ABSTRACT

The United States’ Geologic Mapping Act requires that a National Geologic Map Database (NGMDB) be designed and built by the U.S. Geological Survey (USGS), in cooperation with the Association of American State Geologists (AASG). The Act notes that the NGMDB is intended to serve as a "national archive" of geologic maps, to provide the information needed to address various societal issues. This project is, emphatically, a collaborative effort supported by extensive, open discussion with the geoscience community. In mid-1995, the general stipulations in the Act were addressed in the proposed design and implementation plan developed by the USGS and AASG. Because many maps are not yet in digital form and because many organizations produce and distribute geologic maps, it was decided to develop the NGMDB in several phases.

The first and most fundamental phase is a comprehensive, searchable catalog of all geoscience maps in the United States, in either paper or digital format. The users, upon searching the NGMDB catalog and identifying the map(s) they need, are linked to the appropriate organization for further information about how to procure the map. The map catalog presently is supported by two databases developed under the NGMDB project: 1) GEOLEX, a searchable geologic names lexicon; and 2) Geologic Mapping in Progress, which provides information on current mapping projects, prior to inclusion of their products in the map catalog.

The second phase of the project focuses on public access to digital geoscience maps, and on participation in the development of U.S. and North American digital map standards and guidelines needed to improve the utility of those digital maps. The third phase is now developing, through a series of prototypes, an online, "living" database of geologic map information at various scales and resolution. Information about the project can be found at <http://ncgmp.usgs.gov/ngmdbproject>.
INTRODUCTION

The Geologic Mapping Act of 1992 and its reauthorizations in 1997 and 1999 (PL106-148) require that a National Geologic Map Database (NGMDB) be designed and built by the U.S. Geological Survey (USGS), with the assistance of the state geological surveys and other entities participating in the National Cooperative Geologic Mapping Program. The Act notes that the NGMDB is intended to serve as a "national archive" of geologic maps, to provide the information needed to address various societal issues. The Act required the NGMDB to also include the following related map themes: geophysics, geochemistry, paleontology, and geochronology. In this progress report, the term "geoscience" is used to refer to these five map themes.

In mid-1995, the general stipulations in the Act were addressed in the proposed design and implementation plan developed within the USGS and the Association of American State Geologists (AASG). This plan was summarized in Soller and Berg (1995). Because many maps are not yet in digital form and because many organizations produce and distribute geologic maps, it was decided to develop the NGMDB in several phases. The first and most fundamental phase is a comprehensive, searchable catalog of all geoscience maps in the United States, in either paper or digital format. The users, upon searching the NGMDB catalog and identifying the map(s) they need, are linked to the appropriate organization for further information about how to procure the map. (The organization could be a participating state or federal agency, association, or private company.) The map catalog presently is supported by two databases developed under the NGMDB project: 1) GEOLEX, a searchable geologic names lexicon; and 2) Geologic Mapping in Progress, which provides information on current mapping projects, prior to inclusion of their products in the map catalog. The second phase of the project focuses on public access to digital geoscience maps, and on the development of digital map standards and guidelines needed to improve the utility of those digital maps. The third phase proposes, in the long term, to develop an online, "living" database of geologic map information at various scales and resolution.


Relation of NGMDB Project to USGS Organizational Structure

In many important respects, the NGMDB project is designed as a typical USGS science project. However, it also has some standards development responsibilities that are rather unique and not found in other USGS projects. The USGS is in the process of reorganizing its
management structure, to better support science projects at the local and regional levels. Projects of national scope, such as the NGMDB, are placed within this regional structure (figure 1). Under the new management structure, the NGMDB project chief (Soller) reports to the Eastern Earth Surface Processes Team’s Chief Scientist. [Formerly, the NGMDB project reported directly to the National Cooperative Geologic Mapping Program (NCGMP), which now resides under the Associate Director for Geology.] When the NGMDB project designs policies and standards, it attempts to have them implemented by science projects and data management activities in the USGS; this is accomplished through line management (e.g., it requests the Eastern Region management to coordinate with the other USGS regions). For standards development activities that are coordinated with other entities and the geoscience community in general, the project attempts to directly represent the USGS (e.g., to the Federal Geographic Data Committee and the North American Data Model Steering Committee).

PROJECT ACTIVITIES

As noted above, this project is divided into three phases (figure 2). Brief descriptions of activities conducted under these phases is given below. A more detailed accounting of tasks and progress is available in the References section.

Phase One

Work on the first phase of the NGMDB has included the database and Web interface of the Map Catalog, and development of supporting databases including the Geologic Names Lexicon and the Geologic Mapping in Progress Database.

