

MINERALS/ROCKS



1

What are They?

Anything solid that is not animal or vegetable can be called a mineral. Minerals have characteristic chemical compositions and physical properties. Gold is a mineral, and so is salt. Rocks are made up of one or more minerals, and have varying compositions and properties depending on the minerals in them, and how they were formed. Shale is a type of rock, and so is granite.

Gifts from the Land

Rocks and minerals are essential for making the things we use each day. As you read this, look around. Almost everything you see—the building, your chair and table, the picture frame and the glass in it—all have been made using minerals mined from the Earth. Even if what you see is made of wood, then its manufacture and delivery

was made possible only by using Earth

resources. We couldn't generate electricity without minerals. Minerals also help put food on your table – fertilizers from minerals help fruits and vegetables grow. In Canada, we are fortunate to have huge resources of all kinds of minerals: more than 60 are mined. The mining industry is a major employer, supporting more than a million Canadians.

Polaris Mine Cafeteria, Nunavut



S. McCracken, NRCan



S. McCracken, NRCan

Twin Otter, Griffith Island, Nunavut

For 10,000 years?

People have been mining in Canada for a long time. The first people who arrived about 40,000 years ago used minerals and rocks to make tools, weapons, and decorative objects. On Manitoulin Island in Ontario, quartzite was mined from a quarry 10,000 years ago. From about 7500 to 3500 years ago, the Maritime Archaic people of Labrador were mining Ramah chert and trading it as far south as the northeastern United States! And more than 5000 years ago, people in the Lake Superior region were trading in copper. Much later, European settlers used local materials, such as stone, clay, sand, and lime for building. In 1639, the first coal mine in North America was opened in New Brunswick. In Quebec, iron ore was first smelted for iron in 1737. Canada's first gold rush was triggered by the discovery of gold on the Queen Charlotte Islands of British Columbia in 1862.



GSC A94S0081

Copper slab, Victoria Island



Ramah chert biface and two projectile points, northern Labrador, Newfoundland and Labrador

© 2006, Collection of The Rooms-Provincial Museum of Newfoundland and Labrador

MINERALS/ROCKS



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What is Mined in Canada?

Metals like copper and gold, precious stones like diamonds, and industrial minerals like gypsum, are all mined in Canada. There are many ways to classify mineral and rock resources, but one simple way is to use three groups:

- **Metallic Minerals**
- **Industrial Minerals**
- **Precious and Ornamental Stones**

Some fall into more than one group. For example, diamond is used industrially as an abrasive, and of course it is precious and ornamental. Gold is metallic, but it is also precious, ornamental, and has important industrial uses.

Big Nickel Monument, Sudbury, Ontario



EMR-7968

Gold bars at Inco's refinery



EMR-8234



NRCan-3189

Zinc ore processing, Languis mine, Quebec



ESSO petrochemical refinery,
Cold Lake, Alberta

Metallic Minerals are used to make metals. Precious metals (noble metals) like gold and silver are relatively rare, and because of their desirability, they have high value. Base metals (such as iron, copper, lead, zinc, and nickel) have lower value because they are more common. Inexpensive jewellery can be made with a 'base' of copper or nickel, and 'plated' with gold.



Rare Earth Elements in monitor, DVD burner, hard drives

B. Rutley, NRCan

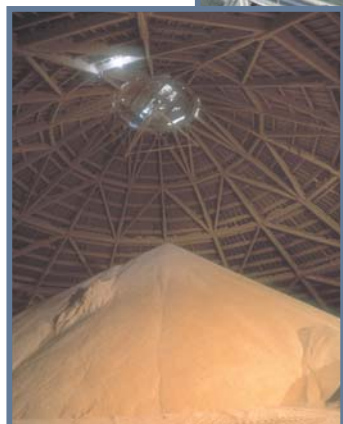
When we think of platinum we most often think of jewellery. But the Platinum Group Metals (PGM) have many uses in the petrochemical and automotive industries. Rare Earth Elements (REE) such as yttrium and scandium are not especially rare in the Earth's crust, but they are rarely concentrated in one place. The REEs are important because they are critical in the production of lasers, TV screens and computer monitors, supermagnets in computer drives, and environmentally friendly rechargeable batteries.

MINERALS/ROCKS

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Industrial Minerals are abundant and have many uses. Salts from ancient seas are used in fertilizer (potash) and as flavouring in our food (halite). Halite is also an important ingredient in the chemical industry. Drywall is made from gypsum. Stone cladding on buildings is called dimension stone and includes limestone, like that quarried at Garson, Manitoba, and labradorite from near Nain in Labrador.

There are more than 3000 stone quarries and sand and gravel pits in Canada. Sand and gravel (aggregate) are used in road and rail construction, and building foundations. Clay is used to make bricks and tiles.



Potash storage, Esterhazy, Saskatchewan

Décarie-Metropolitan Boulevard interchange, Montreal, Quebec



Garson quarry, Manitoba



G. Nowlan, NRCan



Labradorite. Artist Jamie Meyer

B. Rutley, NRCan

Precious and Ornamental Stones are pretty. Some dimension stones, such as labradorite and Tyndall Stone, can be called ornamental if they are carved or sculpted. Jade from British Columbia, amethyst from northern Ontario, pyrophyllite from Newfoundland, and serpentinite from Nunavut are made into

jewellery and ornaments by artists. Canada is one of the world's leading producers of diamonds, which are mined and cut in northern Canada. Other important gemstone discoveries include emeralds in Yukon and Ontario, sapphire on Baffin Island, aquamarine in Yukon, and ammolite (shell of ammonites) in Alberta.



Jade

British Columbia
Geological Survey Branch



Emeralds

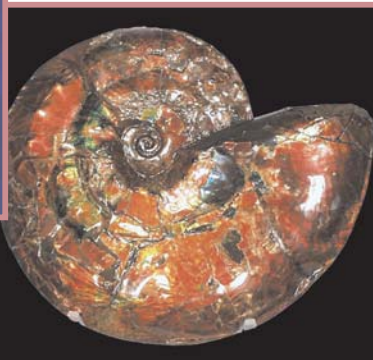
Image compiled by Dillmedia
© True North Gems Ltd.

Amethyst



GSC 1991542

© Canada Fossils Ltd.



Ammonite fossil



Pyrophyllite, Manuels, NL
Artist Nathaniel Thomas Noel

B. Rutley, NRCan

MINERALS/ROCKS

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What is Responsible Use of Resources?

Despite its huge influence on Canada's economy, mining disrupts very little of the land. Less than 3000 km² of Canada's land area (that's less than 0.03%) has been used to produce minerals and mineral products. These days mined areas can be returned back to almost the way they were before mining began. It hasn't always been this way, but people and mining companies understand environmental responsibility better now. Even reusing resources has become an industry. Millions of tonnes of metals and other minerals are recycled annually.



Reclaimed open pit, Luscar Mine, Elk Valley Coal Corp., near Hinton, Alberta

G. Nowlan, NRCan



Metal for recycling

NRCan



Sulphur at Shell Canada's Waterton Gas Complex, Alberta

EMR-6892

An example of using resources in an environmentally responsible way has been the recovery of sulphur from sour gas. This is natural gas that contains hydrogen sulphide. This hydrogen sulphide can be removed and converted to sulphur, which is a valuable resource. Almost 90 per cent of sulphur produced in Canada is from gas deposits in Alberta. It has many uses – pharmaceuticals, fertilizers, asphalt, matches, paints, detergents, glass, steel, plastics, and many others.

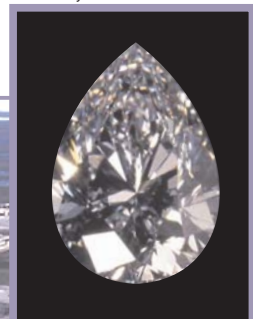
Opportunities in the North

Exploration is taking place now in northern Canada. Diamond mining is a relatively new but major industry, and it is centered in the north. Discoveries of other minerals have led to new mines in northern Quebec and Labrador. And exploration for other precious stones such as emerald and sapphire is going on in northern Canada. Learning more about the geology of the land will allow its hidden gifts to be discovered and turned into opportunity and wealth.



Panda Pit, Ekati Diamond Mine, NWT

Provided by BHP Billiton © BHP

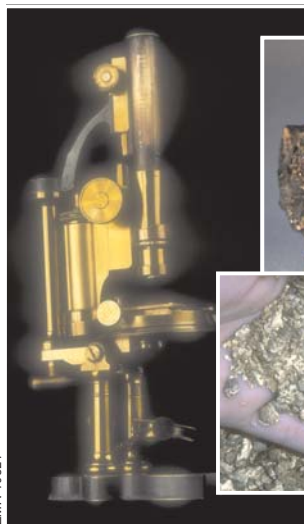


Provided by BHP Billiton © BHP

METALS AND METALLIC MINERALS



1



EMR-10324

Antique brass microscope



GSC F9250256

Pyrite



EMR-8397

Gold

What are They?

Metals usually have shiny surfaces, are good conductors of heat and electricity, and can be hammered into thin sheets or stretched into wires. Metals combine naturally with other elements to form minerals (e.g., pyrite), or can be combined with other metals to form alloys such as brass. Metallic minerals are simply minerals that contain one or more metallic elements.

Metals vary greatly. For examples, tungsten melts at 3407°C, mercury at 38.8°C; platinum is almost 22 times as dense as water, but lithium will float on water; chromium is hard, zinc is soft; potassium oxidizes so quickly it burns, but aluminum hardly oxidizes at all.

Why are They Important?

For centuries, people have used metals to make tools, weapons, and art. Today, metals are used everywhere. The best-known metals are those that we encounter every day: aluminum, copper, gold, iron, lead, silver, tin, and zinc. But there are many others that we use without knowing it: lithium, mercury, platinum, titanium, tungsten, scandium, and yttrium, to name a few.

Aluminum ingots



EMR-7412



EMR-7407

Reynolds Aluminum Company plant, Baie Comeau, Quebec



© First Air

A Boeing 737 has almost 60km of copper wiring

How Do They Form?

The Earth is made up of metallic and non-metallic elements. Non-metallic elements are more abundant than metallic elements, but fortunately, geological processes sometimes produce concentrations of metallic minerals. The trick for geologists and prospectors is finding these concentrations. Examples of these geological processes are streams that concentrate gold nuggets, and submarine hot springs that deposit metal minerals.

Metals and the Environment

Mining for metals requires moving large amounts of rock. On a national scale, the amount of land disturbed is tiny. But at a local level, it can be huge. Our world needs these metals, but it is to our advantage to do this mining and processing responsibly, and to clean up the land during and after this work.



Inco Ltd.

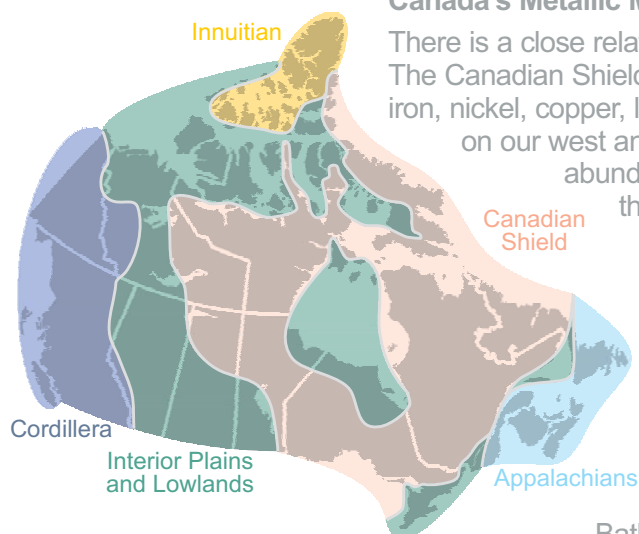
Reclaimed mine, Ontario

METALS AND METALLIC MINERALS

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Canada's Metallic Minerals

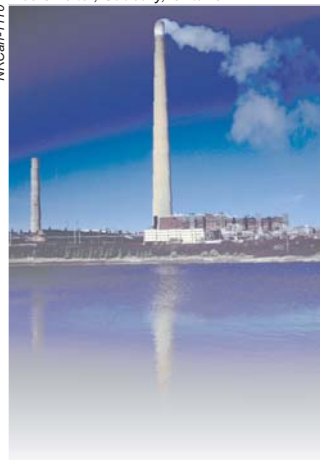


There is a close relationship between the geology of a region and its minerals. The Canadian Shield's igneous, metamorphic, and sedimentary rocks give us iron, nickel, copper, lead, zinc, uranium, gold, and silver. The mountain belts on our west and east coasts (Cordillera and Appalachians) contain an abundance of deposits and mines. The sedimentary rocks of the Interior Plains and Lowlands are most important for their hydrocarbons, but they also contain placer gold, and lead and zinc. Many of Canada's cities and towns had their origins with metal discoveries. Cities such as Sudbury and Thompson grew along with their nickel-copper mines. Yellowknife and Dawson City are famous for their gold mines; Flin Flon exists because of copper, zinc, gold, and silver deposits. Uranium City and Port Radium developed because of uranium and radium, Labrador City because of iron, and Bathurst because of copper, lead, and zinc.

