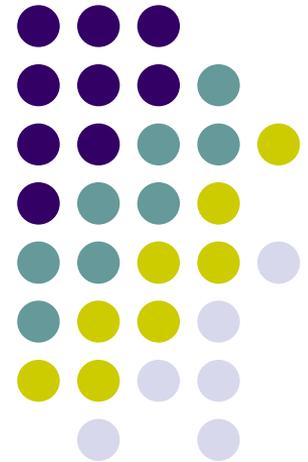
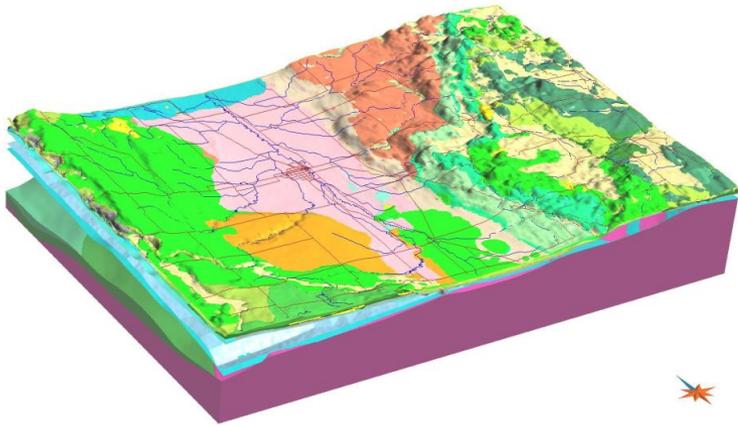


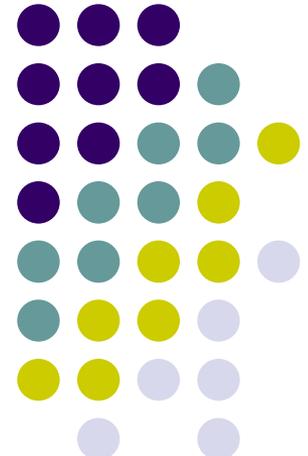
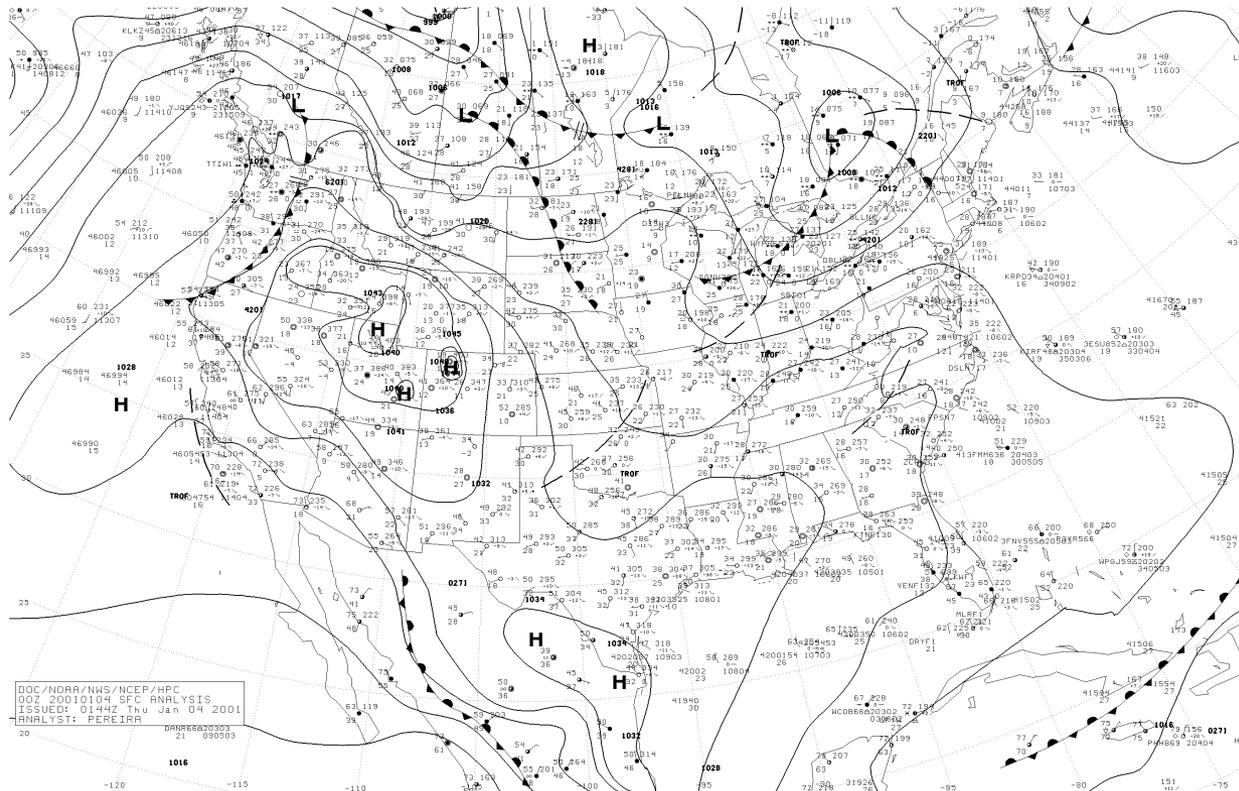
Charting a path forward for geological mapping

*Harvey Thorleifson Ph.D.
Director, Minnesota Geological Survey*

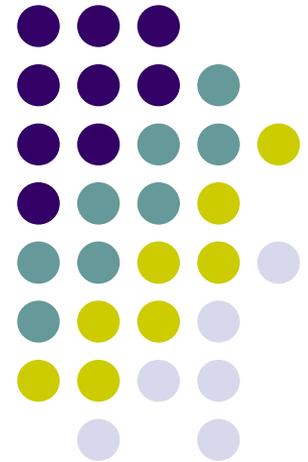
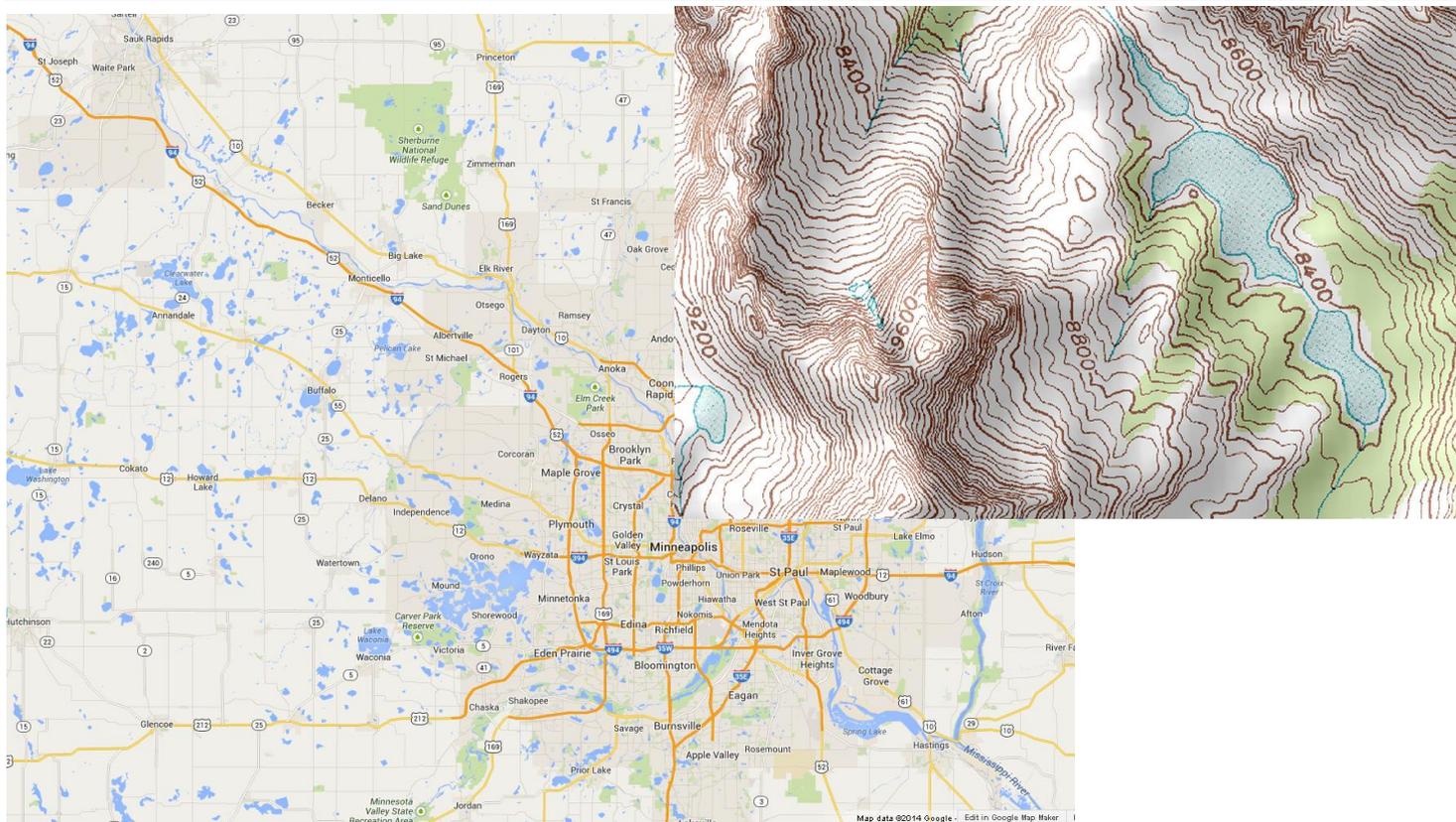
**National Geospatial Advisory Committee
June 24-25, 2014**



