

From Northern Lights to Urban Trails



For the Land...From the Land

Look at a snowmobile. Do you see a sleek, powerful machine or a pile of rocks and minerals?
It's both! Snowmobiles are made from the metals and minerals of the land.



silica COPPER **GOLD** diamonds **titanium** **TIN** MOLYBDENUM
indium IRON **IRIDIUM** zirconium ZINC **lead** YTTRIUM **vanadium**
ALUMINUM **boron** chromium nickel **TUNGSTEN** oil & gas

Mining Makes It Happen

Skis, Windshield



Oil and Natural Gas - Plastics

Top Producers: Saudi Arabia, Russia, U.S., Iran

Oil and gas can be converted to chemicals, or “petrochemicals,” the major raw material in plastics. Petroleum molecules, with their many combinations of carbon and hydrogen atoms, are sorted, split, reassembled, and blended at refineries and petrochemical plants. Different combinations yield plastics with various properties and characteristics.

Ultra High Molecular Weight Polyethylene (UHMW), with its durability, high impact strength, and slippery smoothness, makes an ideal sliding material for snowboards and snowmobile skis.

UHMW can be used to make Spectra fibre, possibly the strongest man-made fibre in commercial use. It is used in body armour, climbing ropes, fishing line, and even dental floss!

Polycarbonate, an extremely strong and lightweight plastic, is shatter and heat resistant—perfect for a snowmobile windshield.

Polycarbonate has many uses, including CDs, cell phones, helmets, automobile parts, water bottles, eyeglass lenses, greenhouse windows, and bulletproof glass.



Spark Plugs

Zinc (Zn)

Top Producers: China, Australia, Peru, **Canada**

Zinc, the fourth most-common metal in use, comes from zinc ore such as sphalerite, and usually occurs with copper and lead. Combined with chromium in zinc chromate, it makes a coating for spark plugs that resists chemical destruction.

🍁 Canada is an important producer of zinc and zinc products; the world's largest zinc mine is in New Brunswick.

Zinc has a low melting point and is lightweight; it is easily die-cast into parts for appliances, automobiles, and toys. The toy market is a large consumer of zinc.

Iridium (Ir)

Top Producers: South Africa, Russia, **Canada**, U.S.

Iridium, a dense, hard, and brittle member of the platinum family, is the most corrosion-resistant metal known. Mainly used as a



hardening agent for platinum alloys, it also makes good electrical contacts for such things as spark plugs.

🍁 In Canada, iridium is produced as a by-product of nickel/copper mining in Ontario and Manitoba.

Iridium is rare on Earth but fairly common in meteorites. Due to its great hardness, iridium is used in the nibs of fountain pens.

Copper (Cu)

Top Producers: Chile, U.S., Peru, Australia

Copper, the first metal ever smelted from ores, is easily shaped and is an excellent heat and electricity conductor. One of the most important copper ores is chalcopyrite. When exposed to air and water, copper develops a blue-green layer that protects it from further corrosion. Copper wire runs throughout a snowmobile; a spark plug's central copper electrode carries the electric charge to the tip.

🍁 Canada's largest copper producer is B.C., followed by Ontario, Quebec, and Manitoba.

If pennies were made from pure copper they'd be worth more than one cent! Today they are copper-coated steel discs.

Ceramics

Produced worldwide from a variety of minerals

Ceramics, valued for their strength, hardness, and durability, are made from minerals crushed to a fine powder. Different minerals are used to make different ceramics. Spark plug insulation uses ceramics containing aluminum silicate minerals like kyanite and andalusite.

Ceramics have numerous uses, from dinnerware to the heat-shield tiles on space shuttles.

Chromium (Cr)

Top Producers: South Africa, Kazakhstan, India

Chromium, a hard metal that takes a high polish, is found primarily in the mineral chromite. It partners with zinc to make zinc chromate, a corrosion-resistant pigment that is added to the coating on a spark plug. Chrome plating gives a high-polish finish to decorative and industrial items.

Rubies and emeralds get their colour from chromium; some green glass is coloured by chromium salts.

Light Bulbs



Boron (B)

Top Producers: Turkey, U.S., Argentina

Boron-bearing water collects during rainy seasons and later evaporates, leaving behind traces of boron. Large deposits of borate minerals are rare. Boric oxide, made with boron, makes glass stronger and resistant to high temperatures; applications include halogen light bulbs and glass ovenware.

