DIGITAL MAPPING TECHNIQUES 2014

The following was presented at DMT'14
(June 1-4, 2014 - Delaware Geological Survey,
Newark, DE)

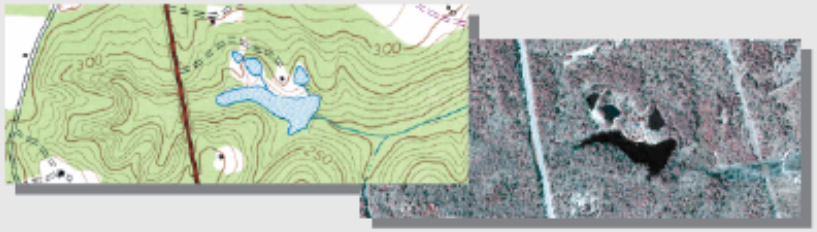
The contents of this document are provisional

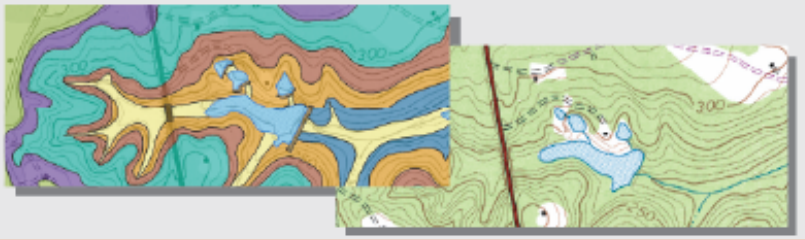
See Presentations and Proceedings
from the DMT Meetings (1997-2014)