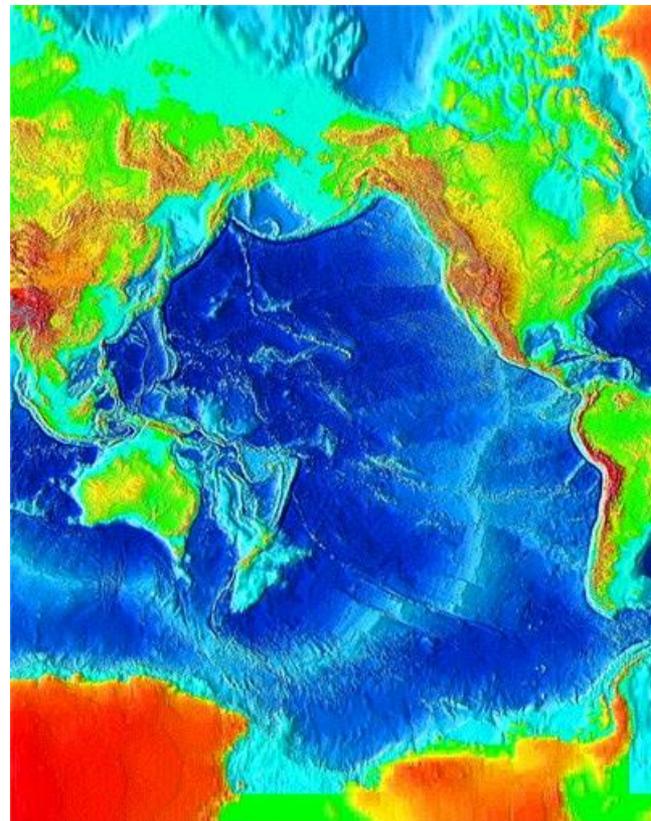
Some of us look up, to construct meteorological charts



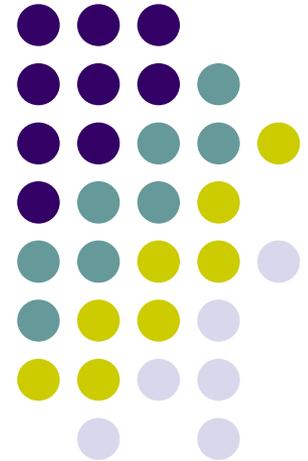
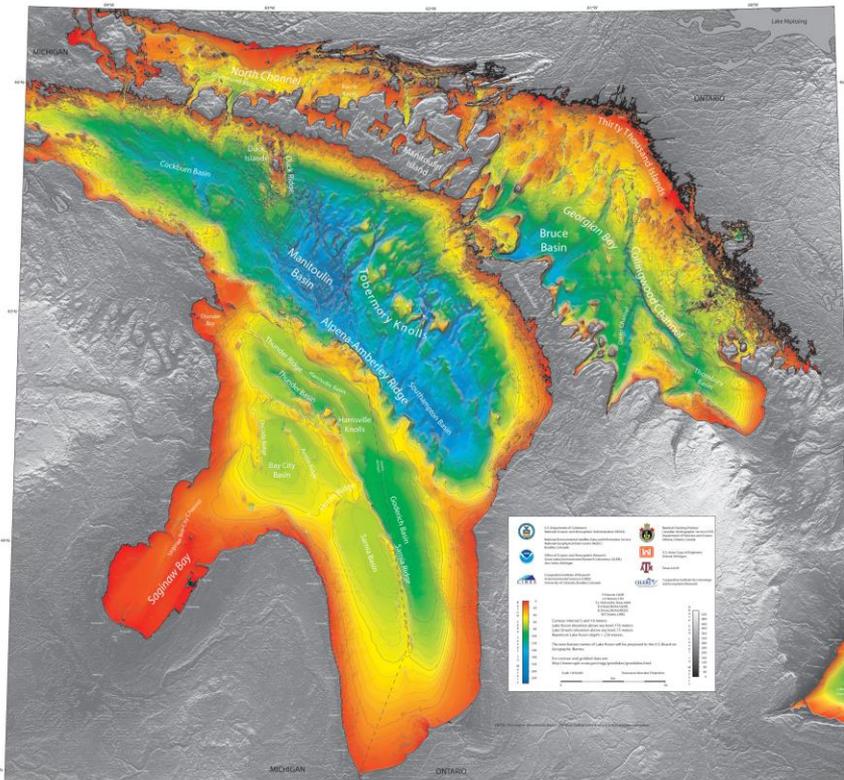
Much of our effort is in depicting land-surface features



