

# DIGITAL MAPPING TECHNIQUES 2021

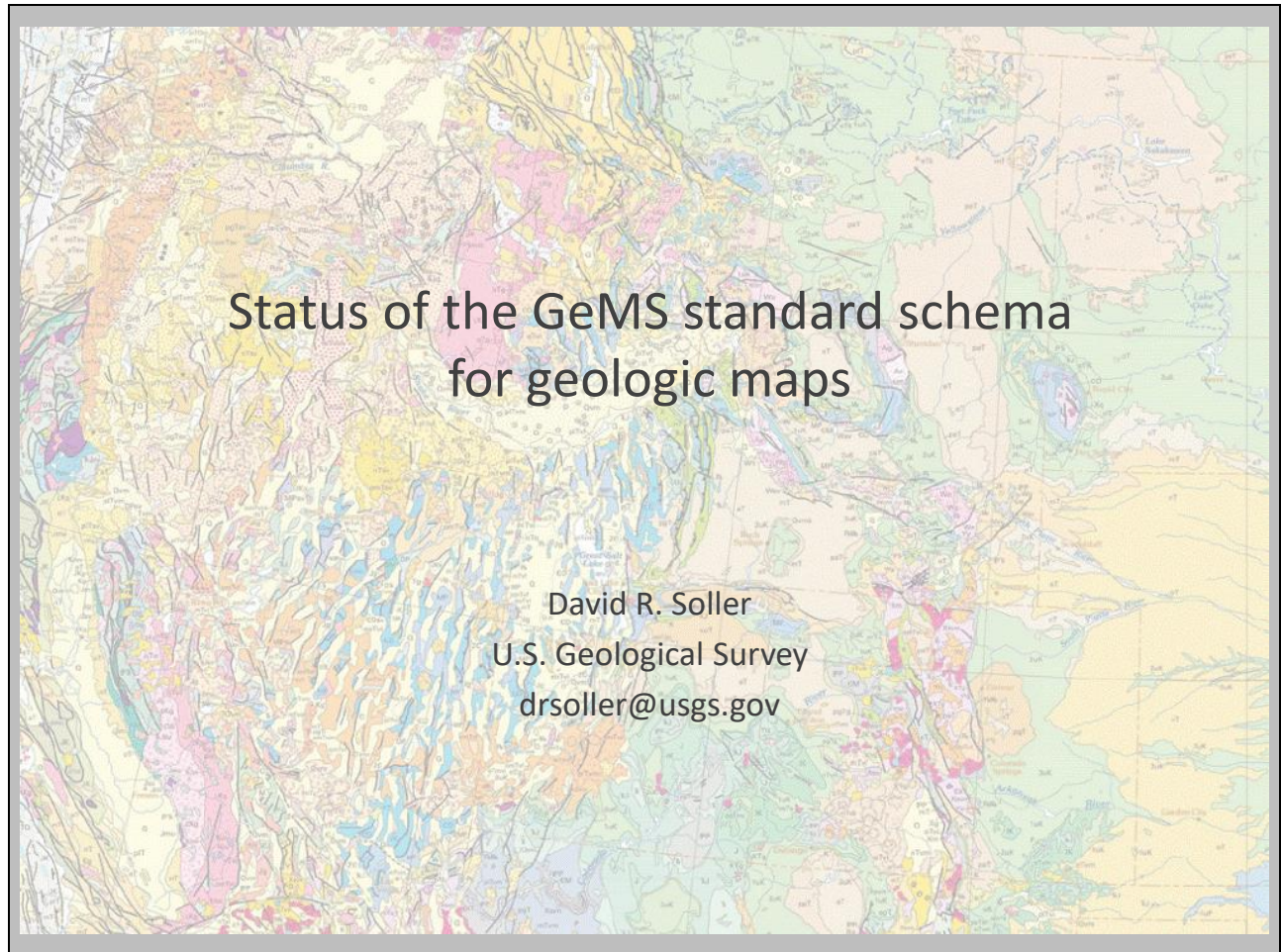
The following was presented at DMT'21  
(June 7 - 10, 2021 - A Virtual Event)

The contents of this document are provisional

See Presentations and Proceedings  
from the DMT Meetings (1997-2021)

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

## SLIDE 1



### PRESENTER NOTES:

It's my pleasure to introduce the day's discussions about the standard geologic map schema (GeMS). This is a team effort, and we're very fortunate that Evan Thoms (USGS) and Ralph Haugerud (USGS) are willing to work with us on this. They write the main scripts, and Evan manages the GeMS Website (<https://ngmdb.usgs.gov/info/standards/GeMS/>) and the Github sites (<https://github.com/usgs/gems-tools-pro>; <https://github.com/usgs/gems-tools-arcmap>). I'll give a brief perspective on how standards development can work, using GeMS as the example.

