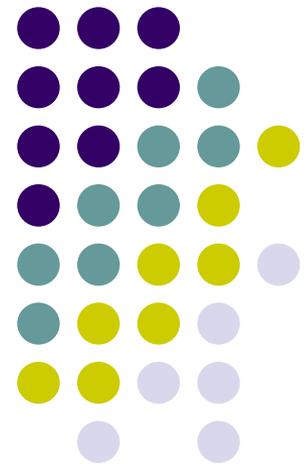
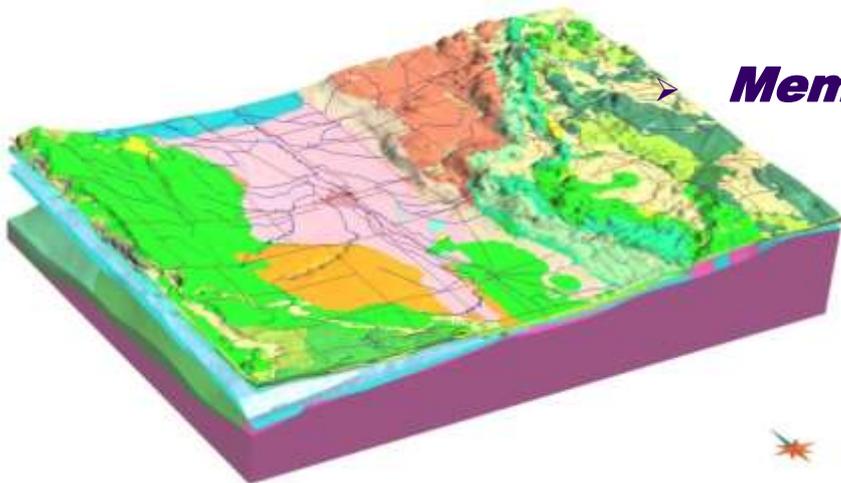


# Planning levels of resolution content in the national geological mapping database

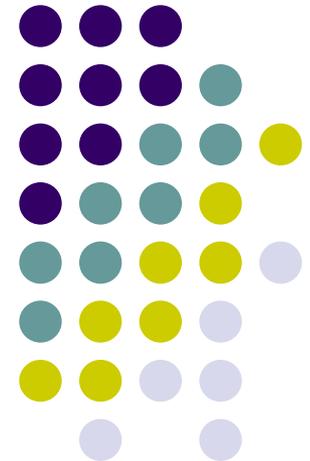
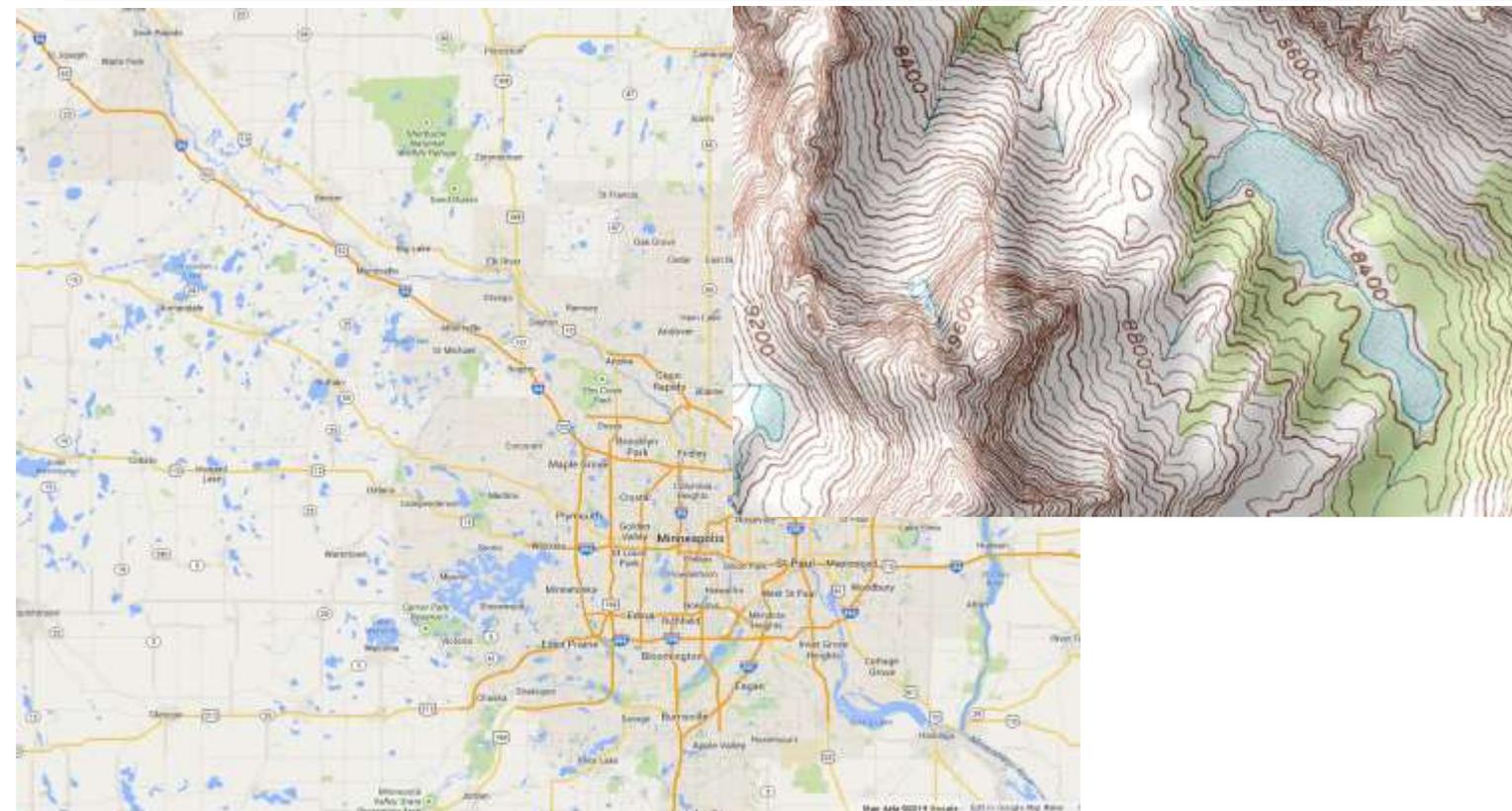
**NGAC September 2017**

**Harvey Thorleifson**

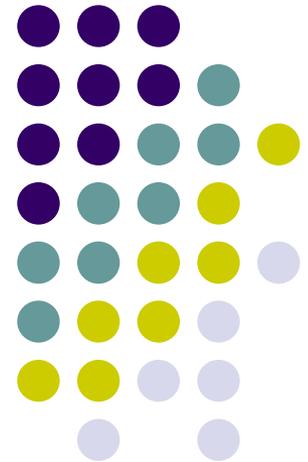
- ***Chair, Association of American State Geologists Mapping Committee***
- ***Member, National Geospatial Advisory Committee***
- ***Director, Minnesota Geological Survey***



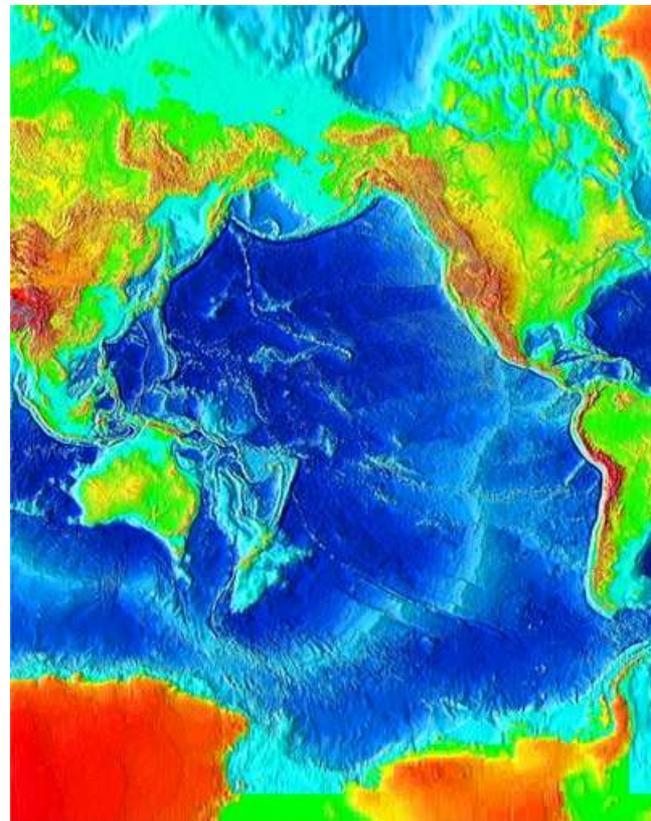
# Most mapping shows land-surface features



