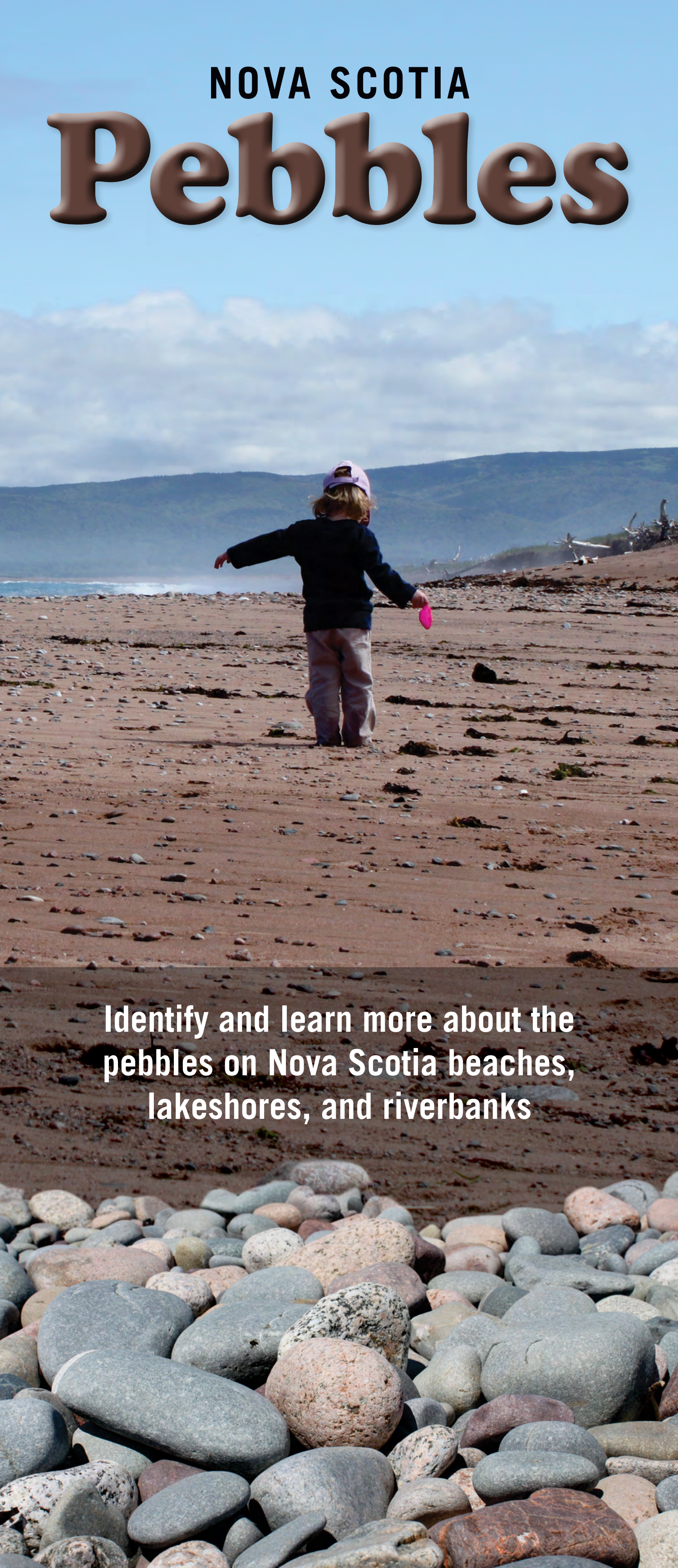
NOVA SCOTIA

Pebbles



Identify and learn more about the pebbles on Nova Scotia beaches, lakeshores, and riverbanks

Pebbles are often our first interaction with geology. We pick them up at the beach, on hikes near lakes or along rivers, or even in our backyard. Perhaps the shape, the colour, or a feature catches our eye – and the most intriguing ones end up in our personal collection. When we examine our new find more closely, taking note of the composition and structure, we begin to **unravel the pebble's geological history.**

When rocks break down they form sediment. Scientists have classified sediment based on size. The specimens illustrated in this guide can fit in your hand.

How are pebbles formed?

The rock that makes up the land beneath our feet is called bedrock. After many years, bedrock fractures and breaks due to physical and chemical weathering. Resulting fragments are moved by wind, water, and ice (eroded), then transported and eventually deposited in sedimentary environments like rivers, lakes, and beaches. During transportation, fragments collide with one another and become smoothed and rounded.

