble are not vesicles, but holes formed where crystals were removed by processes of weathering and erosion.

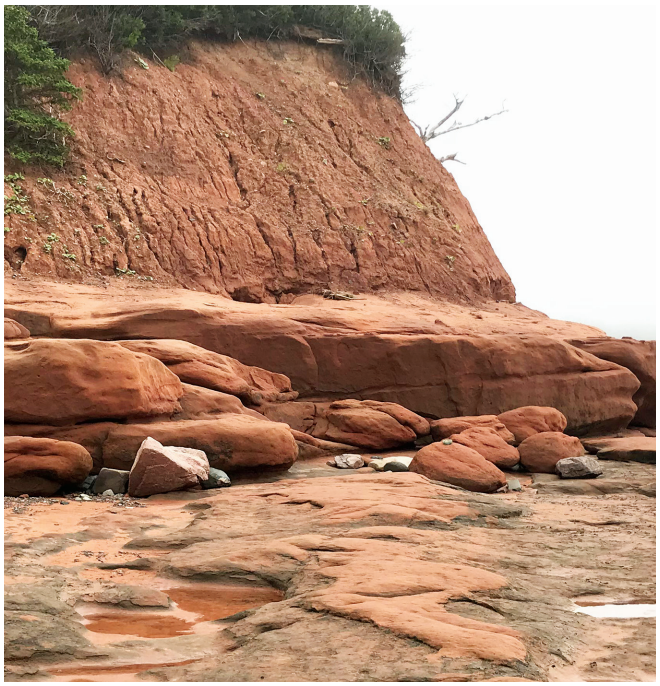
SEDIMENTARY ROCKS

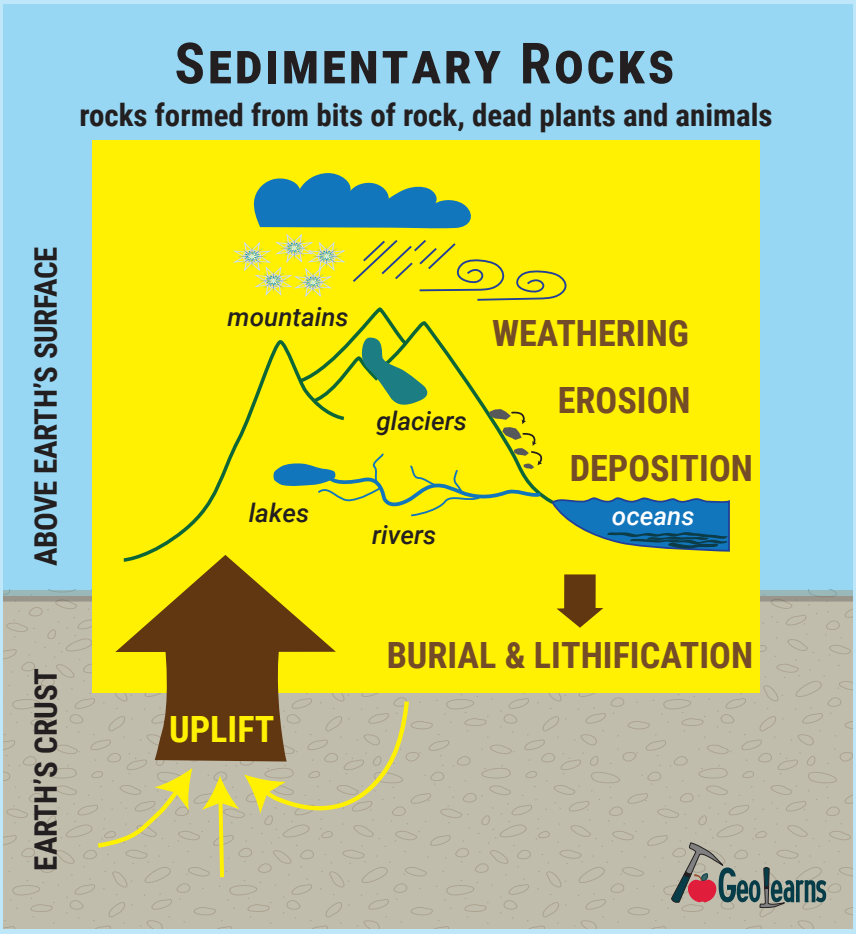
This rock type gets its name from the word “sediment”. There are two types of Sedimentary Rocks - Clastic and Chemical.

