Opinion

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# Bioleaching: Microorganism Metal Solubilisation

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## Opinion

Bioleaching is the process of extracting metals from their ores using live organisms. This is far more environmentally friendly than the classic cyanide heap leaching method. To recover copper, zinc, lead, arsenic, antimony, nickel, molybdenum, gold, silver, and cobalt, bioleaching is one of various applications under bio hydrometallurgy. Bioleaching is a straightforward and efficient method of extracting metals from low-grade ores and mineral concentrates. The activity of chemolithotrophic bacteria, primarily *Thiobacillus ferrooxidans* and *T. thiooxidans*, converts insoluble metal sulphides into soluble metal sulphates, allowing metal recovery from sulphide minerals. Heterotrophic bacteria and fungi can handle non-sulfide ores and minerals. Metal extraction occurs in these circumstances as a result of the synthesis of organic acids as well as chelating and complexing substances that are excreted into the environment.

Bioleaching is currently used mostly for the recovery of copper, uranium, and gold, with heap, dump, and in situ leaching being the most common processes used. For the treatment of refractory gold ores, tank leaching is used. Metal recovery and detoxification from industrial waste products, sewage sludge, and heavy metal-contaminated soil are also possible using bioleaching. Metal recovery from low-grade ores and concentrates that cannot be handled cheaply using conventional methods is increasingly being done using microbial leaching technologies. As with many biotechnological processes, such technologies may have been employed since prehistoric times, and copper from mine water was most likely recovered by the Greeks and Romans more than 2000 years ago. However, bacteria are primarily responsible for the enrichment of metals in water from mineral deposits and mines, which have only been known for roughly 50 years. The process of solubilisation is known as bioleaching, and it occurs naturally wherever favourable conditions for the growth of the ubiquitous bioleaching bacteria exist.

## Some microorganisms involved are:

***Thiobacillus:*** *Thiobacillus* is the genus of bacteria that is most active in bioleaching. These rods are Gram-negative and do not generate spores, and they develop in aerobic environments. The majority of *Thiobacilli* are chemolithoautotrophic, meaning they use carbon dioxide from the atmosphere to synthesise new cell material.

***Leptospirillum***: Another acidophilic obligately chemolithotrophic ferrous iron oxidising bacteria, *Leptospirillum ferrooxidans*, was initially isolated from Armenian mine fluids by Markosyan. This microbe is more susceptible to copper and unable to oxidise sulphur or sulphur compounds than *T. ferrooxidans*, although it can handle lower pH levels and higher quantities of uranium, molybdenum, and silver. As a result, *L. ferrooxidans* cannot attack mineral sulphides on its own. Only *T. ferrooxidans* or *T. thiooxidans* can be used for this.

**Thermophilic bacteria:** Th-bacteria, also known as *Thiobacillus*-like bacteria, are moderately thermophilic bacteria that thrive on pyrite, pentlandite, and chalcopyrite at temperatures around 50°C. The energy source is ferrous iron; however growth is only visible in the presence of yeast extract. Brierley, Norris, Karavaiko, and their colleagues identified extremely thermophilic bacteria that can grow at temperatures above 60°C. *Acidianus brierleyi*, formerly associated with the genus *Sulfolobus*, is a chemolithoautotrophic, facultatively aerobic, extremely acidophilic Archaeon growing on ferrous iron, elemental sulphur and metal sulfides.

## Mechanisms of bioleaching

Currently, bioleaching procedures rely almost entirely on the activity of *T. ferrooxidans*, *L. ferrooxidans*, and *T. thiooxidans*, which convert highly soluble metal sulphides into water-soluble metal sulphates by biochemical oxidation reactions. Metals can be liberated from sulphide rocks by direct and indirect bacterial leaching in theory.

**1. Bacterial leaching directly:** In direct bacterial leaching, the bacterial cell comes into physical contact with the mineral sulphide surface, and the oxidation to sulphate is catalysed by numerous enzymes.

**2. Bacterial indirect leaching:** In indirect bioleaching, microorganisms produce a lixiviant that oxidises the sulphide mineral chemically. This Lixiviant is ferric iron in acid solution, and metal solubilisation occurs.

Microbial leaching of non-sulfide ores, which lack an energy source for bacteria to feed on, poses a new problem that must be addressed. Bioleaching of non-sulfide ores and minerals is a viable option for recovering important metals from ores and minerals, as well as benefiting mineral raw materials. Technically possible methods, on the other hand, will not necessarily be regarded economically attractive, at least not at this time.

Refined sugars, for example, are too expensive as carbon sources for technical leaching since they are utilised in the laboratory as substrates for the growth of heterotrophic bacteria. Bioleaching isn't being regarded solely for its potential to recover valuable metals when it comes to the recovery of valuable metals today. There is a demand for processes that are less expensive and more environmentally friendly. In terms of both technical and biological issues, more progress is required. The latter entails boosting the rate of leaching as well as microorganism tolerance to heavy metals.