NATIONAL COOPERATIVE GEOLOGIC MAPPING PROGRAM

PROGRAM PLAN

2007-2011

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NCGMP Five-year plan draft document 2007-2011

I. Executive Summary

In the next five years, the National Cooperative Geologic Mapping Program (NCGMP) anticipates several significant advances in delivery of our flagship products—geologic maps and reports on Earth history and processes. In this plan we often use the term "geologic map" in an expansive and inclusive manner. Not only do we use the term to mean the traditional paper geologic map that contains text describing the depositional and tectonic history of a particular area, cross sections portraying rocks below the surface of the Earth, correlation charts based on profound amounts of paleontologic and isotopic dating, but we also are talking about new digital products that are databases created with powerful software such as EarthVision. This is an exciting time to be a geologic mapper. Not only does one still have the opportunity to collect information by hiking over beautiful mountains and deserts, but we now are able to combine our data with a broad array of other geologic information, and present that integrated information using powerful visualization techniques that allow anyone to see the "secrets" that only well-trained geologists could understand in the past.

Since passage of the National Geologic Mapping Act (NGMA) in 1992, a durable partnership has been forged between the USGS and the Association of American State Geologists. This partnership has proudly promoted the education component of the program (EDMAP) that to date has trained and mentored more than 600 students at more than 130 universities across the Nation. The program has been tracking these students for several years, and has learned that they are a highly motivated group that continues their geoscience education at a greater rate than average, and to positions where their mapping skills are used and valued. During the past few years, the program has tried to diversify the applicant pool by visiting a number of historically black and tribal universities. During the next five years, we plan to increase this activity and will solicit help from organizations such as the Geological Society of America, the American Geological Institute, and the American Institute of Professional Geologists.

During the past 5 years NCGMP has worked hard to encourage cooperative mapping projects between USGS staff and staff at State geological surveys. We have discovered many instances where the Federal and State priorities for geologic mapping have significant overlap, and that leveraging funds and expertise can accomplish the task more efficiently. We have also learned that these cooperative projects offer a rich mentoring environment for university students receiving training through the EDMAP component of the program. The program anticipates that during the next five years the need for sharing expertise and staff will grow, and the opportunities for joint cooperative mapping projects will increase.

NCGMP funding for ground-water related research increased steadily over the past five years in response to national needs recognized in the program's previous 5-year plan. As with all geologic maps, and most NCGMP research, products originally proposed for one primary purpose, has been used to achieve a range of other outcomes. For instance, many 3-D geologic framework studies in the greater San Francisco, California, region were originally done in close cooperation with a number of county and community water commissions. While a major purpose of this work was intended to provide information on the architecture and extent of ground water aquifers, this information is critically needed to understand the tectonic setting of the San Andreas Fault zone. In 2006, on the 100th anniversary of the devastating 1906 San Francisco earthquake, geologic maps and 3-D geologic frameworks were used to educate the public about future earthquake risk in this part of California. A simulation of the 1906 earthquake was performed by pumping velocity waves through a 3-D framework, and with iterative refinements was able to replicate the historic earthquake with remarkable accuracy. Seismologists learned much new about a number of faults in the San Andreas system, and were able to convey this information to the public over the Internet. NCGMP will promote this sort of public education using geologic map databases during the next five years, and will be uniquely positioned to provide framework needed in many new geologic hazard projects (earthquake, landslide, and others). While this will not require the program to shift significant funds from water-related research to hazard-related research, it may require that our 3-D frameworks are created in a manner to make them useful to a wider variety of modelers. In some cases this may mean incorporating more information into the frameworks about the geologic and engineering properties of earth materials.

The NCGMP will continue to be an active participant in the formation of the standards, goals, and implementation plan for the new National Geological and Geophysical Data Preservation Program (NGGDPP) within the USGS Geologic Discipline. Within the context of data preservation, the NCGMP will create a USGS National Paleontological Preservation Database. By the end of 2010, all USGS paleontologic databases will be served through a common portal. NCGMP will also explore how best to play a role in the worldwide geologic mapping data integration effort known as OneGeology, working with over 50 other national geological surveys.

Since NCGMP was created by the National Geologic Mapping Act in 1992, publication of geologic maps by the USGS and the 50 State geological surveys has been something of a cottage industry--independent and diverse. In a time of rapid transformation of publication methods, and the proliferation of software packages, this has been a good thing. All 51 surveys have learned a great deal from one another, and consequently all our map publications have improved. Indeed, over the last eight years, many of our technical specialists have met annually to discuss how to improve map standards, formats, and common science language at Digital Mapping Techniques conferences organized jointly by USGS and AASG. The time has come for our surveys to begin coalescing around a few formats, to promulgate common standards used by all, and to make all maps available digitally through a single distributed database (i.e., the National Geologic Map Database). The recent review of NCGMP by AAAS made these recommendations, and over the next 5 years we hope to implement them all. While we

are pursuing these goals nationally, we must work more closely with the international community as well. NCGMP plans a follow-up independent external review of NCGMP in 2011 to determine our success in implementing the goals outlined in this plan.

During the past 5 years NCGMP made remarkable strides in defining the geologic frameworks for a number of major aquifers. This work was done iteratively with ground water modelers and published in formats using powerful visualization software. Each time significant improvements are made to the geologic framework or groundwater model, an updated version can be released on CD. We anticipate that this method of publication will become more commonly adopted by our scientists in the coming five years. It has also become apparent that the same method can be employed to better understand the neotectonics of a region, such as southern California or the Puget Lowlands, and help assess the true natural hazard of an area. The ability to incorporate geophysical information into these 3-D models NCGMP has put powerful new analytical tools at our disposal. We will expand hazard assessments in the coming five years, while we try to maintain the current level of emphasis in ground water assessments.

Building upon the evaluation processes initiated during participation in the Office of Management and Budget (OMB) Program Assessment and Rating Tool (PART) process in 2005, the NCGMP will obtain regular, independent reviews of various aspects of the program. A 2007 review will focus on (1) how the program can increase integration and distribution of geologic information to facilitate analysis and decision-making and (2) the effectiveness of the National Geologic Mapping Database (NGMDB). It will be important to determine (1) the types of geologic map derivative products that land managers need and the best way to provide this information, and (2) the most effective way for the NGMDB to provide geologic information in a constantly expanding and interactive digital environment.

Priorities and metrics can only be met with the cooperation of NCGMP partners in the State geological surveys and universities. From 1993 to 2006, more than $60 million has been matched by the States to complete geologic maps, and over 600 students have been trained in geologic mapping.

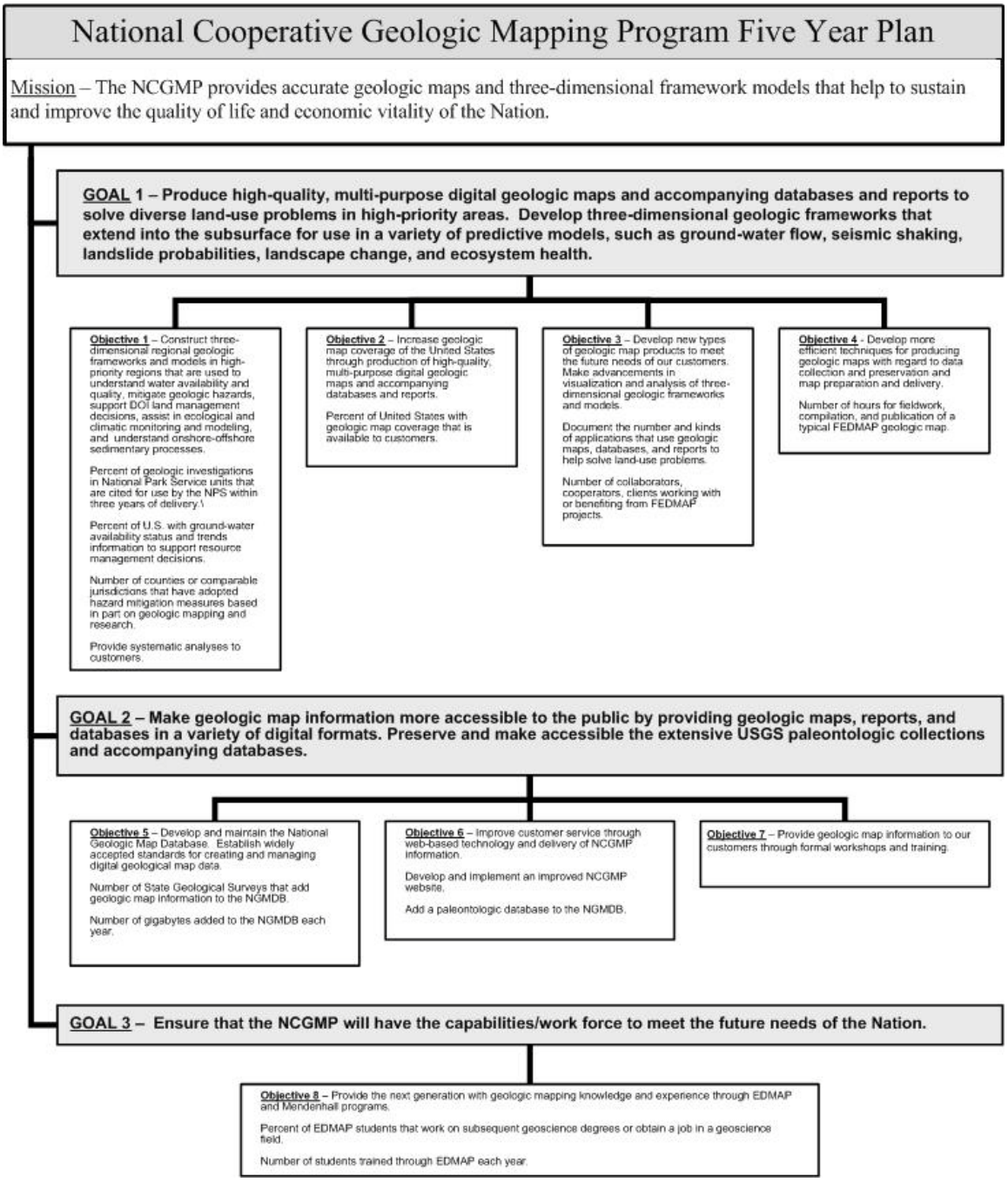


Figure 1. –National Cooperative Geologic Mapping Program 5-year plan and performance metrics.