How are They Produced?

When metallic minerals are mined they are called ores, and ores must be processed further to extract the metals. First the ore is crushed and then the metallic minerals are separated from unwanted rock to form a concentrate. The metals in the concentrate then must be separated from the non-metals. In ancient times, this happened in campfires or ovens. Today this process is done in a smelter. The concentrate is heated to a high temperature, which releases the metals. The molten metal is then cooled. Using electricity is another way to release the metals. This is how aluminum is removed from the mineral bauxite.

Inco smelter, Sudbury, Ontario

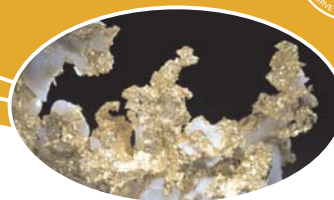


Molten iron, SKW Canada, Inc., Quebec

Did you know?

- It takes 4 tonnes of bauxite to obtain 1 tonne of aluminum
- Canada is a world leader in aluminum production, but Canada has no bauxite! (It is mined in the tropics)
- Galvanizing iron and steel with zinc makes them rust-resistant
- Every tonne of steel recycled saves 1100 kg of iron ore, 650 kg of coal, and 55 kg of limestone
- Framing a 100 m² home (1076 sq ft) requires wood from about 25 trees, or steel from just 3 junked cars
- Most of the millions of parts of a big airliner are made of metals

GOLD



1

The Metal of Kings

Of all the precious metals, gold has been the most prized throughout history. It is beautiful, easy to work with, and never tarnishes. It has been used for over 5000 years as money and decoration, but now is especially important in the electronics and aerospace industries.

Where Do You Find Gold?

Many of the best-known gold discoveries have been placer deposits, where gold is found as dust, flakes, and nuggets in the sand and gravel of streams and rivers. The gold rush of 1897-1898 started with the discovery of placer gold in a tributary of the Klondike River in Yukon Territory. Today about 5% of the gold in Canada comes from placer mining.

Much more gold, about one-third in Canada, comes as a by-product in mining copper, nickel, zinc, and lead. However, the greatest amount of gold, termed lode gold, is found in bedrock, either as vein gold, or as finely dispersed gold (as at Hemlo, Ontario), or a combination of the two (as at Yellowknife, N.W.T.). Dispersed gold can almost be invisible and hard to find. For example, gold was first discovered in the Hemlo



Getty Images Inc.

Death mask of Tutankhamun



with permission of the Royal Ontario Museum © ROM

Gold and quartz, Paymaster Mine, Timmins, Ontario

area in 1869. Many prospectors continued to find traces of gold in the area, but it was not until 1981 that a large deposit was discovered. Most lode gold comes from the volcanic and sedimentary rocks of the Canadian Shield, but the younger rocks of the Cordillera and Appalachians also contain lode gold.

Vein gold forms when hot, gold-bearing fluid flows through faults and fractures in the rocks. These cracks fill up with minerals, mostly quartz, but also gold. The deposits range from a single gold-rich vein that can be mined simply by digging a trench or tunnel, to complex systems of veins that require many levels of underground mining. Examples of vein gold deposits are those of the Yellowknife area, and the Abitibi region of Ontario and Quebec.

Gold has been mined for 6000 years, but 90% of it has been produced since the start of the California gold rush in 1848

Gold is soft: 28 g (1 oz) of gold can be beaten into 16 square metres of gold leaf!

Gold is used in the electronics industry to make more than 10 billion tiny electrical contacts every year

Gold purity is measured in karats—24k gold is 100% gold; 10k gold is 41.7% gold, the rest is some other metal such as silver, copper, or zinc

YELLOWKNIFE GOLD

2



Wildcat Cafe, Yellowknife, NWT, ca. 1945

The Discovery that Changed a Town

Yellowknife is named after the Yellowknives Dene who moved into the area in the early 1800s. The yellow in the name refers to the copper they used to make their knives. But the city owes its growth to the discovery of another metal—gold. In the 1930s, prospectors found gold on Yellowknife Bay, and by 1937, the town was booming. The Con Mine went into production in 1938 and the Giant Mine in 1948. Together they produced more than 400 tonnes of gold. The closure of the mines has not ended Yellowknife's connection with mining—it is now the centre for Canadian diamonds.



Giant Mine, Yellowknife, NWT, 1955

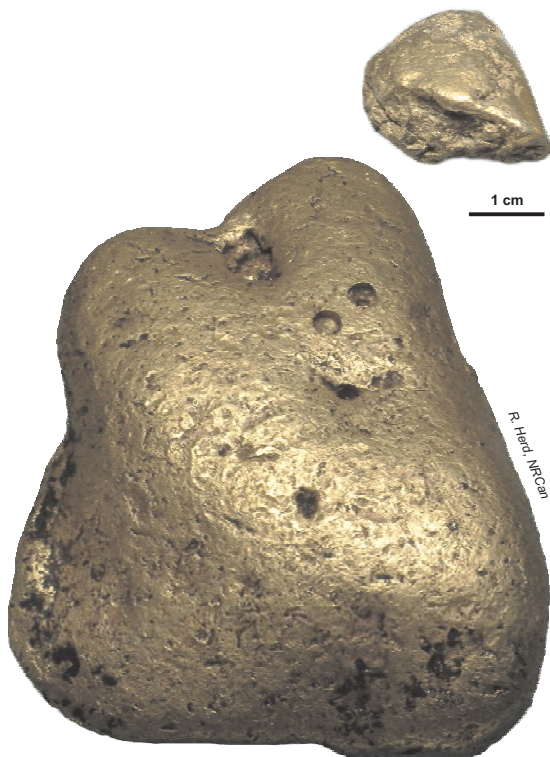
There's No Free Lunch

Gold has been good for Yellowknife, but its production has not been without environmental cost. Since 1948, about 237,000 tonnes of arsenic trioxide dust has been created at the Giant Mine as a result of the roasting process used to break down the gold-bearing arsenopyrite ore. In arsenopyrite, the arsenic is in a stable form and is not a health hazard, but arsenic trioxide is toxic. The dust is stored underground, and at one time it was thought that the natural permafrost would seal the storage chambers. However, open pit mining on the surface caused the permafrost to thaw. To minimize the danger, the solution now favoured is to artificially freeze these chambers so that there will be no seepage of water into or out of the frozen zones, and thus no release of arsenic into the environment. This, and continuous monitoring and treating of groundwater from the area will be expensive—estimated costs are \$200-300 million.



PLACER GOLD

1



Gold nuggets, from near Atlin, British Columbia

Heavy Stuff

Placer deposits are heavy minerals that, after being weathered out of bedrock by wind or water, are concentrated by gravity. Most people think of gold when they hear the word 'placer', but any heavy mineral can become a placer. For example, uranium, tin, and platinum can form important placers.



Gold mining with a sluice box, North Saskatchewan River, near Edmonton, Alberta, 1898

NRCan 199559

Placer Gold Formation

The first thing needed to produce a placer gold deposit is a gold-bearing source rock (sometimes called the 'Mother Lode'). The gold in this rock may be visible, or present in particles so tiny that they can't be seen with the naked eye. Weathering gradually wears the rock away, leaving the gold, which is heavier, behind. With just weathering and no further processing, a low-grade placer can be formed, but transportation and gravity concentrate the gold and produce the best placers. As either rain or stream water moves over the loose gold it is picked up and carried. Where the current slows, such as at a river bend, or where the water encounters boulders in the stream bed, gravity causes the gold to drop out of the flow. This concentrates the gold into 'pay streaks'.

A prospector uses a pan to see if gold is present in the gravel. Swirling the gravel with water in the pan recreates the action of a stream. You can do the same with the palm of your hand. Pick up some beach or stream sand in your palm and gently wash it back and forth in the water. If the sand contains heavy minerals (for example, small dark grains or iron-rich minerals), they will concentrate into a pay streak!



NRCan 21583



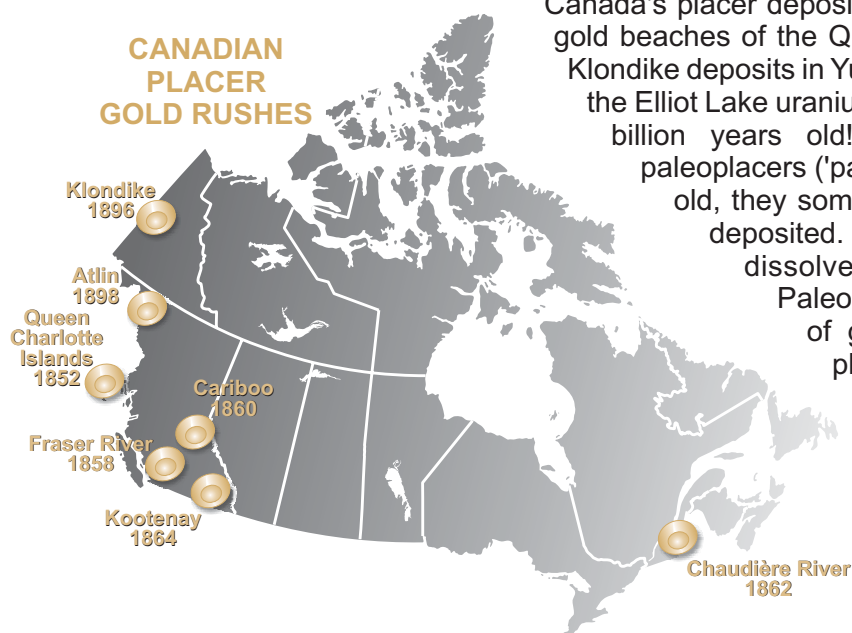
PLACER GOLD

2

When and Where

Canada's placer deposits formed at different times: the placer gold beaches of the Queen Charlotte Islands are recent; the Klondike deposits in Yukon are less than five million years old; the Elliot Lake uranium placers in Ontario are more than two billion years old! Older placer deposits are called paleoplacers ('paleo' means old), and because they are old, they sometimes have changed since they were deposited. For example, the minerals can be dissolved, transported, and recrystallized. Paleoplacers of gold can serve as the source of gold for more recent placers. Today, placer gold exploration and mining are taking place in Canada, especially in the mountains of Yukon Territory and British Columbia. More efficient mining methods can make new discoveries profitable.

CANADIAN PLACER GOLD RUSHES



DID YOU KNOW?

Placer mining accounts for about 5% of Canada's annual production of gold

Placer gold was discovered in beach sands near Halifax, Nova Scotia in 1857, and along Ontario's Vermilion River in 1896

The Klondike is Canada's richest placer gold area: between 1896 and 1900, 77 tonnes of gold were recovered; since then another 100 tonnes have been found

Gold has many decorative and industrial uses, but is also used by governments to back currency and in trade

The Peace, Red Deer and Athabasca rivers in Alberta contain placer gold

Placer gold can be found along the North Saskatchewan River from Rocky Mountain House, Alberta, to Prince Albert, Saskatchewan, a distance of over 600 kilometres



Heading to the Klondike, 1899

NRCan 199645

IRON



1

King Iron

Iron is one of the most useful of all of the metals. People have been using iron for more than 5000 years. Smelted iron artifacts from Iraq and Egypt have been dated to around 3000 BC.

Today we use 20 times more iron, in the form of steel, than all of the other major metals put together. Almost all of the iron ore mined in the world is used to produce steel – for everything from huge bridges, trucks, trains, ships, engines, and machines of all kinds, to tiny pins, needles, and paperclips. You may be sleeping on a bed with a steel frame and a mattress containing steel springs made from iron ore.



E. Macey, NRCan



S. Leong, NRCan



S. McCracken, NRCan

And iron is used for much more than steel-making: it's used as a pigment in makeup, paint and ink, in paper, plastics, and in baked enamel finishes for appliances. Iron is found in medicines, vitamin pills, cereals, fertilizers, magnets, fungicides, and fireworks.



S. McCracken, NRCan

Blue Water Bridges, St. Clair River, connecting Ontario and Michigan

Iron from Space

In 1818 the English explorer John Ross travelled to Greenland and found the Inuit using iron tools in a land where there didn't appear to be any iron ore. They told him that they had been taking this metal from a huge rock far north of the area where they lived.

It turned out to be a large, almost pure iron meteorite that slammed into the Earth near Cape York in northern Greenland, about 10,000 years ago. It broke apart as it descended through the atmosphere.



Manicouagan meteorite impact crater (centre), Quebec (ISS006E34153)

For more than 1000 years, Inuit traveled great distances to this site to take pieces of the meteorite using basalt hammer stones. The pieces were shaped into harpoons and other edged tools by hammering them. Tools made from the Cape York meteorite have been found in Dorset and Thule archaeological sites more than 2000 km away, indicating that there was a widespread trading network among these peoples. With the help of Inuit guides, the American explorer Robert Peary finally found three large pieces of this meteorite in 1894. They are now on display in the American Museum of Natural History in New York and are among the largest meteorite pieces ever found – the largest weighs 34 tonnes and is the size of a small car!

