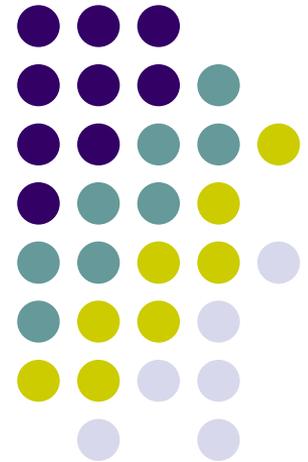
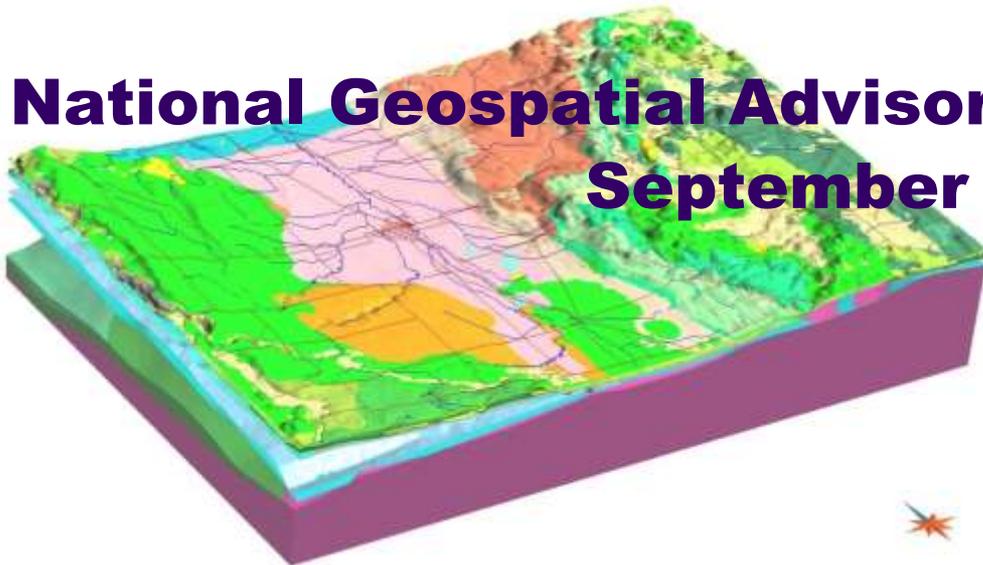


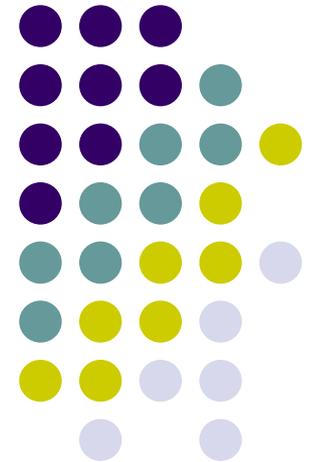
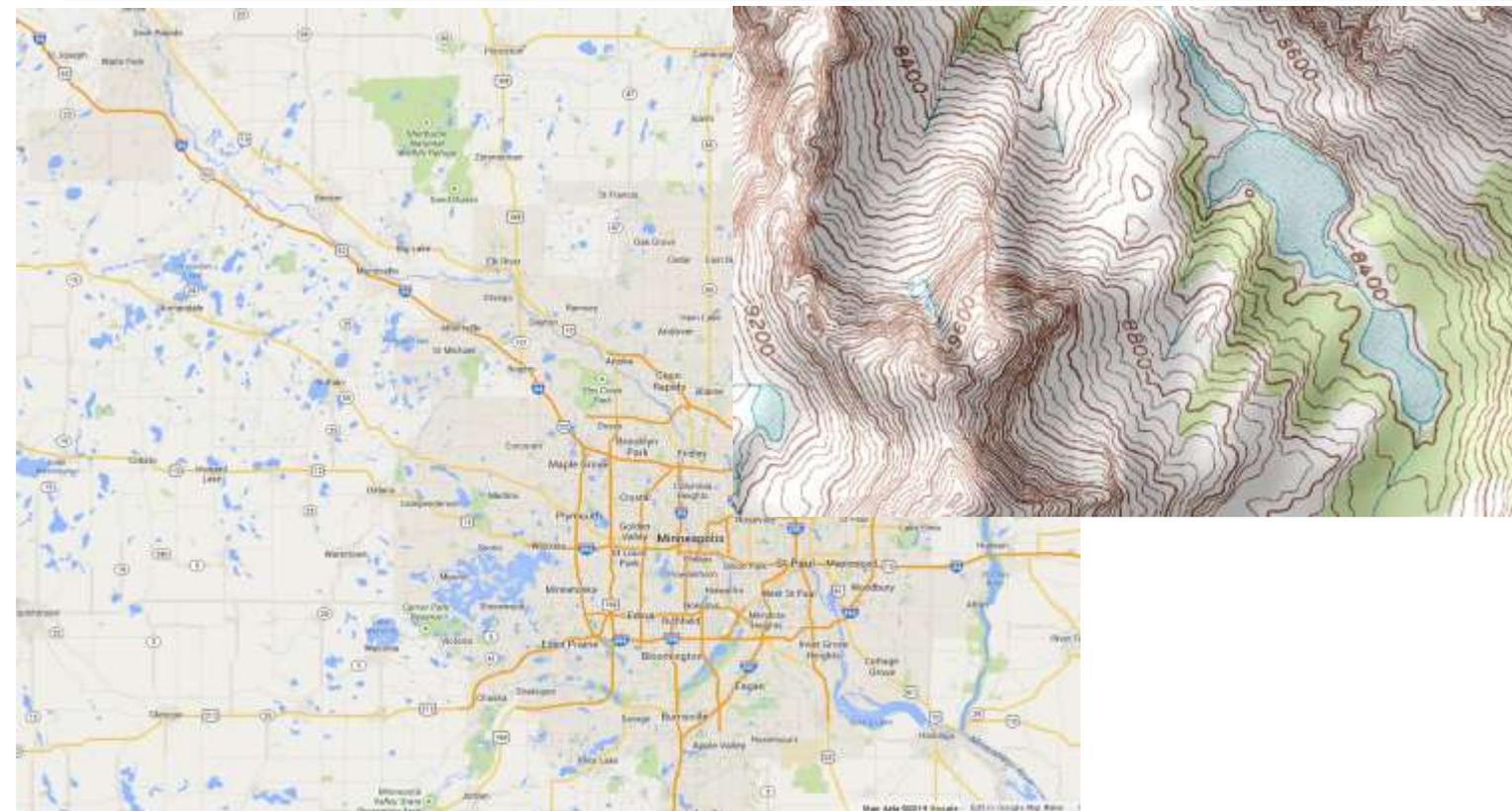
# Geologic map standards

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

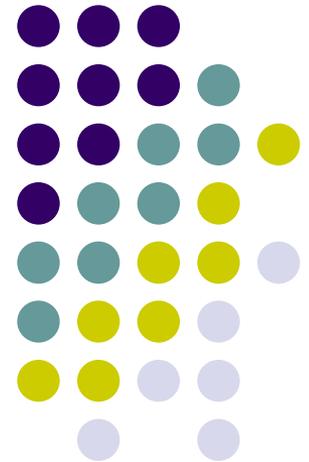
**National Geospatial Advisory Committee**  
**September 27 - 28, 2016**



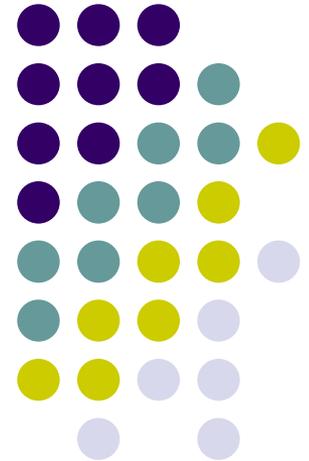
# Much effort in mapping goes toward depicting land-surface features



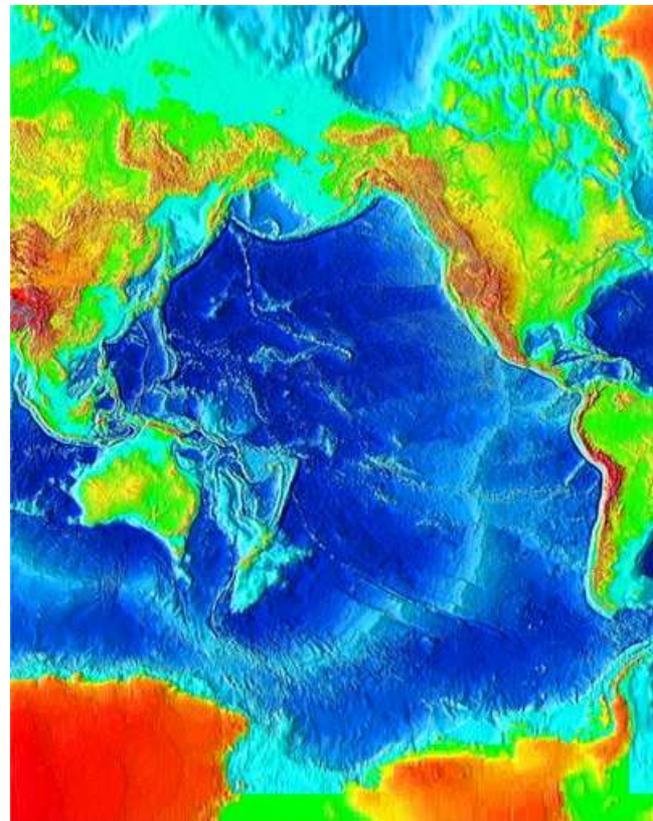
# Some mappers look up, to construct meteorological charts



