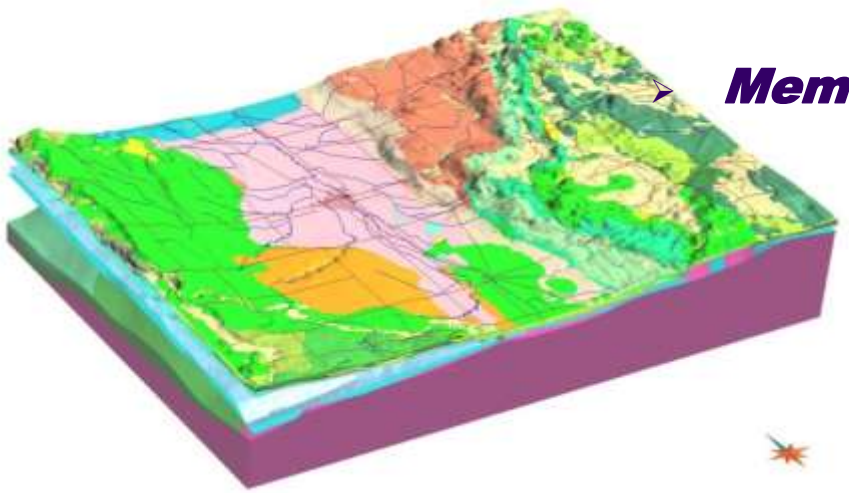
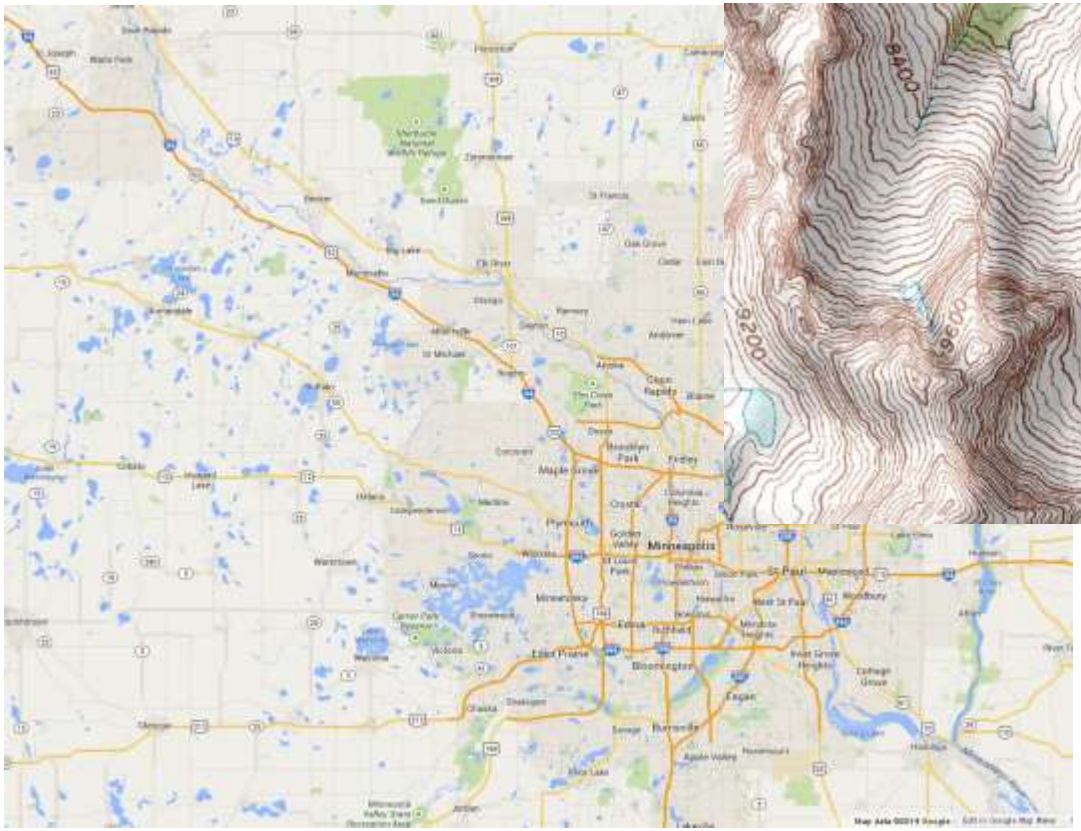
Progress on the US geological mapping strategic plan

Harvey Thorleifson

- *Chair, Association of American State Geologists Mapping Committee*
- *Member, National Geospatial Advisory Committee*
- *Director, Minnesota Geological Survey*

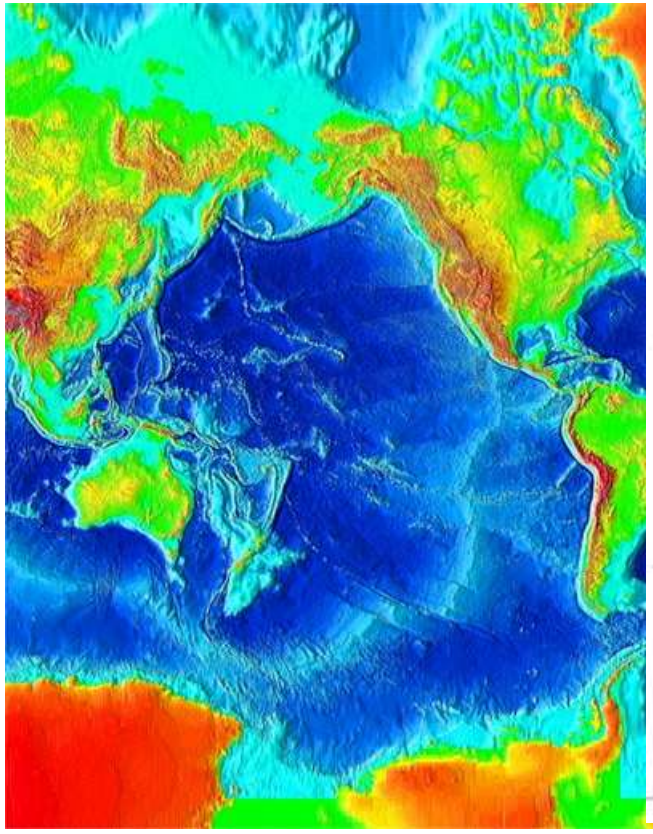


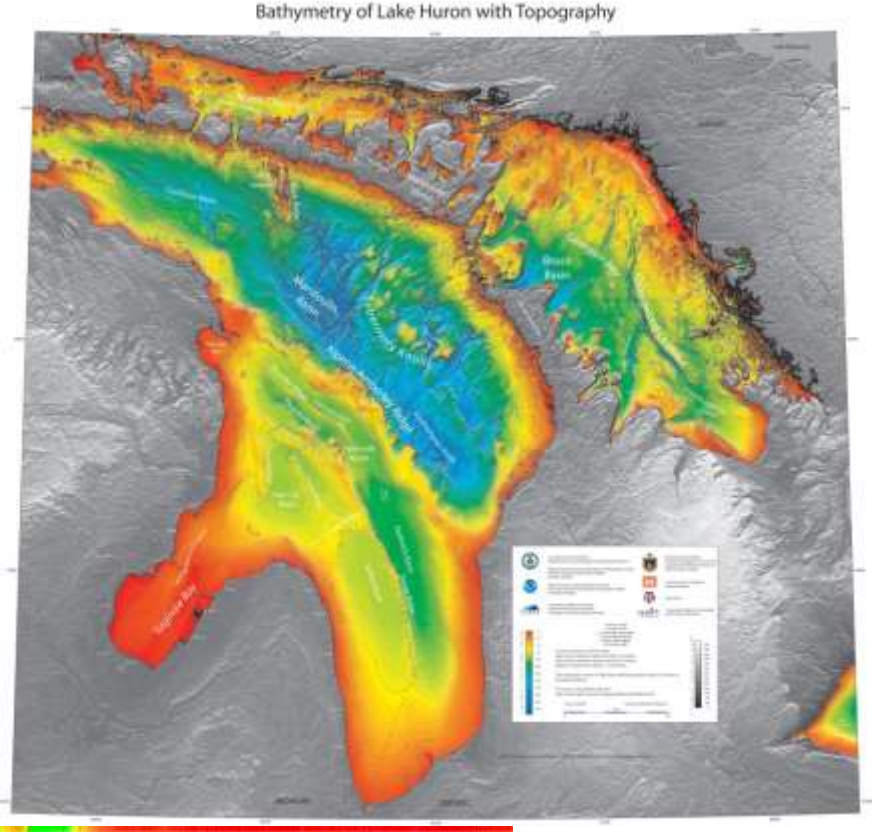
Most mapping shows land-surface features



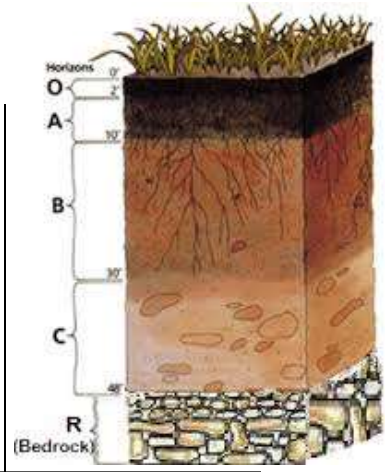
Weather forecasts come from dynamic maps of the atmosphere

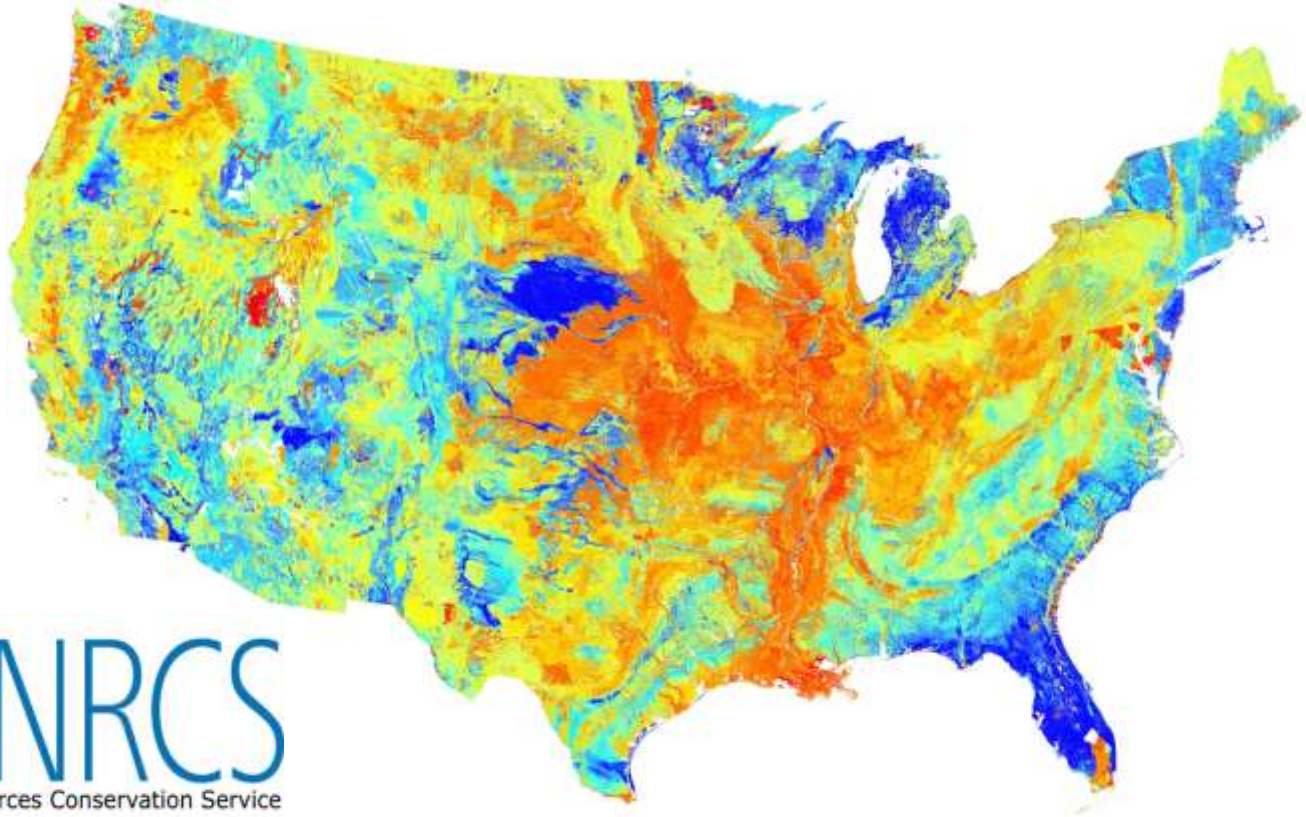
The first subsurface layer is bathymetry