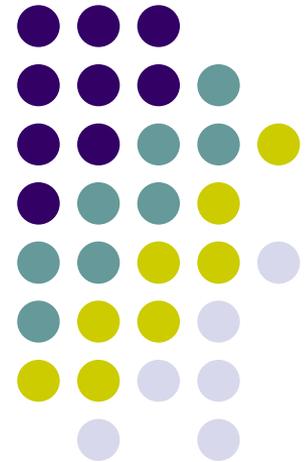
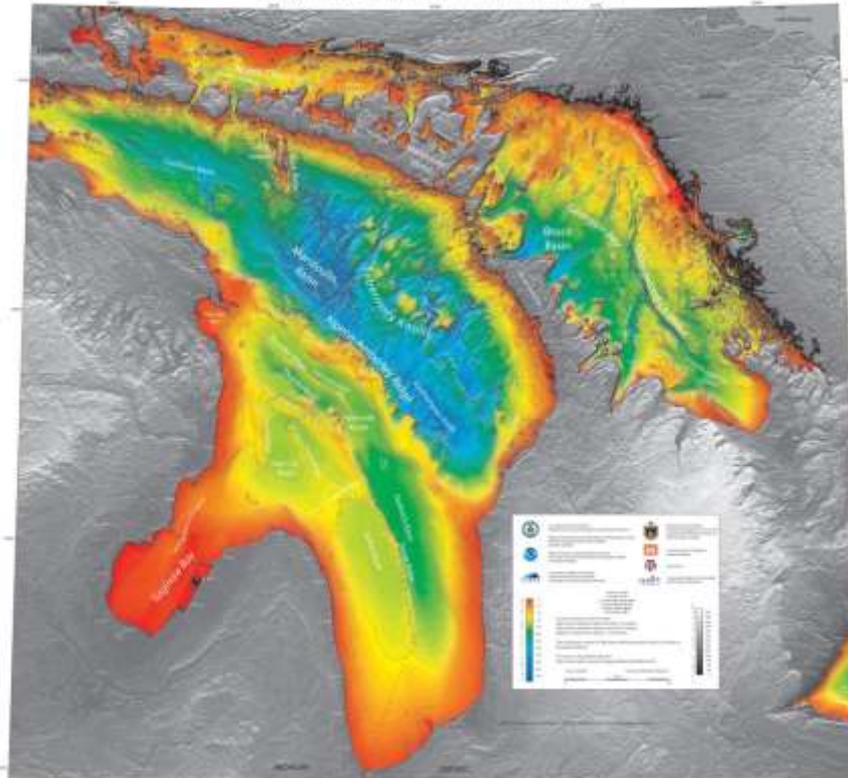
# Weather forecasts come from dynamic maps of the atmosphere



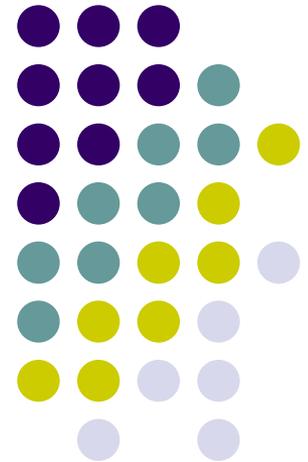
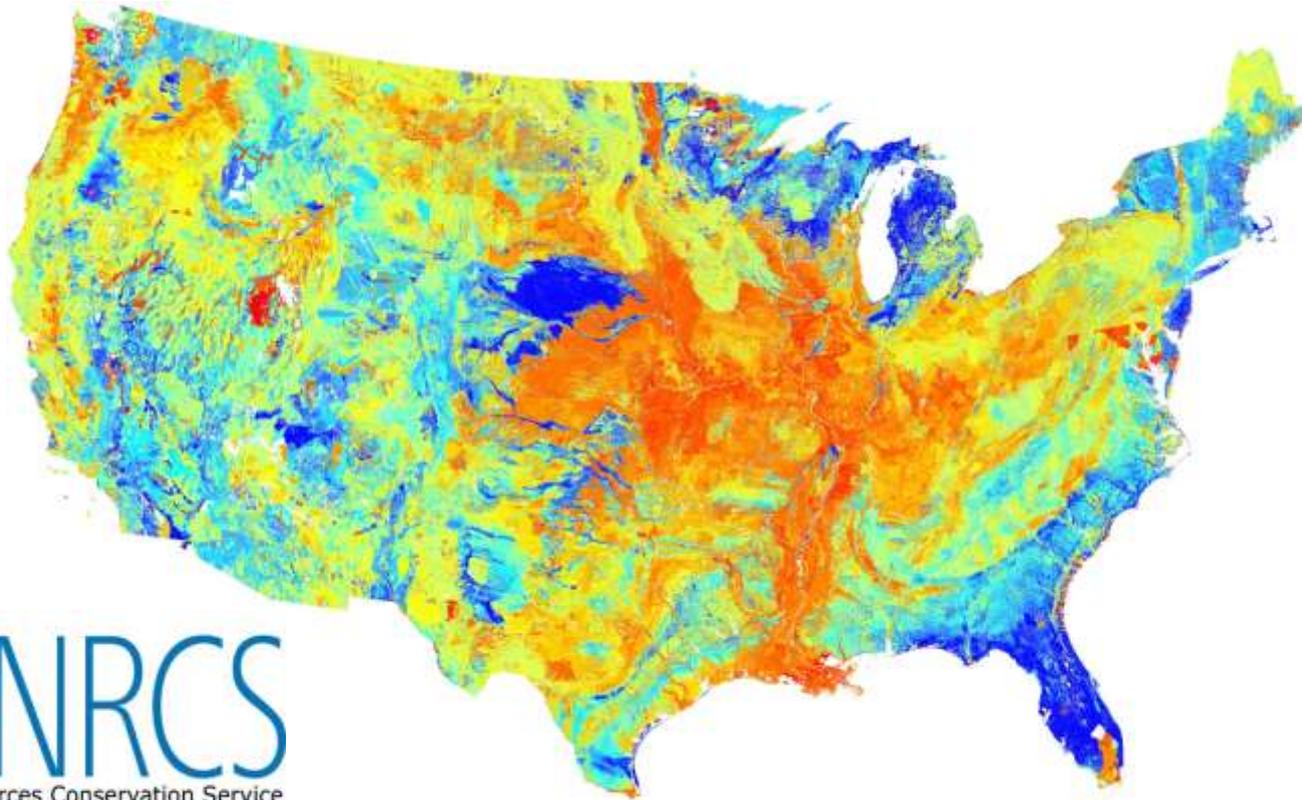
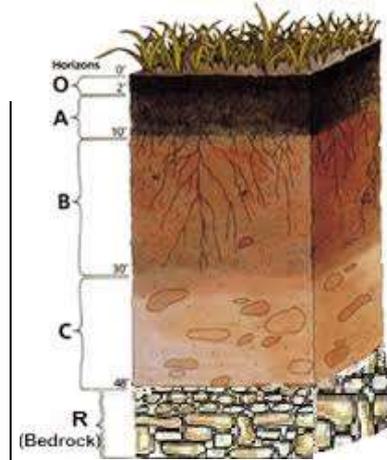
# The first subsurface layer is bathymetry



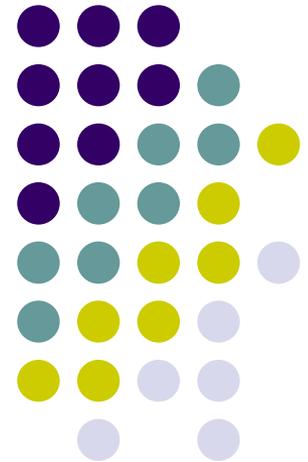
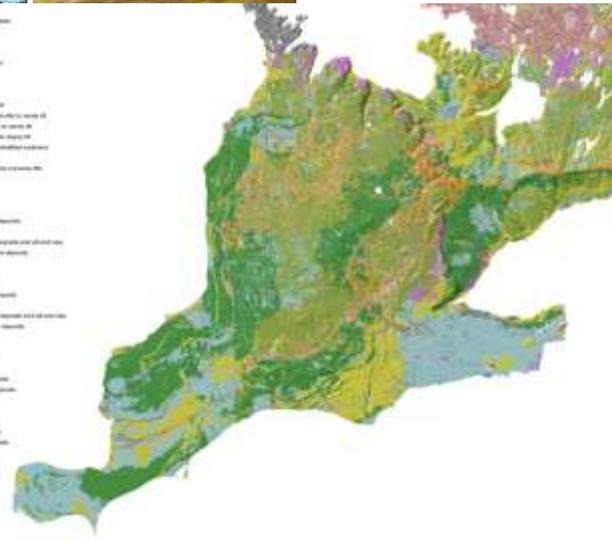
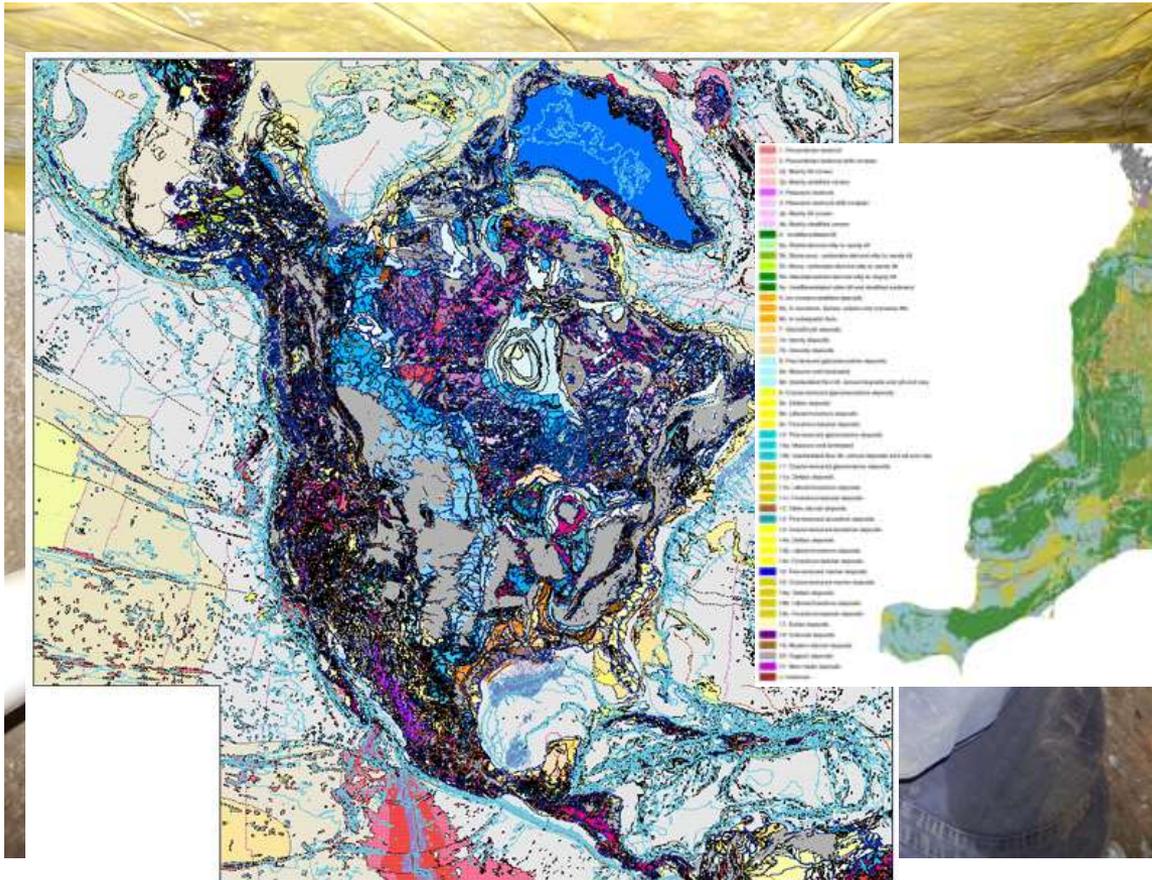
Bathymetry of Lake Huron with Topography



