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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 10, 11, and 12 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.

10) Neon (N) - Most people associate neon with the colorful neon lights used in advertising signs or the orange cast of some types of streetlights. Neon is the least reactive of all the elements. Pure neon is a colorless, odorless, invisible gas and is the 5th most abundant element in the universe.

Since it does not react with anything, it is a member of the group of elements called Noble gases on the far-right side of the periodic table. These include helium, neon, argon, krypton, xenon, radon, and Ununoctium, element #118, which is predicted to be a noble gas as it was created in a particle accelerator and only a few atoms there has not been enough to test.

Neon is found in igneous rocks at 0.005 ppm and seawater at 0.00014 ppm. Its primary usage is in scientific applications.

Gardening and Landscaping Problems Associated with Fluorine (Ne)

Due to its inability to react with anything neon is a harmless gas with no biological role for microbes, plants, or animals.

Sources: Igneous rocks

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11) **Sodium (Na)** - Sodium is a soft silvery white metal which is a member of the group one elements on the periodic table (far left column) called the alkali metals. It is the best tasting and most explosive of this group.

It is found in igneous rocks at 23,600 ppm, in shale at 9,600 ppm, in sandstone at 3,300 ppm, limestone at 400 ppm, fresh water at 6.3 ppm, seawater at 10,500 ppm and soil at 6,300 ppm. In marine plants sodium can reach 33,000 ppm and in land plants at 1,200 ppm, however both marine animals and land animals have 4,000 ppm.

When we think of sodium we are conditioned to think of sodium as the salt (sodium chloride, NaCl) that is essential for life. It is interesting that sodium intake in the USA is 5-12 grams per day while in Japan whose lifespan is 4 years longer consumes 28 grams per day.

Sodium, chlorine, and potassium are three indispensable electrolytes that are intimately connected, and work together in our bodies. One of sodium's most important functions is the movement of electrical signals along nerve fibers. A lack of sodium can cause muscle cramps, brain swelling in infants causing death, and extremely low salt diets have led to death in adults. On the other side, too much salt can cause one to vomit. Salt is commonly used to preserve food as it kills bacteria and other microbes.

Symptoms of sodium deficiency include muscle fatigue, spasms, and heart palpitations. A 2017 book may be of interest, "The Salt Fix: Why the Experts Got It All wrong- and how eating more salt may save your life", by Dr. James DiNicolantonip.

Salt is mentioned in the bible several times. In Jeremiah 2:22 it is mentioned as a cleaning agent (Na_2CO_3) that we call washing soda. In biblical times, salt was collected from areas where seawater had evaporated and it contained high levels of gypsum and other minerals.



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The ovens of the day were lined with this salt as it would absorb and store heat providing more even cooking. Over time the calcium in the gypsum would become more active after repeated exposures to the fire and react with the sodium chloride hence it would no longer taste salty (lose its flavor).

Pure sodium oxidizes rapidly when cut and exposed to oxygen and water vapor in the air, hence it is covered with paraffin wax to prevent oxidation. It reacts violently when exposed to water releasing pure hydrogen, which may ignite into flames (sodium burns in air to form sodium peroxide (Na_2O_2)).

Sodium is a primary feedstock of the chemical industry. The metal is used in the production of airbags, bio-fuels, glass, and as coolant in heat exchangers. Sodium is used in street lights, as sodium makes a very efficient way to convert electricity into a yellowish light. When we combine sodium with water, we get sodium hydroxide (NaOH) often called lye which is very caustic and is the active ingredient in Drano and many drain cleaners.

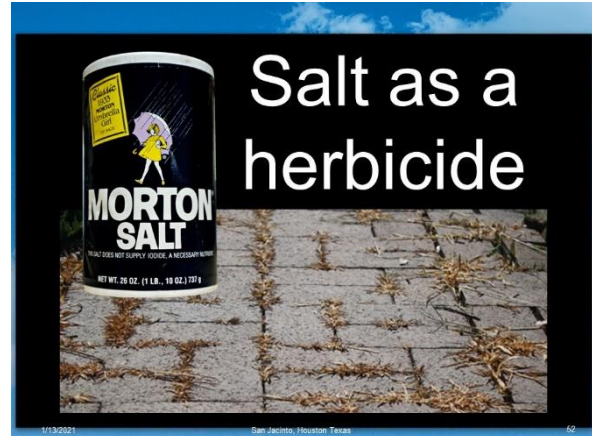
Sodium as common salt is found in several forms; salt from mineral deposits is called rock salt, and salt evaporated from seawater is sea salt and contains all the micronutrients in seawater. Most refined table salt has all the nutrients removed, and then is bleached by some process to make it white and some other chemicals added to make it anti-caking.

