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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, with a look at elements number 13, 14, and 15 on the Periodic table. See previous newsletters (9/17/21 and 9/24/21) for a list of references and introduction to the Periodic Table.

13) **Aluminum (Al)** - Aluminum is the third most common element on the planet; it comprises 12% of the earth's crust and is the most common metal found in the crust. Aluminum is found in igneous rocks at 5,000 ppm, in shales at 82,000 ppm, sandstones at 25,000 ppm, 4,200 ppm in limestone, and 71,000 ppm in clays. Aluminum can be found in every plant grown in soil, including common food crops, squash, wheat, grapes, etc. One cannot eat any grain, fruit, nut, or vegetable without taking in quantities of aluminum.

Aluminum is found in land plants at 500 ppm but only 60 ppm in marine plants. In marine animals, it is found at 19-50 ppm and in mammals the highest levels occur in the hair and lungs. It is now considered an essential nutrient for humans in small amounts. For example, it is used to activate the enzyme succinic dehydrogenase and it increases the survival rate of newborn babies.

Aluminum does not occur as a free or pure metal in nature, but only in combination with other elements. It is the second most used metal after iron. It can be found in many common items from bicycles and airplanes to cooking utensils. It is used in disinfectants and pesticides as well as vaccines. Aluminum production uses 5% of the electricity produced in the USA each year. Another source of aluminum pollution is from chemtrails from airplanes that have been found to have high levels of aluminum in them.

Aluminum oxide (Al2O3) is used in many industrial applications and forms the mineral known as corundum. If we add a few atoms of iron (Fe) to this molecule, we get the gemstone topaz, instead if we add cobalt (Co) we get blue sapphires, and if we add chromium (Cr) we get red rubies. Only 30 mg is the amount of aluminum typical in a human body at any one time. Average daily intake of Americans is between 20-40 mg.

The name Aluminum is from the Latin name "alumen" which means bitter salt. Today we use the word Alum to refer to aluminum sulfate (Al2(SO4)3).

Aluminum sulfate is used in water purification, as it is soluble in water and is mainly used as a flocculating agent that causes contaminating particles to clump into larger, more easily trapped particles. It is used in paper manufacturing and repeated application of using newspaper as mulch can lead to aluminum toxicity in one's soil. Some water systems add aluminum compounds to make the drinking water clearer.

Aluminum is used in anti-perspirants/deodorants and is added to American cheese to make it melt easier on hamburgers. It is found in many of the food dyes used to color candy for children. A 2013 study found that over 30 brands of baby formulas were contaminated with high levels of aluminum. The majority of soft drink cans are made of aluminum, which dissolves when exposed to acids like those in soft drinks.

Potassium aluminum sulfate, aluminum oxide, aluminum chlorohydrate, sodium aluminum phosphate is in baking powders, cheeses and other food products. The European Parliament banned these additives in 2008 due to the health problems they cause, both carcinogenicity and damage to DNA.

Even though it was debated for decades, a recent article in the Journal of Alzheimer's Disease, concluded that aluminum significantly contributes to this disease and may be the single largest factor.

Recent studies have found that the molecule glyphosate will wrap itself around an aluminum atom which makes it easier for this element to cross the blood-brain barrier. Postmortem studies of children's brains that had autism have high levels of aluminum.

Most aluminum passes through our digestive system without being absorbed. Prevention is caused by the presence of silicon (Si), however, once absorbed inside our body it is very difficult to remove aluminum. Aluminum hydroxide is used in anti-acids and it is added to vaccines, as it is believed to make the vaccine more effective. The Journal of Inorganic Biochemistry recently had an article that concluded that aluminum in vaccines was linked to the rise of autism. Aluminum is used as an adjuvant in vaccines along with mercury (thimerosal). Aluminum salts like aluminum hydroxide (Al(OH)3) has been shown by research to be a major factor in macrophagic myofasciitis (MMF) as well as autism.