# Beneath that is soil mapping by agricultural agencies



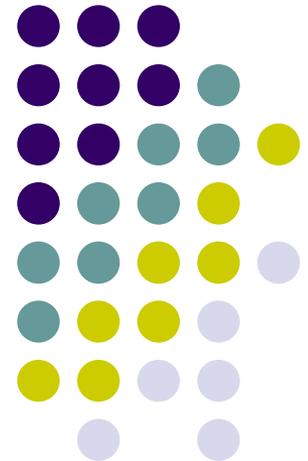
# Then, underground structures, and geology

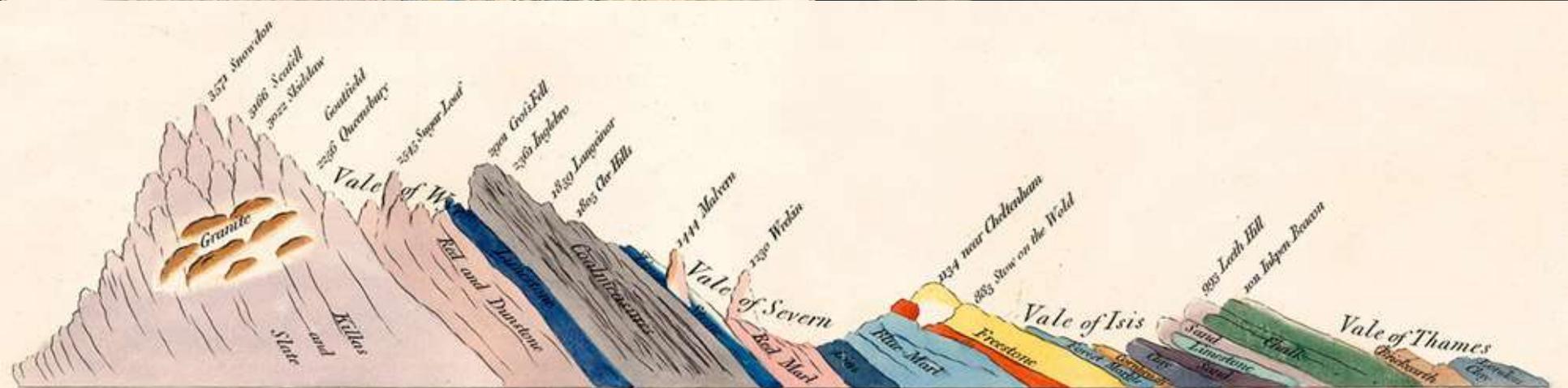
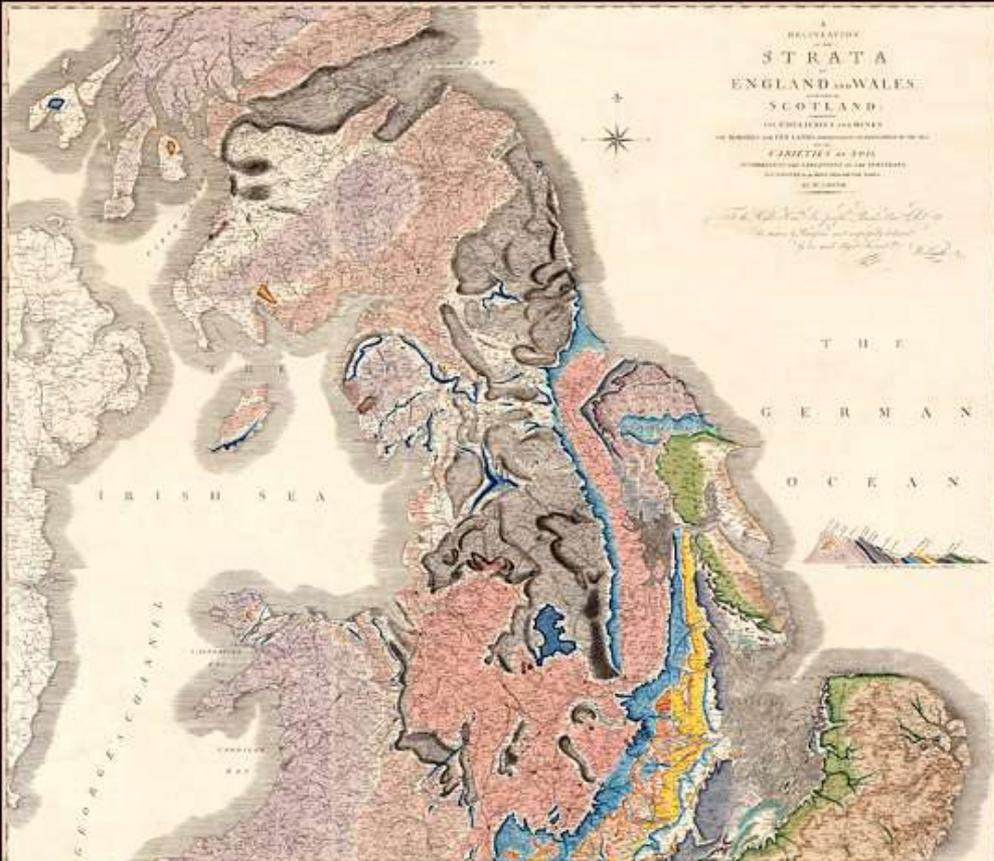


# Geological mapping is needed for:



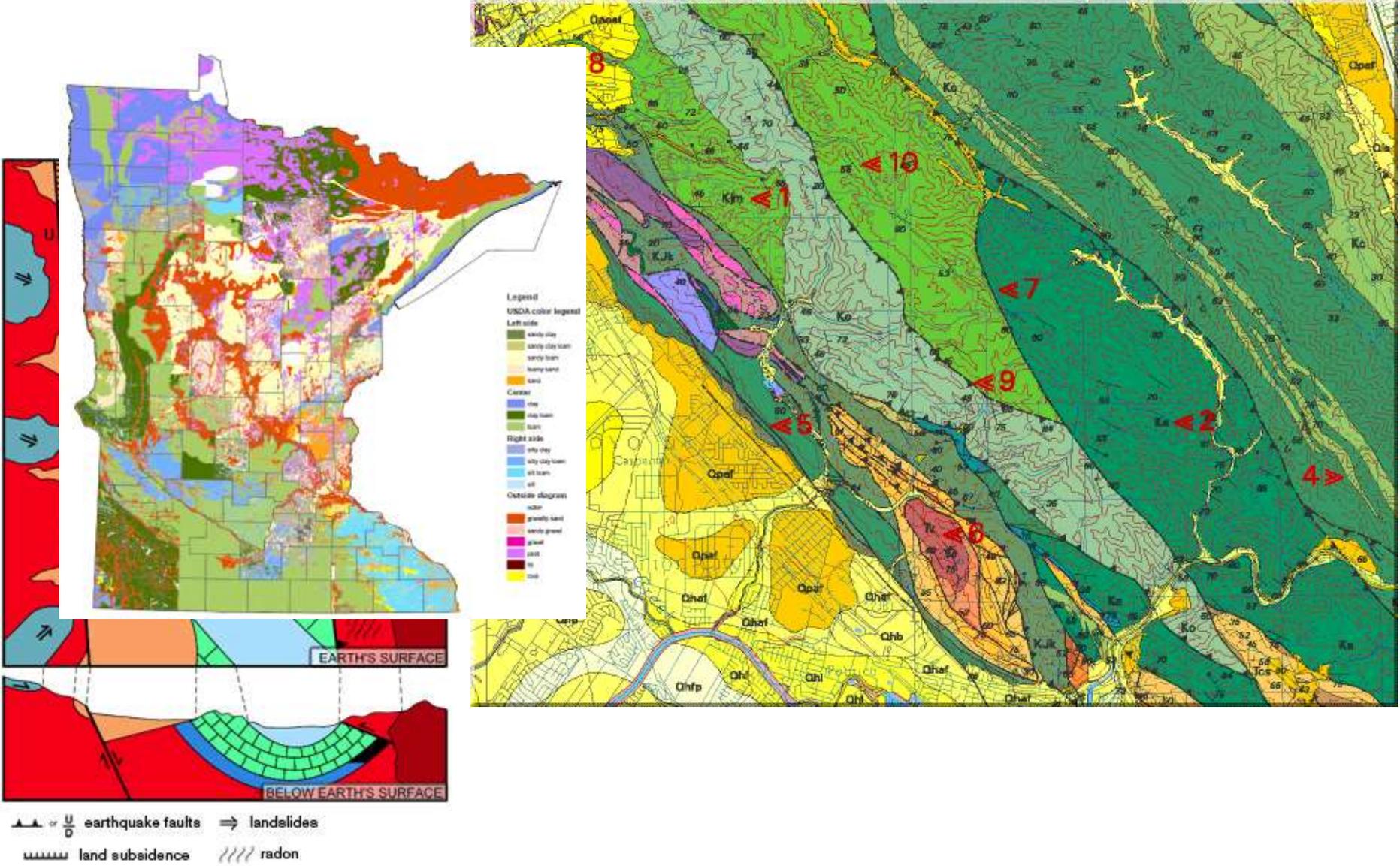
**Energy**  
**Minerals**  
**Water**  
**Hazards**  
**Environment**  
**Waste**  
**Engineering**  
**Research**



