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JOHN'S CORNER:

MINERALS - The Elements and What They Do (Part 25)

by John Ferguson

33) Arsenic (As) - Arsenic is a metalloid that has two common forms, grey or alpha-arsenic which is metallic, brittle, tarnishes, burns in oxygen and resists attack by water, acids and alkalis. The second form is yellow arsenic or beta-arsenic, which is non-metallic.

Arsenic is found in igneous rocks at 1-8 ppm, shale at 13 ppm, sandstone and limestone at 1 ppm, soils at 6 ppm, and there is hardly any in fresh or salt water at 0.003-0.004 ppm. However, in marine plants arsenic can reach 30 ppm but only 0.02 ppm in land plants.

It is an essential trace element for animals and humans, and it is essential for the survivability of newborn and neonatal growth.

In nature, arsenic is rarely found in a pure or uncombined form. The most common minerals are red realgar (As_4S_4), yellow orpiment (As_2S_3), silvery arsenopyrite ($FeAsS$), and iron grey enarite (Cu_2AsS_4).

Most arsenic production occurs as a byproduct of refining other metals such as copper, iron, or lead. Arsenic is found combined in nature with many elements to form a range of minerals as it has electrical oxidation states that range from -3 to +5.

Arsenic compounds were used to make bright yellow or green paint. Other uses include rat poison, taxidermy, weed control, wood preservative, microchips, liquid crystal displays, semi-conductors, batteries, glass, televisions, etc.

One of the first arsenic compounds used was "Paris Green" (copper acetoarsenite) and is one of the few chemicals that were used as both a rat poison and a paint pigment. Paris green was once used to kill rats in Parisian sewers hence the common name. In Britain, this chemical was used to make wall paper that when exposed to humidity, molds would convert the arsenic to



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gas forms that would make people sick (arsenic in the gas form AsH_3 where over 5 ppm is harmful). The doctors of the day would send the people to the beach and the illness would clear up. Hence being at the beach became associated with healing.

Arsenic stimulates growth in chickens, other poultry, and a few other animals like pigs. In chickens in combination with choline, it prevents 100% of perosis (slipped tendon disease). Over 900 tons of arsenic is added to chicken feed each year for the last 30 years, when the manure from these animals are used in fertilizers and applied to fields to grow crops it breaks down into inorganic arsenic, which is absorbed by the crops and enters the food supply causing many health problems.

Although rare, arsenic deficiency in humans results in carpal tunnel syndrome and other repetitive motions type degeneration.

Arsenic can also have a tonic effect by activating enzymes. The arsenite ion (AsO_3)⁻² allows oxidation to proceed at an increased rate hence it stimulates metabolism and formation of red blood cells. Arsenic is found in all body tissues including bone, hair, nails, etc. Arsenic bonds to the sulfur elements in keratin a main component of hair, which is why hair test reveals ones exposure to arsenic.

Arsenic compounds were used as medicines from the Mediterranean to China. Arsenic was the first cure for the disease syphilis in the form arsphenamine and sold under the name Salvarsan. Many of the famous spring waters with healing properties contain dissolved arsenic (Vichy-2 ppm, Zam Zam holy water from Kabba near Mecca has even more).

Pine needles once were crushed and steeped as a tea in boiling water to deliver enough arsenic to prevent mis-carriage.

Low levels of arsenic help fight cancer and high levels have been found to cause cancer. Arsenic has the property "hormesis" which means small amounts are beneficial and large amounts are toxic (poisonous). Animals fed an arsenic free diet had stunted growth, as it is used in the metabolism of essential amino acid arginine.



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Arsenic was often sold in Europe on the black market as "succession powders" as it was used to kill Kings to Popes as only a dose of 200 mg is fatal. A dangerous form of arsenic is "White arsenic" (As_2O_3) that was originally just called trioxide. Several forms of arsenic were used as chemical weapons in World War 1.

Excess arsenic has been linked to numerous detrimental health problems; diabetes, heart disease, cardiovascular issues, respiratory distress, impaired neurological development and depression.

Historically 80% of all produced arsenic has been used in the manufacture of pesticides, soil sterilants, and herbicides used in agriculture. As a result, many of our agricultural soils have high levels of arsenic.

