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# Lake Pavin is a microbial mineralization oasis

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Lake Pavin (Massif Central, France) is a permanently redox-stratified crater lake, with anoxic and ferruginous deep waters extending between 50-55 and 92 m in depth (monimolimnion), and topped by oxic waters (mixolimnion). The strong chemical gradients over several meters deep is prone to the successive mineralization of silica, phosphates, carbonates, and metals and sulfur-bearing containing phases, which is strongly influenced by microbial activities (*1*). While the oxic-anoxic transition zone (OATZ) is technically very challenging to study in sediments, the several meters large OATZ of the water column offers optimal conditions to explore the geochemical and biological drivers of biomineralization for several biological and chemical species. In a few decades, this peculiarity has made Lake Pavin a key natural laboratory for researchers from various disciplines including geochemistry, geomicrobiology.

Starting in 2015, this lake revealed an oasis of bacteria forming intracellular phases of various chemical composition, thanks to their ability to move along magnetic field lines (Figure 1) (*2*). These magnetotactic bacteria (MTB) couple the biomineralization of ferrimagnetic crystals with chemoaerotaxis to navigate more easily through the OATZ. Several field campaigns supported by microbiologists, mineralogists and geochemists not only allowed to characterize that type of biomineralization, but also revealed using a combination of light, electron microscopies techniques and X-rays spectroscopy analyses various other intracellular phases. Here, we propose to review these recent discoveries including the development of a specific sampling strategy of the water column combined with *in situ* geochemical measurements and microbiology (*2*). Several models will be introduced, including polyphosphate hyperaccumulating bacteria (*3*, *4*) and the broad diversity of MTB (*5*) and non-MTB (*6*) forming intracellular amorphous carbonates. These results will be discussed as well as the contribution of these microbial mineralization to geochemical cycles of the lake.

**Reference**

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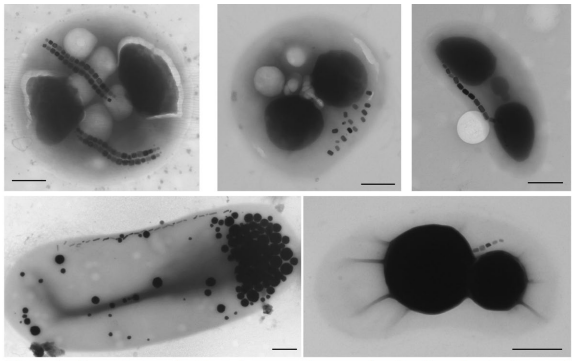

Figure 1. Transmission electron microscope images showing the ultrastructure and organization diversity of biominerals (electron dense inclusions) observed in magnetotactic bacteria from Lake Pavin. Scale bars represent 0.5 µm.