

# Geologic Maps and Digital Data Sets: Their Role In Management and Preservation of NPS Lands

Beneath a surficial veneer of soil and vegetation is the highly varied assortment of rocks and sediments that constitute the outermost part of the Earth's crust. Rocks and sediments vary in composition, structure, age, mode of origin, and many other ways; these variations occur both laterally and vertically within the crust. The spatial relations of the many different kinds of rocks and sediments that can be distinguished at or near the Earth's surface are graphically portrayed through the use of geologic maps.

Geologic maps are among the most useful scientific tools available for the interpretation of Earth history. The Earth's crust has been built up, bit by bit, and through an immense amount of time, by processes as diverse as sedimentation on the sea floor, volcanic eruption, and deep-seated crystallization of molten magma; it has been deformed and modified by such processes as folding, faulting, and metamorphism; its surface has been shaped by the destructive forces of uplift and erosion. Geologic maps depict the rocks, sediments, and geologic structures (such as faults and folds) that have resulted from these processes, and which thereby record the history and evolution of the Earth's crust.

In addition to their basic value as records of Earth history, geologic maps provide information critical for a broad spectrum of practical applications. For example, the maps depict the

variations in the composition, structure, and other characteristics of rocks and sediments that are directly related to the operation of the Earth's natural processes and the distribution of natural resources. Variations in the composition of rocks close to the ground surface, for example, control the composition of the overlying soil, which in turn affects the nature of the vegetative cover.

Variations in the composition and structure of rocks exposed on sloping ground control the susceptibility of such ground to erosion and downslope movement, which determines the risk to areas below from damaging debris flows and landslides. Variations in the permeability and porosity of rocks control the distribution and flow of ground water, which determines the availability of such water and its susceptibility to contamination from ground-penetrating pollutants. By forming a basis for documenting such variations, geologic maps help us avoid the negative effects of these variations or use their positive effects to our advantage, and thus achieve a more harmonious interaction with the land we live on.

Because of their unique information content, geologic maps have an important role to play in the stewardship and preservation of NPS lands, both as educational tools and as tools for balanced land and resource management. As educational tools, geologic maps can help park visitors gain insight into the geologic history and pro-

cesses by which the land has been and continues to be formed. Geologic maps can also provide an indispensable framework for additional research into specific aspects of Earth history or geologic processes, the results of which can have implications that extend well beyond the boundaries of individual NPS land units.

As management tools, geologic maps contain information needed for many fundamental aspects of park management such as resource inventories, assessments of risk from geologic hazards (for example, earthquakes, landslides, volcanic eruptions, and floods), ground-water contamination studies, hazardous materials issues, construction planning, and land acquisition. In areas subject to rapid or even catastrophic geological change from the occurrence of natural hazards, accurate geologic maps also can serve as sources of baseline information for monitoring such changes through time and for predicting the effects of future changes.

Like many other types of mapping, geologic mapping is currently undergoing a major shift from the production of conventional maps on paper to the development of geographically-referenced, digital databases through the use of geographic information system (GIS) technology. More than just a computer-generated picture, a digital geologic map compiled for use in a GIS is a fully attributed data set that can be

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analyzed, searched, or combined with other GIS data to produce derivative maps and data sets designed to address specific research or management problems. Geologic data can be combined with topographic data, for example, to produce derivative maps of slope stability and landslide potential; with hydrologic data to produce derivative maps of ground-water contamination potential; and with soil and vegetation data to produce derivative maps of land cover useful for forest, range, or wildlife management.

Thus, through GIS technology, geologic maps are being transformed from traditional graphic displays into digital data layers that can be used interactively with other types of data in a wider variety of applications than has been possible in the past. This analytical capability, plus the ease with which digital data sets can be updated and revised, clearly point to a future in which the production of geologic maps in digital format will be the norm rather than the exception.

The development of a nationwide, digital database of geographically-referenced geologic information is the principal objective of the U.S. Geological Survey's National Cooperative Geologic Mapping Program, which was established by Congressional legislation enacted on May 18, 1992. The database will be developed through the design and execution of geologic mapping projects and supporting scientific investigations that meet prioritized Federal and State needs for geologic information. The program is intended to foster communication and cooperation between the producers and users of geologic-map information so that the areas in most urgent need of this information can be identified and the production of the information in those areas accelerated.

An essential factor for the timely development of a nationwide, digital geologic-map database is increased cooperation between the USGS and other Federal agencies that either use or produce geologic information. The NPS has an obvious interest in high-quality, digital geologic information for multiple-purpose GIS ap-

plications, particularly in light of the ongoing establishment of the new NPS's Inventory and Monitoring Program and the NPS's long-standing commitment to public education in matters relating to the natural environment. The growing USGS-NPS partnership for geologic data-base development in NPS lands should benefit both agencies by accelerating progress toward mutual objectives.

The partnership builds on a long history of project-level cooperation between the USGS and the NPS, one that has resulted in the publication of geologic maps and related interpretive studies of many individual NPS land units over the years. In the past three years alone, for example, the USGS has published geologic maps of Yosemite, Rocky Mountain, Grand Teton, and Bryce Canyon NPs. The production of geologic maps, digital geologic data sets, or both is currently ongoing in several other NPS units, including Kings Canyon, Sequoia, and Great Basin NPs and Chiricahua National Monument. Despite such individual successes, an even broader framework for cooperation is needed in the future to facilitate logistics and funding, to encourage the application of uniform standards of geologic mapping and data-base development, and to ensure that the work is conducted in a prioritized manner that satisfies the needs and mandates of both agencies.

For further information on available geologic-map data and ongoing USGS geologic mapping projects, for discussing potential cooperative studies, and for information about the National Cooperative Geologic Mapping Program, contact:

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