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## NEWS FROM THE WONDERFUL WORLD OF SOIL AND PLANTS

## MINERALS - The Elements and What They Do

Today we continue with our study of all the minerals (elements) in the human body, what they do. See previous newsletters (9/17/21 and 9/24/21) for a list of references and introduction to the Periodic Table.

Today we look at elements 22-24 which are titanium, vanadium and chromium.

22) **Titanium (T)** - Is a silver metal and the ninth most abundant element in the earth's crust. It is found in igneous rocks at 5,700 ppm, shale at 4,600 ppm, sandstone at 1,500 ppm, soils at 5,000 ppm, and in land plants at 1 ppm.

Titanium is found in nearly all rocks and sediments but not as a pure metal in nature. Titanium has a strong affinity for oxygen (O), typically forming oxide minerals the most common are ilmenite and rutile.

Titanium oxide ($TiO_2$) occurs in many minerals and in the crystal form we call "rutile" that is found in the granite outcrops near the town of Llano, Texas. This type granite is valued when cut and polished to make many decorative items as the rutile crystals sparkle and shine. Minerals with titanium in them are very resistant to weathering so they are often found in soils, as they are not decomposed.

Titanium is used in artificial hips and joints and other medical items. It is used to make white pigments for paper, paints, plastics, etc. Titanium sulfide ($TiS_2$) is used in some types of batteries, used to treat skin disorders and as an additive to toothpaste. If titanium occurs as the compound titanium chloride ($TiCl_4$) it is highly irritating to skin, eyes, and mucus membranes of humans.

**101 Sherbrook Circle • Conroe, Tx 77385-7750**
**(936) 321-6990 Metro • (936) 273-1200 Conroe**

Titanium nitride coatings are extremely hard and used on items like drill bits to jet planes. This compound is used to make knives for scuba divers and it is used to make jewelry.

Titanium is found in humans throughout the body with a total of only 700 mg for an average person. Titanium does not play a significant role in bodily functions, it is relatively non-toxic, and does not accumulate. As a result, it is used in surgical implants as mentioned above since it is well tolerated by tissue. However, titanium in the form of titanium oxide dust is possibly carcinogenic to humans and it is used as a whitener in the manufacture of several cheeses.

**Gardening and Landscaping Problems Associated with Titanium (Ti)**

Not a lot is known about the role titanium plays in soils and plants compared to other elements. Some studies have found that it plays a role in nitrogen fixation by microbes. It may also play a role in the photo-oxidation of nitrogen compounds in higher plants and there is some evidence that it increases yields of some crops.

Only one report on bush beans found it causes necrotic and chlorotic spots on the leaves at levels of 200 ppm.

Titanium is not very soluble in water; hence, it does not move much and is considered relatively unavailable to plants. Most plants have 0.1-7 ppm of titanium. Some plants like horsetail and nettle may accumulate titanium up to 80 ppm.

Other studies have found that titanium stimulates the production of carbohydrates so there may be some biological role since it helps plants grow larger and stronger. However, the mechanism is yet unidentified

Titanium has been found to stimulate the growth of rhizobium bacteria, and diatoms have been found to have levels of titanium up to 1,500 ppm.

A recent study found that a chelated form of titanium (titanium ascorbate) can have beneficial effects on plants, animals and man.

Sources: granite sand, greensand, basalt sand, re-mineralizer

23) **Vanadium (V)** - Vanadium is a silvery grey metal and occurs naturally in over 70 minerals and is essential for all living organisms. Vanadium is found in igneous rocks at 135 ppm, shale at 130 ppm, both sandstone and limestone at 20 ppm, fresh and seawater at 0.001 ppm and soils at 100 ppm. It is found in land and marine plants at 1.6 ppm and 2 ppm respectively.

This metal is used in industry as a few percent vanadium carbide makes steel harder and stronger than even titanium steel. The green color in many emeralds comes from vanadium impurities in the gemstone.

It got its name from the beautiful Norse Goddess "Vanadis", as vanadium forms very beautiful minerals.

Studies from Duke University have found that there has been a major increase of vanadium to the environment due to the burning of heavy oil, tar sands and bitumen and these emissions now exceed natural sources by a factor of 1.7.

