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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 16, 17, and 18 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.

Today we look at elements 16-18 which are sulfur, chlorine, and argon.

16) **Sulfur (S)** - Found in igneous rocks at 260 ppm, shale at 2,400 ppm, sandstone at 240 ppm, limestone at 1,200 ppm, fresh water at 3.7 ppm, sea water at 885 ppm, and soil at 700 ppm, marine plants at 12,000 ppm, land plants at 3,400 ppm, marine animals 5,000-19,000 ppm, land animals at 5,000 ppm.

Sulfur is one of the few elements that is found in pure form in nature and has a yellowish color. It is often found in association with salt domes that create many of our oil reservoirs. Sulfur occurs in several forms, however, in nature sulfur is most commonly found and used as the compound sulfate (SO_4^{-2}).

The mineral pyrite or iron sulfide (FeS_2) is known as fool's gold, manganese sulfate ($MnSO_4$) is used as a fertilizer and as a supplement in animal feed, gypsum or calcium sulfate ($CaSO_4$) is often used to release excess sodium in clay soils and used in many fertilizer formulations, iron sulfate ($FeSO_4$) is sometimes used in gardening.

When in college I remember Lake Nacogdoches being constructed. As the construction crews built the dam, they excavated several hillsides exposing the buried rock layers. In one of them

were beautiful large (3-5" long) clear crystals of a mineral known as selenite which is calcium sulfate with two water molecules attached.

Sulfur is a basic ingredient of gunpowder, hydrogen sulfide (H_2S) smells like rotten eggs and is dangerous at high concentrations; it is a common ingredient in smog from burning diesel fuel or coal. Sulfur is used in car batteries in the form of sulfuric acid (H_2SO_4). Many of the scents we consider odorous contain sulfur.

Sulfur is found in many enzymes and vitamins, it is a main component of keratin, which composes our hair and nails or feathers. Sulfur is an important structural element used in most proteins and many amino acids. Sulfur is a component of vitamins, coenzymes, thiamin, biotin, lipoic acid and participates in many enzymatic reactions.

Sulfur is found in MSM (Methylsulfonylmethane) that is found in plants and animals that reduces inflammation and decreases joint and muscle pain in mammals.

Deficiency of sulfur results in degenerative types of arthritis involving cartilage, ligaments, tendons, Systemic Lupus, Sickle cell anemia and various collagen disorders. Sulfur helps detoxify the body, increase blood circulation, reduces muscle cramps and back pain, helps remove inflammation, and helps the body have more energy that is useful.

Sulfur has recently been found to help protect the myelin sheath over nerve endings.

Sulfites, sulfur dioxide (SO_2) and sulfites (SO_3^{-2}) are a common preservatives and antimicrobial agents added to foods and medicines (think wine) as they kill microbes. Sulfites can trigger adverse reactions in sensitive people, from asthma issues to behavior in autistic children, the FDA records that several deaths have occurred to excess sulfites used in foods

Sulfur is essential for good health: eggs, onions, garlic, and cabbage and other cruciferous vegetables are good sources of sulfur. Nuts and seeds are often good sources on sulfur. However, for proper absorption one needs high levels of vitamin-C.

The main dietary sources of sulfur include allium, shallots, garlic, onions, and cruciferous vegetables, animal proteins, dairy, legumes, nuts, and seeds.

Gardening and Landscaping Problems Associated with Sulfur (S)

In soils up to 90% of sulfur is tightly bound to humus, so SO_4^{-2} is the major exchange anion. It is interesting that soils around the world have carbon to sulfur ratios of 100:1 and most sulfur in soils only occurs in organic forms. Sulfur is a structural component of humic and fulvic acids which are components of humus that is so essential to healthy soils.

Sulfur is considered a primary plant nutrient (.05-1% of a plants tissue contains sulfur) and it is used by plants only in the sulfate form. Soil microbes are responsible for converting sulfur into a sulfate form that plants can use and then plant roots extract sulfate ions (SO_4^{-2}) from the soil.

Nitrogen fixing plants (legumes) require adequate sulfur for good nodule development. If there is not enough sulfur in the soil or it is out of balance in relation to other elements in the soil, then the plant-microbe system cannot obtain nitrogen from the air and fix it in the soil.

All organisms from microbes to earthworms use sulfur in the form of the amino acids (cysteine and methionine) that are used to build proteins.

Plants use a lot of sulfur as it is required in the production of proteins and seeds plus it improves the taste of our foods.

A few plants have been found to emit carbon disulfide (CS_2) from its roots to protect them from parasitic nematodes. Excess sulfates in the soil reduce selenium absorption by plants and can create soils that are too acidic for most plants.

Sulfur is one of the easiest leached of all mineral nutrients and it is easy to mistake a sulfur deficiency as a nitrogen deficiency as well as magnesium, iron or potassium deficiencies. Shortages of sulfur are signaled by sick crops, insect, bacterial and fungal attack, upper leaves may turn yellow, stems stay small and woody, root become long and slender, symptoms often resemble a nitrogen shortage.

