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JOHN'S CORNER:

MINERALS - The Elements and What They Do (Part 20)

by John Ferguson

28) Nickel (Ni) - Nickel is a metal that is in Group 10 of the periodic table which contains what is known as the platinum group metals (palladium, platinum, nickel). Nickel is a silvery white lustrous metal that is malleable, ductile and resists corrosion.

It is found in igneous rocks at 75 ppm, shale at 68 ppm, limestone at 5 ppm, sandstone at 2 ppm, very little in fresh or seawater, soils at 40 ppm, and some marine and land plants at 3 ppm. In mafic rocks like basalt nickel levels can reach 2,000 ppm but varies greatly around the world.

Nickel occurs in soils mainly at the +2 electrical oxidation state, and readily combines with iron. Organic matter and clay minerals exhibit a strong affinity to absorb nickel. As a result, in some oils and coals nickel can become concentrated.

Nickel is widely used in coins and in the United States our nickel coins are only 25% nickel the rest being copper. Nickel is used over iron to prevent rust (e.g. automobile bumpers), and over brass to make it colorless rather than yellow, it is a component in stainless steel and nickel is a key ingredient for nickel-iron super alloys used in jet engines. Rechargeable batteries used to be made from nickel (nickel-cadmium) and even shiny decorative handcuffs are nickel-plated.

Combining nickel with aluminum and a dash of boron creates a metal alloy 6 times stronger than steel, which gets stronger as it is heated. Nickel is used in medicine, food, kitchen equipment, along with dyes in ceramic and glass manufacturing.

Nickel is considered a serious pollutant that is often released from metal processing plants or from the combustion of oil and coal (nickel pollution can now be measured in rainwater). Sewage sludge and some phosphorous (P) artificial fertilizers are sources of nickel pollution on agricultural land. Sewage sludge (Bio-solids) can have 800 ppm and the organic matter makes the nickel more mobile.

Too much nickel in the soil disrupts the activity of some enzymes such as dehydrogenases (used in oxidation reactions), urease (used by bacteria, fungi and algae to convert urea into carbon dioxide and ammonia), and phosphatases (used by microbes to make phosphate available to plants).

Animal requirements of nickel have firmly been established, as it is used in RNA in land animals (0.8 ppm). In animals, a nickel deficiency has been linked to; poor growth, lower hematocrit (anemia), depressed oxidative ability of the liver, high newborn mortality, rough/dry coat, dermatitis, delayed puberty, and poor zinc absorption.

In humans, the role of nickel is not firmly established. However, nickel is found in almost every part of the human body. Some studies have shown that small doses of nickel is beneficial in some cases, while high levels of nickel can cause adverse health effects. However, only 10% of the nickel we ingest is absorbed, hence excess nickel is not common. We do know that nickel functions as a co-factor for metalloenzyme's and facilitates gastrointestinal absorption of iron and zinc. We require optimal levels of vitamin B-12 in our tissues for the biological use of nickel in our bodies (See last week's article on cobalt and B-12). Researchers in Taiwan have found that eating lemon or orange peel helps the body remove excess nickel.

Gardening and Landscaping Problems Associated with Cobalt (Co)

Nickel in soils is highly mobile as it reacts with humic and fulmic acids (some soluble and some not), and microorganisms affect the solubility of nickel.

Nickel is required by bacteria to fix nitrogen from the air. Nickel is also required by legumes (urease enzymes) to help transport nitrogen atoms from the bacteria into the plant and nickel is required for hydrogen usage.
There is no direct evidence that plants use nickel, however there is lots of indirect evidence. It is now believed that nickel is essential for plants.

Plants grown on nickel deficient soils can reduce seed germination by 70%. The plant *Alyssum bertalonii* has 300 ppm, while the microbe *Rhizopus arrhizus* has 1,600 ppm. Over 200 species of plants have been identified as nickel hyper accumulators. The flower *Hybanthus floribundus* will accumulate as much as 6,000 ppm. In plants, nickel tends to be accumulated in seeds and leaves.

Native plants growing in serpentine derived soils have developed the ability to absorb very large amounts of nickel to over 7,000 ppm, which is a higher concentration than many naturally occurring rock ores. These plants may be useful in bio-geo-chemical prospecting where plants are used to mine or recover elements out of the soil and the plants are then smelted to recover the element, in this case nickel.

Too much nickel in the soil reduces plants absorption of nutrients, disturbs some metabolic processes, and strongly retards root growth. Nitrogen fixation in soil by legume plants is retarded. The most common symptom of nickel toxicity is chlorosis (possible caused by preventing iron absorption).

Some plants like beans and maize are very sensitive to nickel and even watering them with only a 40 ppm solution will kill them. Clover will not grow on soils with 80 ppm nickel or higher while oats will. Increasing pH reduces the absorption of nickel and colonization of plant roots by mycorrhizal fungi prevents plants from absorbing too much nickel.

SOURCES: basalt, sewage sludge, coal ash.