[Slide background: Geologic map of the western United States and surrounding areas, extracted from the "Geologic map of North America" (Reed and others, 2005; database from Garrity and Soller, 2009). Image downloaded from the National Geologic Map Database ([https://ngmdb.usgs.gov/Prodesc/proddesc\\_86688.htm](https://ngmdb.usgs.gov/Prodesc/proddesc_86688.htm)).]

## SLIDE 2

# Summary of AASG-USGS collaboration on geologic map database standards

## 1996 Geologic Data Model Working Group

- formed August, 1996, at the meeting in St. Louis, Missouri.
- Released a database design (“v.4.3”) in 1999.

### AASG/USGS Geologic Data Model Working Group

On August 14-15, 1996, in St. Louis, Missouri, the AASG and USGS convened a meeting to discuss development of standards to support the geoscience community and the National Geologic Map Database. At the meeting, this Working Group was formed to develop a standard database design for geologic maps.

#### The Working Group's charge:

- 1) Identify the “core” elements common to all geologic maps and legends.
- 2) Bells and Whistles -- How to add features and capabilities to the core elements?
- 3) Investigate data structures to facilitate generalization and creation of derivative maps from the data (i.e., the “evolutionary” map).

#### Chronology

- In October, 1997, the Geologic Data Model Working Group released a draft data model for public comment. Software tools were written that enabled the model to be evaluated, and implementation to be tested.
- In June, 1998, a workshop to evaluate the data model was held. Twenty-eight members of the USGS, state geological surveys, and the Canadian federal and provincial surveys attended. A revised data model (v.4.2) and software tools were shown. The attendees supported further development of the model. A [meeting summary](#) is available.
- Following the data model workshop, revisions were made to the data model, and these were made available to the public as version 4.3.
- With completion of the workshop and version 4.3, the objectives of this Working Group were considered to be met, and the group was dissolved.
- In late 1998, the Federal, State, and Provincial geological surveys of the United States and Canada formed the **North American Data Model Steering Committee (NADMSC)**, to continue development of the data model. General information on the Committee process, and progress on the data model and standard science language can be found at the [NADM site](#).
- **The National Geologic Map Database** continues to develop its data model and science language, in support of requirements of the National Geologic Mapping Act. Please see the [NGMDB Standards site](#) for information.

Membership in this working group was informal, and all were invited to participate and to evaluate the model as it develops. The original members were:

Gary Raines, USGS (Chair)  
Boyan Brodaric, Geological Survey of Canada  
Jim Cobb, Kentucky Geological Survey  
Todd Fitzgibbon, USGS  
Ralph Haugerud, USGS  
Greg Hermann, New Jersey Geological Survey  
Bruce Johnson, USGS  
Jon Math, USGS  
Jim McDonald, Ohio Geological Survey  
Don McKay, Illinois Geological Survey  
Steve Schilling, USGS  
Randy Schumann, USGS  
Bill Shilts, Illinois Geological Survey  
Ron Wahl, USGS

Comments or questions about the content of this archived page?  
Please submit them via the [NGMDB's Comments form](#).

## DIGITAL GEOLOGIC MAP DATA MODEL

Version 4.3

September 27, 1999

By

Bruce R. Johnson, Boyan Brodaric, Gary L. Raines, Jordan T. Hastings, and  
Ron Wahl