Gardening and Landscaping Problems Associated with Sodium (Na)

Sodium is the twelfth most common element found in plant tissue. It is involved with pH management, maintenance of balanced hormones, and a plants enzyme system. In healthy plants, sodium affects the plants immune systems, which includes insect resistance, bacterial or fungal resistance and weed control. However, only small amounts of sodium are required.

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Sodium influences plant growth in many ways but not fully understood. Sodium is rarely deficient in Texas soils. Hence, for gardeners, too much sodium will stunt growth or even kill most plants (think salt). Table salt used to be advertised as a weed killer when I was a boy.



Perhaps the most important factor is in physiological relationship to plants, in association with potassium (K), as available potassium must exceed available sodium or problems will occur. If we look at the far-left column of the Periodic table, we see that potassium (K) is directly below sodium (Na) which means it has very similar chemical properties. Therefore, in some species of plants like cactus and succulents, sodium will replace potassium resulting in sick plants.

Sodium combines with arsenic (sodium arsenate) which is a common ingredient in many pesticides. In the Houston area, many soil yards purchase worn out topsoil from along the highway 290 corridor, from Northwest Houston to Hempstead, and resell it to homeowners. This is where rice and cotton were grown for many years and arsenic compounds were used to defoliate the plants as it made the cotton easier to pick. This arsenic ends up in the topsoil and may combine with sodium from chicken or cow manure to form this toxic pesticide in one's soil.

Another problems gardener's face is when sodium in the soil is combined with carbon and water it forms sodium benzoate ($\text{NaC}_7\text{H}_5\text{O}_2$) a toxic chemical that kills microbes hence it is added to many foods. Sodium benzoate is linked to hyperactivity and attention deficient in children and it has been found to damage DNA.

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As gardeners, when we have too much sodium in our soil, the soil is saturated with the sodium ion, which prevents other, needed ions (nutrients) from being stored or absorbed by plants. Too much sodium can block calcium uptake by plants and increased levels of sodium can affect (prevent) the absorption of magnesium and potassium. This creates weaker plants that grow slower and are more susceptible to insects and disease.

A few plants that require (or can tolerate) more sodium than others are carrots, barley, beets, wheat, and ryegrass.

Another major issue in our area is drainage and soil health. Sodium as an atom has a very large radius when exposed to water, which prevents clay soils from becoming loose, and friable (flocculating) thereby destroying soil structure. This effect prevents water from entering the soil whether from rain or irrigation.

Recent research has found that roots can sense the presence of salt!

In the photo below there is no salt on the left side of the membrane and the roots grow right on through. However, on the right side there is some salt in the water below the membrane and the roots turn away. When one uses artificial fertilizers, poultry or cow manure products the salt goes into the soil and prevent roots from growing deep. Without a deep healthy root zone, plants require a lot of extra watering and are not as healthy as they could be.

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For healthy landscapes, gardeners in Houston and along the Gulf Coast need to avoid using products that contain high amounts of sodium like poultry and cow manure, etc. Sodium damage is more common on heavy or clay soils than sandy soils where it is easily leached out of the soil.

Sources: poultry and cow manure, some wood and bark ashes, mushroom compost (spent mushroom substrate), some seaweed if not washed to remove excess salt, Sewage sludge and compost made from Biosolids (sewage sludge)

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12) **Magnesium (Mg)** - Essential to all life forms, has electrochemical, catalytic, and structural functions. It is one of the most common elements (7th) in the earth's crust at 2.33%.

Magnesium is considered the first of the structural metals; as it is strong, light, relatively inexpensive, and easy to machine or work.

Magnesium is highly flammable and in small pieces, it lights easily with a match. It burns very hot hence is commonly used in campfire starters. It can be found in racecars, airplanes, bicycles, fireworks, cameras, and luggage. Another use is in birthday candles that relight after being snuffed out.

Magnesium is found in igneous rocks at 23,000 ppm, in shale at 15,000 ppm, in sandstone at 10,700, in limestone at 2,700 ppm, fresh water at 4.1 ppm, saltwater at 1,350 ppm, soils at 5,000 ppm, land plants at 3,200 ppm and marine plants at 5,200 ppm, marine animals at 3,200 ppm, and land animals at 1,000 ppm.

Magnesium is an essential component of the chlorophyll molecule. If the magnesium atom in a molecule of chlorophyll is removed and replaced with an iron atom, it becomes the hemoglobin found in our blood!