Courtesy of the Image Science and Analysis Laboratory, NASA Johnson Space Center

IRON

2



Canadian Iron

Ores are rocks and minerals from which we can get metals economically. Iron ore is one of Canada's most valuable mineral products; we are one of the world's largest producers and exporters of iron ore. There are many iron deposits in Canada, but because of their location or size, not all are economic. Most of Canada's iron ore production is from near Labrador City in the **Labrador Trough**, a geological belt extending through northern Quebec and Labrador. Canada's remaining iron production comes from the by-product recovery of magnetite from copper mine tailings near **Merritt**, British Columbia.

The major Canadian iron deposits are called banded iron formations. These distinctive rocks have layers of hematite or magnetite alternating with bands of red shale or chert. The deposits formed in the seabed along ancient continental margins between 1.8 and 3 billion years ago! The arc shape of the Labrador Trough outlines the edges of one of these ancient continents. Geologists think that these bands show cyclic changes in the oxygen content of the early Earth's atmosphere and ocean.



EMR-4536

Iron ore pellets



EMR-0195

Loading iron ore pellets into hold of a Great Lakes ship



EMR-7499

Molten iron, SKW Canada Inc., Quebec

Did you know?

In 14th century Britain, utensils and other household objects made of iron were considered precious
Pure iron is very reactive and rusts (combines with oxygen from the air) easily – the browns and reddish browns seen in soils and on rocks are usually iron oxides

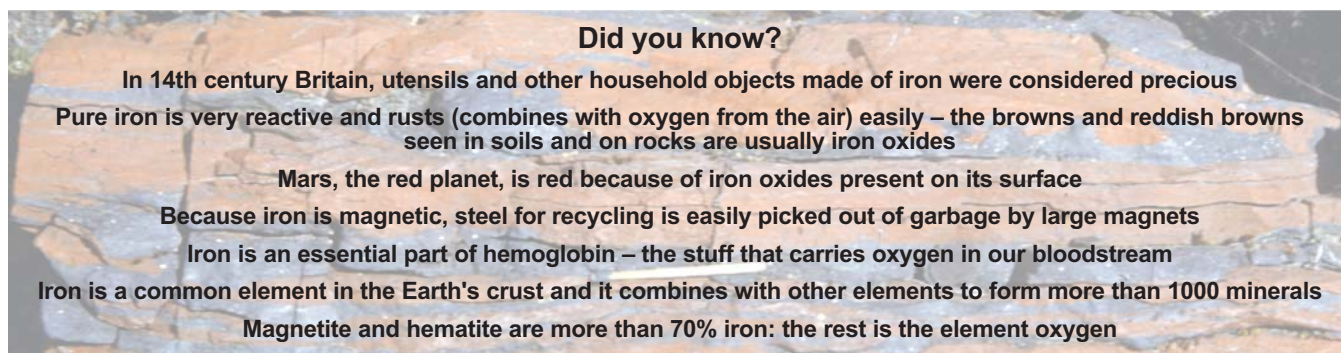
Mars, the red planet, is red because of iron oxides present on its surface

Because iron is magnetic, steel for recycling is easily picked out of garbage by large magnets

Iron is an essential part of hemoglobin – the stuff that carries oxygen in our bloodstream

Iron is a common element in the Earth's crust and it combines with other elements to form more than 1000 minerals

Magnetite and hematite are more than 70% iron: the rest is the element oxygen



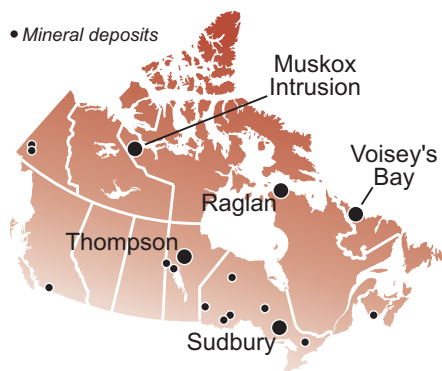
Banded iron formation, Stakit Lake, Newfoundland and Labrador

KGS-441



METALS FROM BENEATH THE CRUST

1



How Do They Form?

Rocks that form by melting in the mantle deep below the Earth's crust contain a lot of iron and magnesium. Geologists call them mafic and ultramafic rocks. They sometimes include minerals rich in metals such as nickel, copper, cobalt, chromium, and platinum. The molten rock rises upward and either erupts on the surface as lava, or cools and solidifies below the surface, forming what is known as an intrusion. Not all intrusions contain concentrations of metals, and that's why minable deposits are hard to find.

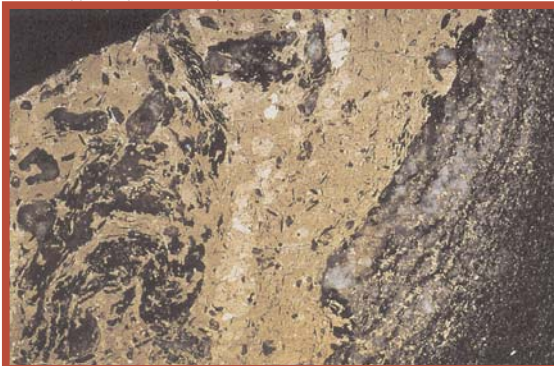
Where Do We Find Them?

Some deposits occur along ancient breaks in the Canadian Shield that mark the edges of former continents. At Thompson, Manitoba and Raglan, Quebec there are nickel deposits that lie along one of these ancient continental margins—more than 2.5 billion years old!

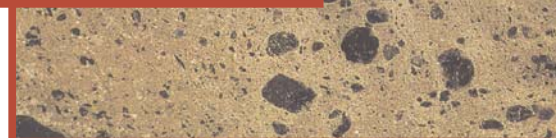
The giant nickel-copper deposits that surround Sudbury, Ontario are among the richest in the world, and lie at the junction of three of these old margins. The Sudbury deposits are unique because they formed in response to a meteorite impact. Over time, the crater has since been squashed by earth movements and eroded beyond easy recognition.

Other deposits occur within large igneous intrusions. The Voisey's Bay deposit in northern Labrador and the Muskox Intrusion in Nunavut are two examples of this type.

Nickel-copper sulphide, Thompson, Manitoba



GS 1995-226



Nickel-copper sulphide, Sudbury, Ontario

GS 1995-225C

DID YOU KNOW?

Nickel is used mainly in the production of stainless steel and high-nickel alloys

Nickel, along with iron, is thought to form the Earth's core

In Canada, nickels and pennies are made mostly of steel, not nickel and copper

Over half the copper in Canada is used in electrical applications, mostly wiring

Police are nicknamed cops or coppers because their uniforms once had copper buttons and badges

Cobalt is used in alloys and superalloys, in the aerospace industry, in steel-belted radial tires, and in battery electrodes

Chromium makes steel harder and more resistant to rusting

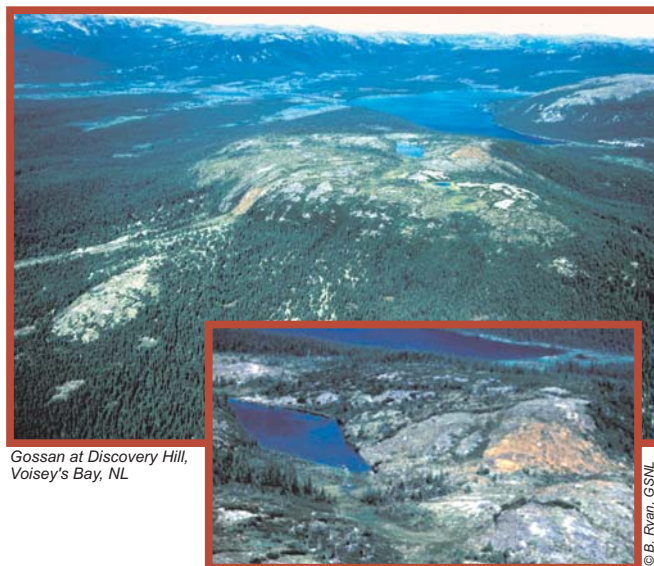
Platinum and palladium are used in catalytic converters to treat car exhaust emissions



METALS FROM BENEATH THE CRUST

The Voisey's Bay Gossan

Many mineral deposits have been found by prospectors who know to search for rusty-looking areas on the ground. These zones, called gossans, form when iron minerals rust. Gossans must be carefully examined because it is common for metals near the surface to be carried away by the acidic water produced by the rusting process. This was particularly important at the Voisey's Bay deposit in Labrador, because, although the gossan zone was huge and could easily be seen from the air, the metals had been leached from the surface. Prospectors in the area kept working—they knew they were onto an important discovery given the size of the gossan, and they were right. The Voisey's Bay deposit is one of the world's largest igneous nickel-copper-cobalt deposits.



Gossan at Discovery Hill,
Voisey's Bay, NL

© B. Ryan, Geological Survey of Newfoundland and Labrador

© B. Ryan, GSNL



Concentrator building and accommodations, Voisey's Bay, NL, October 2004

© Voisey's Bay Nickel Co. Ltd.



Concentrator building, Voisey's Bay, NL, November 2004

© Voisey's Bay Nickel Co. Ltd.

The Muskox Intrusion

The Muskox Intrusion is an enormous mafic-ultramafic intrusion, nearly 500 km long. It lies in Nunavut, on the Coppermine River, southeast of Kugluktuk on the Arctic coast. The intrusion held the molten rock, or magma, that produced the Coppermine Basalts, an immense outpouring of lava nearly 5 km thick.

Minerals containing copper, nickel, chromium, platinum, and palladium have been found at the bottom of the intrusion and in a deep depression that may have been the main pathway for rising magma. Despite its remote location, there has been much exploration. But so far nothing has been found to warrant more advanced exploration.

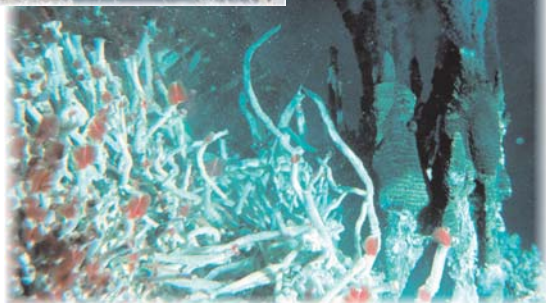
METALS FROM THE SEA FLOOR

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Soft corals on sea floor



©NOAA and V. Tunnicliffe, University of Victoria



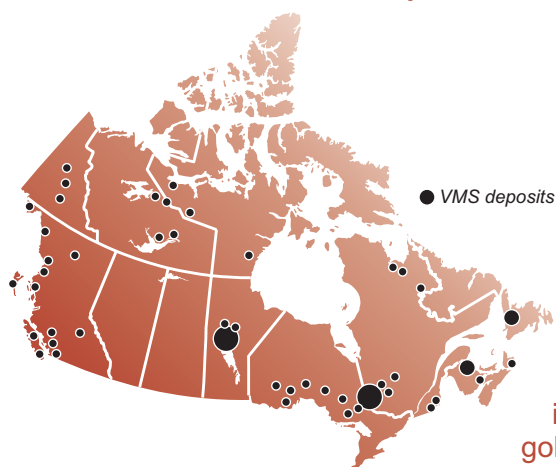
Black smoker and tube worms

©NOAA and V. Tunnicliffe, University of Victoria

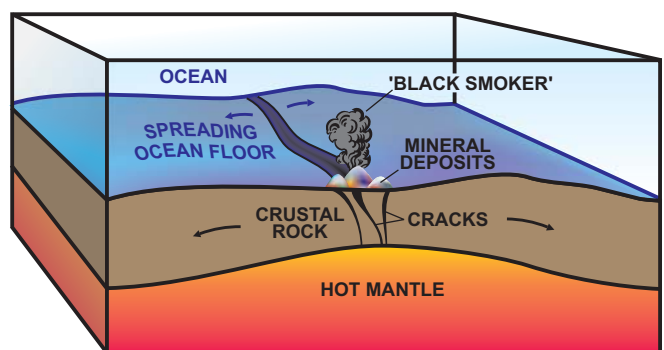
Hot Springs at the Bottom of the Sea

Many different metals occur in deposits that are the remains of ancient deep-sea hot spring systems. Modern examples of these springs are known as 'black smokers' and are found in areas of active volcanism on the ocean floor. These areas are part of the oceanic rift systems, where the Earth's crust is thin and spreading apart. Seawater seeps into cracks and fissures in the crust and becomes heated by the hot rock and magma below. Small amounts of metals such as zinc, copper, lead, gold, and silver in the crustal rocks dissolve in the hot water that rises and escapes through cracks in the ocean floor. When the superheated, metal-rich water billows out from these cracks into the cold ocean water, metals precipitate (form into particles), making plumes of 'smoke' that settle nearby. Over hundreds to millions of years, this activity produces rich mineral deposits known as volcanogenic massive sulphide (VMS) deposits.

Where Do We Find These Deposits?