II. Introduction

Although geologic maps form the primary foundation for virtually all applied and basic earth-science investigations, the process of constructing a geologic map is in itself scientific research on the earth's history and the processes that operated to form our planet's rocks and surficial materials. The definition of what constitutes a geologic map has changed over the years from a traditional paper product to multi-use digital geologic map databases. For the purposes of this document, a geologic map refers to the representation of the geology at the earth's surface, as well as the subsurface projection of that geology, and includes any related databases.

In 1992, the 102nd Congress recognized that a coordinated program was needed to increase the production of geologic maps for the Nation by means of a system that sets priorities based on customer needs. In the late 1980s, less than 20 percent of the United States had detailed geologic map coverage at scales necessary for land-use and resource managers to make wise decisions (Geologic Mapping in the U.S. Geological Survey, 1987, National Academy Press, Washington, D.C.), and very few of these geologic maps were in a digital format that now is the standard for geologic map production.

The National Geologic Mapping Act (Public Law 102-285), which was signed into law in 1992, created the National Cooperative Geologic Mapping Program (NCGMP) to implement and coordinate an expanded geologic mapping effort by the U.S. Geological Survey (USGS) and the State geological surveys. The Act has been re-authorized twice, in 1997 and in 1999, and currently is in the process of its third reauthorization. A more extensive history of the program, including copies of the National Geologic Mapping Act of 1992 (P.L. 102-285), the Reauthorization Acts of 1997 (P.L. 105-36) and 1999 (P.L. 106-148), and reports of the program's Federal Advisory Committee, is available on the NCGMP Web site at http://ncgmp.usgs.gov/.

The NCGMP has a mission to produce accurate geologic maps and three-dimensional geologic framework models that provide indispensable data for sustaining and improving the quality of life and economic vitality of the Nation through understanding earth surface processes and ground-water availability and quality, supporting DOI land management decisions, mitigating hazards, assisting in ecological and climatic monitoring and modeling, and understanding onshore-offshore sediment processes.

The program today represents successful cooperation among Federal, State, and university partners to deliver modern digital geologic maps to the communities and users that need them. Each of the three components of the program, as described below, has a unique role, yet all work cooperatively in the process of determining priorities for and producing new geologic maps. The program provides the regional-scale (generally 1:24,000 or smaller) geologic maps that private sector geotechnical consultants have come to depend on as a base for constructing their larger-scale, site-specific geologic maps. The data from these efforts across all of the U.S. will continue to be stored and made available in the National Geologic Map Database. A common set of geologic map

standards will be published that were developed by the NCGMP in cooperation with the North American Geologic Map Data Model Steering Committee

The goals of the NCGMP will continue to be consistent with those of the Geologic Discipline, USGS, Department of the Interior, and the President's Business Reference Model (Figure 2).

The program is clearly successful because (1) recent geologic mapping has been an important part of scientific advancement in areas as diverse as earthquake mechanisms, ground-water flow modeling, mineral and petroleum exploration, and the mitigation of natural hazards, (2) the percentage of the Nation with geologic map coverage has risen dramatically, (3) the Federal, State, and university partnership mandated by the National Geologic Mapping Act has been the model for creating other government programs, (4) the geologic map standards promulgated by the program are being implemented by the Federal Geographic Data Committee for use by the entire geologic community, and (5) geologic map production, compilation, and training has been promoted in all 50 states and Puerto Rico during the past 13 years (Figure 3).

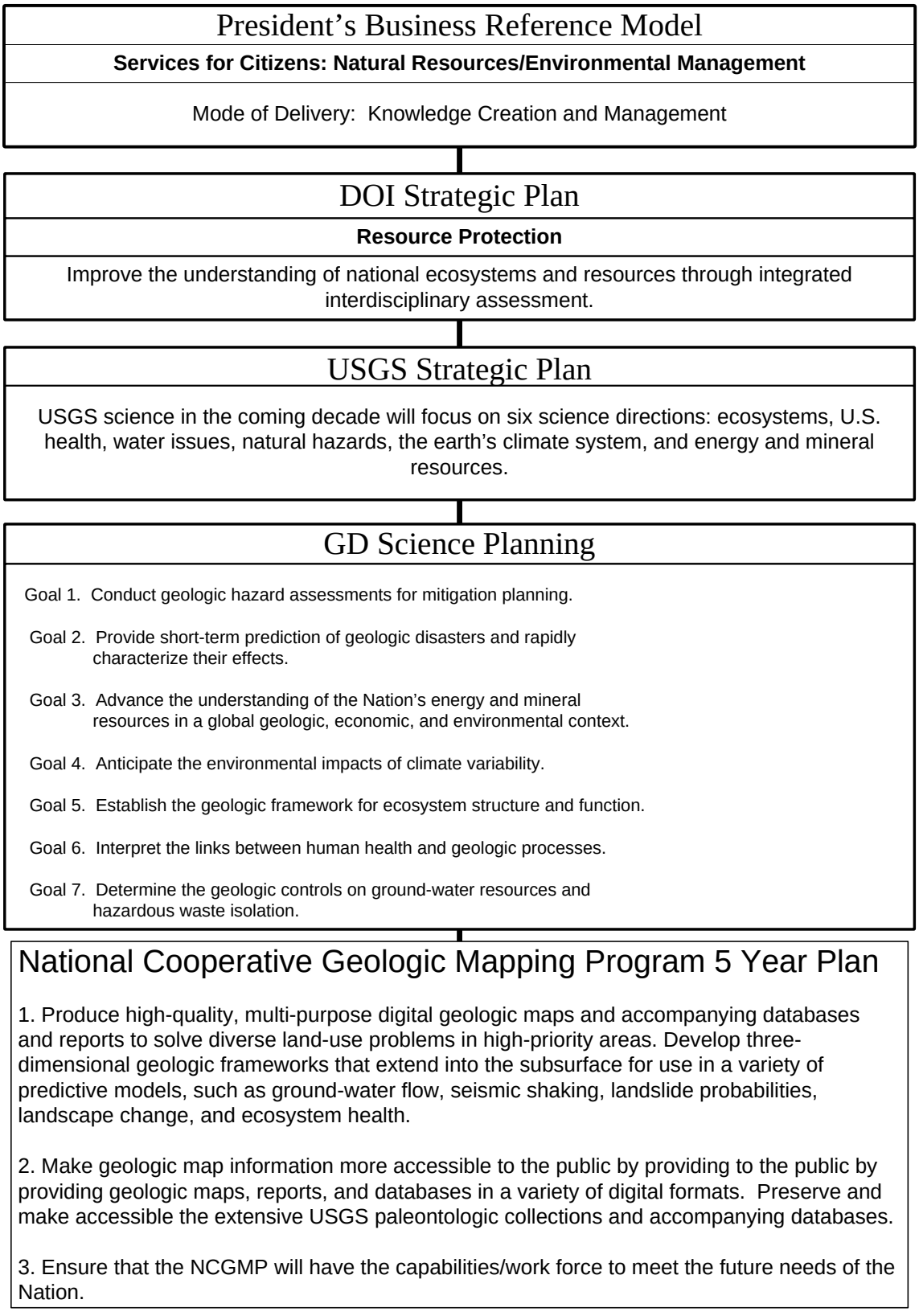


Figure 2. – Linkage of NCGMP goals to other Federal goals

Program Components

Federal Component – The Federal component of the program, FEDMAP, which officially began in 1993, creates regional geologic frameworks for areas that are vital to the economic, social, or scientific welfare of the Nation. The program annually supports approximately 25-30 multi-year USGS projects, which frequently include interdisciplinary studies that add value to the geologic mapping and allow the maps to be used by a wide variety of consumers. National priorities are set with the advice of both a Federal Advisory Committee and a FEDMAP Review Panel, which have Federal, State, private industry, and academic members, and through less formal meetings with customers, collaborators, and cooperators. Program funding also maintains the National Geologic Map Database (NGMDB), an effort mandated by the NGMA, which provides information to the public about all geologic maps produced in the United States, develops standards for use by all components of the program and the entire geologic mapping community, and promotes the use of sophisticated data models for the construction and dissemination of geologic maps.

