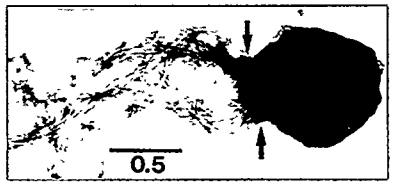
1995 Research at Pacific Northwest led to the development of an in situ redox manipulation technique to immobilize or destroy selected contaminants in ground water. The technique would be promptly applied at DOE sites to clean up ground water contaminated with chromium.

1995 OHER conceived the Natural and Accelerated Bioremediation Research program, a multidisciplinary program designed to enhance the potential of bioremediation as a useful, reliable, and cost-effective technique for cleaning up contaminated environments.

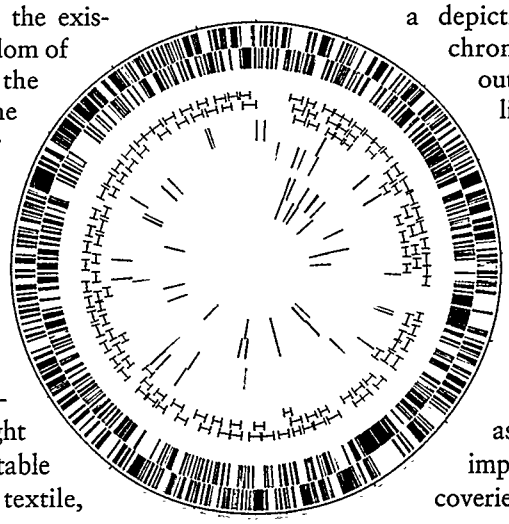
1995 Livermore researchers contributed a news-making analysis to the second Intergovernmental Panel on Climate Change Scientific Assessment: The "balance of evidence suggests a discernible human influence on climate."

1995 Field experiments at Oak Ridge, Kansas State University, and the Smithsonian Institution on plant responses to elevated CO_2 demonstrated enhanced plant growth and productivity and increased carbon sequestration by ecosystems.

DEEP SECRETS



■ In 1996 scientists supported by the DOE's Microbial Genome Program reported the complete genome sequence of *Methanococcus jannaschii,* a methane-producing microorganism that dwells around "white smokers" on the seafloor. The details of the genome confirm the existence of a third kingdom of living organisms, the Archaea (from the Greek word for "ancient"), distinct from other microbes lacking a cell nucleus, as well as higher plants and animals. Details of the genome and the proteins it codes for might well lead to heat-stable enzymes for the textile, paper, and chemical industries; to systems that produce methane for chemical feedstock and renewable power; and even to tailor-made proteins that rid living cells of toxic contaminants. Shown above is a photomicrograph of the microbe itself; at left a depiction of its circular chromosome. The two outer rings of colored lines show the predicted protein-coding regions. The sequencing of *M. jannaschii* was prominently described in the *New York Times* and was chosen by *Discover* magazine as one of the two most important scientific discoveries of the year. ■



waste contaminated by toxic metals. The metals, even uranium, form water-soluble complexes with the citric acid, allowing them to be precipitated by bacteria or, in the case of uranium, by light. The usual products are a relatively small volume of recoverable metal and clean, reusable soil. Apart from its use at contaminated DOE sites, this process has been used successfully to remove cadmium and lead from municipal incinerator ash.

Two other recent thrusts likewise underscore the likely value of microorganisms. First was a careful look underground. In the mid-eighties, a program was inaugurated to explore the deep subsurface environment for microorganisms that might be useful in new bioremediation strategies. Microbiologists, geohydrologists, and geochemists from about thirty universities and national laboratories took part, probing deep beneath the surface at Savannah River, Hanford, and the Idaho National Engineering Laboratory, as well as non-DOE sites. As a result, previously unknown microbes and microbial ecosystems have come to light, including ecosystems that have been isolated for hundreds of millions of years, microbes that thrive at 60 degrees Celsius (140 degrees Fahrenheit) in brine twice as salty as the sea, and nonphotosynthetic bacteria whose only energy source appears to be the hydrogen produced in reactions between water and rock. The resulting Subsurface Microbial Culture Collection, housed at Florida State University, has attracted wide scientific attention—including the interest of pharmaceutical companies, for whom the collection has significant potential market value as an aid to drug screening and discovery.

Direct descendants of this program have included highly successful bioremediation schemes. During demonstrations in the early nineties, underground organic contaminants at Savannah River were effectively eliminated