Green Uses of Minerals

Gold (Au)

Gold plays a special role in *water purification*. Gold-palladium nanoparticles break down trichlorethene (TCE), a common and poisonous groundwater pollutant. Gold catalysts are more efficient and economical than carbon filters or iron because they convert TCE to non-toxic components instead of trapping it in a filter or producing toxic intermediate chemicals. This gold nanomaterial opens up tremendous opportunities in groundwater clean-up.

Molybdenum (Mo)

Molybdenum is highly valued because of how it affects the properties of alloys. *Ultra-high strength moly steel*, for example, is very hard and durable. It is incorporated in drill bits used by the *geothermal energy* industry and in the massive propellers that harness *wind energy*. Moly's conductivity is used by the *solar power* industry to form strong electrical connectors. Moly alloys are also used in "green cars", making them comparatively light-weight and fuel efficient.

Lithium (Li)

The future of zero, and ultralow, emission vehicles depends on lithium - one of Earth's scarcer resources. Ultimately, electric, hybrid, and plug-in hybrid vehicles will all use lithium batteries for *clean energy storage*. Lithium batteries are classified as non-hazardous waste since they don't contain lead or mercury and can be recycled for their cobalt and lithium content. Everyday technology, such as cell phones, uses lithium-ion batteries - the most common type of rechargeable cells today.

Cobalt (Co)

Cobalt is critical for manufacturing *nickel metal hydride batteries*, which are used in hybrid electric vehicles (HEV), laptop computers, cell phones, and other electronic devices. Nearly all current HEV batteries contain about 22 lbs of nickel and 3 to 5 lbs of cobalt. Lithium-ion batteries also contain 5 to 7 lbs of cobalt, and are expected to dominate future HEV markets because they recharge faster and reduce air pollution and fuel consumption by at least 50%.

Platinum (Pt)

Platinum is critical to the development of *fuel cell technology.* Fuel cells convert the energy of a chemical reaction directly into electricity. Platinum is used as a catalyst in fuel cells to efficiently convert hydrogen (fuel) and oxygen to heat, water and electricity. The hydrogen and oxygen come from air, enabling the cells to operate continually. So, unlike batteries, they never "run out". The amount of platinum catalyst required to power a fuel cell is 0.5 to 0.8 grams/kilowatt.

Copper (Cu)

Copper could be referred to as "green gold". Already a well-known component in the electric motor and components of the hybrid car, Cu is also invaluable in solar *photo voltaic systems (PVS)*, which produce electricity from sunlight. PVS using copper-indium-gallium-diselenide (CIGS) *semi-conductors* have a competitive advantage over silicon semi-conductors because the manufacturing process, while complex, is relatively energy-efficient.

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Green Uses of Minerals (page 2)

Titanium (Ti)

Materials engineers are looking at titanium in fuel cell technology for its role in the storage and release of hydrogen fuel at lower temperatures and pressures. Ti may be key to a practical solution to fuel cell storage in vehicles! Titanium is also as strong as steel, but weighs 40% less. It is highly resistant to corrosion and tolerates temperature extremes. It is no surprise that the aerospace industry has its eye on Ti for the next generation of planes to help make them lighter and reduce fuel costs.

Silicon (Si)

The majority of today's *solar photo voltaic systems* use silicon cells as the *semi-conductor* to turn the Sun's rays into energy. These cells are typically made of silicon dioxide which is made from quartz sand, a common and abundant natural resource. The solar energy industry, however, competes with the computer chip industry for this Earth material, driving up the price silicon and creating a shortage of solar-grade silicon.

Silver (Ag)

A glass paste containing ~90% silver is applied along the top and across the bottom of all crystalline *silicon photo voltaic cells* used in solar panels. When sunlight energy strikes the silicon cells, electrons are generated, then collected by the silver and transformed into a useful electric current. A group of roofing-tile solar cells can generate sufficient power to support the day-time energy uses of one house and recharge batteries to supply power after dark.

Vanadium (V)

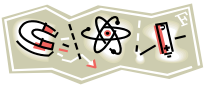
Vanadium is, in some scientific circles, referred to as the element that could change the world. The Vanadium Redox Flow Battery (VRFB) is a promising electrochemical electricity storage technology. The VRFB stores energy in batteries that are capable of mass storage. When connected to an electrical grid, the VRFB can be charged and discharged at will, making them an excellent back-up energy supply during power outages or for use during peak periods to take advantage of lower electricity rates.