http://ngmdb.usgs.gov/info/dmt/

Digital Mapping Techniques

2014

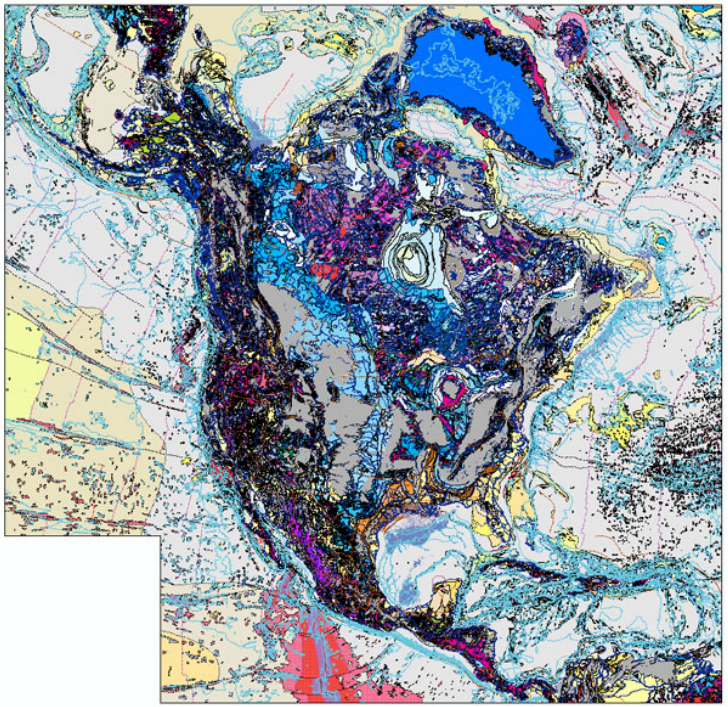


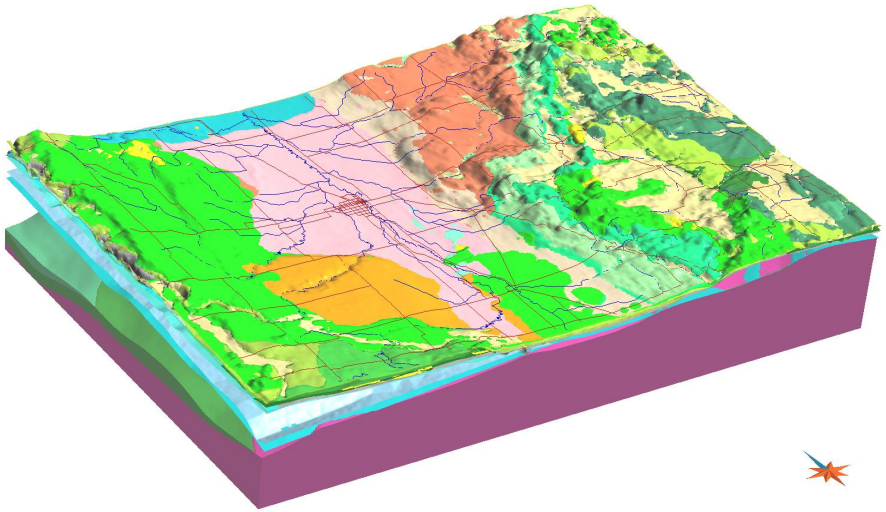


Association of American State Geologists

United States Geological Survey

Charting a path forward for geological mapping in the US





Due to increasingly pressing applications related to energy, minerals, water, engineering, hazards, waste disposal, and research,

society and science will benefit from further acceleration of regularly-updated, well-coordinated, multi-resolution geologic mapping,

including seamless, queryable, statewide and nationwide compilations of onshore and offshore mapping,

as well as 3D mapping of the extent, thickness and properties of the strata that overlie basement.

We have the rationale and capabilities to thus launch a new phase of geologic mapping,

through proven collaboration methods,

along with ongoing progress on administration, infrastructure, formats, and accessibility.

Administration

What allows us to do what we do

NCGMP

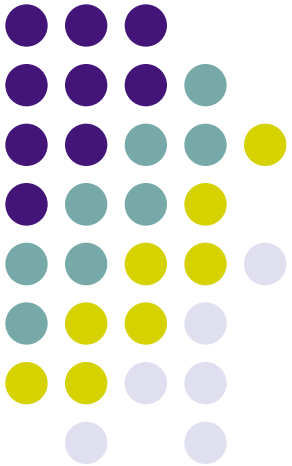
Fedmap

Statemap

Edmap

Demonstration of benefits

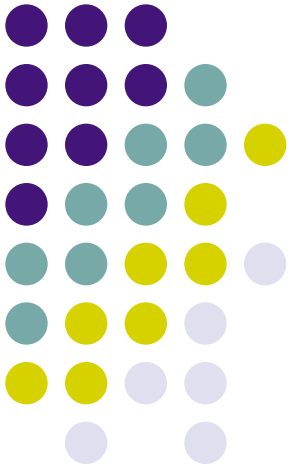
Planning



Demonstration of benefits

Geological mapping

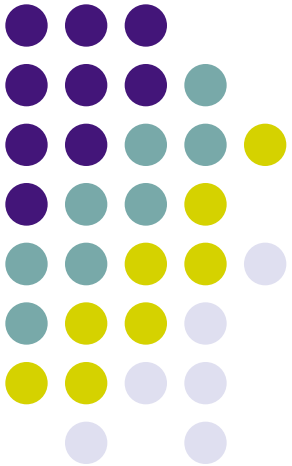
- save lives
- provides economic benefits
- avoids costs
- increases operational efficiency



Planning

The foundation for current geologic mapping in the US was outlined by:

- **a committee advisory to the US Geological Survey (USGS) that reported in 1987**
- **a USGS geologic mapping plan published in 1987**
- **a survey of user needs published by National Academy Press in 1988**

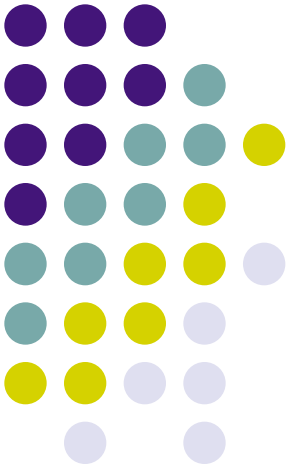


Planning

More recent USGS planning has outlined a vision for national geologic mapping needs

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

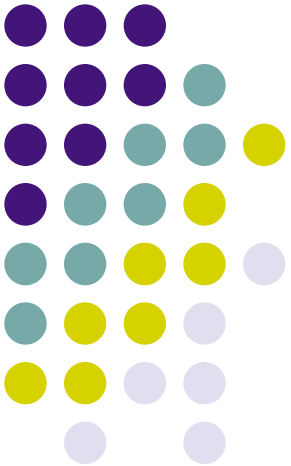
The 2010-2020 plan called for seamless geologic maps, while citing 3D maps as the future standard