A study in the Journal of Trace Elements in Medicine and Biology studied autism spectrum disorder (ASD) and found those with ASD had high levels of aluminum in their brains. They also found a direct correlation with autism and vaccines.

If one drinks fluoridated water (public water systems) the absorption of aluminum is much higher. Note: Fluoride in drinking water increases the aluminum ions absorbability 10-fold.

Aluminum has only one oxidation state that is +3 which allows it to substitute for yttrium (Yt) which also has a +3-oxidation state, in epi-genetic studies. High aluminum and a low magnesium/calcium ratio are associated with Amyotrophic Lateral Sclerosis (ALS) and Parkinsonism dementia. The presence of aluminum in our diet or bodies can trigger a

suppression of probiotic organisms. This may be a contributing factor as to why so many people have microbe problems in their guts.

A study in Medscape (2018), has found that aluminum exposure reduces kidney function.

Aluminum has been linked to autism in children and Alzheimer's disease in older adults. Work by Dr. Schaffner has found that exposure to glyphosate has the ability to potentiate aluminum, thereby worsening its negative effects.

Symptoms of aluminum toxicity are, anemia, impaired iron absorption, muscle weakness, seizures, and impaired immunity. Aluminum has also been found to trigger bone pain, non-healing fractures, spinal deformities, and pre-mature osteoporosis.

Gardening and Landscaping Problems Associated with Aluminum (Al)

Aluminum influences plant growth, but all the effects are not fully understood. It is found predominantly in the green leaves of plants hence there may be an association between aluminum and chlorophyll.

Hydrangeas are the best known users of aluminum to gardeners, and the gorgeous blue color is caused by aluminum. However, like selenium (Se), aluminum (Al) is toxic to animals and that is why we seldom see insect damage on hydrangeas.

In some plants such as "tea", the bushes absorb a lot of aluminum and alum is used as a fertilizer. Wheat has developed a gene that creates a molecule that binds to aluminum rendering it harmless, which allows wheat to grow on soils with high levels of aluminum. Grasses often accumulate aluminum in their tissues reaching 1% concentrations.

Aluminum toxicity in plants is indirect, affecting root growth, uptake of essential nutrients, particularly phosphorous (P), and it causes antagonistic calcium-magnesium issues. If soil becomes acidic below a pH of 4.5 then the solubility of aluminum increases and absorption increases, reducing root growth and phosphate uptake by plants. High aluminum levels occur in plants when the soil is anaerobic and the roots are exposed to these conditions. In anaerobic conditions, microbes produce organic acids that can drop the pH to 2.0 or less at a microscopic level around the root zone.

Aluminum toxicity often occurs on soils fertilized with ammonium nitrate fertilizers, which acidify the soil, and is one of the most limiting factors in production.

It is well known that aluminum ions (Al+3) inhibit plant growth at very low concentrations. Excess aluminum in plants interferes with cell division and prevents some enzymes from working properly. It can also affect the uptake of several nutrients such as phosphorus (P), calcium (Ca), magnesium (Mg), potassium (K) and nitrogen (N).

Elevated aluminum levels in the soil (acidic conditions) will delay or prevent the formation of nodules full of nitrogen fixing bacteria. High levels have been shown to reduce or prevent many enzymes produced by soil microbes from working. This reduces their disease fighting ability and reduces their ability to breakdown organic matter. As a result, gardeners see more insect and disease problem if one uses artificial fertilizers like aluminum nitrate, or aluminum sulfate.

In general, in soils with lower levels of aluminum, plants grow better.