State Component - STATEMAP creates geologic frameworks for areas that are vital to the economic, social, or scientific welfare of the individual States. State geological surveys first received STATEMAP funding in 1993. While maintaining consistency with NCGMP priorities, each State Geologist determines the State's mapping priorities in consultation with a State Mapping Advisory Committee. Highest priorities occur in regions of multiple issues, a compelling single issue, or where geologic maps are essential for solving critical Earth science problems. The Association of American State Geologists, an organization consisting of all 50 State Geologists, routinely provides the program with insightful guidance on critical issues that affect the States collectively. Each year, the NCGMP funds approximately 120 projects in 47 States. STATEMAP is a competitive grants program where Federal funding is matched one-to-one with State funds. Proposals are reviewed by national award panels made up of scientists from the USGS and selected representatives from the State geological surveys. Each STATEMAP project focuses on a specific area or issue. State geological survey employees conduct the geologic mapping and commonly work closely with EDMAP students and their professors, as well as with FEDMAP geologists.

Educational Component – EDMAP, which first received funding in 1996, provides university students with a carefully mentored education in the fundamental principles of geologic mapping and field studies. College or university geology professors, who are skilled in geologic mapping and willing to provide appropriate mentorship, request EDMAP funding to support their undergraduate and/or graduate students' participation in geologic mapping projects. These projects focus on a specific geographic area, and although individual projects last for only one year, they may build upon the results of previous years' efforts. EDMAP geology professors and their students are required to have a partner geologist from a State geological survey or USGS project, which provides opportunities for shared information and resources.

The NCGMP allocates funds to colleges and universities in the United States and Puerto Rico through an annual competitive grant process. Proposals are reviewed by national award panels made up of scientists from the USGS, State geological surveys, and universities. Every Federal dollar that is awarded is matched with university funds.

EDMAP is integrated with the geologic mapping priorities of the Federal and State components of the program. The success of this component is seen in the large number of EDMAP students who have pursued additional geoscience degrees and/or gone on to develop geoscience careers (see Objective 7 below). The program fills a unique role in its training of new geologic mappers because not even the National Science Foundation currently supports this effort. Geologic mapping knowledge is clearly in high demand based on the ease with which EDMAP students are able to find employment in the field of geoscience.

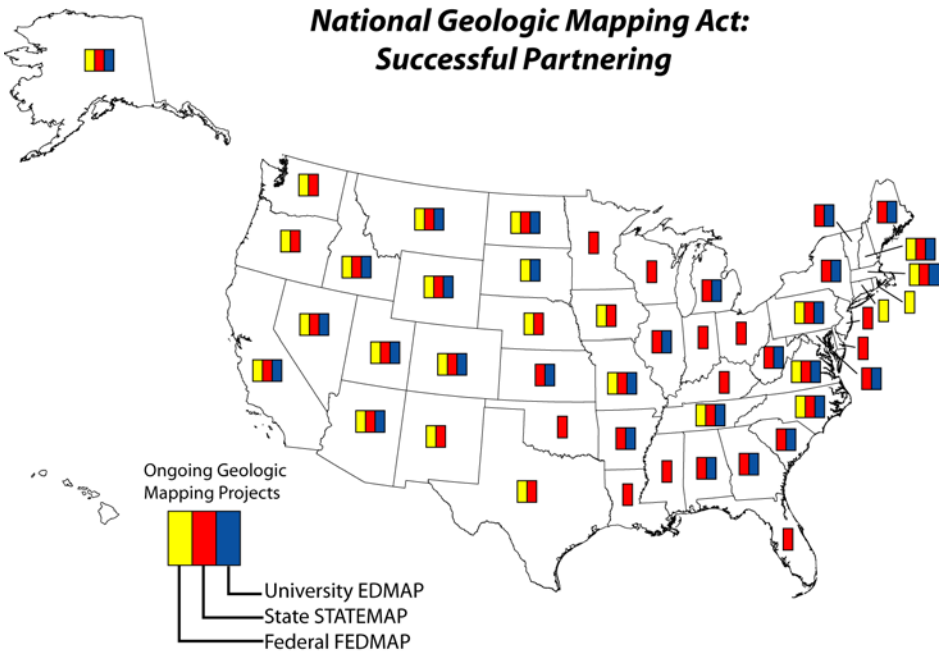


Figure 3. – Geologic mapping projects by component of NCGMP for FY 2006.

Uses of Geologic Maps

Decision makers at the national, State, and local levels are finding that they need increasing amounts of objective scientific information in order to make sound decisions regarding land use, water use, and resource use. A modern digital geologic map often is the best scientific product for providing some of this information because they are the single best source for understanding the history of the Earth. Geologic maps depict and interpret the bedrock and/or surficial geologic units that occur at and beneath the earth's surface. They also present information about the complex depositional and tectonic histories that the rocks have undergone, and may provide information about geologic age, mineral resources, fossils, geochemistry, and a host of other basic earth science

information. Although the original decision to map an area may have been based on a specific need/issue, because of the quality and type of the information found in geologic maps, these maps also are being used to address a multitude of other land-use issues for years after their original publication.

While a traditional geologic map portrays all of its information on a large sheet of paper, new digital techniques and computer software allow geologic mappers to represent the information in ways that are easier for their customers to visualize, understand, and use. These digital presentations frequently include additional information that was difficult or impossible to portray on paper maps. For instance, regional geophysical data sets (e.g., gravity and aeromagnetic anomalies) can be combined with a robust set of point data (e.g., earthquake epicenters and water wells) to form one component or layer of the digital geologic map.

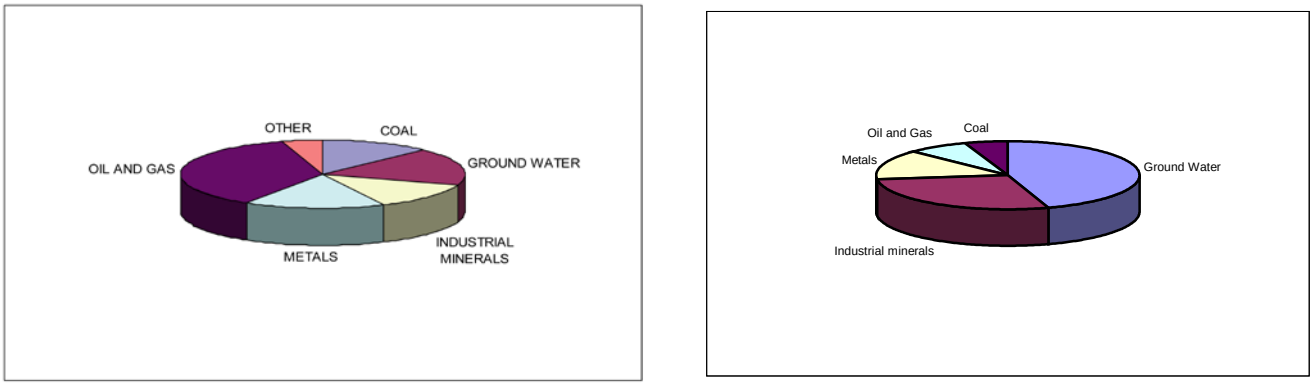


Figure 4 – Changes in justifications for geologic mapping of resources from 1987 to 2007 for FEDMAP and STATEMAP projects. 1987 information from NRC report; 2007 information compiled from NCGMP project descriptions.

Prior to the NGMA, the major justifications for geologic mapping in the U.S. involved the use of maps in discovering and developing energy and mineral resources. In recent years, the need to maintain adequate clean water resources has become a major impetus for geologic mapping (Figures 4 and 5). Another recent demand for geologic maps is to solve a broad array of environmental concerns (e.g., ecosystem restoration and proper siting of waste facilities). The program will continue to recognize and support new uses for geologic maps by staying in close touch with its customers, particularly through the State Geologic Mapping Advisory Committees.

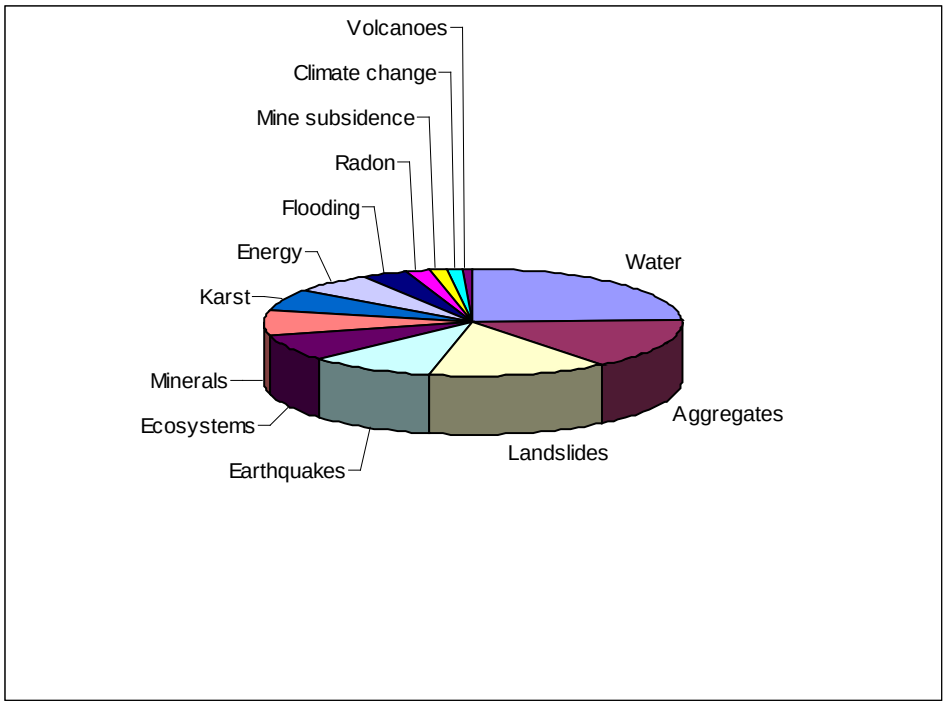


Figure 5. –. Justifications and purposes of geologic mapping for FY 2007 FEDMAP and STATEMAP projects. Information was compiled from NCGMP project descriptions.