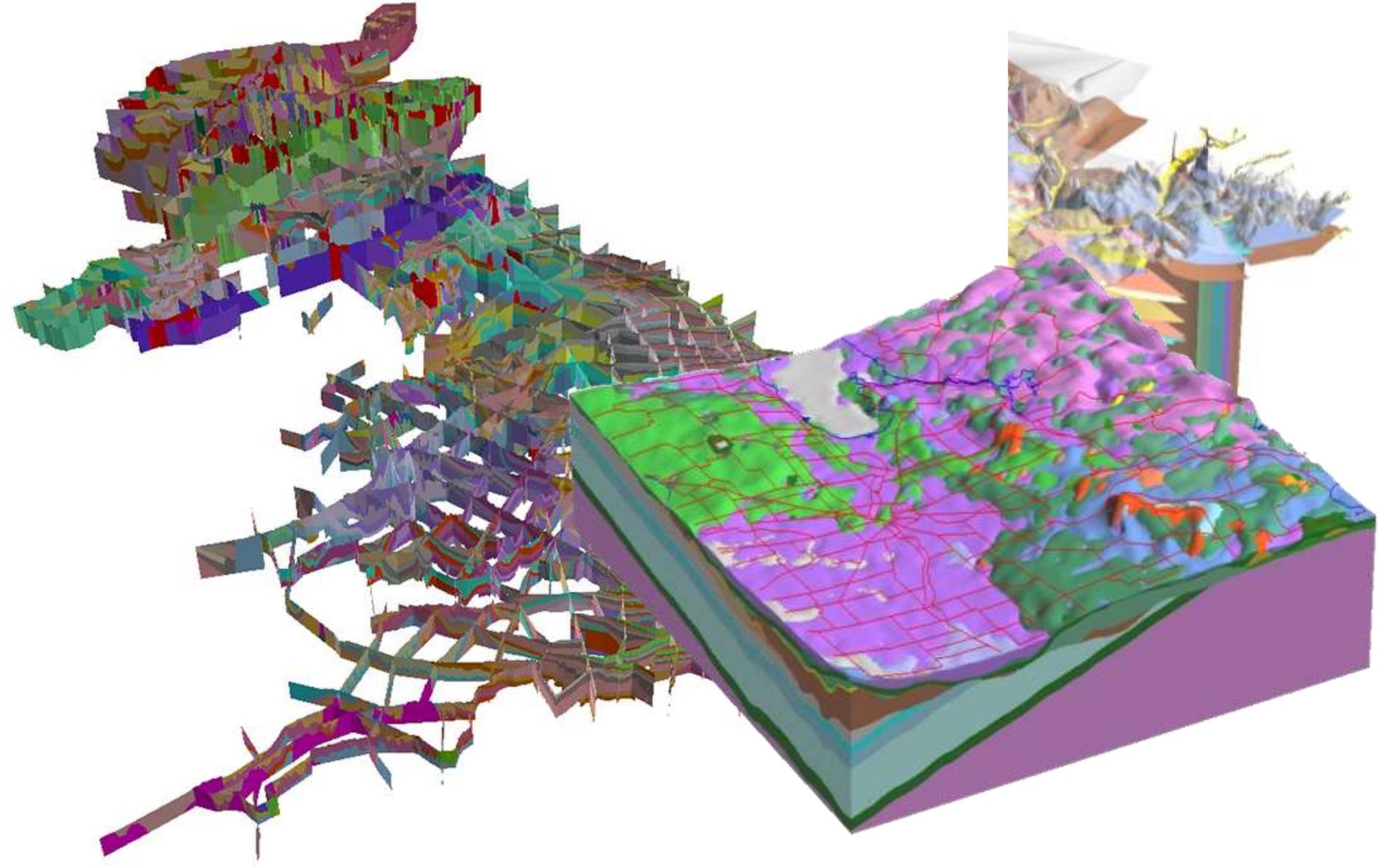


Sketch of the Succession of STRATA and their relative Altitudes. N<sup>o</sup>. 53.

