Introducing GEOINDICATORS

What are Geoindicators?
Geoindicators constitute an approach for identifying rapid changes in the natural environment. An international Working Group of the International Union of Geological Sciences (IUGS) developed geoindicators in order to access common geological processes occurring at or near Earth's surface that may undergo significant change in magnitude, frequency, trend, or rates, over periods of 100 years or less. Geoindicators measure both catastrophic events and those that are more gradual but evident within a human lifespan. Some geoindicators can provide a record of natural events through time.

The 27 geoindicators are:

1. Coral chemistry and growth patterns
2. Desert surface crusts and fissures
3. Dune formation and reactivation
4. Dust storm magnitude, duration, and frequency
5. Frozen ground activity
6. Glacier fluctuations
7. Groundwater quality
8. Groundwater chemistry in the unsaturated zone
9. Groundwater level
10. Karst activity
11. Lake levels and salinity
12. Relative sea level
13. Sediment sequence and composition
14. Seismicity
15. Shoreline position
16. Slope failure
17. Soil and sediment erosion
18. Soil quality
19. Streamflow
20. Stream channel morphology
21. Stream sediment storage and load
22. Subsurface temperature regime
23. Surface displacement
24. Surface water quality
25. Volcanic unrest
26. Wetlands extent, structure, hydrology
27. Wind erosion

Why are Geoindicators important?
Ecosystem management, reporting, and planning generally focus on biological issues such as biodiversity, threatened and endangered species, exotic species, and biological and chemical parameters relating to pollution (e.g., air and water quality). Much less attention is paid to the physical processes that shape the landscape—the natural, changing foundation on which humans and all other organisms live and function.

Geoindicators help answer NPS resource management questions about what is happening to the environment, why it is happening, and whether it is significant. They establish baseline conditions and trends, so that human-induced changes can be identified. Applying the geoindicators approach will provide science-based information to support resource management decisions and planning. Geoindicators help non-geoscientists focus on key geological issues, help parks anticipate what changes might occur in the future, and identify potential management concerns from a geological perspective.

Geology and geological processes are integral to park management and planning. For example, the underlying geology and soils influence natural vegetation patterns, and in turn exert a control on biological communities. Geological processes can affect park roads, infrastructure, and facilities. When measures of natural landscape change are omitted from monitoring and planning, the assumption that natural systems are stable, fixed, and in equilibrium is perpetuated. Natural systems are dynamic, and some may be chaotic; change is the rule, not the exception.

Monitoring the abiotic components of ecosystems using geoindicators will help to emphasize this point.

The geoindicators approach can be a useful reminder both of the prevalence of natural fluctuations and of the difficulty of separating them from human-induced environmental change. Using geoindicators shifts management actions from response (crisis mode) to long-range planning, so issues can be recognized before they become concerns. Geoindicators may also prove to be useful tools for enhancing interdisciplinary research and communication, a way to connect with others concerned with environmental issues and problems.

How do Geoindicators fit into the National Park Service's strategic plan?
In 1999, the NPS Geologic Resources Division (GRD) and the NPS Strategic Planning Office cooperated to develop a Servicewide geologic resource goal as part of the Government Performance and Results Act (GPRA). The NPS Goal Ib4 states, "Geological processes in 75 parks (36% of 270 natural resource parks) are inventoried and human influences that affect those processes are identified." This goal was designed to increase understanding of geological processes and their functions in ecosystems and to help park managers make more informed science-based management decisions.

This goal is intended to be the first step in a process that will lead to inventory, monitoring, and research, and ultimately focus on the mitigation or elimination of human activities that severely impact geological processes, harm geologic features, or cause critical imbalance in ecosystems.

What is the purpose of a Geoindicators scoping meeting?
The purpose of a scoping meeting is to identify significant geological processes in a park's ecosystem and determine if those processes are being affected by human activities. Pertinent human influences may include visitor impacts, park management practices and developments, land use adjacent to parks (e.g., pollutants, timber harvest), and global issues (e.g., industrial dust from China).

In addition, resource management issues related to geology and geological processes will be identified; and inventory, monitoring, and research studies that can provide scientific data to be used in making management decisions will be recommended.

How does the Geoindicators scoping process work?
The GRD coordinates efforts between park resource managers and geologists (from federal and state agencies and academia) through scoping meetings that are held in national parks. The scoping meetings are designed to use the participants' expertise and knowledge and build on the synergy of the participants through field observations, group discussion, and the exchange of ideas. For park staff, the scoping meetings foster a better understanding of the physical resources and geological processes in the park. For scientists, the scoping meetings foster an awareness of management issues and the decision-making and planning processes preformed by park staff. This process brings together the institutional knowledge with the area's past and present research information.

The field trip portion of a scoping meeting highlights the park's setting and geology, as well as key resource management issues related to geological processes. During the discussion portion

of a scoping meeting, selected geoindicators—specific to a park's setting—guide and focus the dialog.

The following questions are addressed during the group discussion of a scoping meeting. The answers are rated and prioritized.

- What are the significant geological processes in the park's ecosystems? Why are they significant?
- Which of these geological processes is being influenced by human activities both from inside and outside the park?
- How significant to park management are the identified geological processes and associated human influences?
- What sort of geological baseline data would benefit the park?
- What geoindicators should be monitored in the park? What protocols are recommended and who are the geoscientists to contact?
- Where are the information gaps? What studies or research are recommended?
- What information should be included in park planning documents?

What are the outcomes of a Geoindicators scoping meeting?
Scoping meetings provide an opportunity for park staff and geologists to connect and build relationships. This is significant because many park managers do not have easy access to geological expertise, and most do not have geologists on staff or in their regional offices.

Managers from participating parks will receive a summary report that highlights the recommendations identified during the scoping meeting. Recommendations include inventory and monitoring—which will provide information to use for park planning and decision-making—and research topics that will fill information gaps.

Where can I get more information?
- Web site about geologic resource monitoring in the U.S. National Parks: http://www2.nature.nps.gov/grd/geology/monitoring/index.htm.
- Detailed descriptions of the 27 geoindicators: http://www2.nature.nps.gov/grd/geology/monitoring/parameters.htm.
- Web site of the IUGS Geoindicators Initiative: http://www.lgt.lt:8080/geoin/welcome.