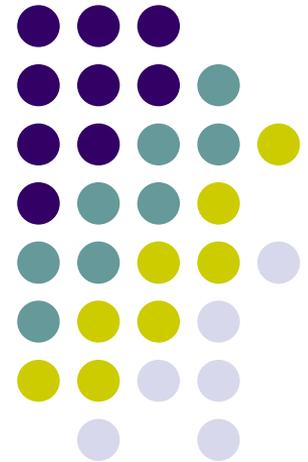
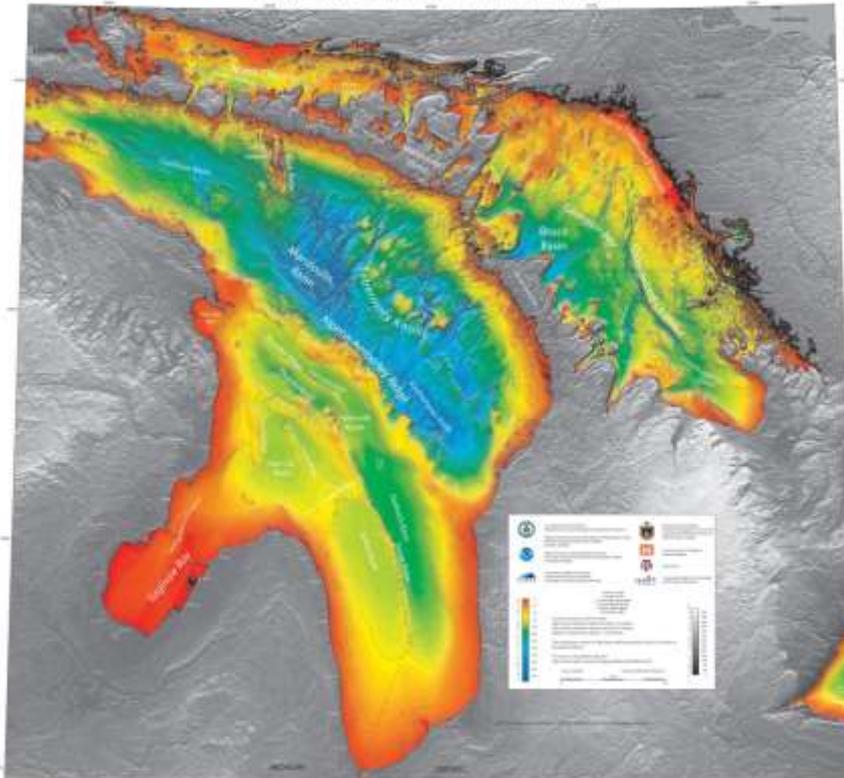
# Some mappers look down



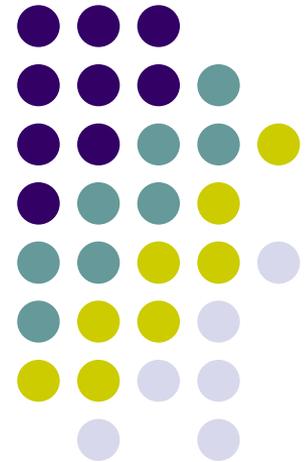
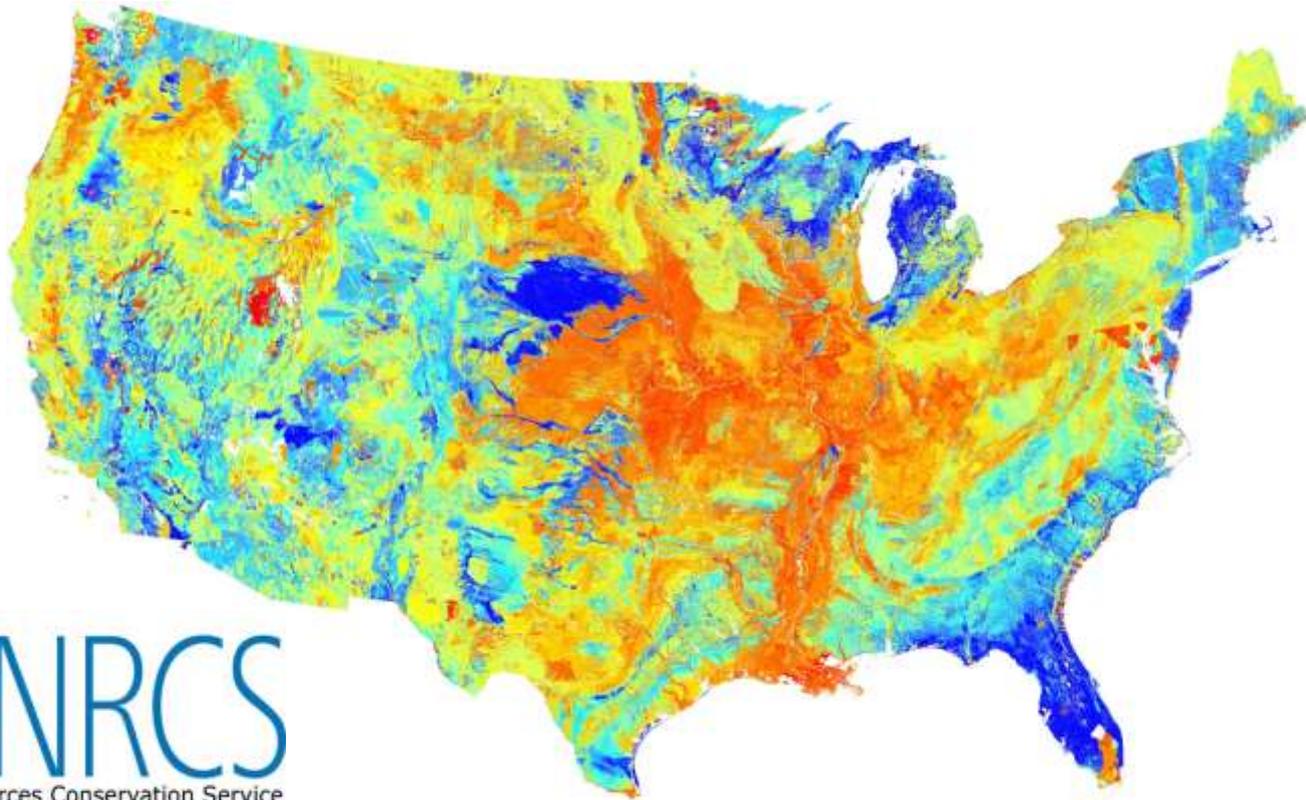
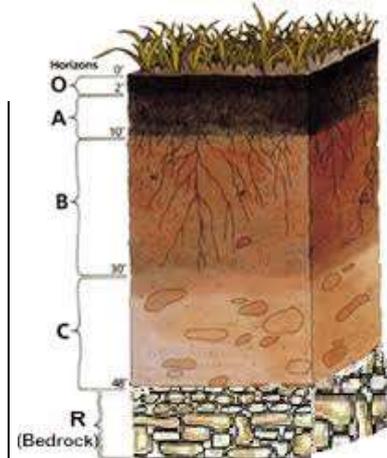
# The first subsurface layer is bathymetry



