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JOHN'S CORNER:

MINERALS - The Elements and What They Do (Part 29)

by John Ferguson

39) Yttrium (Y) - One writer describes Yttrium as a "hippy" element. Yttrium is a silvery metal of group 3 of the periodic table and behaves chemically similarly to the lanthanide group. It is often classified as a rare earth element (even though it is twice as abundant as lead).

Yttrium is found in igneous rocks at 33 ppm, shale at 18 ppm, sandstone at 9 ppm, and limestone at 4.3 ppm. Very little is found in seawater (0.0003 ppm) however in soils it is found at an average of 50 ppm with a range of 2-100 ppm. In marine mammals, it occurs at 0.1-0.2 ppm and land animals at 0.04 ppm. Yttrium is found in mammalian bone, teeth, and liver.

Yttrium has an electrical or oxidation state +3 and never occurs alone in nature. However, it is often found in association with many minerals like oxides, carbonates, silicates, and phosphates.
When yttrium is combined with barium and copper into an oxide ($YBa_2Cu_3O_7$), it becomes a superconductor of electricity when cooled to very cold temperatures. When yttrium is combined with aluminum and silicates we get garnet crystals which is used to produce powerful lasers and it can also make very hard diamond-like gemstones.

It is used in color television and computer monitors, luminescence and semi-conductor devices. It is used in ceramics and glass manufacturing and is used as a catalyst in the production of some plastics.

Exposure to some yttrium compounds can cause lung disease in humans. Excess yttrium may cause some toxicity issues from enzyme inhibition to indirect effects by binding to cofactors, vitamins, and substrates. In general, yttrium salts, are considered mildly toxic if they are soluble and non-toxic if they are insoluble.

For years, it was thought that Yttrium had no biological role in humans even though it is found in every living organism (sometimes in high amounts). However, recent research is suggesting that it does play a role.

It has been found that high levels of aluminum suppresses the body's ability to utilize yttrium and boron, and can trigger the suppression of beneficial probiotic organisms.

Yttrium also enhances normal cell growth and doubles the lifespan of laboratory animals. In rodent studies, 14% of the ingested Yttrium can be detected in the newborn mice. Yttrium has been detected in nucleic acids and even human breast milk contains 4 ppm of Yttrium.

A deficiency of yttrium has been linked to several metabolic diseases (Lou Gehrig's, Alzheimer's, multiple sclerosis, and Parkinson's disease). In the absence of certain trace elements, DNA will make use of substitutes. One doctor has found that if there is an Yttrium deficiency, which is used at junction of a gene and DNA molecule, without Yttrium, aluminum is used which is a different size atom that results in misalignment of the gene and a genetic mutation due to nutrition.

Gardening and Landscaping Problems Associated with Yttrium (Y)

Most plants have about 0.6 ppm of yttrium. However, many *edible plants* may have 20-100 ppm with cabbage at the higher end of the range.

The seeds of woody plants can have 700 ppm of yttrium. Nuts are seeds and are some of the healthiest foods we can eat; I wonder if this is a coincidence?

Mosses and lichens tend to accumulate more yttrium (20-100 ppm) than other species, which suggest that a lot of their accumulation is from atmospheric deposition.

Sources: NPK artificial fertilizers at 14 ppm, Phosphorous (P) fertilizers at 114 ppm, sewage sludge 11 ppm, fly ash from burning coal at 44 ppm

40) Zirconium (Zr) - Zirconium is a hard silvery metal that is very resistant to corrosion due to an oxide layer that forms. It will burn in air like a few other metals and is unaffected my most acids. Zirconium is the 12th most abundant element in the earth's crust.

Zirconium is found in igneous rocks at 165 ppm, shale at 160 ppm, sandstone at 220 ppm, and limestone at 19 ppm. Fresh and seawater have very little zirconium at less than 1 ppm. Soils average around 300 ppm, marine plants at 20 ppm, and land plants at less than 1 ppm. Due to its low solubility, it does not tend to accumulate in living organisms with land animals at less than 1 ppm, and marine animals 0.1-1.0 ppm.

Zirconium occurs naturally in a combined state with other elements. It is not very soluble hence; we do not know as much about it as other elements in regards to living systems. The most common electrical state is +4 even though others do occur. The most common mineral is zircon ($ZrSiO_4$) which is zirconium silicate.

One of the first uses for zirconium was in the form of zirconium carbonate where it was used to treat poison ivy. The zirconium compound reacted with the irritant urushiol and rendered it inactive. Several semi-precious gemstones have zirconium as a component (made from zirconium silicate and zirconium oxide). The most famous is the gemstone cubic zirconia that out sparkles diamond. Zirconium is used in certain types of incendiary cluster bombs due to its burning in air. Zirconium compounds are very hard (8.5 Mohs) which is many times harder than quartz. When zirconium is combined with yttrium, it makes a coating that protects jet engines and turbines from the high temperatures (does not melt until 4,377^{0}C).

Zirconium is used in many products from televisions to ceramics (ex. ceramic knives). Zirconium oxide (ZrO_2) is very hard and often used as an abrasive.

Gardening and Landscaping Problems Associated with Zirconium (Zr)

Zirconium is not considered essential to plants however new research suggests that zirconium participates in several physiological processes (similar to titanium).

Growth of chlorella green algae is stimulated if exposed to trace amounts of zirconium ascorbate. In experiments with fungi (yeast) it was found that zirconium ascorbate or zirconium citrate increased protein synthesis.

Some plants have no measurable zirconium at all. However, the leaves of deciduous trees can have as much as 500 ppm (ex. Ash tree).

Organic acids form decaying organic matter and fungi help zirconium become more available. Recent research has found zirconium in the nodules produced by nitrogen fixing bacteria. Zirconium tends to accumulate in the roots of some plants. Zirconium in Tomato roots have been found to range from 0.5-7.0 ppm.

In remediation of mine tailings and in some soils mycorrhizal fungi hyphae colonize mostly on zirconium and titanium mineral grains and would not colonize a soil if these minerals were missing. Zirconium toxicity is extremely rare.

Sources: granite sand, basalt sand, compost made from deciduous leaves,