

Guidelines for Digital Review of a Geological Map Database

Version 2

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This document was prepared for the National Cooperative Geologic Mapping Program by Susan S. Priest. In 2009, a preliminary version of this document was circulated within USGS. The current version addresses the comments provided by many USGS scientists, and also incorporates the database requirements for geologic maps submitted to the USGS Menlo Park Publishing Service Center.

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National Cooperative Geologic Mapping Program

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Introduction

This document provides guidelines and a checklist for the digital geologic map database review process. Digital geologic maps have been mandated by the National Cooperative Geologic Mapping Program (NCGMP) since 1999. Geologic Division digital map product requirements are at: <http://ngmdb.usgs.gov/Info/standards/dataexch/USGSpolicy.html>. Most digital products are created using ESRI software, and output format typically includes coverages, shapefiles and more recently geodatabases. The latest version of ArcGIS is moving toward streamlining the process of both creating the geologic map digital database and producing final cartographic output. Current and future trends are melding the geologic map database and cartographic products derived from the database. Because the current most widely used GIS software is ArcGIS, it is desirable to create and publish databases in a current ArcGIS format. Because the current standard database format for ESRI's ArcGIS is the geodatabase, the trend in output format is moving away from ArcView shapefiles and ArcInfo coverages.

Currently the Enterprise Publishing Network (EPN) will not accept new publications until the digital review has been completed. Therefore, a digital review should take place after the second peer review has been completed. Digital reviews are handled either by a geologist with a good working knowledge of GIS or by GIS personnel with open access to GIS-savvy geologists. Digital reviewers do not make any changes to the database itself, but supply comments back to the author.

Digital reviews of USGS map products are required in order to insure integrity of the digital database. The digital review serves to check the data for consistency among data structure, content and metadata documentation.

The current USGS review process focuses the scientific (peer) review on a cartographic paper map output, whereas the digital review focuses on the mechanics and integrity of the digital database from which a cartographic product is (ideally) derived. The digital review also provides an opportunity to check whether current USGS and/or team and/or project standards have been incorporated in the digital product.

What is not happening on a regular basis is a peer review of the database, in addition to the cartographic map product. Hopefully as the digital and cartographic products merge, peer reviewers will begin to use the digital database to check for geologic integrity. We recommend, therefore, that the author make the GIS database available to the two scientific peer reviewers prior to the formal GIS review. The two peer reviewers are encouraged to use the database if it will assist them, but they should not be obligated to write formal review comments about the database. There are lots of geologic and database integrity checks a GIS savvy scientific reviewer can make with the database in hand; for example 1) a map unit description claims a unit is found only in the NW corner of the map, but a database check shows unit polygons are in other places on the map, 2) adjacency relations, 3) are there intersections that are not geologically correct? The digital review can optionally include a bit of geologic checking by virtue of its querying abilities.

The document is organized as follows:

First, the elements of a map database review package are listed. Second, a preliminary digital review checklist is provided for those science centers that require an initial check of the database before it is submitted for peer review. Finally, a complete digital review checklist provides guidance on the NCGMP perspective of a quality digital review. The appendix lists techniques for polygon adjacency tests.

Review Package

The digital review package from the author should include the following:

- Routing sheet
- Geodatabase (Optional: shapefiles and/or interchange format coverages)
- Style (Optional, but required if used)
- Readme file (less structures "metadata")
- Metadata completed down to feature class level (recommended, though some authors write only one metadata file for the whole database)
- Pamphlet and/or DMU (MS Word or PDF)
- DMU (table included in database for NCGMP09)
- CMU (+/- included in database)
- LMU (+/- included in database)
- Printout of map
- Cross sections (+/- included in database)
- Associated tables (lookup/summary tables)
- Basemap: Additional files used to view map (topographic base, imagery, etc.)
- ArcMap document (.mxd). This must be included if an .mxd will be part of the published product. It is otherwise optional, the reviewer might want to use it to check authors intended database product.

Preliminary Digital Review

Check for fundamental database completeness and cleanliness (optional). Note: If the database is considered not ready for a full digital review after the preliminary check, the manuscript can be sent back to the author for adjustments.

Note: Incorporate these checks into the complete review if a preliminary review is not done.