Bathymetry of Lake Huron with Topography



# Next, soil mapping by agricultural agencies

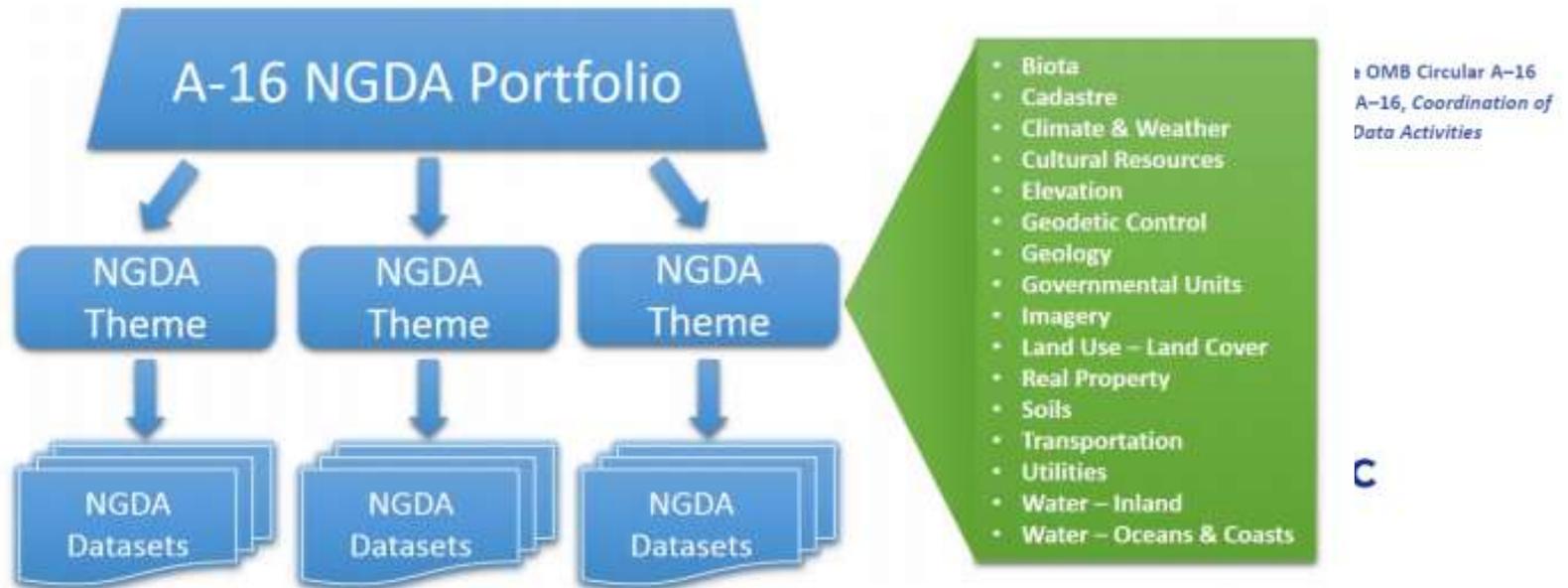




# Spatial data infrastructure

## National Spatial Data Infrastructure Strategic Plan 2014–2016

## National Geospatial Data Asset Management Plan



Federal Geographic Data Committee

December 2013

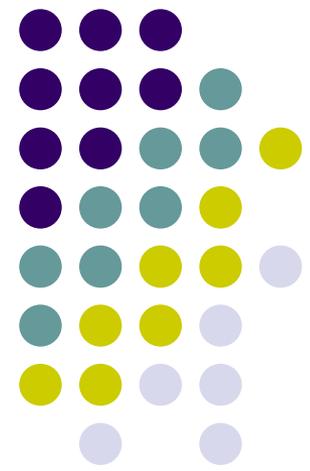


**Geology is one of the  
National Geospatial  
Data Assets**

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

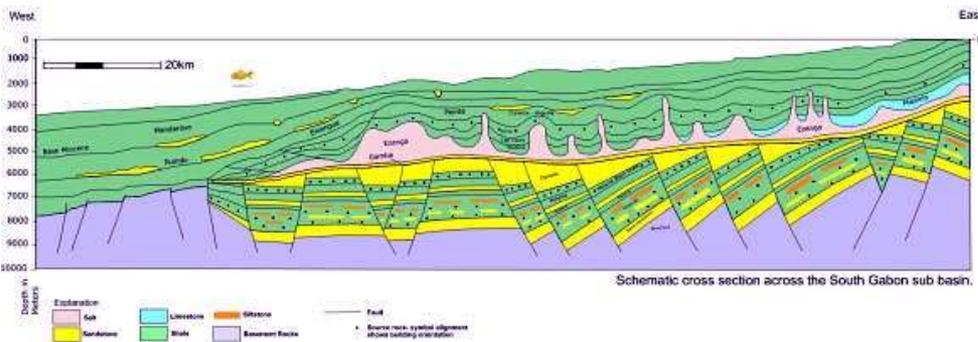
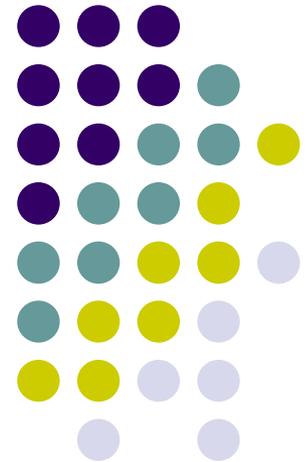


**Energy**  
**Minerals**  
**Water**  
**Hazards**  
**Environment**  
**Waste**  
**Engineering**  
**Research**



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

**lives saved**  
**resources discovered**  
**costs avoided**  
**increased efficiency**  
**fundamental**  
**understanding**



# Future geological mapping needs to be

**Regularly updated**

**Zoomable**

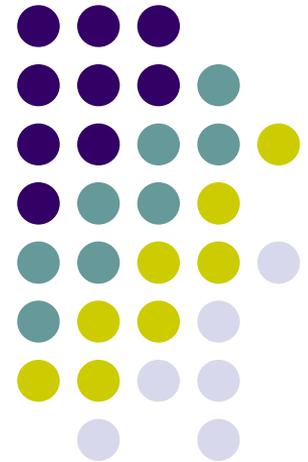
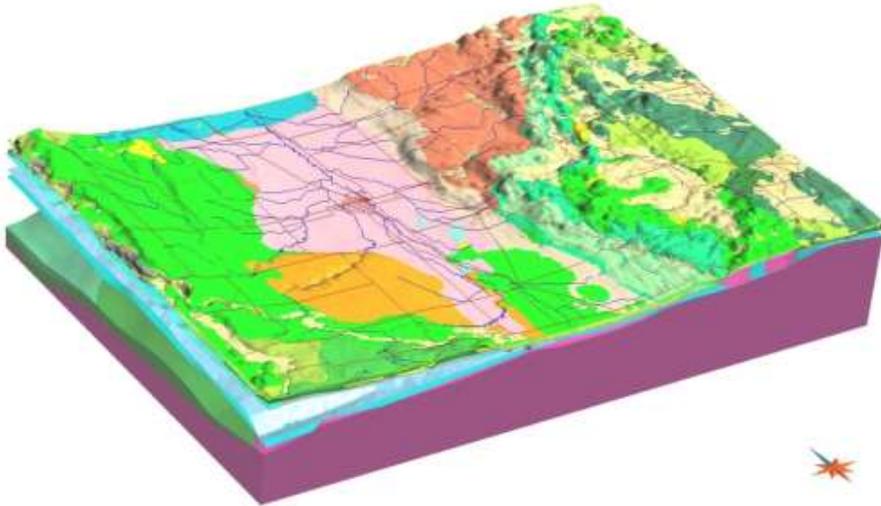
**Queryable**