Arsenic in the soil can switch between two different forms depending on soil conditions, in soggy flooded fields, we get arsenite, or after it dries out a little it becomes arsenate. Arsenic easily changes from any of its electrical states to a different one.

Symptoms of mild arsenic poisoning are alopecia, constipation, confusion, delayed healing, dermatitis, diarrhea, edema, fatigue, seizures, numbness and weakness, etc.

Arsenic is often added to artificial fertilizers as a disposal method for hazardous waste as it is very profitable for fertilizer manufactures. Note: It is illegal to add toxic waste to organic fertilizers.

A good book on why and how this happens is Fateful Harvest by Duff Wilson, Harper Collins Publisher, ISBN 0-06-019369-7, It is a history of how hazardous waste is disposed of in synthetic fertilizers and ends up contaminating the food supply. Wilson was an investigative reporter for the Seattle Times Newspaper and published a series of articles in 1997-1999 on this dangerous method of disposing toxic wastes.

Farmers in Washington State used these toxic fertilizers to grow potatoes, which are then used to make French fries by the fast food industry.



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Researchers at the University of Oklahoma have found that in Bolivia farmers use wastewater from mining to irrigate their fields of potatoes and the level of arsenic is 9-71 times higher than the safe level. Note: Heavy metals like arsenic have been linked to autism and ADD, and ADHD.

Agricultural soils of Oklahoma and Texas are contaminated with arsenic with levels as high as 830 ppm from years of pesticide and herbicide application. Researchers have found that fields treated with arsenic trioxide pesticides during the 1950's are now leaching into groundwater and soils.

Some animals have high levels of arsenic; oysters at 4 ppm, mussels at 120 ppm, and prawns at 174 ppm. However, it does not hurt those that eat them as the arsenic is in an organic form known as arsenobetaine, which is easily absorbed and excreted in our urine.

Gardening and Landscaping Problems Associated with Arsenic (As)

Arsenic over 2 ppm by dry weight will kill most plants; hence arsenic is a common ingredient in many herbicides.

Note: Many artificial fertilizers can have 188 ppm of arsenic in them.

Rice as a crop has higher levels of arsenic than other foods as rice absorbs arsenic from both soil and water and in the inorganic form. However, rice plants have enzymes that can convert arsenic into a non toxic form and return it to the soil, leaving less in the plant to harm humans. The plants transform arsenate into arsenite and push the molecules back into the soil (Plant Physiology 11/16).

Arsenic is phytotoxic to tomato plants at concentrations of 2 ppm where it accumulates in the roots. The level in all plants increases with increasing concentration in the soil.

Symptoms of too much arsenic in our soil are wilting; violet coloration of leaves, root discoloration, cell plasmolysis, and the most common is slow growth.



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The flowers of *Linanthus parviflorus* (a member of the pink family) turns from white to red when exposed to soils with heavy metals.

Some plants thrive on arsenic such as the Chinese Ladder or Brake Fern (*Pteris vittata*) which can have over 2% (2,000 ppm) in its tissues. The Douglas fir can absorb high levels of arsenic. Sarghina (*Corrigiola telephiifolia*) has been measured at 2,110 ppm. Other hyper-accumulators of arsenic are Huisache (*Acacia farnesiana*) and Smooth Mesquites (*Prosopis laevigata*). Arsenic in the form of arsenic acid (H_3AsO_4), was used as a defoliant for decades especially for cotton. Hence, after many years of application there is a large accumulation in the soil. Even though arsenic is no longer used, cotton meal and cotton burr compost may still have high levels of arsenic from being grown in soils where the arsenic accumulated over decades of use.

A major source of arsenic in landscaping is from CCA treated wood (Copper, Chromium, and Arsenic). These elements slowly leach into the soil over time as the wood decomposes. Some garden soils have been found to have 15,000 ppm of arsenic!

Sources: poultry manure, some greensands, artificial fertilizers, CCA treated wood, some seafood, some cotton burr products (meal and compost), sewage sludge (Biosolids and composted Biosolids), coal ash, pesticides and herbicides.