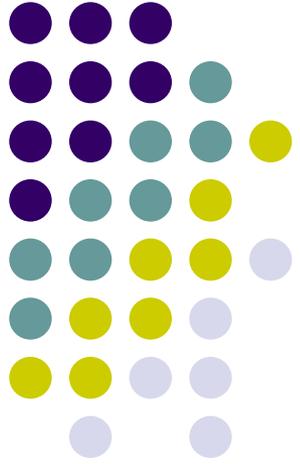
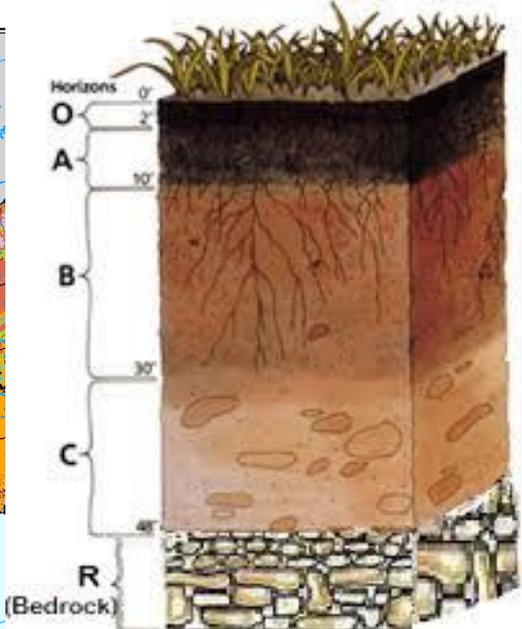
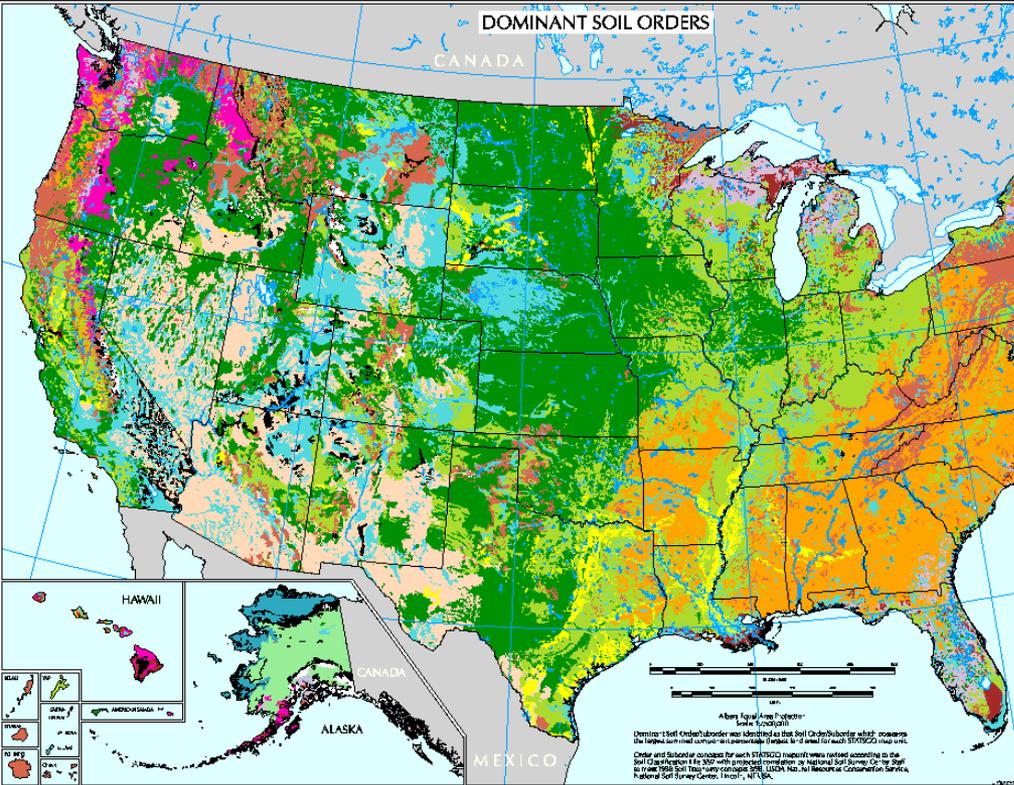
The first subsurface layer is bathymetry



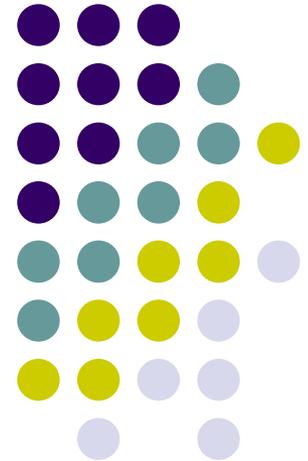
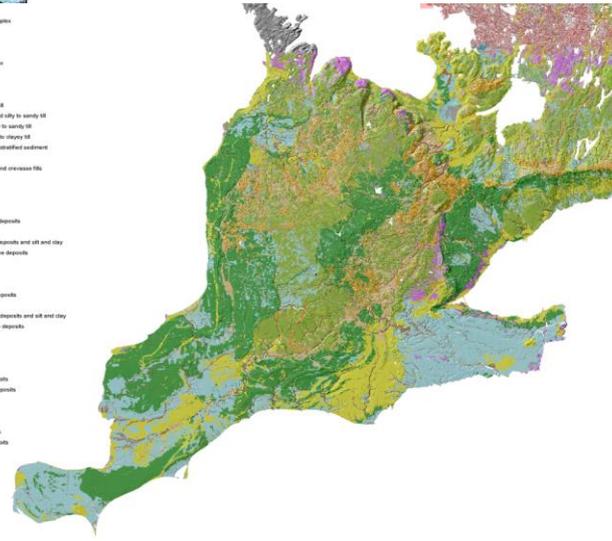
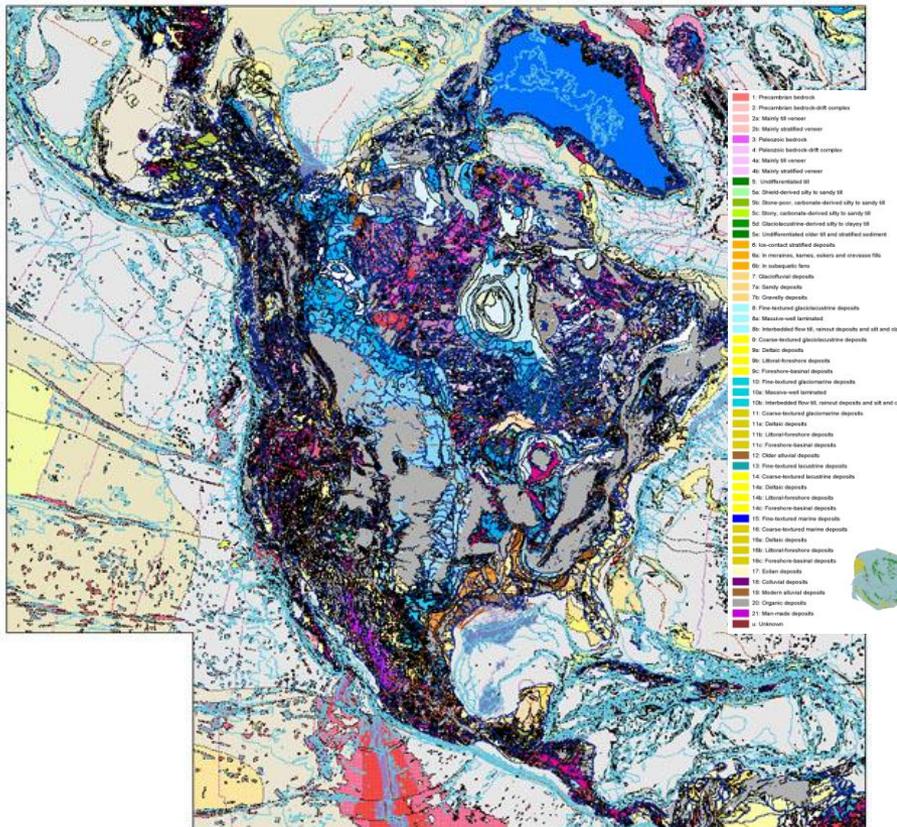
Bathymetry of Lake Huron with Topography



Next, soil mapping by agricultural agencies



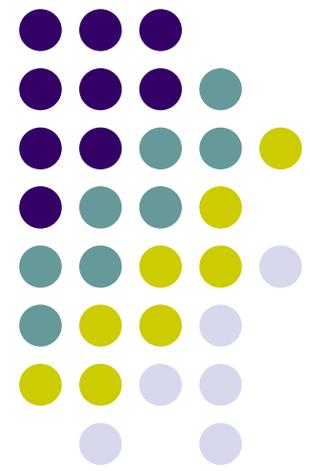
Then, geology



Geological mapping, like all of the mapping we do, is an essential service

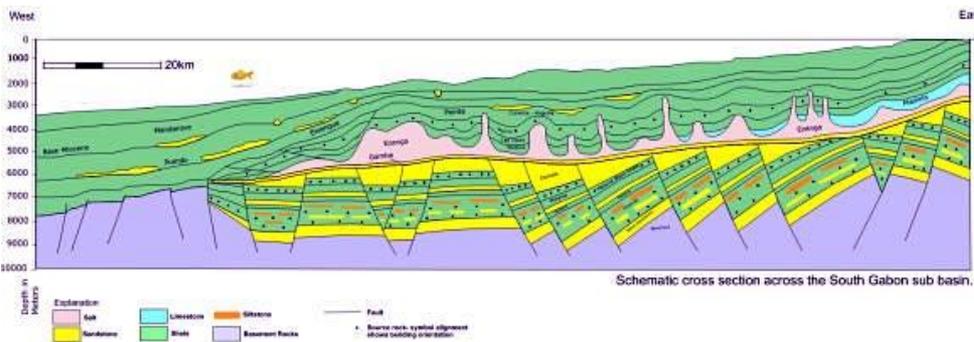
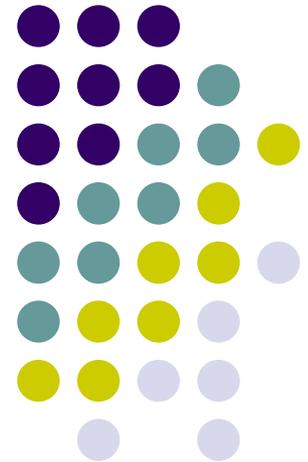