**Complete**

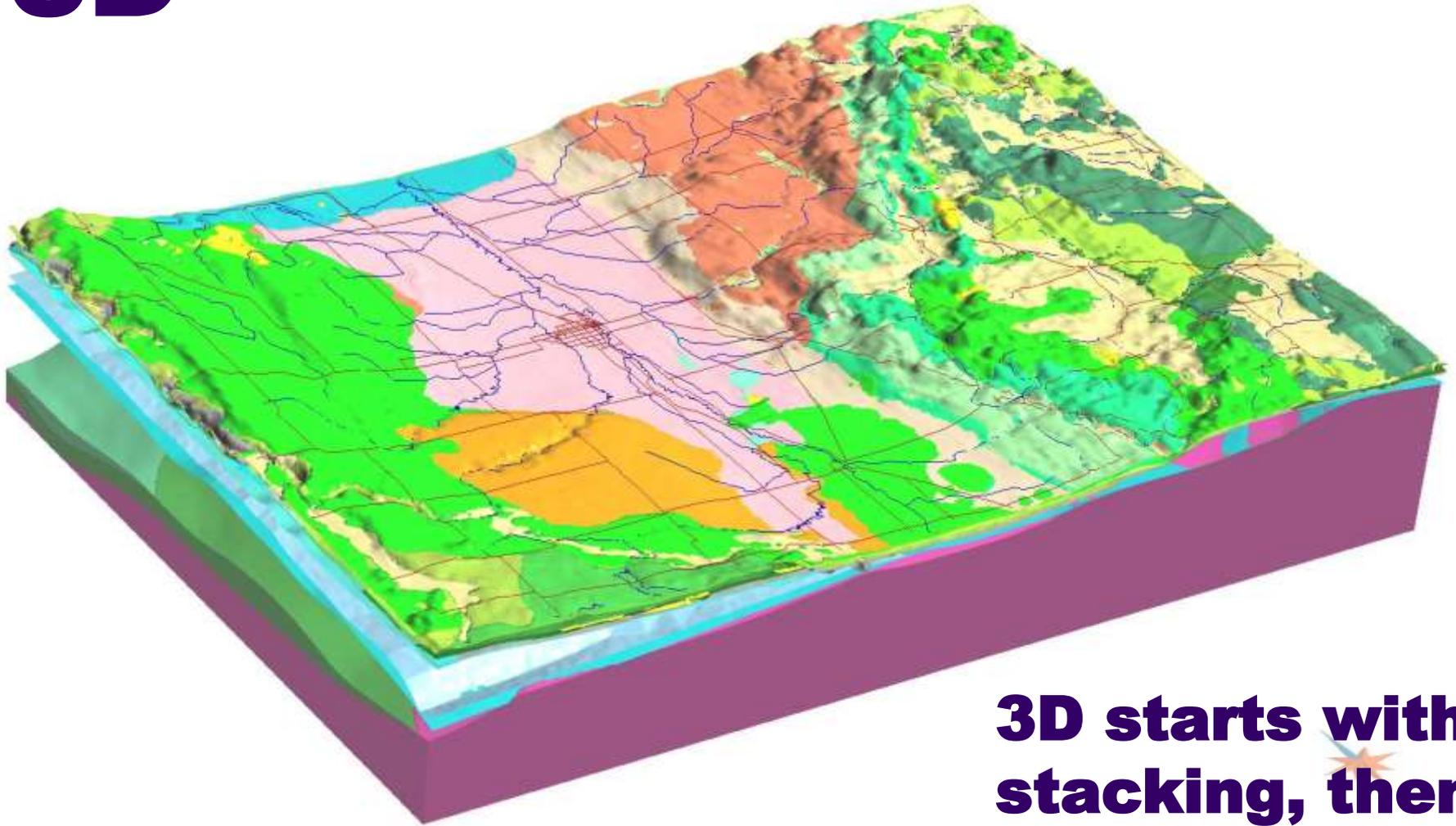
**Seamless**

**3D**

**Onshore to offshore**



**3D**

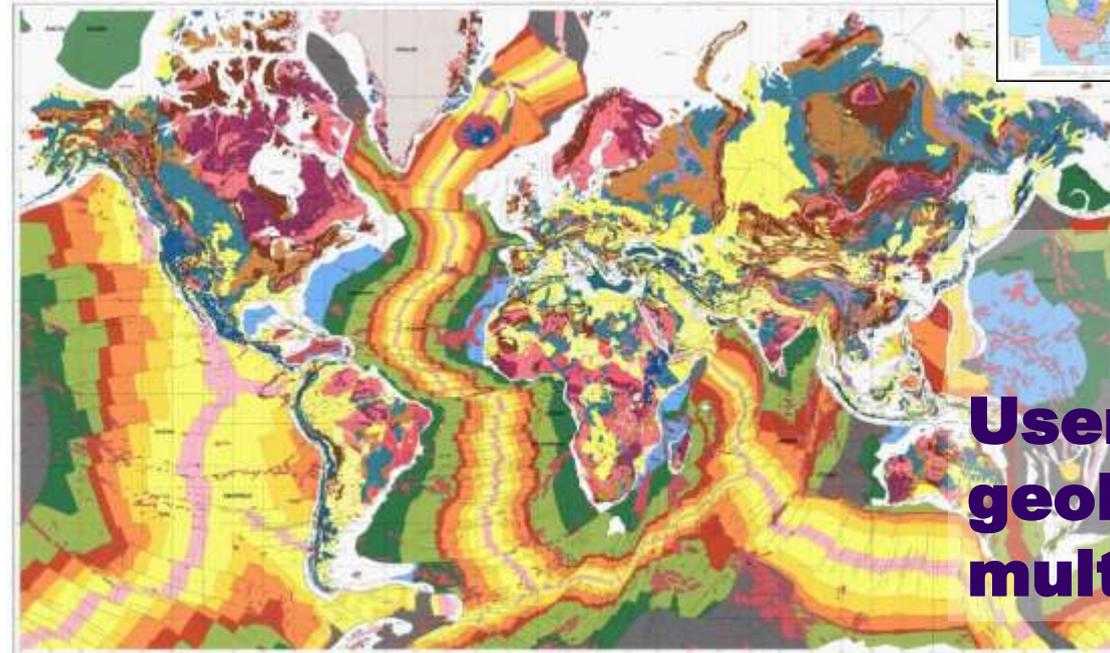
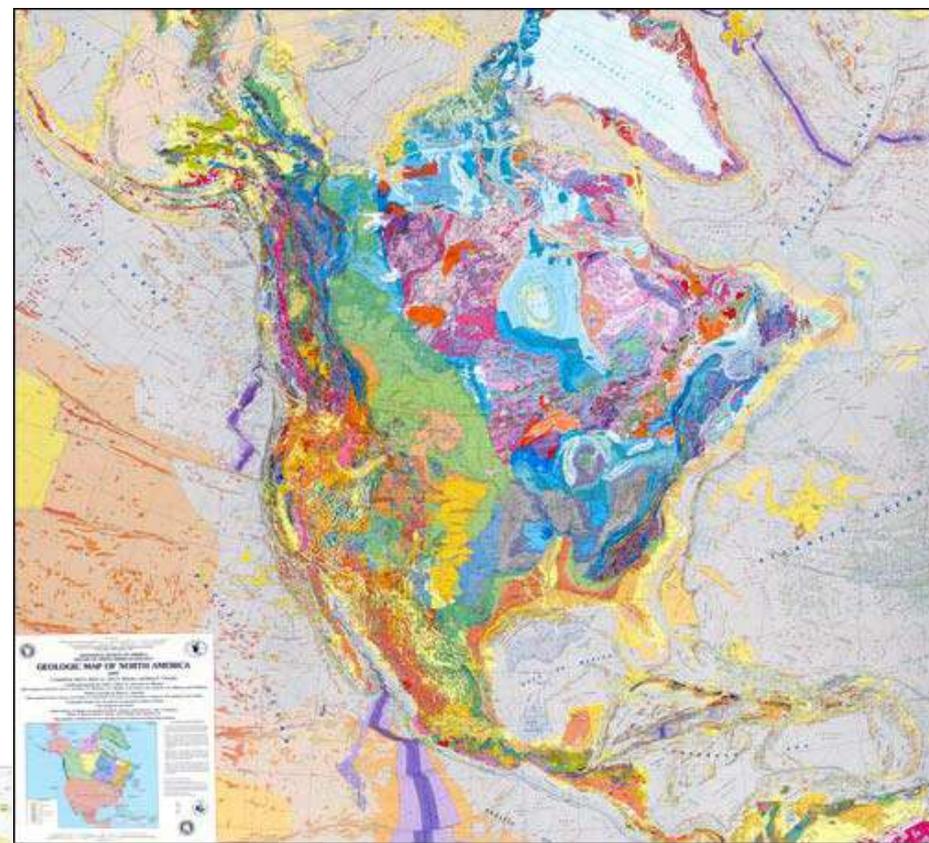