With the advent of digital technology and the demand for map data in geographic information systems (GIS), the program, through its support of the National Geologic Map Database Project, is setting standards for digital geologic map production. These standards have been developed through collaboration with State agencies and other organizations and have been approved by the Federal Geographic Data Committee (FGDC). The NCGMP will continue to be a leader in the digital field as new technologies are developed.

The Previous Plan

The previous NCGMP five-year plan was organized around the seven science goals of the Geologic Discipline. The Program successfully implemented and completed projects that contributed to the understanding of (1) geologic hazards for mitigation planning (Pacific Northwest), (2) short-term prediction of geologic disasters (California), (3) mineral and energy resources (Wyoming and Nevada), (4) impacts of climate , (5) ecosystem frameworks (Chesapeake Bay region), (6) links between human health and geologic processes (Arizona), and (7) geologic controls on ground-water resources (Texas).

III. Program 5-year goals

GOAL 1 - Produce high-quality, multi-purpose digital geologic maps and accompanying databases and reports to solve diverse land-use problems in high-priority areas. Develop three-dimensional geologic frameworks that extend into the subsurface for use in a variety of predictive models, such as ground-water flow, seismic shaking, landslide probabilities, landscape change, and ecosystem health.

Implementing this goal is the fundamental purpose of the program. Geologic maps provide the scientific underpinning of most geologic research, and routinely contain information about a region's geologic history (depositional, structural, tectonic, metamorphic, and plutonic). These maps are used for a broad range of purposes and traditionally have had a useful "shelf life" of several decades. With the advent of digital technologies, this "shelf life" can be extended because digital modifications can easily be added, and these updated products are then delivered promptly via the Internet.

Most FEDMAP geologic mapping projects are conducted out of the three regional Earth Surface Processes Teams (Eastern, Central, Western), but the NCGMP also funds geologic mapping tasks in projects led by other programs, including Earthquake Hazards, Landslide Hazards, Volcano Hazards, Mineral Resources, Energy Resources, Earth Surface Dynamics, and Coastal and Marine Geology. To accomplish inter-program and inter-disciplinary science objectives, NCGMP also supports a number of important laboratories in the Geologic Discipline, primarily geochronology and paleontology laboratories. Other programs and disciplines often reciprocate by funding tasks within geologic mapping projects.

Each year, FEDMAP, STATEMAP, and EDMAP projects work collaboratively with hundreds of cooperators and customers. These include other USGS Disciplines, Department of the Interior Bureaus, other Federal agencies (such as the U.S. Forest Service), State agencies, county and local agencies, universities, and private industry. In order to receive funding, geologic mapping projects must have strong scientific foundation and merit, application to societal needs, relevance to USGS science goals, and an appropriate government role.

Objective 1 - Construct regional geologic frameworks and models in high-priority regions that are used to understand water availability and quality, mitigate geologic hazards, support DOI land management decisions, assist in ecological and climatic monitoring and modeling, and understand onshore-offshore sedimentary processes.

High-priority regions are selected and prioritized through use of the program's Federal Advisory Committee and three review panels, and through coordination with other programs and disciplines within the USGS, the National Park Service (NPS), other Federal agencies, and the State Mapping Advisory Committees.

Cooperate with Federal Land Management Agencies

The USGS provides digital geologic maps primarily at scales of 1:24,000 to 1:100,000, with an occasional map at 1:1,000,000, to land management agencies in the Federal Government. The National Park Service, Bureau of Land Management, U.S. Fish and Wildlife Service, and the U.S. Forest Service have benefited from and will continue to benefit from using NCGMP geologic maps and products. For example, NPS scientists use geologic maps when locating and documenting habitats for threatened or endangered plant and animal species and for identifying current and potential geologic hazards associated with watershed restoration, road relocations, ground-water developments, tunneling projects, landslide and potential flood assessments, and land management projects. Park managers use surficial geologic maps when making land-use decisions in park units that receive increasing demands from nearby large population centers. These maps assist in predicting what will be the future climax vegetation component of land areas, in selecting areas that require limited visitor access, determining anti-invasive species actions, and in implementing controlled burning.

More than 100 NPS units have benefited from NCGMP-funded products that include: (1) integrated tectonic and hydrogeologic data models for large areas, such as southern Death Valley, which are used to support management issues related to water quality and quantity, (2) studies of regional volcanism, faulting, and seismic hazard potential, (3) geochronologic studies of Tertiary and Quaternary deposits, (4) stratigraphic studies of surface outcrops and subsurface cores, (5) re-evaluation of previously mapped regional structure and stratigraphy, (6) development of geologic data for public dissemination, and (7) training for Park personnel so they can be more effective in communicating geological information to the general public. Similar efforts will continue over the next five years.

The USGS will maintain its outreach Web site for information on National Parks and continue to assist in NPS park staff training. For example, (1) USGS personnel have assisted in making a 3-D map of the San Andreas Fault trace for a park display and will continue such efforts as needed in the future; (2) geologic maps form the basis for delineating mineral resources, such as limestone resources in National Forests; (3) at Lake Mead National Recreation Area, geologic studies have provided understanding of the processes that are altering the landscape and the land's sensitivity to these changes; and (4) USGS employees in Alaska monitor, inventory, and assess the history of climate change on glacier resources in eight National Park units.

Over the next five years, NCGMP Program Coordinators and NCGMP-funded geologists will continue to work with the NPS through joint meetings and scoping sessions to determine which NPS units are of highest priority and what are the most appropriate products that the USGS can provide to these units to solve their land-use issues. For example, in 2007, the program will participate in a scoping session in Alaska to explore cooperative opportunities for STATEMAP and FEDMAP with Gates of the Arctic National Park managers.

Priorities for Federal Land Management Agencies

2007

- Explore opportunities with other Federal agencies and Alaska Division of Geological and Geophysical Survey for providing geologic maps to National Parks in Alaska, including Gates of the Arctic.
- Complete preliminary geologic mapping of Big Bend National Park, Texas.

2008

- Deliver a geologic map of the Shenandoah National Park, Virginia, for ecosystem analyses.
- Complete geologic maps for the Grand Canyon region to be used by NPS for water resource management.
- Complete geologic map of Big Bend National Park, Texas for understanding geologic history.

2009

- Complete surficial geologic mapping in the Mono Basin region, California, to understand past tectonic/volcanic history and provide interpretive information to the NPS.
- Provide web-based interpretive geologic guide to the NPS for the Glen Canyon National Recreation Area.

2010

- Deliver a karst map of the Nation to be used by the NPS and other Federal agencies to manage sensitive environments and serve as a portal to detailed information through the National Cave and Karst Research Institute.
- Complete a large-scale surficial geologic map of the Mesa Verde National Park area, Colorado, to provide insight on potential landslides, debris flows, and rock falls.

2011

- Complete surficial geologic map of Mono Basin Watershed, California, a product requested by the U.S. Forest Service.

Create Geologic Frameworks for Understanding Water Resources

NCGMP geologic frameworks help to define aquifer characteristics that are then used to produce accurate ground-water flow models. These models are essential for making quantitative regional hydrologic assessments of the Nation's highest priority regional aquifer systems. More than 60 percent of FEDMAP geologic mapping projects, and STATEMAP projects in 43 states, provide geologic information for water resources issues. The program recently implemented a shared goal with the USGS Water Resources Discipline to improve understanding of the 65 principal aquifers in the U.S (figure 6).