Germanium (Ge)

Germanium is more effective at converting solar heat into electricity in photo voltaic cells than silicon. Germanium solar cells, having a 40% efficiency of converting sunlight into electricity, are the ideal substitute to the popular, low cost silicon solar cells (20% efficiency), but its high cost is a deterrent. In its raw form, germanium costs about $680 per pound. At this point, germanium-based solar cells are used primarily on spacecraft because they are more efficient and lighter than silicon-based solar cells.

Rare Earth Elements (REE)

The use of rare earth magnets in electrical appliances continues to grow in parallel with society's interest in reducing its energy consumption. Magnetic refrigeration is a clean technology that uses magnetic fields to manipulate the degree of ordering (or entropy) to reduce a material's temperature, allowing it to serve as a refrigerant. An industrial-sized air conditioner uses a lot of these magnets - about 400-500 kg - which contain roughly 30% (~150kg) of REEs! Some examples of REEs used in these magnets are: Dysprosium, Gadolinium, Neodymium, Samarium, etc.



The following links are complementary to each of the mineral profiles and are meant to provide more in-depth information about their important role in the evolution of green technologies and applications, as well as some of the locations in which these minerals are mined or produced. For an overall look at major mining operations in Canada, visit InfoMine and Natural Resources Canada.

Gold: Learn more about the widely varied uses of gold from the World Gold Council and read about some of the **e**nvironmental applications of this fascinating mineral. Also, read the USGS Gold minerals information. *Mined in:* BC - Eg. Kemess, Myra Falls, Table Mountain, QR.

Molybdenum: Learn more about the impressive uses of Moly at the International Molybdenum Association. Also, read the USGS Molybdenum minerals information. *Mined in:* BC - Eg. Endako, Max, Gibraltar, HVC, Huckleberry.

Lithium: Read a technology review on Lithium-ion batteries. Find out how Li-ion batteries work. Also, read the USGS Lithium minerals information and the "Future of Electric Vehicles" from the Journal of Energy Security. Visit LithiumSite and Mining Top News (Li) for comprehensive lists of lithium projects and mines in Canada and the world.

Cobalt: Learn more about cobalt through the Cobalt Development Institute and explore the more uses of this essential mineral here. Also, read the USGS Cobalt minerals information. Visit Mining Top News (Co) and Formation Metals to learn more about cobalt projects and producers around the world.

Platinum: Platinum and other Platinum group elements (PGEs) are coveted for their applications in fuel cell technology. The potential of fuel cells is widely discussed. Read a technology review and more details on fuel cells. Also, read the USGS Platinum Group Metals minerals information and Mining Top News (PGE) to find out where platinum can be mined.

Copper: Learn all you can and more at the Copper Development Association. Investigate the uses of Cu in solar power technologies and hybrid cars. Also, read the USGS Copper minerals information. *Mined in:* BC - Eg. HVC, Gibraltar, Huckleberry, Myra Falls, Mount Polley.

Titanium: Read about some uses of Ti and a brief history of the metal. Learn about the role Ti plays green technologies such as hydrogen storage, and water purification. Also, read the USGS Titanium minerals information. Canada is among the top producers of Ti in the world.

Silicon: Read about some of the most common uses of Silicon. This mineral is essential in photo voltaic systems and solar energy production. Also, read the USGS Silicon minerals information. *Mined in:* BC - Eg. Monteith Bay, Apple Bay, and various other parts in Canada and the world.

Silver: Learn more about the widely spread uses of Ag at the Silver Institute and, particularly, its role in solar energy production. Also, read the USGS Silver minerals information. *Mined in:* BC - Eg. Myra Falls and various other parts in Canada and the world.

Vanadium: Read about a brief history and applications of Vanadium. Read Discover Magazine's "The element that could change the world" (Sep 2008). For a shorter version, go to Vanadium highlights. Also, read the USGS Vanadium minerals information and Mining Top News (V). *Projects in:* Northern BC, Newfoundland and Labrador, and Australia.

Germanium: Read about a brief history and applications of Ge, particularly in solar cell technology. *Produced in:* Southern BC at Teck's Trail operation - the largest integrated Germanium producer in the world. War Eagle's Tres Marias property also has a history of, and revived potential for, Ge production. Also, read the USGS Germanium minerals information. ***NOTE:*** Germanium is not mined as a principal mineral deposit but rather extracted as a by-product in the smelting process of base metals like zinc and lead.

Rare Earth Elements: Get the basics of REEs or read more about the uses of REEs and their role in green technologies. Also, read the USGS REEs minerals information. *Projects in:* Saskatchewan, Quebec and other parts of Canada. The major producer of REEs is China.