Boron gives a distinctive green colour to fireworks and is also used to make Silly Putty!

Tungsten (W)

Top Producers: China, Russia, **Canada**

Tungsten, mainly found in the minerals wolframite and scheelite, has the highest melting point of all metallic elements. It is used to make light bulb filaments, and is alloyed with other metals to harden and strengthen them.

🍁 Canada has the largest operating tungsten mine in the western world, situated on the border of the Yukon and the Northwest Territories.

In a typical 60-watt light bulb, the tungsten filament is about 2 m long, but only 1/4 mm thick.

Silica

Produced widely around the world

Silica sand, the main ingredient of nearly all glass, is the product of erosion of rocks rich in quartz. Quartz is a hard mineral that survives the grinding journey along riverbeds and collects along beaches when it reaches the sea. Silica sand is also used in fiberglass, plastics, and electronic parts.

Heated in furnaces, silica sand produces pure silicon (Si), which is used to make silicon chips or wafers—the backbone of the computer industry.



Electronics

Gold (Au)

Top Producers: South Africa, U.S., Australia

Gold, a rare element and the most easily shaped metal known, conducts heat and electricity and will not tarnish, rust, or corrode. Widely distributed in the Earth's crust in low concentrations, gold is often produced as a by-product of mining for other metals. Used for coins, jewellery, and other ornamentation, gold is also found in electrical connections, printed wiring boards, and sensors for ignition and exhaust systems.



🍁 The famous Klondike Gold Rush in the Yukon began with discoveries of placer deposits—gold nuggets, flakes, and dust found in river sand and gravel. Ontario, Quebec, and B.C. are Canada's top gold-producing provinces.

Thin sheets of gold, called "gold leaf," decorate such things as picture frames and statues. A sheet of gold leaf can be 400 times thinner than a human hair.

Tin (Sn)

Top Producers: China, Indonesia, Peru

Tin, derived from the mineral cassiterite, is easily shaped and corrosion resistant. It is used as a protective coating on other metals and is in bearings, gasoline tanks, and the solder in electrical connections.

Stannous fluoride (tin-fluoride) is in some toothpaste; because tin is non-toxic to humans, this is a safe way to deliver fluoride to your teeth.

Liquid Crystal Display (LCD)

An LCD is a thin, lightweight display device using liquid crystals—organic molecules synthesized from petroleum. In the mid-1800s, researchers noticed that some materials behaved strangely near their melting points, displaying both liquid and solid properties. In the 1950s, these flowing crystals were put to use. Snowmobiles use LCDs for gauges, such as tachometers, speedometers, and odometers.

Where would we be today without the LCDs in our laptop computers, digital watches, cell phones, calculators, electronic games, and TVs?

Indium (In)

Top Producers: China, Japan, **Canada**

Indium, a rare, soft, easily shaped metal, is produced mainly as a by-product of processing zinc ores. Indium is used to make low-temperature fusible alloys and solder, but the primary use, in the form of indium tin oxide, is to make a thin coating for liquid crystal display (LCD) panels.

🍁 Canada has the world's largest reserves of indium. It is recovered from smelter dust in B.C. and Ontario.

Indium is the temperature-sensitive metal that makes pop-up turkey timers work!

Fuel and Oil



Oil and Natural Gas

Top Producers: Saudi Arabia, Russia, U.S., Iran

Oil and natural gas, found in sedimentary basins throughout the world, provide a key source of power. They heat and light our homes, as well as fuel our vehicles.

- Canada has seven distinct sedimentary basins. Their combined output makes Canada the world's third-largest producer of natural gas and ninth-largest producer of crude oil. Canada has the world's second-largest oil reserves when oil sands are included.

Gas appliances cook our food, heat our water, and dry our clothes.



- Canada has no bauxite deposits, but has several aluminum smelters located near inexpensive sources of electricity, since aluminum smelting uses a lot of energy.

Until the 1880s, pure aluminum was rare—Emperor Napoleon III of France reserved precious aluminum cutlery for his most important guests; the rest used gold and silver utensils!

Iron (Fe)

Top Producers: China, Australia, Brazil, India, **Canada**

Iron, primarily obtained from the minerals hematite and magnetite, is the most abundant metal on Earth; in the form of steel, it is used 20 times more than all other metals combined. Iron is present in snowmobile chassis and engines, as well as in other parts requiring strength, like the springs, brakes, clutch, starter, generator, exhaust system, and gearbox.

