The U.S. Geological Survey
Recent Highlights—*Environment*

U.S. Department of the Interior | U.S. Geological Survey

Introduction

Our Nation's environment—the air, water, soil, and plant and animal life—is constantly changing as natural processes and human actions affect it. The issues facing our society have become increasingly complex, demanding new approaches and partnerships. The new U.S. Geological Survey (USGS), with the incorporation of the former National Biological Service as our Biological Resources Division, is uniquely able to integrate the physical and biological sciences to provide the understanding and scientific information needed to recognize and mitigate adverse impacts and to sustain the environment. USGS activities in the environment theme area include studies of both natural processes and the results of human actions, data collection, long-term assessments, ecosystem analysis, predictive modeling, and process research on the occurrence, distribution, transport, and fate of contaminants. Science has an important role to play in helping society make informed decisions about our environment.

Mississippi River—Assessment of Water Quality

The Mississippi River System drains water from 31 States and is the source of 23 percent of the public surface water supply for the United States. In 1987, the USGS began the Nation's first systematic water-quality study that eventually covered the entire length of the Mississippi River. In conducting this study, the USGS made use of new technology for representative sampling of large rivers that it had developed in studies of the Amazon and Orinoco Rivers. Initially the study was started to assess the water quality of the Mississippi River System below St. Louis, including an assessment of the contributions from the Missouri and Ohio Rivers. In 1991, the study was expanded to cover the entire Mississippi River System. USGS scientists coordinated their activities with various States along the Mississippi

Confluence of the Ohio and Mississippi Rivers at Cairo, Illinois. Note contrasting appearance between sediment-laden Ohio River and clearer Mississippi.

River, as well as with the U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers, and with members of the Upper Mississippi River Basin Association, the Upper Mississippi River Conservation Commission, and the Interstate Council on Water Policy. Following are some of the findings of this study:

- Concentrations of agricultural contaminants—pesticides and nutrients—in the river vary seasonally and are greatest following rainstorms that occur soon after they are applied to croplands.
- The discharge of high concentrations of nitrate into the Gulf of Mexico accentuates the cycle of fertilization, decay, and oxygen depletion in the offshore waters of Louisiana.
- More than 40 pesticides and pesticide degradation products were detected in the Mississippi River. Although the maxi-mum concentrations of a few pesticides, including atrazine, the most extensively used herbicide, may occasionally exceed the Environmental Protection Agency's (EPA) Maximum Contaminant Levels, the annual average concentrations of these compounds are well below health-based limits and do not violate the Safe Drinking Water Act.
- Overall sewage contamination has decreased in the Mississippi since the enactment of the Clean Water Act of 1972.
- EDTA, a general indicator of industrial contamination, was only about one-fourth of the concentration found in some major European Rivers.
- PCB's persist in Mississippi River sediments even though their disposal in the river was banned some 15 years ago.

A copy of the USGS Circular 1133, "Contaminants in the Mississippi River, 1987-1992," may be obtained from:

USGS Information Services
Box 25286
Denver Federal Center
Denver, CO 80225

Science in the Parks: Providing Informa-tion to Preserve the Environment of America's Treasures

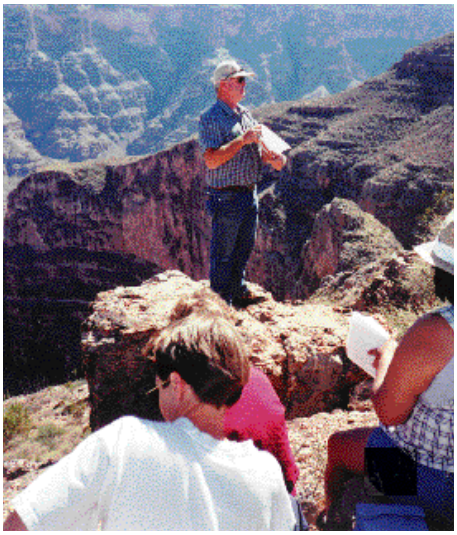
The USGS is working with the National Park Service (NPS) in more than 250 parks, monuments, national rivers, and recreation areas to address a fascinating

variety of environmental and management questions about their water resources, geology, biology, and ecology. For example, USGS scientists and their counterparts in the NPS and other agencies are investigating the link between fish endocrine system anomalies and pesticides and organic chemicals in the Lake Mead National Recreation Area (NRA). Endocrine-system disruption may result in diminished sexual development and reproductive capability and may affect both wildlife and people. The NPS managers will use this information to ensure continued safe fishing, swimming, and boating in Lake Mead. This investigation is one of many being conducted under a partnership between the USGS National Water Quality Assessment Program and the NPS.