The Map Catalog

The map catalog is designed to be a comprehensive, searchable catalog of all geoscience maps of the United States and its territories, whether in paper or digital format. Entries to the catalog include maps published in geological survey formal series and open-file series, maps in book publications, maps in theses and dissertations, maps published by park associations and scientific societies, maps published by other agencies, and publications that do not contain a map but instead provide a geological description of an area (for example, a state park). The catalog now contains a record for each of nearly 38,500 map products. Essentially 100% of all USGS maps have been recorded in the catalog, and in the past year emphasis has shifted to support the State geological surveys as they begin to enter their maps and related maps (e.g., in University theses) into the catalog. The catalog is available for searching at <http://ngmsvr.wr.usgs.gov/ngmdb/ngm_catalog.ora.html>.

Geologic Names Lexicon

The searchable, on-line, geologic-names lexicon (“GEOLEX”) now contains roughly 90% of the geologic names found in the most recent listing of USGS-approved geologic names (published in 1996 as USGS Digital Data Series DDS-6, revision 3) and is estimated to contain
roughly 75% of all geologic names in the United States. Work remaining includes incorporating additional geologic names not found on DDS-6 but recorded in the geologic names card catalog at USGS Headquarters, and incorporating names approved by the state geological surveys but not yet in the USGS records. GEOLEX is intended to be the comprehensive, authoritative listing of approved geologic names, and is available as a resource for geologic mappers nationwide. State geological surveys are encouraged to add new geologic names to GEOLEX, through a Web-based application form that will be introduced later this year. Geolex is available at <http://ngmdb.usgs.gov/Geolex/geolex_home.html>.

Geologic Mapping in Progress Database

To provide users with information about current mapping activities at 1:24,000- and 1:100,000-scale (1:63,360- and 1:250,000-scale in Alaska), a Geologic Mapping in Progress Database is maintained. This database is available at <http://ngmdb.usgs.gov/MapProgress/MapProgress_home.html>.

Phase Two

Most efforts related to phase two have been directed toward the development of standards and guidelines needed to help the USGS and state geological surveys more efficiently produce digital geologic maps and to produce those maps in a more standardized and common format. Significant progress has been made toward developing some of these standards and guidelines, and to providing map catalog users with access to online products.

Standards Development


Geologic Map Symbolization

A draft standard for geologic map line and point symbology and map patterns and colors, published in a USGS Open-File Report in 1995 (report number 95-525), was in 1996 reviewed by the AASG, USGS, and Federal Geographic Data Committee (FGDC). It was revised by the NGMDB project team and members of the USGS Western Region Publications Group and was circulated for internal review in late 1997. The revised draft then was prepared as a proposed Federal standard, for consideration by the FGDC. The draft was, in late 1999 through early 2000, considered and approved for public review by the FGDC and its Geologic Data Subcommittee. The document was released for public comment within the period May 19 through September 15, 2000 (see <http://ncgmp.usgs.gov/fgdc_gds/mapsymb/> for the document and information about the review process). This draft standard is described in some detail in Soller and Lindquist (2000). The document is being revised for late-2001 or early-2002 submittal to FGDC, for discussion and adoption as a Federal standard.
The AASG/USGS Data Capture Working Group has coordinated four annual “Digital Mapping Techniques” workshops for state, federal, and university geologists, cartographers, and managers from the United States and Canada. These meetings have been highly successful, and have resulted in adoption within agencies of new, more efficient techniques for digital map preparation, analysis, and production. The most recent workshop, held in Tuscaloosa, Alabama, and hosted by the Geological Survey of Alabama, was attended by approximately 110 representatives of 48 state, federal, and Canadian agencies and private companies. The workshop proceedings are published (Soller, 1997, 1998, 1999, 2000, and in press) and served on-line at (<http://ncgmp.usgs.gov/pubs/of97-269>; <http://pubs.usgs.gov/openfile/of98-487>; <http://pubs.usgs.gov/openfile/of99-386>, and <http://pubs.usgs.gov/openfile/of00-325>.

Map Publication Requirements

Through the USGS Geologic Division Information Council, one of us (Soller) led development of the USGS policy “Publication Requirements for Digital Map Products” (enacted May 24, 1999). A less USGS-specific version of this document was developed by the AASG/USGS Data Information Exchange Working Group and presented for technical review at a special session of the Digital Mapping Techniques ‘99 workshop (Soller and others, 1999). The revised document (entitled “Proposed Guidelines for Inclusion of Digital Map Products in the National Geologic Map Database”) is now under review by the AASG Digital Geologic Mapping Committee for consideration as a guideline for newly-produced maps available through the NGMDB.