Energy
Minerals
Water
Hazards
Environment
Waste
Engineering



Geological mapping, like all of the mapping we do, saves money

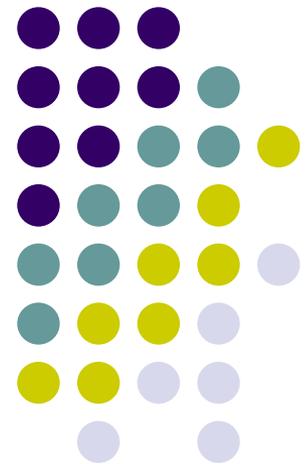
lives saved
resources discovered
costs avoided
increased efficiency
fundamental
understanding



We need to accelerate in response to societal needs

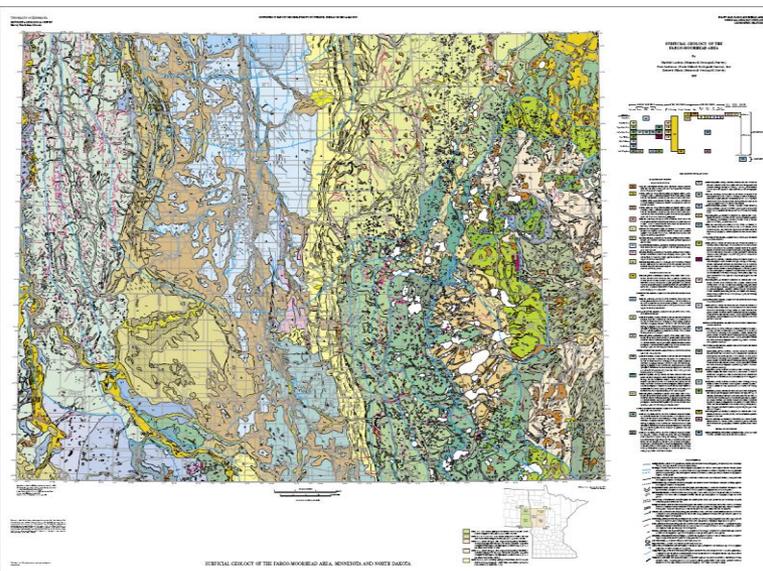
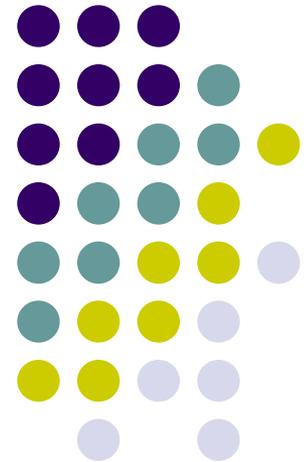


Content
Collaboration
Administration
Infrastructure
Formats
Accessibility



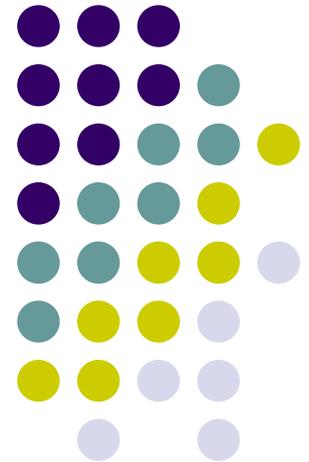
Paper maps and their digital equivalents will continue to be our foundation

information content is rich
standards well-developed
formats are familiar
usable indefinitely
authorship
peer review



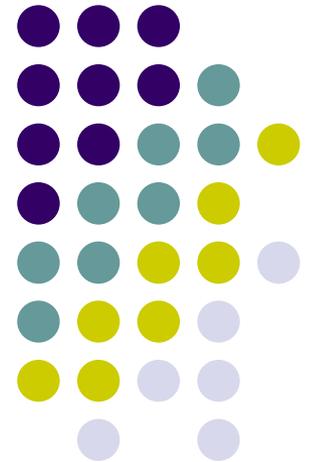
Ongoing geological mapping will be supported by

*new drilling,
geochronology,
geochemistry,
geophysics, &
data compilation*



**All geological mapping
will be vertically
georeferenced using the
best available**

***topography,
bathymetry,
drillhole data, &
geophysical surveys***



Future geological mapping needs to be

Regularly updated

Zoomable

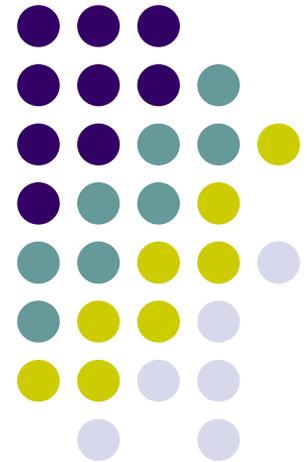
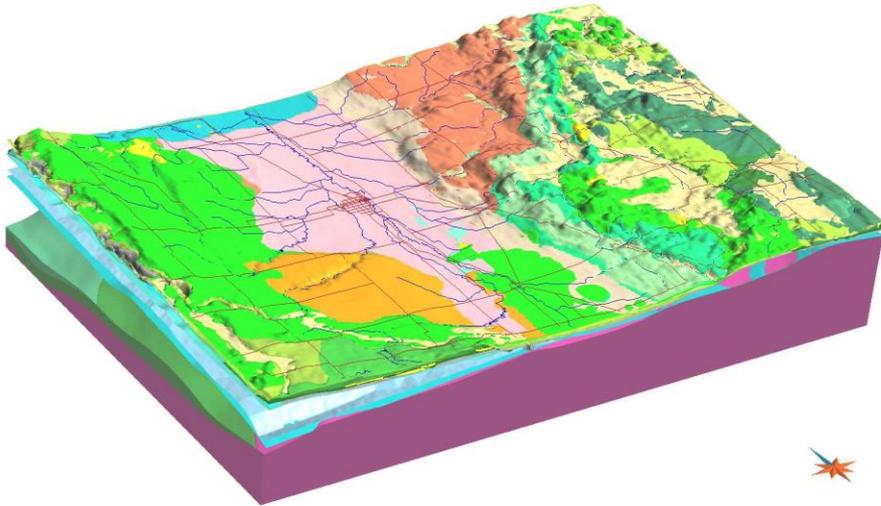
Queryable