PLACE: The origin of all sedimentary rocks is from sediments formed on the Earth’s surface in places such as lakes, rivers, oceans, deserts, mountain sides and even next to glaciers. Sediments form from “bits”, or fragments, of rock (non-living material), preserved plants and animals (organic material), and precipitated solutions in oceans and lakes. At shallow depths in the Earth’s surface the sediments are transformed into clastic and chemical sedimentary rocks.

PROCESS: The processes for clastic sedimentary rocks are weathering, erosion and deposition. These are explained in the table on the next page. Chemical sedimentary rocks come from organic material and solutions that are transformed into a solid by chemical processes. Burial and lithification are the final processes. This is when sediments are laid down in layers, or **beds**, buried and then glued together by a **cement** to form a solid rock.

PRODUCT: Clastic sedimentary rocks are classified based on the size of their sediments. A **CONGLOMERATE** has a mixture of large and small rounded sediments. A rock with sand-size sediments is a **SANDSTONE** and mud-size sediments is a **MUDSTONE**. Common chemical sedimentary rocks are **LIMESTONE**, formed from shells of sea animals, and **GYPSUM**, formed from a solution.





PROCESSES OF CLASTIC SEDIMENTARY ROCKS

PROCESS	DEFINITION	DESCRIPTION (WITH EXAMPLES)
WEATHERING	"breaks rock" process of rock breaking into smaller fragments	types of weathering physical (freeze-thaw and sand blasting) chemical (reaction to acid) biological (plant roots & microorganisms)
EROSION	"removes rock" process of fragments being picked up and moved to a different place	physical agents or methods of erosion by water (rain, waterfalls, rivers and waves) by wind by ice (glaciers and ice sheets) by gravity (landslides and rockfalls)
DEPOSITION	"dumps rock" process of fragments being layed down and coming to rest in a place	places where deposition takes place in water (rivers, ponds, lakes and oceans) on land (deserts, coasts, cliffs and slopes) near a glacier (in, under, next to, on top and in front)
BURIAL and LITHIFICATION	Sedimentary rocks form after the deposited sediments are buried and then compacted by the weight of more sediments being deposited on top of them. The temperature present at and near the Earth's surface also helps the sediments form into a solid rock.	

CLASTIC SEDIMENTARY ROCKS

CONGLOMERATE (CON-glom-er-AT)

These rocks contain a mixture of many different sizes and types of rounded “bits” of rocks. In this example there are different pebble sizes within the rock. Most conglomerates have no pattern (all jumbled up), like this one.

SANDSTONE (SAND - STONE)

This type of pattern with many layers, is called bedding. All the sediments in a layer are the same size. The bedding pattern is formed because each layer represents a different size of sediments. The very thin, darker layers, shown here, may be clay (or mud) mixed with organic material.

MUDSTONE (MUD - STONE)

These rocks are composed of silt (or mud) size sediments that can’t be seen by the naked eye. Sedimentary bedding can sometimes be distinguished by darker, usually thinner, black layers that might contain preserved organic material, such as decomposed plants.

CHEMICAL SEDIMENTARY ROCKS

Chemical sedimentary rocks are NOT usually found as beach pebbles in most locations because they break down quickly into smaller bits from weathering and erosion.