Metadata

The AASG/USGS Metadata Working Group developed its final report in 1998. The report provides guidance on the creation and management of well-structured formal metadata for digital maps (see <http://ncgmp.usgs.gov/ngmdbproject/standards/metadata/metaWG.html>). The report contains links to metadata-creation tools and general discussions of metadata concepts (see, for example, the metadata-creation tools, “Metadata in Plain Language” and other helpful information at <http://geology.usgs.gov/tools/metadata/>.

Geologic Map Data Model

The AASG/USGS Data Model Working Group, which was coordinated under the NGMDB project, produced in 1998 a draft standard conceptual data model. This model continues to be revised and refined, now under the auspices of the North American Data Model Steering Committee (NADMSC). State and USGS collaborators on the NGMDB serve as representatives to the NADMSC, assisting in the process of developing, refining, and testing the North American Geologic Map Data Model. The NADMSC has now formed various technical
teams to conduct specific tasks within a one-year period, and longer time-frames. If interested, please visit the NADMSC web site, <http://geology.usgs.gov/dm/>.

Access to Online Products

As standards are developed under Phase Two and via other mechanisms, the products released by geological surveys increasingly are standardized in format and content. A principal goal of Phase Two is to provide links from the Map Catalog to the more standardized of these products. Through searches of the NGMDB Map Catalog, users are directed to web sites for perusal of selected online products. This feature of the Map Catalog is now available for USGS products served on USGS Regional Publications Servers, and for metadata served on the USGS Clearinghouse node. At this time, more than 500 links exist to online map products and their metadata.

Phase Three

Over the past few decades, significant advances in computer technology now permit complex spatial information to be stored, managed, and analyzed to the satisfaction of a growing number of geoscientists. At the beginning of the NGMDB project, we judged that computer-based mapping was not a sufficiently mature discipline to permit us to develop an online database. Further, technology for display and query of complex spatial information on the Web was in its infancy, and hence was not seriously considered by the NGMDB project as a viable means of delivering useful information to the general public. Now, six years after the project's inception, there exists sufficient digital geologic map data, sufficient convergence on standard data formats, data models, and digital mapping practices, and sufficient technological advances in Internet delivery of spatial information to warrant a research effort aimed at building a prototype, online National Geologic Map Database.

To design an online database, the project has held numerous discussions with geoscientists and the general public, to gauge interest in an online database, and to define its scope. Based on these discussions, it is clear that this database should be:

1. built from edge-matched geologic maps at various scales,
2. managed and accessed as a coherent body of map information, not just as a set of discrete map products,
3. updated by mappers and/or a committee, "on the fly" when new information becomes available (i.e., this will be a “living” database),
4. standardized, adhering to a standard data model and with standard scientific terminology, and
5. available to users via Internet browsers and common GIS tools (e.g., ArcExplorer).

The NDMDB project has begun a series of prototypes designed to build this online, “living” database. A brief overview of the first prototype is found in Soller and others (2000),
and results of this prototype will be available in Soller (in press). We anticipate further prototypes that will advance our understanding of the technical and management challenges to be addressed in development of the operational system.

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REFERENCES


Figure Captions

Figure 1. USGS organizational chart. Only those elements relevant to geologic map information management and the National Geologic Map Database (NGMDB) project are shown. The Associate Directors were formerly known as the Division Chiefs (e.g., Chief Geologist). The Disciplines were formerly known as Divisions (e.g., Geologic Division). The funded programs
(e.g., National Cooperative Geologic Mapping Program) are organized under the appropriate Associate Director. Staff members working on science projects (e.g., the NGMDB) are managed under the Regional structure, reporting directly to the Team Chief Scientists. The NGMDB project reports to the Eastern Earth Surface Processes Team’s (EESP) Chief Scientist.

Figure 2. Diagram showing user access to the various components of the National Geologic Map Database (NGMDB) project, and to related external databases and services. The three project phases are shown, and the relations among them. Dashed arrows indicate planned relations. This diagram, for example, shows that a user might access the Map Catalog and identify a map of interest; the user might then purchase the map or link to a map server where the product can be downloaded. In the latter case, the arrow passing through “Standards Development” indicates that the NGMDB project’s standards development activities affect the content and format of products served.
Map Sales
National Spatial Data Infrastructure (NSDI)

Related Science Databases

Map Catalog
Online "living" map database
Standards Development
Publication policy, Symbology, Data Model, ...

Mapping in Progress

GEOREF

USER

Map Servers