Complete

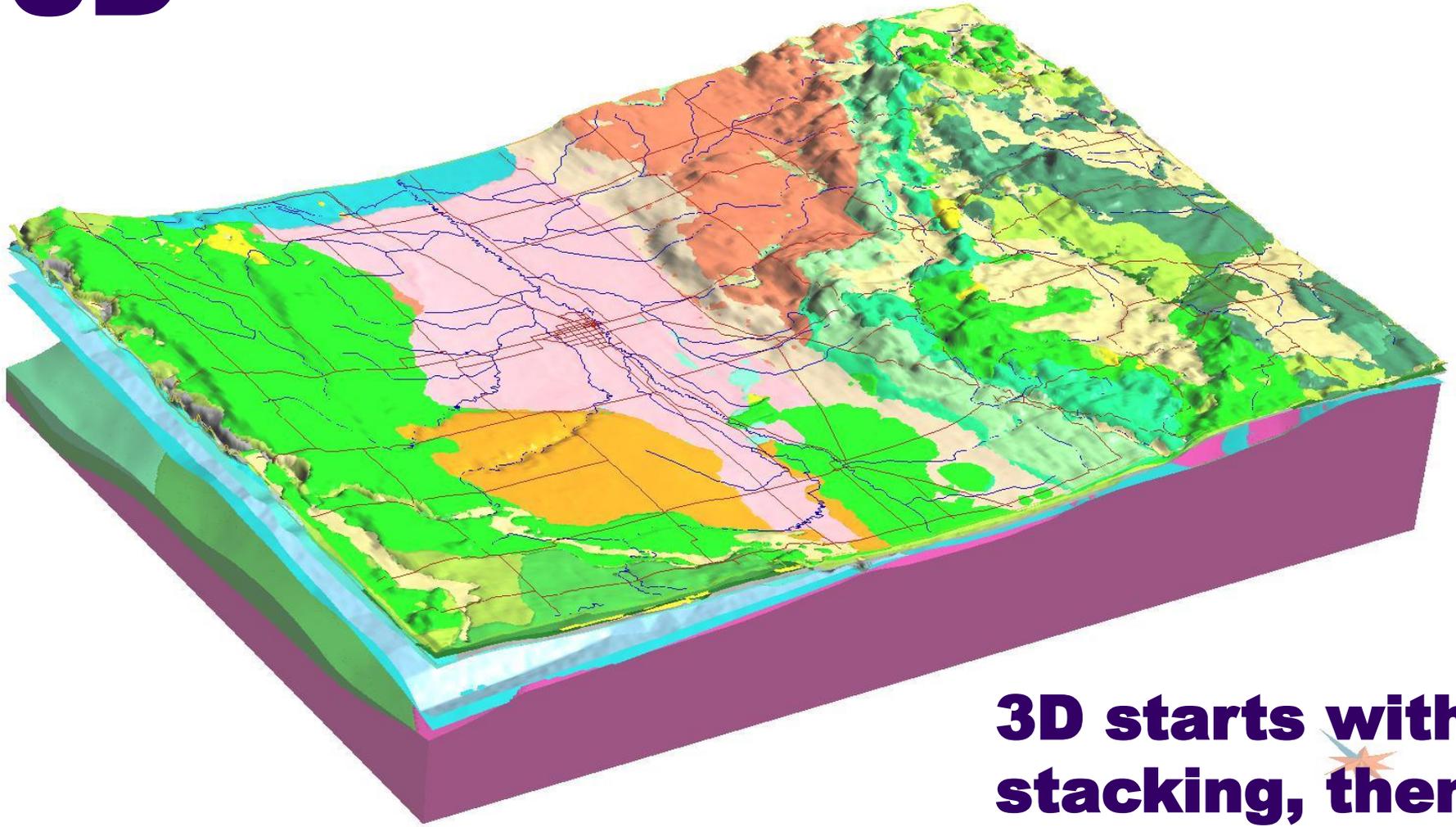
Seamless

3D

Onshore to offshore



3D

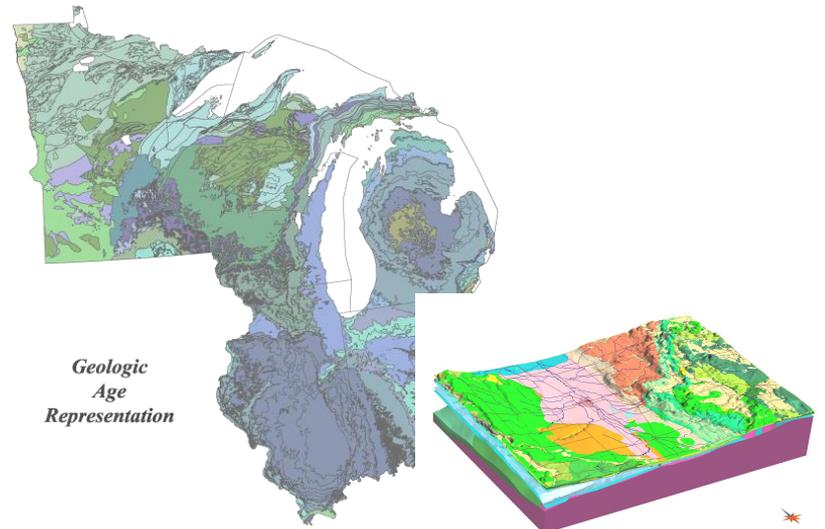
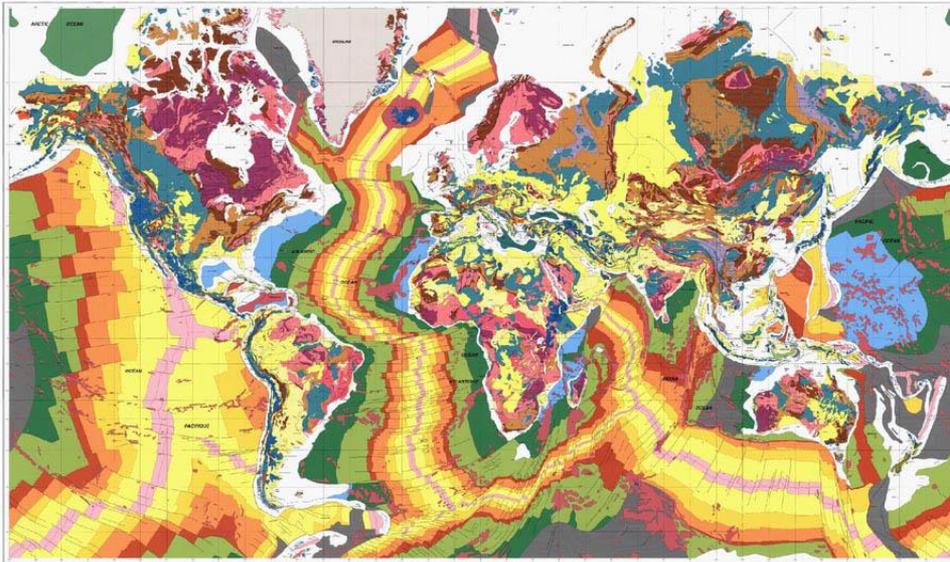
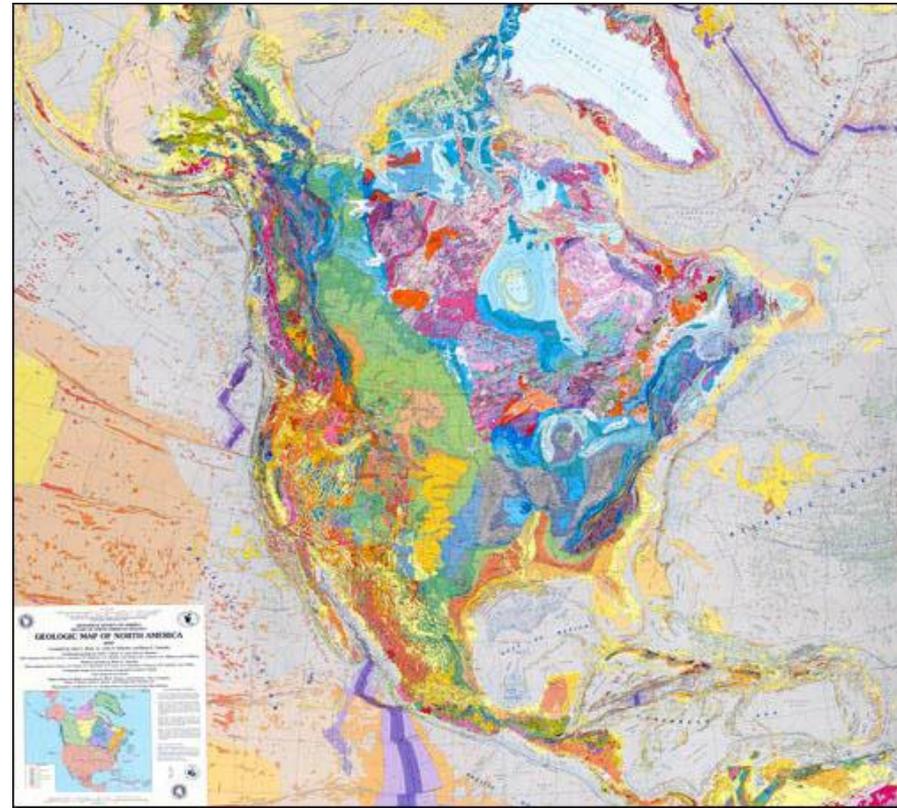