- Iron ore is one of Canada's most important mineral products, with mines in northern Quebec, as well as Newfoundland and Labrador. In B.C., iron is produced as a by-product of base-metal smelting.

Mars has a bad case of rust! The reds, oranges, and yellows seen in Martian soils and rocks are iron oxides—the same stuff that covers rusty nails.

Diamonds

Top Producers: Botswana, Russia, **Canada**, South Africa

Diamonds, the hardest natural substance, are best known as gemstones, but in fact, are used primarily in industrial applications. Diamonds have been used for centuries as abrasives in cutting, grinding, drilling, and polishing. Today, they help produce finely finished surfaces on metal machine parts, such as the aluminum-alloy pistons in engines.

- Canada has two operating diamond mines in the Northwest Territories, one in Nunavut, and others being developed.

Diamonds are measured in "carats." The carat, originally the weight of a carob tree seed, is the standard to weigh precious stones. One carat is equal to 1/5 gram.



Engine

Nickel (Ni)

Top Producers: Russia, Australia, **Canada**, New Caledonia

Nickel, a product of laterite deposits, such as garnierite, and sulphide ores, is hard but easily shaped. Used primarily to make stainless steel, nickel also has excellent plating qualities that suit it to industrial and decorative coatings. Nickel can be used in exhaust systems, thermostats, spark plugs, gears, and drive shafts of snowmobiles.

- Canada is one of the largest nickel producers in the world, with mines in Quebec, Manitoba, and Ontario, as well as Newfoundland and Labrador.

Nickel's magnetic property produces an electromagnetic response in nickel-coated Canadian dimes, nickels, and quarters that allows their use in vending machines.

Aluminum (Al)

Top Producers: Australia, Brazil, Jamaica

Aluminum, primarily extracted from bauxite, is lightweight, easily shaped, easily machined and cast, and has tremendous corrosion resistance and durability. Its uses are varied, from pop cans, window frames, and foil wrap to airplane propellers and snowmobile chassis.

Battery



Galena

Lead (Pb)

Top Producers: China, Australia, U.S., Peru

Lead, found in the mineral galena, is a heavy, easily shaped metal that is very resistant to common corrosion problems. The primary use of lead today is in the lead-acid storage battery, a vital power source in vehicles.

- Canada ranks sixth in the world in lead production. In Canada, lead is produced mainly as a co-product of zinc, but recycled lead from scrapped car batteries represents nearly 50 per cent of the total refined production.

Have you ever had an x-ray? A lead apron shields your body from excess radiation.



Zircon



Ilmenite



Molybdenite



Vanadinite

Springs

Zirconium (Zr)

Top Producers: U.S., South Africa, Australia, Brazil

Zirconium, a product of the mineral zircon, is corrosion resistant and can withstand great heat. In specialty alloys, including steel, it enhances strength and reduces rusting.

In the ceramics industry, zirconium whitens and hardens tiles; ceramic glazes on kitchen tiles and bathroom porcelains contain zirconium compounds.

Titanium (Ti)

Top Producers: South Africa, Australia, Canada

Titanium, from the mineral ilmenite, is lightweight, corrosion resistant, easily worked, and able to withstand temperature extremes. Titanium alloys give lightweight strength and flexibility to products ranging from golf clubs to spacecraft.

- Canada's only titanium mine, in Quebec, is the largest solid ilmenite deposit in the world; the mine may last for 100 years.

Most titanium production is for titanium dioxide, a white pigment used in everything white, from paper to makeup and toothpaste—even the white coating on gum.



Vanadium (V)

Top Producers: South Africa, Russia, China

Vanadium occurs in small amounts in crude oil and a number of minerals, including vanadinite, and is produced as a by-product of mining operations and petroleum extraction. Used in steel alloys, it increases resistance to corrosion and fatigue—ideal for the moving parts of engines and transmissions.

Strong and beautiful, vanadium—named after Vanadis, the Scandinavian goddess of beauty—strengthens steel used to support the massive weight of drilling platforms.

Molybdenum (Mo)

Top Producers: U.S., China, Chile, Canada

Molybdenum, a product of the mineral molybdenite or by-product of copper mining, strengthens and toughens steel alloys used in vehicle construction. It is also an ingredient in many lubricants, such as the grease and oil used in snowmobiles.