Planning

The 2013 plan 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

Similarly, the British Geological Survey has recognized that enhanced monitoring will require a national 3D geology, including the offshore



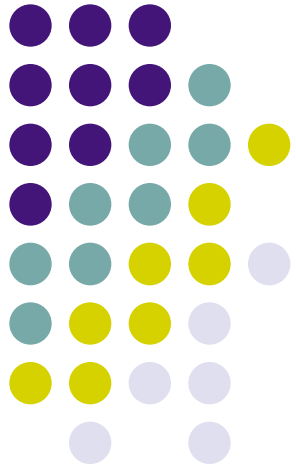
Content

What we do

- **North American Stratigraphic Code**
- **North American Commission on Stratigraphic Nomenclature**

> stratigraphic principles

- **derivative maps**



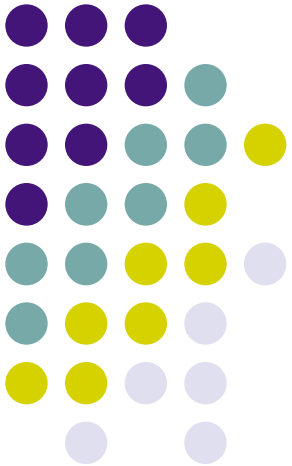
Infrastructure

What we need to do what we do

Topographic bases

Lidar

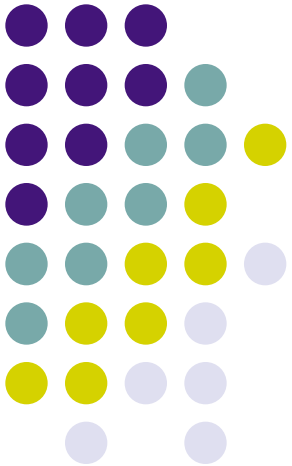
3DEP



Format & accessibility

The digital format of what we do
How we convey what we do to users

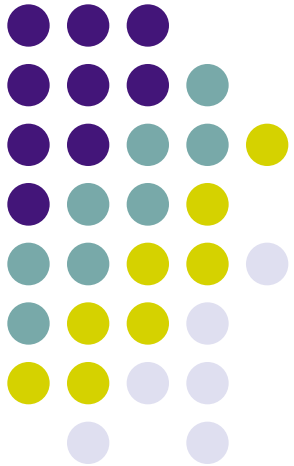
NGMDB
NADM
NCGMP09
GeoSciML
OneGeology
USGIN



Rising expectations

Geological mapping provides large positive benefits, so jurisdiction-wide, multi-resolution, regularly-updated, fully-web-accessible, plan-view surficial and bedrock mapping remains urgently needed

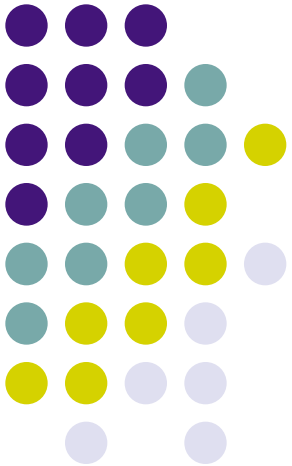
Well-designed paper maps and their digital equivalents will continue to be our foundation, as their information content is rich, standards for their production have been meticulously developed, formats are familiar to users, durable copies of the maps will be usable indefinitely, and the formats facilitate authorship and peer review



Rising expectations

The urgency of user needs calls for mapping of this nature to be completed on a statewide and nationwide basis, ideally within a decade or two;

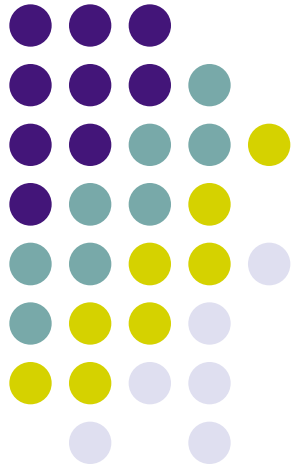
concurrently, geologic maps need to be updated, ideally every two decades or so, due to increasing access, accumulation of data, new topographic mapping, as well as progress in science and technology.