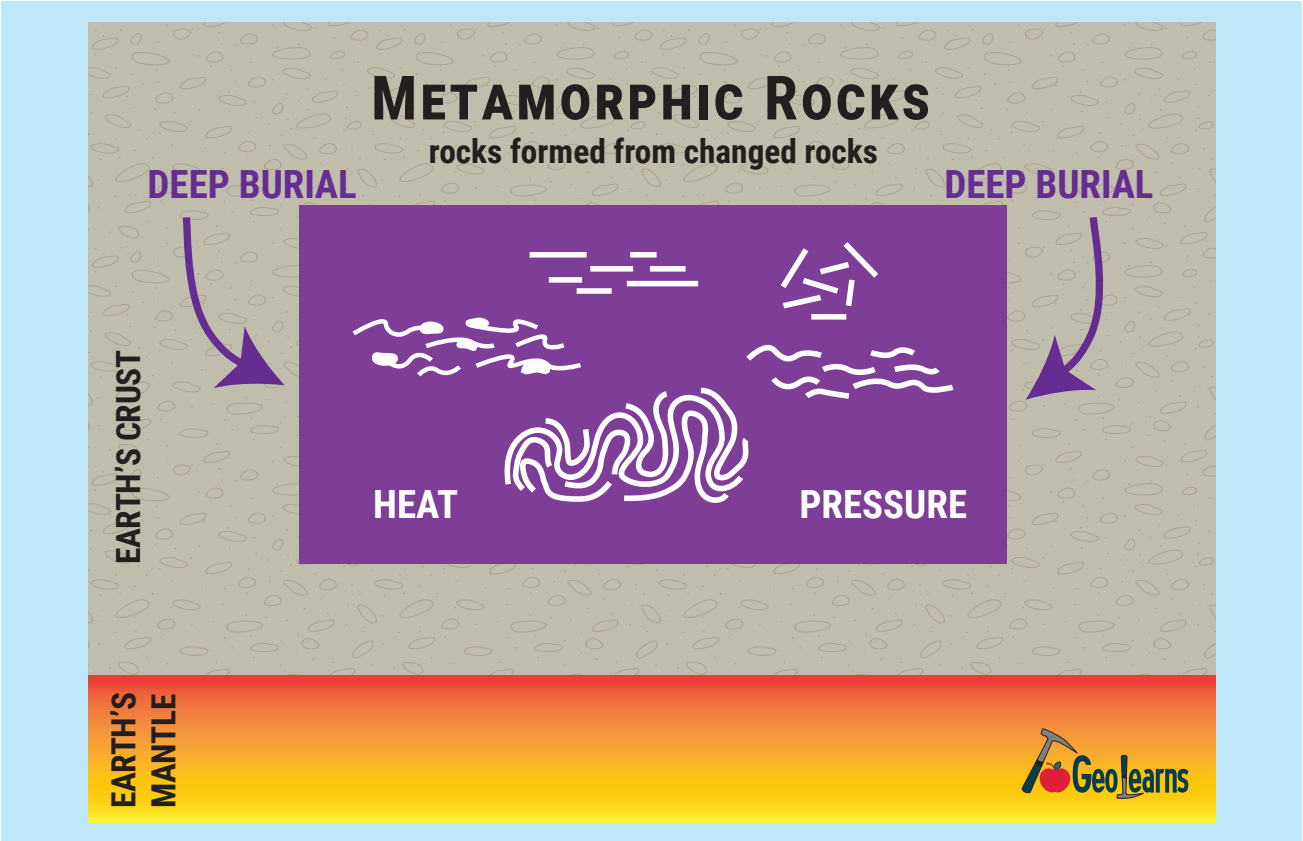
LIMESTONE (LIME - STONE)

Many limestones have shell fossils, like the tiny dark patches in this rock. Add a small drop of vinegar and you might be able to see tiny bubbles form on the rock surface. This is the rock dissolving with acid.

GYPSUM ROCK (JIP - SUM)

Gypsum is formed from a salt solution when water is evaporated out of it. It usually has a sugary appearance and it can be scratched with the blade of a pocket knife. It's easily weathered and eroded because it is very soft, so they are not usually preserved as a beach pebble.

METAMORPHIC ROCKS



This rock type gets its name from the prefix "meta" meaning change or transformation.

PLACE: All metamorphic rocks are formed deep below the surface of the Earth where heat and pressure causes the rock to change. The depth that these rocks are formed is deeper than sedimentary rocks but not so deep that the rock will be melted into magma.

PROCESS: The main processes that determine the type of metamorphic rock that is formed are heat and pressure. The greater the amount of heat and pressure, the greater the amount of change occurs.

PRODUCT: The different amounts of heat and pressure, in combination with its composition determine the type of metamorphic rock that is formed. Common rock names listed in order from small to big changes, are **SLATE**, **PHYLLITE** and **GNEISS**.