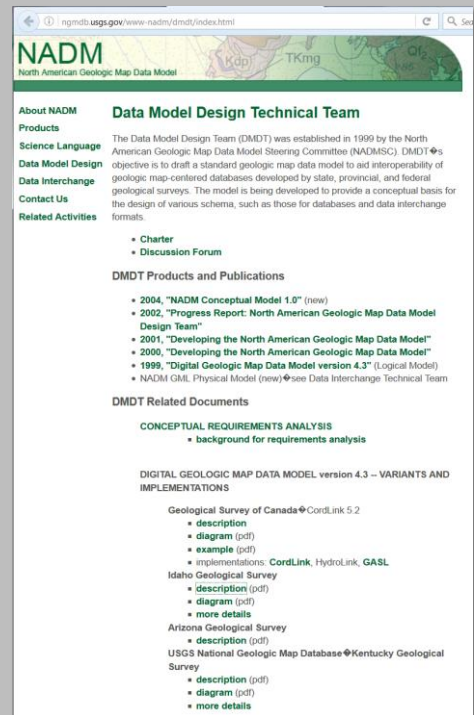
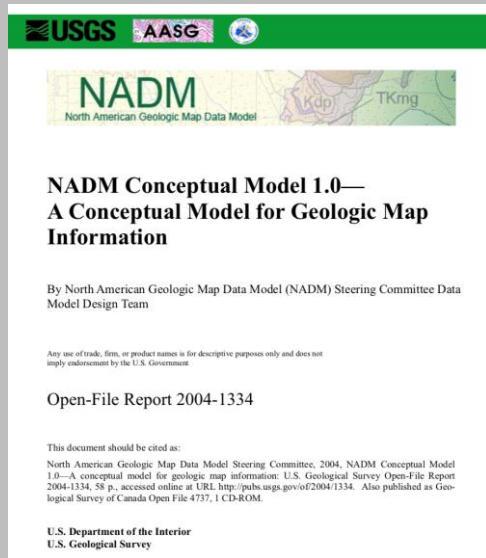
## PRESENTER NOTES:

The long road to GeMS began in 1996, with a meeting in St. Louis, Missouri, where a half-dozen National Geologic Map Database (NGMDB) Working Groups were formed. This one, the Data Model Working Group (<https://ngmdb.usgs.gov/archive/datamodelWG.html>), had two members with us today -- Ralph Haugerud (USGS) and Randy Schumann (USGS). They released a conceptual data model design in 1999 (Johnson, B.R., and others, Digital geologic map data model, version 4.3, unpublished AASG-USGS working document dated September 27, 1999, 69 p.; <https://ngmdb.usgs.gov/www-nadm/prd/Model43a.pdf>).

## SLIDE 3

### 1998 North American Data Model Steering Committee

- Published the "NADM" multi-map, enterprise-level design in 2004.