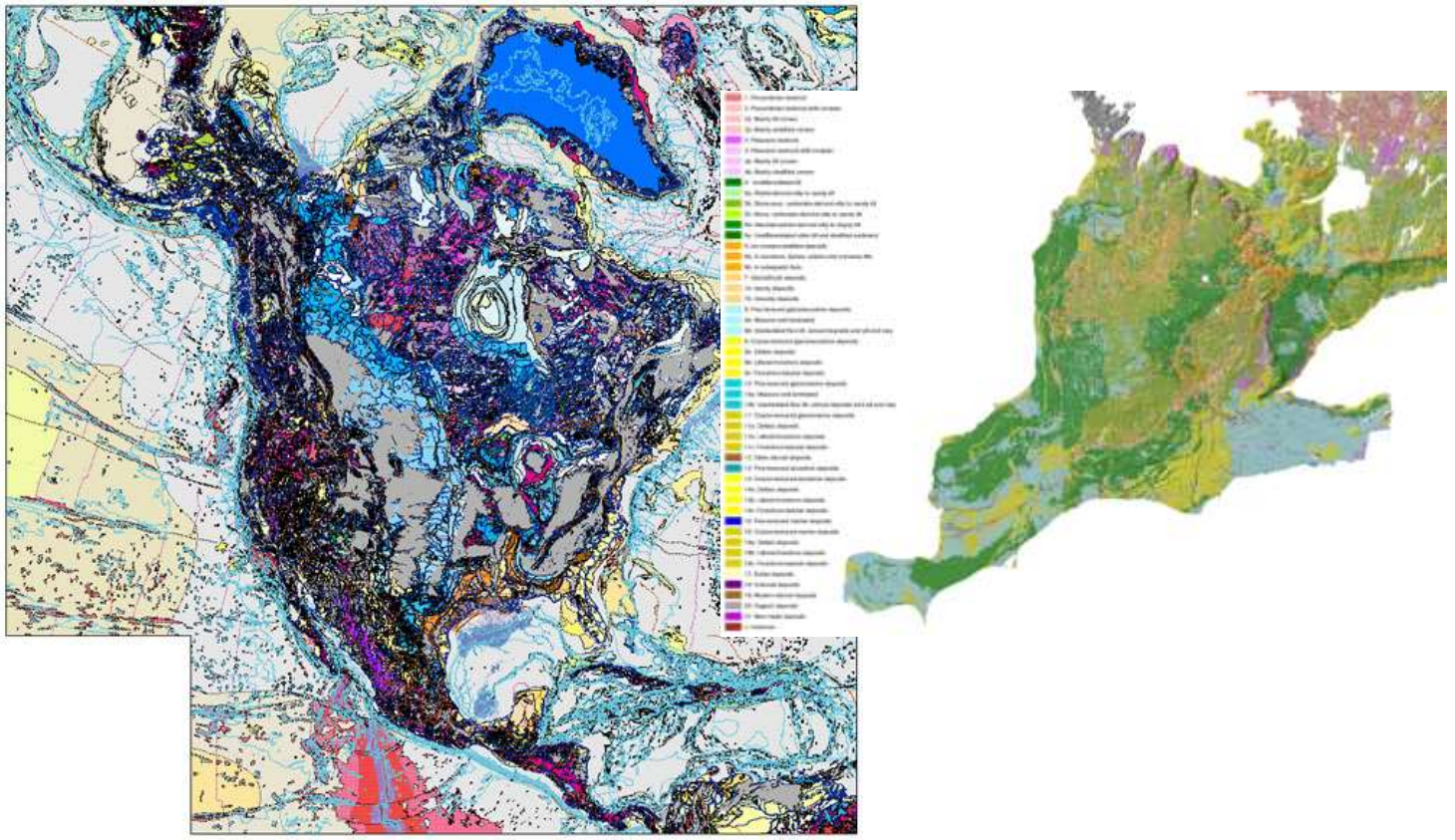
Next, soil mapping by agricultural agencies





NRCS
Natural Resources Conservation Service

Then, geological mapping showing sediments and rocks



Geological mapping is needed for:

- Energy
- Minerals
- Water
- Hazards
- Environment
- Waste
- Engineering
- Research

Geological mapping saves money

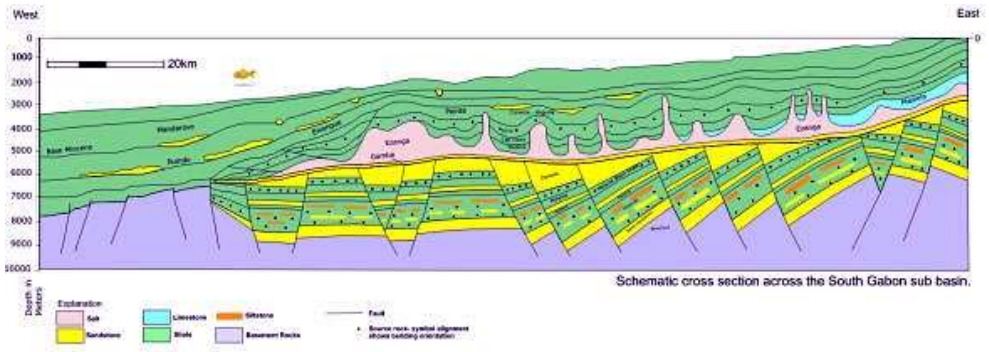
lives saved

resources discovered

costs avoided

increased efficiency

fundamental understanding



Schematic cross section across the South Gabon sub basin.

Benefits

U.S. GEOLOGICAL SURVEY CIRCULAR 1111

Societal Value of Geologic Maps

18 (1997)

c benefits
d
mapping
cky

ap Information: A

mia

rvey

McKee

ist
rvey

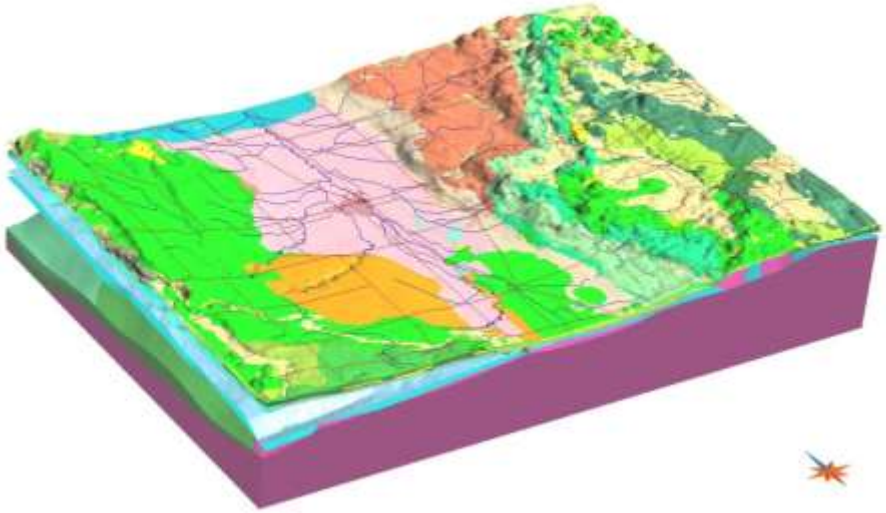
uerque, New Mexico

1996

Very favorable benefits relative to costs have been quantitatively demonstrated

geologic maps describes the

Future geological mapping needs to be



Regularly updated

Zoomable

Queryable

Complete

Seamless

3D

Onshore to offshore

Geological mapping

Springer Handbo

Geograp

Informat

27. Geology

Kristine Asch, Stephen J. Mathers, Holger Kessler

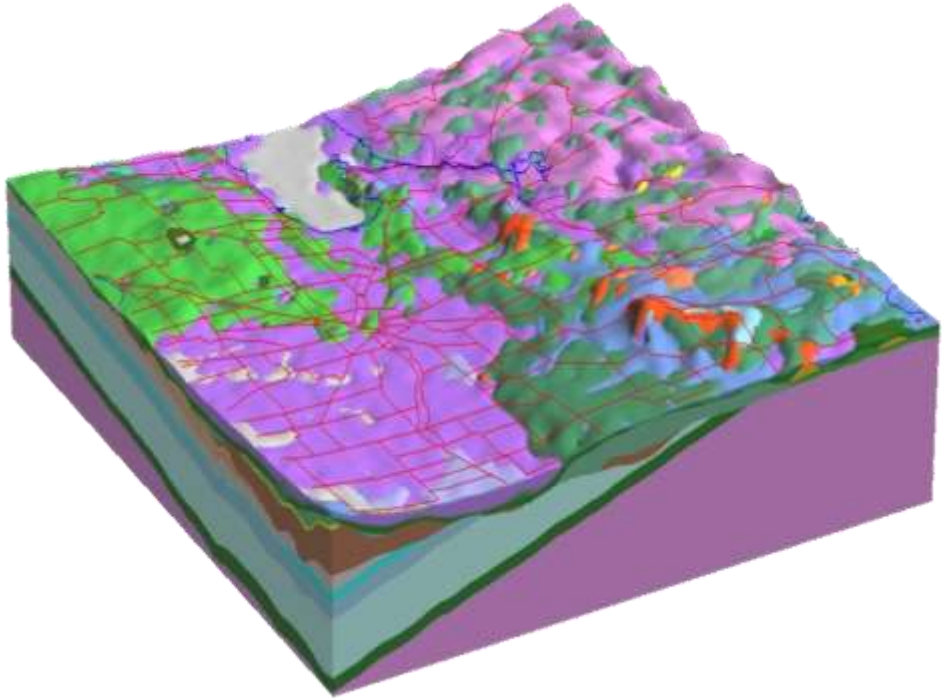
This chapter explains the historic impact and future direction of geoinformatics on geological sciences. The history and the purpose of geological surveys is discussed and an introduction into the basic techniques of traditional field mapping is presented. The authors then discuss the recent emergence of digital field capture tools and 3-D geological modelling software and methodologies which is beginning to replace the 2-dimensional techniques. The main impact of these advances is that geologists are now able to capture their knowledge in digital 3-dimensional form freeing them from the constraint of 2-dimensional media such as paper and later GIS. The impact on the delivery of geoscience information through 3-dimensional viewers and over the web is going to revolutionise the way in which ... are able to communicate their scien... look is also given why geology is only ... viron... eed f... geolo... er wit... tails s... g way ... ards, ... able ... oss di... tual a...

... of static ... dynamic ... forecast ... science ... challenge

... Ear... Greek ... a bet... toget... kind ... they...

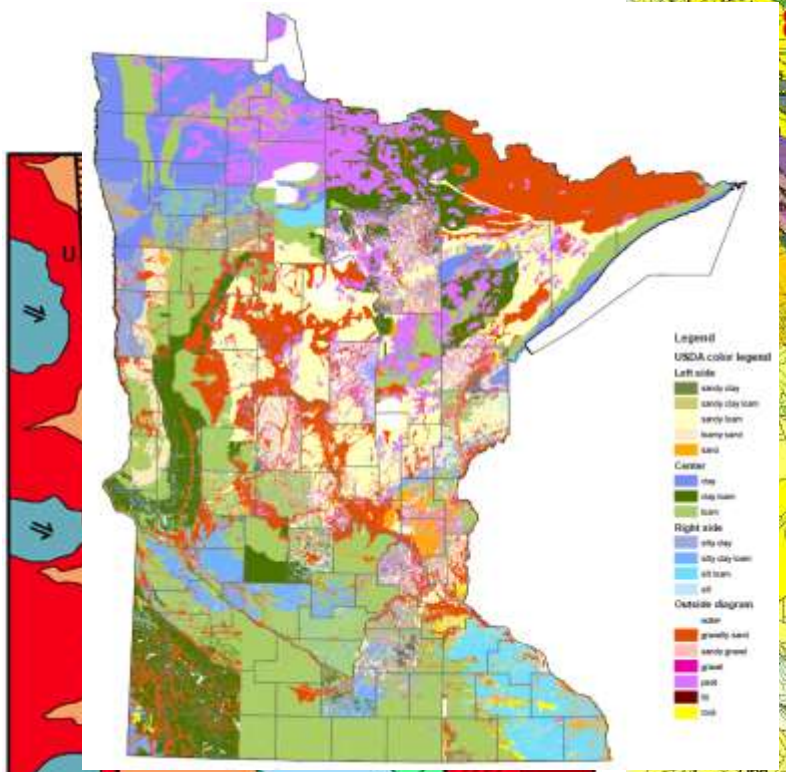
... aps have un... ... with black ... resources ... and beau... (27.2) to 3-D ... the Internet. Geographic

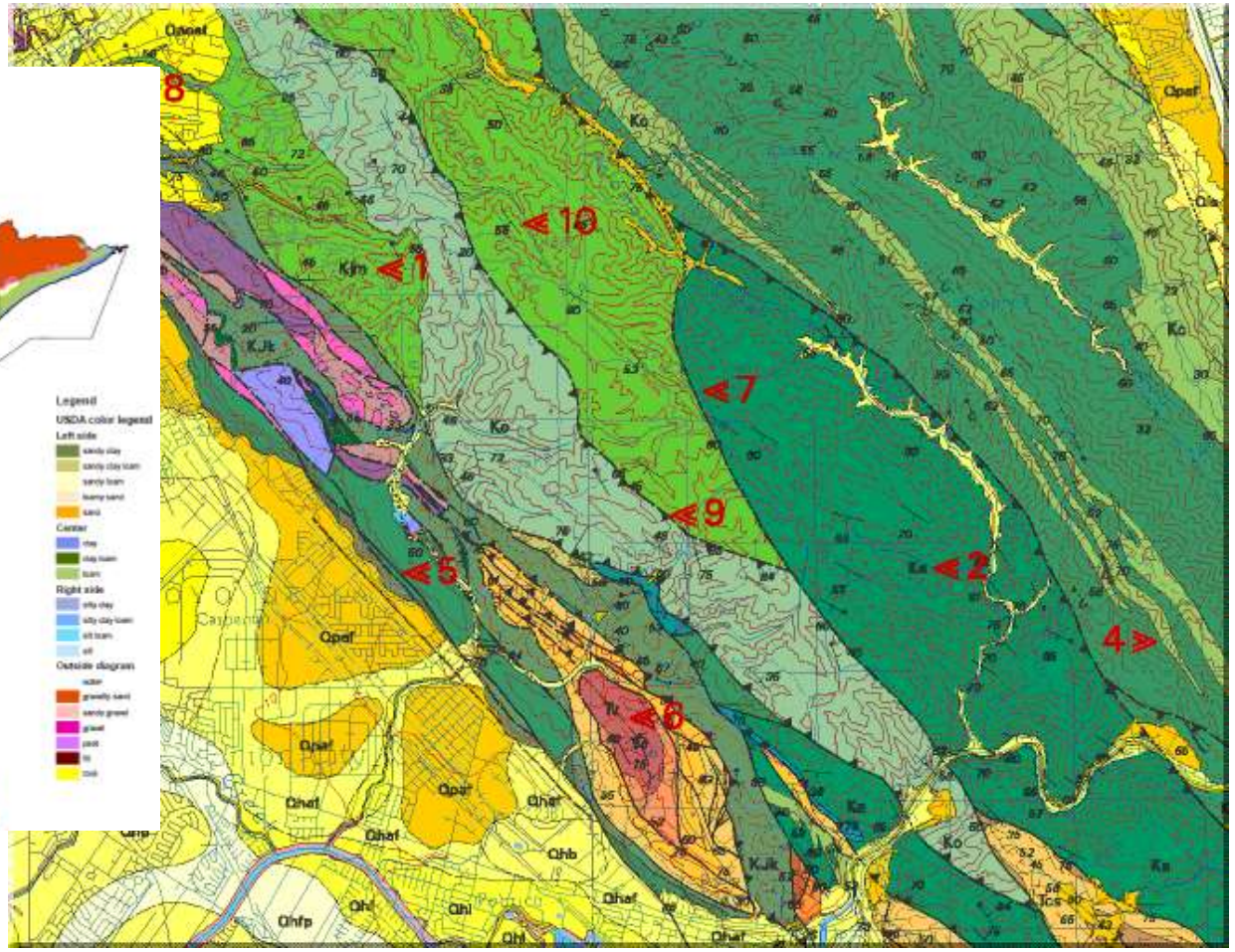
Geological mapping in the 2010s (Asch et al., 2012)