# 2D geological mapping

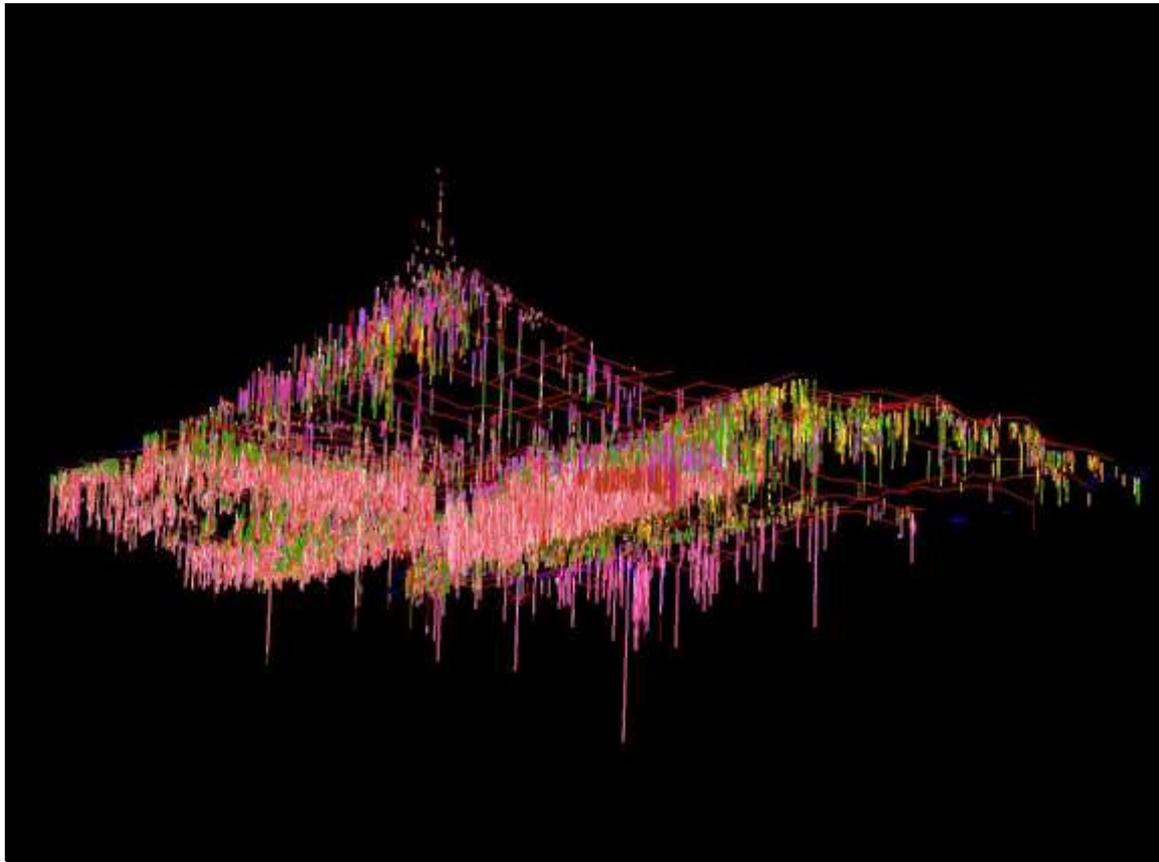


# 3D geological mapping



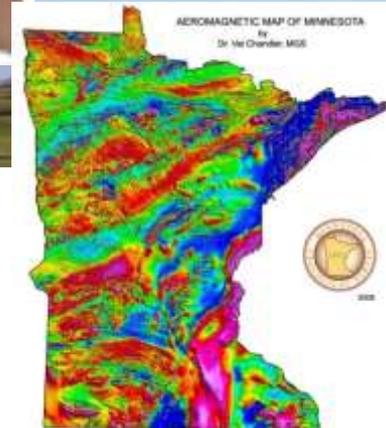
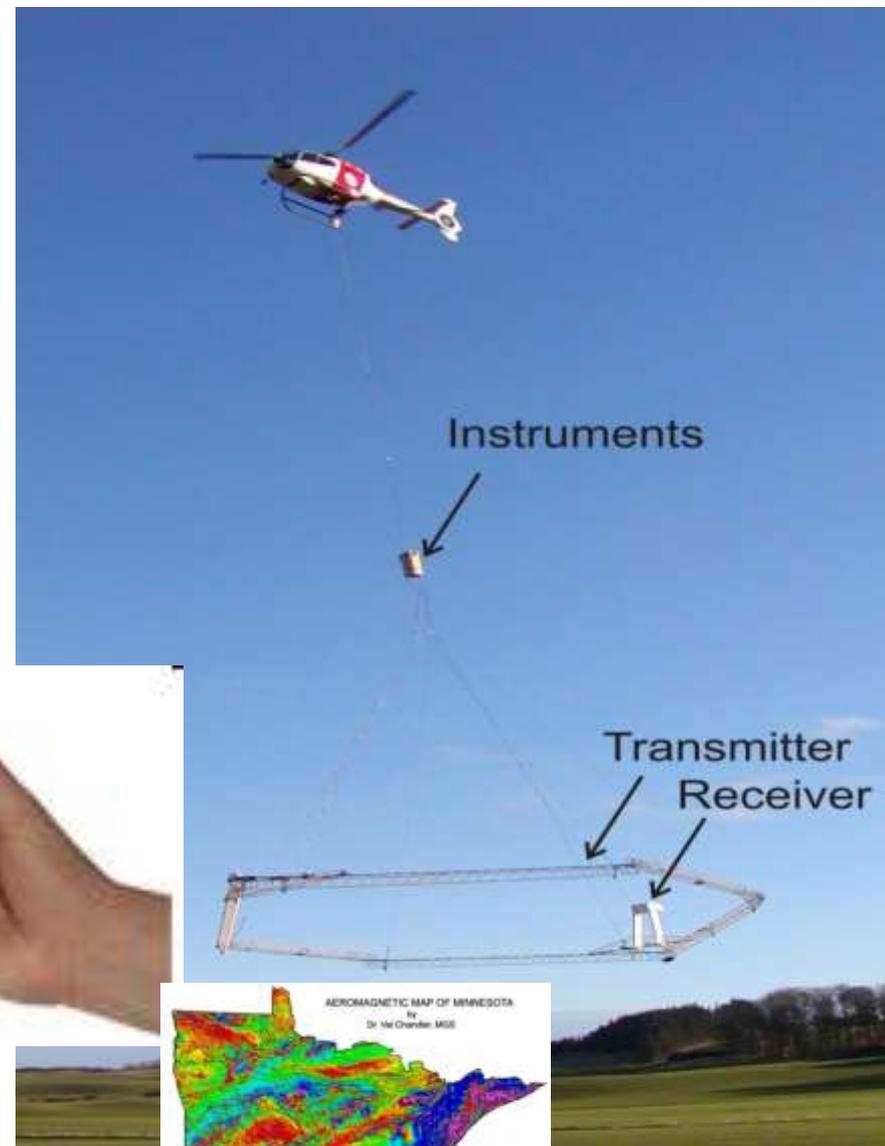
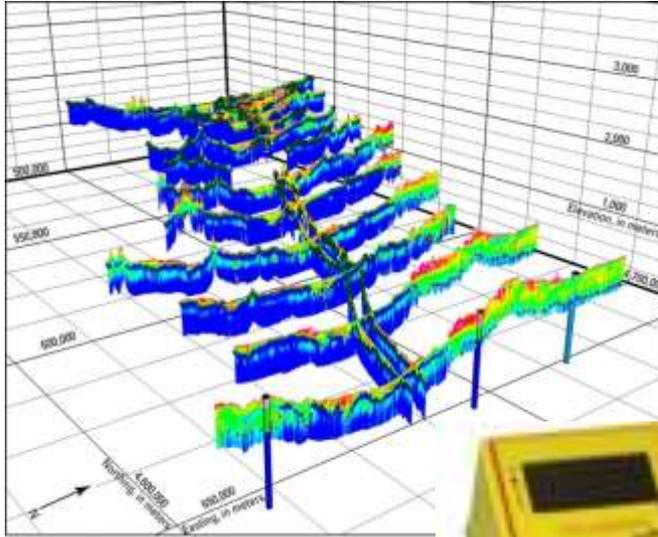
# Drillhole data

- **acquire**
- **digitize**
- **georeference**
- **categorize**



# Geophysics

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



# 1980s



Geologic Mapping in the  
U.S. Geological Survey



Geologic Mapping

Future Needs

**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

106 STAT. 166

PUBLIC LAW 102-285—MAY 18, 1992

Public Law 102-285  
102d Congress

## An Act

May 18, 1992  
[H.R. 2768]

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

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

### SECTION 1. SHORT TITLE.

This Act may be cited as the “National Geologic Mapping Act of 1992”.

### SEC. 2. FINDINGS AND PURPOSE.

(a) FINDINGS.—The Congress finds and declares that

(1) during the past 2 decades, the amount of geologic maps has been drastically curtailed;

(2) geologic maps are the primary source of information for all applied and basic earth-science investigations;

(A) exploration for and development of oil, gas, and water resources;

(B) screening and characterizing areas for nuclear waste disposal;

(C) land use evaluation and planning for environmental protection;

(D) earthquake hazards reduction;

(E) predicting volcanic hazards;

(F) design and construction of structures such as utility lifelines, dams, and surface-water impoundments;

(G) reducing losses from landslides and other geologic failures;

(H) mitigating effects of coastal erosion and sea level rise;

(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



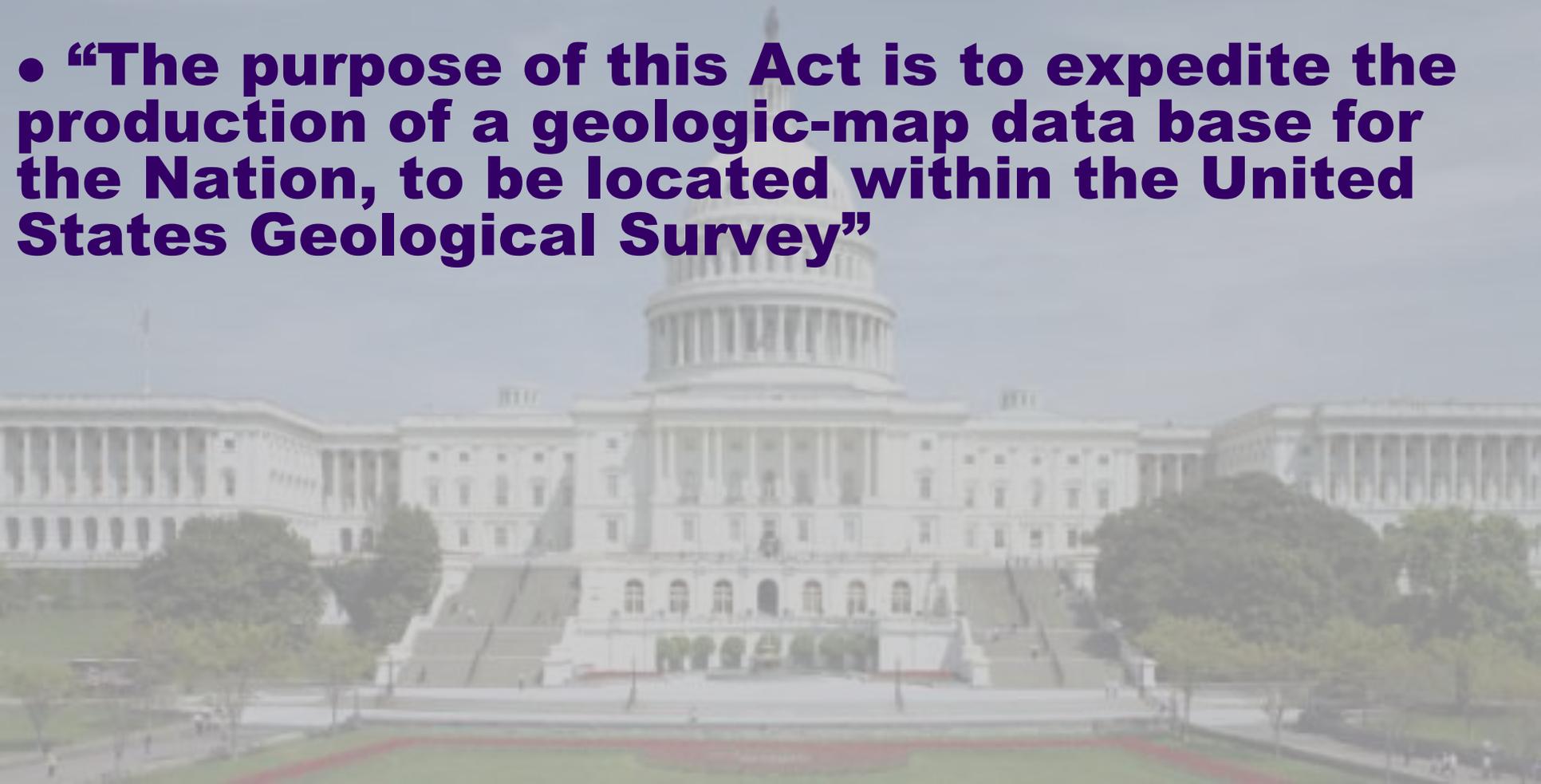
**As a result, the National Geologic Mapping Act (NGMA) became Law in 1992**