**3D starts with
stacking, then
thickness**

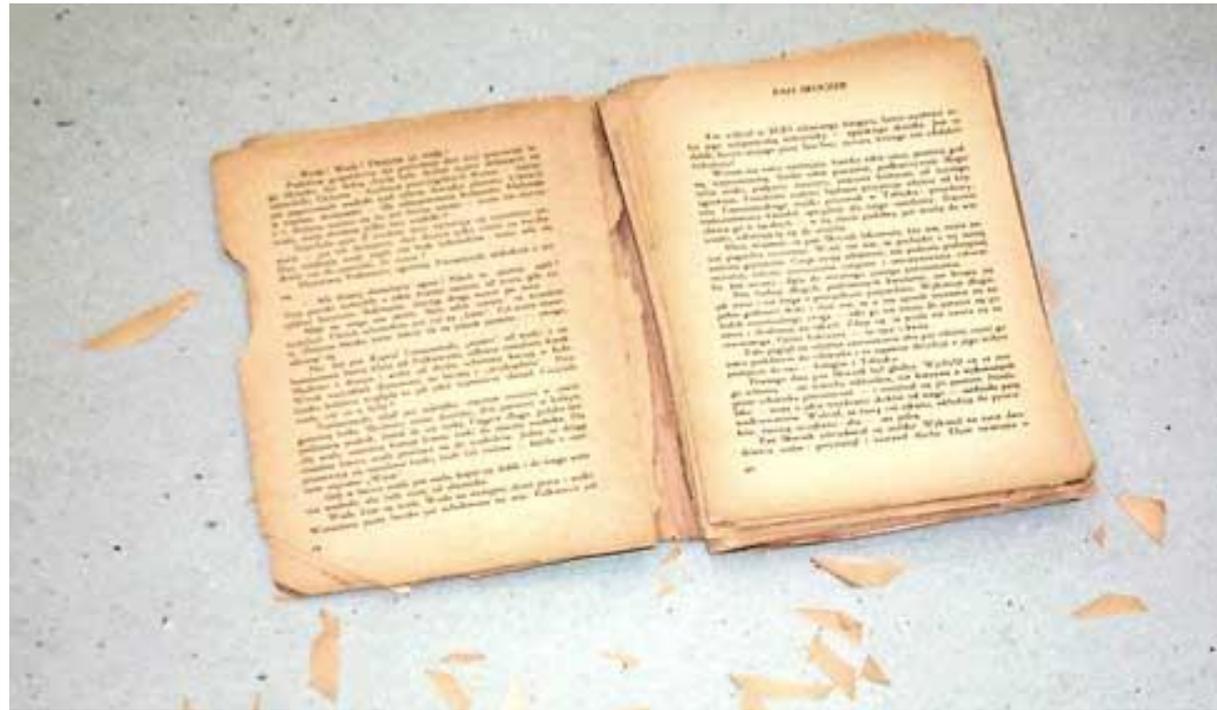
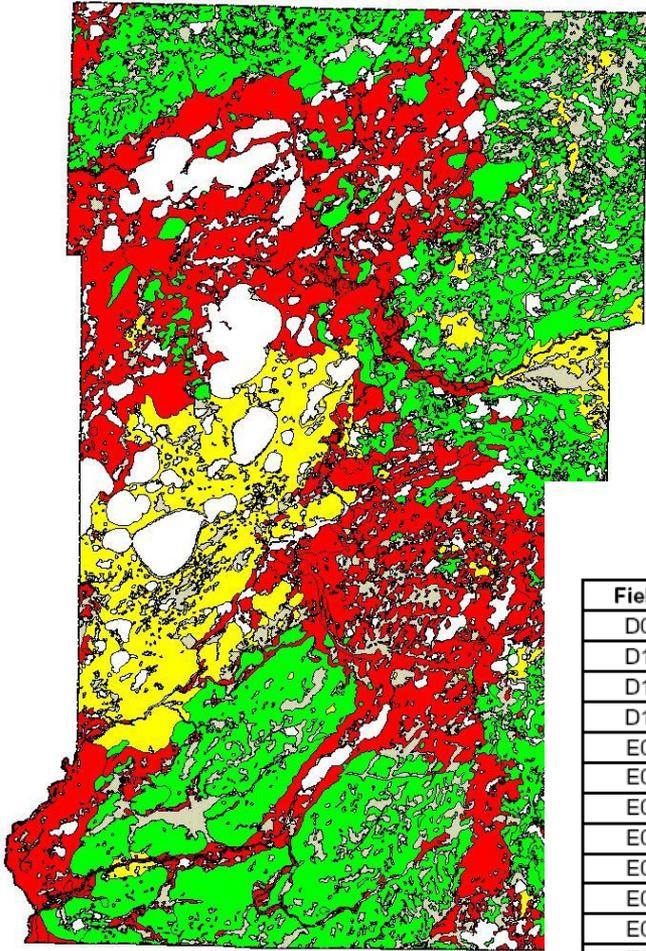


Resolution

Global
National
State
County



Linked



Appendix. Geochemistry of the <63 micron fraction

Field	Lab	Ag_ppm	Al_%	As_ppm	Au_ppb	Ba_ppm	Be_ppm	Bi_ppm	Ca_%	Cd_ppm	Ce_ppm	Co_ppm
D09	139	0.16	6.10	10.9	25	620	1.30	0.22	4.65	0.32	59.8	11.7
D10	127	0.13	5.11	7.7	0.5	400	1.30	0.19	4.02	0.38	70.9	11.0
D11	39	0.15	6.41	8.8	0.5	320	1.55	0.27	4.15	0.28	75.7	7.4
D12	225	0.13	6.57	13.6	1	480	1.50	0.25	1.62	0.34	86.1	11.6
E02	92	0.14	5.76	12.5	7	400	1.44	0.23	7.83	0.54	60.4	9.2
E03	190	0.14	5.16	13.4	0.5	390	1.32	0.27	9.55	0.65	65.2	10.8
E04	186	0.20	5.84	18.2	0.5	500	1.46	0.32	6.61	0.91	72.3	10.6
E05	61	0.10	4.24	11.0	2	520	0.93	0.16	4.09	0.28	52.0	8.5
E06	12	0.14	6.15	9.0	1	690	1.18	0.24	5.19	0.34	63.4	11.4
E07	195	0.11	4.56	7.5	0.5	460	1.12	0.18	5.20	0.40	51.8	9.6
E08	113	0.13	5.52	12.3	3	610	1.18	0.21	4.87	0.31	56.5	11.0
E09	181	0.13	5.30	5.2	7	520	1.26	0.20	5.39	0.34	64.4	11.4
E10	101	0.04	6.91	6.2	2	400	1.66	0.20	2.63	0.09	72.5	10.0
E11	167	0.15	7.34	9.0	0.5	420	2.03	0.26	4.18	0.32	91.4	15.3
F02	185	0.17	5.68	10.0	0.5	440	1.48	0.34	8.66	1.13	75.8	10.8
F03	198	0.19	5.64	14.6	3	550	1.28	0.31	6.94	0.66	66.8	12.4