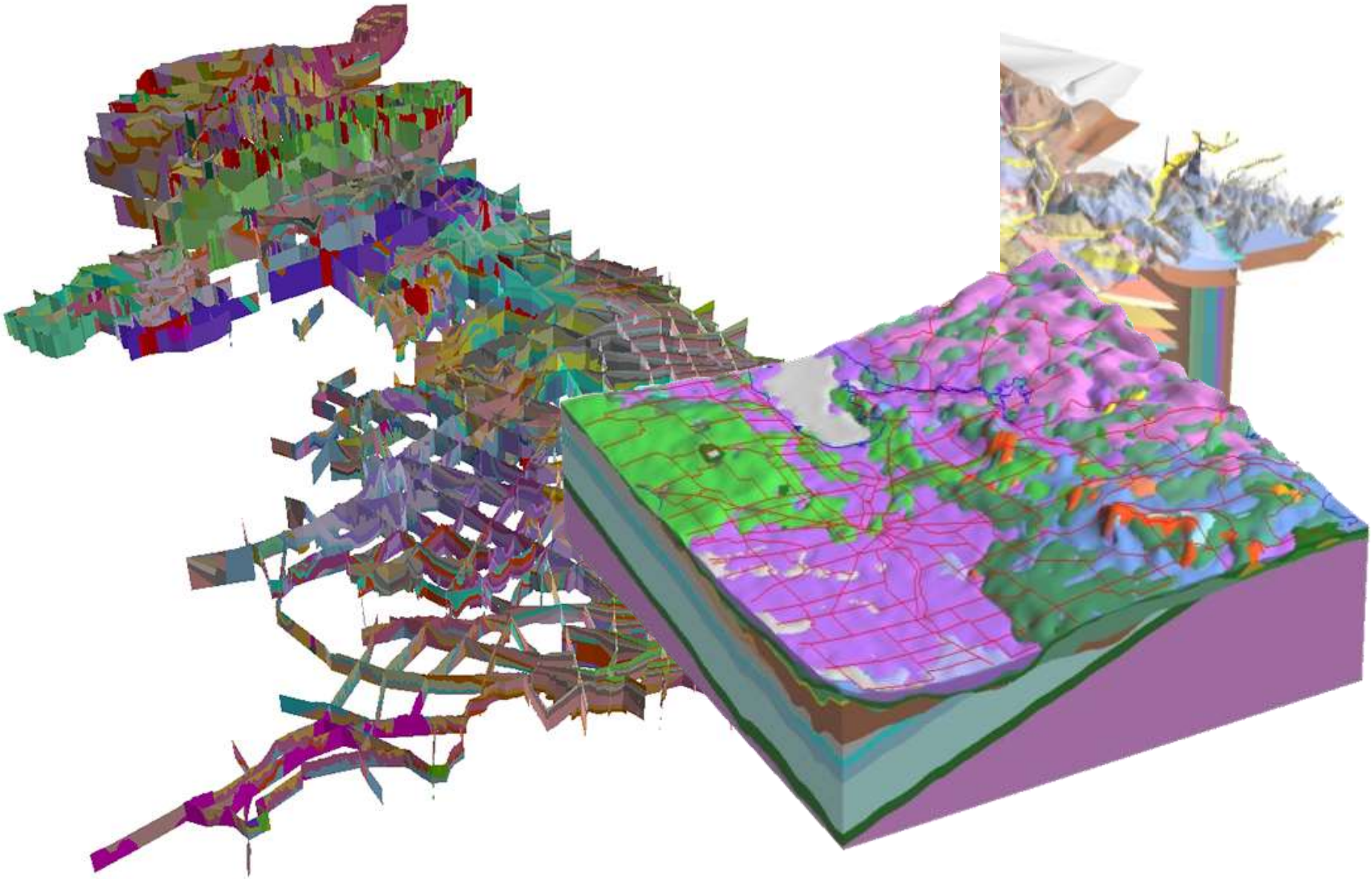
- Asch et al. (2012) highlight the shedding of constraints through digital capture of field data, application of geoinformatics, and 3D methods, thus allowing greater contributions to science and planning, largely through modeling made possible by improved 3D mapping that is well-coordinated with spatial data infrastructure, and well-supported by global initiatives designed to avert duplication of effort on standards, arrangements, policies, and dissemination tools

2D geological mapping





3D geological mapping

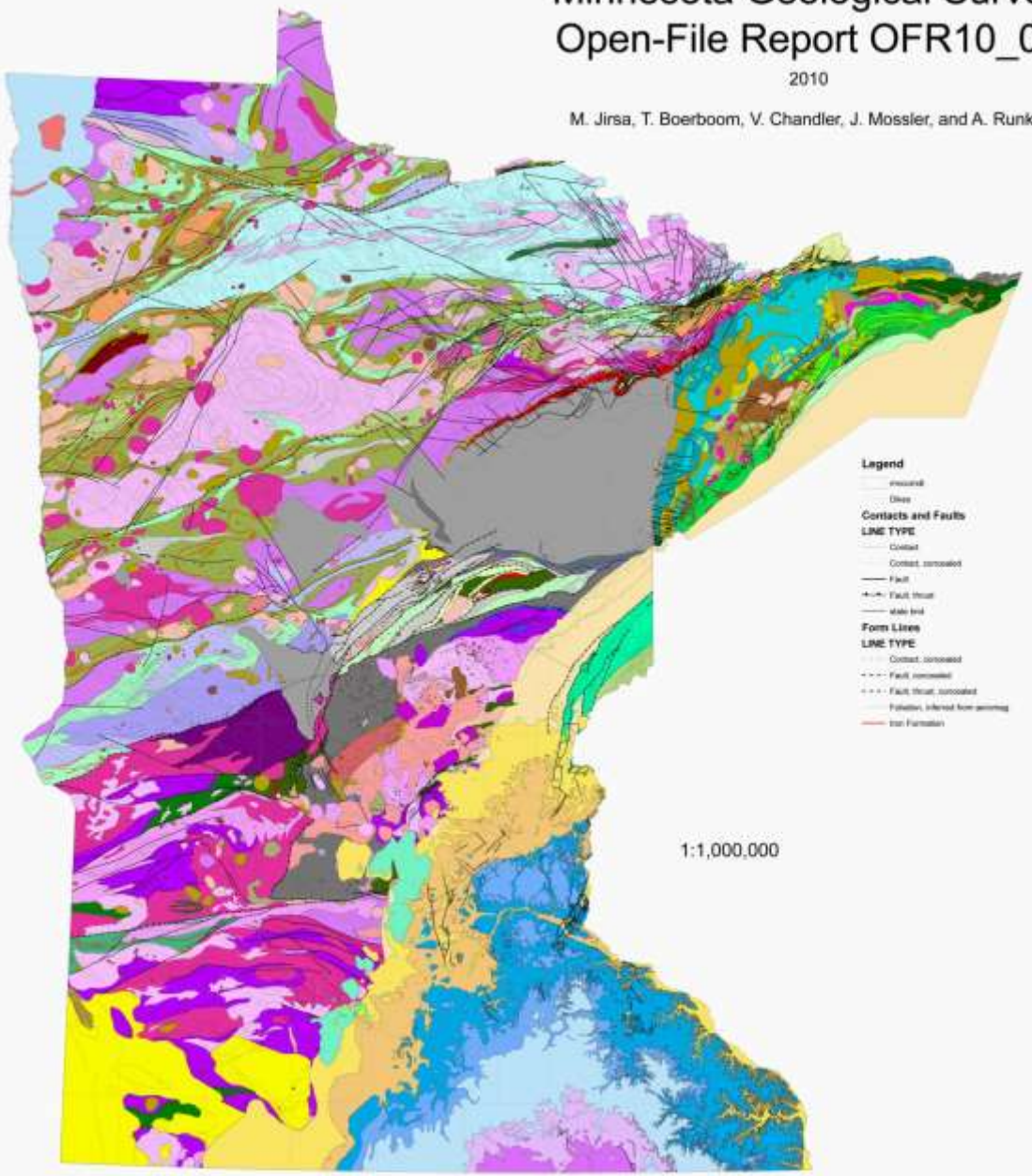


Preliminary Bedrock Geologic Map of Minnesota

Minnesota Geological Survey
Open-File Report OFR10_02

2010

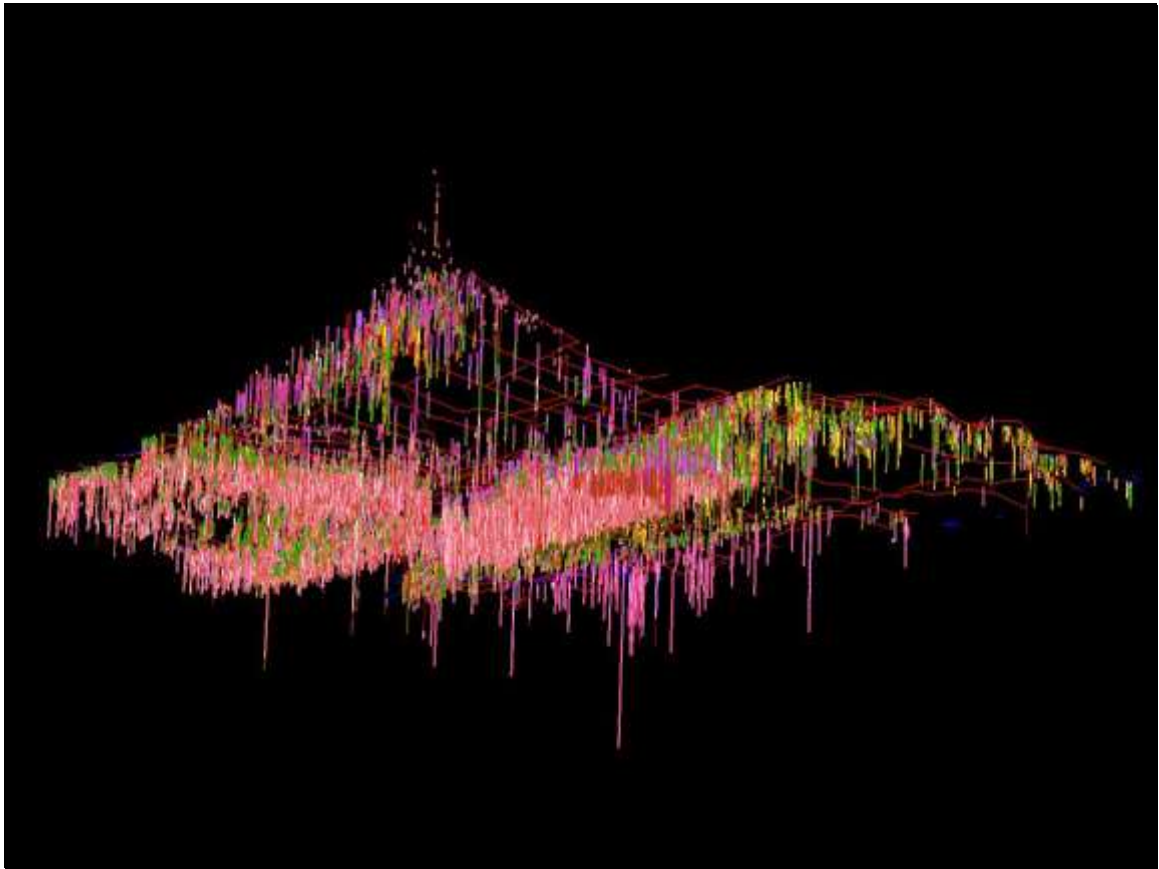
M. Jirsa, T. Boerboom, V. Chandler, J. Mossler, and A. Runkel



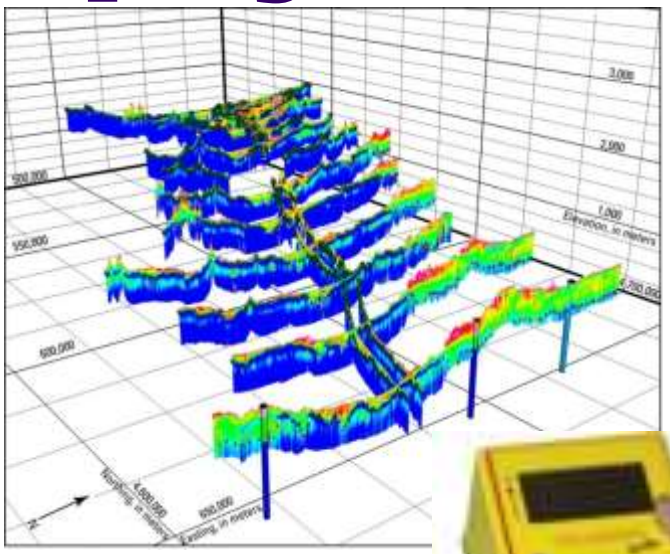
Drillhole data

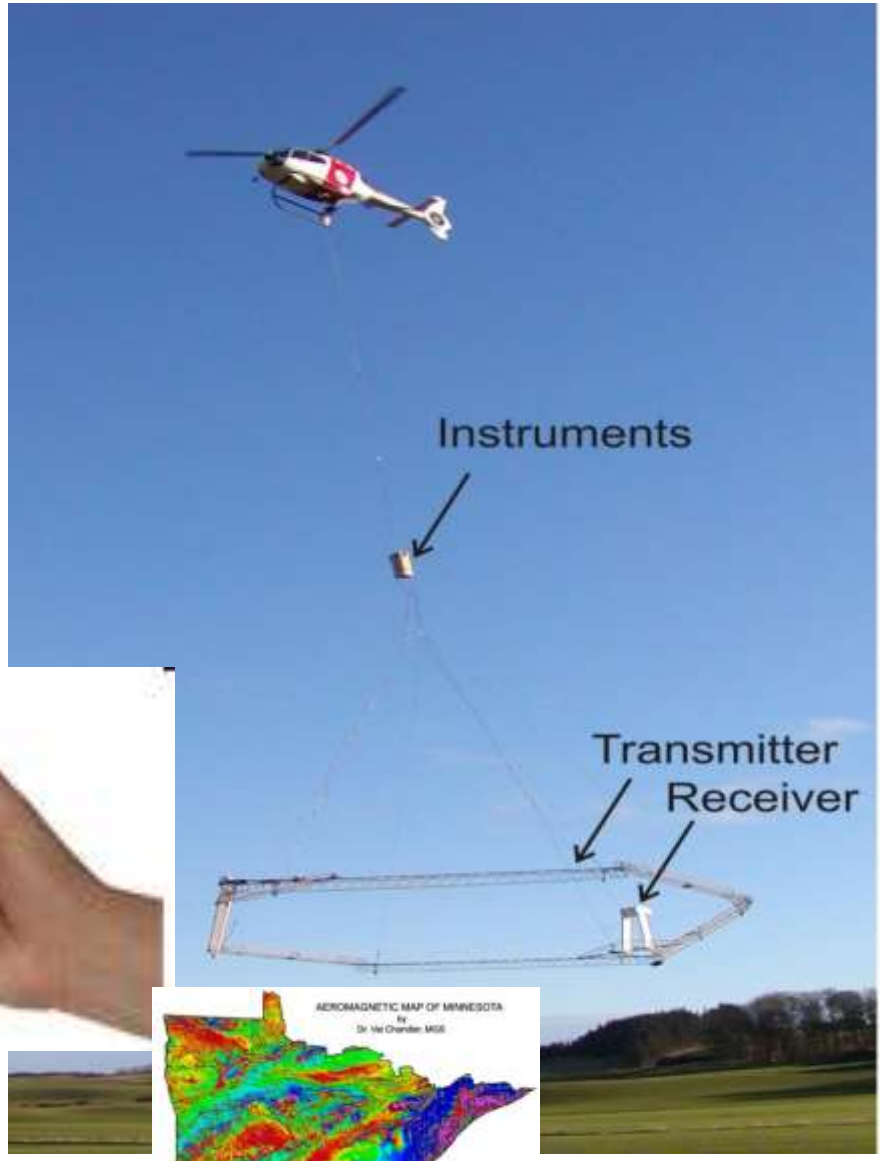
- acquire
- digitize
- georeference
- categorize

