

## Silver nanoparticles: Biosynthesis and comparative toxicity on Gram-ve and Gram+ve bacteria

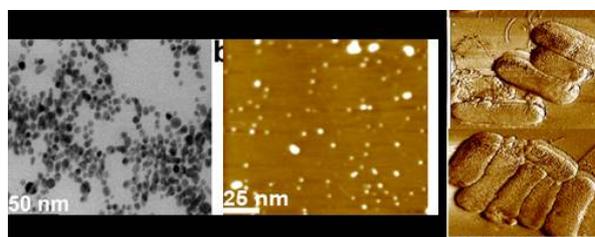
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The biosynthesis of extracellular silver nanocrystallites of well-defined composition and homogeneous morphology utilizing *Shewanella oneidensis* MR-1, upon incubation with aqueous silver nitrate solution is reported.



**Figure 1:** TEM and AFM images of silver nanoparticles and their interaction with bacteria.

Characterization of these particles revealed that the crystals consist of small, reasonably monodispersed spheres in the 2–11 nm size range (average of  $4 \pm 1.5$  nm). The bactericidal effect of these nanoparticles is compared to similar chemically synthesized silver nanoparticles and assessed using *E. coli* and *B. subtilis*. Relative toxicity was based on the diameter of inhibition zone in disc diffusion tests, minimum inhibitory concentrations, Live/Dead assays, and atomic force microscopy. A clear synthesis, and a surface coat- and strain- dependent inhibition were observed. Biogenic-Ag was found to be more toxic when compared to colloidal-Ag for both *E. coli* and *B. subtilis*. *E. coli* was found to be more resistant to either of these nanoparticles than *B. subtilis*. In contrast, Oleate-Ag was not toxic to either of the bacteria. These findings have implications for the potential uses of Ag nanomaterials and for their fate in biological and environmental systems.

## H<sub>2</sub> generation during simulated earthquake faulting: Its implication for subsurface microbial evolution

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Since the discovery of deep-sea hydrothermal vents in the late 1970s, the most ancient microbial ecosystems are considered to evolve at habitable environments in the vicinity of H<sub>2</sub>-rich hydrothermal fluids (e.g. Russell & Hall, 1997). In the modern ocean, the H<sub>2</sub>-rich hydrothermal fluids that are observed along the slow-spreading Mid Ocean Ridges (MOR) are most likely to be provided by the ultramafic rock-water reaction (e.g. Seyfried *et al.* 1979). However, such H<sub>2</sub>-rich fluids can be also found at the East Pacific Rise (EPR) where ultramafic rocks are not exposed. In this study, we hypothesized that the H<sub>2</sub>-rich fluids at the EPR are produced during the seismic events in basaltic rocks, and that the H<sub>2</sub> generation associated with seismic faulting could contribute to sustaining the subsurface biological communities.

In order to confirm above hypotheses, we performed laboratory friction experiments on basalt, dunite and granite at normal stresses of 0.5~2 MPa, slip velocities, *V*, of 0.09~1.6 m/s (nearly coseismic slip rates) and displacements of up to 10 m using a rotary-shear apparatus. Slip on the simulated fault was conducted within a small pressure vessel that was filled with air. Hydrogen gas released during experiments was measured by a micro gas chromatograph which was directly connected to the pressure vessel. The main findings of our preliminary experimental work are: (1) the amount of H<sub>2</sub> gas increased almost linearly with frictional work energy. The amount of H<sub>2</sub> generation in granite samples is a few times higher than that of basalt. (2) When a few drops of distilled water were added to the sliding surfaces, the H<sub>2</sub> production was enhanced for all rock types. (3) When the wet basalt specimen was sheared at *V* of 1.6 m/s corresponding to a total mechanical work energy of ~2.8 kJ (calculated as shear stress multiplied by displacement), the H<sub>2</sub> gas of ~3.2E<sup>-7</sup> mol was released from the simulated fault.

In terms of frictional work energy during seismic faulting, the total work energy of several kJ applied on the simulated fault in our experiments corresponds to an earthquake moment magnitude, *M<sub>w</sub>* of ~5. Enormous number of such small earthquakes (*M<sub>w</sub>* <1) currently occurs along the MORs (i.e. Bohnenstiehl *et al.* 2008). Based on the experimentally-determined correlation between H<sub>2</sub> production and frictional work energy, estimated H<sub>2</sub> release during an earthquake with *M<sub>w</sub>*=1 is the order of mmol. Although further careful consideration is needed to evaluate the contribution of earthquake related H<sub>2</sub> generation to the microbial ecosystems, our results imply that H<sub>2</sub> generation due to seismic faulting could possibly affect the evolution of subsurface microbes.