How many acres of grizzly bear habitat are protected by the NPS? How many areas are susceptible to gypsy moth infestation in Southern Appalachian parks? How much and what kind of vegetation was lost in the recent fires at the Santa Monica Mountains NRA? These are the kinds of practical questions that are important to park managers in the NPS. To answer such questions, information about the presence and distribution of resources is essential. The USGS's Technology Transfer Center is working with others to provide the NPS with information developed through extensive field work and aerial photography, including mapping the composition and distribution of vegetation for more than 200 park units. This information will allow the parks to document and manage plant communities and animal habitats, predict the behavior of wildland fires and insect infestations, and monitor changes to the environment over time.

In South Florida, the USGS is working in the Everglades, Biscayne, and Dry Tortugas National Parks, investigating potential impacts of climate change, sea-level rise, and hurricanes on the health and distribution of mangrove species and forests. Scientists have conducted field surveys to monitor plant growth and changes of mangrove sites affected by Hurricane Andrew. The USGS developed a mangrove simulation model, MANGRO, to predict the effects of climate change and hurricanes on future mangrove forest growth and development.

The geologic heritage of the parks is



USGS geologist George Billingsley explains the Paleozoic history of the southwest as seen from the rim of the Grand Canyon.

being highlighted through newly designed geologic displays for visitor centers, staff training, curriculum development, television programming, and book production. Visitor centers at the Grand Canyon National Park, Lake Mead NRA, and Golden Gate NRA are being redesigned, in partnership with the USGS, to emphasize the geologic histories of the parks.

At the Grand Canyon, USGS geologists have participated in the production of television programming for elementary students, led training field trips for earth science teachers and NPS staff, and partnered with the park education specialist in assembling teaching materials for elementary schools.

The USGS provides base digital cartographic data such as orthophoto quadrangles, elevation models, digital line graphs, and raster graphics to the NPS on a cost-share basis to support the NPS Inventory and Monitoring Program geographic information system (GIS) database. The GIS will be used by park managers to identify alternative courses of action, assess trade offs, and evaluate the consequences of these actions. The base cartographic information provided by the USGS is the foundation for other thematic layers of information. More than 100 parks have completed their data requirements and data for approximately 30 parks are in production at this time.

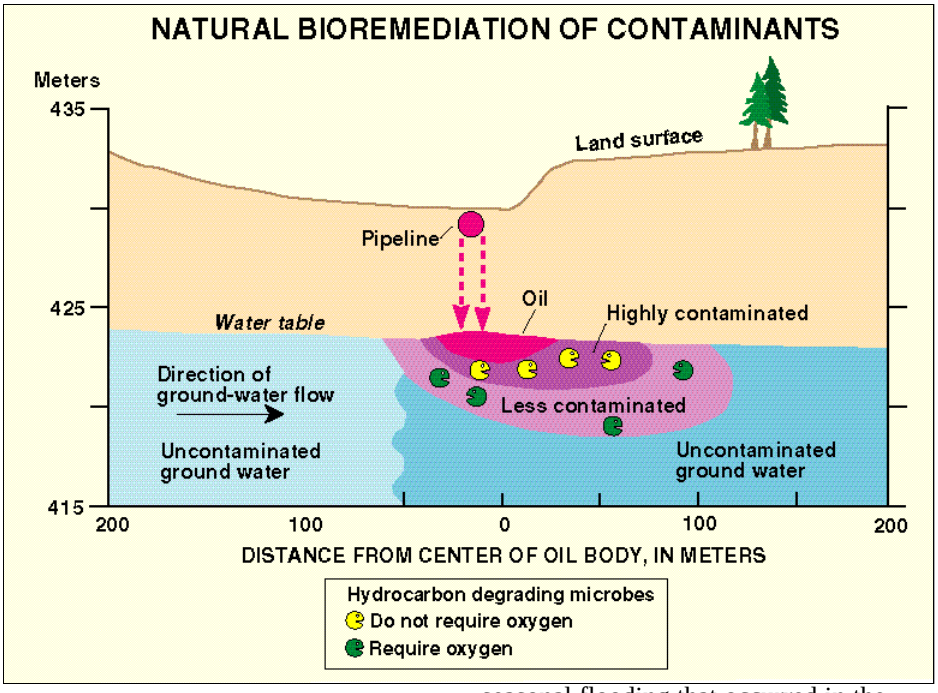
Nature's Way to a Cleaner Environment

The ancient Romans were the first people to design and build drainfields for dis-posing of sewage wastes. In doing so, the Romans were taking advantage of natural attenuation, or the ability of the bacteria living in soils and aquifers to naturally cleanse and renovate contaminated water.

All soils and aquifers contain microorganisms that assimilate and detoxify contaminants. However, the ability of microorganisms to perform this useful function varies widely from place to place and for different kinds of contaminants. Centuries of trial and error have taught engineers how to use natural attenuation to detoxify sewage wastes. Until recently, however, little was known about how effective natural attenuation might be in detoxifying petroleum hydrocarbons or chlorinated solvents—chemicals that have contaminated ground water at thousands of sites nationwide.