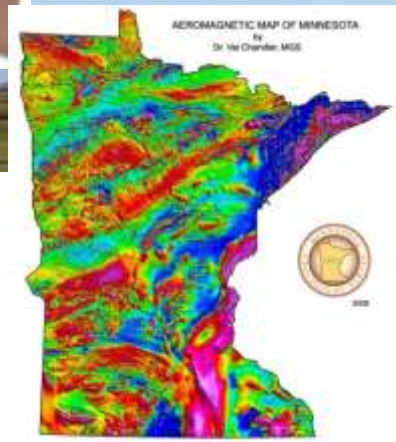
energistics®
Energy Standards
<WITSML/>™
certified product



Geophysics



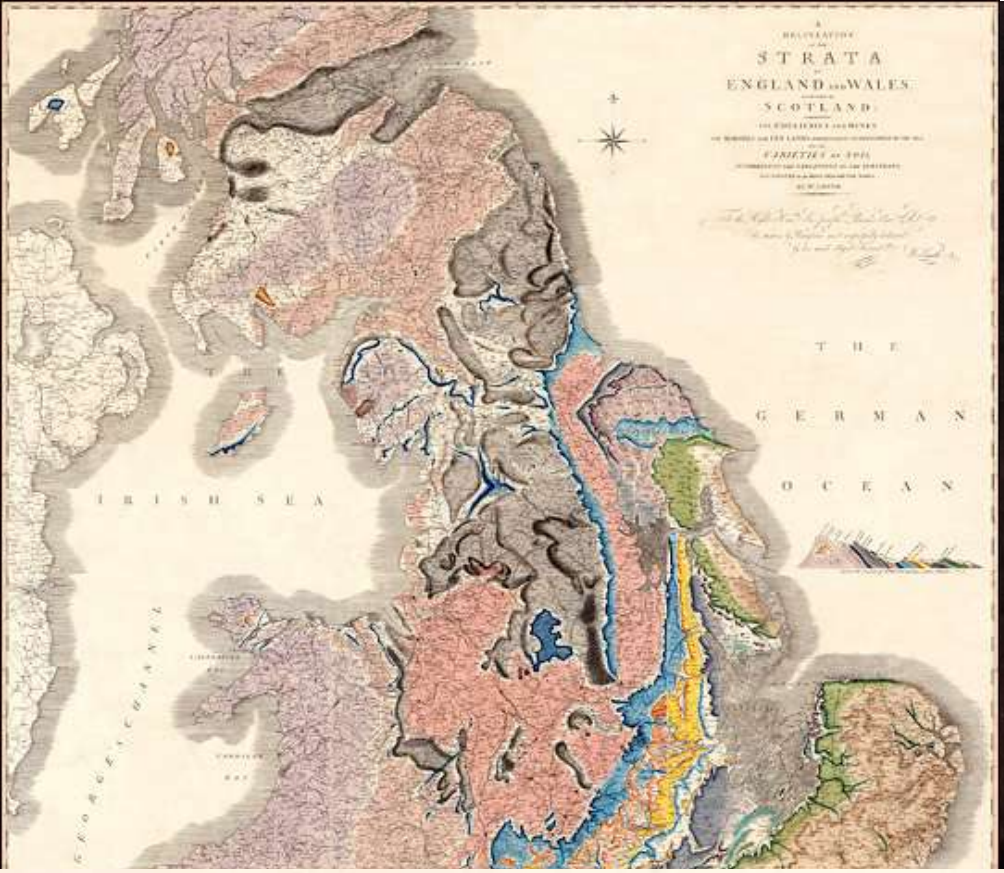


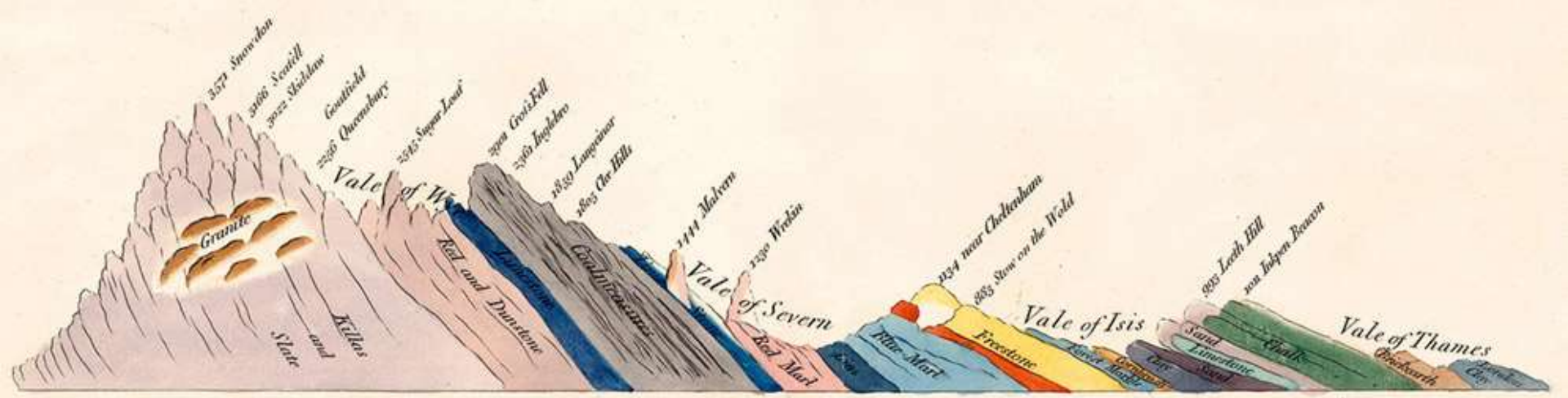


- EM
- Seismic
- Radar
- Borehole surveys
- Marine geophysics
- Gravity, magnetics

Drilling

- Stratigraphic benchmarks

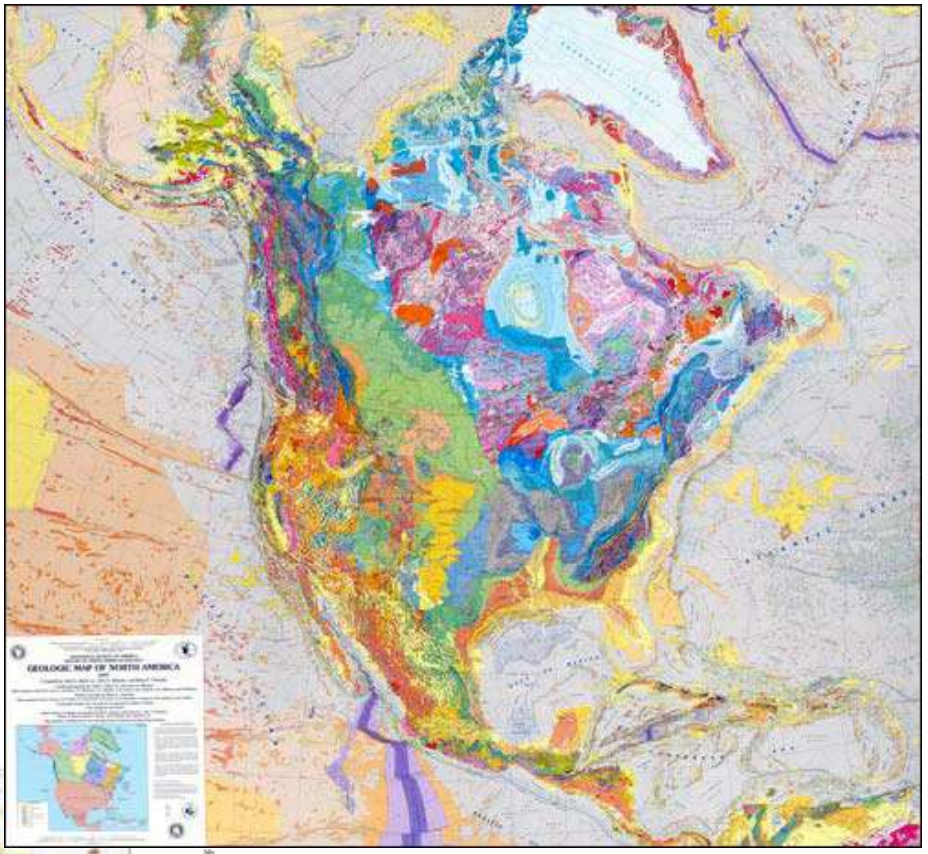


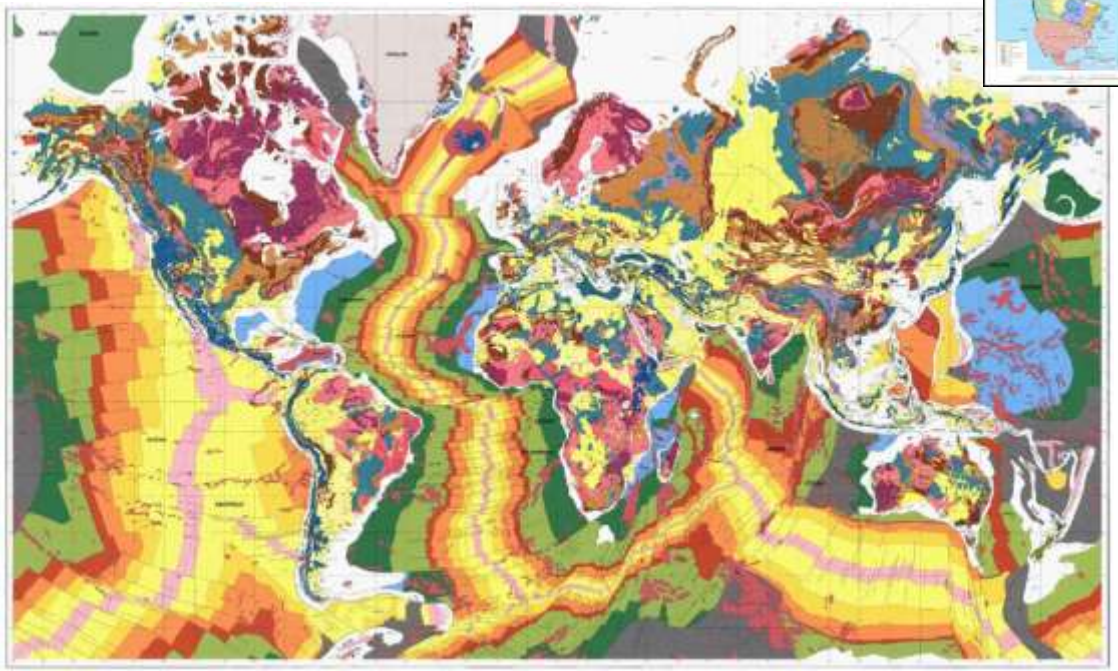


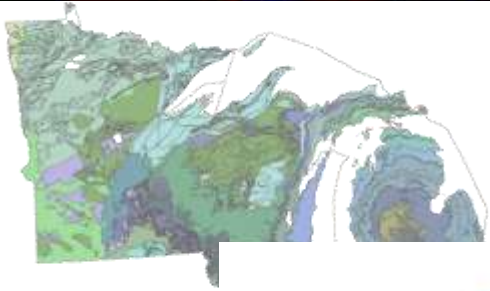
Sketch of the Succefsion of **STRATA** *and their relative Altitudes.* *N°.53.*

