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JOHN'S CORNER:

MINERALS - The Elements and What They Do (Part 18)

by John Ferguson

26) Iron (Fe) - Iron is the fourth most abundant element in the earth's crust and is a component of many rock forming minerals. Iron is found in igneous rocks 56,300 ppm, shale at 47,200, sandstone at 9,800, and limestone at 3,800 ppm. In soils it is found at 38,000 ppm and when combined with oxygen it gives many soils the reddish color (ex. East Texas). However, in fresh water at only 0.67 ppm and seawater at 0.01 ppm. In marine plants, iron can be found at 700 ppm and land plants at 140 ppm. In some mafic rocks like basalt, iron can be up to 8% of the total minerals.

Iron is a silvery lustrous metal that rusts in air and dissolves in weak acids. The chemical symbol (Fe) comes from the word "Ferrum" which is Latin for iron.

Iron is one of the most important metals in human history allowing great advances in science and technology, hence the name the Iron Age. Even today iron, in the form of steel is used everywhere from cars, railroad tracks, bed frames, ovens and stoves, horse shoes, nails, bolts and screws, tools, drill bits, skillets, and many more items.

Iron has a unique geo-chemistry with electrical charges that range from +2 to +6 with +3 being the most common. This allows iron to combine with other elements in many ways. Iron (Fe) combines with oxygen (O) to form many minerals from common rust to even magnetic minerals like magnetite (Fe_2O_3). Another form of iron we find in nature when combined with sulfur (S) is "fools gold" or iron pyrite (FeS_2).

Iron is essential for our health as it is required for hemoglobin, myoglobin, respiratory enzymes, a cofactor and activator of enzymes, and has many more functions. Iron (Fe) is to

hemoglobin as magnesium (Mg) is to chlorophyll and to the process of electron transfer for utilization of oxygen that both plants and animals require.

Excess iron in the body can cause increased inflammation, fatigue, diabetes, joint and muscle pain, erectile dysfunction, arthritis and cirrhosis of the liver but it is rare compared to iron deficiencies (DNA Restart 2016).

Iron from plants is only one percent absorbable while iron from meat is 10 percent absorbable. As a result, iron deficiency is often a cause of "pica" where children eat dirt. Iron deficiency is linked to many human diseases and health problems.

A few iron deficiency symptoms in humans are anemia, brittle nails, fatigue, irritability, confusion, dizziness, fragile bones, anorexia, and constipation.

The amount of iron in our food supply has decreased dramatically in recent years. For example, to get the same amount of iron one received from an apple in 1950 by 1998 we had to eat 36 apples! If we go back further and look at 1914 to 1992 we find calcium has declined by 48%, phosphorous by 85%, iron by 96% and magnesium by 83%. If we want to be healthy, we have to grow our own food!

The herbicide glyphosate (Round-Up) locks up iron and prevents it from being absorbed properly by plants. When we eat food sprayed with glyphosate (all grains including corn and other vegetables) we are eating glyphosate. The glyphosate then prevents us from absorbing what little iron that did make it into the food. This is another reason to purchase organic food and avoid GMO's.

Microbes use iron and combine it with other elements to form over 18 different minerals in the soil. Since iron combines with other elements so easily, it is not very soluble or mobile in the soil and is why we do not find very much iron in water.

Iron is essential for phytoplankton and the limiting factor in their growth. The addition of iron can greatly increase their biomass. One of the ideas proposed to remove carbon dioxide (CO_2) from the atmosphere as a method to fight global warming, is to salt the oceans with iron dust,

which would trigger a massive phytoplankton bloom. When the plankton dies, they would sink to the ocean bottom sequestering the carbon (C).

Gardening and Landscaping Problems Associated with Iron (Fe)

Iron readily combines with oxygen to form rust. Think about a pair of pliers that was left outside in the dew and rain for a couple weeks. Rust is formed and the pliers are cemented together and will not move. The same thing happens in our soils; too much iron will cement soil particles together forming hardpan. This is very common when artificial fertilizers are used. A couple of the common iron minerals formed is ferricrete and ironstone. What do these names suggest to you?

Iron is a micronutrient and is required for the production of chlorophyll as it is involved with the building of chlorophyll molecules, although not contained in them. In addition to chlorophyll formation, iron is used as an oxygen carrier; it is used in cell division and growth, and used in nitrogen reduction and fixation.

Iron occurs in concentrations of 10-2,000 ppm in plant tissue and is involved with many plant physiological processes such as enzyme and co-enzyme systems. Iron is required as a carrier of oxygen in the process of biologic oxidation and aids in the prevention of chlorosis.

Iron deficiency results in poor uptake of other nutrients resulting in mineral imbalances in plant tissues. Plants best absorb iron when it is chelated in an amino acid form, however; iron is unavailable if there is excess calcium in the soil.

Mycorrhizal fungi have a great ability to bind iron at the root surface or in the root cells and make it available to plants. When one uses artificial fertilizers plants do not form the mycorrhizal associations, hence they do not absorb critical elements needed for good health (see reduction in nutrients on apples mentioned above).

Too much iron prevents plants from absorbing several trace elements like manganese (Mn), nickel (Ni) and cobalt (Co) and can be toxic to plants. Too much phosphorous (P) in the soil interferes with iron absorption and utilization by plants. As mentioned too much calcium in the

soil will suppress iron availability and can lead to chlorosis. This is why applying gypsum, which is calcium sulfate ($CaSO_4$) when not needed, can create many other problems. Too much phosphate, copper, or manganese can cause iron deficiencies. The *balance* of nutrients is critical for good soil and plant health.

Plants use iron in its ferrous form (Fe^{+2}) rather than ferric form (Fe^{+3}) hence applying iron compounds in the wrong form can do more harm than good.

The solubility of iron decreases about 1,000 times for each whole number rise in pH hence iron is more available chemically in acidic soils. Cool temperatures or dry soils can reduce iron availability and cause temporary shortages of this nutrient.

Hence, it is critical to have plenty of fresh organic matter (compost and mulches) in the soil to ensure the availability of iron via the soil-root-microbe system.

When iron is exposed to excess zinc (Zn) it forms the mineral franklinite ($ZnFe_2O_4$) which decreases the availability of both metals to plants. This has been proposed as one of the mechanisms as to why "rubber tire" mulch is so toxic to plants.

Iron deficiency is a major problem worldwide in cultivated fields, which are now low in *available content*. The most common deficiency symptom is interveinal chlorosis of young leaves that are yellow in areas between veins on older leaves, initiates first from top to bottom; veins margins and tips stay green. However, different species of plants respond differently to iron deficiencies. Plants growing in compacted soils are more likely to develop iron deficiencies.

Sources: basalt sand, greensand, compost, most organic fertilizers, native mulches, pyrite (iron sulfate), rust (iron oxide), chelated iron products