Scale

Users now expect maps to be zoomable between layers of varying resolution

Site-scale mapping on private property or lease areas is the task of property owners, lease-holders, and their consultants; this work tends not to enter the public domain

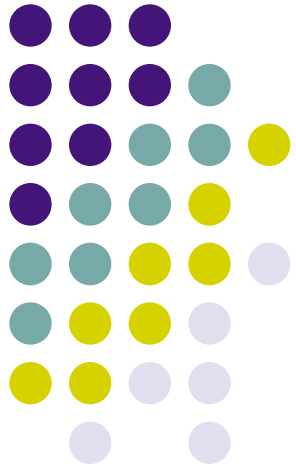


Scale

Beyond site scale is local-scale, which is the task of geological surveys, and which is by far the most important scale for planning

Each survey can determine the most appropriate scale for their focused investigations, and also the scale that will be achievable statewide

In addition, regional-scale maps such as state geologic maps, continental-scale, and global-scale maps are needed to place local mapping into context

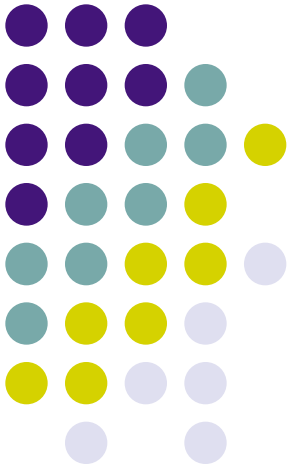


Seamless

Users also expect mapping to be queryable over broad areas

Better meeting this need will require seamless, jurisdiction-wide compilations of local-scale mapping, which can be built on an incremental basis

Links from the compilation to the input maps, at least as scanned and searchable versions of both maps and reports, will provide documentation for advanced users, as well indicate credit and responsibility for the authors of the source maps

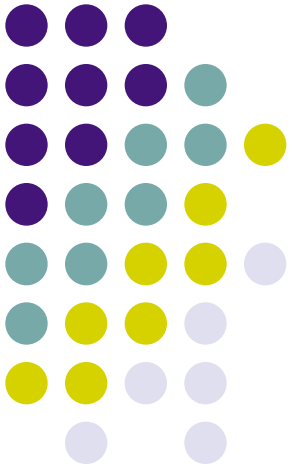


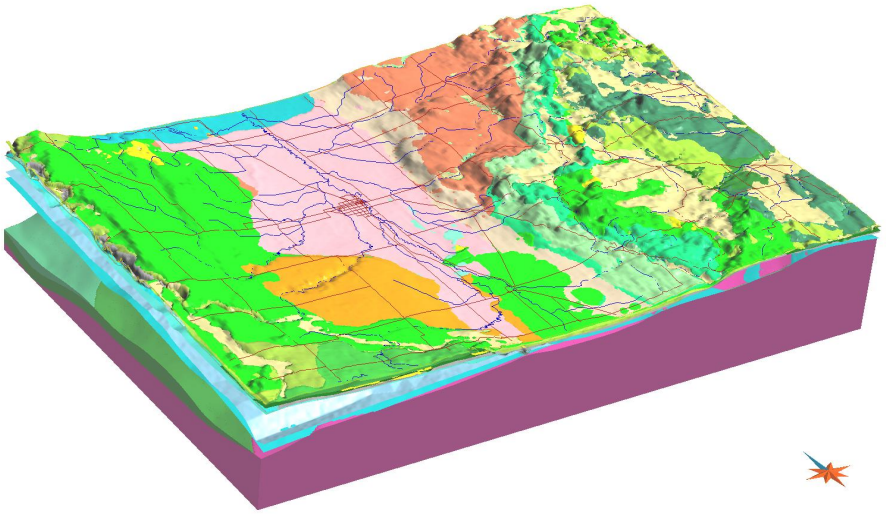
Seamless

Also required will be a well-accepted query language

These compilations will support spatial queries, which increasingly are replacing key word and series number searches, as well as providing a base from which to access geological, geophysical, and geochemical databases

Finally, seamless compilations of local-scale mapping in which the level of detail in the input maps is retained will solve the increasingly impractical task of attempting to maintain GIS files for individual maps.