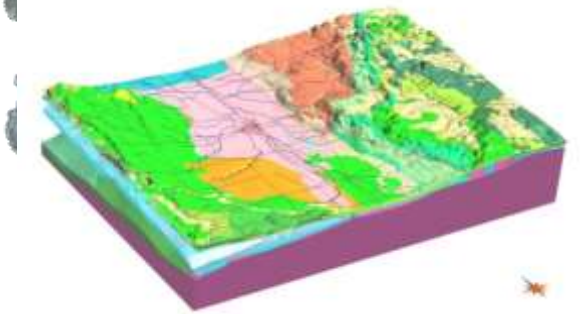
Resolution

- Global
- Continental
- State/National
- County/Quadrangle
- Urban





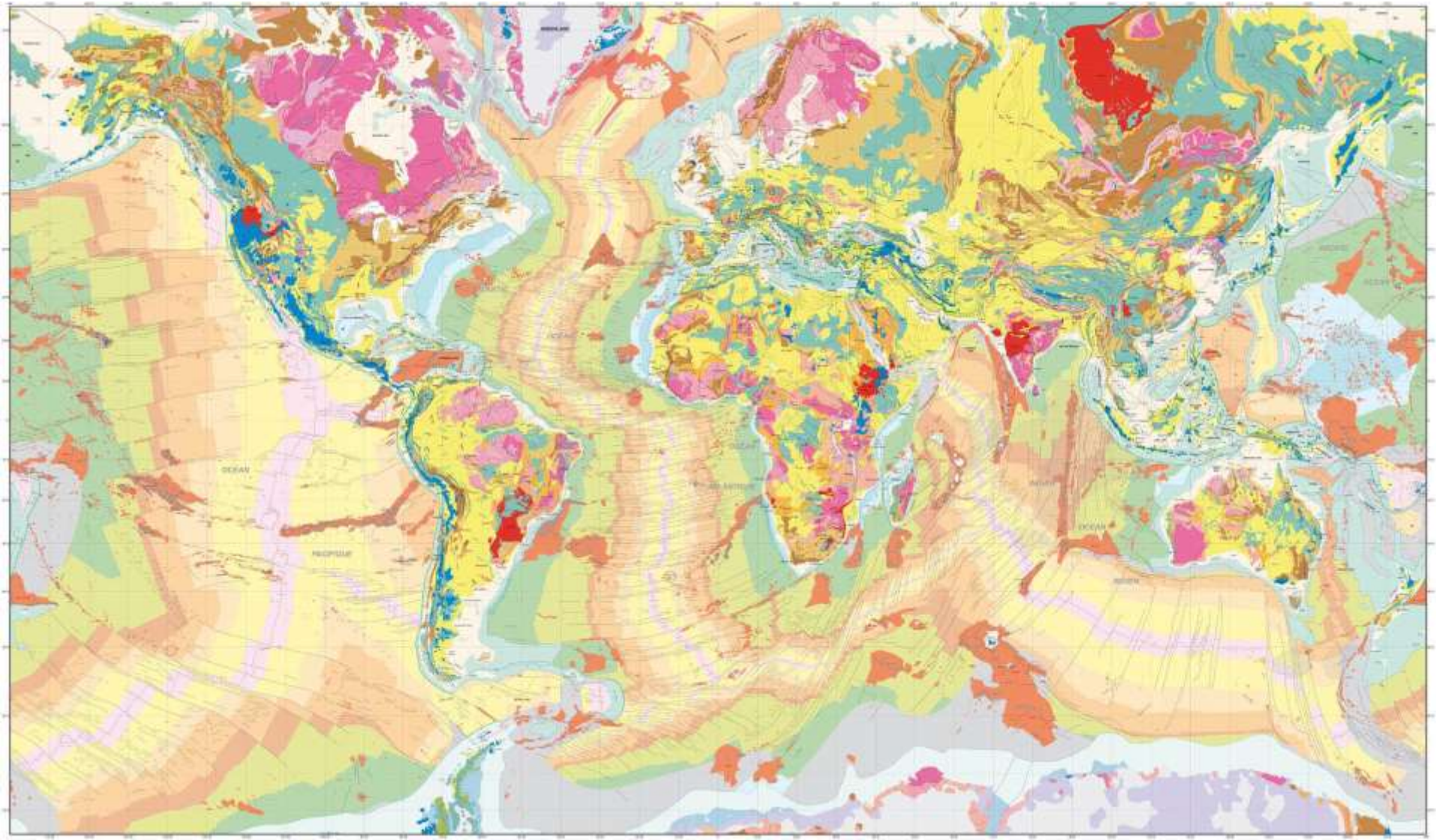


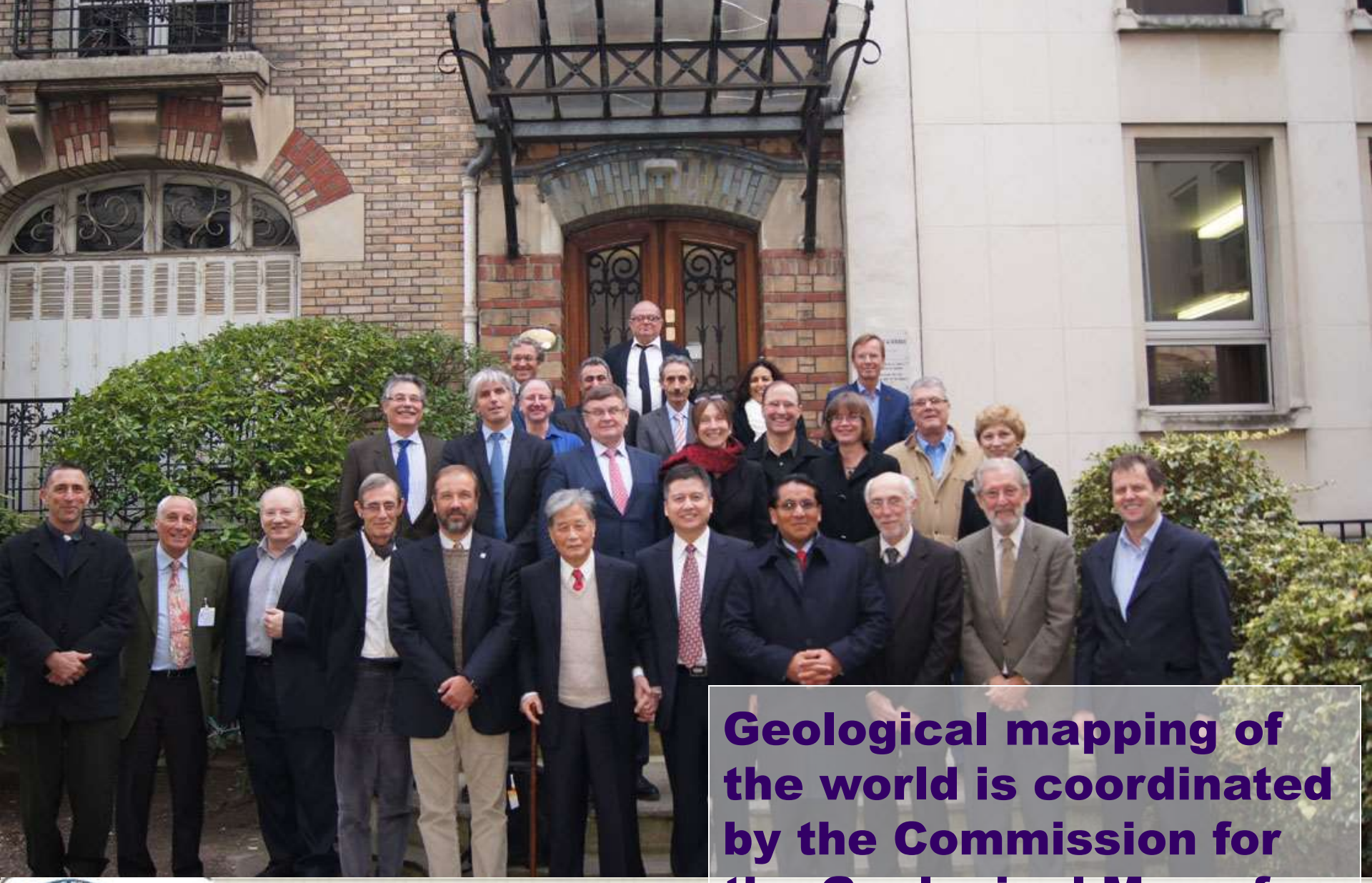


Resolution

	Global	Continental	State/National	County/Quadrangle
Sediments	None	One layer	Gross lithologic breaks	Formations
Layered rocks	Half dozen layers	A dozen or more	Formations	Formations +
Basement	Basement	Basement	Basement	Basement
***Preliminary outline for discussion**				

Global





Geological mapping of the world is coordinated by the Commission for the Geological Map of the World (CGMW)

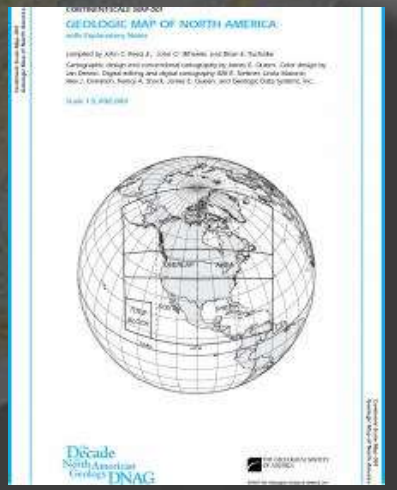
CCGM
CGMW

COMMISSION FOR THE GEOLOGICAL

Continental

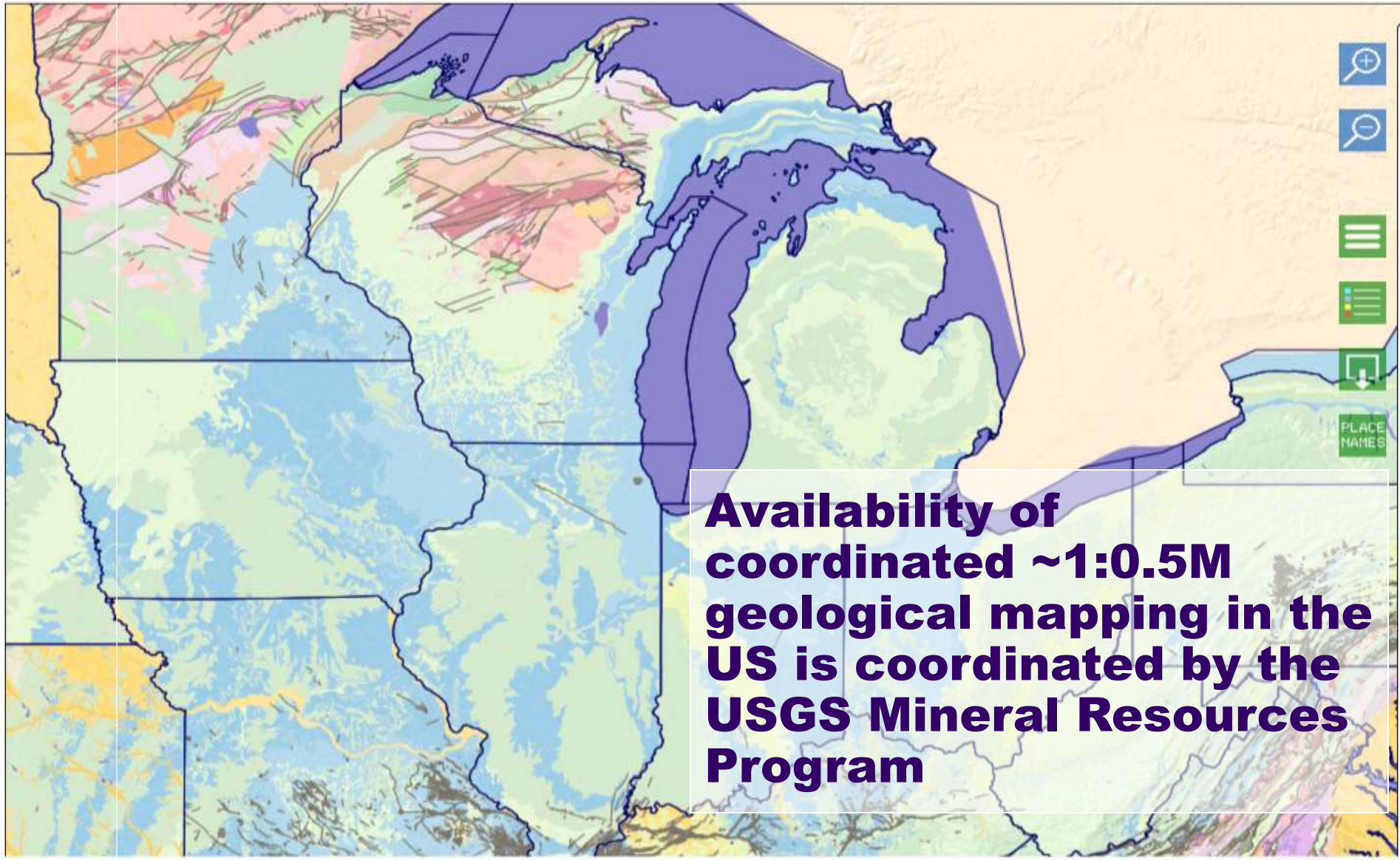
Mapmakers (from left to right) Jack Reed, Linda Masonic, and Will Stettner at Pikes Peak Litho in Colorado Springs for the final press check of the 2005 *Geologic Map of North America*.

MAPPING NORTH AMERICA—WHOI Senior Scientist Brian Tucholke helped create a newly published Geologic Map of North America for the Geological Society of America—the first such map since before the plate tectonic revolution of the late 1960s and the first that includes seafloor geology. (Credit: Tom Kleindinst)