This fast-flowing river is wearing down the underlying bedrock and transporting fragments downriver.

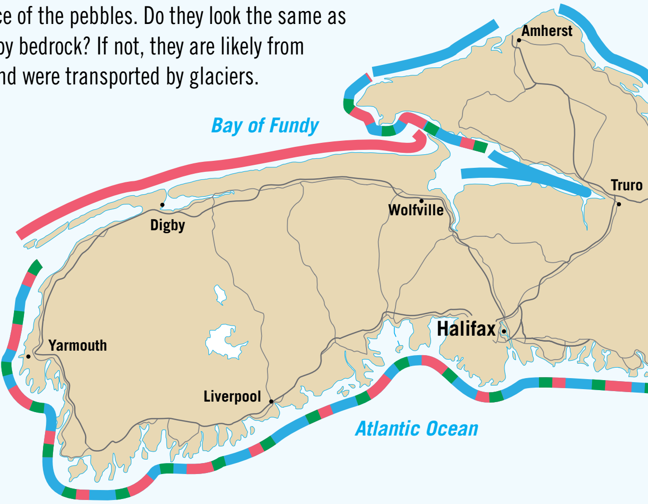
Glacial till as a source of pebbles

Thick sheets of ice called glaciers covered much of Nova Scotia until about 15,000 years ago, moving and grinding rock when advancing (growing) and depositing sediment when retreating (melting). The glacial deposit, till, is composed of a wide range of loose, usually angular sediments of various types and sizes. Till is easily eroded by waves, tides, currents, and rainfall adding sediment to nearby beaches, lakeshores, and riverbanks. Over time, pebbles and other sediment can be rounded by further weathering and transportation to new environments. In many parts of Nova Scotia, till blankets the bedrock and is a major source for pebbles.

Erosion of this glacial till allows cobbles and pebbles to tumble out and become part of the rocky beach below.

Local bedrock as a source of pebbles

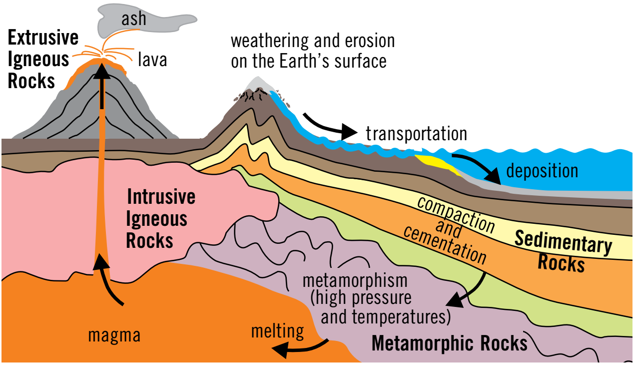
Along Nova Scotia's coast the local bedrock is igneous, sedimentary, and/or metamorphic. When pebble hunting, look around to find the source of the pebbles. Do they look the same as nearby bedrock? If not, they are likely from till and were transported by glaciers.



Using this guide

The pebbles in this guide are organized according to the three rock types, and then on their composition, textures, and/or features.

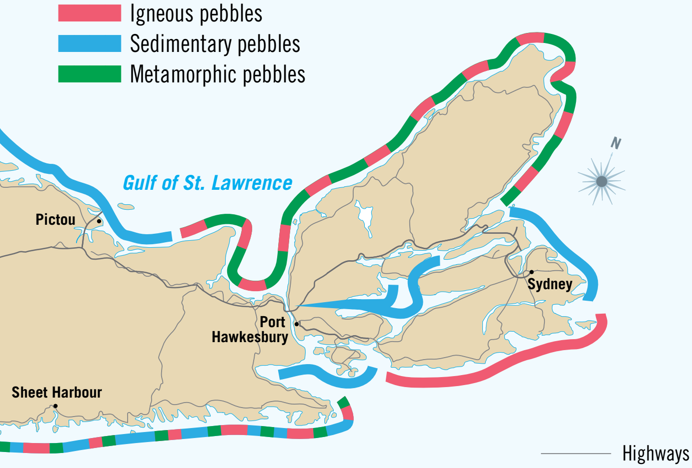
The rock cycle illustrates the origin, destruction, and alteration of rocks by processes at and below the Earth's surface. It's an ongoing cycle connecting the three main rock types: igneous, sedimentary, and metamorphic.