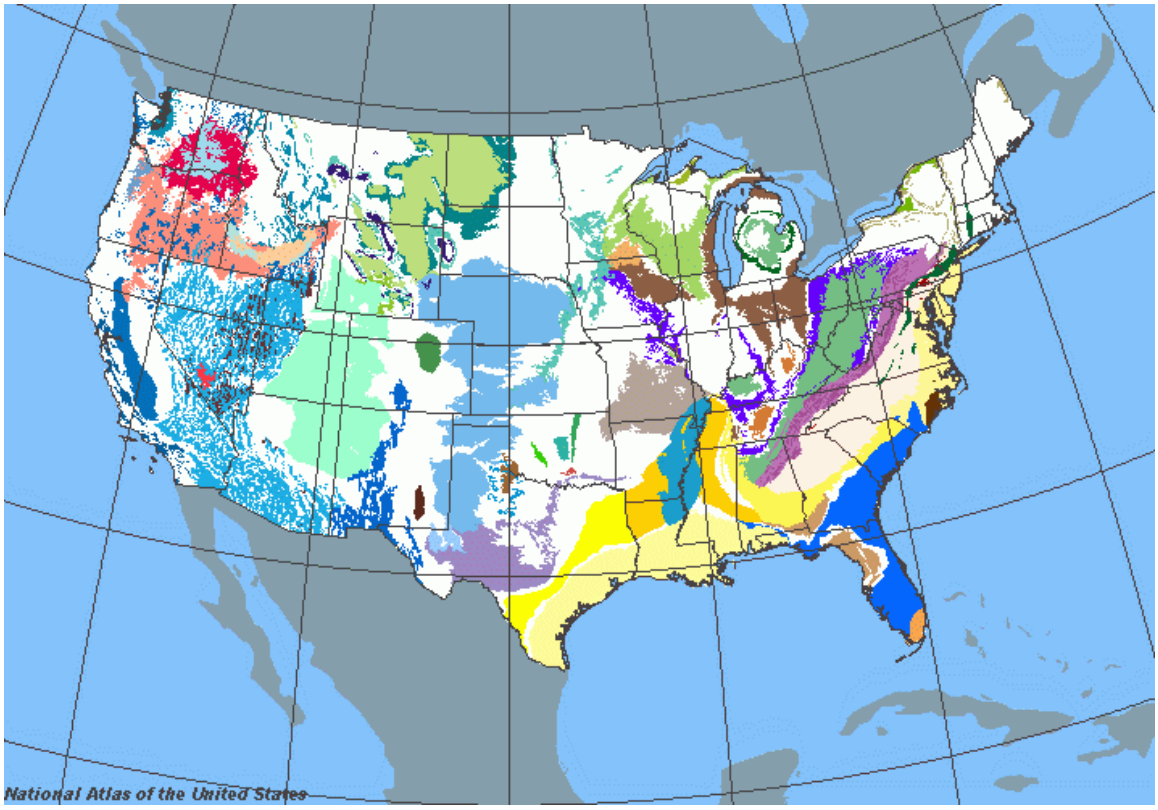


Figure 6. - Principal Aquifers of the U.S. (Taken from The National Atlas of the United States of America, www.nationalatlas.gov)

A principal aquifer is a regionally extensive aquifer or aquifer system that has the potential to be used as a source of potable, agricultural, or industrial water. Because an aquifer is contained within a geologic formation or group of formations, it is critical to understand the characteristics of the rock or sediment container that holds and conveys the ground water. The Ground-Water Resources Program conducts regional ground-water evaluations to improve quantification of ground-water availability data for selected principal aquifers. In 2006, work on the Mississippi alluvial and Sparta aquifers began in parts of Arkansas, Louisiana, Mississippi, and Tennessee. Each year, a new principle aquifer is selected for investigation. Potential high-priority aquifers in the future include the Basin and Range carbonate, High Plains, Columbia Plateau, Northern Atlantic Coastal Plain, and Floridan aquifers.

The FEDMAP Carolina Continental Margin Project and STATEMAP projects have contributed geologic framework information to North Carolina and South Carolina. FEDMAP project information is being used to develop ground-water models in the Edwards-Trinity aquifer system of Texas, the Arbuckle-Simpson aquifer in Oklahoma, the Espanola Basin in New Mexico, and the Valley and Ridge aquifer system of Virginia, West Virginia, and Maryland.

The Office of Ground Water staff, Regional Directors and their staffs, and geologists set the priorities for new aquifer studies based on the following criteria: (1) must be a large regional resource with significant hydrologic information available on the framework, (2) must have a ground-water model analysis available to build upon, and (3) must be experiencing

environmental stress resulting from multiple water availability issues. NCGMP Program Coordinators actively participate in these planning efforts.

Future development of improved geologic frameworks will enhance regional ground-water assessments by expanding the ability to simulate more accurately the effects of (1) ground-water withdrawal on the quantity of the resource, (2) human-caused contamination of ground water, (3) movement of naturally occurring chemical species in ground water, (4) saltwater intrusion of freshwater systems, and (5) subsidence and fissuring due to ground-water withdrawal. Accurate 3-D geologic models are also needed to improve estimates of the volume of ground water in storage and the hydraulic properties of geologic units. Future management of ground-water resources will increasingly depend on computer simulations of alternative management scenarios, and these will require increasingly sophisticated 3-D geologic maps. The new generation of 3-D geologic framework models that specifically target aquifer systems will be based on (1) cutting-edge geologic maps augmented with field data specifically related to hydrogeologic properties, (2) subsurface mapping techniques based on sophisticated down-hole logs similar to those used in the hydrocarbon industries, (3) shallow, high-resolution geophysical surveying and mapping, and (4) quantitative empirical models relating sedimentary environments to the properties of aquifers and confining units.

Priority Activities for Water Resources

2007

- Complete a geologic framework and EarthVision model of Chesapeake Bay Impact Crater, Virginia, for understanding water quality and salt-water intrusion in Atlantic Coastal Plain aquifers.
- Complete a geologic framework of Espanola Basin, New Mexico, in the Rio Grande Rift Basins for use in ground-water models.
- Explore future efforts for producing geologic maps along the U.S.-Mexico border to understand aquifer characteristics and interaction.
- Develop a new regional Coastal Plain project in cooperation with State agencies that will develop a stratigraphic framework for use in ground-water models.

2008

- Deliver geologic maps for use in understanding the Great Basin aquifer system in Utah and Nevada.
- Deliver a geologic map of the Mississippi Embayment aquifer system in Arkansas.
- Complete a geohydrologic framework of Columbia River Basalt, Willamette Valley, Oregon, to understand stresses on water resources and to be used in development of a ground-water model in cooperation with the USGS Water Resources Discipline.
- Complete glacial geologic maps of various areas of Massachusetts to apply to aquifer characterization studies.

2009

- Explore opportunities for the USGS and the Florida Geological Survey to contribute to the hydrogeologic framework of the Floridan aquifer.
- Develop a hydrogeologic model of the Edwards-Trinity aquifer system, TX, in cooperation with the USGS Water Resources Discipline.
- Complete geologic maps of the Commonwealth of the Northern Mariana Islands to be used for planning water resource usage of these developing islands.

2010

- Work with the USGS Water Resources Discipline to develop a geologic framework of the High Plains aquifer.
- Deliver a geologic framework for Arbuckle-Simpson aquifer system, Oklahoma, to be used in ground-water models.
- Complete geologic frameworks of the Rio Grande Rift Basins in the San Luis Basin, Colorado and New Mexico, to be used in ground-water models.

2011

- Deliver a geologic framework for Arbuckle-Simpson aquifer system, Oklahoma, to be used in ground-water models.

Create Geologic Frameworks for Use in Hazard Mitigation

Cooperation with the USGS Hazards Programs focuses on providing geologic mapping information to counties or comparable jurisdictions for use in developing hazard mitigation measures. For example, sophisticated and precise crustal-scale 3-D geologic models will be needed in the future to support advances in the understanding of earthquakes and the hazards they present. Detailed knowledge of geologic formations and structures, such as faults, is crucial for the accuracy of these models. The Three-Dimensional Geologic Maps and Visualization Project has developed 3-D geologic maps and databases that have allowed land-use planners to have a better understanding of potential geologic hazards related to earthquakes and landslides in California. One application of this product is to quantify ground shaking and refine earthquake location forecasting. The Kentucky Geological Survey is producing surficial geologic maps and databases to understand landslide hazards in the eastern part of the State. Cooperation between NCGMP, the Kentucky Geological Survey, and the USGS Landslides Hazards Program will benefit these jurisdictions in Kentucky and will be transferable to other areas of the U.S. Americans are more at risk to loss of life and property to wildland fires than ever before. NCGMP has been funding a project over the last several years to construct geologic maps of the Front Range urban corridor in Colorado. These maps are used to show the influence of geology on fire effects throughout the region. This information will be extremely useful for land managers in developing plans for fire mitigation efforts, treatment of burned lands, erosion management, and evaluation of post-fire slope stability. Future efforts will expand into other regions of the United States that are prone to wildfire hazards.

Priority Activities for Hazard Mitigation

2006

- Complete 3-D geologic maps and frameworks of the San Andreas Fault zone in the San Francisco, California, region for use in understanding earthquake shaking potential.
- Deliver a geologic map of southern California (Riverside area) and western Arizona for understanding current tectonic framework for earthquake hazards.

2007

- Deliver geologic maps of the Pacific Northwest to be used by localities to mitigate earthquake hazards.

2008

- Complete geologic maps of the Pacific Northwest to be used to understand volcano and landslide hazards.

- Complete surficial geologic maps of wildfire-prone areas in the western U.S. to understand debris flow potential and impact on land use.

2009

- Complete a 3-D model of the Hayward fault zone, California, for use in understanding earthquake hazards.
- Deliver surficial geologic maps of landslide-prone areas in Kentucky to develop risk assessments

2010

- Deliver geologic maps of areas of the Navajo Nation, Arizona, to be used to assess flash flood, erosion, and dust storm hazards.