Se

Fly To

e.g., R
brightc

Accessible

Brighton_UK

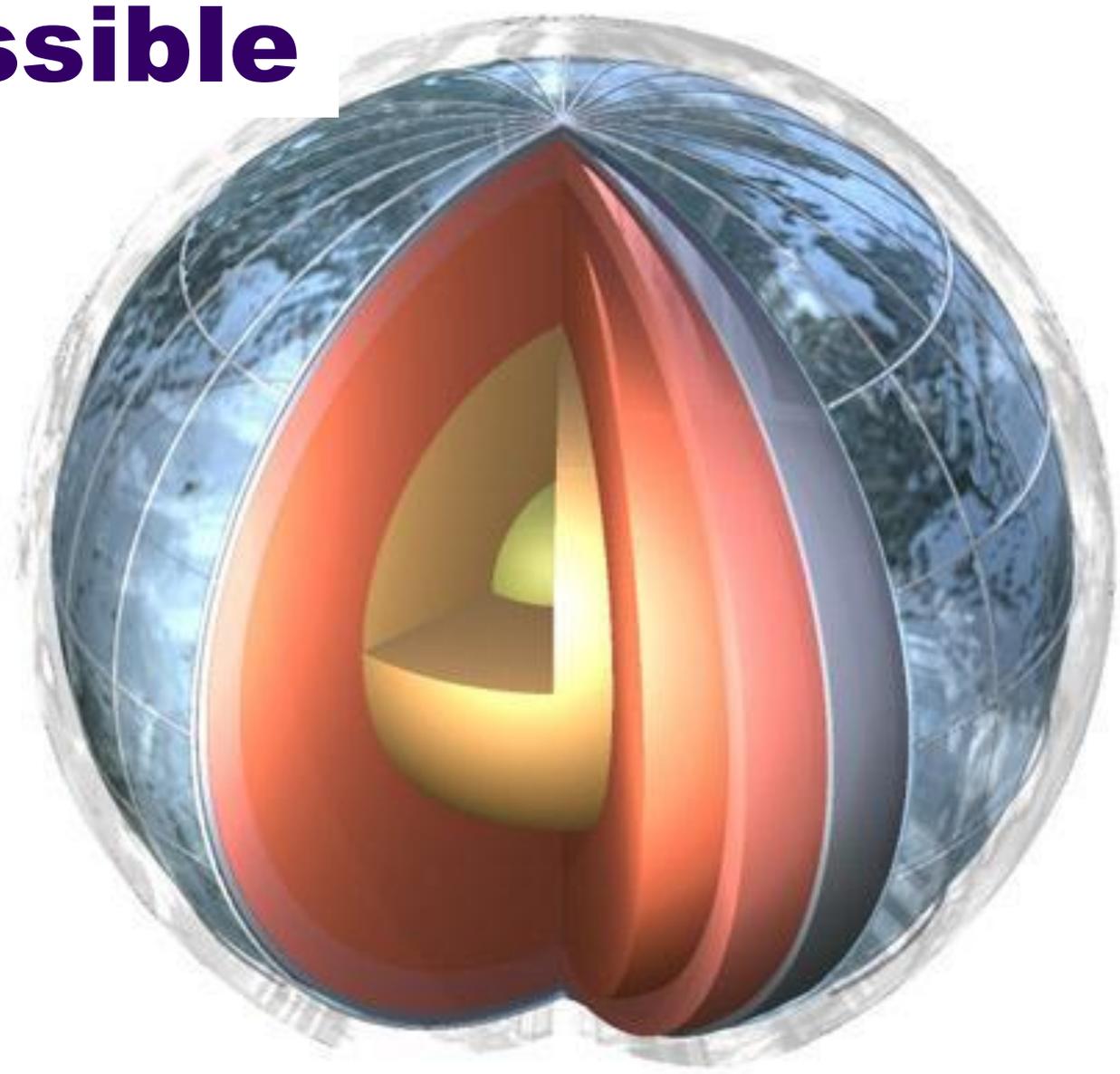
- Places**
- My Places
 - AAFC
 - Harvey Thorleifson's Workou
t on 12/10/2006

Layers

View: Core

- Primary Database
- Terrain
- Geographic Web
- Featured Content
- 3D Buildings
- roads
- borders
- Populated Places
- Alternative Place Names
- Dining
- Lodging
- Google Earth Community
- Shopping and Services
- Transportation
- Geographic Features
- Travel and Tourism
- Parks and Recreation Areas
- Community Services
- US Government
- Digital Globe Coverage

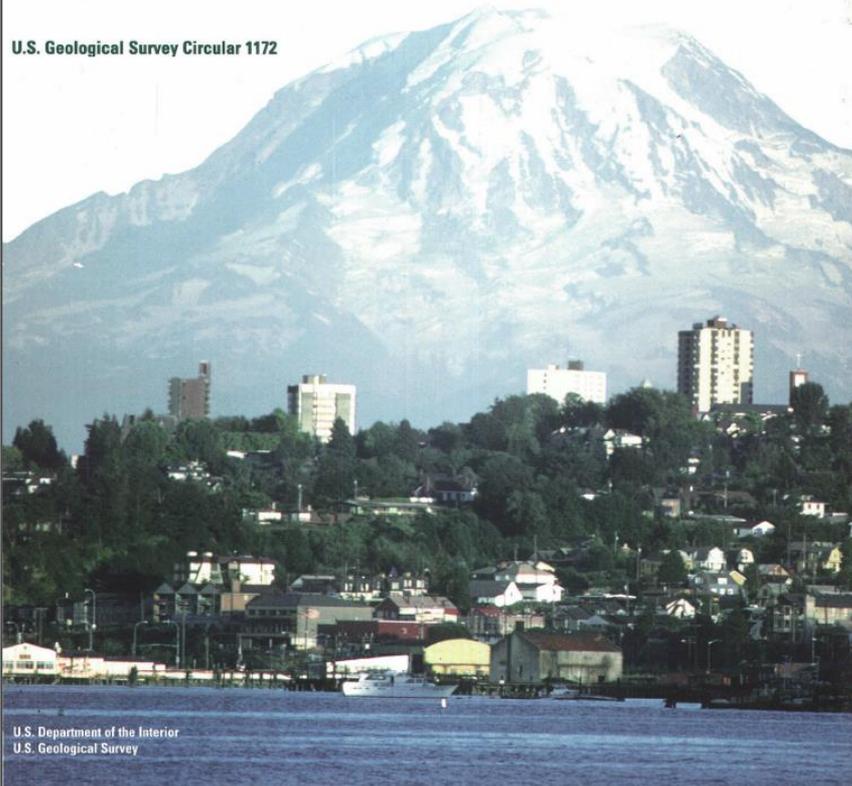
Pointer



Geology for a Changing World

A Science Strategy for the Geologic Division
of the U.S. Geological Survey, 2000–2010

U.S. Geological Survey Circular 1172



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

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

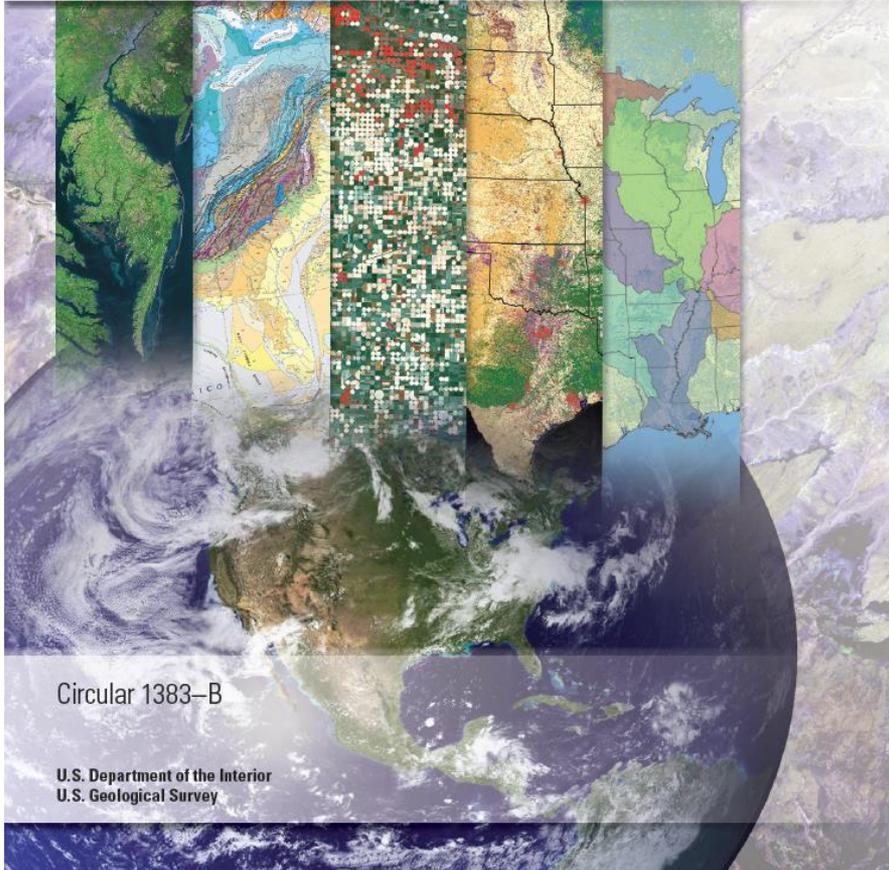
**Geology for a Changing World 2010–2020:
Implementing the U.S. Geological Survey
Science Strategy**