**3D starts with  
stacking, then  
thickness**

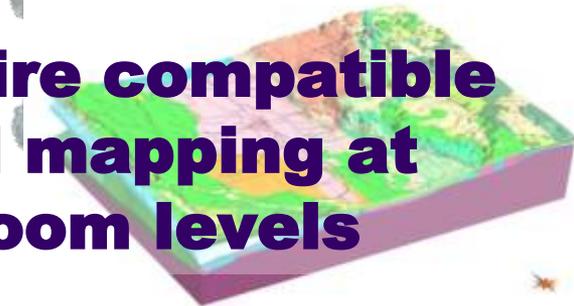


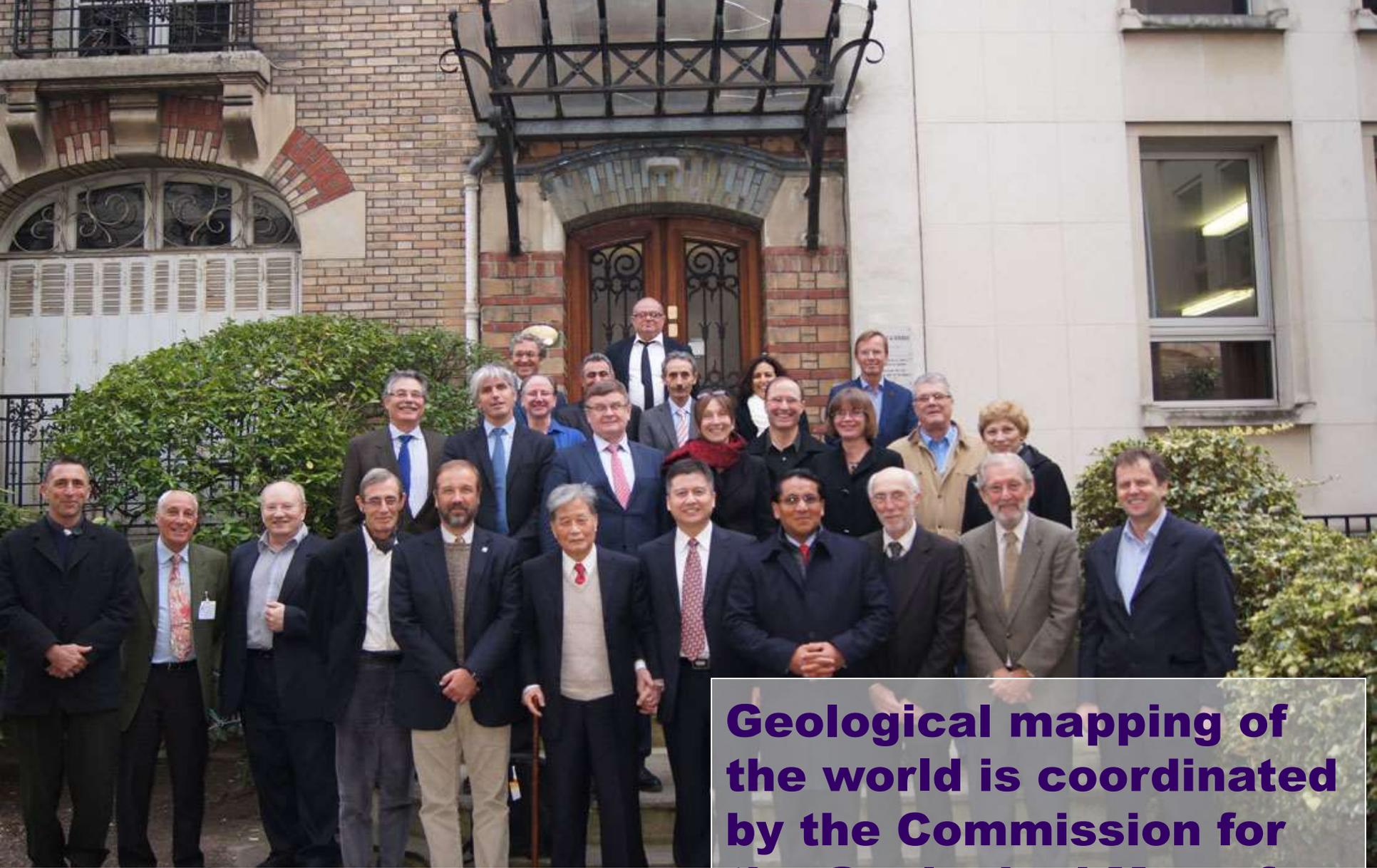
# Resolution

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



**Users desire compatible geological mapping at multiple zoom levels**





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



COMMISSION FOR THE GEOLOGICAL MAP OF THE WORLD



## 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

# NCGMP

Tuesday, October 29,  
2013 at GSA in Denver,  
CO. For more details,  
please go [here](#).

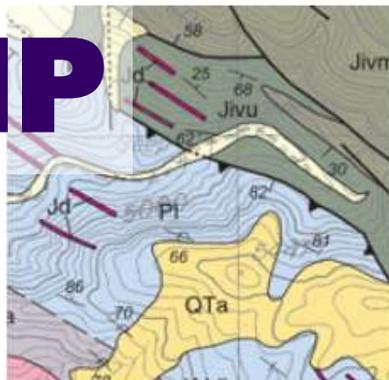
NCGMP Scientist  
Receives Presidential  
Honors

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 in cooperation with the 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)

# Planning



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

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brightc

# Accessibility

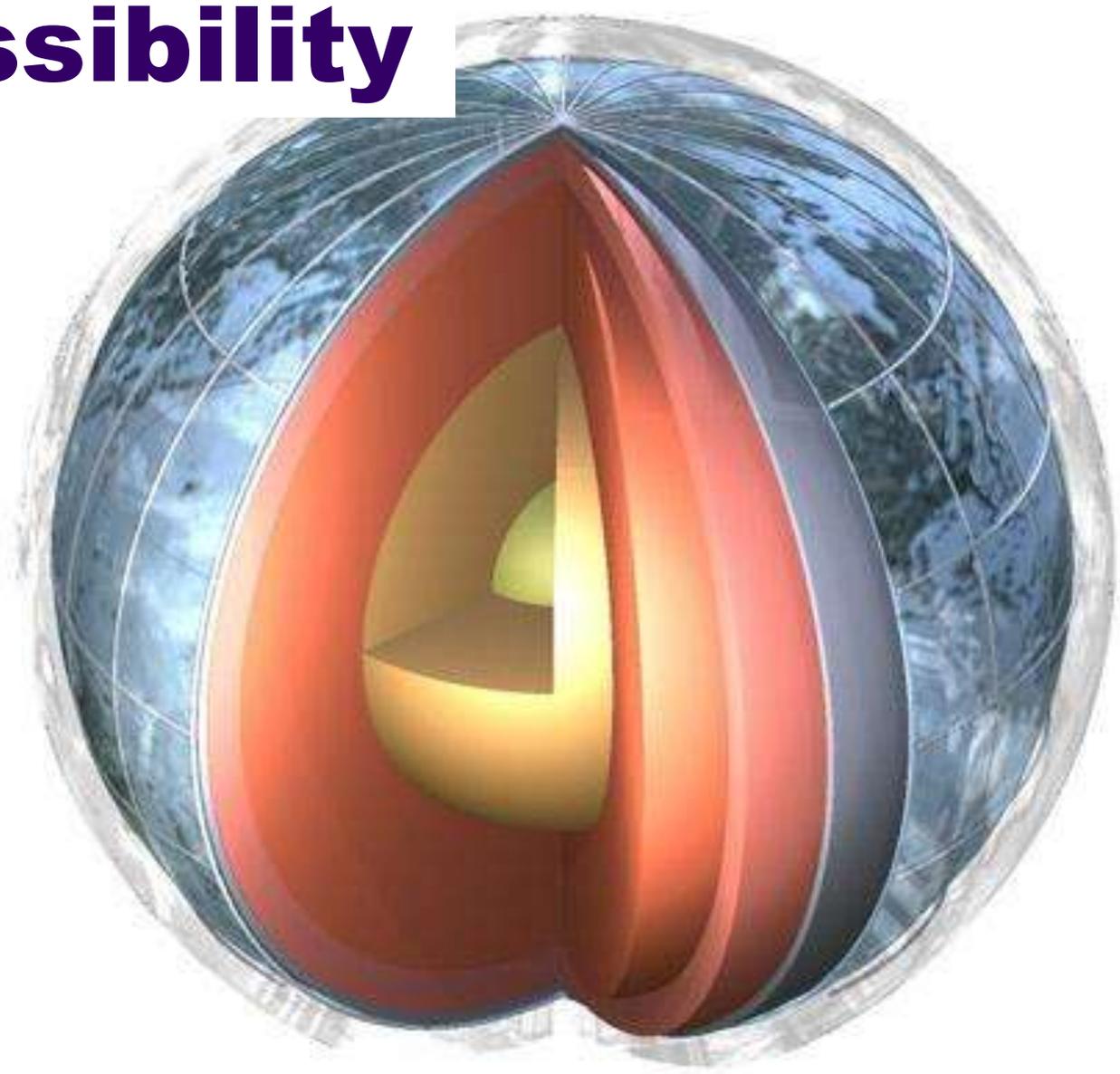
Brighton\_UK

- 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



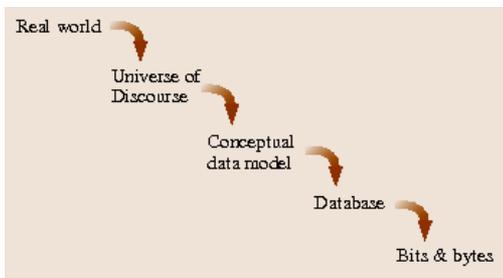


International  
Organization for  
Standardization

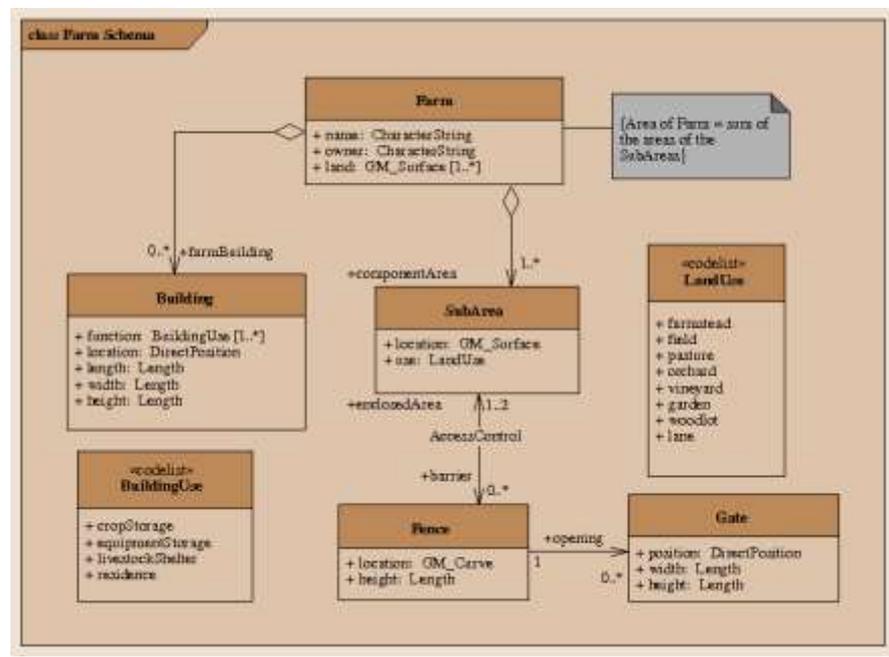


# Standards

- Users expect standardization (Kresse et al., 2012)
- A standard launched too early will be overtaken; if too late, the cost to reconcile competing solutions is great, so industry consortia define abstract standards before development
  - **Key principles are: do it once, do it right, and do it internationally**
- Any national approach is at best preparation for an international solution
- **Abstract standards are independent of operating systems, applications, hardware, and encodings**
  - **Implementation standards determine encoding**
  - **Interface standards determine hardware or firmware**
- **Most ISO standards are abstract; industry standards are at the implementation or interface level**