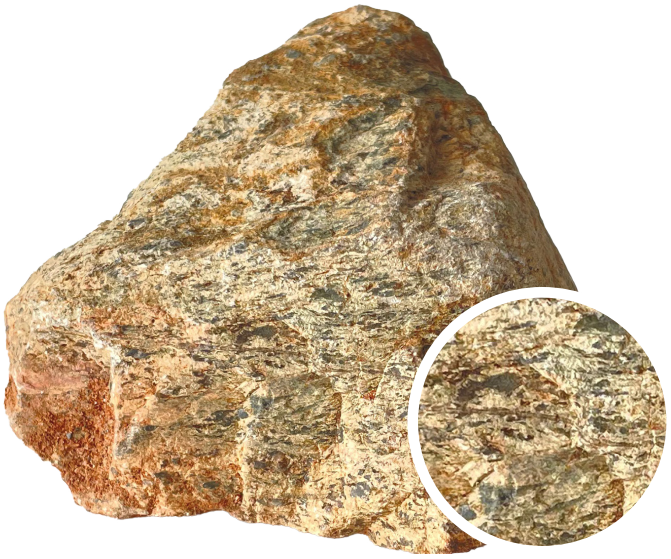
METAMORPHIC ROCKS

SLATE (sl - ATE)

Slate usually has thin and slightly wavy layers which represent preserved sedimentary layers (bedding) that have been slightly changed by heat and pressure. It is brittle, making a sharp pinging noise when you hit it on a hard surface.

PHYLLITE (FILL - ite)

Phyllite usually has thinner and wavier layers indicating there was slightly more heat and pressure that changed the sedimentary layers when compared to slate. The surface sometimes feels soapy and you might see glittery specks of mica (flaky) minerals.



GNEISS (NICE)

Gneiss rocks have patterns that range from flat to slightly wavy bands that have dark and light colours and also usually have different thicknesses. The different colours represent different minerals that have formed from different compositions and different amounts of heat and pressure that transformed this rock.

FIELD TRIP PLANNING

Now it's time to plan your field trip, collect some pebbles and test your knowledge!

Protected Sites

In most cases it is okay to collect loose materials from the beach, such as pebbles, but it is not permitted to collect fossils. A permit is required to remove material from the cliff face and to collect fossils from the beach.

Safety

TIDES: One of the most important safety concerns is being aware of the tides, especially in the Bay of Fundy and the Minas Basin. The rising tide may cut off your beach access and leave you stranded with no route to return back safely. The general rule of thumb is to start your hike when the tide is falling (going out) and return at least two hours before the high tide time.

Make sure that you check the tide schedule for the area you will be visiting as they are different from one place to another.

DANGEROUS SURFACES: The best places to collect pebbles are along the rocky beaches so you will need good, sturdy footwear to walk safely. Avoid slippery rocks covered with seaweed, green algae or mud. Walk carefully on rocks near cliff faces as these usually have very sharp edges. It is best to leave your beach sandals at home.

CLIFFS: Do not walk close to the cliff face. Rocks and debris may fall down from the cliff without notice. A safe distance away from the cliff is about 10 metres (the length of a school bus).

SAFETY KIT: It's a good idea to carry a small safety kit and a whistle in your backpack. If you get injured, an adult will be able to use this kit to provide first aid for minor cuts or injury. The whistle can be used to call for help or warn others of dangers.

WEATHER: Weather can change very quickly if you are not paying attention. You should bring extra clothing for cold and wet

