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JOHN'S CORNER:

MINERALS - The Elements and What They Do (Part 23)

by John Ferguson

31) Gallium (Ga) - Gallium is the 34th most abundant element on Earth and is found on average in the earth's crust at 18 ppm. Gallium is a soft silvery-white metal that will melt in your hand.

If gallium is mixed with indium (In) and tin (Sn) it will not freeze until -190 C (-20 F)! This combination of elements is known as "Galinstan" and is used to replace toxic mercury in thermometers.

Gallium is found in igneous rocks at 15 ppm, shale at 19 ppm, with less in sandstone and limestone. Very little gallium is found in fresh or seawater. In soils, gallium occurs at an average of 28 ppm with a range of 0.4-70 ppm. It is found only in small amounts in plants and animals. It occurs in marine plants at 0.5 ppm and land plants at 0.06 ppm, in marine animals at 0.05 ppm and land animals at only 0.006 ppm.

Gallium is generally stable in air and water, but it will react with both acid and alkali chemicals to form various compounds. Gallium is more abundant than lead but there are no natural processes that concentrate it as lead or other minerals.

Gallium is most commonly found in nature with a +3 electrical (oxidation) state. Aluminum also has a +3 electrical state hence gallium behaves similarly to aluminum in nature. In nature, we often find gallium in the form of gallium oxide (Ga_2O_3).

The production of aluminum (Al) from the bauxite ore is where the majority of our gallium comes from. Smaller amounts are recovered as a by-product of zinc (Zn) and copper (Cu) mining. Other sources include coal flue dusts that can contain 1.5% of this element.



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Gallium is used to make semi-conductors but must be very pure (99.9999%) or what is called four nine pure, in the form of gallium arsenide (GaAs). Gallium arsenide has the ability to convert sunlight into electricity. Aluminum gallium arsenide gives LED (Light Emitting Diodes) lights their red color. When used in laptop computers to cell phones as gallium arsenide, it generates less heat than silicon based semi-conductors which helps the batteries last longer.

When gallium nitride is used to make semi-conductors it produces a full range of colored light in LEDs. The lasers used in Blu-ray technology uses gallium nitride.

For years, it was assumed that gallium has no known biological role except that it stimulates our metabolism. It has no adverse health effects as we do not accumulate it in our bodies and humans easily excrete it in our urine. However, recent research has discovered that gallium is an essential nutrient for humans. It is required for metalloenzyme activity in the human brain and it reduces the amount of brain cancer in animal studies. British studies have shown then women whom receive gallium supplements during pregnancy; it reduces the amount of brain cancer in their children.

Gallium has also been shown to inhibit the growth of some types of leukemia cells and some types of breast cancer cells. In animal studies, adding gallium nitrate to their diets contributes to bone formation in rats on a low calcium diet. Gallium is believed to have a stimulatory effect of the absorption of iron by humans.

Since gallium has a +3 oxidation or electrical state, it behaves like iron in many compounds. Gallium compounds are being researched as anti-malaria drugs and gallium nitrate ($\text{Ga}(\text{NO}_3)_3$) has been used to treat bone cancers.

There is a radioactive form of Gallium called Ga-67, which has a half-life of 78 hours and is used to locate and treat cancers like melanomas since it concentrates in these tissues.

Toxic amounts of gallium are found in residuals from coal combustion, and in sewage sludge (bio-solids).



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Gardening and Landscaping Problems Associated with Gallium (Ga)

Plants show a selective absorption of Gallium depending on the level in the soil. In general, land plants have 0.03-5 ppm dry weight and edible vegetables 0.01- 2 ppm. However, gallium is found in plants tissue up to 30 ppm depending on the species.

Gallium is found in soils in the form of gallium hydroxide $Ga(OH)_3$ which is not very soluble in water hence gallium has low mobility in soils.

In small quantities, gallium stimulates the growth of some microorganisms like the fungus *Aspergillus niger*. It also promotes the growth of algae and the biosynthesis of photosynthetic pigments. In the case of *Anacystis nidulans* it increased oxygen (O_2) production and enhanced other key enzymes.

Supplemental gallium in the form of gallium nitrate $Ga(NO_3)_3$ has been shown to increase the yields and quality of tomatoes. Gallium also increased the absorption of iron (Fe) into the tomatoes increasing the amount of this nutrient.

However, gallium nitrate is phytotoxic to blue-green algae.
Sources: compost, basalt sand.