



### **Apparatus for Cold, Pressurized Biogeochemical Experiments**

**Bacteria are grown under conditions imitating those at ocean depths.**

*NASA's Jet Propulsion Laboratory, Pasadena, California*

A laboratory apparatus has been devised as a means of studying plausible biogeochemical reactions under high-pressure, low-temperature aqueous, anaerobic conditions like those conjectured to prevail in a liquid water ocean on Europa (the fourth largest moon of the planet Jupiter). The experiments to be performed by use of this apparatus are intended to enhance understanding of how life (if any) could originate and evolve in the Europa ocean environment. Inasmuch as terrestrial barophilic, psychrophilic organisms that thrive under anaerobic conditions are used in the experiments, the experiments may also contribute to terrestrial biogeochemistry.

The apparatus (see figure) includes a bolt-closure reaction vessel secured inside a refrigerator that maintains a temperature of 4 °C. Pressurized water is supplied to the interior of the vessel by a hydrostatic pump, which is attached to the vessel via high-pressure fittings.

The terrestrial organisms used in the experiments thus far have been several facultative barophilic, psychrophilic stains of *Shewanella* bacteria. In the experiments, these organisms have been tested for reduction of ferric ion by growing them in the presence of a ferric food source under optimized terrestrial conditions. The short-term goal of these experiments has been to select *Shewanella* strains that exhibit iron-reduction capability and test their ability



This **Laboratory Apparatus** is used to study biogeochemical reactions in liquid water at high pressure and low temperature. Bacterial specimens are loaded from the top of the vessel into sample cells equipped with 0.2- $\mu$ m filters. The vessel is filled with water, air is vented from the top through a valve, and then the water is pressurized to 5 kpsi (=34 MPa).

to facilitate biogeochemical reduction of iron under temperature and pressure conditions imitating those in Europa's ocean. It is anticipated, that, once growth under Europa-like conditions has been achieved, the selected *Shewanella* strains will be used to facilitate biogeochemical reactions of sulfate and carbonate with hydrogen gas. Any disequilibrium of the products with the

environment would be interpreted as signifying biogenic activity and the possibility of life in Europa's ocean.

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### **Growing B Lymphocytes in a Three-Dimensional Culture System**

**Cells grown in this system live long and closely resemble in vivo cells.**

*Lyndon B. Johnson Space Center, Houston, Texas*

A three-dimensional (3D) culture system for growing long-lived B lymphocytes has been invented. The capabilities afforded by the system can be expected to expand the range of options for immunological research and related activities, including testing of immunogenicity of vaccine candidates *in vitro*,

generation of human monoclonal antibodies, and immunotherapy.

Mature lymphocytes, which are the effectors of adaptive immune responses in vertebrates, are extremely susceptible to apoptotic death, and depend on continuous reception of survival-inducing stimulation (in the

forms of cytokines, cell-to-cell contacts, and antigen receptor signaling) from the microenvironment. For this reason, efforts to develop systems for long-term culture of functional, non-transformed and non-activated mature lymphocytes have been unsuccessful until now.