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

# 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

## NATIONAL GEOLOGIC MAPPING PROGRAM

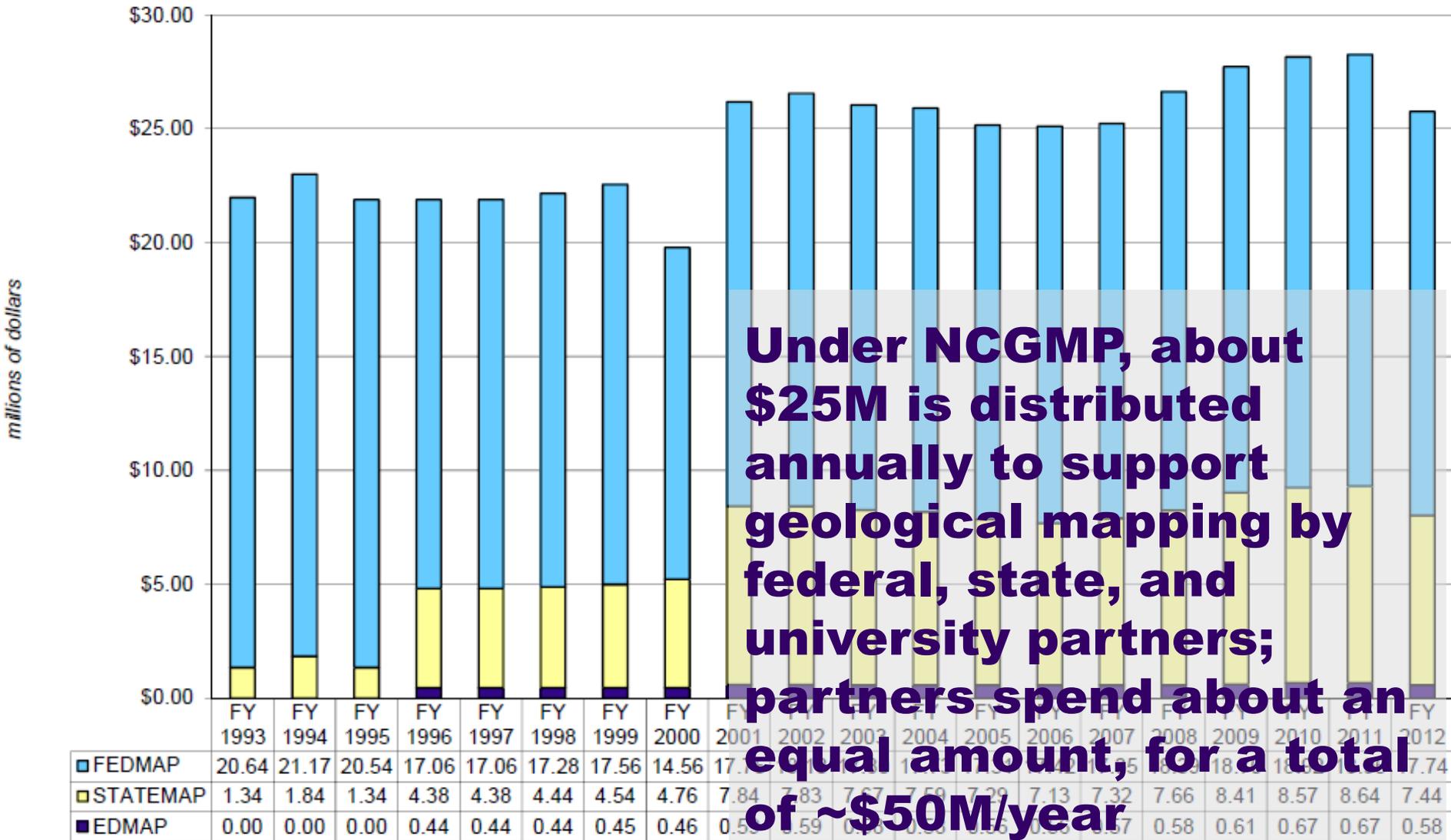
GOALS, OBJECTIVES, AND LONG-RANGE PLANS

U.S. GEOLOGICAL SURVEY CIRCULAR 1020

**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

## National Cooperative Geologic Mapping Program — Funding 1993 - 2012



Home

Catalog

Lexicon

MapView

Standards

Comments

# NGMDB

## STANDARDS AND DATABASES

### Information standards

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

### NGMDB

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

## The National Geologic Map Database

Developing a distributed archive of standardized geologic information for the nation.



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

Map Catalog

Find over 90,000 products from over 600 publishers



Strat

Find geologic maps and guides



TopoView

Access the Historical Topographic Map Collection



ACCESSIBILITY

FOIA

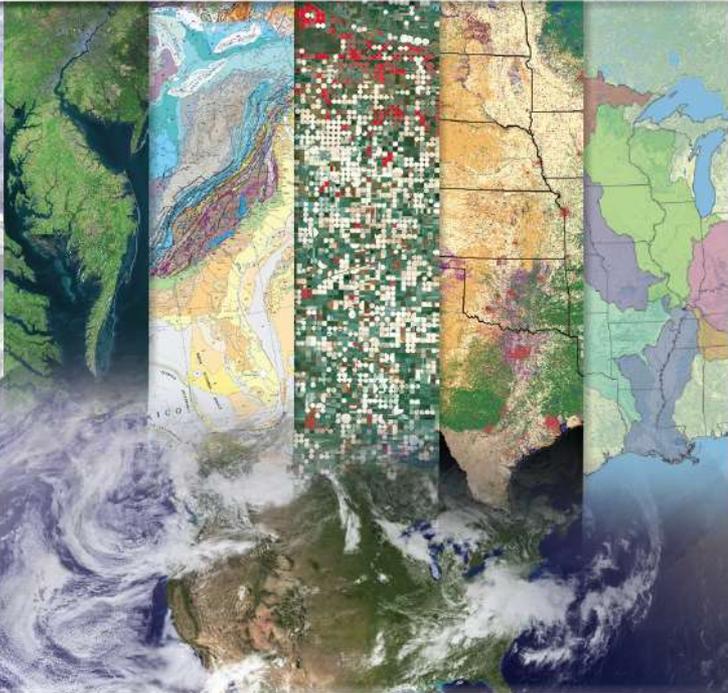
PRIVACY



# Planning



U.S. Geological Survey Core Science Systems Strategy—  
Characterizing, Synthesizing, and Understanding the Critical  
Zone through a Modular Science Framework



Circular 1383-B

U.S. Department of the Interior  
U.S. Geological Survey

**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**



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,

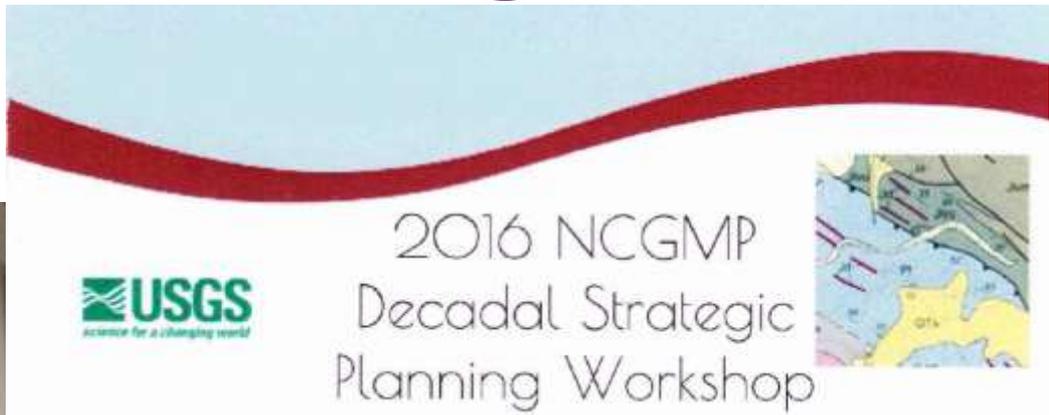
*thus better fulfilling the essential role that geological surveys play in response to the needs of society.*

*Lexington, Kentucky, June 11, 2014*



**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



**Last year, we held the NCGMP Decadal Strategic Planning Workshop from August 9th to 11th in Denver**

# Renewing the National Cooperative Geologic Mapping Program as the Nation's Authoritative Source for Modern Foundational Geologic Knowledge

*Authored By:*

*Karen Berry<sup>1</sup>, John Brock<sup>2</sup>, James Faulds<sup>3</sup>, Kyle House<sup>4</sup>, Michael Marketti<sup>2</sup>, Darcy McPhee<sup>2</sup>, Kevin Schmidt<sup>5</sup>,  
James Schmitt<sup>6</sup>, David Soller<sup>2</sup>, David Spears<sup>7</sup>, Ren Thompson<sup>8</sup>, Harvey Thorleifson<sup>9</sup> and Gregory Walsh<sup>10</sup>*

**Affiliations:**

- 1: Colorado Geological Survey, Colorado School of Mines, Golden, CO 80401
- 2: National Cooperative Geologic Mapping Program, USGS, Reston, VA 20192
- 3: Nevada Bureau of Mines and Geology, University of Nevada, Reno, NV 89557
- 4: Geology, Minerals, Energy, and Geophysics Science Center, USGS, Flagstaff, AZ 86001
- 5: Geology, Minerals, Energy, and Geophysics Science Center, USGS, Menlo Park, CA 94025
- 6: Department of Earth Sciences, Montana State University, Bozeman, MT 59717
- 7: Virginia Department of Mines, Minerals and Energy, Charlottesville, VA 22903
- 8: Geosciences & Environmental Change Science Center, USGS, DFC, Denver, CO 80225
- 9: Minnesota Geological Survey, University of Minnesota, St Paul, MN 55114
- 10: Eastern Geology and Paleoclimate Science Center, USGS, Montpelier, VT 05602

**The strategic plan was  
completed in May 2017**



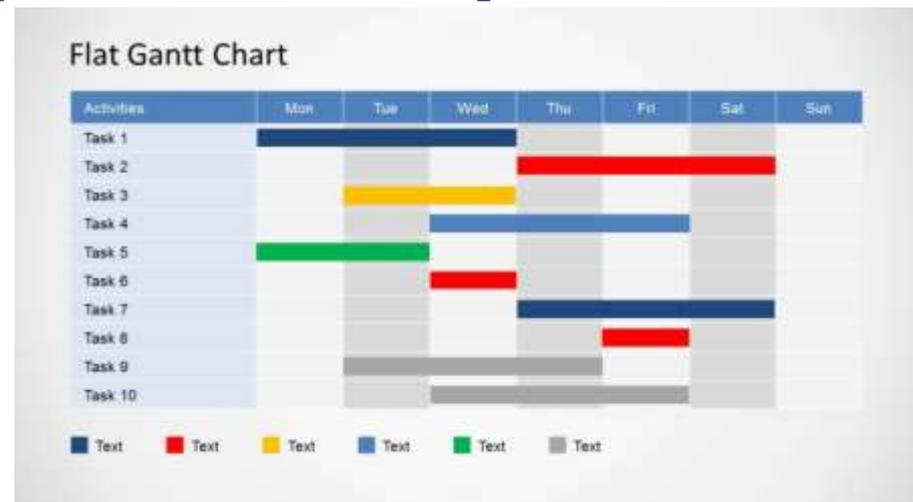
# Implementation plan

**How shall we build a national, regularly-updated, well-coordinated, multi-resolution, seamless, 3D, material-properties-based geological mapping database?**