Sources: clay, granite sand, artificial fertilizers, coal ash

14) Silicon (Si) - Silicon is the second most abundant element in the earth's crust (28% by mass) and most abundant element in soils 43-63%. Silica is found in igneous rocks at 281,500 ppm, in shale at 73,000 ppm, sandstone at 368,000 ppm, limestone at 24,000 ppm, in fresh water at 6.5 ppm, and seawater at 3 ppm. Silicone is found in marine plants at 1,500-20,000 ppm, some marine animals at 70,000 ppm, and land animals 120-6,000 ppm. In our soils, we find silicon at 330,000 ppm in the form of silicon oxide (SiO2) in silicate minerals from sand to clay.

Silicon, chemically speaking is a very stable element with a primary oxidation state of +4. The element carbon has an oxidation state of -4. When we combine silicon (Si) with carbon (C) we get silicon carbide (SiC) that we call carborundum and it is one of the hardest minerals known (second only to diamond) and used in many industrial applications. Silicon is also similar to carbon in its ability to form complex molecular chains.

When we combine silicone with oxygen in a crystal form, we get the very common mineral called silicone dioxide (SiO2) which we know as quartz. However, if we combine silicone and oxygen in a non-crystalline form, it then occurs as the gemstone, which we know as Opal and is believed to be of biological origins.

We know that aquatic organisms like diatoms use dissolved silica to make their shells and they are the base of the aquatic food chain and a major way that carbon dioxide is stored in the oceans. A study in Geophysical Research (March 2017) has found that trees like sugar maples are silica pumps. They absorb silica from the soil where it is used to strengthen roots and protect them from pathogens. They also convert it into a more useable form in their fine roots, eventually releasing silica into our waterways to get to the ocean. However, they found that the drop in snow cover in recent years has led to a 28% reduction of silica.

Silicon is used in timing devices like quartz watches, it is a major ingredient in common glass and when silicon is combined with oxygen, it is used in many lubricants. Silicon is required in producing the semiconducting crystals used in many types of electronics (computers, radios, television, cell phones, to solar cells). If we combine silicone polymers with boric acid, we get the children's toy called "silly putty". Note: Silicon is not silicone, which is a rubber or plastic like polymer. In rare cases (mining operations), too much silicon dust can result in silicosis caused by breathing very fine particles of silicon dust.

Silicon is the third most abundant trace element in the human body and present in all bodily tissues. The highest levels are in bone, connective tissues, skin, hair, arteries, and nails. Silicon supplementation can increase collagen in growing bones by 100%.

Silicon promotes the absorption and metabolism of calcium and significantly reduces the absorption of aluminum. In areas of the world that have higher silicone levels in their food they also have the lowest prevalence of hip fractures. Ovarian cancer is linked to a broken gene, silicon has been found to protect and keep this gene functioning properly. Silicone gel applied to badly burned skin rapidly increases healing.

Silicon has been found to be required (helps with the absorption) to help the body utilize zinc (Zn), which is essential for our immune system to fight off viruses.

Silicon deficiencies are linked to brittle hair, brittle finger and toenails, poor skin quality, poor calcium utilization, and arterial disease. It is believed that silicon is an essential trace element in a number of areas of human physiology and metabolism, especially bone and connective tissue.

The best sources of silicon for humans are from plants such as cereal grains as they have higher silicon contents or beer made from barley malt which is also a good source of bioavailable silicon. Other whole grains, fruits and vegetables.

Gardening and Landscaping Problems Associated with Silicon (Si)

Silicon is a component of all earthy materials; rock, sand, silt, or clay (e.g., soil). Silicon is more available in alkaline soils. A common component of plants that is absorbed from the soil or growth media as dissolved silicon in the form of (H_4SiO_4) silicic acid. Silicon definitely influences plant growth but all the effects due to silicon are not fully understood.

We now know that silicone is necessary for the growth and development of plants. It helps plants resistance to withstand exposure to toxic chemicals. It increases a plants resistance to diseases especially those caused by pathogenic fungi and it strengthens plants cells and walls which reduces water lost in tissues.

Silicon is found in grasses 0.3-1.2%, in leguminous species at .05-0.2%. Some plants have silicon content of over 10% such as sedges, nettles, horsetails, sponges and diatoms. Needles made of silicon cause nettle stings.