Rocks vs. minerals: Rocks are made up of one or more minerals. Minerals are naturally occurring, inorganic solids with specific chemical compositions and crystal structures.

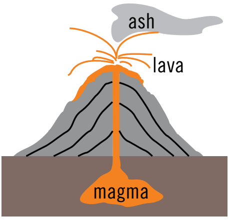
granite (rock) = feldspar + quartz + biotite (minerals)

Predominant pebble types sourced from local bedrock:



See *Nova Scotia Rocks* for more information about bedrock geology of Nova Scotia.

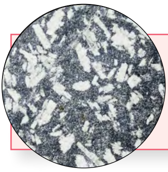
IGNEOUS PEBBLES



Igneous rocks form by the cooling and solidification of magma (deep below ground) or lava (above ground). Because the chemical and mineral composition of lava and magma varies, igneous rocks range in colour from light (felsic) to dark (mafic).

INTRUSIVE igneous rocks form when magma cools very slowly deep beneath the Earth's surface. Slow cooling gives minerals time to "grow," forming crystals you can see with the naked eye (> 1 mm).

EXTRUSIVE (or volcanic) igneous rocks form at the Earth's surface where lava erupts. Lava cools quickly with little time for minerals to "grow," so crystals are small (< 1 mm) or non-existent as in volcanic glass. During more explosive eruptions, lava mixes with ash and rock fragments.



Both intrusive and extrusive rocks can be **porphyritic**, meaning there are two sizes of mineral crystals. The larger crystals are called **phenocrysts**.

Interesting Igneous Finds

Xenolith – An older rock fragment trapped in a younger rock as it forms, such as a rock fragment caught in cooling magma or lava

grey quartzite in pink granite

granite within basalt

Volcanic Breccia – Angular rock fragments, ash, and lava weld together during a violent volcanic eruption.

Intrusive Igneous

felsic (light)

Granite – Mostly white and/or pink minerals with small amounts of dark minerals

Porphyritic Granite

large orthoclase feldspar crystals (phenocrysts)

Diorite – A mix of equal amounts of light and dark mineral crystals

mafic (dark)

Gabbro – Comprised of dark minerals, these pebbles are black to green and feel heavy for their size.

Extrusive Igneous

Flow-banded Rhyolite – Microscopic quartz crystals make these pebbles hard enough to scratch glass.

The bands are different lava flows.

Porphyritic Rhyolite – Magma can start crystallizing slowly underground, and then erupt as lava and cool quickly. The rock formed has phenocrysts in a matrix of microscopic crystals.

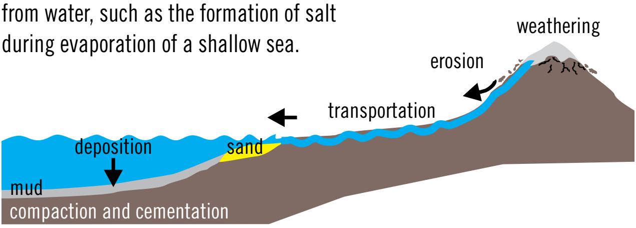
Porphyritic Dacite – Grey or pale brown with large light-coloured feldspar phenocrysts

Stilbite, a zeolite, is the Provincial Mineral of Nova Scotia

Basalt – Fine-grained, dark volcanic rock. Gas bubbles can be trapped in cooling lava and form holes (vesicles). Later, minerals like these white and pink zeolites crystallize from cooling fluids to fill the holes and form amygdaloidal basalt.

SEDIMENTARY PEBBLES

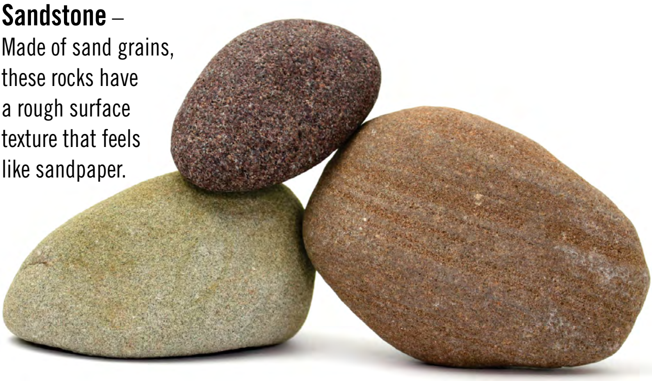
Sedimentary rocks form at the Earth's surface. These rocks form by the lithification (burial, compaction, and cementation) of sediment (including plant and animal remains) and/or the precipitation of minerals from water, such as the formation of salt during evaporation of a shallow sea.