2011

- Deliver a 3-D palinspastic reconstruction of San Andreas Fault System deformation through time.

Understand Surficial Processes

Surficial geologic maps continue to be critical for understanding and predicting the effects of climate, associated hydrologic changes, and human impact on landscapes, ecosystem function, and earth-science hazards. Surficial geologic maps, particularly when combined with databases describing physical properties of surficial materials, constitute multi-purpose tools for evaluating diverse land attributes. Because landscape processes are tightly coupled to climatic and hydrologic processes, sedimentary sequences record information about past climate and geomorphic responses to climatic variability. Physical properties of sediments also influence the availability of water and nutrients for biota, making this information vital for predicting and monitoring ecosystem function, health, and recovery. In order to determine rates of these processes and quantify links to climate, future efforts will work to increase competence in geochronology as related to surficial geologic studies.

Priority Activities for Understanding Surficial Processes

2007

- Deliver study of relationship of surficial and bedrock geology to flora and fauna of Great Smoky Mountains National Park based on geologic mapping.
- Complete surficial geologic maps of the Mojave Desert region to model ecosystem function related to porosity and permeability of units.

2008

- Explore opportunities for developing geologic frameworks for Alaska ecosystems.

2009

- Complete geologic maps of the Navajo Nation, Arizona, to be used to for ecosystem function monitoring.

2010

- Complete cooperative effort between USGS, State geological surveys, and National Park Service on understanding geologic controls on ecosystems along the Missouri River corridor.
- Complete large-scale surficial geologic map of the Mesa Verde National Park area, Colorado, for understanding prehistoric land-use and ecosystem patterns, landslide hazards, and land-use planning.

2011

- Deliver a model for understanding post-fire effects on debris flow susceptibility.

Produce Onshore-Offshore Geologic Maps

Geologic stratigraphic units frequently continue across the coastline uninterrupted, as do most gravity and magnetic anomalies. The coastline does not form a boundary to saltwater intrusion, subsurface water contamination, or mineral and hydrocarbon resources. In contrast, most current geologic maps show no information beyond the coastline. This is due primarily to the fact that there is significantly less detailed information available about offshore geology. However, there is a growing need for geologic maps that present onshore and offshore geology in an effective manner. This type of geologic map is currently being produced in southern California, depicting the surface geology, and in the San Francisco Bay area, to understand earthquake hazards. NCGMP will work with the USGS Coastal and Marine Program and partners outside of the USGS to develop methods to produce seamless geologic maps for onshore to offshore geology.

Annual Targets for PART and GPRA - Objective 1

Annual targets have been developed for NCGMP to assess program performance to measure progress through the PART, and meet the requirements of the Government Performance and Results Act (GPRA).

1. National Park Service shared goal: percent of geologic investigations in National Park Service units that are cited for use by the National Park Service within three years of delivery.

Explanation: The National Park units (National Monuments, National Parks, National Preserves, National Recreation Areas, National Reserves, and National Seashores) for which NCGMP provides assistance are selected through participation in National Park Service's Geologic Resource Evaluation annual scoping sessions and through discussions with NPS Geologic Resources Division, Water Resources Division, and Resource Managers. The type of NCGMP investigations/products delivered to each park depends upon the needs of the park and may include, but not be limited to, geologic maps, geologic reports, 3-D interpretations, assistance with park displays, and interpretive signs. Of the 270 park units designated for Inventory and Monitoring, 52 already have geologic maps, and 21 have maps in progress.

2007	80% of investigations cited
2008	80% of investigations cited
2009	80% of investigations cited
2010	80% of investigations cited

2. Water Resources Discipline (WRD) shared goal: percent of U.S. with ground-water availability status and trends information to support resource management decisions.

Explanation: The NCGMP has provided and continues to furnish 3-D geologic frameworks to WRD to incorporate into hydrogeologic models.
This measure was developed by the USGS Water Resources Discipline to meet specific program goals. The program realizes its goal of providing ground-water availability information to support resource management decisions is substantially improved with the

geologic framework provided by NCGMP scientists. The geologic units mapped 3-dimensionally by NCGMP define the aquifers, or the vessel that holds the ground water. NCGMP, through a shared goal with the Ground Water Resources Program, will contribute by supplying geologic frameworks used in hydrogeologic models for a percentage of the total 65 principal aquifers of the U.S.

2007 9% of aquifers will receive geologic frameworks
2008 10% of aquifers will receive geologic frameworks
2009 11% of aquifers will receive geologic frameworks
2010 12% of aquifers will receive geologic frameworks

3. Hazards Programs shared goal: number of counties or comparable jurisdictions that have adopted hazard mitigation measures based in part on geologic mapping and research.

Explanation: Geologic maps with their information about the structural/tectonic history of an area, and the geotechnical properties of rock materials, provide a fundamental basis for many hazard mitigation efforts across the Nation. NCGMP works cooperatively with the three Geologic Discipline Hazard Programs (Earthquake Hazard Program, Volcano Hazard Program and Landslide Hazard Program), all of which have similar measures. NCGMP, through STATEMAP, also works with state-level emergency management agencies to develop mitigation measures.

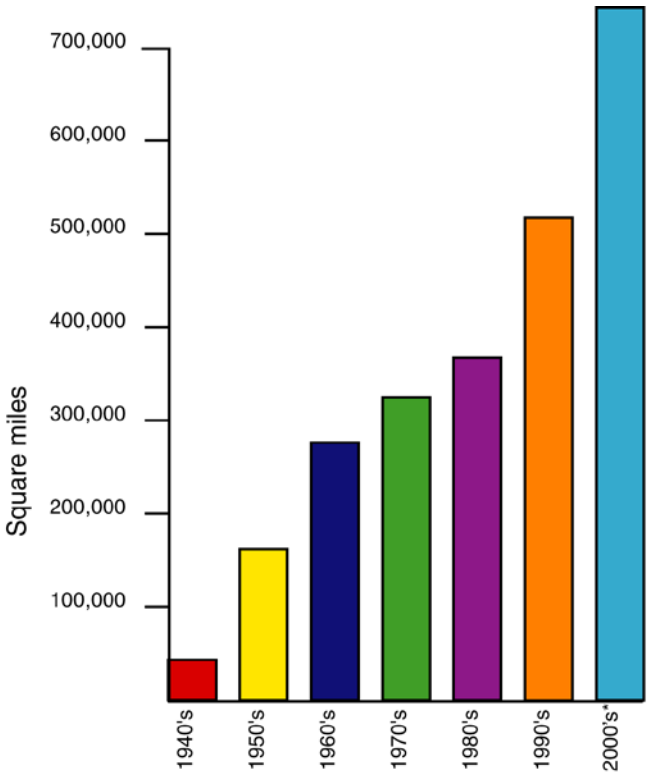
2007 14 counties or jurisdictions
2008 14 counties or jurisdictions
2009 15 counties or jurisdictions
2010 15 counties or jurisdictions

4. Provide systematic analyses to customers.

Explanation: NCGMP follows USGS guidelines for this GPRA (Government Performance Results Act) measure and counts the number of scientific publications produced each year with program funding.

2007 100
2008 98
2009 96
2010 94
2011 92

Objective 2 – Increase geologic map coverage of the United States through production of high quality, multi-purpose digital geologic maps and accompanying databases and reports.



Number of square miles mapped at 1:100,000 scale or larger by geologists during the last six decades and projected for 2000-2009 (compiled from the National Geologic Map Database).
* projected

Figure 7.

The production rate for geologic maps (1:63,360 and larger scales) was high during the 1950s and 1960s. The rate decreased in the 1970s and 1980s (Fig. 7). Through passage of the National Geologic Mapping Act of 1992, and its reauthorizations in 1997 and 1999, Congress recognized the importance of geologic mapping in utilization of mineral resources, effective stewardship of the environment, safe disposal of domestic and industrial waste, and mitigation of natural hazards. It established the National Cooperative Geologic Mapping Program under the leadership of the USGS to increase production of geologic maps of the U.S. Although this program has never been funded at the levels anticipated by the Act, it has had a significant impact on geologic mapping efforts. Production rate of geologic maps increased almost immediately after passage of the Act and has continued to increase since then (Fig. 7).

The NCGMP is committed to producing high-quality geologic maps well into the future, and ensuring that digital map information layers will be appropriate for development of special-use derivative maps. Databases that support and build the maps contain critical information for map users, and the Program encourages investigations that will develop effective ways to serve these data. The Kentucky Geological Survey, in cooperation with the USGS National Geologic Map Database Project, has taken the lead on this effort and has developed geologic map databases that link to specific societal issues related to resources and hazards. Many STATEMAP and FEDMAP projects cooperate to serve similar geologic information. For example, in California,

digital databases are being compiled that are used to develop seismic hazard zone maps. In the future, similar information will become available in more and more regions of the U.S.

Annual Targets for PART and GPRA – Objective 2

1. Percent of United States with geologic map coverage that is available to customers.

Explanation: The NCGMP measures the percent of the United States with modern geologic map coverage that is available to customers. Although more than one type of geologic map may be generated for each geographic area (bedrock versus surficial maps, maps of different scales), this measure only counts coverage once. Thus, the number can never exceed 100% of the U.S.