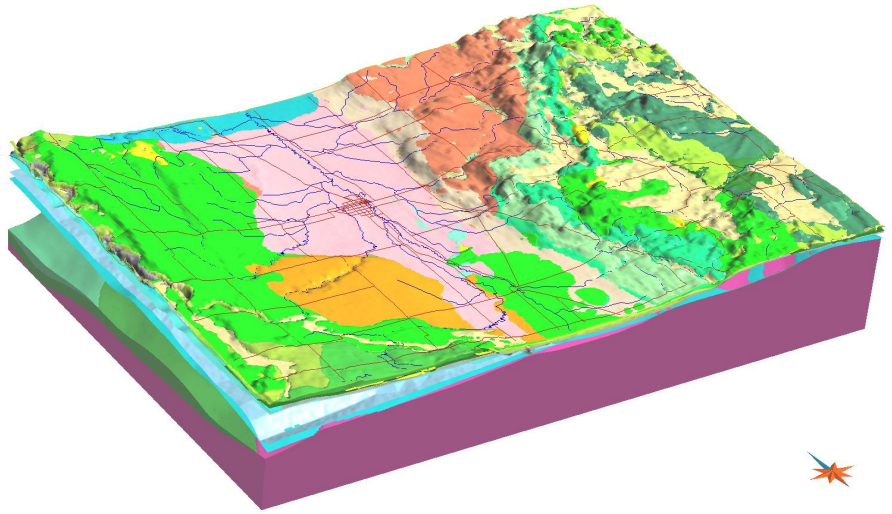


3D

Regional 3D geological mapping is an extension of plan view methods to depiction and prediction of the extent, thickness, and properties of all mappable lithologic strata in a jurisdiction, to support applications such as groundwater management, engineering, and sedimentary basin assessments

Facies modeling and basin analysis guides this lithology-focused mapping which is needed for inference of crucially-important properties such as hydraulic conductivity

The mapping applies only to layers over basement, as complexly deformed strata, as well as igneous and metamorphic rocks, can not be mapped on a regional 3D basis



3D

The mapping requires incorporation of topography, bathymetry, soil mapping, plan view surficial and bedrock mapping, and drillhole data

Data acquisition includes geophysics such as EM, seismic, radar, borehole geophysical surveys, or marine geophysics, while drilling is needed to acquire stratigraphic benchmarks

Model construction methods vary depending on resolution as well as data format and adequacy, while geostatistical methods will be used at various phases of nearly all projects

Upon depiction of layers, heterogeneity, properties, and uncertainty are added, and efforts ensure transfer to users.

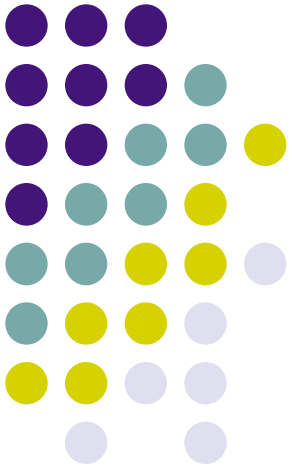
Goals

To the extent that support can be arranged, current & anticipated user needs call for the federal and state geological surveys to increase progress toward the following objectives:

Through advisory committees & planning, renewed insight into user needs – groundwater, energy, minerals, hazards, engineering, and waste disposal

Science and society will benefit if fully-web-accessible geological mapping is accelerated, so long as user needs are reconciled with a clear & comprehensive assessment of the state of existing databases and mapping

While there will remain a need for more detailed mapping in carefully selected areas, each state should also choose a scale for which statewide completion of local-scale mapping is achievable within a decade or two



Goals

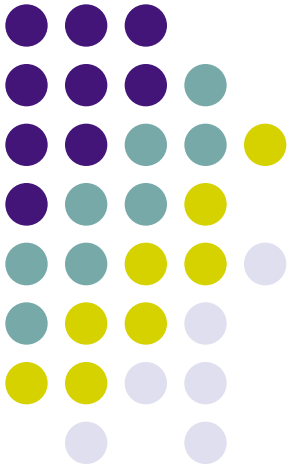
The expectation that all maps should be updated every two decades or so should be more firmly established

