

ACTIVITY OF THE ENZYME HYDROGENASE AS A PROXY FOR HYDROGEN METABOLISM IN DEEPLY BURIED SEDIMENTS, AND AS A DIAGNOSTIC TEST FOR LIFE.

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The microbial communities that inhabit deeply buried sediments are of considerable interest to geochemists and astrobiologists because they are important in terrestrial biogeochemical cycles, and can serve as models for extraterrestrial ecosystems. The metabolic rate of these communities can be extremely low and is therefore difficult to measure directly; this issue is a current challenge in terrestrial deep biosphere studies, and is relevant to life-searching space missions.

Hydrogen gas (H₂) is a key intermediate in anaerobic metabolism, because it is produced and utilized by a large number of organisms, and because it acts as a metabolic link between microbes with very diverse substrate requirements. The importance of H₂ suggests the hypothesis that enzymatic (catalytic) activities related to its metabolism might be good indices of overall microbial community metabolism. Thus, an assay to measure H₂-related enzymatic activities would be very valuable for deep biosphere studies, and if sensitive enough, it might be useful as an exploratory tool for the presence of life. To test this hypothesis, we are developing a radiotracer assay for *Hydrogenase*, an enzyme that all H₂-producing and H₂-consuming microbes possess.

The method relies on the known ability of hydrogenase to catalyze an isotopic exchange between dissolved H₂ and the hydrogen atoms in water. This property has been exploited for water column measurement of hydrogenase with tritium gas as tracer (Schink et al, 1983), but has never been applied to sediments. To simulate sediment with low microbial activity, a dilute slurry of local coastal sediment is used as the test material. The slurry is incubated under a tritiated H₂ headspace, sampled over time, and scintillation counted. With high partial pressure of H₂ (0.5 atm) the rate of accumulation of tritium in the sediment slurry is proportional to the amount of enzyme present. Currently, the assay can measure hydrogenase activity routinely in a 1:10,000 sediment dilution. Work in progress is focused on further increasing the sensitivity of the assay. The set-up has been adapted for future deployment in an International Ocean Drilling Program expedition. With appropriate modifications (e.g. use of deuterium mass spectrometry), this simple and sensitive technique might be applicable to planetary exploration.

References

Schink B., Lupton F.S., and Zeikus J.G. (1983). Radioassay for hydrogenase activity in viable cells and documentation of aerobic hydrogen-consuming bacterial living in extreme environments. *Applied and Environmental Microbiology*, **45** (5) 1491-1500.