**We seem to need 1) 2D, 2) X-S, 3) 3D of the layers, 4) basement 2D/3D – in that order?**

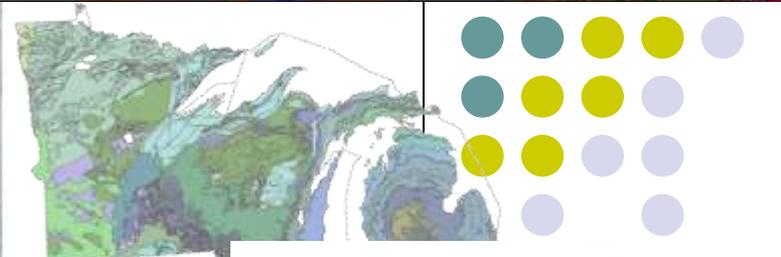
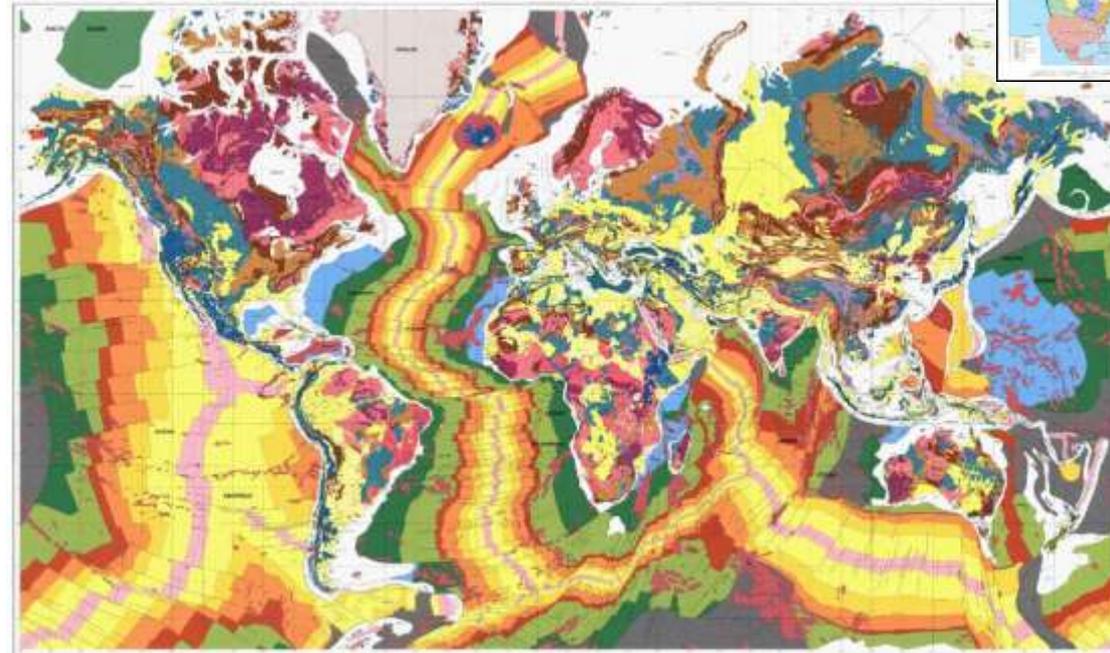
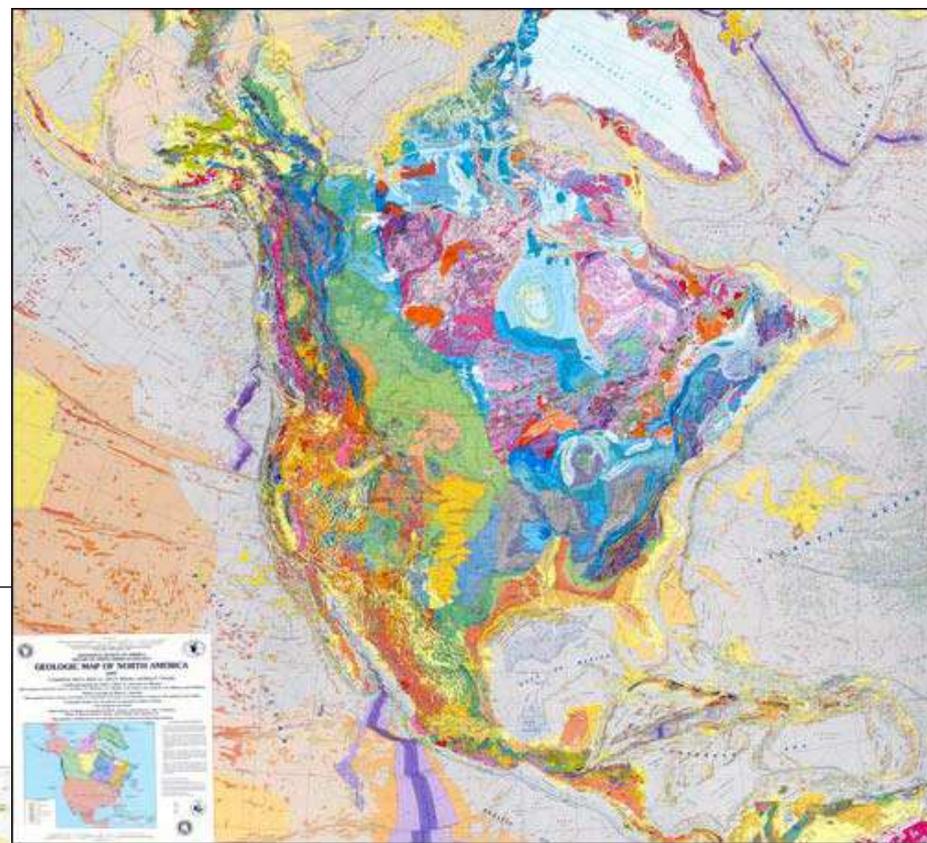
**Which resolution level should we start with?**

**Next, we need an implementation plan**

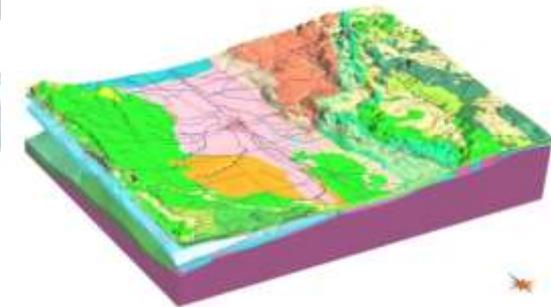


# Resolution

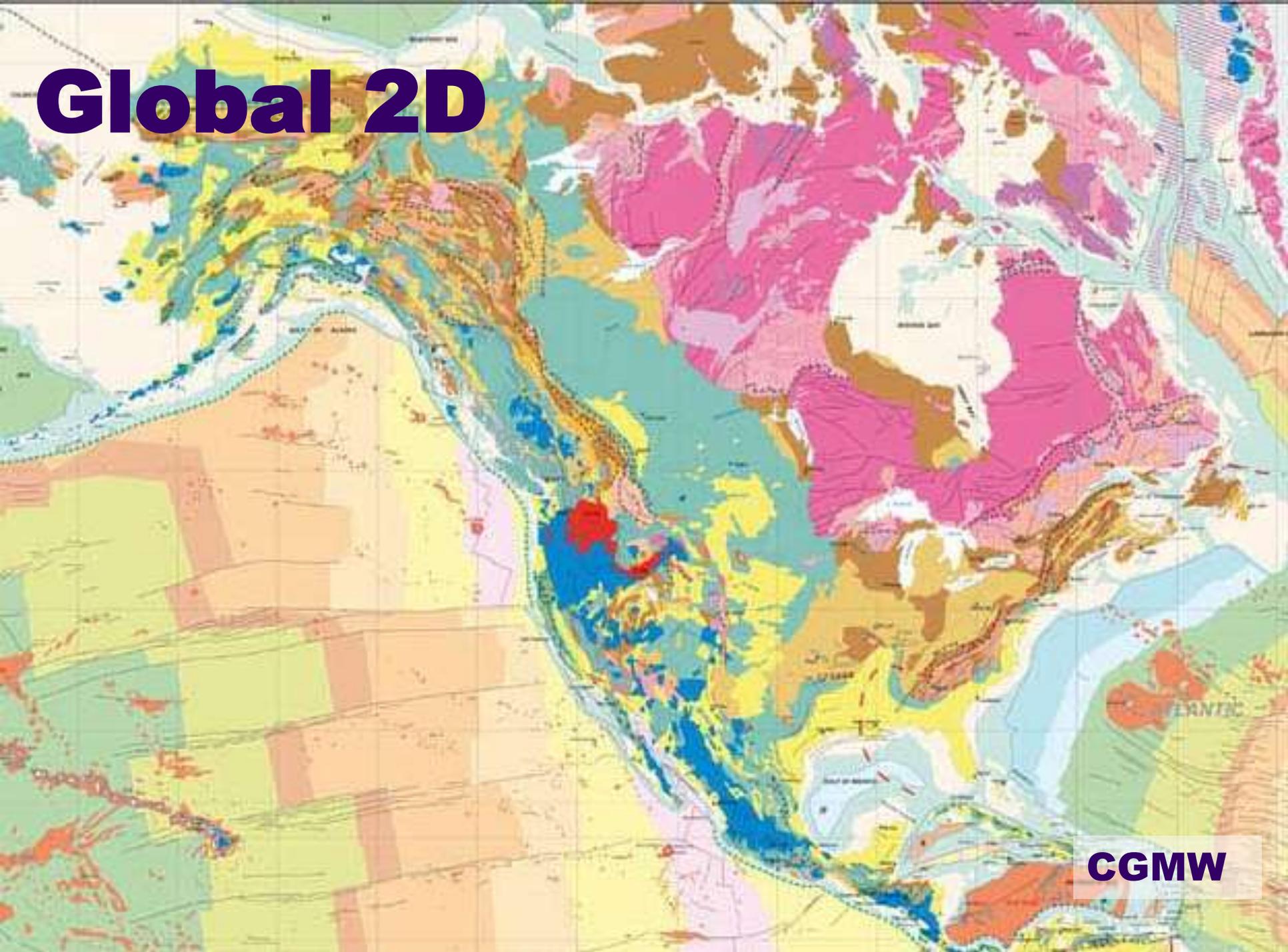
- Global
- Continental
- National
- County
- Urban