Magnesium activates numerous enzymes and is used in human bone formation and in the production and transfer of energy required for protein synthesis. While it is rare, too much magnesium prevents bone calcification but a lack of magnesium allows calcium (Ca) to form kidney stones in our bodies. Magnesium is a cofactor in more than 300 reactions in the body and is found at more than 3,750 binding sites in the human body.

A lack of magnesium is linked to asthma, anorexia, menstrual migraines, growth failure, ecg changes, neuromuscular problems (acts as neurorelaxant), hypertension, diabetes, cardiovascular disease, heart arrhythmias, osteoporosis, pregnancy complications, pre-eclampsia and eclampsia, stroke, endothelial dysfunction, convulsions, depression, muscular



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weakness, tremors, vertigo, calcification of small arteries and malignant calcification of soft tissue, and constipation. Additionally, in adults, a lack of magnesium is linked to hypertension, muscle cramps, and preterm contractions. A magnesium deficiency is a major contributing factor to migraine headaches as it affects both serotonin receptor function and is used in the production of neurotransmitters. Additional studies have shown that a lack of magnesium is a factor in the formation of kidney stones, cancer, insomnia, menstrual cramping, blood clotting and in the control of free radical damage. A lack of magnesium is also a leading cause of inflammation. There is an inverse relationship between magnesium and c-reactive proteins. A lack of magnesium has been linked to hardening of our arteries.

An article in the Dr. Mercola newsletter reported that a lack of magnesium is related to the hearing issue called tinnitus. Magnesium supplements help reverse this hearing disorder. It was also reported that a lack of magnesium is related to depression and other personality disorders. Low levels of magnesium have been found to be linked to sleep disorders. Another article published in the journal of The American Osteopathic Association (2018) found vitamin-D cannot be utilized without sufficient magnesium (Mg) present in our bodies.

An article in the Dr. Mercola newsletter reported “two common pathologies associated with magnesium deficiency are Type 2 diabetes and heart disease.

According to one scientific review, low magnesium may actually be the greatest predictor of heart disease, and other recent research published in the Open Heart journal suggests even subclinical magnesium deficiency can compromise your cardiovascular health.

As noted in a 2018 scientific review published in the Open Heart journal, a “vast majority of people in modern societies are at risk for magnesium deficiency” due to “chronic diseases, medications, decreases in food crop magnesium content, and the availability of refined and processed foods.”

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In children whom are magnesium deficient, they can suffer from constipation, asthma, anxiety, ADHD, migraines, tics, and seizures.

The December 2016 issue of Life Extension had several articles on the importance of Magnesium to our health. The majority of Americans (70-80%) are magnesium deficient and do not obtain enough from dietary sources leaving them vulnerable to disorders linked to this nutrient. Magnesium protects us against a whole series of degenerative disorders.

Magnesium is the 4th most abundant mineral in the human body and more than 300 enzymes require magnesium to function properly. Higher levels of magnesium in our bodies are associated with reduced risks of sudden cardiac death, stroke, type II diabetes, asthma, metabolic syndrome, heart disease, hypertension, lower rates of kidney disease, less risk of cognitive decline, heart arrhythmia, angina, healthier bones and teeth, osteoporosis and lower risk of migraine headaches. Adequate magnesium levels are also linked to increases in longevity.

A lack of magnesium is associated with ADHD, bipolar disorder, depression and schizophrenia, fatigue, anxiety, weakness, loss of appetite, muscle spasms and tremors, hypertension, etc. The energy currency of our cells is ATP (adenosine triphosphate) and requires magnesium to work.

Humans that are magnesium deficient have a 76% risk increase of Pancreatic cancer and Pancreatic cancer risk increased by 24% for every 100 mg below the RDA.

Other studies found that for every 100 mg increase in magnesium intake the risk of developing type II diabetes decreased by 15%. Optimal RDA intake is 420 mg for males and 320 mg for females. Men with the highest intake of magnesium had a 50% less chance of contracting colon cancer.

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Magnesium is often the limiting factor in bone development and maintaining bone density as low levels of magnesium directly leads to osteoporosis. Magnesium regulates the movement of calcium into our bones. A low level of magnesium accelerates the aging process at the cellular level and the risk of death from any cause in those 65 and older is significantly higher in those with lower levels of magnesium. Without adequate magnesium, the human body cannot utilize calcium efficiently.

A recent article in the Nutrition Journal found that men and women with higher levels of magnesium had a lower risk of artery calcification.

An article in the Journal Hypertension Research an increase in endothelial progenitor cells (good) and a decrease in free radicals when people supplement with magnesium and taurine. Life Extension January 2017.

Medical research back in 1937 found that low magnesium levels, not high cholesterol or consumption of too much saturated fat were the leading cause of heart disease.