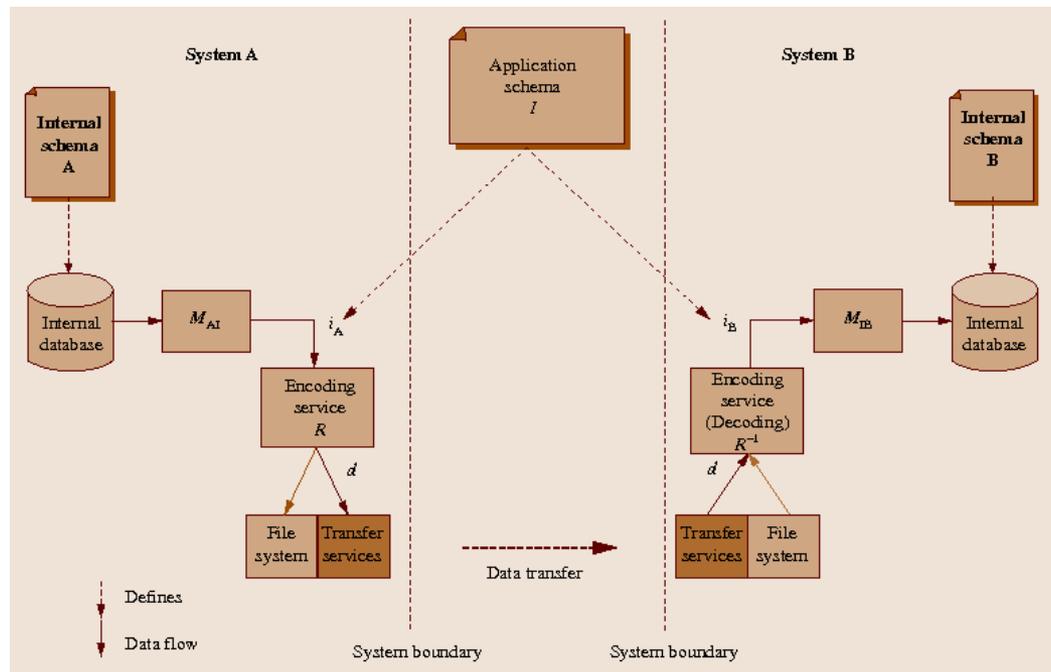


# Data model



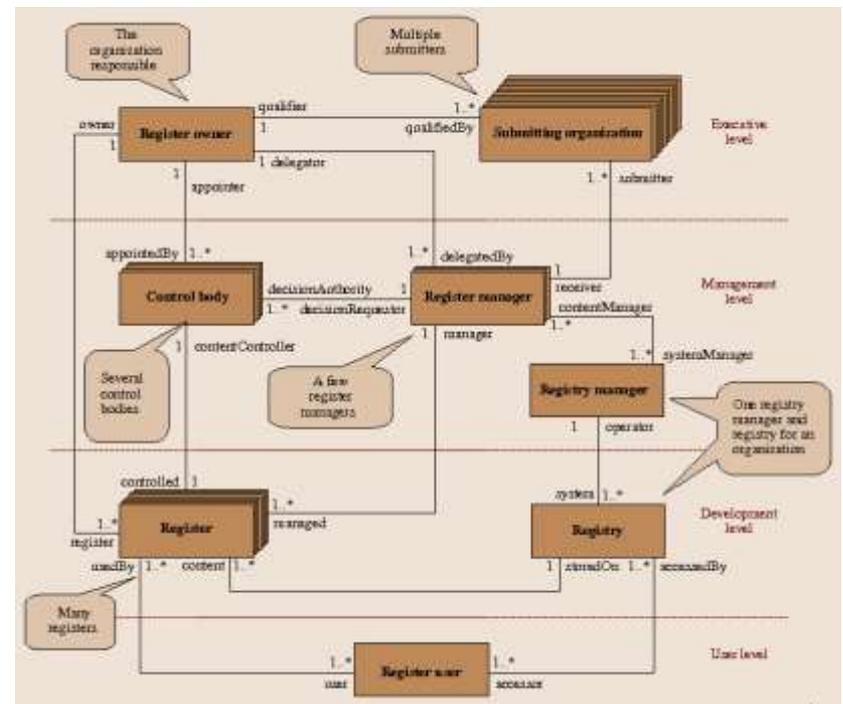
- **A conceptual model is fundamental to geographic system design (Roswell, 2012; ISO/TS 19103:2015)**
- **data models define concepts, their relationships, and how they are represented as data**
  - **semantic elements define terminology, while syntactic elements define structure, of discrete and continuous features, and their attributes, relationships, and functions, categorized as feature types**
- **the model is summarized as a diagram or schema**

# Encoding



- Encoding of geographic information according to an application schema allows storage and transfer (Portele, 2012)
  - An encoding rule is used to create a data structure that is system independent and suitable for a transfer protocol such as ftp or http
- Encoding rules are specified implicitly by formats such as ESRI shapefiles, and geography markup language (GML)

# Registration



- **Registers are dictionaries and common code lists that hold definitions applicable to datasets of geospatial information elements that include features, attributes, relations, and metadata (O'Brien and Lott, 2012; ISO 19135-1:2015)**

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

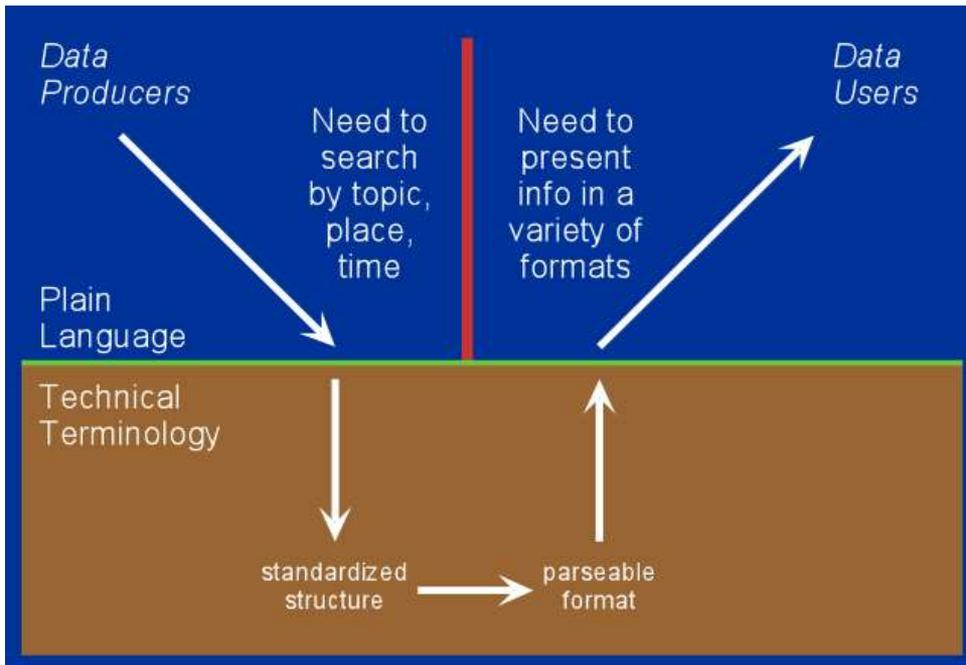
PRIVACY



# Metadata standard

*How will I find data, and will I know how to use it?*

- **data about other data that assists in their discovery and use**

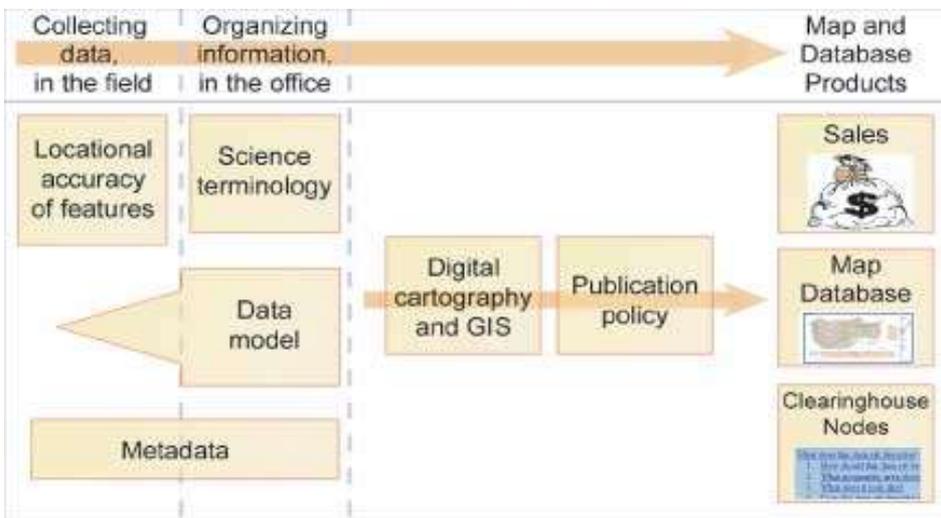


- **what the data describes**
- **by whom, why, and how the data were created**
- **how reliable the data are**
  - **problems remaining**
- **how the data can be obtained**
- **who wrote the metadata**