FIELD TRIP PLANNING

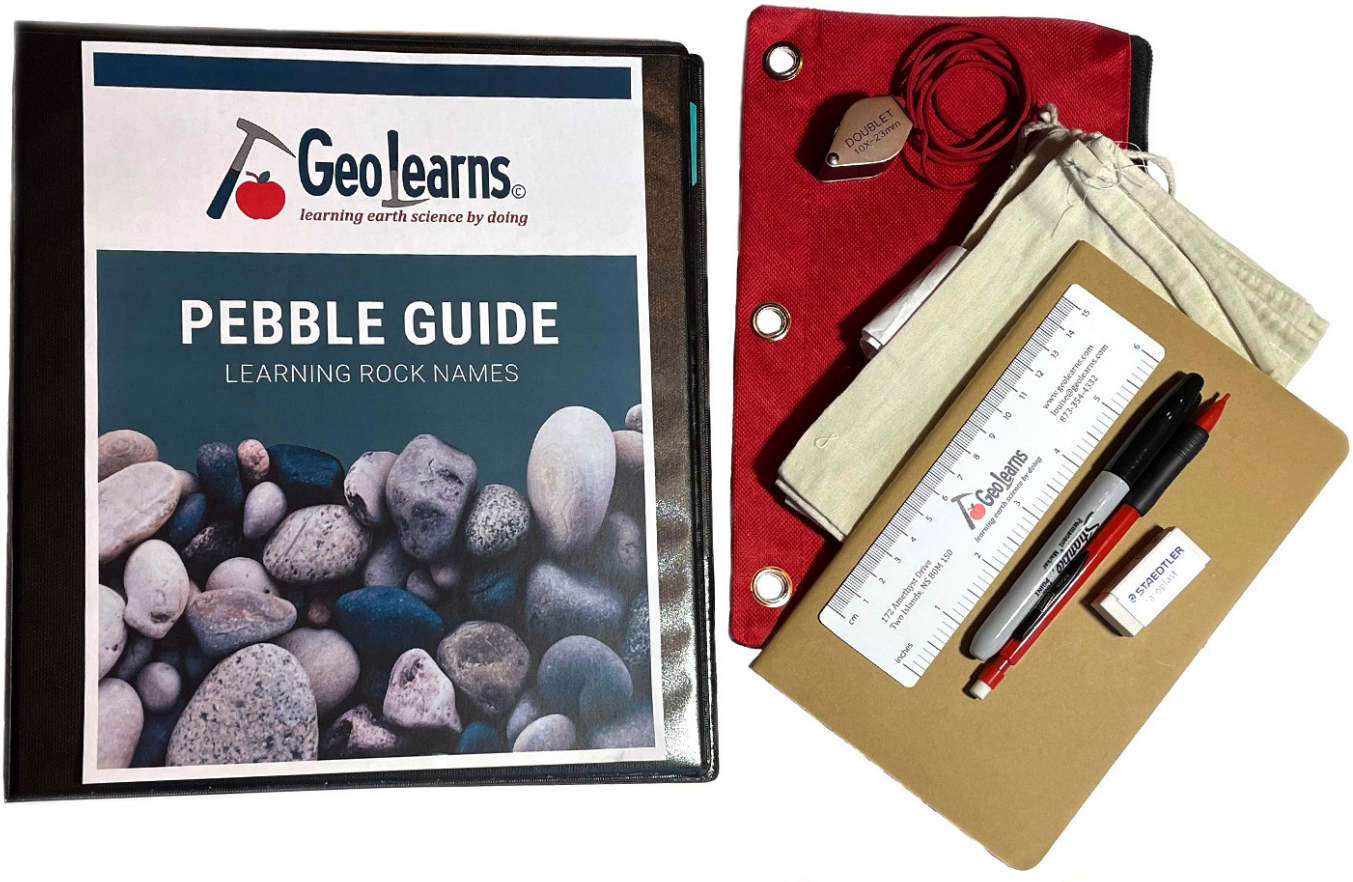
weather, and also have a hat and sunscreen for a hot, sunny day.

Personal Equipment

Along with your Pebble Kit, you might also want to pack a small snack, water bottle and cell phone in your backpack for your trip to the beach just in case there is an emergency. A cell phone will also be handy to take photos of all the interesting things you'll discover on your hike along the beach.

GeoLearns Pebble Kit

In addition to the Pebble Guide, the Pebble Kit includes some useful field tools to help you with your rock identification while you are on your field trip. It will have a hand lens, ruler, pencil, eraser, marker, notebook, binder and sample bags to hold each of the pebbles you collect. The small notebook will allow you to draw more sketches and journal your adventure to the beach.



ROCK IDENTIFICATION FORM & TABLE

Whenever a geologist does field work they have a form to help them record their observations.

One rock identification form is filled out for each pebble sample you collect. Start with writing your name (Collector), date, the sample number you've assigned to your pebble and information about your location in the upper part of the form.