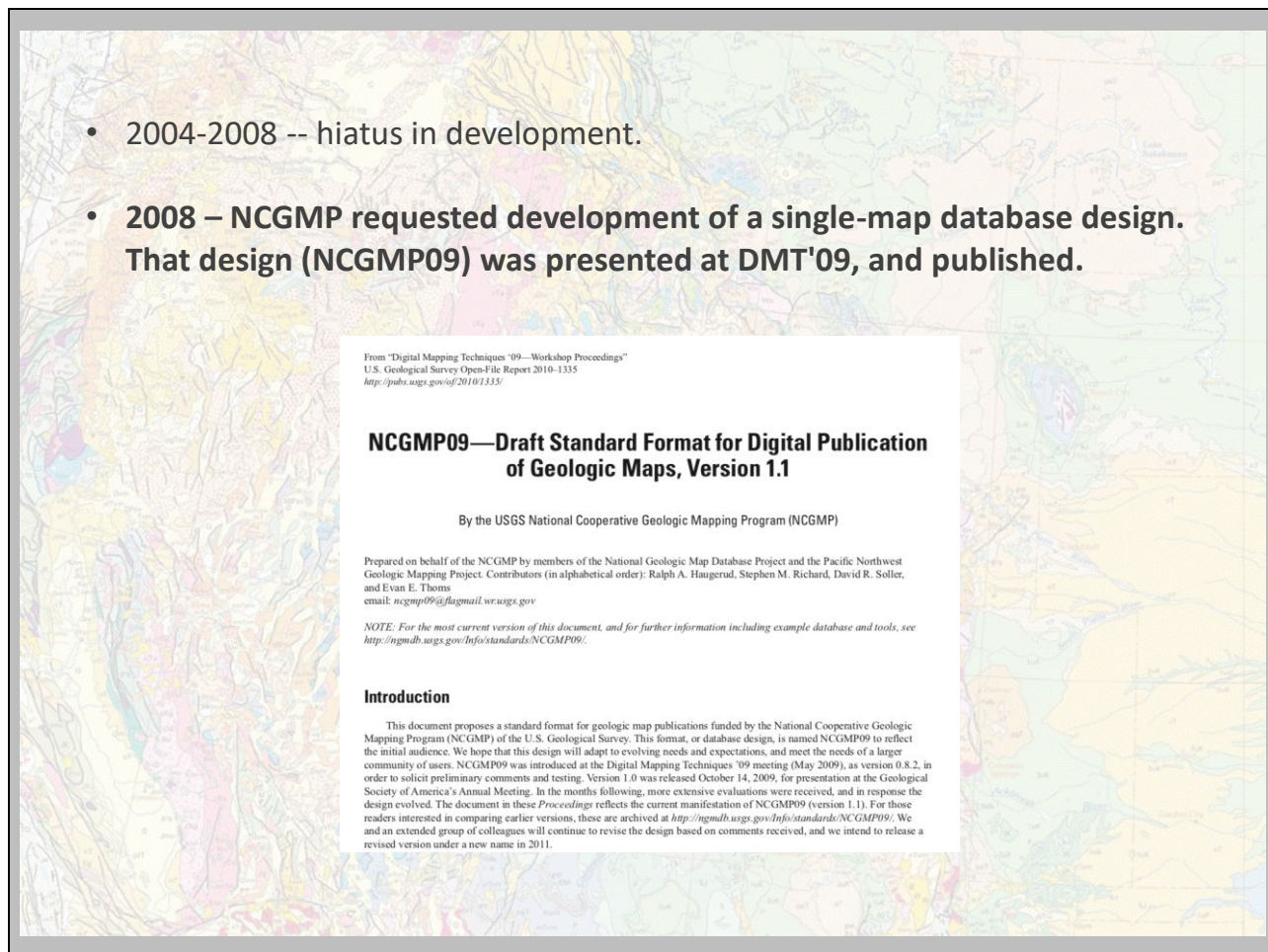


### PRESENTER NOTES:

By that time (1999), in part through the Association of American State Geologists (AASG) / USGS Digital Mapping Techniques Workshops (DMT; <https://ngmdb.usgs.gov/Info/dmt/>), we had begun working with Canadian geologists, and formed the North American Data Model Steering Committee (NADM; <https://ngmdb.usgs.gov/www-nadm/>). The NADM design, published in 2004, was an evolution of the data model ver. 4.3, in the last slide. It was envisioned as a very complete, robust design that would serve many analytical needs, at the enterprise level (North American Geologic Map Data Model Steering Committee, 2004, NADM Conceptual Model 1.0—A conceptual model for geologic map information: U.S. Geological Survey Open-File Report 2004-1334, 58 p.; <https://pubs.usgs.gov/of/2004/1334>. Also published as Geological Survey of Canada Open File 4737, 1 CD-ROM).

## SLIDE 4

- 2004-2008 -- hiatus in development.
- **2008 – NCGMP requested development of a single-map database design. That design (NCGMP09) was presented at DMT'09, and published.**



### PRESENTER NOTES:

However, the NADM Conceptual Model 1.0 was judged to be too complex for implementation by the Nation's geological surveys at that time, and so I phased us out of this work, although continuing to fund some involvement in the GeoSciML activity (<https://geosci.ml.org/>), which was informed by the NADM design.

In 2008, Peter Lyttle (USGS), the National Cooperative Geologic Mapping Program (NCGMP) Coordinator, asked us to design a data schema that would at least address the needs of authors of individual geologic maps. Ralph Haugerud (USGS), Evan Thoms (USGS), Steve Richard (Arizona Geological Survey), and I developed this, presented it at DMT'09, and published it (USGS National Cooperative Geologic Mapping Program [NCGMP], 2010, NCGMP09—Draft standard format for digital publication of geologic maps, version 1.1, in Soller, D.R., ed., Digital Mapping Techniques '09—Workshop Proceedings: U.S. Geological Survey Open-File Report 2010–1335, p. 93–146, 4 appendixes; [https://pubs.usgs.gov/of/2010/1335/pdf/usgs\\_of2010-1335\\_NCGMP09.pdf](https://pubs.usgs.gov/of/2010/1335/pdf/usgs_of2010-1335_NCGMP09.pdf)).

## SLIDE 5

- 2013 – based on discussions at DMT'13, a Progress Report on NCGMP09 implementation was released.

### **Progress Report on the evaluation and implementation of NCGMP09**

Submitted to the U.S. Geological Survey (USGS) and Association of American State Geologists (AASG), by David R. Soller (Chief, National Geologic Map Database) on behalf of colleagues noted in the "Summary of Progress", below.

September 25, 2013

The purpose of this report is to provide USGS and AASG management with a summary of progress toward adoption of NCGMP09 as a standard format for the publication of geologic maps. Background information on NCGMP09, and justification for its use and adoption is, therefore, purposely brief. It is recommended that any questions be addressed to the technical experts whose input provided the basis for this Progress Report.