- **Schweitzer, 1998; 1999; 2000; 2001**



# Digital map standard

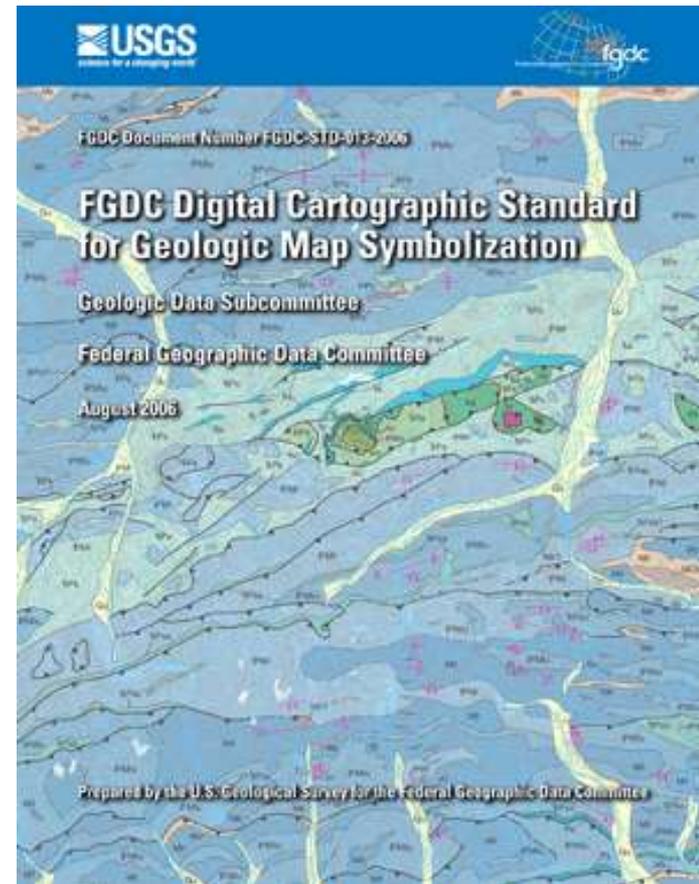


- **guidelines for publication of digital maps as a common set of digital files, which undergo both peer review and release in a consistent manner (Soller et al., 1999b)**
  - **guidelines for authorship credit and citation format for geologic maps, digital geologic maps, and associated digital databases (Berquist, 1999; Richard, 2000; Berquist and Soller, 2001)**
- **NCGMP ‘Guidelines for Digital Review of a Geological Map Database’**
  - **NCGMP ‘Guidelines for Peer Review of a Geologic Map Product’**
  - **guidelines for citation of unpublished GIS Files (Soller, 2012)**

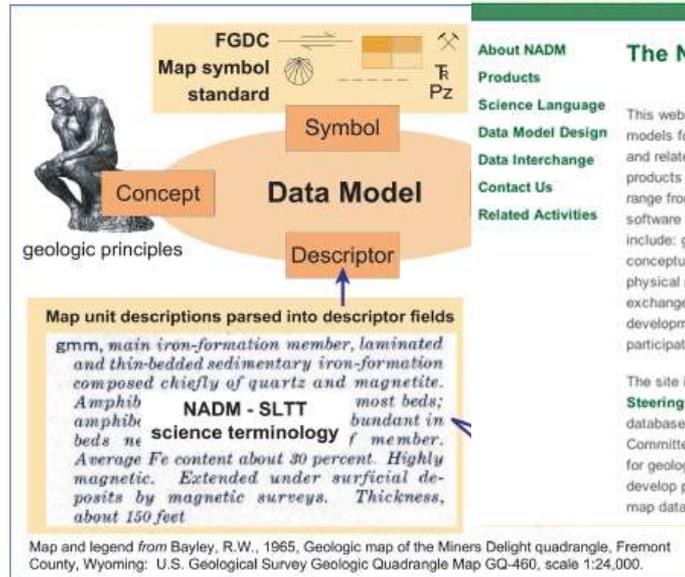


# Cartographic standard

- defines geologic map symbols, colors, and patterns
  - needs to be regularly updated
- prevailing USGS standard of the early 1990s was Hansen (1991)
- updated by a committee led by Mitch Reynolds (USGS, 1995a; 1995b)
  - reviewed initiated by Soller (1996)
  - review process was described by Soller and Lindquist (2000)
  - published in 2006 (FGDC, 2006)
    - standard undergoes ongoing maintenance



# Database standard

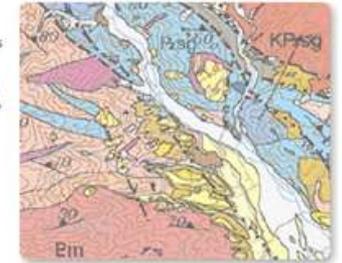


NADM  
North American Geologic Map Data Model

About NADM  
Products  
Science Language  
Data Model Design  
Data Interchange  
Contact Us  
Related Activities

## The North American Geologic Map Data Model

This website is about data models for digital geologic maps and related data sets. Our products and discussion topics range from design philosophy to software implementation. They include: geoscience language: conceptual, logical, and physical models; data exchange; and tool development. We invite you to participate.



The site is managed by the **North American Geologic Map Data Model (NADM) Steering Committee** – a consortium of American and Canadian geoscientists, database designers, and developers of geologic map information. The NADM Steering Committee sponsors and facilitates cooperative development of digital infrastructure for geologic map databases, and it works on behalf of the sponsoring agencies to develop products and ideas that can be adapted as agency standards for geologic map databases.

- **The US-Canada NGMDB Data Model working group produced a relational and object-oriented database structure for geologic map information (Raines et al., 1997; Johnson and others, 1998)**
- **The North American Geologic Map Data Model (NADM) Steering Committee developed a prototype to more effectively manage map information (Soller et al., 2002)**
  - **In 2004, the NADM C1 conceptual data model was published (NADM, 2004a), and a draft standard terminology for earth materials was produced (NADM, 2004b)**
- **The ESRI Geologic Mapping template was later produced by Frye and Day (2011)**
- **NGMP09 is now the standard format for geologic maps funded by NCGMP**
  - **GeoSciML standard is being developed on the international level**
    - **Work also has focused on the Terminology Standard**

# Washington State Division of Geology and Earth Resources NCGMP09 Migration Pilot Project

Search this site

## Project Home

Links

Project Participants

## Project Documents and Deliverables

Sitemap

## NCGMP09 and Washington State Geology

This website hosts the deliverables from the National Spatial Data Infrastructure (NSDI) Cooperative Agreements Program (CAP) grant received by the Washington State Division of Geology and Earth Resources (DGER).

The documentation includes project reports, user-experience documentation, geodatabases, tools, and other materials used to execute the project.