CLASTIC sedimentary rocks form by the accumulation and lithification of sediment. Most sediment is composed of fragments of weathered bedrock but can include plant and animal remains. Once eroded (removed), sediment is transported by water, wind, ice or mass movement, and eventually deposited in a sedimentary environment like a beach. Over time, layers of sediment accumulate, are buried and then compacted. When groundwater moves through these layers, minerals precipitate and cement the sediment into rock completing the process of lithification. Sediment can include clay (mud), silt, sand, pebbles, or organic matter. The predominant sediment determines the name of the rock. For example, a rock made mostly of sand is called sandstone. Mudstones and shales are generally softer, easily weathered, and uncommon in pebble form.

Conglomerate – Rounded pebbles in a matrix of sandstone or mudstone that form in environments with fast-flowing water (beaches and rivers)

Sandstone – Made of sand grains, these rocks have a rough surface texture that feels like sandpaper.



Clastic Sedimentary

Siltstone – Grains of silt sediment are barely visible with the naked eye and often accumulate in layers.

Fossils – Shells, skeletons, and plant fragments can act like particles and become part of the sediment. Eventually, if preserved, they become fossils in sedimentary rocks.

black bivalve shells in siltstone

carbonized plant fragments in sandstone

Sedimentary Structures – Layers represent the accumulation of sediment over time. Variations in colour reflect changes in composition and conditions in the sedimentary environment.

Inclined and wavy layers represent the cross-section of ripples, like those on a beach.

Chemical Sedimentary

CHEMICAL sedimentary rocks form in warm climates where minerals such as gypsum and halite (salt) precipitate from seawater as it evaporates. Because these rocks are very soluble in water, they are not common as beach pebbles.

Gypsum – Pink, white, or grey in colour, gypsum is so soft you can scratch it with your fingernail.

BIOCHEMICAL sedimentary rocks are made of sediment formed by biological processes. As an example, limestone is commonly comprised of fossil skeletons of corals, shells, and/or microscopic organisms.

Limestone – Made mostly of the mineral calcite (calcium carbonate), a scratched surface reacts with weak acids like vinegar. Try it!

Boreholes in limestone form when small, present-day animals make homes in the rock.

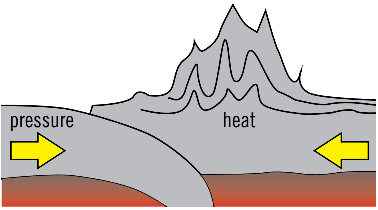
fossiliferous limestone from an ancient sea

Coal – When plant materials in a swamp die, accumulate, and are compressed by overlying sediment over millions of years, coal is formed.

The carbon in coal allows you to “write” with it on paper.

METAMORPHIC PEBBLES

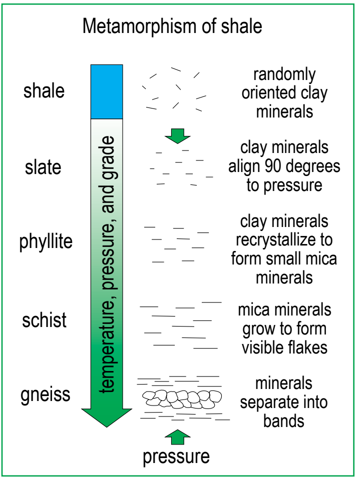
Metamorphic rocks form when heat and pressure deep below the Earth's surface cause pre-existing rocks to physically or chemically alter (metamorphose). These conditions are generated by plate-tectonic processes such as continental collisions (regional metamorphism). Magma chambers also act as heat sources to alter the surrounding rock (contact metamorphism).



Mountains form by continental collisions.

Metamorphic Grade

With increasing temperature and/or pressure, metamorphic rocks increase in grade or the amount of change. These changes can include enhanced layering (foliation), formation of new minerals, and the development of banding.



FOLIATED metamorphic rocks have a layered or banded appearance due to heat and directed pressure (pressure that is greater in one direction). As a result, minerals in the original rock grow and are reoriented. Long and flat minerals are aligned perpendicular to the direction of greatest pressure.