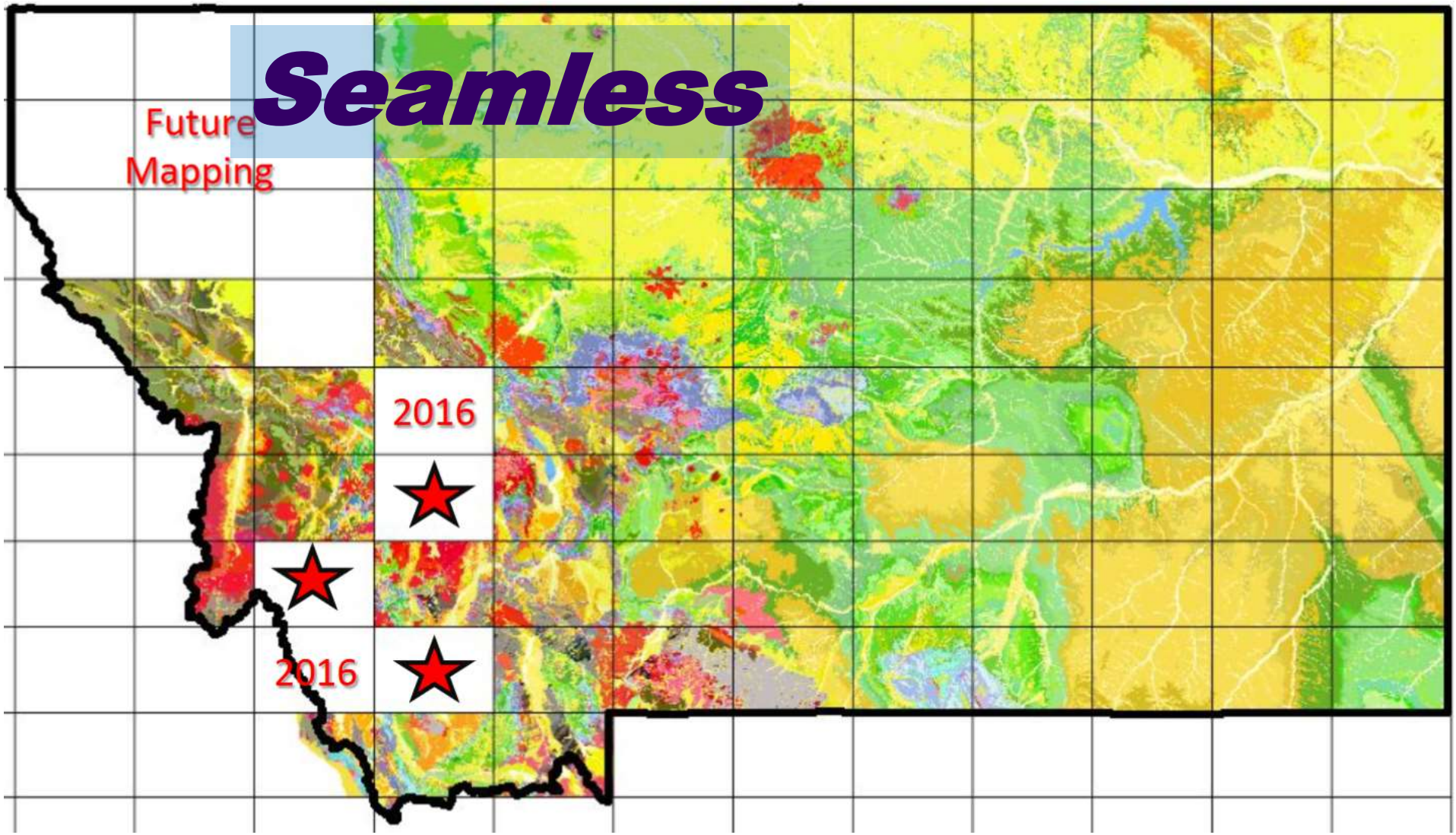
State/National

Mineral Resources > Online Spatial Data > Interactive map

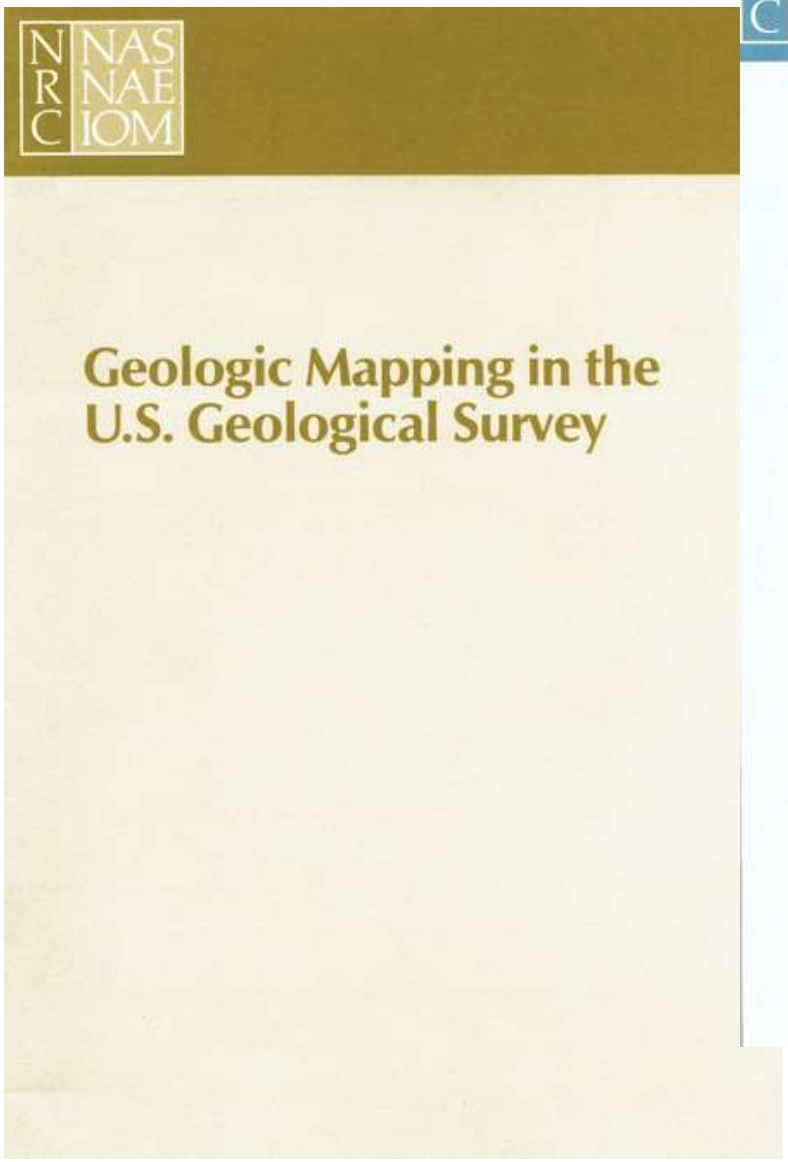


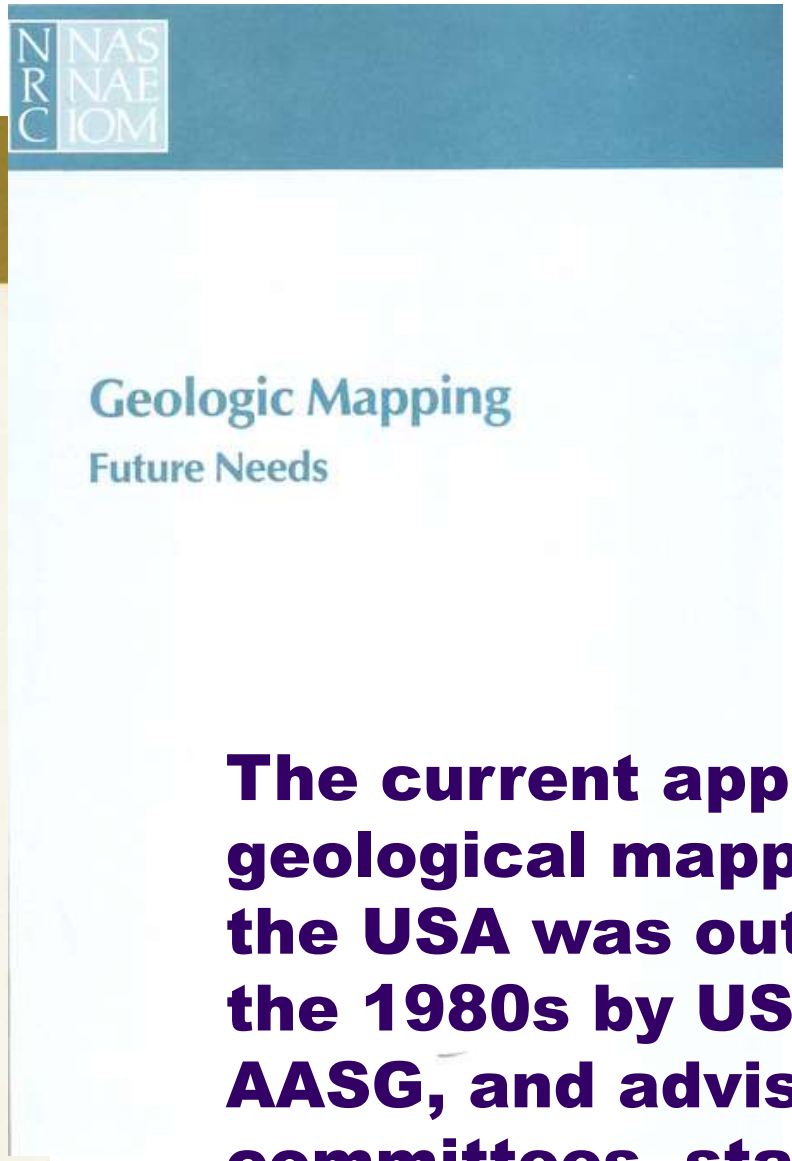
Availability of coordinated ~1:0.5M geological mapping in the US is coordinated by the USGS Mineral Resources Program

County/Quadrangle



1980s





The current approach to geological mapping in the USA was outlined in the 1980s by USGS, AASG, and advisory committees, starting with a meeting in Illinois in 1982

NGMA

Public Law 102-285
102d Congress

An Act

May 18, 1992
[H.R. 2763]

To enhance geologic mapping of the United States, and for other purposes.

National Geologic Mapping Act of 1992.
Conservation.
Environmental protection.
43 USC 31a note.
43 USC 31a.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress as

SECTION 1. SHORT TITLE.

This Act may be cited as the "Nationa
of 1992".

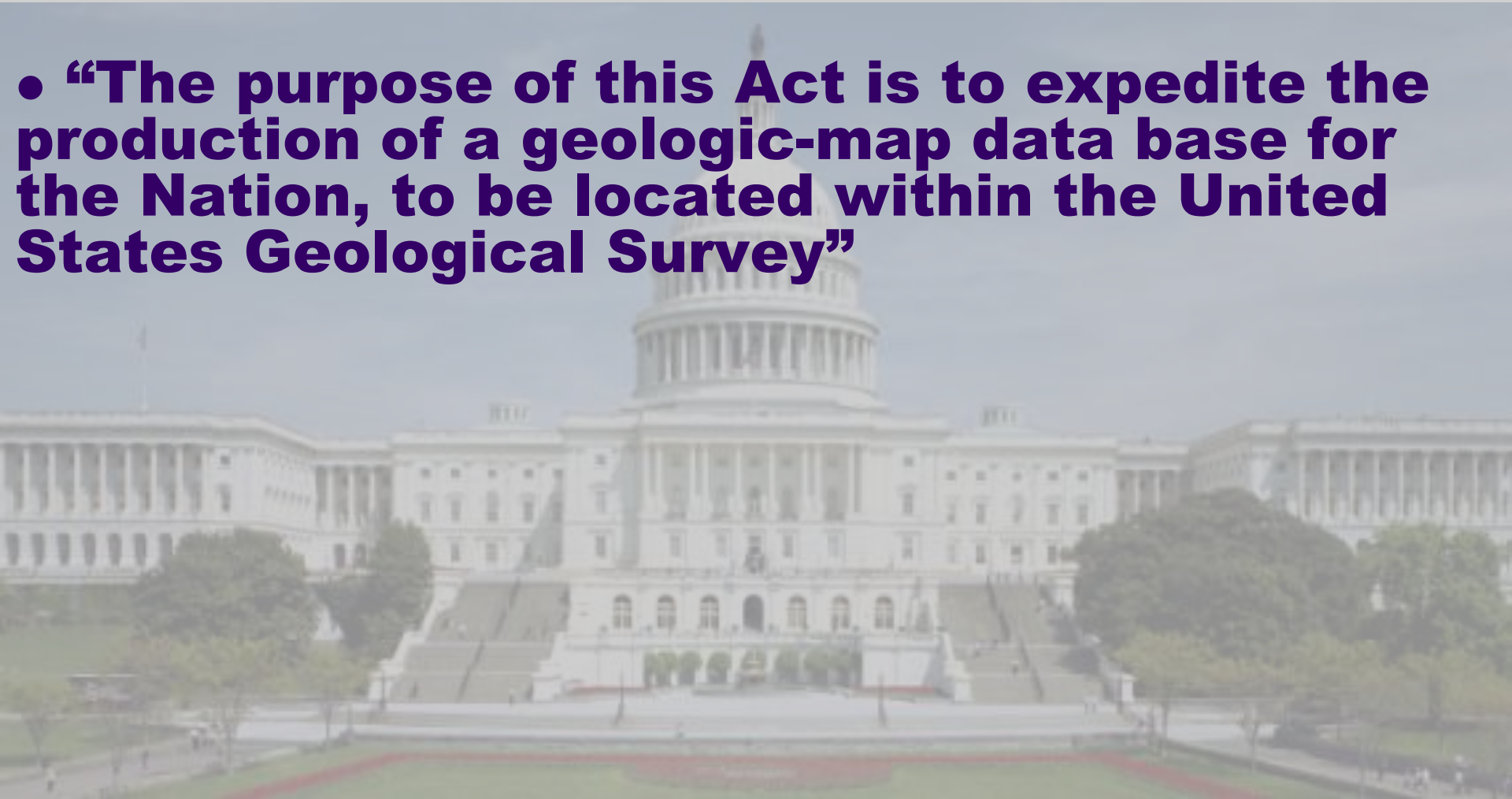
SEC. 2. FINDINGS AND PURPOSE.

(a) FINDINGS.—The Congress finds and de
(1) during the past 2 decades, th
maps has been drastically curtailed;
(2) geologic maps are the primary
all applied and basic earth-science in
(A) exploration for and develop
and water resources;
(B) screening and characteriz
nuclear waste disposal;
(C) land use evaluation and pla
protection;
(D) earthquake hazards reductio
(E) predicting volcanic hazards;
(F) design and construction o
ments such as utility lifelines,
and surface-water impoundments;
(G) reducing losses from lands
failures;
(H) mitigating effects of coastal a
(I) siting of critical facilities; and
(J) basic earth-science research;
(3) Federal agencies, State and local governments, private industry, and the general public depend on the information provided by geologic maps to determine the extent of potential environmental damage before embarking on projects that could lead to preventable, costly environmental problems or litigation;
(4) the combined capabilities of State, Federal, and academic groups to provide geologic mapping are not sufficient to meet the present and future needs of the United States for national security, environmental protection, and energy self-sufficiency of the Nation;
(5) States are willing to contribute 50 percent of the funding necessary to complete the mapping of the geology within the State;
(6) the lack of proper geologic maps has led to the poor design of such structures as dams and waste-disposal facilities;
(7) geologic maps have proven indispensable in the search for needed fossil-fuel and mineral resources; and