### PRESENTER NOTES:

There then ensued a period of evaluation by the DMT community. Four years later, at DMT in 2013, we had a long discussion about it, and compiled this Progress Report (Progress report on the evaluation and implementation of NCGMP09, submitted to the USGS and AASG September 25, 2013, 14 p.;

[https://ngmdb.usgs.gov/Info/standards/GeMS/docs/NCMP09\\_ProgressReport\\_Sept2013.pdf](https://ngmdb.usgs.gov/Info/standards/GeMS/docs/NCMP09_ProgressReport_Sept2013.pdf)).

I recommend reading it, as it remains quite relevant.

SLIDE 6

- 2014-2016 – revisions to NCGMP09 were systematically debated among a large group of AASG and USGS staff.
- 2017 – Version 2 (renamed “GeMS”) provisionally released.
- March 2018 – Update to GeMS version 2 posted to Web site

**NOTE: As of March, 2018, this draft manuscript<sup>1</sup> is still provisional; however, it has passed Peer Review, and it is now being prepared for technical edit and, ultimately, for formal publication.**

*NOTE: For the most current version of this draft manuscript, and for further information including example database and tools, see <http://ngmdb.usgs.gov/Info/standards/GeMS/>.*

*Please contact Ralph Haugerud and Dave Soller (USGS, [gems@usgs.gov](mailto:gems@usgs.gov)) with questions or comments, or to request access to the software tools.*

**GeMS (Geologic Map Schema)—a standard format for digital publication of geologic maps<sup>1</sup>**

By the USGS National Cooperative Geologic Mapping Program (NCGMP)<sup>2</sup>

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PRESENTER NOTES:

Following that, we went through a 4-year period of review, re-evaluation, and updates to NCGMP09, renaming it GeMS and posting it to the website for use while awaiting publication (Soller, D.R., and Haugerud, R.A., Recommendations for State and federal compliance with NCGMP’s standard “Geologic Map Schema” [GeMS] for geologic map databases, with contributions from, and approval by, the NGMDB Technical Advisory Working Group, unpublished draft document dated April 5, 2019, 6 p.;

[https://ngmdb.usgs.gov/Info/standards/GeMS/docs/GeMSv2\\_draft7q\\_ProvisionalRelease.pdf](https://ngmdb.usgs.gov/Info/standards/GeMS/docs/GeMSv2_draft7q_ProvisionalRelease.pdf)).

## SLIDE 7

- 2018-2019 – USGS Peer and editorial reviews
- 2020 – Published as a USGS Techniques and Methods Chapter
- This schema will be formally proposed as the FGDC Standard for geologic map databases.



