# Life underground: Energetics and microbial diversity in a gold mine

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Understanding the extent of life in the deep subsurface is critical for quantifying the environmental scope and metabolic diversity of life on Earth. To this end, the NASA Astrobiology Institute *Life Underground* is targeting the continental subsurface biosphere, including at the Sanford Underground Research Facility (SURF) in the former Homestake Gold Mine, SD, USA. At this site, 500 km of tunnels cut through metamorphosed paleoproterozoic iron formation host rock to a depth of 8100 ft [1]. Mine drifts and boreholes can intersect subsurface aquifers, allowing for direct sampling of otherwise inaccessible environments.

Geochemical analyses of borehole fluids and pools from the 300 to 4850 ft levels of the mine have revealed enormous geochemical diversity. Fluids ranged from fresh to brackish, correlating with a transition from oxidizing to reducing conditions (ORP 330 to -275 mV). The concentration of redox sensitive species also varies considerably (e.g. $Fe^{2+}$ bdl to 6.2 mg/L and $S^{2-}$ 7 to 305 μg/L). The composition of these fluids reflects mixing between isolated subsurface fluids and fresher meteoric fluids [2]. Variable geochemical composition produces wide-ranging energetic yield for chemolithotrophic microbial metabolisms. Many reactions range from highly exergonic to endergonic depending on location. Extrapolated across the mine footprint, this suggests a complex spatial mosaic of potential subsurface primary productivity.

DNA sequencing was performed on filtered borehole fluid and *in situ* microbial biofilms. These data reveal diverse microbial communities including chemolithoautotrophs, some with significant homology to previously reported subsurface strains [3,4]. Despite low water temperatures (10 to 32.2 °C), a number of thermophilic genera are present, suggesting either local adaptation to low temperature or fluid flow from warmer, deeper environments. Comparison of energetic and phylogenetic data will be used to unravel biogeochemical cycling at each site and extrapolate to the local subsurface.

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