These materials are found in the

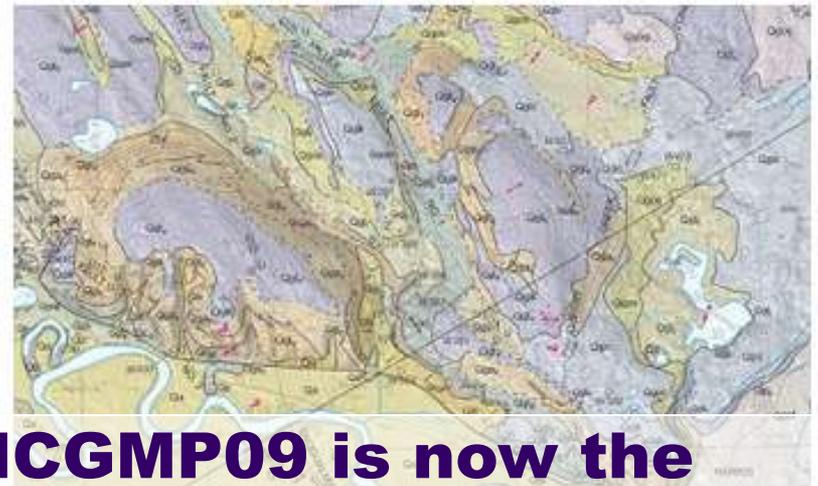
## Project Home

Welcome to the Project  
webpage for  
**Transitioning to the FGDC  
Draft Geologic Map  
Database Standard: A  
Washington State Geologic  
Survey Pilot Project**

Recipient of Award Number

G12AC20145, a 2012 NSDI Cooperative Agreements Program Award in Category 5:  
FGDC-endorsed Standards Implementation, Training and Outreach

This pilot project involved the development of a process to execute and evaluate a test migration of a legacy geologic map geodatabase, from the format of the Washington State Department of Natural Resources, Division of Geology and Earth Resources (DGER) "in-house" schema, to the "NCGMP09" draft



**NCGMP09 is now the  
standard format for  
geologic maps in the US  
funded by NCGMP**

- Home
- About Us
- Join CGI
- Data Standards
- Publications
- Useful links
- Contact Us

## Welcome to the CGI

CGI's mission is to foster the interoperability and exchange of geoscience information, by active community leadership, collaboration, education, and the development and promotion of geoscience information standards and best practice.

[Join Now](#)

Explore our website for resources about data sharing, standards, and best practice in geoscience information management.

If you have any feedback, comments, or suggestions, please send them to us via our [Contact Us](#) page.

## Current Working Groups

[GeoSciML](#) - a collaborative OGC-CGI standards working group developing a geological data transfer standard - [Join](#)

[EarthResourceML](#) - developing a data transfer standard for mineral resources and mining information - [Join](#)

[Geoscience Terminology](#) - developing multilingual vocabularies for geoscience and earth resources information - [Join](#)

[Geoscience Information in Africa \(GIRAF\)](#) - a collaborative network of African and global geoinformatics professionals working together to enable geoscience information to contribute to the environmental and economic prosperity of the people of Africa.

## Join us at the 35<sup>th</sup> IGC in Cape Town

The 35<sup>th</sup> International Geological Congress is rapidly approaching in Cape Town, 27 August – 4 September.

The CGI is coordinating a symposium at the IGC on [Geoscience Data & Information Systems](#), with over 40 presentations on a wide range of digital geological data management, data integration, and data delivery topics.

The CGI is also offering a one day workshop on geoscience data services, entitled ["Working with Interoperable Data"](#) on 28 August. Registration costs only 800 ZAR (~50 USD). The workshop will explain CGI and OGC geoscience data standards, and demonstrate how to apply them in delivering and consuming WMS and WFS web services. The workshop will be presented by

The nominations for CGI Councilors for the 2016–2020 term are now open. If sufficient nominations are received, election of new councilors will take place in Cape Town. Read the [new councilors at the 35<sup>th</sup> International Geological Congress in Cape Town](#). Read the [procedure for Council nominations](#).

The final version of the GeoSciML data transfer standard, version 1.0, has been published. The standard, and encoding examples are available at [www.geosciiml.org](#). The new version of GeoSciML covers the same breadth of data as the previous version, but has been designed to be more user-friendly and simpler implementation by a wide range of user communities. The GeoSciML Standards Working Group is currently compiling an OGC modular specification document with the goal of ratification

**CGI**

**The Commission for the Management and Application of Geoscience Information works with OGC to develop international geologic map standards**

# GeoSciML and GeoSciML-Portrayal



## GeoSciML SWG

### Chair(s):

Raymond, Ollie (Geoscience Australia)

Richard, Stephen (Arizona Geological Survey)

### Group Description:

#### 1. IUGS-OGC GeoSciML v4.0 SWG

- o How To Serve a GeoSciML v4.0 Web Feature Service (WFS) Using GeoServer
- o GeoSciML v4.0 Encoding Cookbook for OneGeology and OneGeology

- Reference database

...s released!

About ...g web services

[GeoSciML News Archive](#)

[Home](#)

[Introduction to GeoSciML](#)

[GeoSciML schemas](#)

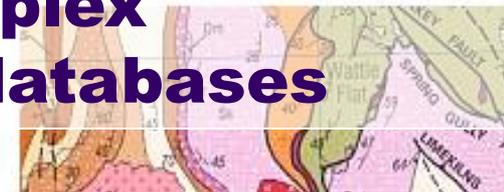
[Geoscience vocabularies](#)

[GeoSciML Standards Working Group \(SWG\)](#)

...l data - from basic map data up to

...ML)

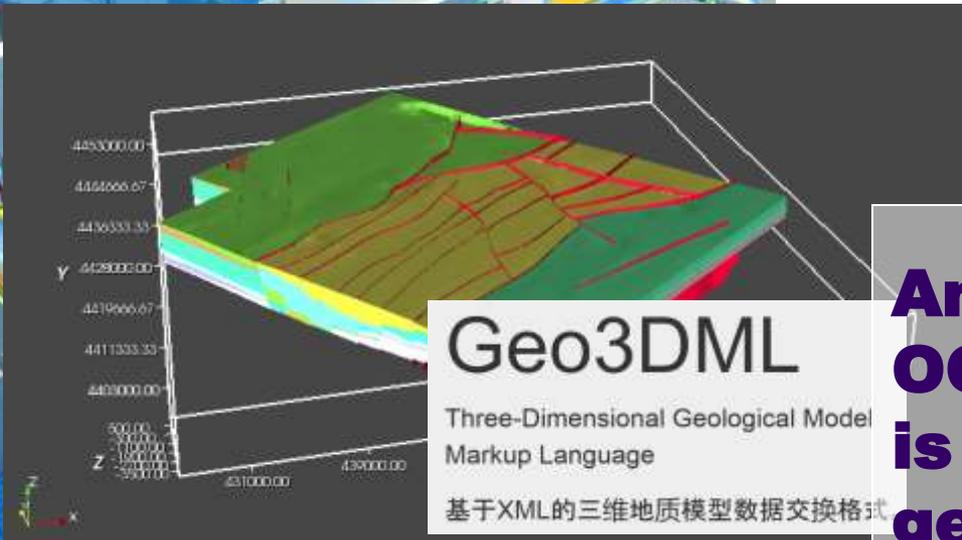
**GeoSciML is now a data transfer standard for all geological data from map data to complex geological databases**



# 3D Database standard



**BIM**



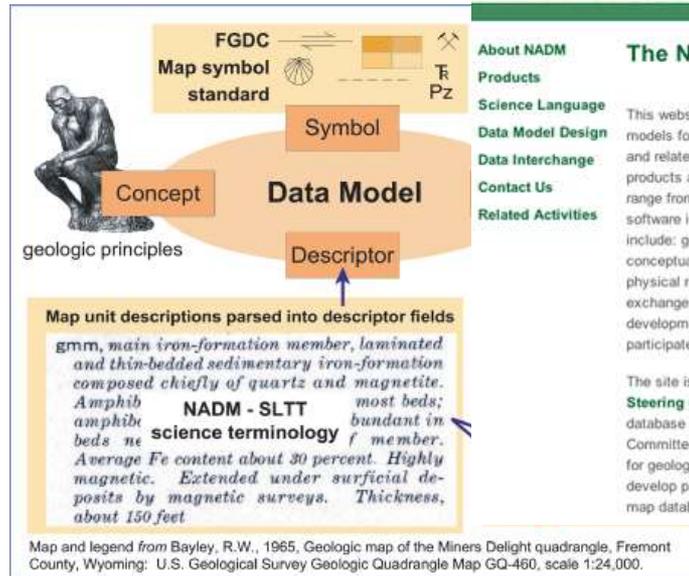
**Geo3DML**

Three-Dimensional Geological Model Markup Language

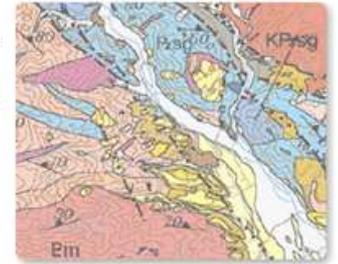
基于XML的三维地质模型数据交换格式

**An outcome of the June OGC meetings in Dublin is a group examining 3D geologic map standards**

# Next steps



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The site is managed by the **North American Geologic Map Data Model (NADM) Steering Committee** – a consortium of American and Canadian geoscientists, database designers, and developers of geologic map information. The NADM Steering Committee sponsors and facilitates cooperative development of digital infrastructure for geologic map databases, and it works on behalf of the sponsoring agencies to develop products and ideas that can be adapted as agency standards for geologic map databases.

- **Ongoing efforts to require NCGMP09 compliance under NCGMP**
  - **Consideration regarding whether USGS should engage with international activity**
    - **Launch of GeoSciML 4.1 as an OGC standard**
- **Consideration whether GeoSciML 4.1 will be able to accommodate 3D geological maps**
  - **OGC examination of competing 3D geology standards**