● VMS deposits



E. Macey, NRCan

Today, VMS deposits are forming at the Explorer and Juan de Fuca ridges in the Pacific Ocean, west and southwest of Vancouver Island. They contain pyrite, sphalerite, galena, and chalcopyrite (minerals containing iron, zinc, lead, and copper-iron, respectively), as well as smaller amounts of silver and gold. Districts where ancient VMS deposits are mined include the

Bathurst district in New Brunswick, the Abitibi region of Ontario and Quebec, and the Flin Flon-Snow Lake area in Manitoba. Farther north, promising areas are in the Canadian Shield of northern Quebec, Nunavut, and the Northwest Territories. These deposits are uneconomical to mine today, but they may be a resource in the future.



METALS FROM THE SEA FLOOR

2



Statue of Flintabbatey Flonatin, Flin Flon, Manitoba

Flin Flon

While prospecting in northern Manitoba in 1911, Thomas Creighton read a novel called *The Sunless City*, which was a fantastic story about an explorer, Josiah Flintabbatey Flonatin, who journeyed down a subterranean river and travelled through a Valley of Gold. Three years later, when Creighton staked some claims over a mineralized area, he gave one of the deposits the nickname of the hero of this book. Perhaps he was hoping for a city of gold. He was close—the Flin Flon deposit contains gold, silver, and huge amounts of zinc and copper.



Headframe, Hudson Bay Mining and Smelting, Flin Flon, Manitoba

The deposit is one of many in an east-west belt of ancient volcanic rocks that occur in eastern Saskatchewan and western Manitoba. Almost two billion years ago this was a system of submarine volcanoes. Pyrite is the most common sulphide mineral, but the principal ore minerals are sphalerite (for zinc) and chalcopyrite (for copper). Mining began as a large pit on the surface but soon went deeper underground. The mines at Flin Flon have been operating for more than 80 years, and the search continues for nearby deposits.

DID YOU KNOW?

Humans started using copper to make tools 9000 years ago.

More than half the copper in use in Canada is for electrical wire.

The first black smoker was discovered in 1977, off the coast of the Galapagos Islands, eight years after Neil Armstrong became the first man to walk on the moon!

Gold, silver, and copper are very soft, and can be pulled out into very thin wires: for example, 28 g (the weight of about 12 pennies) of silver can be drawn into a wire 48 km long!

Zinc is a unique and useful material, used mainly to keep metals from rusting, but also in paints, rubber products, sunblocks, diaper creams, soap, textiles, and electrical equipment.



KLONDIKE GOLD

1

It's Gotta Be Here Somewhere

The story of the discovery of placer gold in the Klondike is famous, but what's been forgotten is that prospectors had been toiling away in the valleys of the Yukon River for years. Gold was first reported in 1863, and by the 1870s, numerous small discoveries were being made. But it was the Bonanza Creek strike in 1896 that started the big rush.

That summer, Skookum Jim Mason and his nephew Dawson Charlie, both from southern Yukon, met Robert Henderson, an American prospector, at the mouth of the Tr'ondëk (Klondike) River. Robert told them of his discovery of gold 40 km to the southeast. Skookum Jim, Dawson Charlie, and George Carmack visited Henderson, and on their return found a richer location in a nearby creek. Carmack named the creek 'Bonanza' (a Spanish word for a rich ore deposit), and when they recorded their claim, the stampede for gold began.

Gold from the Klondike area, Yukon Territory



Panning for gold, Yukon Territory



EMR-8397



Stampedeers packing their loads to the top of the Chilkoot Pass, Alaska-British Columbia boundary, Spring 1898

Glenbow Archives NA-2615-10

Glenbow Archives NA-4033-1

The Rush is On!

Through the winter of 1896-97, prospectors and others who were already in the region staked more than 200 claims on Bonanza Creek. And when some of these newly rich gold miners stepped off the steamships in Seattle and San Francisco the following summer, news of the discovery reached the rest of the world.

More than 100,000 people set out to strike it rich, and more than 30,000 completed the arduous trip to Dawson at the mouth of the Klondike River. Many traveled by steamship to Skagway in Alaska, backpacked 53 km over the infamous Chilkoot Trail (a Tlingit trade route), and finally reached Dawson by navigating 1,000 km down the Yukon River. Regulations required each person to bring a year's worth of supplies. For those carrying the load themselves this meant crossing the Chilkoot Pass as many as 40 times!

The stampede to the goldfield was brief, fueled by sensational reporting when the first boats arrived at ports along the west coast. Only a few stampedeers became rich, mostly by "mining the miners": operating hotels and stores. By 1899, most had moved on, either returning home or joining the new rush to Cape Nome in Alaska.

KLONDIKE GOLD

2



They Needed More Than Pans

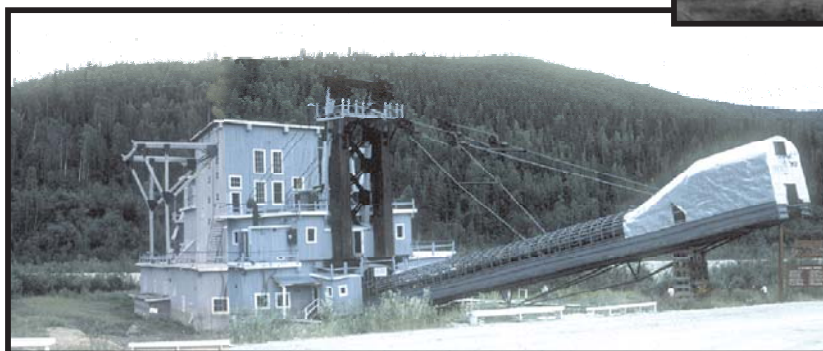
The Klondike gold was originally eroded, particle by particle, from rock, and carried by streams to the Klondike area where it was concentrated in gravels. These gold-bearing gravels, called placers, were mostly deposited on bedrock, overlain by a layer of permanently frozen gravel and a surface layer of decayed organic matter called 'muck'. To be successful, the miners had to dig down to reach the 'pay streaks'. The digging was usually done in the winter when the frozen ground would not cave in. The ground was thawed by wood fires (later steam), vertical shafts were dug to reach the bedrock, and from there horizontal drifts were dug to follow the pay dirt. The gravel was brought up the shaft by a hand-cranked windlass and heaped, ready for sluicing. Sluicing removes the gold from the gravel, and was done in the summer when running water was available. It was brutally hard work, and very few made (or kept) any money.

By about 1907 the rich pay streaks were depleted, leaving the less rich, lower grade gravels. Hand labour was replaced by machinery and more expensive mining methods, including scrapers, shovels, and dredges. Dredges worked the river until 1960, and you can still see the massive piles of tailings they left. Placer mining continues in a small way today using bulldozers, backhoes, and hydraulics (jets of water), and though production is nothing like what it was during the gold rush, the yield is more than 70,000 ounces (1,984,500 g) a year.

Dawson City, Yukon Territory, 1898



GSC 199665



Dredge No. 4 National Historic Site of Canada, Bonanza Creek, Yukon Territory



NRCan 1992-123

Crystalline gold (0.5 cm) from Hunker Creek, near Dawson, Yukon Territory

DID YOU KNOW?

George Mercer Dawson, of the Geological Survey of Canada, explored the Yukon in 1887 and predicted that an important gold find would occur there (Dawson City was named in his honour)

Because of the cost of transportation, prices in Dawson during the gold rush became outrageous: milk sold for \$30 a gallon, tomatoes were \$5 a pound!

Few stampeders became rich and most never staked claims—almost as much money (50 million dollars) was spent in the search for gold as was recovered in gold

Today, you can hike the Chilkoot Trail, which is jointly managed by Parks Canada and the US Parks Service

PINE POINT



1



S. McCracken, NRCan



S. McCracken, NRCan

Pine Point mine, 1975

Town of Pine Point, N.W.T., 1975

The Town That Isn't There

How would you like to visit Pine Point? Well, you can't, because it no longer exists. But it did, for more than 20 years. Now the only evidence left of this once-bustling town is a cemetery, some radio towers, and a few paved streets, overgrown with weeds.



So What Happened?

The town of Pine Point, located about 10 km inland from the south shore of Great Slave Lake, came into existence because of large deposits of lead and zinc. The deposits had been known about for a long time. Prospectors heading along the Great Slave-Mackenzie route to the Klondike in 1898 met a party of Dene, who had musket balls and fishing weights made from a local metal. Claims were staked that year, but it was 67 years before the mine became a reality. A railway and an all-weather road were built, along with a mill, hydroelectric plant, and town. At its peak, the population of Pine Point was nearly 2000, and 650 of those people worked at the mine. Nearly 70 million tonnes of ore were produced, but by 1988 the remaining deposits were too costly to mine. The town was dismantled and the site reclaimed. You can't even find it on highway maps anymore.



S. McCracken, NRCan

Open pit mine at Pine Point, 1975

PINE POINT

2



Devonian reef in western Canada

©Dennis Budgen Illustrations Ltd.

A Tropical Paradise

It's hard to believe, but Pine Point used to be a tropical paradise, part of a long barrier reef that separated a shallow salty lagoon to the southeast from a deep ocean to the northwest. The reef was formed mainly of corals and stromatoporoids (sponge-like animals), shells, and flower-like crinoids. Large predators were ammonoids, which looked like squid with coiled shells, and arthrodire fish. The arthrodires must have been terrifying! They were covered with a bony armour and grew up to six metres in length! Arthrodire means jointed neck—this feature allowed them to open their mouths very wide and take huge bites out of their prey (they didn't have teeth, but the sharp jawbones were just as dangerous!).

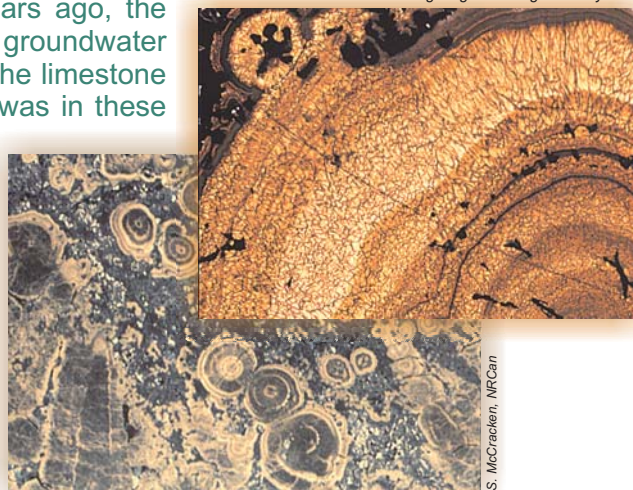
Minerals Form

When the sea level dropped, about 380 million years ago, the limestone reef was exposed to the elements. Rain and groundwater flowed through the naturally porous reef, dissolving the limestone and forming underground caverns and channels. It was in these spaces that ore-bearing fluids later deposited high concentrations of sphalerite and galena, minerals that contain zinc and lead.

The sphalerite formed layer upon layer, gradually making mounds and columns in the caverns. The galena crystals grew in spaces between the sphalerite crystals.

Today, geologists study these minerals by sawing the rock. These cut and polished slices nicely show the grey galena, and the brown and yellow sphalerite. When sliced, the thin layers in the sphalerite columns look like tree rings.

Thin slice of a sphalerite column showing its growth rings and crystals



Cut and polished rock with sphalerite (light to dark brown) and galena (grey)

S. McCracken, NRCan

Pine Point was one of Canada's most profitable lead-zinc mines ever

68.8 million tonnes of ore were mined between 1963 and 1987

The trucks used to haul ore at Pine Point were 50- and 85-tonne dump trucks; today, trucks used in oil sand mining are 400-tonne dump trucks!

In 1975, the population of Pine Point was 1861; in 1991, it was nine

POLARIS



1

An Amazing Story

Imagine mining for metals where the ground is frozen solid! Where winters are long and dark and temperatures often drop below -40°C . Where the only time you can ship your ore to market is during a six to ten week period in the summer. And where everything, from mining equipment to construction materials, workers and food has to be brought in either by ship or plane. Imagine doing this every day for 20 years, 24 hours a day, and making a profit! And then imagine closing the mine, and restoring the landscape so well that years from now it will be hard to tell there was ever anything there.

This is the story of the Polaris lead-zinc mine, the most northerly metal mine in the world.



1992

A Unique Situation

The Polaris orebody was discovered in 1971 on Little Cornwallis Island, Nunavut, about 35 minutes by plane northwest of Resolute (Qausuittuq). Testing revealed a massive concentration of galena and sphalerite in limestone, 60 to 300 metres below the surface. Studies continued throughout the 1970s, leading to the start of construction in 1979, and first production of ore in late 1981.



2003

Although you might think that permafrost would make mining operations difficult, it actually helped. In more southerly mines, a lot of waste occurs because pillars of rock are left in place to support excavated tunnel roofs and cannot be mined. At Polaris, excavated backfill was saturated with water and left to freeze. This was used instead of pillars, allowing more ore to be mined.