- Canada is the fourth-largest producer of molybdenum; all operating mines are in B.C.

Molybdenum pigments (red to orange) are used to colour fibres, pottery, inks, and paints.

Yttrium (Y)

Top Producer: China

Yttrium, occurring in almost all rare earth minerals, is often a by-product of mining for other metals, especially uranium and tin. Like vanadium and titanium, it adds strength when alloyed with other metals.

Look closely at your TV screen or computer monitor: see the red, blue, and green dots or stripes? The red ones come from red phosphors produced by yttrium compounds.

What's in it for YOU?

From pop cans to video games, mining makes it happen! Look at the pictures below to see where else you'll find the metals and minerals used in a snowmobile.



Aluminum
Engine
Pop Cans



Boron
Light Bulbs
Fireworks



Ceramics
Spark Plugs
Space Shuttle



Chromium
Spark Plugs
Water Taps



Copper
Spark Plugs
Pennies



Diamonds
Engine
Jewellery



Gold
Electronics
Gold Bullion



Indium
Electronics
Solder



Iridium
Spark Plugs
Fountain Pens



Iron
Engine
Nails



Liquid Crystal Display
Electronics
Watches



Lead
Battery
X-ray Shields



Molybdenum
Springs
Red Dye



Nickel
Engine
Coins



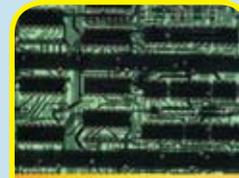
Oil & Natural Gas-Plastics UHMW
Skis, Windshield
Fishing Line



Oil & Natural Gas-Plastics Polycarbonate
Skis, Windshield
CDs



Oil & Natural Gas-Fuel
Fuel and Oil
Home Appliances



Silica
Light Bulbs
Computer Chips



Tin
Electronics
Toothpaste



Titanium
Springs
Golf Clubs



Tungsten
Light Bulbs
Home Lighting



Vanadium
Springs
Construction Steel



Yttrium
Springs
Computer Monitors



Zinc
Spark Plugs
Die-cast Toys



Zirconium
Springs
Ceramic Glazes

CANADA



- One of the world's largest mining nations, producing over 70 minerals, metals, and their products, from just 0.03 per cent of our land area (less than half the size of Prince Edward Island)
- One of the world's top five producers of such mineral commodities as uranium, potash, aluminum, diamonds, zinc, gypsum, molybdenum, platinum group metals (a group of six rare metallic elements), salt, cadmium, titanium concentrate, and asbestos
- A country with about 200 principal metal, non-metal, and coal mines; over 3,000 stone quarries, and sand and gravel pits; and about 50 non-ferrous smelters, refineries, and steel mills
- A leading producer and exporter of minerals and mineral-based products, exporting approximately 80 per cent of our mineral production
- A major producer of diamonds, with three operating mines and two new mines scheduled to open



RECYCLING

- New Life for an Old Snowmobile

- Once mined and refined, metals are perpetually recyclable—they can be used over and over again without losing their chemical and physical properties
- Recycling metals means less energy is needed to transport and process ore
- Recycling metals conserves valuable natural resources and reduces waste in landfill sites

Recycling is not just about cans, bottles, and paper. Exploration, mining, and processing metal ore are costly activities, and some metals are found in only a few parts of the world, making them difficult to produce. Alloy metals such as tungsten, molybdenum, titanium, and vanadium can be recovered from stainless and specialty steels. Iridium, the most rare of the platinum group metals, can be recovered from electronic, automotive, and other post-consumer scrap.

Used motor oil can contain additives and contaminants (e.g., arsenic, lead, magnesium, cadmium, chromium, benzene, and zinc) that are potentially toxic and carcinogenic—one litre of oil can contaminate a million litres of groundwater. Used motor oil is insoluble and slow to degrade, posing a health hazard to humans, plants, and animals. Just 7.5 litres of recycled motor oil could generate enough electricity to run a TV for 180 hours—that's 7.5 days!

Snowmobile LCDs can contain recoverable precious metals such as gold, silver, copper, and tin, but they also can contain toxic metals such as antimony, chromium, cadmium, mercury, and lead. When discarded, these harmful elements could leak into the groundwater or, if incinerated, could pollute the air.

Treat the Earth well. By recycling a snowmobile, we help conserve our Earth's resources.

www.pdac.ca/miningmatters

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