Scientists from the USGS have now developed practical methods for assessing the effectiveness of natural attenuation to treat ground water contaminated with petroleum hydrocarbons and solvents. They found that when biodegradation processes are fast relative to how fast ground water is flowing (see diagram on next page), natural attenuation can be as effective—or even more effective—than much more expensive remediation technologies. In these cases, contami-nants are naturally contained and pre-vented from reaching nearby wells
or wetlands where they could threaten humans or wildlife.

For example, in 1990 approximately 10,000 gallons of jet fuel leaked from a storage tank at the Marine Corps Air Station in Beaufort, S.C. To remediate this spill, conventional air sparging technology was estimated to cost about $600,000. Studies by the USGS, however, showed that natural attenuation processes were effectively confining contaminated ground water and that the spill posed no environmental or health hazard. As a result, the Marine Corps achieved regulatory closure of this site using natural attenuation and continuous environmental monitoring at a cost of less than $60,000. The economic savings generated by using this new technology at this site were so impressive that the Marine Corps was awarded the prestigious Environmental Sustainability Award by the nationally recognized environmental group Renew America.



At the Naval Air Station Cecil Field, near Jacksonville, Fla., a spill of chlorinated solvents was slated to be cleaned up with conventional pump-and-treat technology at a cost of more than $800,000. The USGS demonstrated that natural attenuation processes would be equally effective in cleaning up the site, at a total cost of less than $100,000. This site has also attained regulatory closure with natural attenuation and environmental monitoring as the sole remedial technology.

Natural attenuation is an expression of the Earth's inherent capacity to absorb and detoxify environmental contamination. When this capacity is accurately assessed and wisely used, it can save tremendous amounts of public resources. **It is estimated that this technology can save as much as a billion dollars over 5 years** at Department of Defense sites alone. As a leader in developing methods for assessing the efficiency of natural attenuation, the USGS has contributed, and will continue to contribute, to conserving these public resources.

Colorado River Experimental Flood

At 2:00 p.m. on March 13, 1963, the gates of Glen Canyon Dam swung shut. The Colorado River and Grand Canyon would never be the same. In the early morning hours on March 26, 1996, an experiment began to try to undo some of the undesirable environmental impacts of the Glen Canyon Dam. An experimental, controlled flood was done to simulate the seasonal flooding that occurred in the Colorado River basin under natural conditions prior to construction of the Glen Canyon Dam in northern Arizona. USGS scientists have long been studying the changes in river channels caused by dams. These changes have major impacts on fish habitat, stream bank vegetation, and opportunities for recreation. The causes of these changes include the cutting off of natural sediment supplies by the dam and the timing and magnitude of water releases from the reservoir. Water released by Glen Canyon Dam carries almost no sediment. Any sediment along the Colorado River below the dam was either already present when the dam was built or has since been brought in by tributaries below the dam.

USGS scientists have made major advances in understanding the processes responsible for the building and erosion of beaches and sandbars along rivers, the long-term storage and transport of sediment in the river, and the supply of new sediment from tributaries. These advances are now being applied to the Colorado River.

On the basis of USGS computer models, which predicted that controlled flooding could replenish beaches that had deteriorated after construction of Glen Canyon Dam, the flood was planned in cooperation with the Bureau of Reclamation and the NPS. The management objective of the controlled flood experiment was to restore some ecosystem features, such as sediment deposits (beaches), endangered fish habitat, and other natural resources. Preliminary results indicate that sand was mobilized from the channel bottom and deposited in eddies and along the channel margins. Beaches were formed or enlarged throughout the system, even in Marble Canyon where the sand supply was thought to be most depleted.

The USGS preliminary findings suggest that the majority of sediment redeposition occurred in the first 2-3 days of the experiment. This finding, when verified, will have valuable management implications that may permit future controlled floods to be of much shorter duration and

Example of newly formed sandbar along the Colorado River 2 weeks after the controlled flood.

therefore substantially less costly. Understanding how sand and sediment move through our river systems is a

major concern across the country for many reasons, including preservation of depositional features like the Colorado River beaches, maintenance of navigational channels, and retention and movement of pollutants such as DDT long after their use has stopped. The controlled flood experiment on the Colorado River will have benefits across the country, as it will yield information that is needed to expand the usefulness of models employed to predict the effects of higher flows on other rivers in the country.