Research at the University of Vermont's medical school found that just 248 mg of magnesium per day can treat and prevent depression for pennies per day and it worked better than any antidepressant drug!

Another article published in the journal of The American Osteopathic Association (2018) found vitamin-D cannot be utilized without sufficient magnesium (Mg) present in our bodies.

The US Academy of Sciences has estimated that adding calcium and magnesium to water would reduce the annual cardiovascular death rate by 150,000 in the United States. Note: Most bottled water does not contain magnesium except Adobe Springs mineral water which contains 110 mg magnesium per liter.

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Magnesium is used in almost every fertilizer made whether synthetic or organic and regularly applied to our fields.

So why do we not have enough magnesium in our diets?

1) Many common drugs deplete the body of magnesium of which the proton pump inhibitors (PPI's) which are drugs used by millions of Americans for heartburn relief are the most notorious and widespread.

2) Soft drinks use phosphoric acid that depletes our bodies of magnesium. It is also used in many food items.

3) Typical grain refining removes 80-95% of total magnesium that was in the grain. This is another reason to purchase organic whole grain breads.

4) Genetically modified foods (GMO's) commonly have 10 times the amount of Round-Up on them as conventionally grown food. Glyphosate is the active ingredient in Round-Up. Glyphosate was originally patented as a mineral chelator to tie-up and clean mineral scale out of pipes. One of the minerals it binds strongest to is magnesium, preventing the body from absorbing it even if it is present in our food. To make the problem worse farmers not only use Round-Up for weed control spray they also spray their grain crops (wheat, etc.) with Round-Up to dry them out to help make the crop easier to harvest adding even more glyphosate to our food supply. Glyphosate contaminates our food supply and occurs in the highest amounts on genetically modified crops of which corn is the worst (up to 10 times the amount than non-gmo corn) and on grain crops like wheat.

Over 300 bodily functions require magnesium hence magnesium deficiency is a major risk factor for cancers of all types. "The Truth About Cancer", T. Bollinger, 2016, Hay House Publishing, ISBN: 978-1-4019-5223-5

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Additionally, magnesium regulates the sodium-potassium pump and a lack of sodium can lead to a magnesium deficiency as can a lack of vitamin B-6 or selenium.

Food's high in magnesium are cashews and almonds, avocados, bananas, cacao or chocolate (very high), lentils, figs, okra, squash, black beans, long grain brown rice, sunflower seeds, spinach, Swiss chard, turnip greens, beet greens, and collard greens. Other foods include egg yolks and tofu.

Gardening and Landscaping Problems Associated with Magnesium (Mg)

One of the growing reasons more and more gardeners are raising their own vegetables and fruits is the lack of essential nutrients in our food and the chemical contamination in them that is making us sick. Normally, dietary magnesium is related to the amount of magnesium in the soil and to a lesser degree the mineral content of the water one drinks. However, the contamination of our food supply prevents adequate absorption even if the magnesium was present.

A magnesium deficiency for plants the leaves become thin, lose their green color from between veins on older leaves, it typically starts out from the bottom of plant and moves up, and leaves tend to curve upward. Depending on the species of plants there may be yellowing of leaves or reddening of leaves. Note: Too much potassium competes with absorption of magnesium into plants and also causes deficiencies.

Magnesium aids in the formation of fats, oils, and starches in plants as well as being required for the chlorophyll molecule. It is involved with pH management, maintenance of balanced hormone and enzyme systems, healthy plants (immune systems from insect resistance, bacterial or fungal attack to weed control).

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Pound for pound, magnesium will raise the pH of the soil 1.4 times as much as calcium, however, excessive magnesium will cause phosphorous, potassium, and nitrogen deficiencies. Healthy soils will have five times more calcium than magnesium.

Excessive magnesium in the soil can combine with aluminum to form toxic substances, which can enter the food chain and cause health problems. Excessive magnesium will cause the soil to crust, which reduces aeration, it releases soil nitrogen to atmosphere, and creates phosphorous and potassium deficiencies by mineral tie up. This can lead to anaerobic decay forming alcohols in the soil (only 1 ppm alcohol can kill a plants root). A large imbalance in soil of the calcium to magnesium ratio (Ca:Mg) permits organic residues not only to decay into alcohol (a sterilant) but into formaldehyde (a carcinogen and preservative). This is why applying Epsom salts which is magnesium sulfate ($MgSO_4 \cdot nH_2O$) to our gardens often cause more problems than it fixes.

Sources: sedimentary deposits like magnesium sulfate (Epsom salt), granite and basalt sands, compost, native mulches, Sul-Po-Mag mineral supplement, plant residues, dolomite (a type of limestone with much higher magnesium levels), Remineralizer.

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