As a result, the National Geologic Mapping Act (NGMA) became Law in 1992

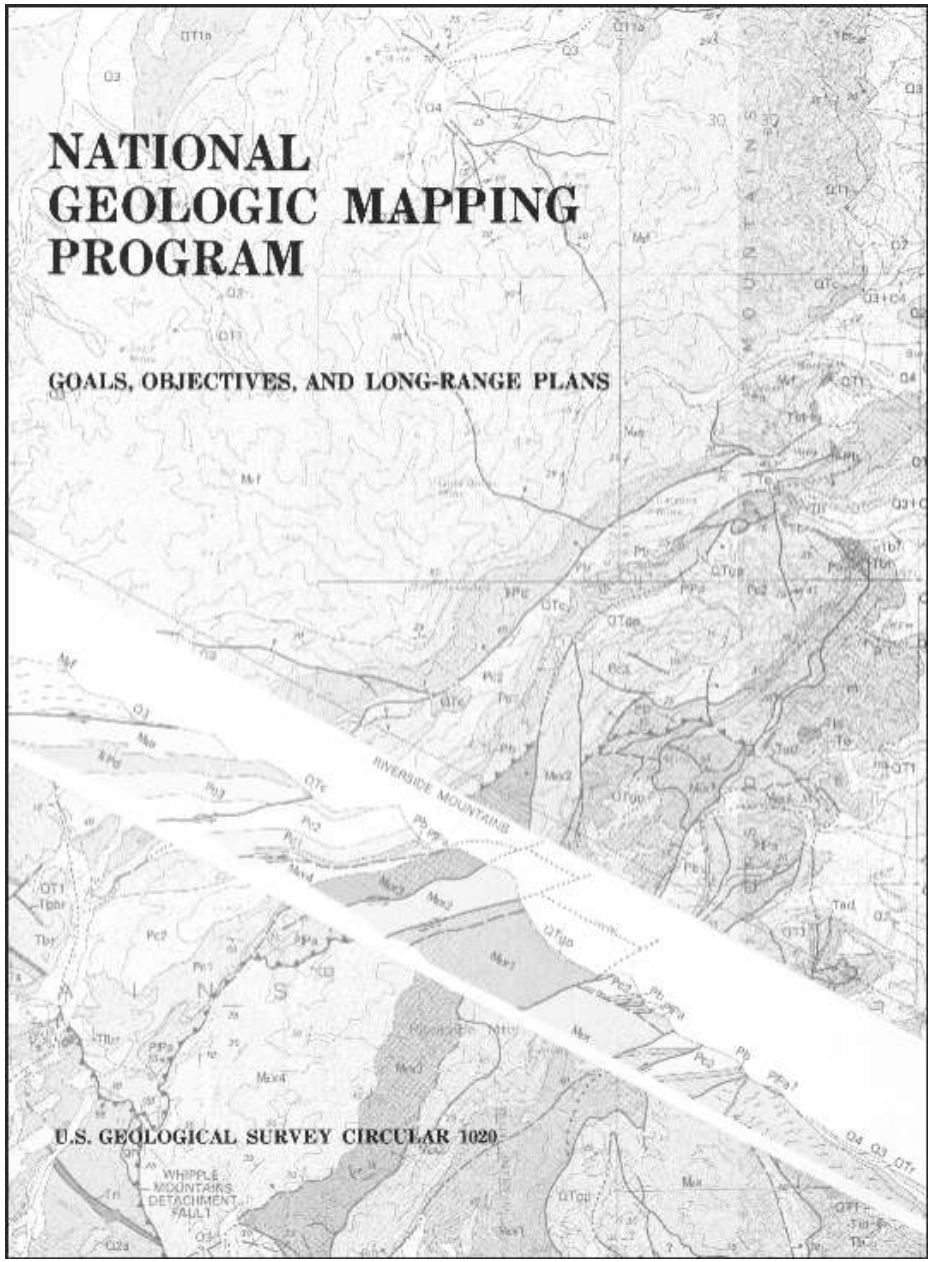
NGMA

National Geologic Mapping Act of 1992



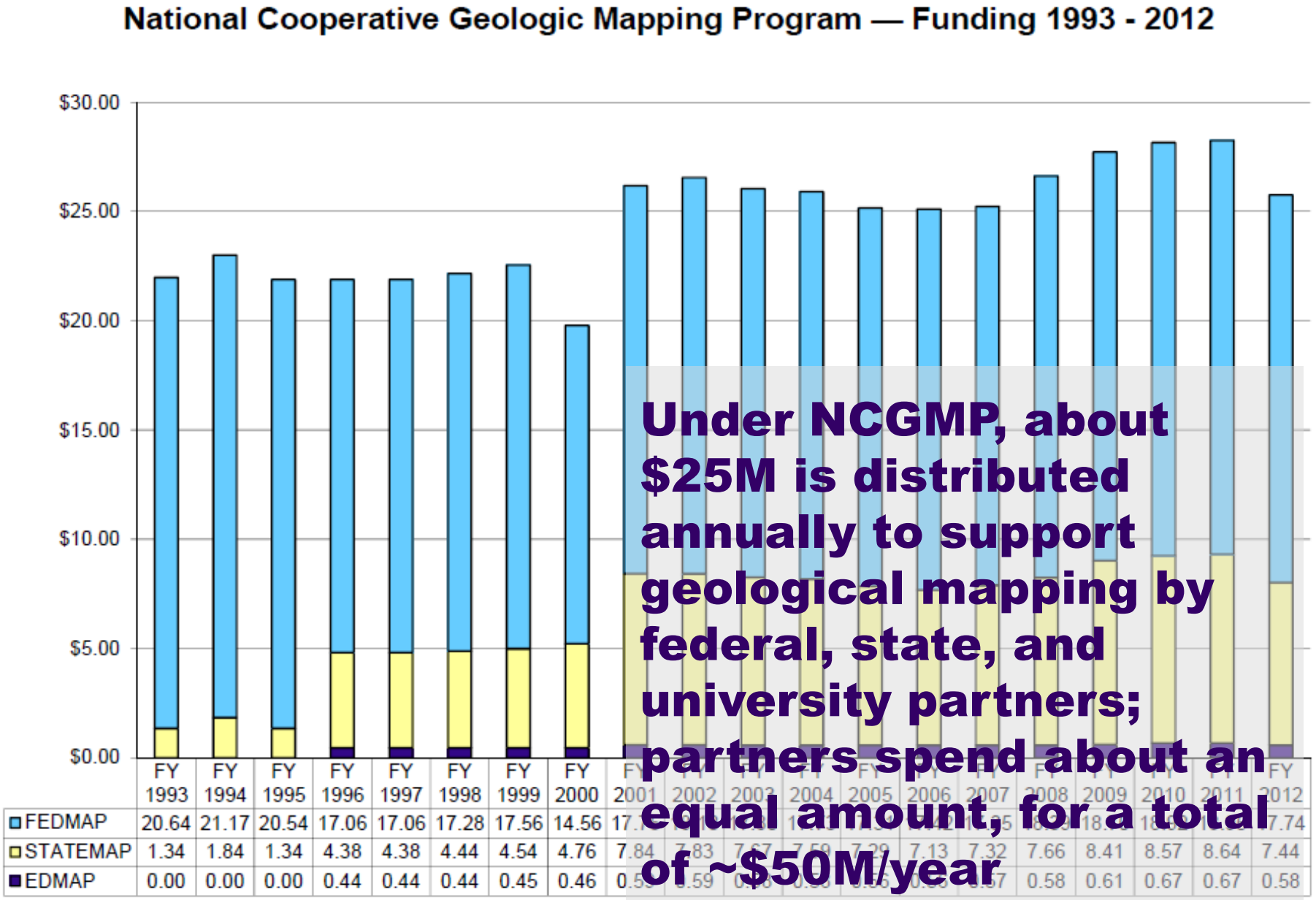
- "The purpose of this Act is to expedite the production of a geologic-map data base for the Nation, to be located within the United States Geological Survey"

NCGMP



The National Geologic Mapping Act (NGMA) mandated the National Cooperative Geologic Mapping Program (NCGMP), consisting of geological mapping by federal, state, and university partners, made consistent and available as the National Geologic Map Database (NGMDB)

Funding



	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012
FEDMAP	20.64	21.17	20.54	17.06	17.06	17.28	17.56	14.56	17.7											17.74
STATEMAP	1.34	1.84	1.34	4.38	4.38	4.44	4.54	4.76	7.84	7.83	7.67	7.59	7.29	7.13	7.32	7.66	8.41	8.57	8.64	7.44
EDMAP	0.00	0.00	0.00	0.44	0.44	0.44	0.45	0.46	0.59	0.59					0.57	0.58	0.61	0.67	0.67	0.58

NGMDB

STANDARDS AND DATABASES

Information standards

- Metadata standard
- Cartographic standard
- Digital map standard
- Database standard

NGMDB

- Publication database
- Paleontology database
- Lexicon database
- Mapping database

As part of NCGMP, the NGMDB Project has coordinated development of standards and databases under the leadership of Dave Soller

National Geologic Map Database

Digital Mapping Techniques Workshop

A workshop series that focuses on collegial interaction, to develop efficient and standardized methods for digital geologic mapping, publication, and GIS analysis

About the Workshop

The Digital Mapping Techniques workshop series ("DMT") brings together scientists, cartographers, and GIS specialists, from State and Federal agencies, as well as Universities, the private sector, and international colleagues. This annual series of workshops began in 1997. It is a highly regarded venue [illegible] digital mapping techniques, standards, and guidelines both in the United States and internationally.

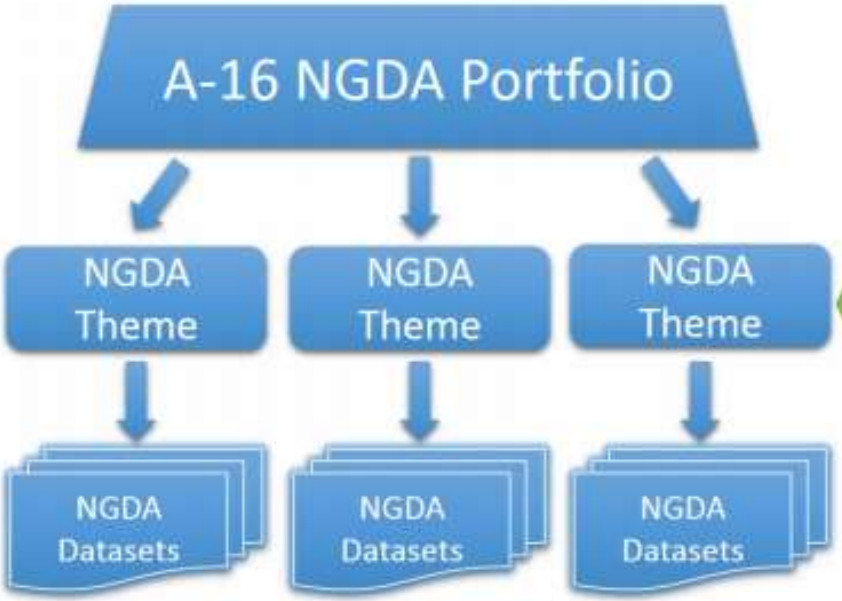
The workshop's objective is to foster informal discussion and [illegible] develop more efficient methods for the many aspects of creating, managing, and serving digital geoscience map information. There is not, of course, a single "solution" or approach [illegible] each program or group within an agency. Instead, each agency must plot its own course, based on personnel, funding, and many other constraints. The value of the DMT workshops and [illegible] these agency-specific approaches to digital mapping, and especially to find applicable approaches used by other agencies.

For information regarding the DMT workshops, or if you wish to attend our next meeting, please contact Dave Soller (drsoller@usgs.gov).

Our principal forum for the development of geologic map standards in the US is the annual DMT workshop, which will be held in Minneapolis this year

Spatial data infrastructure

National Spatial Data Infrastructure Strategic Plan 2014–2016



Federal Geographic Data Committee

December 2013

National Geospatial Data Asset Management Plan

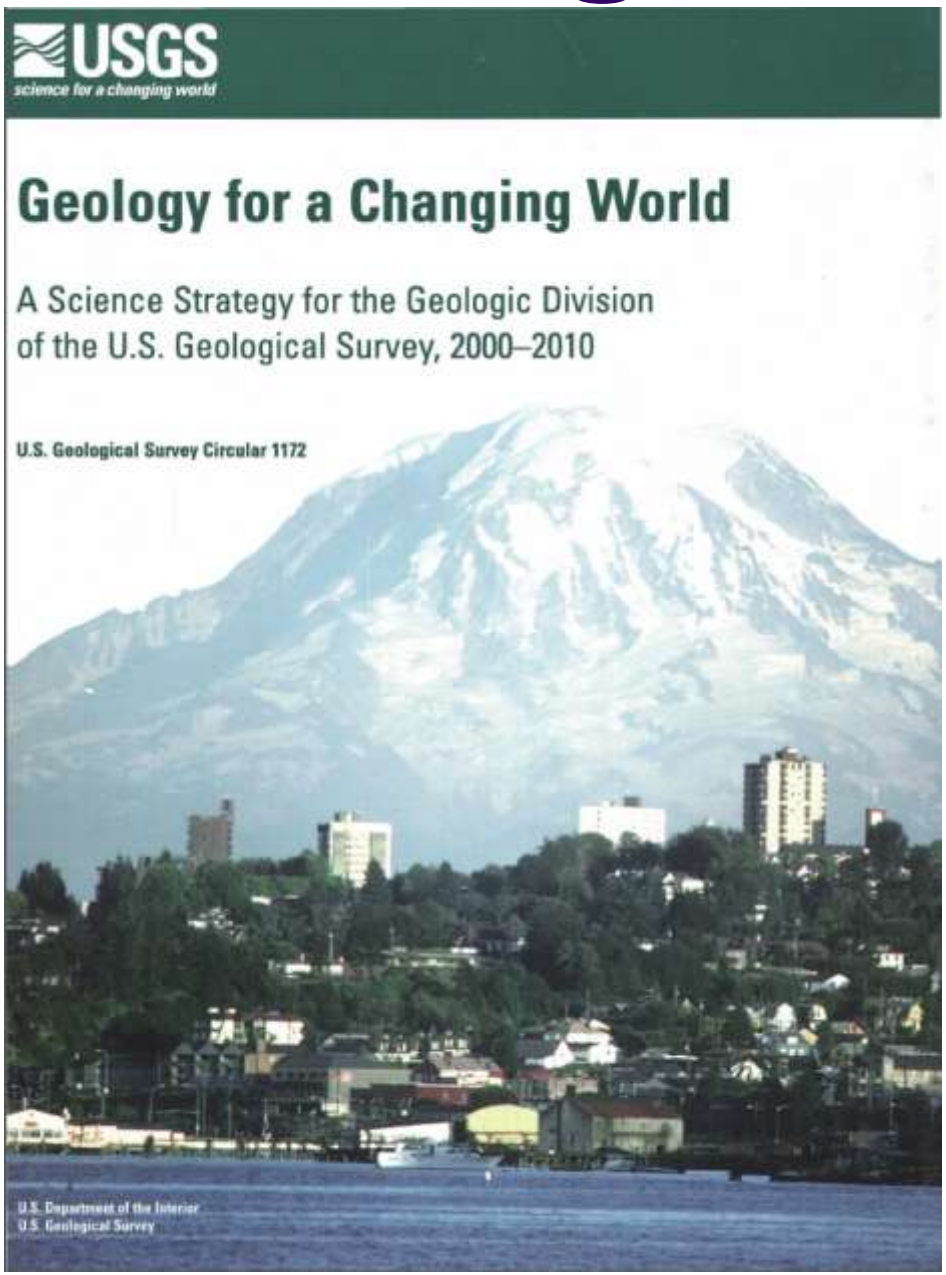
- Biota
- Cadastre
- Climate & Weather
- Cultural Resources
- Elevation
- Geodetic Control
- Geology
- Governmental Units
- Imagery
- Land Use – Land Cover
- Real Property
- Soils
- Transportation
- Utilities
- Water – Inland
- Water – Oceans & Coasts