### PRESENTER NOTES:

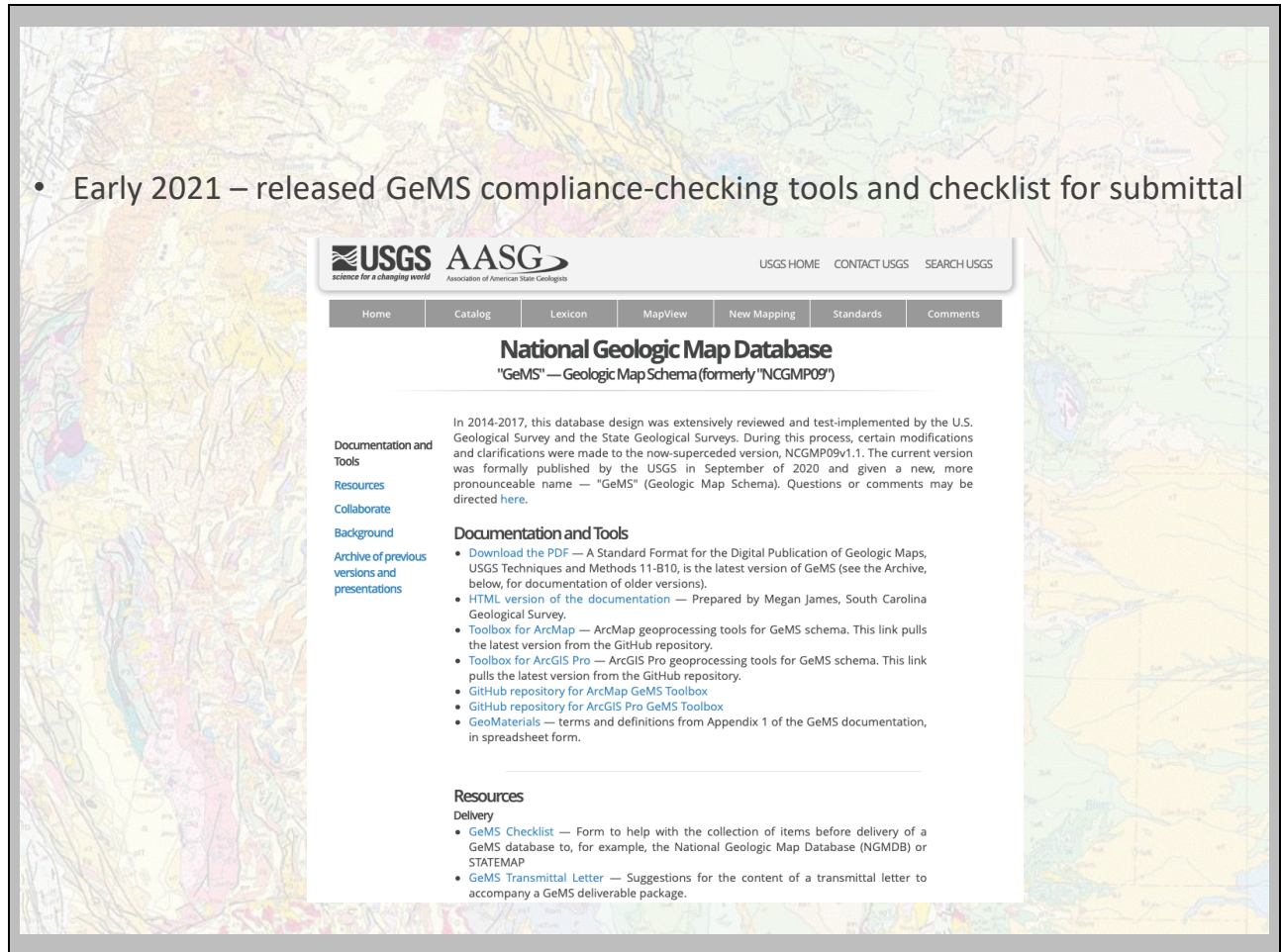
That process was completed just last Fall.

U.S. Geological Survey National Cooperative Geologic Mapping Program, 2020, GeMS (Geologic Map Schema)—A standard format for the digital publication of geologic maps: U.S. Geological Survey Techniques and Methods, Book 11, Chap. B10, 74 p.; <https://doi.org/10.3133/tm11B10>, <https://pubs.usgs.gov/tm/11b10/tm11b10.pdf>.



## SLIDE 8

- Early 2021 – released GeMS compliance-checking tools and checklist for submittal



The screenshot shows the National Geologic Map Database (NGMDB) website. The header includes the USGS and AASG logos, with the tagline "science for a changing world" and "Association of American State Geologists". Navigation links include Home, Catalog, Lexicon, MapView, New Mapping, Standards, and Comments. A search bar is also present.

### National Geologic Map Database

"GeMS" — Geologic Map Schema (formerly "NCGMP09")

In 2014-2017, this database design was extensively reviewed and test-implemented by the U.S. Geological Survey and the State Geological Surveys. During this process, certain modifications and clarifications were made to the now-superseded version, NCGMP09v1.1. The current version was formally published by the USGS in September of 2020 and given a new, more pronounceable name — "GeMS" (Geologic Map Schema). Questions or comments may be directed [here](#).

**Documentation and Tools**

- [Download the PDF](#) — A Standard Format for the Digital Publication of Geologic Maps, USGS Techniques and Methods 11-B10, is the latest version of GeMS (see the Archive, below, for documentation of older versions).
- [HTML version of the documentation](#) — Prepared by Megan James, South Carolina Geological Survey.
- [Toolbox for ArcMap](#) — ArcMap geoprocessing tools for GeMS schema. This link pulls the latest version from the GitHub repository.
- [Toolbox for ArcGIS Pro](#) — ArcGIS Pro geoprocessing tools for GeMS schema. This link pulls the latest version from the GitHub repository.
- [GitHub repository for ArcMap GeMS Toolbox](#)
- [GitHub repository for ArcGIS Pro GeMS Toolbox](#)
- [GeoMaterials](#) — terms and definitions from Appendix 1 of the GeMS documentation, in spreadsheet form.

