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JOHN'S CORNER:

MINERALS - The Elements and What They Do (Part 38)

by John Ferguson

79) Gold (Au)

Gold is a member of the group of metals known as "Noble" metals. It derives its name from the Latin, *aurum,*meaning "glow of sunrise" and its chemical abbreviation Au. It is a soft yellow metal that is virtually unaffected by air, water, and most acids.

Gold is found in igneous rocks and sedimentary rocks at 0.004 ppm and very little in fresh or seawater. Gold is probably the most famous and valued metal in history. Gold of all the metals is the only one that is both golden colored, and keeps its shine and beauty forever. In addition to its beauty, gold is extremely useful. It is an excellent conductor of electricity and it does not tarnish which makes it one of the best materials to use in electrical contacts. It is also the most malleable and ductile of all the elements.

Some microbes can extract gold from the soil (*Thiobacillus ferrooxidans*) and accumulate it. Several plants (*Sedum aceotatum, Phacelia sericea*, and *Artemisia sp*.) accumulate gold and their tissue has been used in prospecting to find gold deposits and even veins of gold. Gold has a high degree of resistance to colonization by bacteria hence it is used in medical implants.

Gold is not known to provide any essential function in humans. However, recent research has used gold compound in drugs to that reduce the pain and swelling of rheumatoid arthritis and tuberculosis.

Gardening and Landscaping Problems Associated with Gold (Au)

Gold is easily phytoavailable hence many plants can absorb it. Microorganisms often release gold atoms and make them soluble for plants to absorb.

Brown algae can accumulate gold. Some plants produce cyanide, which allows the plant to extract gold atoms and absorb them.

Gold accumulator plants like *Artemisia persia, Prangos popularia*, and *Pinus laricio* may contain up to 100 ppm of gold. Peat and algal mats near mining areas often accumulate high levels of gold

Too much gold in plant tissues causes necrosis and wilting due to loss of turgidity in the leaves.
Sources: mineral sands of igneous rocks, coal, sewage sludge

80) Mercury (Hg)

Mercury is found in igneous rocks at 0.08 ppm, shale at 0.4 ppm, sandstone, and limestone at 0.03 ppm, and very little in fresh or seawater. Most soils only have 1 ppm of mercury. Soils normally have very little mercury, as it is easily leached or vaporized. Mercury is a shiny silvery metal that is liquid at room temperature.
Raw humus and organic materials have a great capacity to bind mercury and other heavy metals.

The most common electrical or valence state is +2 and in this valence state, it is very mobile in soils. It will then combine readily with chloride, hydroxide, sulfides, and soil organic matter. Soils that are acidic in nature have mercury that is more available. Some coals have 10 ppm of mercury, which is released when it is burned.

Mercury is easily combined with other metals and is used in many applications. One of the most common is in dental amalgams. It is used in electrical devices from thermostats to light switches. When used in batteries it created a very stable voltage output good for sensitive or scientific applications.

Vermillion paint used mercury sulfide (HgS) as a pigment, and the mineral cinnabar is composed of mercury sulfide. Mercury vapor lights are highly efficient and produce a pleasant light.

Mercury accumulates in the fatty tissue of animals especially fish.

Mercury is found in Thimersol that is used in most vaccines which has been linked to many behavioral problems in children. Mercury is used in many fungicides and pesticides due to its toxicity.

Many microorganisms can methylate mercury, making it available in a form that can be absorbed by living organisms. Mercury is more toxic in this form than in its elemental form.

"Flu shots contain over 50,000 ppm of mercury which is about 25,000 times the amount allowed in drinking water."

Food Forensics

Mercury is a hazardous pollutant, as it is easily bioaccumulated. Mercury affects the immune system, many enzymes, and damages the nervous system. The list of damage and health problems is very long.

Mercury is absorbed into the human body from food, medicine, vaccines, etc. and is excreted in our feces.

Gardening and Landscaping Problems Associated with Mercury (Hg)

Plants easily absorb mercury from the soil and the amount in plants increases as the amount in the soil increases and it tend to accumulate in the roots.

Plants like lettuce, spinach, and mushrooms take up more mercury than other species. They can also absorb mercury from the air. Indian mustard (*Brassica juncea*) has the ability to hyper-accumulate mercury from contaminated soil often reaching 1,000 ppm.

Mercury inhibits the synthesis of proteins in plant leaves and disrupts other metabolic processes. Symptoms of too much mercury are; stunting of seedling growth, poor root development, and inhibition of photosynthesis.

The plant *Arabidopsis thaliana* has the ability to convert the toxic mercury (Hg^{+2}) into the relatively inert form (Hg^{0}).

Sources: mineral sands of igneous rocks, sewage sludge, fly ash from burning of c**oal**

81) Thallium (Ti)

Thallium is a soft silvery grey metal that tarnishes easily. It is 10X more common than silver. It is found in igneous rocks at 0.45 ppm, shale, and limestone at 0.8-1.4 ppm, and soils at 0.1 ppm.