Rice plants accumulate up to 10% silica in their hulls and 4% in the grains and it strengthens the rice stalk. Note: The high levels of silicon in rice hulls make it slow to decompose hence the hulls are often used as a planting media as it does not shrink as quickly as other type media. Researchers at the University of Florida have found that silicon boosts the disease resistance of rice crops to fungal diseases. However, a lack of phytoavailable silica will cause rice crops to fail.

A lack of silicon in most plants will cause young leaves and fruit to look lumpy or otherwise deformed since silicon is required in the cell's skeleton (structural element).

Sources: diatomaceous earth, algae and bacteria, sand, clay, granite or basalt sand and other mineral silicates, remineralizer, chicken skin has high levels of silicon

15) **Phosphorous (P)** - The name of this element is derived from the Greek phosphoros, meaning bringer of light. It was once called "the devil's element" and "cold fire" as it can glow in the dark or spontaneously ignite in air.

Phosphorous is found in igneous rocks at 1,050 ppm, shale at 700 ppm, limestone at 400 ppm, sand at 170 ppm, and soil at 650 ppm, seawater at 0.07 ppm. It can be found in marine plants at 3,500 ppm, land plants at 2,300 ppm, marine animals at 4,000-18,000 ppm, and land animals at 17,000 to 44,000 ppm.

When four oxygen (O) atoms surround an atom of phosphorus (P), it is known as phosphate (PO_4^{-3}) a key component of life and the most common way this element is found and used in nature.

When in a pure form, it is known as white phosphorus, which is very dangerously flammable and a deadly poison. It was used to burn Hamburg, Germany to the ground during WW-II. Also, in war, it is used in tracer bullets, flares, incendiary bombs, smoke grenades, and firebombs. Phosphorous is also used to make common kitchen matches due to its flammability.

If phosphorus is combined with chlorine (PCl_3) we get phosphorus trichloride which is used to make the extremely dangerous chemical called glyphosate used in many herbicides (Round-Up). Phosphoric acid (H_3PO_4), is also added to soft drinks.

Phosphorous is used in many things in nature; it is part of the energy molecule ATP (adenosine triphosphate), it is a major structural element in bones and teeth, and is used in more functions in the human body than any other mineral/element. It is second only to calcium in the human body, composing 22% of body's mineral content. Deficiencies in animals lead to pica, cribbing, and fractures.

Soil archeologists have found that a lack of phosphorous in the soil throughout history has caused mass starvations.

Phosphorous is known to combine with more than 30 other elements to form many types of minerals. Over 350 different minerals containing phosphorous have been identified. The most common is Apatite, a type of sedimentary rock that is mined for phosphorus to make phosphate fertilizers.

In the soil, most phosphate minerals occur in microscopic forms and in low concentrations. If the phosphate ion (PO4-3) combines with aluminum (Al) to form the mineral Wavellite, it can cement the soil creating hardpan, particularly in sandy soil. If iron (Fe) is present, the cementation can be even stronger. This is common in soils where artificial fertilizers have been used.

Depending on the soil, it may contain a lot of phosphorous but very little is available for plants as it is chemically bound up. Microbes living on the organic matter do the conversion of phosphorous from mineral forms to available forms in healthy soils. In healthy soils the P:K ratio should be 1:1 and around 175 pounds per acre. A C:P ration of 18:1 is ideal.

In many areas, excess phosphorous (P) is becoming a major source of pollution. Excess phosphorous from water soluble artificial fertilizers often runs off into our streams and lakes. This allows for a tremendous growth of algae and aquatic plants that consume all the oxygen in the water. As a result, animal life, from minnows to crawfish die. Without these predators there are no animal life to eat mosquito larva hence we now have a greatly increased mosquito problem.