POLARIS

2



A Difficult Job



S. McCracken, NRCan

The Polaris mine on Little Cornwallis Island was incredibly expensive to build, but the lead and zinc deposits were well worth it. Many of the facilities, including the mill (used to crush and concentrate the ore), were built on a barge in Trois-Rivières, Quebec and towed 4800 km to the mine site. Also needed was a place to store the concentrate until it could be shipped out during the brief summer, so an enormous A-frame building was constructed, capable of holding about 215,000 tonnes! Machine shops, storage sheds, and staff accommodations all needed to be built and maintained during the 20-year life of the mine. Persuading people to work and live in such a remote place was a challenge in itself, but their accommodations included a swimming pool, whirlpool, sauna, gym, running track, and TV and game rooms, which made leisure time more enjoyable. And for many who worked there, the isolation and hard work coupled with the beauty of the land gave them an opportunity to experience something unique.

When the mine closed in 2002, everything had to be taken apart and moved out or buried. Reclamation of Polaris will cost an estimated \$40 million.



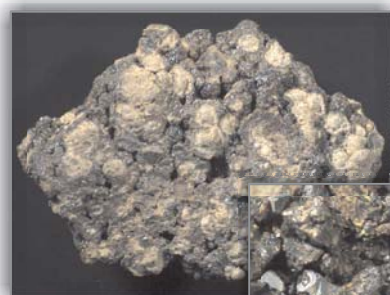
Did you know?

Zinc is a major ingredient in many sunscreen products.

Nearly 50% of the lead produced in Canada comes from recycled car batteries.

Half the zinc produced worldwide is used to galvanize steel.

One-third of the zinc we use comes from recycling.



B. Rutley, NRCan



B. Rutley, NRCan

*Sphalerite:
the source of zinc*

If you combine zinc with copper, you get brass.

There is no lead in a lead pencil; it's graphite and clay, but it still isn't a good idea to chew on pencils.

Most lead (75%) is used in batteries; the average car battery contains about 10 kg of lead!



B. Rutley, NRCan



B. Rutley, NRCan

*Galena:
the source of lead*

GEMSTONES



1

Beautiful and Rare

Pirate's loot! A chest spilling over with rubies, diamonds, emeralds, and other precious stones – a vision that has inspired countless treasure hunters and writers of fiction. Prized and sought after for millennia, gems and other ornamental stones are valuable because they're beautiful and they're rare.

Most gems, like diamonds and emeralds, are mineral crystals. Some, such as lapis lazuli and jade, are actually rocks. But living things can produce gem material as well – ivory from the tusks of woolly mammoths, or pearls from oysters.

Gemstones are often changed to enhance their beauty. They are cut and polished. Rubies, sapphires, and aquamarines are heated to clarify the colour, and emeralds are oiled to hide internal blemishes. Others, such as agate, are stained to more interesting colours.

Since the 1800s, some gems, such as synthetic diamond and cubic zirconium, are made in laboratories.

Although gemstones tend to be durable, some aren't. Pearls generally do not last a long time, and opal, because it contains water in its crystal structure, can dry out and crack. Even diamond, the hardest natural substance known, is brittle and can fracture.



Lazulite in quartz,
northern Yukon

ESS 1992-123C



Brooch carved from mammoth ivory

S. McCracken, NRCan



Iolite in rock, and gemstones, near Nelson, British Columbia



Garnets, near Nelson,
British Columbia

Anglo Swiss Resources Inc.

Anglo Swiss
Resources Inc.

Making Gems



56 facets.

The gemstone industry not only needs prospectors, geologists, and miners, it needs people to make rough stones into gems. First the gemstones are graded for size, weight, clarity, and colour, and then worked by a lapidary or gem cutter. A gem is first shaped by splitting or sawing. It is then ground and polished to make the facets. These smooth, flat surfaces reflect light at different angles, giving the gem its sparkle. A typical diamond in an engagement ring has at least

Size Matters

Gems are measured in carats. One carat is equal to 200 mg (a gold karat is a measure of purity, not mass). The more carats the bigger the gem. For example, a 1 carat (0.2 g) brilliant cut diamond is 6.5 mm in diameter. The largest uncut diamond ever found was 3106.75 carats (over 600 g). Size matters in gem price, but so do other factors such as clarity, colour, and cut.



GEMSTONES

2

How do They Form?

Mineral and rock gemstones form through geological processes. Diamonds, sapphires, and emeralds crystallize in rock that was once molten (magma). Other gemstones form when water containing the right elements cools slowly in cavities and fissures.

Ellsworth sapphire (CMNMC 30052)



Groundwater also plays a role in forming gems. It flows through cracks in rocks and dissolves minerals. Later, recrystallization happens, forming minerals such as agate, opal, turquoise, and malachite.

Organic gemstones come from plants or animals. Amber is fossilized tree sap. Jet is a hard form of coal that was once used in mourning jewellery and rosaries. Pearls from oysters, and shell from the abalone snail and the extinct ammonite are all used to make jewellery.

© Okanagan Opal Inc., 2005



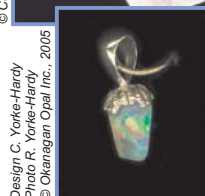
Opal in rock



Tourmaline in quartz

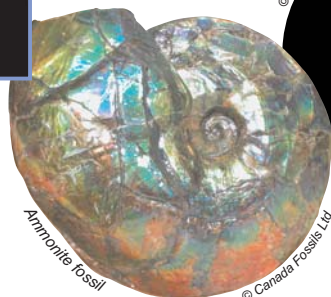
GSC KGS-2359W

Courtesy of the Canadian Museum of Nature
© Canadian Museum of Nature



Opal pendant

Design C. Yorke-Hardy
Photo R. Yorke-Hardy
© Okanagan Opal Inc., 2005



Ammonite fossil

© Canada Fossils Ltd.



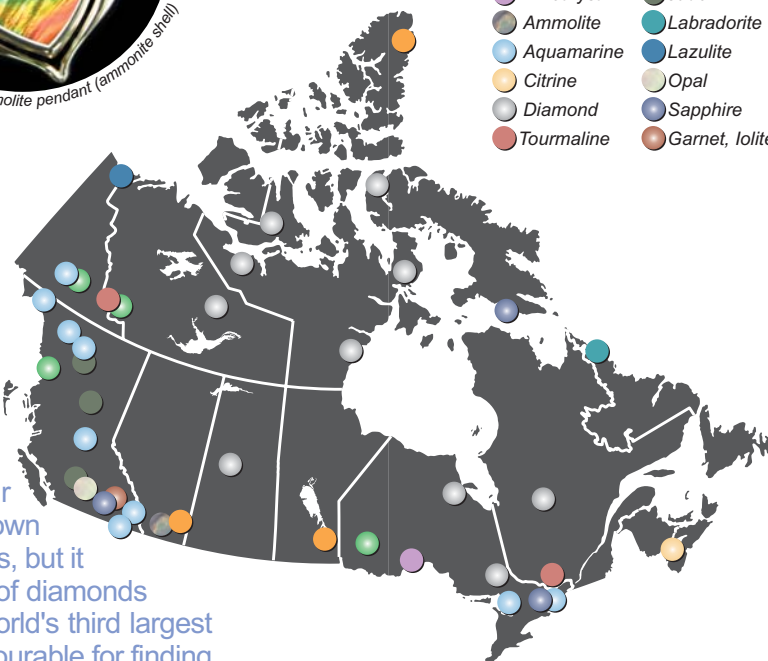
Ammonite pendant (ammonite shell)

© Korte International

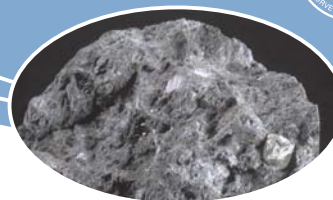
- | | |
|------------|----------------|
| Amber | Emerald |
| Amethyst | Jade |
| Ammolite | Labradorite |
| Aquamarine | Lazulite |
| Citrine | Opal |
| Diamond | Sapphire |
| Tourmaline | Garnet, Iolite |

Does Canada have Gemstones?

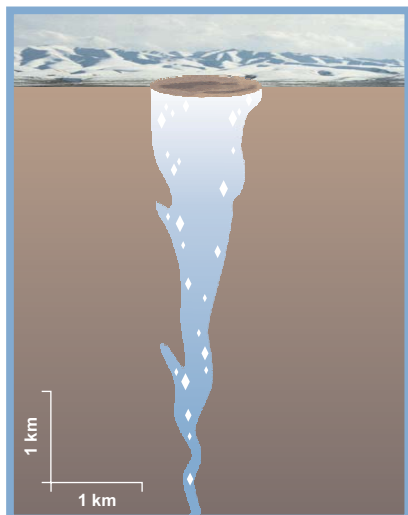
Lots! The Precambrian Shield of Canada is a good place to look for gemstones. This includes areas of Ontario, Quebec, Northwest Territories, and Nunavut that were once ancient mountain ranges. The younger mountainous areas of eastern and western Canada are also excellent places for prospecting. For years, diamonds were known from scattered occurrences in glacial sediments, but it was not until 1991 that commercial quantities of diamonds were found in bedrock. Now, Canada is the world's third largest producer of diamonds. Our geology is also favourable for finding more deposits of coloured gemstones.



DIAMONDS



1



Kimberlite pipe

E. Macey, NRCan

How Diamonds are Formed

Diamonds are made of plain old carbon, the same material found in pencils or in the graphite powder used to lubricate locks. The difference between black powder and brilliant gemstone lies in the way the carbon atoms are joined together. In a diamond, each carbon atom is bonded to four other carbon atoms in a structure like a pyramid. It is this tightly bonded structure that gives diamond its characteristic hardness. In fact, diamond is the hardest natural substance known! To make diamonds, tremendous heat and pressure are required, and natural diamonds can only be formed deep in the Earth. They are brought to the surface by volcanic activity and are found in 'pipes' of kimberlite. Kimberlite is a type of rock named after Kimberley in South Africa, where it was first found. Sadly, only a small percentage of kimberlites contain diamonds.



Panda Pit, Ekati Diamond Mine, NWT

Provided by BHP Billiton © BHP

Did You Know?

Diamonds are the hardest known natural substance, four times harder than the next hardest, corundum (rubies, sapphires).

The name diamond comes from the Greek word *adamas*, which means unconquerable.

At 1400°C, the pressure needed to change graphite into diamond is equal to 450 snowmobiles (or 250 walrus) resting on a penny.

The largest uncut diamond was the Cullinan - 3106 carats (0.62 kg). The largest cut diamond is the Cullinan I - 530.20 carats, and is on the British royal sceptre.

It is rare to find a diamond in drill core, but a 4 carat diamond was found in kimberlite drill core from Quebec.



© Ashton Mining

DIAMONDS

2

Canada is a Great Place to Find Diamonds !

Although Canada's vast territory has always held potential for diamond discovery, surprisingly little exploration has been done until recently. In 1991, the discovery of diamonds in kimberlites in the Lac de Gras region of the Northwest Territories sparked new interest. Today, there are diamond mines in Canada—Canada is one of the world's leading producers of diamonds. A direct result of the mines has been the growth of cutting and polishing facilities, providing employment and income to northerners. A jewellery-making industry is also being encouraged. Elsewhere in Canada, diamond exploration is going on in Nunavut, Alberta, Saskatchewan, Ontario, and Quebec.



Provided by NWT Centre for Geomatics © Space Imaging

“What, this old thing?”



Provided by BHP Billiton © BHP

Most diamonds are more than a billion years old!

Even the youngest were formed more than 70 million years ago.

And as far as we know, no diamonds have come to the surface within the last 40 million years.

EMERALD and AQUAMARINE



1

The Mineral Behind the Gems

Emerald and aquamarine are found in igneous and metamorphic rocks; they are varieties of the mineral beryl. Beryl is an important mineral because it is the main source of the element beryllium, a metal that is used in aerospace applications because of its light weight and very high melting point. But beryl is better known by the name of the gemstones used in jewellery.

Beryl is clear in its pure form, but traces of impurities cause it to take on different colours. As gemstones, these colours have different names: the deep green variety is called emerald; other green gems that do not have as intense a colour are just called green beryl. The light blue to blue to light green beryl is called aquamarine, the yellow to light yellow-green is heliodor or golden beryl, raspberry-red beryl is called bixbite, pink to violet or salmon-coloured beryl is morganite, and the colourless gem is named goshenite. Chemically, all of these are pretty much the same.

Working the Stone

Emeralds generally have internal fractures, which make them fragile. They are commonly oiled so that the fractures and other internal imperfections are not as visible. Most emeralds sold are treated this way – it is considered an acceptable practice.



Emerald (cabochon cut)



Aquamarine (True Blue Beryl, emerald cut)

The way a gem is cut is determined by the quality of the stone. Plain cuts, such as the cabochon, are usually applied to opaque gemstones. Transparent gemstones are cut with facets to reflect light. The fragile nature of emerald led to the creation of the emerald cut, a rectangular shape in which the four corners are truncated by facets to prevent breakage. There are many other types of cuts, such as the brilliant cut commonly used for diamonds.