NON-FOLIATED metamorphic rocks form under high temperatures during contact or regional metamorphism and are not layered or banded. The original minerals in the rock recrystallize to 'grow' in size or form new minerals.

Unusual Metamorphic Find

Mylonite – Deep below the Earth's surface in ductile (hot) fault zones where rocks slide against one another, mylonite forms. Minerals are smeared, decrease in size, and align in layers (foliation). Large crystals can form augens, which in German means eyes.

Foliated Metamorphic

Slate – Hard, flat, shiny pebbles make a “ping” sound when tapped with a nail.

The original sedimentary layers may be present.

Phyllite – Small, shiny mica minerals grow and align to give the surface a sheen.

Schist – As grade increases, mica minerals “grow” into visible, flaky crystals.

Biotite is a black to dark brown mica.

Muscovite is a silver- to gold-coloured mica.

Gneiss – Alternating light and dark-coloured mineral bands.

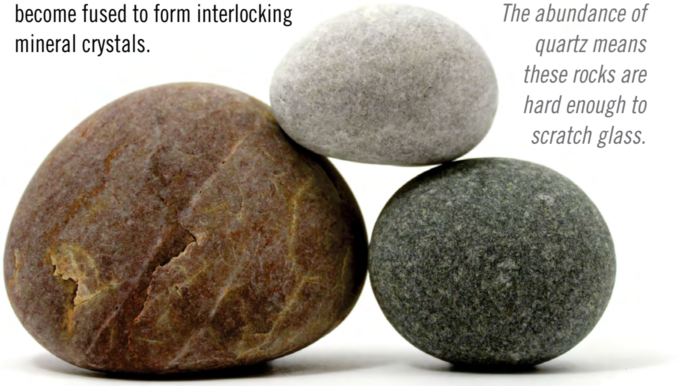
Pink orthoclase feldspar is eye-shaped in augen gneiss.

Granite metamorphosed to granite gneiss.

Non-foliated Metamorphic

Quartzite – Sand grains in sandstone become fused to form interlocking mineral crystals.

The abundance of quartz means these rocks are hard enough to scratch glass.



Hornfels – Hard, fine-grained, and commonly derived from clay-rich sedimentary rocks

Dark-coloured cordierite crystals indicate low-grade contact metamorphism.

Amphibolite – Comprised of milky white and dark coloured minerals, these rocks may have a weak foliation or layering.

Granofels – These rocks form under high temperatures and pressures at great depths below the Earth's surface. Minerals are equant in shape (equal dimensions) and can be randomly oriented.

GEOLOGICAL FEATURES

Quartz Veins – Veins form when minerals like quartz (and even gold) precipitate from hot fluids flowing through fractures in the rock.

Microfault – Faults form when rocks fracture and the adjacent sides move in opposite directions. Faults in pebbles are small and called microfaults.

See how the layers are offset.

Microfolds – Rocks squeezed under intense pressures beneath the surface of the Earth, become folded. These small folds are called microfolds.

MINERALS

Pyrite – The mineral pyrite (fool's gold) usually has a golden, metallic colour and cube-shaped crystals. Weathering may cause pyrite to rust or pluck the crystals from pebbles leaving square-shaped holes.

pyrite

Quartz – Most of these white to grey pebbles started as fragments of large quartz veins. Fresh broken surfaces of quartz have a conchoidal (curved) fracture pattern.

Quartz can scratch glass.

Chert – Microscopic quartz crystals cause this pebble type to be hard and smooth to the touch. Red varieties are called jasper.

Agate is the Provincial Gemstone of Nova Scotia.

Agate is usually banded and found as veins in volcanic rocks.

Feldspar – Large feldspar crystals (phenocrysts) in granite can weather out to become solitary pebbles.

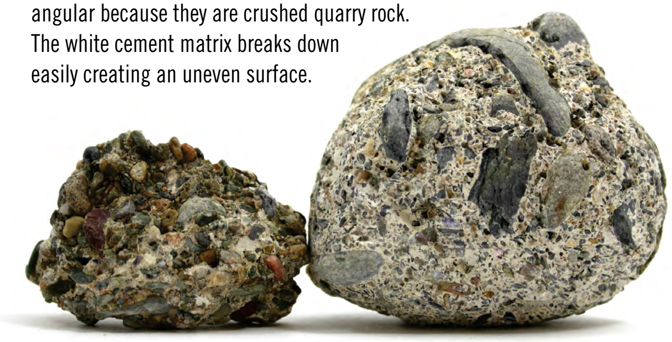
Plagioclase feldspar is usually white.