Sources: compost, native mulches, molasses, sulfates, gypsum, elemental sulfur, feathers, green sand, fish emulsion

17) **Chlorine (Cl)** - Chlorine is found in igneous rocks at 130 ppm, shale at 180 ppm, limestone at 150 ppm, sandstone at 10 ppm, fresh water at 7 ppm, sea water at 19,000 ppm, marine plants at 4,700 ppm, land plants at 2,000 ppm and land animals at 2,800 ppm. Most soils only have around 100 ppm of chlorine.

If you notice that chlorine is found in the same column on the periodic table as fluorine (F) and bromine (B), hence it has very similar chemical properties and is highly reactive.

Chlorine is an element where small amounts are essential to health from microbes, plants, animals, and humans and too much is toxic.

Chlorine exists as a molecule in the form of two chlorines atom that are coupled (Cl_2) which is extremely reactive and dangerous. It is a dense greenish-yellow gas with a sharp pungent smell. Chlorine is extremely reactive and will form compounds with all elements except the noble gases.

Chloride is a chlorine atom that has a negative electrical charge (Cl^-) which is stable and relatively safe. Chlorine is commonly found in nature as Halite (rock salt) which is a crystal form of sodium chloride (NaCl) and is the main source of chlorine for all living organisms.

Chlorine is essential for all living species, used in electrochemical and catalytic functions, activates numerous enzyme functions, and raw material our digestive system uses to make stomach acid which is hydrochloric acid (HCl). It is required for vitamin B-12 absorption.

Chlorinated lime or calcium hypochlorite $Ca(ClO)_2$ was one of the first disinfectants used by doctors to wash their hands between patients, reducing mortalities by 90% after it started being used. Chlorine is the most common disinfectant used in public water systems.

Chlorine is required to make plastics like (PVC) poly vinyl chloride $(CH_2CHCl)_n$ which is long chains of carbon atoms with a chlorine atom attached to every other one. Chlorine is used in the manufacture of hundreds of products.

Chlorine gas (Cl_2) was used as a chemical weapon in WW-I due to its extreme toxicity, as it effectively attacks all living cells (both good and bad). It starts attacking eyes and lungs in concentrations as low as 3 ppm. Studies have found that our white blood cells use chlorine gas to fight infections.

When we drink chlorinated water, it kills the good bacteria in our stomachs leading to many intestinal disorders. Reports in the Journal Scientific American have linked chlorine in public water systems to rectal and breast cancer.

Exposure to chlorine diminishes vitamin E, vitamin C, and polyunsaturated fatty acids in our skin that makes one more sensitive to eye and skin irritations. It often leads to dry skin issues.

Chlorine is an active ingredient in bleach, in the form sodium hypochlorite (NaOCl). Chlorine dioxide (ClO_2) is used in bleaching paper pulp or white flour. It is a major ingredient in

pesticides, fungicides, other chlorinated compounds like dioxin/furans and PCB's. Many other cancer-causing chemicals have chlorine in them. Women with breast cancer have 50-60% higher levels of organochlorines (chlorine by-products) in their breast tissue than women whom are cancer free. People whom bath in chlorinated water have a significantly higher risk of bladder cancer and people whom swim in chlorinated water have higher risks of asthma and allergies.

If we combine chlorine with ammonia, we get chloramines (monochloramine (NH_2Cl), dichloramine ($NHCl_2$), trichloramine (NCl_3)) depending on the acidity of the water. Chloramines are known to cause cancer in rats and the byproducts of chloramines are more toxic than those of chlorine. See Citizens Concerned About Chloramine (CCAC) http://www.chloramine.org for a more detailed list of health effects.

Chlorine in its anion form chloride readily combines with copper (Cu), mercury (Hg), zinc (Zn), lead (Pb), cadmium (Cd) and other heavy metals and makes them soluble and easier to absorb.

Gardening and Landscaping Problems Associated with Chlorine (Cl)

Chlorine levels in soils are low compared to other elements and they tend to decrease as one moves inland away from the coastline.

Chlorine is used in the process of photosynthesis; it raises osmotic pressure that affects the stomata, increases the hydration of plant tissue, believed to be related to the suppression of leaf spot and take-all diseases. It is considered an essential element for plants where it concentrates in the chloroplasts. Cereal grains absorb very little chlorine (10-20 ppm) while potatoes can contain over 5,000 ppm. Celery, seaweed, and table salt are other sources of chlorine

If chlorine levels in the soil drop below 2 ppm plant growth will suffer (extremely rare). Plants deficient in chlorine exhibit chlorosis of younger leaves and wilting of the plant. Plants that are deficient in chlorine are more likely to develop the disease "take-all".

If chlorine levels reach only 700 ppm in the soil, many plants begin to suffer (beans, apples, etc). Other plants like tobacco, tomatoes, cotton can tolerate levels as high as 3,000 ppm before suffering damage.