Emeralds have a long history of being valued. They have been mined in Egypt since the late 4th century BC, and prized for more than 1000 years in South America. But greed gave the emerald a sad and violent history. In Colombia in the 1500s, the Spanish conquistadors looted temples and enslaved the native people to work in the mines.



Did You Know?

Emerald is the birthstone for the month of May; aquamarine is March's. The biggest aquamarine ever found came from Brazil—it weighed more than 110 kg (550,000 carats) and was 48.5 cm long and 42 cm in diameter. The Roman Emperor Nero wore emerald sunglasses to view the gladiators in his Circus. Aquamarine is so named because of its seawater colour.



Emerald necklace

© True North Gems Inc.

© True North Gems Inc.

© Emerald Images from True North Gems Inc.

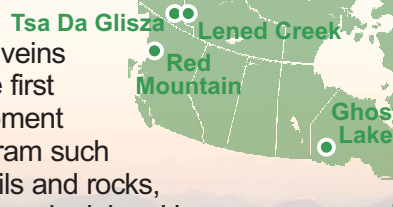
EMERALD and AQUAMARINE

2

Canada's Emeralds

Emeralds have been discovered at Ghost Lake near Dryden in Ontario, at Red Mountain near Stewart in British Columbia, near Lened Creek in southwestern N.W.T., and on the Tsa Da Glisza property in southeastern Yukon.

At Tsa Da Glisza, the emeralds occur in quartz and tourmaline veins that cut across metamorphosed volcanic rocks. Emeralds were first discovered in 1998, and since then an exploration and development program has been carried out by True North Gems Inc. A program such as this takes time – prospecting and mapping, sampling the soils and rocks, digging pits, trenches, and adits (underground tunnels), drilling, and mining. Heavy mining equipment – mechanical hoes, shovels, and trucks, transported to the remote site by winter roads – extracts and moves the emerald-bearing rock to a processing plant. The plant crushes and screens this rock, which then travels by conveyor belt past stone sorters, the people who watch for flashes of colour. Sometimes special techniques using gravity and magnetism are used to help concentrate and separate the gemstones from the rock. The gemstones then are cut and polished, and graded and appraised for clarity and colour.



© True North Gems Inc.



Working the trench at Tsa Da Glisza, Yukon



Processing the rock



Rough emeralds



True Blue Beryl in rock



Emerald in rock

Canada's Aquamarines

About 100 km northwest of the Tsa Da Glisza property is True North Gems' True Blue Property. Here, aquamarines with colours from dark to light blue, and from yellow-green to green to turquoise have been found in veins in igneous rocks. Dark blue aquamarines are exceptionally rare, found in only a few localities worldwide; this Yukon variety has been given the name True Blue Beryl.

RUBY and SAPPHIRE



1

A Blood-Red Ruby

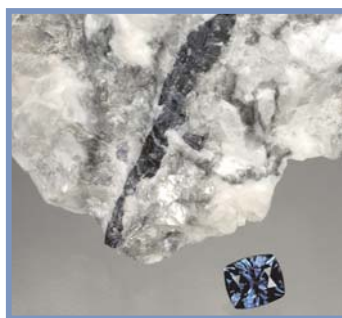
... and a deep blue sapphire are crystals of the same, relatively common mineral corundum. Corundum occurs in colours that vary from blue to red, green, violet, orange, yellow, and clear. Red gemstone varieties are called ruby: all the other coloured gems are referred to as sapphires. The colours come from trace amounts of elements: chromium gives ruby its red colour, lesser amounts creates pink sapphires. Iron and titanium make a sapphire blue, vanadium makes a violet sapphire; smaller amounts of iron and vanadium creates orange tones, a bit of iron gives yellow and green tones. Internal needle-like crystals of the mineral rutile produces a silky shine which when aligned just right produces a six-rayed star sapphire.

Sapphire and ruby have been desired and mined for centuries – the most famous regions for sapphire are in Asia (Kashmir, Myanmar, and Sri Lanka). Myanmar and Sri Lanka also have ruby.



Greenland ruby crystal

© True North Gems Inc.



Sapphire in rock, and gemstone, from Baffin Island, Nunavut

© True North Gems Inc.



Greenland ruby in rock

© True North Gems Inc.



Yellow sapphires from Baffin Island, Nunavut

© True North Gems Inc.



Sorting pink sapphires and rubies

© True North Gems Inc.



Sapphire from Baffin Island, Nunavut

© True North Gems Inc.

DID YOU KNOW?

Corundum is second only to diamond in hardness, so it is an excellent abrasive and is used in sandpaper

Expensive watches use slices of clear synthetic sapphire as covers because they are scratch resistant

Some red gems that look like ruby are really spinel, beryl, or garnet – completely different minerals

Some lasers use synthetic sapphire crystals to concentrate their light

Emery is a mix of the minerals corundum, magnetite, and quartz

Ruby is rarer and can be more valuable than diamond

Sapphire is September's birthstone; ruby is July's

RUBY and SAPPHIRE

2



Canada's Sapphires

Canada's first corundum crystals were discovered near Bancroft, Ontario in 1847 when T. Sterry Hunt of the Geological Survey of Canada recognized them as tiny rubies and sapphires.

There are gem- and near-gem-quality sapphires in British Columbia, Ontario, and Nunavut. So far, gem-quality rubies have not been discovered in Canada, but ruby deposits in Greenland indicate they may be found on Baffin Island where the geology is similar.

Almost two billion years ago, the southern Baffin Island and western Greenland area was a warm and shallow ocean at the edge of a tectonic plate. Rocks and gemstones began as mud at the bottom of this ocean. Over time, this plate collided with another plate, squeezing the sediments. Heat and pressure transformed the old ocean bottom, first into

limestone and mudstone, and as more and more heat and pressure built up, finally into metamorphic rocks: marble, quartzite, and gneiss. In forming these metamorphic rocks, the temperature and pressure were so high that the rocks almost melted, and the minerals in the rocks changed form or combined to produce new crystals. The geological setting for this region is like that of the famous gem-producing areas of Kashmir and Myanmar where the Indian and Asian continents collided more than 40 million years ago.

Beluga Sapphire

Sapphire was discovered in 2002 by Inuit prospectors Seemeega and Nowdla Aqpiq in metamorphic rocks near Kimmirut on southern Baffin Island. A follow-up exploration project by True North Gems Inc. resulted in discovery of blue, pale blue, clear, and yellow sapphires. Some are gem-quality and naturally coloured, which means that they do not need to be heated to enhance their appearance like almost all other sapphires.

© True North Gems Inc.



Beluga area, Baffin Island, Nunavut



Sapphire crystal in rock

© True North Gems Inc.

Blu Starr Sapphire

Gemstones are found in metamorphic rocks of the Slocan Valley near Nelson in southeastern British Columbia. The exploration company Anglo Swiss Resources Inc. has discovered sapphires ranging in colour from sky-blue to cornflower and indigo blue, violet, and purple. Some of these are the desirable star sapphires. Gem quality iolite and garnet are also found in these rocks.



Sapphires from Beluga property, Baffin Island, Nunavut

© True North Gems Inc.



1

INDUSTRIAL ROCKS AND MINERALS

Then

© Robert W. Park, University of Waterloo



End scraper (top) and knife from the Arctic Small Tool tradition, Arctic Islands

People in Canada began using industrial rocks and minerals thousands of years ago for tools, weapons, and decorative objects. Chert was used for spear points, arrowheads, and scrapers, soapstone for small carvings and oil lamps, and clay for pottery. Pigments were made from minerals such as copper and ochre. Many of these materials were traded by the aboriginal peoples and ended up far from their original source.

Much later, European settlers also used rocks and minerals in their daily lives – mainly building stone, brick clay, sand, gravel, and limestone. For example, in the late 1600s, limestone deposits were quarried to build forts and buildings in New Brunswick, and in the late 1700s, gypsum was mined in Nova Scotia for use as a soil conditioner. Salt, an excellent food preservative, has been mined in Canada since the 1800s.



Fort Beauséjour, New Brunswick

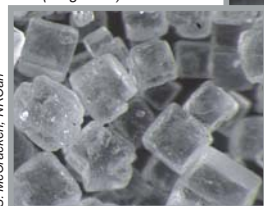
© Parks Canada/Brian Townsend

Load of gypsum, Milford Station, Nova Scotia



EMR-3782

Salt (magnified)



S. McCracken, NRCan

Salt



E. Macey, NRCan

EMR-4899



Salt mine, Goderich, Ontario

. . . and Now

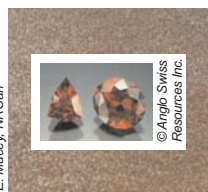
Industrial rocks and minerals are those that have value, but are not used as a source of energy, metals, or gems. So aggregate (sand and gravel) for road construction, limestone for cement, dimension stone (granite, labradorite, or Tyndall Stone) for building material, or ornamental stone (soapstone, argillite, jade) for carving are all well known examples of industrial minerals. But did you know that laundry detergent contains zeolite, soda ash, borax, and other ingredients made from industrial minerals, or that vitamin pills can contain calcium carbonate, magnesium, iron, and zinc, which come from industrial minerals? Limestone is quarried across Canada for building material, but it is also used in paint, paper, rubber, cosmetics, and steel. Gypsum, mined in Canada, is used to make wallboard, cement, fertilizer, and dental moulds. Gypsum can even be found in bread, as a source of calcium!

INDUSTRIAL ROCKS AND MINERALS



2

A Double Life?



Gem and sandpaper (garnet)

The definition of industrial minerals is not as clear-cut as you might think. Many minerals lead a double life. You can find the same mineral doing duty as a sparkling gemstone or as the abrasive agent in sandpaper (garnet); in a metal jet engine or in correction fluid (titanium).

Silica sand is used to make glass, cement, and ceramics, but is also used to produce silicon, the backbone of the computer chip industry. Sphalerite is an important ore of zinc, which has industrial applications such as in sun-protection creams and for making rubber and paint.



Jets and correction fluid (titanium)

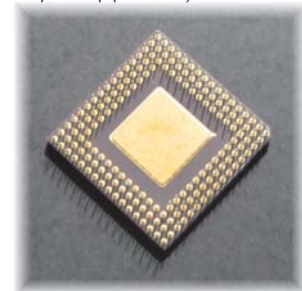
Decorative glass (silica sand)



In the past, peat was mostly used as fuel, but today it has many agricultural and environmental uses, from garden-plant mix to water filtration and purification. It is even found in some cosmetics.

Minerals such as diamond, corundum, and beryl may be either gemstones or industrial minerals. Diamonds that are not gem quality are used in cutting tools and drill bits; sapphire and ruby are the gem varieties of the mineral corundum, commonly used as an abrasive; and emerald is the gem variety of the mineral beryl, which is also a source of beryllium used in the nuclear, electronic, and ceramic industries.

Silicon and gold-plated computer chip (silica sand)



Mid-1800's millstone (sandstone),
Inglis Falls Conservation Area, Ontario



There are lots of
minerals in toothpaste



Light bulb filament (tungsten)

DID YOU KNOW?

Peat moss harvested in Newfoundland is used throughout the world to clean up oil and chemical spills
Sifto Canada Inc.'s mine at Goderich, Ontario is the largest underground salt mine in the world and can produce 6.5 million tons of salt annually

Toothpaste is full of industrial minerals - bauxite, silica, calcium carbonate, trona, fluorite, ilmenite or rutile, mica, cassiterite, various phosphate minerals, and petrochemicals (from oil and gas)

AGGREGATE



1

What is Aggregate?

Crushed bedrock or gravel, boulders, sand, and till (sediment deposited beneath glaciers) are all different types of aggregate. In cities, most aggregate is used to make concrete. Aggregate is also used in the production of asphalt, and great quantities are needed to build roads, pipelines, airstrips, and building pads. Aggregate is also used in water filtration systems, and we spread it on roads in winter to provide traction.

Different types of aggregate have different engineering properties. Gravel is commonly crushed to give it sharper edges that help it lock together. Large rocks are used to prevent erosion along riverbanks and shorelines. In remote areas, particularly in permafrost and wet terrain, roadbeds are built using till dug from large borrow pits. Even these roads must often be covered with a thin layer of gravel because, when it is wet, the till can be too slippery to drive on.



Gravel pit, Rainbow Lake, Alberta

I.R. Smith, NRCan



Crushed gravel and a loonie coin

I.R. Smith, NRCan

Aggregate is the most abundant geological resource available, and it's just as well, because we use a lot of it. One kilometre of two-lane highway uses 18,500 tonnes! Since so much material is used in construction, it's not surprising that the greatest cost associated with aggregate is for transporting it. Suitable aggregate deposits are not found everywhere; searching for local aggregate resources is a very important task.



Gravel deposited by glacier, southeast Yukon

I.R. Smith, NRCan

Rivers of Gravel

Over time, as rivers cut down into the landscape, they leave behind large flat terraces, usually made up of sand and gravel. These terraces are often our main source of aggregate. Sand and gravel deposits left by ancient rivers flowing from the ice sheets that covered Canada during the last Ice Age (30,000–10,000 years ago) are another major aggregate source.