The lower part is the Pebble Observations section. This is where you'll record your observations and sketch your pebble sample. Fill in as much as you can during the field trip. Don't worry if you run out of time, you can finish recording information about your pebbles when you're back in the classroom.

Use your own words to describe everything you see. Write neatly with descriptions that others will be able to understand. Sketching what you see will help you look a little closer to describe as many details as possible.

It's important to include labels and a scale on your sketch. Draw a line from each label to the place on your pebble where you observed the features you describe. A scale is drawn next to the sketch to show dimensions of your pebble sample.

To help you determine the rock name and rock type, match your observations to the descriptions in the Rock Identification Table, on the next pages.

ROCK IDENTIFICATION FORM

Collector	Date	Sample #
Location Name	**Location Description**	

Pebble Observations (describe the following characteristics)

Colour (give one or more)

Dimensions (shortest & longest lengths)

Shape (choose one of the following)

rounded

angular

Texture (crystals, sediments, or too small)

Permeability test
(pour tiny amount of water onto the pebble)

water is absorbed =	water runs off =
permeable	not permeable

subrounded

subangular

Feels (smooth or rough) (light or heavy)

Pattern (no pattern or organized)

Describe your observations (include patterns and other characteristics you can see)

Sketch your pebble (include labels such as the pebble's dimensions and any special features)

Rock type: (circle one)

Igneous Sedimentary Metamorphic

Rock name:

If you are having difficulty describing the rock characteristics in the Rock Identification Form, use the descriptions below in the Rock Identification Table to help you. Start on the

ROCK IDENTIFICATION TABLE

TEXTURE	PERMEABLE	COLOUR	PATTERN
sediments are visible	high permeability	light and dark colours	has no pattern
	medium permeability		may have no pattern may have organized pattern of flat layers may have organized pattern of parallel and wavy layers
	small permeability		
sediments and crystals too small to see	no permeability		has an organized pattern of thin and slightly wavy layers
		dark colours	has no pattern
		dark to medium colours	may have no pattern may have organized pattern of flat to wavy layers
crystals are visible		light and dark colours	has no pattern
		dark colours	
		light and dark colours	has an organized pattern of thin and slightly wavy layers
			has an organized pattern of thin to thick and flat to wavy layers

left hand side of the table by selecting the texture of your rock. Then, work your way to the right to determine the rock name and its rock type.

ROCK IDENTIFICATION TABLE

OTHER CHARACTERISTICS		ROCK NAME	ROCK TYPE
contains rounded pebbles with different sizes and rock types		CONGLOMERATE	CLASTIC SEDIMENTARY
layers can be slanted in one or more directions may have fossils or plant material may have ripples or mud cracks	sand-size sediments	SANDSTONE	
	surface feels smooth like baby powder surface may feel greasy	SILTSTONE OR MUDSTONE	
rock surface fizzes (bubbles) with a drop of vinegar may have fossil shells		LIMESTONE	CHEMICAL SEDIMENTARY
fresh rock surface has sugary texture crystals look like they are glued together		QUARTZITE	METAMORPHIC
may contain glittery flakes of mica		PHYLLITE OR SCHIST	
looks like a mudstone but is more brittle		SLATE	
may contain holes shaped like gas bubbles may have hexagonal shape on the outer rock surface		BASALT	IGNEOUS EXTRUSIVE (VOLCANIC)
may be reddish or greenish colour		RHYOLITE	
may have holes filled with light minerals or crystals		BASALT	
may be reddish or greenish colour may contain visible crystals of one or more colours		RHYOLITE	
contains crystals of grey (quartz), white or pinkish-orange (feldspar) and black (biotite) colours		GRANITE	IGNEOUS INTRUSIVE (PLUTONIC)
contains mostly dark coloured crystals with a smaller amount of grey (quartz) and white (feldspar) crystals		DIORITE OR GABBRO	
may contain glittery flakes of mica and a few visible crystals of different colours		PHYLLITE OR SCHIST	METAMORPHIC
contains layers with different thicknesses of dark and light coloured crystals		GNEISS	

GLOSSARY

ASTHENOSPHERE A partially molten layer in the mantle, beneath the lithosphere, that is 100 to 700 km below the Earth's surface which flows and helps the tectonic plates move.

BED (BEDDING) A layer in a sedimentary rock, originally laid down as a layer of sediment.