It is an essential growth element as it influences plant growth in several ways but not fully understood. Chlorine is required for strong stalks, it stimulates crops to grow, required for disease resistance, plays a role in photosynthesis, and regulates water movement in plants. Plants can absorb chloride by their roots or leaves.

Chlorine inhibits the growth of many microorganisms in the soil that help plants grow by disturbing their biological activity. Too much chloride (most common form is sodium chloride) in soil prevent plants from absorbing water.

Chlorine exists in the soil solution as chloride anion (Cl^-), thus the chloride anion competes with other anions required by plants. Too much chloride (think salt) in the soil prevents required nutrients like nitrate (NO_3^-) and sulfate (SO_4^{-2}) from being absorbed by plants, which starves them, making them more susceptible to insects and disease.

One of the most toxic forms of chlorine in landscaping and gardening is chloramines from our public water systems. Chloramines are highly toxic to fish, amphibians and other aquatic life forms (Note - Canada's EPA has ruled chloramines as toxic). If one overwaters their landscape, the water will enter our streams and may cause fish kills. If one has a pond in their landscape, it may kill your fish as water from irrigation collects in the pond. Chloramines in the runoff from broken water mains enter our storm sewers and into our rivers and streams which kills

the minnows and crayfish that eat the mosquito eggs and larva aggravating the mosquito problem.

Chloramines make the water acidic, which over time can change our soil pH. This may result in nutrient tie-up and create yellowing (chlorosis) problems in many plants. Chloramines prevent the absorption of other nutrients, which also may lead to yellowing.

The action of chlorine and chloramines kill bacteria both good and bad. Many good bacteria that live in the soil control fungal diseases. When we lose these good bacteria there is no natural control, and turf grass diseases like "Brown Patch, Take All and St. Augustine Decline" become rampant. In other words, the more one waters, the greater the chance that one will experience disease problems in their grass and other plants.

Chlorine and chloramines kill the nitrifying bacteria that fix nitrogen from the air into the soil. Hence, additional nitrogen must be supplied to the plants to replace the loss of free nitrogen from nature. Container plants (hanging baskets, pots, etc.) are more susceptible to damage from chloramines as they tend to require more watering. Other studies have shown that chloramines hurt the germination of seeds from many species of plants. Another problem caused by using artificial fertilizers is that chloramines can also be formed in the soil when ammonia (from artificial fertilizers, animal manures, pesticides, etc.) is combined with chlorine in the water.

Chloramines is neutralized in the soil by chemical reactions with organic matter (humus) which is destroyed in the process. Organic matter in the form of humus can hold 15 times its weight in water, hence every time we water with municipal water, the soil loses some of its ability to hold and store water. Chloramines hurt the production of compost tea as it kills off some of the microbial species that one is trying to grow to high densities. Note: One teaspoon of humic

acid (liquid form of humate) can neutralize the chloramines in 100 gallons of water depending on the exact concentration of chloramines.

Using high humus products like a quality compost, native mulches (that have been composted) and humate in one's landscape is the easiest way to minimize the damage from chloramines and chlorine. This ensures that even if some of the organic matter is destroyed and some of the beneficial microbes are killed, there is plenty left over so the soil life can quickly regenerate and prevent problems.

Sources:

Chloride toxicity often occurs after application of potassium chloride (KCl) which is also known as muriate of potash and used in artificial fertilizers. Dairy and feedlot manure can have 50,000-100,000 ppm of salt (sodium chloride). Most poultry manure is another source of salt along with sewage sludge (bio-solids). Spent mushroom substrate (mushroom compost) is generally very high in salt but it varies greatly around the world. Other sources include manure-based compost, Biosolids (sewage sludge) compost, municipal water supplies, artificial fertilizers, some organic fertilizers made from poultry manure, thunderstorms and storm water run-off from roads treated with salt, burning coal, and ammonium chloride (NH_4Cl) is also used in artificial fertilizers.

18) **Argon (Ar)** - The name argon comes from the Greek meaning "inactive" as argon is the cheapest totally inert gas. It is a colorless, odorless gas that is soluble in water. One percent of our atmosphere is argon, it is found in igneous rocks at 3-5 ppm, fresh and seawater at 0.06 ppm, and in mammalian blood at 0.75 ppm.

Argon is used to date ancient rocks and artifacts by various dating methods and it is used in scientific instruments. It is used as a filler in the old incandescent light bulbs, used to fill partially empty wine bottles to keep them from oxidizing and going bad, sometimes used as the gas in double pane windows. It is also used to make the blue lasers used in eye surgery. Argon is produced by the decay of radioactive potassium atoms and has built up in the atmosphere over billions of years.

Argon has no known biological role. However, bacteria in the nodules of certain plants like beans can absorb argon but cannot process further.

Gardening and Landscaping Problems Associated with Argon (Ar)

None known, good or bad.