Circular 1369

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

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

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



The most recent USGS planning called for collaboration leading to 1) seamless nationwide geologic 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

**The Association of
American State
Geologists (AASG)
unanimously passed
a compatible
resolution in
Lexington on
June 11, 2014**

**USGS & AASG
presently are
developing strategies
for next steps**

National Cooperative Geologic Mapping Program

Home About ▾ Program Components ▾ What's a Geologic Map? ▾ Geologic Map Database Products-Standards ▾ Contacts

Highlights

Best Student Geologic Map Competition

Inaugural Best Student Geologic Map Competition to be held on Tuesday, October 29, 2013 at GSA in Denver, CO. For more details, please go [here](#).

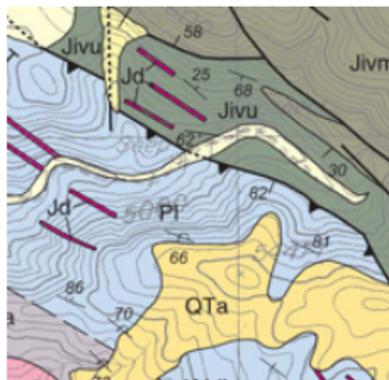
NCGMP Scientist Receives Presidential Honors

NCGMP FEDMAP Project Chief **Joseph Colgan** is a recent recipient of the **Presidential Early Career Award for Scientists and Engineers** (PECASE). More details at the [USGS Newsroom](#).
Congratulations, Joel!

Celebrating Geologic Map Day 2013

As part of [Earth Science Week](#), the second annual [Geologic Map Day](#) will be celebrated on **October 18, 2013**. Brought to you by the [American Geosciences Institute](#) (AGI), the [American](#)

National Cooperative Geologic Mapping Program



The **National Cooperative Geologic Mapping Program** (NCGMP) is the primary source of funds for the production of geologic maps in the United States and provides accurate geologic maps and three-dimensional framework models that help to sustain and improve the quality of life and economic vitality of the Nation and to mitigate natural hazards.

The NCGMP represents over 2 decades of successful cooperation among Federal ([FEDMAP](#)), State ([STATEMAP](#)), and university ([EDMAP](#)) partners to deliver digital geologic maps to customers. Each of these three

components has a unique role, yet all work cooperatively to select and map high-priority areas for new geologic maps.

Geologic mapping data from all of North America are presented via the [National Geologic Map Database](#), and a common set of geologic map standards is being developed by the NCGMP in cooperation with the [North American Geologic Map Data Model Steering Committee](#).

The USGS National Cooperative Geologic Mapping Program is congressionally mandated by the [National Geologic Mapping Act of 1982](#).



Please join us at the Inaugural **Best Student Geologic Map Competition**. The competition, hosted by the USGS NCGMP, will be held at the [Geosciences Association of America](#) (GSA) with sponsorship from the [GSA Foundation](#), [Association of American State Geologists](#) (AASG), [American Geosciences Institute](#) (AGI), [American Institute of Professional Geologists](#) (AIPG), and the *Journal of Maps* will bring



Geoscience resource for maps and related information about geology, natural hazards, earth resources, geophysics, paleontology, marine geology, and [more](#).

Related Information

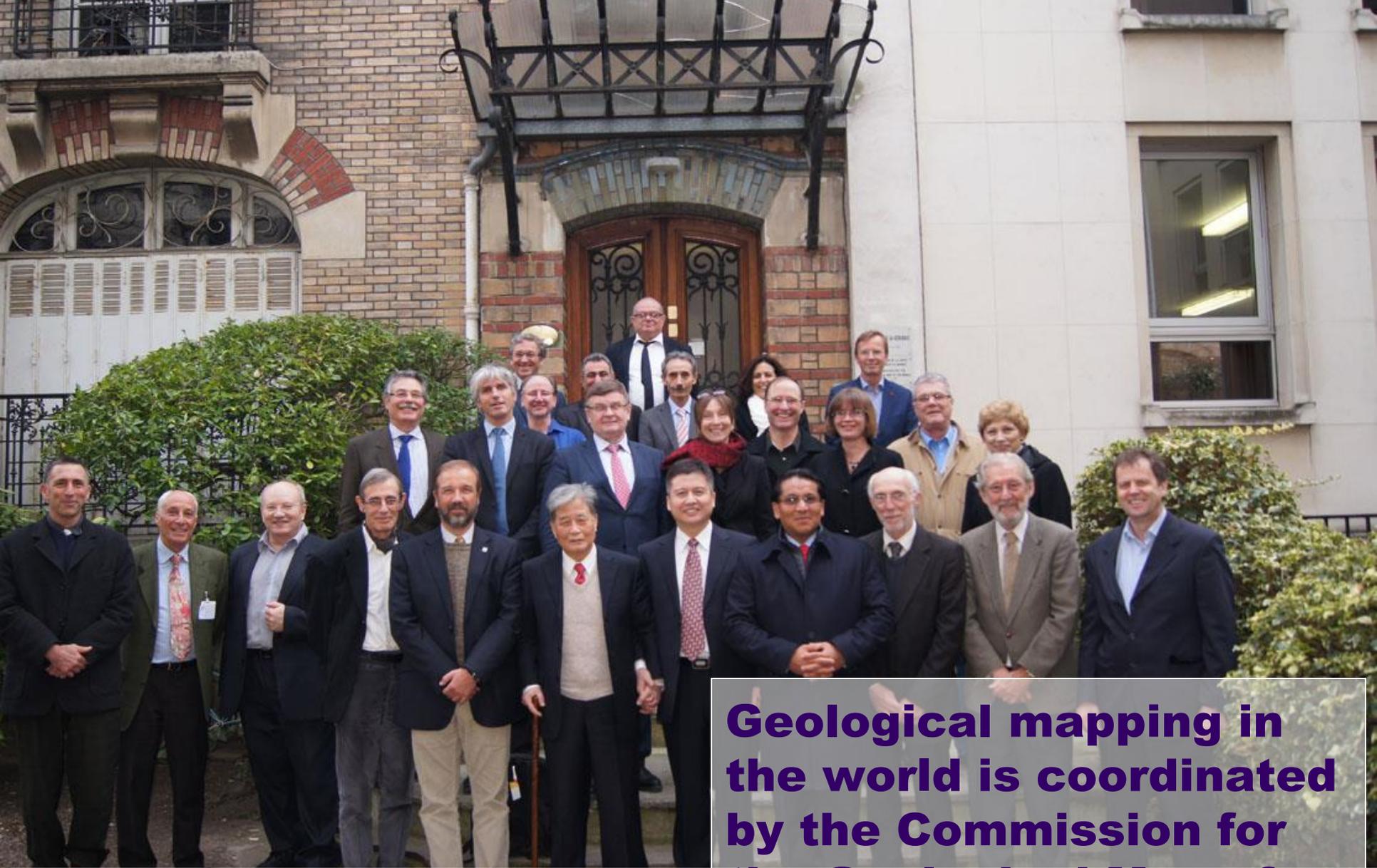
NCGMP Science Centers:

[Geology, Minerals, Energy, and Geophysics](#)

[Geosciences and Environmental Change](#)

[Eastern Geology and Geophysics](#)

Geological mapping in the US is coordinated by the National Cooperative Geologic Mapping Program (NCGMP)



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



COMMISSION FOR THE GEOLOGICAL MAP OF THE WORLD

Charting a path forward for geological mapping

*Harvey Thorleifson Ph.D.
Director, Minnesota Geological Survey*

**National Geospatial Advisory Committee
June 24-25, 2014**