Its main electrical or oxidation state is +1 and often behaves chemically like potassium (K), hence, it can replace potassium in many biological functions.

Thallium is the first acutely toxic element discovered; and it was commonly used to kill someone. The major source of thallium in the environment comes from the burning of coal and cement manufacture.

Thallium can be complexed by organic matter and methylated, forming volatile compounds. In this form, thallium is toxic to microorganisms and prevents nitrate formation, which hurts plant growth.

Thallium sulfate (Ti_2SO_4) is an odorless and tasteless compound, which is used as a rat and ant poison. For years, thallium was used in pesticides, but the law no longer allows it.

There is no known biological role for thallium. Some marine organisms can concentrate thallium in their tissues.

Gardening and Landscaping Problems Associated with Thallium (Ti)

Thallium concentration in plants is directly related to the amount found in the soil.

Kale tends to concentrate thallium, as does Kohlrabi. In some plants, levels of thallium can reach 100 ppm. The plant *Iberis intermedia* can contain 4,000 ppm of thallium. Thallium levels in some flowers have been measured at 17,000 ppm (1.7%).

Tobacco plants are sensitive to thallium. As little as 150 ppm of thallium sulfate (Ti_2SO_4) will kill collards and wheat plants.

High thallium levels hinders seed germination and affects both photosynthesis and transpiration. It also results in visual leaf chlorosis.

Sources: mineral sands of igneous rocks

82) Lead (Pb)

Lead is a soft weak ductile grey metal that tarnishes easily. Lead is found in igneous rocks at 12.5 ppm, shale at 20 ppm, sandstone at 7 ppm, and limestone at 9 ppm. Very little is found in fresh or seawater. A few granites may have 25 ppm and most soils naturally range from 18-27 ppm. However, with widespread pollution some soils now have 349 ppm. This is often a large problem in urban areas, where people are trying to establish vegetable gardens and orchards.

Coal can vary between 10-1,900 ppm of lead, and fly ash from the burning of coal to 50 ppm. Lead has a strong affinity for organic matter, which increase its mobility in soils. Some modern soils now have 10,000 ppm due to pollution.

The most common electrical or valence state of lead is +2 and it combines readily with other elements. The common mineral galena which is lead sulfide (PbS) is an example.

For decades, lead was added to gasoline as an anti-knock compound but is now illegal in most countries. Lead is famous for its use in shielding us from radioactive particles. Lead is used in lead

bullets, one of the metals in common solder, and once was used to make pipes as it was easy to mold. Lead glass can contain 20% lead and still be totally transparent. Lead is used to make fishing weights, commonly used in paints, and is used to make batteries like the lead-acid batteries used to start our cars

Human and animal health problems caused by exposure to lead are well known from intellectual impairment to direct poisoning. Children are the most sensitive to lead exposure.

Gardening and Landscaping Problems Associated with Lead (Pb)

There is no known benefit of lead to plants. However, lead is easily absorbed by plants and is taken up into the roots where it is stored. Plants can also absorb lead via atmospheric deposition through their foliage.

Some microorganisms like (*Rhizopus arrhizus*) can accumulate lead. Many sunflowers are hyper-accumulators of lead as is the plant *Amorpha canescens*.

Lead salts like lead nitrate $Pb(NO_3)_2$ has been shown to stimulate the growth of some plants.

Fertilizers made from dried sewage sludge (Milorganite, Hou-Actinite, etc.) often have high levels of lead.
Sources: mineral sands of igneous rocks, combustion of coal, incineration of wastes, sewage sludge

83) Bismuth (Bi)

Bismuth is the last known stable element (has such an extremely long half-life that it is considered stable for all practical purposes).

Bismuth is found in igneous rocks 0.17 ppm, and shale at 1 ppm. There is very little in fresh or seawater and very little in animals. Soil organic matter tends to bind to bismuth.

It is a semi-metallic element and can become a super conductor at five ten-thousandths of a degree above absolute zero. Combined with other elements in can make powerful magnets.

Phosphorous fertilizers often have high levels of bismuth associated with them.

A lack of bismuth in an animal's diet often results in ulcers from the bacteria *Helicobacter pylori.* The active ingredient in the stomach medicine Pepto-Bismol that is 57% bismuth by weight (bismuth subsalicylate) and along with antibiotics will cure ulcers.

Compounds of bismuth are used in several medical applications.

The role of bismuth in humans and animals is relatively unknown and appears to be a benign heavy element.

Gardening and Landscaping Problems Associated with Bismuth (Bi)

Not much is known about the role of bismuth in plants. Plants grown in soils with higher levels of bismuth will have higher levels in their tissue. Some trees will accumulate bismuth to 800 ppm.

Sources: mineral sands of igneous rocks, coal combustion, sewage sludge, artificial fertilizers

NOTE: This is the last of the stable elements one is likely to encounter or need. The remaining elements are rare and radioactive and will not be covered at this time.