**Resources**

**Delivery**

- [GeMS Checklist](#) — Form to help with the collection of items before delivery of a GeMS database to, for example, the National Geologic Map Database (NGMDB) or STATEMAP
- [GeMS Transmittal Letter](#) — Suggestions for the content of a transmittal letter to accompany a GeMS deliverable package.

### PRESENTER NOTES:

To support this standard, we've been working on compliance-checking tools (which you've seen at previous DMTs), and various things that are needed so we can keep track of the information as it is reposted, and then searched for and downloaded for use (<https://ngmdb.usgs.gov/Info/standards/GeMS/>).

SLIDE 9

- Early 2021 – released GeMS compliance-checking tools and checklist for submittal

**GEMS SUBMITTAL CHECKLIST** Dec 8, 2020

ELEMENT	PATH/NAME (relative to .zip file)
<b>Contents of submittal package</b>	
<b>REQUIRED</b>	
<input type="checkbox"/> Transmittal letter	
<input type="checkbox"/> Validation.html from Validate Database tool	
<input type="checkbox"/> ValidationErrors.html from Validate Database tool	
<input type="checkbox"/> Report from Geologic Names Check tool	
<input type="checkbox"/> Map publication folder (described below)	
<b>Contents of map publication folder</b>	
<b>REQUIRED</b>	
<input type="checkbox"/> High resolution graphic	
<input type="checkbox"/> Browse graphic	
<input type="checkbox"/> FGDC-compliant metadata in valid XML	
<input type="checkbox"/> Map database folder (described below)	
<input type="checkbox"/> Shapefile version folder of database archive (described below)	
<b>AS NEEDED</b>	
<input type="checkbox"/> Map pamphlet	
<b>Contents of database folder</b>	
<b>REQUIRED</b>	
<input type="checkbox"/> gdb folder	
<input type="checkbox"/> .mxd map document or .aprx project file	
<input type="checkbox"/> FGDC-compliant metadata in valid XML (copy of above)	
<input type="checkbox"/> Resources folder (described below)	
<b>AS NEEDED</b>	
<input type="checkbox"/> Map pamphlet	
<input type="checkbox"/> Base data folder (required if not published elsewhere)	
<b>OPTIONAL</b>	
<input type="checkbox"/> ArcReader document, KML files, QGIS project, i.e., files for viewing data with free software	
<b>Contents of Resources folder</b>	
<b>REQUIRED</b>	
<input type="checkbox"/> Symbology as style, stylex, carto rep, lyr, etc.	

12/21/2020

**To ensure efficient uptake of your GeMS files into the NGMDB, we ask for the following information that isn't generated by the GeMS Validate Database and Geologic Names Check tools. We need this information in order to link the GIS data to the published map, and to understand how GeMS might need to evolve.**