*Geologic  
Age  
Representation*



# Global 2D



**CGMW**

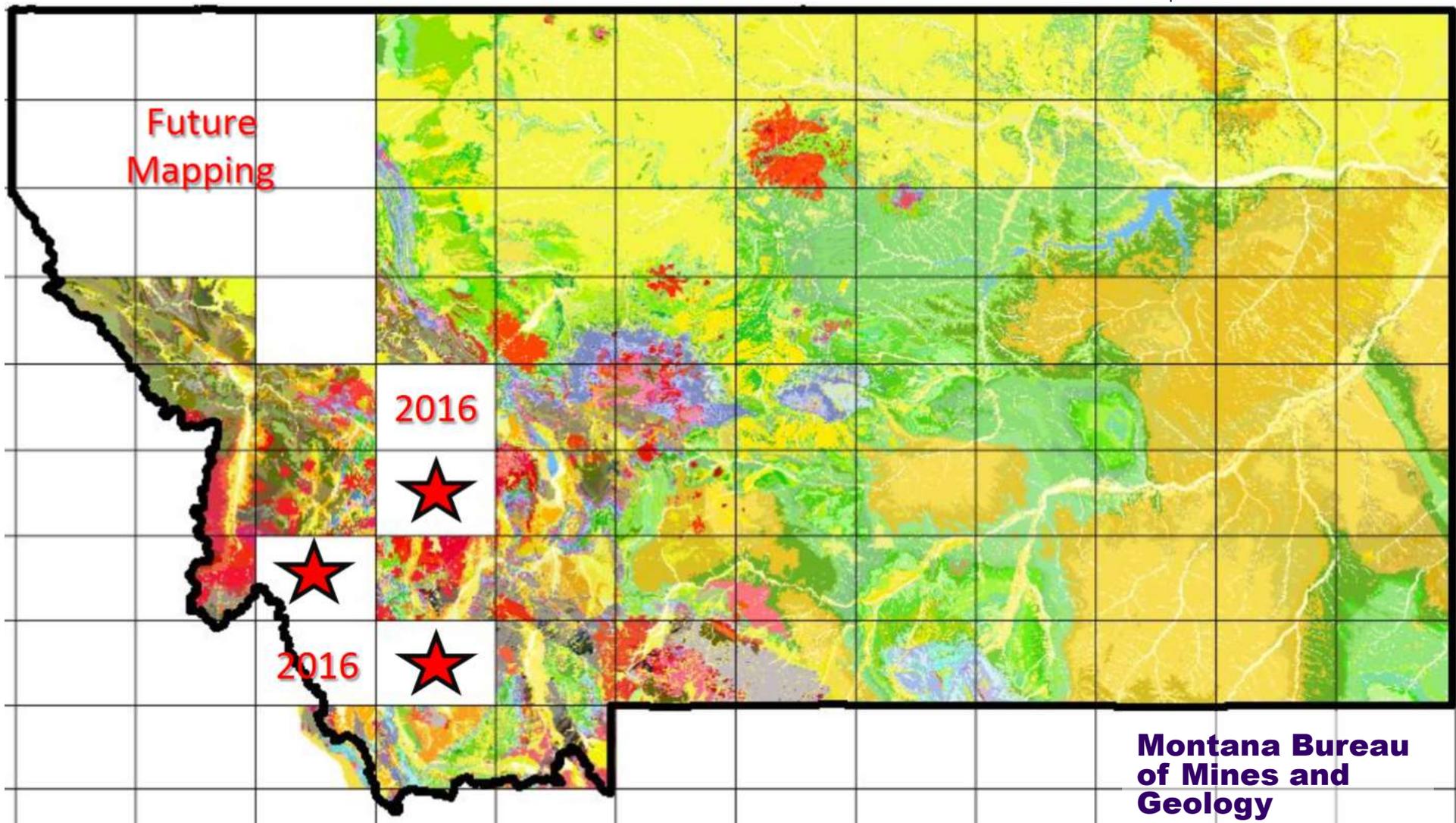


# National 2D

A geological map of the United States showing various mineral resources. The map is color-coded: red for coal, yellow for oil and gas, blue for uranium, and green for other minerals. The map is overlaid on a satellite-style background of the United States and surrounding regions.

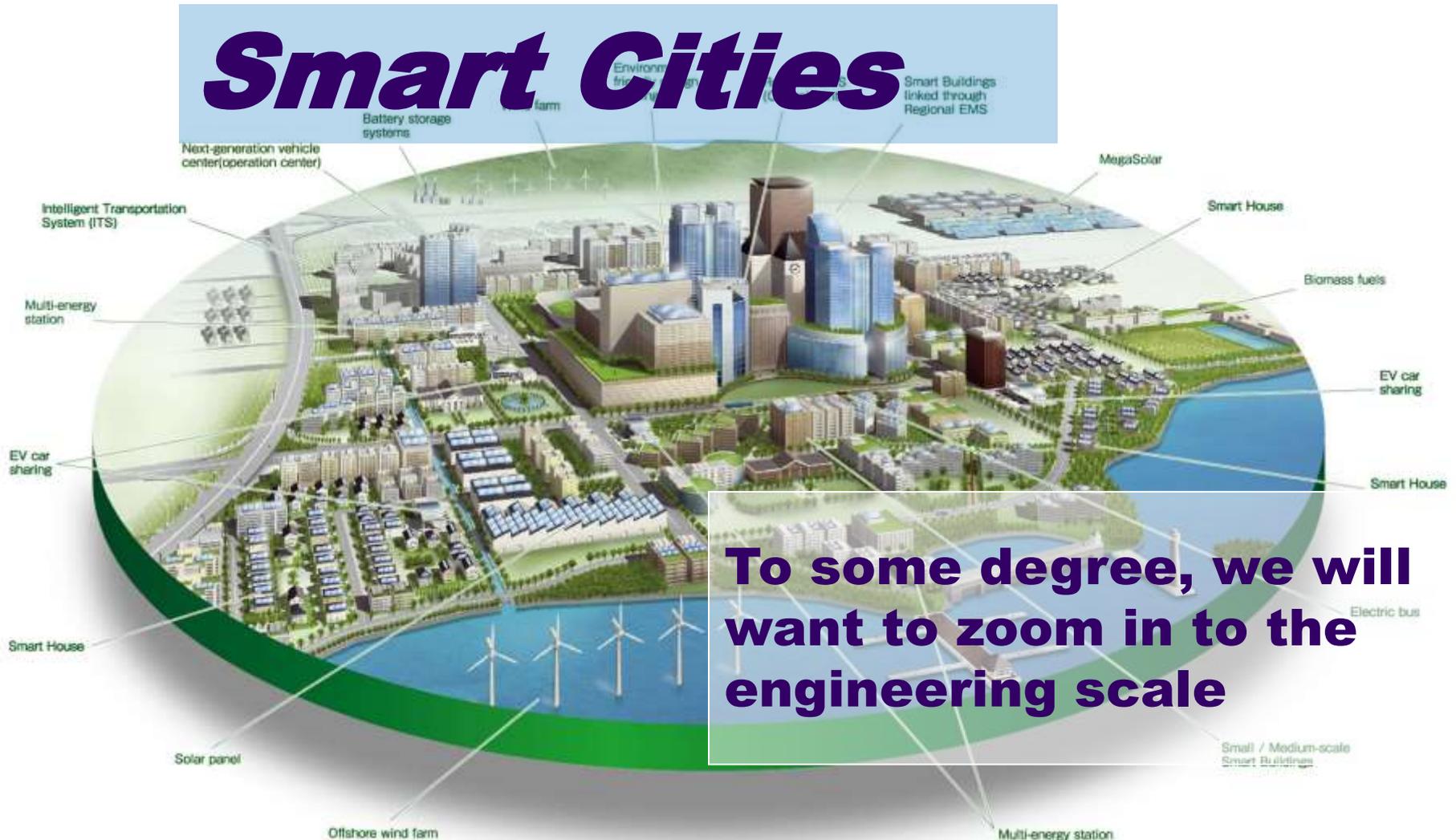
**USGS Minerals  
Program**

# County 2D



# Urban

## *Smart Cities*



# Resolution

	Global	Continental	State/National	County/Quadrangle
<b>Sediments</b>	None	One layer	Gross lithologic breaks	Formations
<b>Layered rocks</b>	Half dozen layers	A dozen or more	Formations	Formations +
<b>Basement</b>	Basement	Basement	Basement	Basement

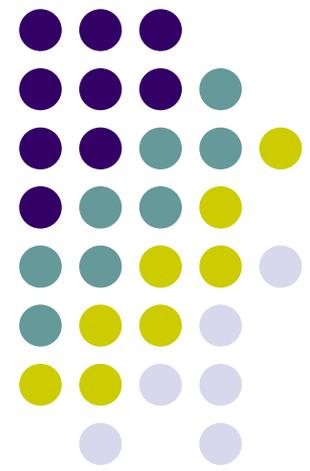
***\*\*Preliminary outline for discussion***

**A challenge presently being addressed is the planning of levels of resolution content in the national geological mapping database**

# Planning levels of resolution content in the national geological mapping database

**NGAC September 2017**

**Harvey Thorleifson**



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

