

## JOHN'S CORNER:

### MINERALS - The Elements and What They Do (Part 31)

by John Ferguson

**45) Rhodium (Rh)** - Rhodium is a shiny silvery white, very hard metal of group 9 on the periodic table and is the least common of the platinum group metals. As one of the rarest, it is also one of the most valuable of these metals. It is produced most often as a byproduct of refining platinum bearing ores. In a few ferromanganese minerals, it can be concentrated to 44 ppm. A few animals like crustaceans easily bioaccumulate this element up to 12 ppm.

Rhodium is found on average in the Earth's crust at 6 ppb and in igneous rocks at 1-20 ppb. In fresh and saltwater, it only occurs only in a few parts per billion (ppb).

The most common electrical or oxidation state is +3 even though it has others depending on how it is combined. There are very few rhodium-containing minerals.

European studies have found it higher along highways as rhodium is used in catalytic converters found in automobiles; in Sweden, the soils now have 40 ppb in some areas.

Rhodium is used in production of jewelry, as it is shinier than platinum and more valuable. In special tools, it is used as an alloying agent with other metals. Because of its high reflectivity, and its ability to form extremely thin layers, it is used to coat optical fibers to make them more efficient.

For years, it was thought that rhodium did not play any biologic role as the amounts in human bodies are almost below detection limits. In its elemental form, the metal is very inert and is considered harmless.



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Recent research has suggested that it plays a role in the absorption, utilization, and excretion of several metallic elements. Chemists at the University of Purdue have found that rhodium based compounds that when exposed to light can kill tumor cells and deactivate several viruses. We still have much to learn about this element.

### **Gardening and Landscaping Problems Associated with Rhodium (Rh)**

Plants contain 1-2 ppb, and almost all food plants contain 1 ppb of this element.  
Sources: coal, coal ash

**46) Palladium (Pd)** - Palladium is another member of the platinum group of metals and is a shiny, silvery-white metal which is malleable and ductile. It is found in igneous rocks at 0.01 ppm, and land animals at 0.002 ppm where it accumulates in mammalian livers and kidneys. Palladium is not very soluble hence very little is found in fresh or seawater.

Palladium is regarded as having low toxicity to humans as it is poorly absorbed and has no known biological role. Palladium chloride ( $\text{PdCl}_2$ ), was once used as a treatment for tuberculosis. Tests on rodents have shown it to be carcinogenic to them.

Palladium's main use is in catalytic converters for car exhausts; however, it is used in electronic devices from computers to cell phones. It is also used in jewelry and coinage.

In Eastern Europe where they burn sewage sludge as a disposal method, the ash has been measured to have 100-600 ppm.

### **Gardening and Landscaping Problems Associated with Palladium (Pd)**

Plants do not absorb palladium as a pure element; however, some palladium compounds are absorbed where they accumulate in the roots.

Palladium is found in the leaves of some trees at 0.4 ppm. However, some Birch trees in Canada growing near mineral deposits containing palladium have over 4,000 ppm.



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Very low levels of palladium salts will kill some plants like water hyacinth; while it does not bother most plants until 3 ppm then it affects growth.

Sources: coal, black shales, sewage sludge, sewage sludge ash, Biosolids

**47) Silver (Ag)** - Silver is a soft lustrous metal of group 11 in the periodic table and is part of the group called the "Nobel Metals".

Silver is most often found with igneous rocks, in sedimentary rocks it is found at 0.07 ppm and in soils around the world at 0.1 ppm. There is very little silver in fresh or seawater. In marine animals, silver is 3-11 ppm and less than 1 ppm in land animals.

Silver forms many silver bearing minerals as it is easily combined with other elements and is produced as a by-product of refining other metal ores. Most silver produced is a by-product of the mining of gold, copper, lead and zinc.

The most common electrical or valence state for silver is +1 and readily combines with other elements to form various minerals. Argentite, which is silver sulfide ( $\text{Ag}_2\text{S}$ ), cerargite which is silver chloride ( $\text{AgCl}$ ), arsenide which is silver arsenide ( $\text{Ag}_3\text{As}$ ) and many more, with sulfur minerals being the most common.

Silver has very high electrical and thermal conductivity (best of any metal) and is used in many electrical devices. Silver in the form of nano-particles has antibacterial properties.

Silver is used in mirrors (highest reflectivity of any metal), catalytic chemistry (since silver oxidizes easily), jewelry and much more.

Most soils range from 0.05 to 0.4 pp

m with some organic soils reaching 5 ppm. Silver occurs in the soil most often as compounds of sulfide and chloride.



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Silver can be found in soils as both a cation such as silver oxide ( $\text{AgO}^+$ ) or an anion species like silver chloride ( $\text{AgCl}_2^-$ ). Silver does not exist in soils as an element but is very mobile in the soil when combined with other elements. Bacteria, Achaea, and cyanobacteria control the solubility and precipitation of silver compounds. Some bacteria hyper accumulate silver in their spores up to 1,100 ppm.

Humic substances in the soil tend to absorb and complex silver. Humic and fulmic acids limit silver's phytoavailability. Hence, silver is more toxic in soils of low organic matter content.

Some feel that silver is not known to provide any essential function in humans as 90% of ingested silver is excreted. Others feel that silver is essential, as it is systemic disinfectant and involved with immune system support. Silver compounds are absorbed more readily as proteins like those of DNA and RNA that tend to bind to silver. Silver has anti-bacterial, anti-fungal, and anti-metabolite properties, hence a deficiency would result in an impaired immune system. A paper in the 1978 Science Digest found that silver kills over 650 disease organisms.

Silver sulfadiazine is used in most burn centers to treat injuries. It is also used to treat syphilis, cholera, herpes, and malaria.

The acid in our stomach causes silver to form a compound that precipitates out of solution where it is eliminated in our stool. As a result, silver accumulates in sewage sludge where over 360 tons of silver is dumped into our streams every year. Sewage sludge and compost made from Biosolids is a major source of silver contamination when applied to soils.

### **Gardening and Landscaping Problems Associated with Silver (Ag)**

Plants can absorb silver in its soluble forms, which then enters the roots vascular systems where it is transported to other parts of the plant.

The amount of silver in plants varies greatly where most plants have 1 ppm silver or less in their tissues. However, there are some accumulator plants where the level of silver can reach 100 ppm. Root



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exudates of cyanogenic plants are known to dissolve silver from soil minerals. For most plants, the amount of silver in them is closely related to the amount of silver in the soil.

Some fungi (ectomycorrhizal and saprobes) can accumulate silver to 20-30 ppm and up to 235 ppm have been measured.

Too much silver in the soil leads to toxicity like necrosis, wilting in the leaves by loss of turbidity. Often yields and growth are reduced, without any visible symptoms. Excess silver can also prevent plants from absorbing other cation's, like potassium, cobalt, copper, iron, calcium, etc.

Sources: sewage sludge, composted Biosolids, wastewater from sewage treatment plants.