2007	57½% of U.S. with geologic map coverage
2008	60% of U.S. with geologic map coverage
2009	62% of U.S. with geologic map coverage
2010	64% of U.S. with geologic map coverage

Objective 3 – Develop more efficient techniques for producing geologic maps with regard to data collection and preservation and map preparation and delivery.

Although organizations that produce geologic maps use a variety of methods to collect, compile, and publish geologic map data, all are moving toward the use of digital methods to streamline geologic map production. Prior to 1995, most field data were recorded on paper maps and in notebooks. Recent advances in hand-held computer and global positioning system (GPS) technologies have reduced the amount of navigation time in the field and allowed for more efficient collection and processing of field data. Because data can be placed directly into a geographic information system (GIS) in the field, many parts of a geologic map are produced in real time. Prior to this advancement, data were hand drafted on stable base maps in the office, which increased the chances of introducing errors. Digital collection of field data also permits multiple backup systems, which make the information more secure and eliminate the necessity for recollection if a field notebook or field map is lost. Also, new digital photogrammetry has made possible the production of accurate digital elevation models from aerial photography allowing the geologist in-office mapping of some geologic features. This advance preparation for fieldwork saves time spent in the field mapping a particular structure.

In-office compilation of the geologic map can now be edited on-screen in a GIS, and various types of computer graphics software can easily be used to produce a map plate. Prior to digital methods, each piece of a geologic map was compiled separately, and it usually was drafted by hand. Digital compilation has added one step to the process because metadata must now accompany every digital product. Currently, many different techniques are being used in map compilation. In the future, standardization of these procedures will save time and provide significant cost benefits.

In the past, publication of paper geologic maps required hand cartographic and photographic techniques, which are time-consuming tasks. By using digital files for map publication, many of these time-consuming tasks are eliminated. Additional time and cost savings occur when the

geologic map is published as digital files because they can be downloaded or plotted on demand by the geologic map user. In the past 10 years, advances in digital techniques for geologic map production have reduced both production time and costs. In the future, additional efficiencies will be realized through implementation of standardized procedures and use of improved technologies as they are developed, especially for geologic map compilation.

Annual Targets for PART and GPRA - Objective 3

Number of hours for fieldwork, compilation, and publication of a typical FEDMAP geologic map.

Explanation: The NCGMP is tracking the number of work hours saved by achieving efficiencies in field work, map compilation, and publication time of a typical geologic map.
Increased use of recently developed digital techniques reduces the time it takes to produce a geologic map - from the time the geologist goes into the field to the time the map is available to customers. This saves hours and money, gets products to the customers sooner, makes the products more accessible through digital means, and provides more security for the data with multiple backups through the entire process. Digital production eliminates the costs of maintaining large inventories of printed maps and improves the currency of information provided on the maps. The numbers in the annual targets are actual hours that a specific map is worked on. This does not include an average of 4 months maps are in queue waiting for editing and digital cartography.

2007	2250	hours for geologic map production
2008	2170	hours for geologic map production
2009	2080	hours for geologic map production
2010	2000	hours for geologic map production

GOAL 2 - Make geologic map information more accessible to the public by providing geologic maps, reports, and databases in a variety of digital formats. Preserve and make accessible the extensive USGS paleontologic collections and accompanying databases.

The Nation now requires products that are interactive and can be integrated into land-use and decision-making tools. Changes in computer technology and geographic information systems (GIS) have increased the utility of geologic maps. Geologic information can now be presented as separate digital layers, which can be manipulated and easily integrated into other geoscience data sets and land management information. This provides new ways of looking at information that is especially useful for making land-use decisions. For example, if a municipality is interested in a location for a landfill, they can pull karst potential geologic units and rule out these areas for the site.

Recent advances in integrating information from multiple geoscience disciplines have improved the usefulness of the geologic map databases. Geophysical surveys, such as aeromagnetics, drill-well logs, and other investigations, can be included with the geologic

map database and help the geologist see into the subsurface. Integration of these types of investigations aid in developing 3-D geology and are useful for modeling.
This does not mean that the traditional geologic map product is no longer relevant. The traditional geologic map is used by many field-based disciplines because it is easy to use and shows all of the geologic data in one place. It often isn't practical to carry a computer into the field, and for field applications, the restricted size limitations of a computer screen is not the most efficient way to capture information. Computers aren't as reliable as a printed geologic map in the field because they can lose battery power, develop viruses, and don't respond well to weather extremes.

In the next five years, NCGMP will continue to implement improvements in the way it serves geologic map data. Geologic map products of the future will include all geologic data in digital layers that can be stored in several formats for easy use by other geologists, land-use planners, and engineers. At the same time, field data will continue to be compiled into a traditional geologic map that can be printed or plotted for use in the field and for regional compilation and seamless maps.

There are several requirements for successful development of digital geologic map databases for the future. First, the USGS must have available the personnel who can collect and manipulate data, which includes paleontologists, geochronologists, geophysicists, GIS technicians, and computer programmers. Computer programmers will be critical for developing software to serve geologic data efficiently and affectively. Second, a large amount of virtual space on servers must be available to store and transmit the large databases behind the geologic maps. Third, communication and cooperation within the state and federal geoscience community is essential for developing consistent platforms to serve the data. Fourth, specific standards for web serving and database structure will need to be developed. Last, there will need to be adequate funding to support the personnel and computer software and hardware needed to make these changes.

Objective 4 – Develop and maintain the National Geologic Map Database. Establish widely accepted standards for creating and managing digital geological map data.

As required by the National Geologic Mapping Act of 1992, the National Geologic Map Database (NGMDB) serves as a national catalog and archive that is distributed through links to Federal and State geologic map holdings. It includes information on how to obtain all maps developed with funding from the NCGMP, databases developed in connection with interdisciplinary studies that add value to geologic maps, and other maps and data that the USGS and the Association of American State Geologists (AASG) consider appropriate. NGMDB also includes a lexicon of geologic names used to communicate geologic science and an image library for the user to examine available maps. In the future, the database will include (1) studies that lead to the implementation of cost-effective digital methods for the acquisition, compilation, analysis, production, and dissemination of geologic map information, and (2) paleontologic, geochronologic,

and isotopic investigations that provide information critical to understanding the age and history of geologic map units.

Another future goal is to use more standardized format, symbols, and technical attributes on geologic maps that are contributed to the NGMDB so that archival information can be accessed, exchanged, and compared more efficiently and accurately. Entities that contribute geologic maps to the database have worked to develop these standards in cooperation with the Federal Geographic Data Committee (FGDC).

Annual Targets for PART and GPRA – Objective 4

1. Number of State geological surveys that add geologic map information to the NGMDB.

Explanation: Incorporate geologic map information from all State geological surveys and Puerto Rico. The NCGMP monitors the number of State geological surveys that add geologic map information to the NGMDB. In order to provide one Web site for geologic map information for the entire U.S. and its territories, the NGMDB needs to include geologic maps published by all 50 State geological surveys and their equivalents. The NCGMP has been involved in an ongoing process to develop cooperative relationships with these surveys that will make this possible. This measure shows the success of this effort.
This measure is a first step toward having every geologic map product ever produced in the United States listed, with its metadata and information on how to obtain the map, in the National Geologic Map Database catalog. Successful accomplishment of this goal helps NCGMP achieve Goal 2 in its 5-year plan, and requires both continuous coordination between USGS and AASG, and thoroughness in annual maintenance.

2007	50 states/Puerto Rico
2008	51 states/Puerto Rico

This measure ends in 2008 or when there are 51 participants.

2. Number of gigabytes added to the National Geologic Map Database (NGMDB) each year.

Gigabytes added	Total gigabytes
2007	200 1350
2008	200 1550
2009	200 1750
2010	200 1950

Objective 5 – Improve customer service through Web-based technology and delivery of NCGMP information.

As more and more information is being distributed through the Internet, customers are expecting efficient, effective, and timely access to data. The NCGMP is striving to provide the data that customers need. For example, in 2005, the NCGMP released its

completely redesigned Web site that was developed through cooperation with the USGS Geographic Information Office.

With the establishment of the new National Geologic and Geophysical Data Preservation Program within the Geologic Discipline of the USGS, there is renewed emphasis on preserving valuable USGS geoscience samples and capturing and making available digital information about these materials. Many USGS paleontologists are near retirement, and before they leave, it is important that their accumulated information to be captured in a manner that provides maximum accessibility to our customers. In addition, an effort must be made to preserve paleontological information from those paleontologists who have already left the USGS because their data are the most "at risk."

In the next five years, the program will focus on developing and serving an Internet-based USGS paleontological database that provides geographical-based information about more than one hundred years of USGS fossil studies.

Priority Activities for Implementing National Geologic and Geophysical Data Preservation Program

2007

- Publish booklet on examples of good data preservation in cooperation with Texas Bureau of Economic Geology.
- Establish USGS Paleontology Committee to recommend guidelines for preservation of current and future USGS fossil materials and associated data.

2008

- Work with Smithsonian Institution to determine guidelines for which USGS fossil materials should go to the Smithsonian. Develop guidelines for what fossil materials are donated to the Smithsonian.

Priority Activities for Establishing a USGS National Paleontological Database

2007

- USGS Paleontology Committee evaluates existing Internet-based databases for usability with USGS fossil data and makes recommendations.