AGGREGATE

2

I'll Take the Dry Road!

Deposits left by glaciers have characteristic shapes and appearances. Geologists can identify them using tools such as air photographs and satellite imagery. Once identified, they still need to be inspected on the ground to determine what types of sediment they contain.



Sharp-crested esker, northwestern Manitoba

GSC 2001-106

One very conspicuous glacial deposit commonly used as a source of aggregate is an esker. Eskers are long, narrow, snake-like ridges made up of sand and gravel formed by rivers flowing under the ice sheets. They can be anywhere from 100 metres to more than 100 kilometres long! Because they are made up of sand and gravel, they are usually firmer and drier than the surrounding countryside and for thousands of years have been used by people and animals to travel on—almost like roads.

DID YOU KNOW?

The ancient Greeks made a concrete-like substance by combining crushed rock, sand, and ash—some of the buildings constructed with this mixture remain standing today.

Roman roads were commonly built using crushed rock. Some of those roads are still being used.

World production of aggregate is over 17 billion tonnes per year.

Over half of Canada's aggregate production each year is used to build and repair roads.

At 17 tonnes per person, per year, Canada's consumption rate of aggregate is triple the average of European countries.

Canada's aggregate needs are large—over 500 million tonnes are used each year.



Gravel quarry, Nogath Road, British Columbia

I.R. Smith, NRCan

CARVING STONE



1

Then and Now

Long ago, the Inuit people used carving stone to make everyday household items, such as cooking pots and lamps. Stone was also carved into amulets, jewellery, and small toys - things that could be carried easily between the summer and winter camps. Today, Inuit sculpture has earned an international reputation as a major art form. Because it is difficult to transport, most carvers try to use stone from quarries nearby, moving it by boat in the summer and by snowmobile in the winter. Many communities are scattered across the vast northern land, and the carvings from each differ in style and in the stone used to create them.



EMR-7940

Outside? In the Winter?

It's true. Most carvers work outside, even in the winter! Working the stone creates clouds of very fine dust that can irritate the lungs, especially these days when carvers sometimes use chainsaws and other power tools as well as the traditional ones.

Artist David Rubin, Paulatuk

Alabaster cliffs, Victoria Island



Rob Rainbird, NRCan

Rob Rainbird, NRCan

Victoria Island Alabaster

Finding good carving stone is not always easy. Recently, Dr. Robert Rainbird of the Geological Survey of Canada and his assistant Wayne Goose (brother of artist Rex Goose) were studying the rocks on Victoria Island when they decided to have a closer look at some huge white cliffs in the distance.

At the foot of the cliff, blocks of white rock had fallen into a creek. In the pale sunshine, the smooth, naturally sculpted blocks looked like chunks of ice in the water. Rainbird and Goose both thought of the same thing: alabaster! This type of rock is a prized carving stone all over the world. The local carvers, delighted with the find, promptly got out their tools and set to work.

CARVING STONE

2



Artist Mary Muckpa, Pond Inlet

B. Rutley, NRCan

How is Carving Stone Formed?

The stone used for carving varies across the Arctic, but can be grouped into two main types. Both are metamorphic rocks, meaning that they have been transformed or changed by Earth processes involving increased heat and pressure, and percolation by water-rich fluids, into something different than they were originally.

The first type forms by melting deep in the Earth. The molten rock moves upward and either cools and solidifies beneath the Earth's surface, or flows onto the surface as lava during volcanic eruptions. When it cools and becomes solid, it is much too hard to be used for carving. But during

metamorphism, heated water percolating through the rock transforms its minerals into softer, hydrous minerals like serpentine, talc, and chlorite. The process produces rocks such as soapstone and serpentinite. People often talk about 'soapstone' carvings, but in reality soapstone is too soft to be a good carving stone. The somewhat harder serpentinite is commonly preferred. It can take various finishes, including a smooth polish, and comes in a variety of beautiful colours, from black and dark green to yellowish green.

The second type of stone comes from sedimentary rocks. When these rocks are buried in the Earth, higher temperature and pressure transform them into beautiful light coloured marble and alabaster. Even mudstone can be transformed into lovely, finely banded, dark coloured argillite by relatively low-temperature metamorphism. Argillite is the second most common carving stone used in the Arctic. It ranges in colour from light green to nearly black, and takes a fine polish.



EMR-7943

DIMENSION STONE

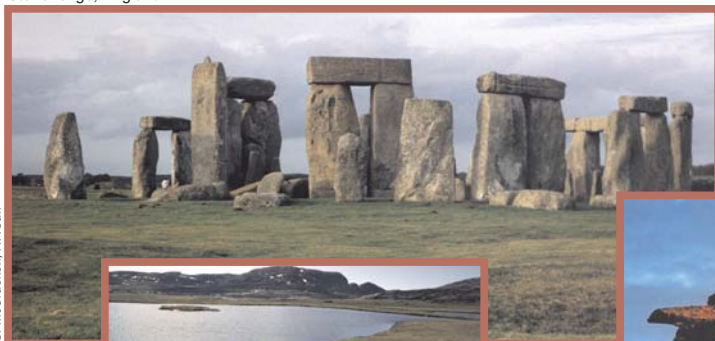


1

Rocks from Another Dimension?

Dimension (or architectural) stone is any naturally occurring rock that is quarried, cut, and finished for use in construction or as decoration. Almost every type of rock can be and has been used as dimension stone, but the most common types are sedimentary rocks such as limestone and sandstone, igneous rocks such as granite and anorthosite, and metamorphic rocks such as marble and slate. Some stone is very attractive and is used for ornamental purposes such as monuments and tombstones.

Stonehenge, England



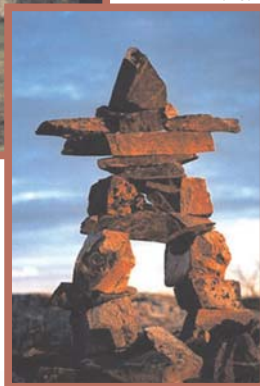
S. McCracken, NRCan



Thule winter house, reconstructed, Baffin Island, Nunavut

© Robert W. Parks,
University of Waterloo

Inuksuk



GSFC 2007-025

Rock of Ages

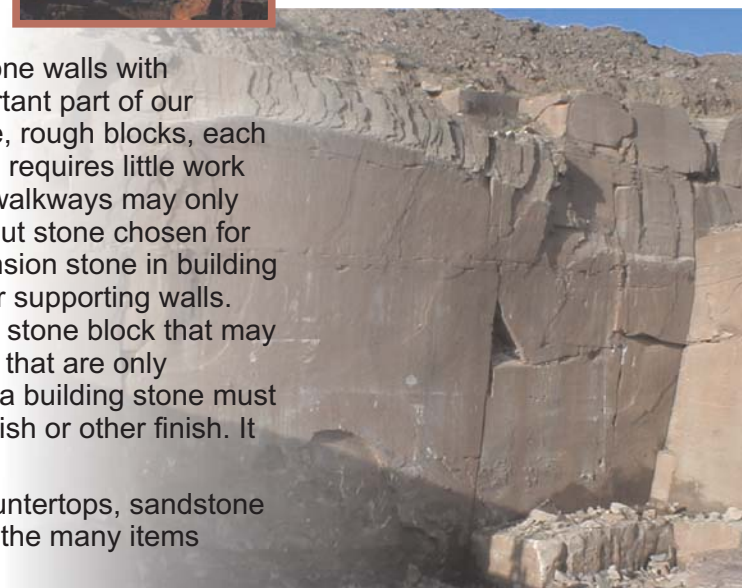
Stone has been used as a building material for thousands of years because it is easily available, strong, and resistant to fire and the wearing effects of time and the elements. Many ancient stone structures are still standing today.

Flagstone floors have been found in stone houses of the Thule Inuit in northern Canada, and the Inuksuk, which has become a symbol of the North, is made of stone.

Looking Good . . . Rocks!

Modern building construction has replaced stone walls with concrete and steel, but rocks are still an important part of our buildings. Dimension stone is quarried in large, rough blocks, each of which can weigh many tonnes. Some stone requires little work before being used – stone for use in walls or walkways may only need to be roughly shaped with a hammer – but stone chosen for other uses may need more processing. Dimension stone in building construction is used as facing or cladding over supporting walls. Stonecutting tools and techniques allow a raw stone block that may weigh up to 20 tonnes to be sliced into panels that are only centimetres thick! In addition to looking good, a building stone must be easy to work with and be able to take a polish or other finish. It must not crack, crumble, or weather easily.

Marble sinks, granite floor tiles, soapstone countertops, sandstone walkways, even slate pool-tables are a few of the many items made of dimension stone today.



Wallace sandstone, Wallace Quarries, Wallace, Nova Scotia

© Wallace Quarries Ltd.

DIMENSION STONE

2

Is it Easy to Find?

Although there is no shortage of rocks in Canada, most are not suitable to use as dimension stone: they are too fractured, too weathered, too inconsistent in their texture, or just plain ugly. Most of the dimension stone produced in Canada is granite, limestone,

marble, labradorite, sandstone, and

slate. Manitoba is the only producer of Tyndall Stone (mottled limestone), and Canada's only producing slate quarry is in eastern Newfoundland.



Tyndall Stone



Manitoba's Legislative Building, made of Tyndall Stone, Winnipeg, Manitoba

Grotesque 'Thinker', Parliament Hill, Ottawa, Ontario



Peace Tower, Ottawa, Ontario



Our Parliament Rocks!

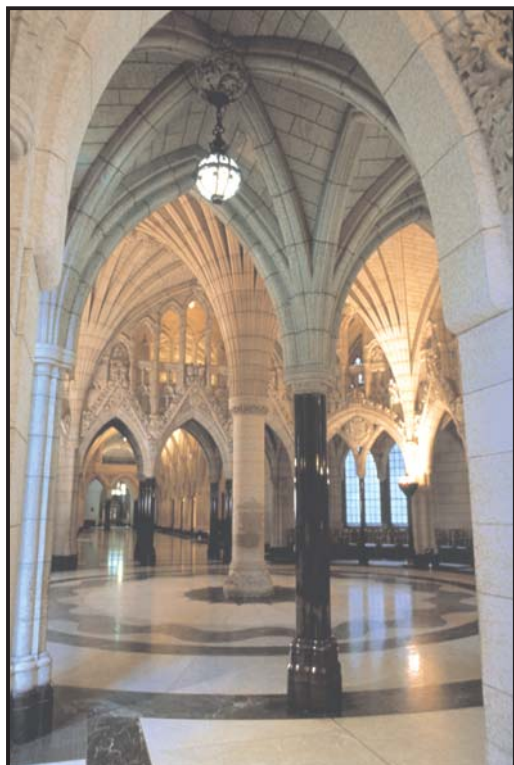
The Peace Tower in the Parliament Buildings in Ottawa is named to honour the thousands of Canadian soldiers who died during World War I in service to their country. The rocks chosen for the Memorial Chamber of the Peace Tower are full of symbolism. The floor is made of stones taken from the World War I battlegrounds where Canadian soldiers fought. The walls and columns are faced with stone from France and Belgium, the countries where Canadian soldiers saw the most combat. The central Altar is carved from the same British stone used for the tombstones in military cemeteries.

There are many figures and carvings, most of Wallace sandstone, in the Peace Tower and many blocks of stone waiting to be carved in the interior of the Centre Block. The Parliament Buildings are the only federal buildings in North America where stone carving is still taking place on a full-time basis.

TYNDALL[®] STONE



1



Confederation Hall, Parliament Building, Ottawa

©Library of Parliament, Mone's Photography

Beautiful Building Stone

You may not have heard of Tyndall Stone before, but you've probably seen it. Think of news reports from the halls of Parliament in Ottawa that you've watched. The backdrop of elaborately carved walls, columns, and ceilings are made of this stone.

Tyndall Stone is used as an ornamental building stone in many cities in Canada and the United States. It is a light brown, fossil-bearing limestone that has darker coloured branching streaks called trace fossils. While there are many limestones used as building stone in North America, Tyndall Stone is unique.

Tyndall Stone is quarried at Garson, Manitoba, about 40 km northeast of Winnipeg. It was first discovered in the area around 1894, when a farmer came upon the mottled limestone while digging a well. The first large quarry was opened by William Garson in 1898. Gillis Quarries Limited began quarrying there in 1915, and the fourth generation of this family-owned business is still at it today.

The colour, beauty and strength of Tyndall Stone has allowed for its use in a variety of ways and architectural styles. Impressive buildings containing Tyndall Stone include the Parliament Buildings in Ottawa, the Canadian Museum of Civilization in Gatineau, the Provincial Legislature in Manitoba, the Rimrock Hotel in Banff, and the Empress Hotel in Victoria.

DID YOU KNOW?

The fossils in Tyndall Stone are 450 million years old!

Garson calls itself the Limestone Capital of North America.

"Shoddy" is the name given to rough, undressed building stone.

Tyndall Stone is quarried using diamond-tipped saw blades that are 2.4 metres in diameter!