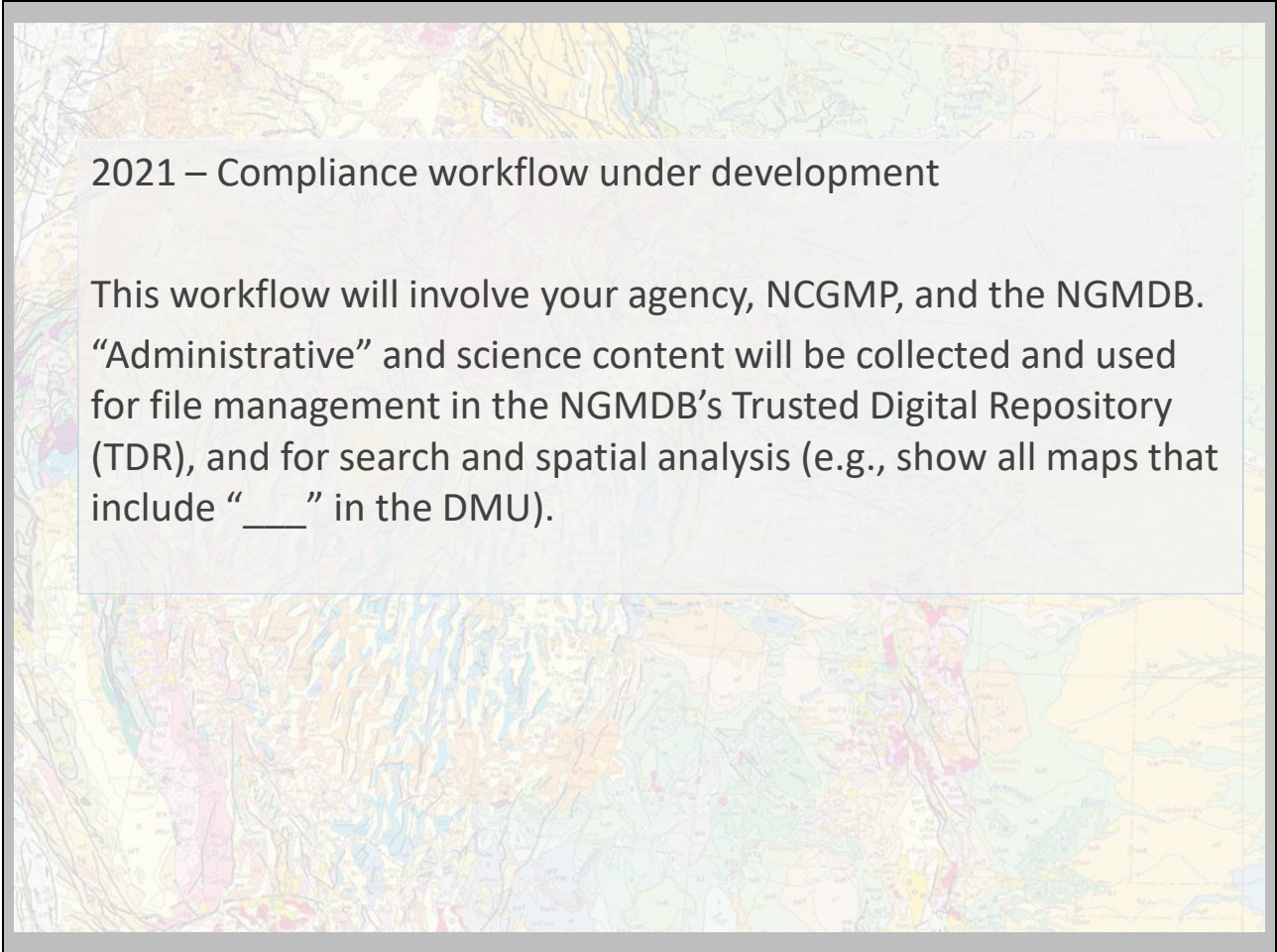
*If you're submitting the files to USGS, these items could be included in or accompany your transmittal letter:*

- 1) Full bibliographic citation for the published map.
- 2) URL to its NGMDB Product Description Page (e.g., [https://ngmdb.usgs.gov/Prodesc/prodesc\\_108054.htm](https://ngmdb.usgs.gov/Prodesc/prodesc_108054.htm)). *NOTE: if not in the NGMDB, please so indicate.*
- 3) Is the GeMS database considered to be:
  - a. a "reprint" of the publication listed in the NGMDB Map Catalog,
  - b. an updated (revised) version of the publication listed in the Catalog, or
  - c. a new publication that is not currently listed in the Catalog?
- 4) URL where users may access the GIS files from the State Survey site. *NOTE: if GIS data aren't yet available, provide URL to downloadable PDF of the map (and report, if any).*
- 5) Indicate whether GeMS Level One, Two, or Three.
- 6) High-resolution PDFs of published map and other oversize sheets (if not already shown at the NGMDB Product Description Page)
- 7) High-resolution PDFs of published report or pamphlet accompanying the map. *NOTE: these will not be downloadable from the NGMDB site unless they're published by USGS or the State GS has given permission.*
- 8) Describe, in a sentence or two, any significant deviations from full GeMS compliance as revealed by the GeMS Validate Database tool and the Geologic Names Check tool. If the deviation was necessary to address agency or science needs for this publication, please so indicate; this insight could help guide future GeMS development.

PRESENTER NOTES:

For example, this compliance checklist and transmittal letter which, along with the tools, were released in January of this year.

## SLIDE 10



2021 – Compliance workflow under development

This workflow will involve your agency, NCGMP, and the NGMDB. “Administrative” and science content will be collected and used for file management in the NGMDB’s Trusted Digital Repository (TDR), and for search and spatial analysis (e.g., show all maps that include “\_\_\_” in the DMU).

### PRESENTER NOTES:

We're now reasoning out what the workflow needs to be, for repositing, search, and use.

**SLIDE 11**

Next, how best to explain GeMS to our end users?

E.g., tutorials, Continuing Education Credit courses prepared in cooperation with AGI, presentations to AIPG, ASCE, etc.

Suggestions welcome!

**PRESENTER NOTES:**

Regarding how best to explain GeMS to our end users, your suggestions are welcome (gems@usgs.gov).

**\*END OF PRESENTATION\***