Dams have profound but varied impacts on the rivers that they harness. More information on the downstream effects of dams can be obtained from the newly released USGS Circular 1126, "Dams and Rivers," Primer on the Downstream Effects of Dams available from:

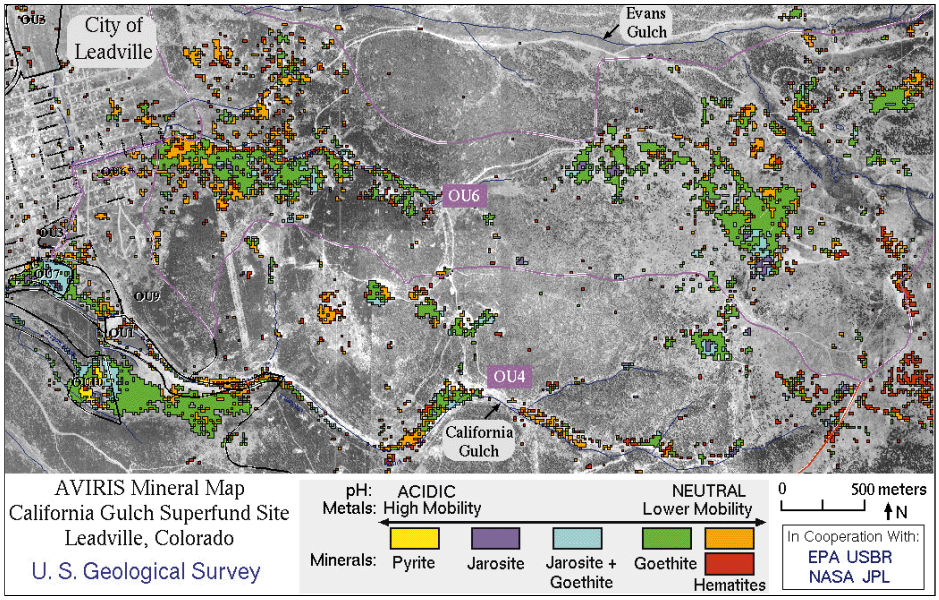
USGS Information Services
Box 25286
Denver, CO 80225

Remote Sensing Aids Cleanup

A recently completed study at the California Gulch Superfund Site in Leadville, Colo., has demonstrated the application of a new technology capable of locating and pinpointing sources of acid mine drainage and a tremendous variety of other surface materials. Mineral maps produced by the USGS are cutting costs and accelerating cleanup of hazardous mine waste over a large area.

Scientists at the USGS are producing these specialized maps using a new tool called imaging spectroscopy, the latest in remote sensing science. All materials, whether gaseous, liquid, or solid, contain chemical bonds that give rise to unique spectroscopic signatures. These features are readily identifiable in measurements of light reflected or emitted from the material itself.

Using modern infrared detector technology, NASA and the Jet Propulsion Laboratory have developed an advanced airborne imaging spectroscopy instrument that generates image data containing



Imaging spectroscopy is used for mapping minerals at hazardous waste sites to help in remediation, saving time and money, and proving imaging spectroscopy is a robust and accurate tool.

detailed spectral information. USGS scientists have created computer software to analyze these new types of data and are now able to quickly produce maps of

almost any material. The applications of this method range from mapping the health, productivity, and diversity of vegetation communities, to searching for economic mineral deposits, to assessing environmental hazards. For mine waste, this method can be used to pinpoint the location of contaminants.

More than a century of silver, gold, lead, and zinc mining at the Leadville site has resulted in widespread acid mine drainage and heavy metal contamination. The Bureau of Reclamation and the EPA enlisted the support of the USGS in searching for rapid, cost-effective methods to locate the sources of acid mine drainage to expedite and streamline the remediation process. Imaging spectroscopy quickly moved to the forefront of these efforts.

The resulting mineral maps reveal characteristic mineral assemblages centered on mine dumps and tailings rich in the mineral pyrite, a primary source of acidic runoff. Field checks demonstrated that highly acidic (low pH) water forms in the pyrite-rich tailings and is gradually neutralized as it spreads away from the dumps. This process deposits the progressively less acidic mineral byproducts in concentric zones near the dumps, creating diagnostic patterns easily recognized in the mineral maps. The imaging spectroscopy data in the above image took less than a minute to obtain by a NASAhigh altitude aircraft.

Analysis of the data was completed in only a few months. Traditional field mapping to produce such mineral maps would take years, making it prohibitively expensive. Using imaging spectroscopy has, in this study alone, produced demonstrably superior and more detailed information while saving more than a year in remediation effort and more than half a million dollars. This technique will work at other problem mine areas as well, potentially saving millions in costs and remediation time.

The USGS Spectroscopy Lab home page is <URL: http://speclab.cr.usgs.gov>

Information

For information on these and other USGS products and services, call 1-800-USA-MAPS, fax 703-648-5548, or e-mail: esicmail@usgs.gov.

Receive information from the EARTHFAX fax-on-demand system, which is available 24 hours a day at 703-648-4888.

The address for the USGS home page is <URL: http://www.usgs.gov/>

The address for the Environment Theme home page is <URL: http//www.usgs.gov/themes/environ.html>