Most mined phosphate deposits are often found with arsenic, lead, cadmium, mercury, and other toxic elements. Hence, when one uses artificial fertilizers, one is adding these toxic materials to their soil.

Fungi in nature are very good at extracting phosphorous from rocks and minerals and making it available to plants. However, when one uses a toxic chemical fungicide, they lose this benefit. Roots with mycorrhizal fungi can double or even triple the amount of phosphorous available to plants per unit of root length.

If one looks at the periodic table, we see that arsenic (As) is directly below phosphorous (P) hence they have similar chemical properties and can be substituted for each other in molecules. A lack of phosphorus in our diets would accelerate our absorption of arsenic, which would then block normal functioning of many enzymes and other systems.

Gardening and Landscaping Problems Associated with Phosphorous (P)

Phosphorus plays a role in the molecules used for energy storage and transfer hence it is important part of the genetic material in plants (part of the molecules that make up genes associated with DNA and RNA). Sometimes phosphorous is called the soil's catalyst, as many processes cannot work without it. For example, without sufficient phosphorous, plants cannot use nitrogen effectively.

In soils phosphorous is often deficient or chemically locked up and unavailable to plants, hence plants concentrate this element in its seeds and fruits. It is involved with stimulating many plant activities (called a "Go" food for plants). All plant tissues contain this element, it is directly related to root and fruit development, required for sugar development and it aids in disease resistance.

Rock phosphate has low solubility along with many other mineral forms found in nature so it is often not readily available to plants. This is why plants store phosphate in their seeds, so new

seedlings do not have to depend on finding it in the soil. This is why foods like nuts are a good source of this element.

Many of our area soils have sufficient phosphorous for plant growth, however it is not in an available form. At a pH below five, phosphorous is chemically locked up by aluminum (Al) and iron (Fe). At a high pH (above 7.0) calcium (Ca) and magnesium (Mg) will precipitate the phosphorous into rock phosphate and it becomes unavailable.

One needs to be careful in that high levels of phosphorous can create a zinc (Zn) deficiency. This often occurs when one uses super phosphate or other artificially created forms of this element. Interestingly, a low level of zinc reduces the absorbability of phosphorous by plants. Mineral forms of phosphorous quickly become insoluble and not available to plants while organic forms are readily absorbed, and used by plants (another value of good compost).

For plants to utilize phosphorous efficiently, it requires soils with high organic matter content to provide food and a home for the microorganisms, which then make phosphorus available to plants. Microorganisms excrete acids that release phosphorus from mineral forms. The humic and fulmic acids found in good quality compost, helps release phosphorus.

A phosphorous deficiency shows up in plants as reddish or purplish cast to leaves, tips die off, seeds, tubers, and grains suffer or fail to develop. Other deficiency issues may show up as stunting, slow growth, delayed maturity, short internodes, purple or dark green foliage, old leaves will die back. Problems are more severe in cold weather (lower microbial activity).

Researchers at Pennsylvania State University have found that excess phosphorus is very detrimental to plants, decreasing drought tolerance and stress resistance in general.

For gardeners that grow their own vegetables, most vegetable plants absorb all the phosphate it needs in the first few weeks of growth. This is why small amounts of rock phosphate directly under the seed or a transplant works so effectively.

For years, bone meal was the best source of this element. Today, most modern bone meal is nutrient deficient, as it has been leached to remove the nutrients for use in other manufacturing processes. However, it is easy to make your own. Save your bones and then dry them in the sun or your oven. When dry place on a concrete surface and use a hammer to break them into tiny pieces.

Mycorrhizal fungi transfer nutrients (especially phosphorus) and water to the plants. Excess phosphorous from artificial fertilizers or manure products (especially poultry manure) will prevent plants from forming mycorrhizal relationships with plants.

Sources: compost, native mulches, rock phosphate, phosphoric acid (soft drinks), manures, sewage sludge (Biosolids), bat or bird guano, bone meal, some fish and seaweed by products.