Tyndall Stone is not only used in large, impressive buildings—it can be found in fireplaces, chimneys, planters, and patios.

The name of the stone comes from Tyndall, the closest railway point to the quarries; the railway station was itself named after the noted British physicist Professor John Tyndall.



Canadian Museum of Civilization, Quebec

©Canadian Museum of Civilization, photo Harry Forster, no. S93-1294



Garson quarry, Manitoba

G. Nowlan, NRCan

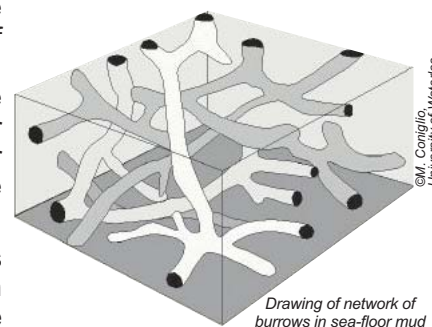
TYNDALL[®] STONE

2

How did Tyndall Stone Form?

Four hundred and fifty million years ago, what is now southern Manitoba was part of a warm, shallow, inland sea. During this time, which geologists call the Ordovician Period, this area was just south of the equator. Many different types of animals lived in this ocean. Some, such as corals, sponges, molluscs, and algae, we would recognize today. Others, such as trilobites and stromatoporoids, are extinct. All of these creatures lived on or above the soft, muddy sea floor. After they died, their remains became part of it. The calcium carbonate in their skeletons made the mud limey, so that when it hardened into rock it became limestone. Fossils of these animals and plants are visible today in Tyndall Stone.

Other animals burrowed in the mud of the sea floor for food or protection. And it is the preserved burrows of these creatures that make the beautiful mottling which gives Tyndall Stone its unique appearance. Nobody knows what exactly these animals were, because the traces of their burrows are all that they left behind. But shrimp in the Caribbean Sea make similar burrows today, so it's possible these creatures were shrimp-like.

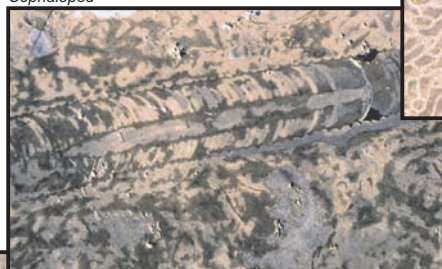


Drawing of network of burrows in sea-floor mud

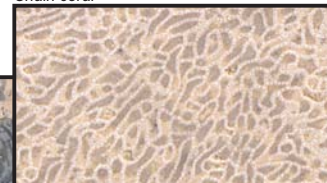


Bison, Winnipeg; Artist W. Arthur

Cephalopod



Chain coral



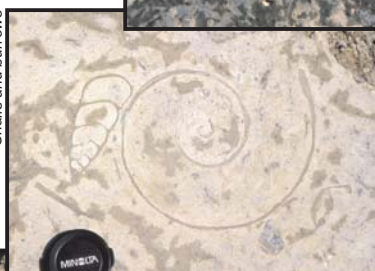
©G. Young, Manitoba Museum



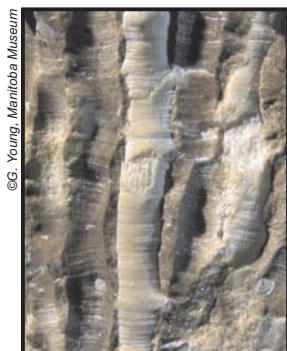
Burrows on a flat surface

G. Nowlan, NRCan

Snails and burrows



©G. Young, Manitoba Museum



Coral



Algae

©G. Young, Manitoba Museum

Burrow vs. Rock

Why are the burrows a different colour from the rest of the rock? Well, it all comes down to a difference in grain size and chemistry. As the animals burrowed through the soft, limey mud, they left traces of their passage that caused the mud in the tunnels to be slightly different from the surrounding sediment. The more tightly packed surrounding mud hardened before the less dense deposits in the burrows. Later, magnesium-rich waters percolated through the rock and deposited dolomite in the burrows, but couldn't penetrate the tightly cemented limestone rock. The darker colour of the burrows may be a result of oxidation of trace amounts of iron in the dolomite, or of pyrite that was deposited along with the dolomite.

JADE



1

Stone of Heaven

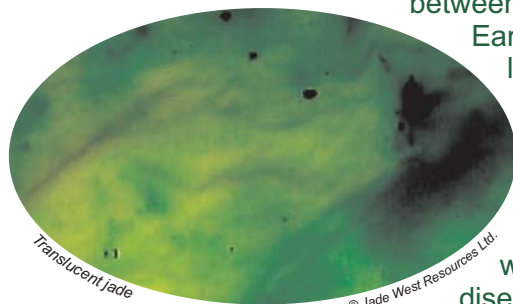
Jade is a green, translucent gemstone. Its hardness, toughness, and beauty have led to many uses as tools and jewellery for thousands of years. Jade objects represented great wealth and power in the world's three great jade cultures: the Chinese, the Maori of New Zealand, and the Olmec, Maya, and Aztec people of Central America. In China, jade represented the link

between Heaven and Earth. The Maori

launched canoe expeditions to

search for jade and used it to make fearsome war clubs. Aztec nobility wore bright green amulets around their waists in the belief that this

would protect them from kidney disease. These ancient civilizations prized jade above gold and silver.



Translucent jade

© Jade West Resources Ltd.



© Jade West Resources Ltd.



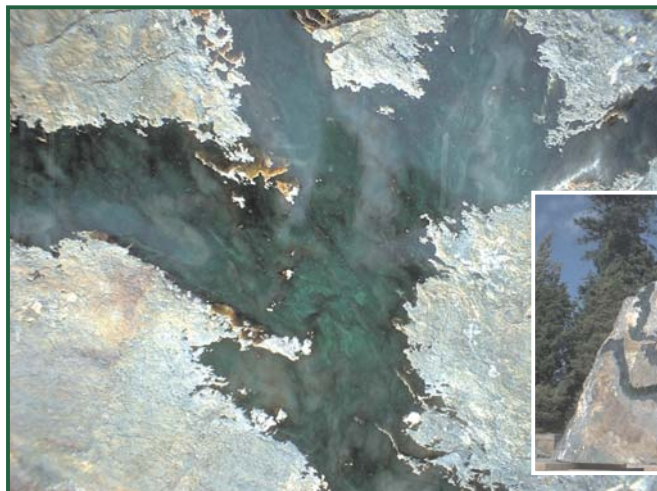
Jade sculptures and jewellery

© Jade West Resources Ltd.

British Columbia Geological Survey Branch

A Tangled Web . . .

The gemstone known as jade is actually not a single mineral type, but two: nephrite (a silicate of calcium and magnesium) and jadeite (a silicate of sodium and aluminum). They are similar to each other in appearance and hardness, but it was not until 1863 that a French chemist was able to distinguish between the two. However, by then it was too late to straighten out the mineralogical tangle and scientists agreed that the term jade would be used for both.



"Emperor's Stone", a 5 tonne boulder from the Polar Jade mine, polished in the shape of a tree

© Jade West Resources Ltd.



© Jade West Resources Ltd.

Nephrite is one of the world's toughest materials—you cannot scratch it, it's as hard as steel, and it's very difficult to shatter, so very delicate shapes can be sculpted without risk of them breaking. It can be cut so thin that light passes through.

Nephrite was the jade revered by the Chinese for over 7000 years, until the 1700s when China's own supplies dwindled. Since then, large quantities of jadeite have been exported to China from Myanmar and jadeite became the material most commonly used by Chinese jade carvers.

JADE

2

Canadian Jade

Nephrite has been used by aboriginal people in Canada for thousands of years for axe heads, knives, and other tools. Nephrite artifacts dating back 4000 years were discovered at Salish cultural sites near Lillooet, British Columbia. Nephrite artifacts have been found over much of the Arctic coast and on the Arctic Islands. An Inuit adze, found on Victoria Island, has a nephrite blade bound to a bone handle.

Canada has the world's largest proven reserves of nephrite, enough to supply world demand for 300 years. Most of Canada's nephrite is found in British Columbia and the Yukon along a belt



Copper Inuit adze with jade blade, Victoria Island

Royal Ontario Museum, with permission © ROM

trending northwest from the US border near Hope, B.C. to the Yukon, north of Watson Lake. Minor amounts of nephrite have been found in Newfoundland.

British Columbia's nephrite is found in more than a dozen shades, depending on trace elements such as iron, chromium, and manganese, ranging from white to near-black, but the most common colour is green. Only about 20% of the nephrite found is gem quality. The rest is good for carving and ornamental stone.



Jade fireplace

© S. McKeown, Sid Rock, Yukon



Jade incense burner

© Jade West Resources Ltd.

DID YOU KNOW?

- Jade is the official gemstone of British Columbia
- Nephrite is too hard to carve using chisels: it is sawn and polished using diamond-tipped tools and abrasives
- Jade polishing techniques and compounds are closely guarded secrets
- The surface of a jade boulder is grey or brown, and it's only when it is cut that the colour is revealed
- The largest piece of nephrite ever found is from B.C. – 'Big Papa' is a boulder that weighs about 152 tonnes and is worth over a million dollars
- Polar Pride: The world's largest piece of gem-quality nephrite is an 18-tonne boulder (4.3 x 2.0 m) – it will be carved into the world's largest solid jade statue of Buddha for a temple in Australia

© Jade West Resources Ltd.



Diamond-tipped saw, cutting jade boulder



"Polar Pride" jade boulder, from the Polar Jade Mine, near Dease Lake, British Columbia

© Jade West Resources Ltd.

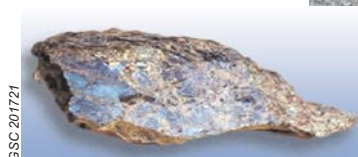
LABRADORITE



1

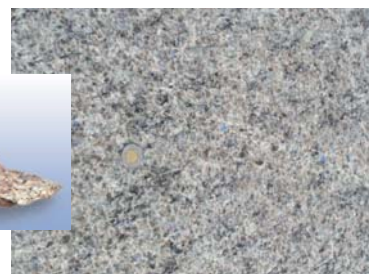
What is Labradorite?

Labradorite is a type of feldspar, and near Nain in Labrador, it is found in a rock called anorthosite. Anorthosite is an igneous rock that is almost completely composed of feldspars.



GSC 201721

Labradorite



Polished "Blue Eyes" anorthosite

© Government of Newfoundland and Labrador



Artist Gilbert Hay

©Birches Gallery



Ten Mile Bay Quarry, Labrador

© Government of Newfoundland and Labrador

In the past, labradorite was thought to have mystical qualities because of its captivating play of colours. It was called firestone, and pulverized labradorite powder was used as a potion to cure ailments. Labradorite was collected near Nain in the 1770s by missionaries and taken to Europe, where it was valued for its beauty.

The quarry rights to the Nain labradorite and anorthosite deposits belong to the Labrador Inuit Association.

The anorthosite is quarried at the Ten Mile Bay and Igiak Bay quarries, and huge blocks are shipped to Italy for finishing as dimension stone (decorative cover for building). The main market is European, but it is sold all over the world. Anorthosite is also used for table and counter tops and other decorative pieces.



The Nain anorthosite rocks are about 1.29-1.35 billion years old!

Labradorite is the provincial mineral of Newfoundland and Labrador.

The Ten Mile Bay Quarry produces 1,000 m³ of dimension stone per year.

Gilbert Hay of Nain creates sculptures in anorthosite and labradorite mined from the Ten Mile Bay Quarry.

Nain labradorite is used locally in jewelry and other handicrafts, and is sold to rock shops outside of Labrador.

LABRADORITE

2



Shimmering Rocks!



Artist Jamie Meyer

The mineral labradorite is one of the most beautiful and popular of the semiprecious stones and is often used in jewellery and ornaments. It is found in abundance near the community of Nain and elsewhere in Labrador, and on the island of Newfoundland.

Labradorite is usually dark grey, but in the right angle of light, it displays a play of colours mainly in shades of blue and green, but sometimes in yellow, red, and gold.

This shimmering effect has nothing to do with surface colour. It is due to internal reflection, and the colours vary depending on the angle of light.



Artist Gilbert Hay

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Did you know?

Labradorite is one of the feldspars (the others are orthoclase, microcline, albite, oligoclase, andesine, bytownite, and anorthite).

Feldspar is used in making glass and ceramics.

Feldspar is one of the most common rock-forming minerals.

On the mineral hardness scale of 10, feldspar has a hardness of 6, but diamond, at 10, is 22 times harder.

Moonstone (the June birth stone), is a feldspar with bluish reflections (commonly albite, oligoclase, or labradorite); sunstone is an oligoclase with reddish-gold reflections.

Labradorite is found in Labrador, eastern and western United States, northern Mexico, and Madagascar.

Labradorite is named after Labrador, andesine after the Andes in South America, and bytownite is named after Bytown, the former name of Ottawa.



Artist Jamie Meyer

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