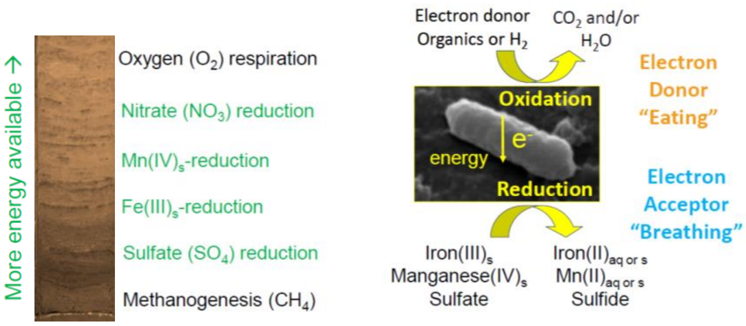
Dr Laura Newsome (Camborne School of Mines): Making microbes work for us

Laura Newsome

Dr Newsome began her fascinating presentation by describing the range, abundance, tolerance and metabolic capabilities of microbes, which include bacteria, archaea, fungi, protozoa, algae and viruses. Archaea and bacteria are single-celled, the rest are multi-celled – and all are extremely tiny, as small as 1µm (1/1000 mm) in diameter.

What microbes lack in size, they make up for in abundance. Bacteria alone have a combined mass on Earth equivalent to 50 million blue whales. Archaea produce 90% of the world's methane. And, although it wasn't discovered until 2002, the bacterium *Pelagibacter ubique* turns out to be the most abundant free-living organism known.

Microbes thrive in different conditions varying from alkaline chalk to acid sulfidic rocks. They live in communities and can multiply in almost any environment where there is free water, even deep within rocks. The vitality of microbes is expressed by their ability to metabolise. They "eat" by taking up energetic electrons and "breathe" by giving up electrons. In the sediment column, microbes in the oxygen-rich environment at the top will metabolise rapidly. Lower down, others will reduce other compounds, such as manganese IV and iron III, releasing less energy. At the bottom, methanogenesis maintains small single-celled prokaryotic archaea – a metabolic style likened to "living on lettuce".



Microbial metabolism

Image courtesy of Dr Laura Newsome with sediment column from Hannes Grobe [CC BY (https://creativecommons.org/licenses/by/3.0)]

By changing the oxidation state of metal ions and hence their solubility, microbes can change the partitioning of metals between water, soil and rock. This allows mining of a target or decontamination of a toxic site. Dr Newsome's research concerns biomining of cobalt, decontamination of the Sellafield nuclear site and the nature and tolerance of the microbial community in former metal and coal mines.

To make the microbes work, you have to feed them. An example of this with adverse effects for humans is seen in Bangladesh where weathering of arsenopyrite leads to the accumulation of arsenic (V) and iron oxyhydroxides in aquifers. Organic matter in the form of agricultural waste feeds microbes and stimulates the reduction of iron oxyhydroxides, releasing arsenic to groundwater and exposing the population to dangerous amounts.

Bacteria that can oxidise metals and sulfides are currently used to mine about 15% of copper and 5% of gold globally. But an element that is increasingly in demand, for uses ranging from wind turbines to electric car batteries, is cobalt. Dr Newsome has found that 64% of available cobalt can be extracted from laterites by sequentially increasing acidity in the presence of a consortium of bacteria including laboratory-grown *Geobacter sulfurreducens*. Also that by increasing the levels of organic substrates, such as glucose, some bacteria will reduce manganese and release the associated cobalt into solution. Dr Newsome has now proposed a two-step technique using glucose and acetic acid to promote microbial extraction of cobalt.

Microbial metabolism can control how metals behave in the environment, and we can stimulate these processes to precipitate metals and form minerals, or to solubilise metals and minerals.

Dr Newsome showed that these reactions are not only useful for mining metals but can also be used to clean up metal contamination. At Sellafield in Cumbria, *Serratia* sp. are present in the soil and, when fed fumarate and glycerol, precipitate uranium from groundwater. If this reaction can be encouraged underground it could prevent leaching of uranium from contaminated areas. Aseptic sampling from former lead mines in the Mendip Hills shows that there are prokaryotes and fungi known to be oxidisers of manganese (II) present. Also, heavily iron-polluted mine waters in Saltburn, Yorkshire have been treated in settlement ponds where bacterial reactions precipitate the metal and the resulting fluid is further cleaned by passing through reed beds.

Bill Hinton and Mike Grover