BURIAL A sedimentary process of burying layers of sediment deeper below the Earth's surface from the weight of the overlying layers of sediment.

CEMENT A material that consists usually of quartz or calcite minerals that crystallize in the pore spaces of sediments.

CORE A zone at the Earth's centre consisting mostly of iron with a solid inner core and a liquid outer core.

CRUST The uppermost layer of the Earth that overlies the upper mantle, consisting of a continental crust which makes up most of the rock under continents and an oceanic crust which makes up most of the rock under oceans.

CRYSTAL A three dimensional form with flat, regular, repeated surfaces created from the internal orderly arrangement of atoms in a mineral.

CRYSTALLIZATION The formation and growth of a solid (crystal) from a liquid or gas, such as magma cooling into solid rock.

DEPOSITION A process of laying down, or "dumping" rock-forming materials such as sediments or mineral matter precipitated from a solution.

DYKE An igneous intrusion that cuts across one or more layers of other rocks.

EROSION A sedimentary process that "removes" sediments by gravity, flowing water, wind, and glaciers (ice).

FOSSIL The remains and traces of animals and plants which have been preserved by natural causes in the Earth's crust.

GEOSPHERE Consists of all the solid parts of the Earth, including the lithosphere.

INTRUSION A body of molten rock that has travelled upward through the Earth's crust and solidified within another rock.

LAVA A fluid rock originating from magma that erupts from a volcano.

LITHIFICATION A process that cements sediments together to form a solid rock.

LITHOSPHERE An outer rigid shell layer, around 100 km thick, consisting of the crust and part of the upper mantle, broken into tectonic plates.

GLOSSARY

MAGMA A molten material, or liquid rock, formed very deep below the Earth's surface.

MANTLE A zone beneath the crust and around the core which makes up about 80% of the Earth's volume with mostly solid outer and inner layers separated by the partially molten asthenosphere.

MELTING A process when solid rock is transformed into a fluid rock, or magma.

MINERAL A naturally occurring inorganic compound or element with defined chemical composition and physical properties.

MINERAL MATTER A substance formed from decaying plants and animals.

MOLTEN A term to describe partially melted or 'liquid' rock.

PERMEABILITY A measure of how quickly a fluid will flow through a rock.

PLASTIC A property that describes partially melted or molten rock that allows rock to flow.

PLUTON An intrusive igneous body that forms when magma cools and crystallizes within the Earth's crust.

ROCK A consolidated naturally occurring material composed of a mixture of minerals, rock fragments and fossils.

ROCK CYCLE A cycle of processes through which Earth materials are formed and transformed from one rock type to another.

SEDIMENT A material that consists of loose particles created from the processes of weathering and erosion of rock, by chemical precipitation from a solution in water, or from secretions or material discharged from organisms.

SOLUTION A change in matter from a solid or gas into a liquid state that mixes together.

TECTONIC PLATES A series of large rigid segments of broken up plates of the lithosphere that move relative to one another over the asthenosphere.

TEXTURE A property describing the way crystals and sediments fit together, including shapes, sizes and orientation of crystals and sediments.

UPLIFT A process that pushes rocks, of any type, upward towards the surface of the Earth.

VESICLES A series of small holes or cavities in a rock that are formed by trapped gas bubbles in the lava when the rock was cooling.

WEATHERING A sedimentary process that "breaks" a rock by physical, chemical and biological action.

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About the Author

Louise Leslie is a passionate earth science educator. She draws on her knowledge and experience as a geologist and outreach specialist to create concise, science-based, visually engaging guides. Her classroom-ready resources encourage hands-on inquiry-based activities focused on outdoor learning. She strives to create invaluable educational tools for teachers which are also equally enticing for the outdoor enthusiast curious about our planet Earth.

Having recently moved to Nova Scotia, Louise discovered the untapped, resource-rich potential of the beach pebbles found near her home. Who hasn't combed beaches for those one-of-a-kind pebbles? Her handy Pebble Guide lets you have fun unravelling the stories in the pebbles and at the same time, helps you gain a broader understanding of important Earth processes.

Louise has an MSc in Quaternary Geology and an MA in Environmental Education and Communication in field-based earth science education.

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