Orthoclase feldspar is usually pink.

PEBBLE IMPOSTERS

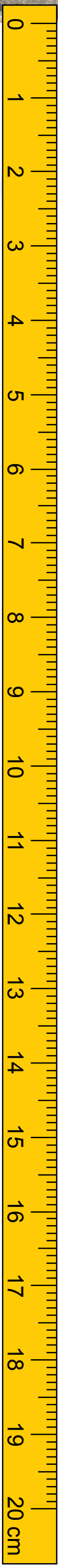
Manufactured materials can be easily confused with naturally formed pebbles.

Concrete – Larger rock fragments in concrete are typically angular because they are crushed quarry rock. The white cement matrix breaks down easily creating an uneven surface.



Brick – Very porous (many small holes) and easily weathered, bricks are manufactured from clay and can be a variety of colours.

Sea Glass and Pottery – Glass shards and pottery can become rounded and frosted by many collisions with other particles in a beach setting.



PEBBLE COLLECTING AND SAFETY

Getting started

Tools you may need include a sturdy pack, map, notebook, scale for measurement, first aid kit, and GPS unit. Many smart phones can take images of the location, provide GPS co-ordinates, and be a communication tool. Wrap specimens and record the location where they were found.

Provincial guidelines for collecting

Recreational collecting is for personal interest, recreation or pleasure, and is done with the use of hand tools only, without disturbing the ground. The collector can only remove the amount of material he/she can carry unassisted, and can collect at a specific site or location one day per year. When possible, use public access or obtain permission from the landowner to cross to the beach. Public (Crown) lands extend seaward from the high water mark. Collecting must be done in a manner that respects the environment and does not conflict with other land users or businesses.

Collecting cannot take place in areas where it is not permitted, such as Provincial Wilderness Areas, Nature Reserves, Provincial Parks and Reserves, Protected Beaches, National Parks, and National Wildlife Areas. For additional information, refer to the Nova Scotia Department of Natural Resources brochure, "A Guide to Rock and Mineral Collecting in Nova Scotia."

All fossils in Nova Scotia are protected by the Special Places Protection Act. It is against the law to excavate or collect fossils in Nova Scotia without a valid Heritage Research Permit. If you find an unusual fossil, leave it in place, take detailed information about the specimen, its location, and a photo if possible, and contact the Nova Scotia Museum of Natural History or the Fundy Geological Museum.

Safety

You are responsible for your own safety, so always use caution. Prepare a trip plan – let someone know where you are going and when you plan to return. Dress appropriately for the weather, including sturdy footwear. Be prepared. Take food, water, and appropriate gear for the location. Cliffs can be high and steep and may have overhangs. Wear a hard hat if possible – rock falls can be deadly. Collecting with a friend is safer and more fun!

There are some specific safety concerns when collecting in coastal areas. Check tide tables in advance (tides.gc.ca) and collect on the falling tide. The tidal ranges are extreme along the Bay of Fundy, Minas Basin, and the rivers that flow into them. Choose safe access points, and allow enough time to safely leave the shore. Rock that is wet, loose, or covered in seaweed can be very slippery. There are similar concerns when collecting along lakeshores and riverbanks.

Every pebble tells a story …

Nova Scotia has a rich and diverse geological history and a variety of pebble types can be found while travelling the province. This guide can be a great companion on your adventures.

**Download this guide at:
ags.earthsciences.dal.ca/NSpebbles**

The **Atlantic Geoscience Society** (AGS) brings together earth science professionals, students, and enthusiasts in the Atlantic Provinces. AGS is a volunteer, non-profit association with a small membership fee. One of AGS's main goals is to encourage an interest in the earth sciences, especially in the Atlantic Provinces. As part of this effort, the Society has developed a series of educational resources for students and the general public.

Related AGS Publications:

- Nova Scotia Rocks (2nd edition)
- Geological Highway Map of Nova Scotia (3rd edition)
- The Last Billion Years: A Geological History of the Maritime Provinces of Canada
- Discovering Rocks, Minerals, and Fossils in Atlantic Canada: A Geology Field Guide to Selected Sites in Newfoundland, Nova Scotia, and New Brunswick

Additional Recommended Resources:

- Four Billion Years and Counting: Canada's Geological Heritage
- Geology of Nova Scotia: Touring through time at 48 scenic sites

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