2008

- Select database and begin modifications to accommodate USGS fossil information.

Objective 6 – Provide geologic map information to our customers through formal workshops and training.

One effective method for geologists to transmit geologic mapping information to customers is through face-to-face meetings and workshops. Excellent examples include the Española Basin Technical Advisory Group (EBTAG) Workshop and the Great Valley Water-Resources Science Forum.

EBTAG is a group of technical professionals who represent government and academic organizations that conduct geologic, geophysical, and hydrologic studies related to understanding the Española Basin. Geologic mapping projects that are supported by NCGMP through FEDMAP and STATEMAP play an integral part in improving the understanding of the three-dimensional hydrogeologic and geologic frameworks of the Española Basin, and provides a requisite step toward better management of ground water in the area. Once a year, they hold a two-day workshop to share information about local ground-water resources. On the first day of the workshop, scientists share technical information, while the second day is devoted to sharing important results with interested members of the local community, including politicians, land-use managers, and tribal representatives.

The Great Valley Water-Resources Science Forum enhances the regional integration of USGS science programs to address the availability, vulnerability, and quality of ground water in the Great Valley of the eastern United States. The forum includes representatives from the USGS and universities, State and local agencies, and public interest groups from Pennsylvania, Maryland, Virginia, and West Virginia. The USGS presents its data and findings through this forum, which is held twice each year and is aimed at local governments, land-use managers, and public interest groups.

Annual Targets for PART and GPRA – Objective 6

1. Provide geologic map information to customers through formal workshops and training.

2007	10 workshops/training
2008	10 workshops/training
2009	10 workshops/training
2010	10 workshops/training
2011	10 workshops/training

GOAL 3 – Ensure that the NCGMP will have the capabilities/work force to meet the future needs of the Nation.

USGS science priorities continually evolve to meet the needs of the Nation. Responding to changing science priorities requires changes in workforce capabilities, adding capabilities to move in new science directions, and reducing capabilities in areas for which funding is increasingly difficult or impossible to obtain. Level funding creates a difficult environment for programmatic growth or redirection because operational funds are increasingly consumed by inflation, rising facility costs, and increasing salary costs from promotions and cost-of-living increases. Level funding and inflation confound efforts to add new skills. Within five years, more than fifty percent of the geologic research staff, fifty-seven percent of the administrative staff, and approximately forty-seven percent of the technical staff will be eligible for retirement. While USGS employees typically do not retire immediately upon becoming eligible, the large number

of prospective retirements threatens USGS with the loss of critical skills needed to perform core activities. On the other hand, prospective turnover of positions provides an opportunity to adjust the size of the workforce, add new capabilities, introduce more flexibility in the workforce, and increase operating margins.

These challenges are mirrored in the staff supported by NCGMP. Over the last ten years, the number of geologic mappers and paleontologists has decreased through retirements and the movement of geologists into management positions. NCGMP will use the EDMAP component of the program and the USGS Mendenhall Postdoctoral Research Fellowship and Student Career Education (SCEP) Programs to help replace needed capabilities.

Objective 7 – Provide the next generation with geologic mapping knowledge and experience through EDMAP, the Student Career Education Program (SCEP), and the Mendenhall program.

Within the agencies responsible for geologic mapping, the workforce of geologic mappers has declined over the past decades. As part of the National Geologic Mapping Act, the NCGMP, in 1996, created the EDMAP component to train the next generation of geologic mappers. The NCGMP allocates funds to colleges and universities in the United States and Puerto Rico through an annual competitive grant process. Every Federal dollar that is awarded is matched with university funds. Geology professors, who are skilled in geologic mapping, request EDMAP funding to support undergraduate and graduate students at their college or university in one-year mentored geologic mapping projects that focus on specific geographic areas. Although individual projects last for only one year, they may build upon the results of previous years' efforts. EDMAP geology professors and their students frequently work closely with STATEMAP and FEDMAP geologists who may be mapping nearby.

Each year since 1996, the NCGMP has funded 60-70 students on EDMAP projects at 30-40 colleges and universities in 20-30 states, the District of Columbia, and Puerto Rico. These projects include both bedrock and surficial geologic mapping. Over 600 students from 133 universities have received EDMAP cooperative grants, totally approximately $4 million. After their EDMAP experience, 40 of these students have obtained employment with the USGS, other DOI bureaus, other Federal agencies, or State geological surveys. In 2006, 65 students from 37 universities received funding. One-third of these students were upper-level undergraduates. The success of the EDMAP experience is due primarily to the high quality of the mentoring received by the students. Many EDMAP projects not only include time in the field with the university professor, but also include time in the field with geologists from the USGS and State geological surveys. These experiences, along with field reviews, clearly enhance the learning experience.

EDMAP is a unique program that fills a niche not supported by the National Science Foundation or any other granting organization. In the next 5 years, NCGMP will (1) continue to track EDMAP students as they complete their education and obtain

employment, (2) explore opportunities with historically black colleges and other minority institutions to increase diversity in the geosciences, (3) encourage field reviews of EDMAP projects by State and Federal geologists, and (4) make these maps available to the public through the NGMDB.

A recent NCGMP survey, which received replies from nearly 200 former EDMAP students, illustrates the success of EDMAP. Over ninety percent of these students have either pursued an additional degree in geoscience or obtained professional employment in the geoscience field. This high percentage of EDMAP students remaining in the geoscience field is well above the national average. While this is partially due to the fact that professors choose their best students for the EDMAP experience, there is also the factor that the students' ability to make and use geologic maps is recognized as a marketable commodity for private industry, State and local governments, and the Federal government.

The Mendenhall Postdoctoral Research Fellowship Program provides an opportunity for postdoctoral fellows to conduct concentrated research in association with selected members of the USGS professional staff, often as a final element to their formal career preparation. The program is also intended to provide research experiences that enhance their personal scientific stature and credentials. The Mendenhall Postdoctoral Research Fellowship Program brings the most current expertise in the earth sciences into ongoing research. Mendenhall Fellows are appointed to the USGS for two years and receive full salary and benefits at the GS-12 level. In the next five years, the NCGMP will continue to support this important effort, and it is anticipated that former EDMAP students will continue to participate in the Mendenhall Program. SCEP allows the USGS to hire promising graduate students and pair them with geologists and geologic mappers for mentoring. Several geologic mappers have recently been hired by the USGS through this program.

Annual Targets for PART and GPRA – Objective 7

1. % of EDMAP students that work on subsequent geoscience degrees or obtain a job in a geoscience field.

Explanation: This information is gathered through questionnaires that are sent to students three years after they complete their EDMAP experience. EDMAP students are well above the National average for remaining in the geoscience field, and the program has a goal to maintain this high success rate. This measure facilitates continued availability of geologic mapping expertise in the geoscience field.

2007	95% of students continuing in geoscience
2008	95% of students continuing in geoscience
2009	95% of students continuing in geoscience
2010	95% of students continuing in geoscience

2. Number of EDMAP students trained each year.

Explanation: Although NCGMP funding is expected to remain essentially level, the amount available for the three program components will be less due to salary increases. The program is committed to find ways to continue funding 60 EDMAP students per year. This measure indicates a continued pool of students with geologic mapping capabilities.

2007	60 students
2008	60 students
2009	60 students
2010	60 students

IV. Program Review and Strategic Planning

The NCGMP will continue to seek advice from and be reviewed by its external and internal partners and clients. Principal overall guidance on broad program direction and implementation of the National Geologic Mapping Act is provided by the program's ten-member Federal Advisory Committee, which is composed of representatives from the U.S. Environmental Protection Agency, Departments of Energy and Agriculture, Office of Science and Technology Policy, the USGS, State geological surveys, academia, and the private sector. The National Geologic Map Database project sponsors annual workshops and forums wherein partners from within and beyond USGS can provide input and feedback. New FEDMAP projects are developed in partnership with State agencies, and derive their goals from needs assessment workshops in the regions of interest.

The program is committed to obtaining an independent external review every 5-10 years. In 2007, a review by the American Association for the Advancement of Science (AAAS) focused primarily on improved methods to serve geologic information to customers, including the role that the program should take in producing derivative products and setting standards for data collection and preservation. Several recommendations from AAAS will be implemented over the next several years: (1) a more formalized process will be put in place to solicit input and engage stakeholders in discussions and decisions about mission, priorities, and resource allocation; (2) a clear description of funding philosophy of the Program will be developed and communicated to stakeholders inside and outside the Program; (3) accomplishment of high-priority national and state mapping needs will be achieved through closer collaboration and complementary projects between FEDMAP and STATEMAP; and (4) work toward including derivative products under the STATEMAP component.

As part of the annual Science Planning Process, the FEDMAP advisory committee, made up of program managers, project scientists, and representatives from USGS Water Resources Discipline, National Park Service, Fish and Wildlife Service, and the Association of American State Geologists, reviews FEDMAP project proposals and makes recommendations for improvement of ongoing projects and on the merits of new project proposals. The external grants proposals for STATEMAP and EDMAP are

reviewed by national award panels made up of scientists from the USGS, State geological surveys, and universities. NCGMP, the Federal Advisory Committee, and STATEMAP and EDMAP panels provide guidance and input into the Program Announcement, the yearly call for proposals for the external projects.