› OMB Circular A–16
A–16, *Coordination of*
Data Activities

C

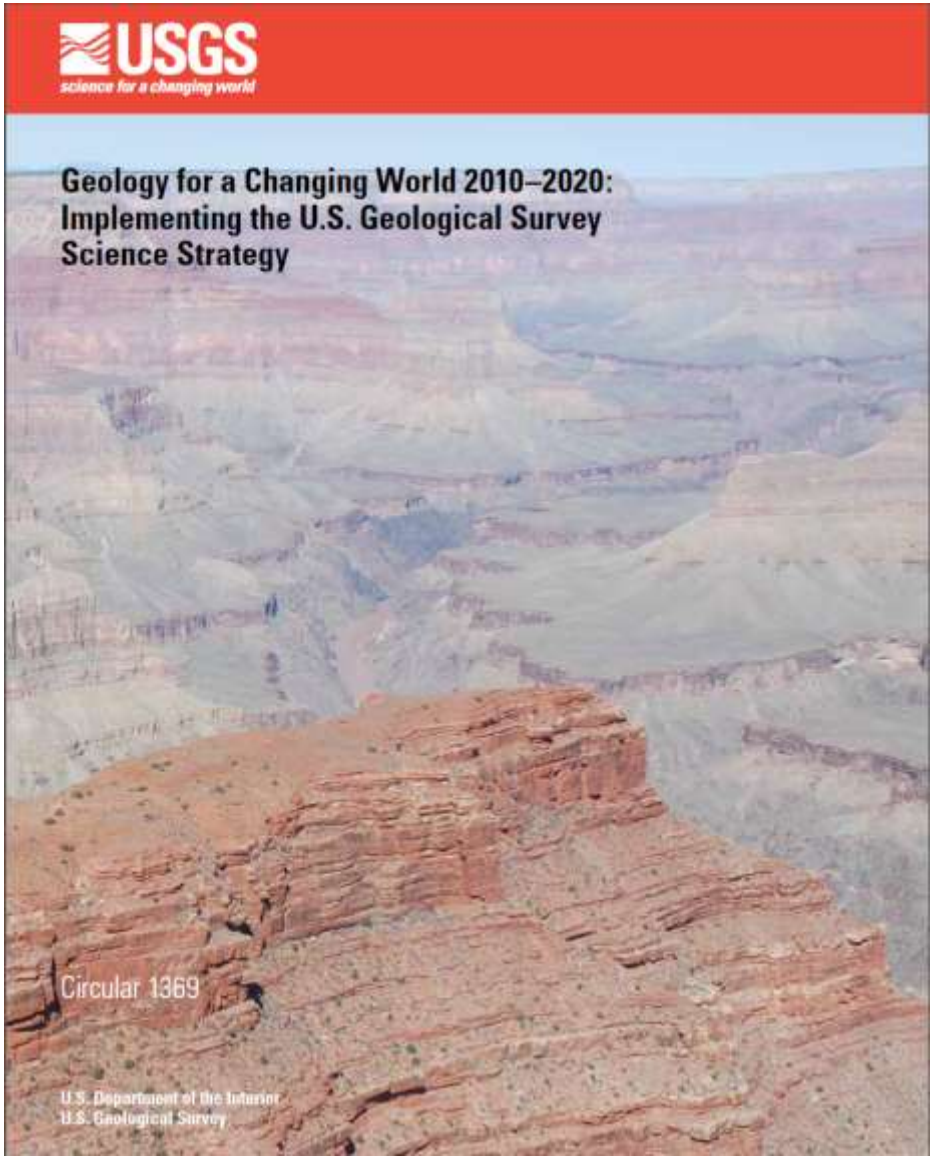
Geology is one of the National Geospatial Data Assets

Planning



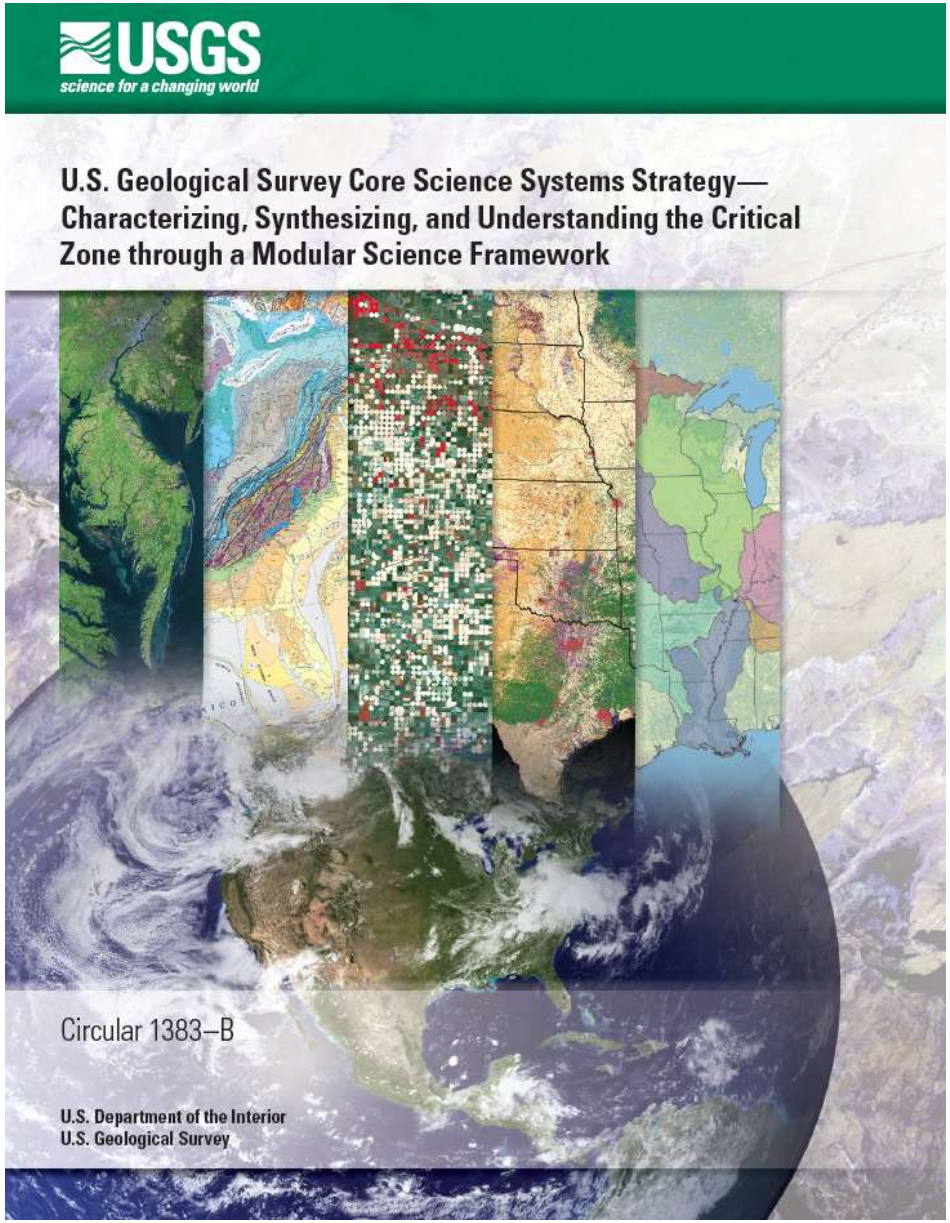
1998: The 2000-2010 plan for USGS geology cited the need for basin-scale, nationally consistent maps showing the 3D distribution of hydrogeologic properties

Planning



2011: The 2010-2020 plan for USGS geology called for development of the interpretations, protocols, and standards needed to provide seamless geological maps, while foreseeing that 3D geologic maps of continental and offshore areas will become the standard

Planning



2013: The most recent USGS planning called for collaboration leading to 1) seamless nationwide geological maps, 2) 3D maps that will for example improve understanding of sedimentary basin processes, and 3) 4D modeling that will elucidate the operation of processes through time

AASG

Association of American State Geologists

RESOLUTION ON AASG COMMITMENT TO THE ROLE OF GEOLOGIC MAPPING IN SOCIETY

WHEREAS geologic mapping is a core activity for geological surveys that underpins geoscience as a whole and that provides the framework and understanding that supports subsurface prediction;

WHEREAS managers of energy, minerals, water, hazards, climate change, environment, waste, and engineering increasingly rely on and therefore need to invest in well-devised applications of geologic mapping;

WHEREAS investments in geological mapping return benefits including lives saved, resources discovered, costs avoided, increased efficiency, and fundamental understanding of earth composition, structure, and history;

WHEREAS geological surveys can accelerate progress in response to societal needs through proven collaboration methods, concurrent with efforts in program administration, infrastructure, formats, and accessibility;

WHEREAS benefits will be enhanced by this nationwide acceleration, including updating, coordination, and seamless compilation of multi-resolution plan view and 3D onshore and offshore geological mapping; and

WHEREAS with adequate funding, the following key objectives could be achieved by 2030: an ongoing vibrant pace of detailed mapping, regular updating, nationwide multi-resolution seamless coverage, and 3D mapping at least of depth to bedrock and basement as well as subdivision of sediments and/or little-deformed rock strata where data allow;

NOW, THEREFORE BE IT RESOLVED, that members of **AASG** believe that state geological surveys should increase their commitment to work with USGS and other partners through the National Cooperative Geologic Mapping Program to ensure timely provision of optimal geological mapping that will progressively be more:

- focused on immediate **user** needs while accommodating unanticipated applications, and being designed with reference to ongoing statewide **assessment** of the status of databases and mapping;
- focused on the most **detailed** mapping where needed, while committed to statewide **completion** at an appropriate scale;
- reconciled with integrated, appropriate **topographic** and bathymetric data, integrated from onshore to **offshore**, and coordinated with **soil** mapping;
- based as needed on compilation ideally of all public domain drillhole and other relevant **data**, along with strategic drilling and newly acquired geochronology, geochemistry, and geophysics;
- based on sound **stratigraphic** naming, and categorized using broadly accepted **query** language;
- committed to regular **updating** of maps as science and technology progress, and assembled as statewide **seamless** compilations;
- 3D, in which the extent, thickness, and properties of all little-deformed sediment and rock units, and selected complex structural features such as faults and folds, are distinguished;
- coordinated with increasingly 3D versions of state, **continental**, and global-scale maps, while being fully **accessible** through robust and open-source software for conveying subsurface mapping; and
- **linked** to a complete compilation of scanned and searchable publications, as well as consistent and comprehensive geological, geophysical, and geochemical databases,

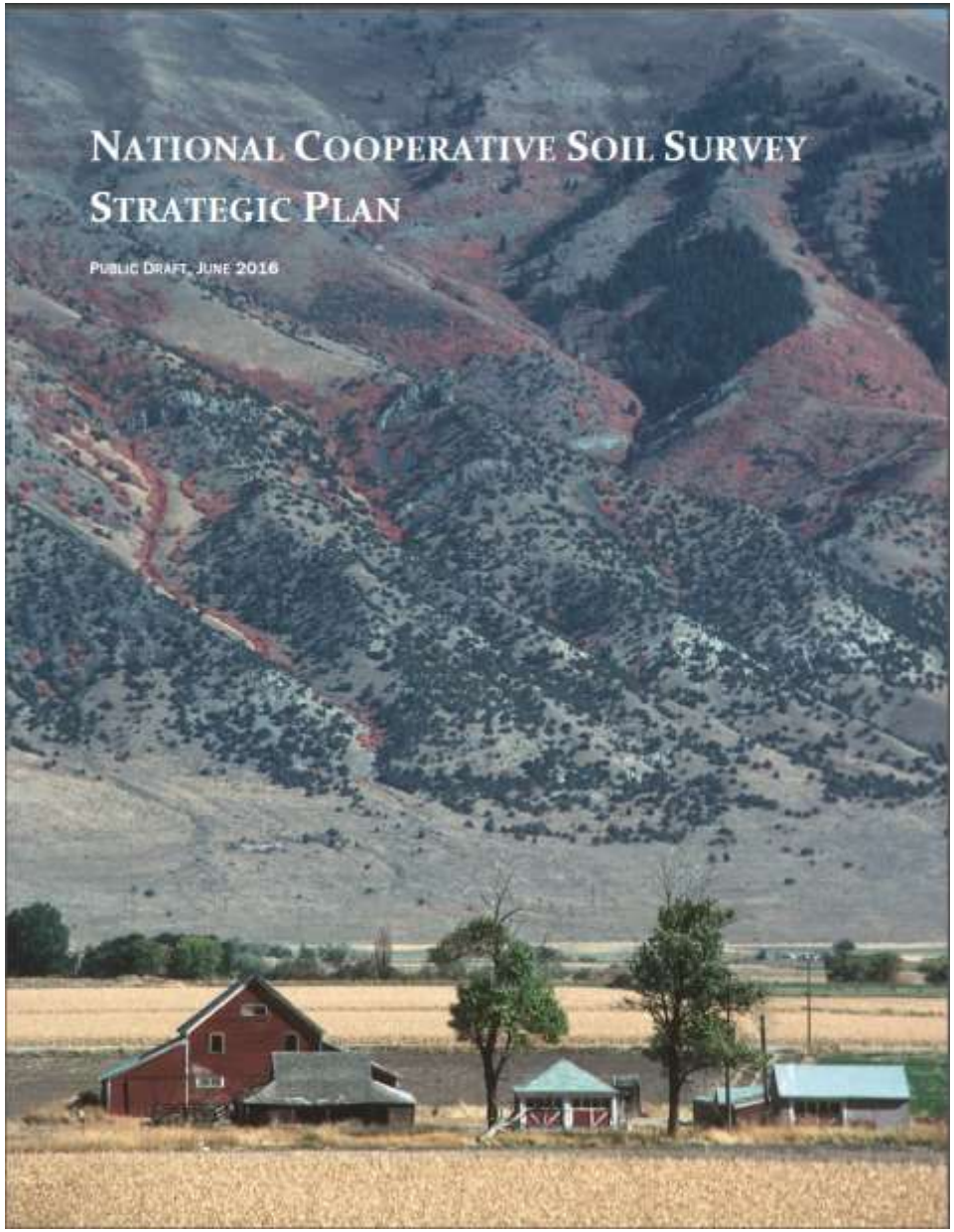
thus better fulfilling the essential role that geological surveys play in response to the needs of society.

Lexington, Kentucky, June 11, 2014

AASG ANNUAL MEETING 2014 GEOLOGY: *making an impact*

2014: The Association of American State Geologists (AASG) unanimously passed a resolution on geologic mapping that is fully compatible with USGS planning in Lexington, Kentucky on June 11, 2014

Planning



A new plan is concurrently in development for the National Cooperative Soil Survey

Planning

From August 9th to 11th, 2016, the NCGMP Decadal Strategic Planning Workshop was chaired by John Brock

Timeline for completion

- March 1st: 1st draft
- March 21st: Teleconference
- March 24th: 2nd draft
- April 4th: ppt, Chicago
- April 7th: deadline for reviews of 2nd draft
- April 28th: 3rd draft
- Apr 30th: internal USGS review
- May 22: ppt, Minneapolis
- June 12th: ppt, Branson, Missouri

Progress on the US geological mapping strategic plan

Harvey Thorleifson

- *Chair, Association of American State Geologists Mapping Committee*
- *Member, National Geospatial Advisory Committee*
- *Director, Minnesota Geological Survey*