While maintaining the detail of customary legends, common query languages should be further assessed and adopted on a nationwide basis in a manner that allows inference of properties such as hydraulic conductivity

Users require increased coordination of seamless compilations of local scale mapping for many applications

Compilations and other interfaces require increased linkage to scanned and searchable publications; ideally every publication ever produced by every survey

& geological, geophysical, and geochemical databases



Goals

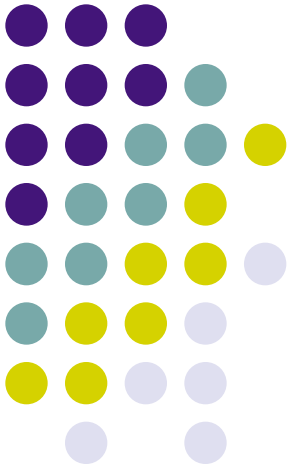
To facilitate subsurface work, compilation of all public domain drillhole data, with strategic geophysical surveys and drilling

To vertically georeference geology, and to facilitate offshore mapping, we require integrated topography and bathymetry

All geology should be recognized as being either a layer, or basement; the thickness of a layer can be mapped regionally, and underlying geology can be mapped to some degree

We will need definition of regionally significant stratigraphic horizons for a national 3D geology

Layers will ideally be stacked, so an overlying polygon can be turned off, to reveal mapping of underlying strata, to the extent that data and inference allow



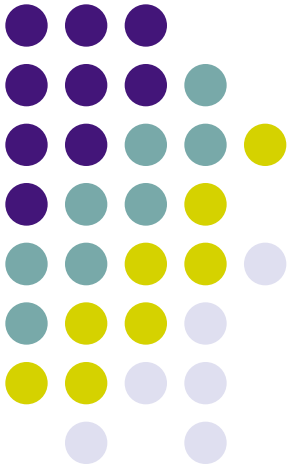
Goals

We can now increase focus on basement maps, which will be bedrock maps from which layers are removed

We need to accelerate local-scale 3D mapping extending to basement, within a statewide plan

We require increased coordination with soil mapping, an activity very similar to our own, and our work should recognize soil mapping as the authoritative reference at least for the top meter

We should assess the status of regional, continental, and global-scale maps, while cooperating in the launch of 3D versions of these maps, which are needed for applications such as sedimentary basin assessments



Lexington Resolution

AASG

Association of American State Geologists

***RESOLUTION ON AASG COMMITMENT TO THE ROLE OF GEOLOGIC MAPPING IN SOCIETY**; draft 29 May 2014 PM*

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

WHEREAS management of energy, minerals, water, hazards, waste, and engineering increasingly rely on applications of geologic mapping;

WHEREAS investments in geologic mapping return benefits including lives saved, costs avoided, and increased efficiency;

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

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

WHEREAS with adequate support these goals along with initiation of a well-conceived, ongoing program of updating could be achieved by the year 2030;

NOW, THEREFORE BE IT RESOLVED, that members of **AASG** believe that state geological surveys should increase their commitment to work with the federal geological survey and other partners to ensure timely completion of optimal geologic 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 **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 new geochronology, geochemistry, and geophysics;
- based on sound **stratigraphic** naming, and categorized using broadly accepted **query** language;
- committed to regular **updating** of maps, while integrated with statewide **seamless** compilations;
- **3D**, in which layers whose thickness, extent, and properties can be mapped are distinguished from similarly mapped underlying layers and from basement;
- coordinated with increasingly 3D versions of regional, **continental**, and global-scale maps;
- fully-**web**-accessible, and **linked** to 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*

What are the implications?

- assessment of the status of databases and mapping
- ongoing detailed mapping
- statewide completion [illegible]ppropriate scale
- integrated topographic and bathymetric data
- geologic mapping integrated from onshore to offshore
- coordination with soil mapping
- compilation of all public domain drillhole data
- broadly accepted query language
- regular updating of maps
- statewide seamless [illegible]ations
- 3D [illegible]ng of layer thickness, extent, and properties
- basement maps
- 3D regional, continental, [illegible]obal-scale maps
- fully-web-accessible
- linked to scanned and searchable publications
- linked to geological, geophysical, and geochemical dbs
- *by 2030*