Vanadium was found to be an essential trace element in 1971, however it is poorly absorbed by humans when in its metallic state with only 0.1-1% of what is present being absorbed. As in many nutrients if the mineral form of vanadium is chelated then absorbability can reach 40%, and if it is in plant derived colloids up to 98% absorption can be achieved. As in most nutrients, we must get them in a plant-derived form to ensure we have sufficient amounts for good health.

Vanadium stimulates glucose oxidation and transport in fat cells, along with glycogen synthesis in the liver and muscles. Vanadium enhances the stimulating effect of insulin on DNA synthesis. It appears to function like insulin by alternating cell membrane function, hence vanadium has a very beneficial effect for humans with glucose tolerance problems. Vanadium supplementation can have a major effect in reducing or eliminating most cases of adult-onset diabetes.

Vanadium has been found to help treat diseases like high cholesterol, heart disease, tuberculosis, and syphilis.

Vanadium inhibits cholesterol synthesis in animals and humans and vanadium has known anti-carcinogenic properties. A few vanadium deficiency diseases are slow growth, increased infant mortality, infertility, elevated cholesterol, elevated triglycerides, hypoglycemia, diabetes, cardiovascular disease, and obesity.

It is an essential component of several human enzymes and vanadium supplements has shown a growth promoting effect on chickens.

Often our cravings for sweets and chocolate are often symptoms of a vanadium and chromium (Cr) deficiency. Chocolate often has higher levels of these nutrients. Other sources include mushrooms and shellfish, black pepper, wine and beer, some grains and unrefined salts.

**Gardening and Landscaping Problems Associated with Vanadium (V)**

Many plants absorb vanadium easily from the soil (especially if the soil is acidic) if vanadium is present in the soil. Vanadium is absorbed and stored in soils by humus (especially in alkaline soils) and by clay minerals to some degree.

Observations have found that the ions of vanadium, vanadate ($VO_4^{-3}$) and vanadyl ($VO^{2+}$) in various complexes have both stimulating and inhibiting impacts on several plant enzymes.

Vanadium may substitute for molybdenum (Mo) in nitrogen fixation by some microorganisms. Vanadium also accumulates in the nodules on certain legumes.

Other plant enzymes use vanadium to convert atmospheric nitrogen into ammonia to make amino acids. Vanadium is required by some algal and bacteria species for them to grow.

Adequate phosphate is in the soil helps solubilize vanadium making it more available to microbes and plants.

Spinach (500-800 ppm) and lettuce (280-710 ppm) tend to accumulate more vanadium than other plants.

One study found that vanadium levels over 3,000 ppm (very rare), might have some inhibitory effects on some plants.

Sources: granite sand, basalt sand, re-mineralizer,

24) **Chromium (Cr)** - The name comes from the Greek word "chroma" which means color, as the various chemical salts of chromium are brightly colored. Chromium is a hard and slippery metal with a blue sheen and a member of Group 6 on the periodic table.

Chromium is found in igneous rocks at 100 ppm, shales at 90 ppm, sandstone at 35 ppm, and limestone at 11 ppm. However, in soils derived from basalt or serpentine, levels of 3,000 ppm have been recorded. Most forms of chromium are not soluble, so seawater has only 0.3 ppm chromium and fresh water even less under normal conditions (not polluted).

Chromium will dissolve in some acids but not phosphoric acid. It is used to make stainless steel, and in chrome plating. Chromium oxide ($Cr_2O_3$) is used as a green pigment in glass, paints, and glazes. It is also used in tanning leather (Tanneries are a major source of chromium pollution today). Potassium chromate is a dye while chromium (Cr-VI), and copper arsenate, (CCA) was used as a wood preservative till outlawed due to its toxicity.

It is also added to make chrome vanadium steel, which is used to make high quality tools due to its hardness, strength and rust resistance. Small amounts of chromium in the gemstone emeralds gives them the green color and in ruby's the red color. Chromium oxide ($CrO_2$) is magnetic and was used in magnetic tapes and discs for many years.

Chromium commonly occurs in nature in two common oxidation states, chromium (III) as in ($Cr^{+3}$) which is safe. However, the other form chromium (VI) ($Cr^{+6}$), as chromate ($CrO_4^{-2}$) is very toxic and carcinogenic. The dangers of chromates have been known for 100 years. The 2002 film "Erin Brockovich" brought attention to the illegal dumping of chromate waste. Sewage treatment plants are a major source of toxic chromium pollution. This one of the reasons that compost made from sewage sludge (biosolids) is bad for home usage or dried and pelletized sewage sludge like Milorganite.

Chromium is essential to human health, while it is very rare, too much can be toxic. For many years it was estimated that 25-50% of US citizens were deficient in chromium because of low soil levels while other new studies suggest over 90% of the population is deficient. Trivalent chromium (Cr(III)) improves the efficiency of insulin performance in individuals with impaired glucose tolerance.

Artificial fertilizers only contain 16 elements at best and do not contain chromium, vanadium, and other trace minerals. This has led to major deficiencies of trace elements in our food supply. As a result, hundreds of health problems are caused or aggravated by nutritional deficiencies.

Humans do not store chromium as we excrete chromium in our urine. High sugar drinks from sodas to some juices increase the natural loss of chromium by 300% for over 12 hours.

Animals that lack chromium have an impaired ability to use glucose, suffer mild diabetes, and have reduced cholesterol levels.

We know that mild deficiencies of chromium can produce symptoms such as anxiety and fatigue and people with chromium deficiencies have shorter life spans. Diseases associated with a chromium deficiency are aggravated by a vanadium (V) deficiency.

People with hyperglycemia are deficient in chromium. Molecules with chromium are required to burn fat and is used in muscle contractions.

People with higher levels of chromium have a much lower incidence of diabetes and atherosclerosis than those with low levels. Some studies have found that chromium supplementation increases muscle gain and fat loss. It has been found that sufficient amounts of chromium can prevent and cure adult-onset diabetes as chromium picolinate regulates insulin. The first studies linking low blood sugar and diabetes to chromium were in 1957.

The organ in humans with the highest amount of chromium in the body is the placenta. We know that human levels of chromium decrease with age, hence supplementation is important as we get older.

Chromium is involved with hormones that affect protein, carbohydrate, and fat metabolism. It is also involved with the body's metabolism of glucose (sugar), brain function, insulin performance, thyroid function, and in hormonal balance.

Foods's high in chromium are oysters, calf's liver, egg yolks (free range), peanuts, black pepper, brewer's yeast, molasses, and wheat germ.

Cravings for sweets and chocolate are indicators of chromium (Cr) and vanadium (V) deficiency, as some chocolates has 1,800 ppm of chromium!

**Gardening and Landscaping Problems Associated with Chromium (Cr)**

The role of chromium in soils, microbes, and plants is not fully understood. We have learned that 150 ppm of chromium is toxic to some plants and that chromium tends to accumulate in the roots. However, sufficient amounts of chromium stimulate plant growth.

In healthy soils, soluble chromate gradually turns into insoluble chromium (III) salts and then becomes unavailable for plants to absorb. In soils with lots of organic matter, toxic chromium VI is reduced and converted to chromium III the non-toxic form.

Chromium is found in the bodies of microorganisms that live in the soil. Most soils average 60 ppm of chromium. However, the application of artificial fertilizers containing phosphorous can lead to toxic amounts of chromium in the soil of over 700 ppm.

More chromium is absorbed and held in clay soils than sandy soils. In mafic soils derived from alkaline igneous rocks, chromium levels can be much higher.

If there are low chromium levels in the soil, seed germination is reduced, plant growth and yield can be reduced, functional enzyme activities may be shut down, and photosynthesis reduced.

Bacteria in the soil can absorb chromium into their bodies reducing the available amount in soils and bacteria have been used in remediating some toxic areas.

Plants cells also have the ability to convert chromium VI to chromium III that then reacts with DNA and proteins. Some grasses and clovers can accumulate chromium up to 4,000 ppm. Aquatic plants tend to accumulate more chromium than land plants.

More and more people are growing their own vegetables and fruits so they can have healthy food full of beneficial trace minerals to eat. Sources: basalt sand, serpentine, re-mineralizer