Most of these checks can be done from ArcCatalog

- Browse the database and familiarize yourself with all the elements
- Is the review package complete?
- Check database structure and contents for conformity with any program standards.
- Is the database structure fairly easy to understand and does it follow a pre-defined data model (either NCGMP09 or other)?
- Spatial reference (Projection/XY Coordinate System)
 - Is it defined for all appropriate elements (feature dataset, feature classes, add'l rasters, tables)?
- Feature classes

- __ Are the feature classes appropriate for the data they represent? For example – are thin dikes represented as polygons when their shape is better suited as lines?
- __ Are temporary feature classes deleted?
- __ Feature class fields
 - __ Are there fields left over from ArcInfo or data processing that don't belong in the final database?
 - __ Check for null values. Are any fields mostly empty, if so, does this represent missing data, incomplete data OR is the field unnecessary? Check to see if null values are explained in the metadata.
 - __ **Note to author:** It is recommended that empty fields (null value) are reconciled with a qualifier (NoData, xx, etc.)
 - __ Are there unattributed features?
 - __ Are there short arcs?
 - __ Are there small polygons?
 - __ Are field values stored as codes that require a table to be readable, if so, is there a way to make the value immediately useful (i.e., remove codes as much as possible and use simple geological term OR make sure relates work)
 - __ Is plain text field used in conjunction with any fields requiring keyboard substitutions. (ie. geologic unit names) or standard text substitutions for age fonts (ie. symbols for Triassic [TR], Pennsylvanian [IP], Cambrian [C], etc.)?

Complete Digital Review

General – ArcCatalog

Complete all of the preliminary digital review checks listed above as well as the following:

- __ Are domains and subtypes used?
 - __ If so, do they make sense?
 - __ Are all domains being used?
 - __ Any domains that are not being used? Author should delete these.
 - __ Are domains abbreviated to include only those values used in the deliverable database and documented in the metadata.
- __ Topology - create new topology using data model rules (NCGMP09 rules or other) and, if needed, additional rules specific to data structure or content. Validate new topology.
 - __ Polygon boundaries must be coincident with lines
 - __ Provide comments/errors to author
 - __ Check that topologic rules are documented in feature dataset or feature class metadata

Note to author: Delete topology from deliverable dataset

Note to author: Compact deliverable database before sending out final package

General – ArcMap

- __ Create a new ArcMap document (.mxd) adding all the map elements
 - __ Does everything import and project correctly?
- __ Apply the optionally supplied style and check that everything symbolizes correctly and approximates the printed map version
- __ Create summary tables for all user defined fields in all feature classes; these are lists of all unique attributes for a specific field in a given feature class and how many times it occurred in the

database. These tables are used to cross-check database attributes against metadata, LMU, CMU, and DMU. The tables, along with any comments, are passed back to author

__ Check all the tables for attribute typos.

Optional tool: ESRI Metadata Attribute Statistics sample (<http://tinyurl.com/qp4cqq>) can extract attribute info and record it in ArcCatalog metadata

__ If an .mxd was provided

__ Are paths set properly?

__ Is the database saved with relative path names? (File/Document Properties/Data Source Options)

__ Check Document Properties (File/Document Properties)

Title: <xxx.mxd>

Subject: Full title of paper or map <Geologic Map of the...>

Author: list all authors, first name first <George H. Billingsley, Susan S. Priest>

Category: Series and number <USGS Open-File Report 2007-1270>

Keywords:

Comments:

Hyperlink base:

Arcs - Contacts and Faults (required for NCGMP09)

__ All ltypes are represented in the style (use summary table)

__ No extraneous ltypes are in the style

__ All features are attributed (no null arcs, they can indicate missing data)

__ No invalid short arcs (use map scale to determine validity)

__ Check line directionality (confirm right-hand rule on decorated lines)

__ Make new topology and check for errors (see NCGMP09 schema for standard rules)

__ No un-expected pseudonodes

__ Check for polygon adjacency problems using an identity layer made in ArcCatalog (see Appendix)

__ No invalid internal arcs (certain contacts with same geologic unit on both sides). Exceptions may include, but are not limited to concealed contacts, faults, scarps and levees (Appendix - Test 1)

__ No concealed faults separating polys with different ptypes (Appendix - Test 2)

__ Check concealed fault validity in units older than Q or T (Appendix - Test 3)

__ No certain faults in Q units (Appendix - Test 4)

__ No certain faults with Q units on both sides (Appendix - Test 5)

__ Confirm null polygons are only associated with the map boundary (Appendix - Test 6)

__ All user defined fields are listed in metadata Entity_and_Attribute_Information

__ All ltypes are listed in metadata Entity_and_Attribute_Information (use summary table)

__ Confirm number of arcs in feature class ____ = number arcs listed in metadata ____

__ All ltype metadata definitions jive with LMU, DMU, and metadata

Label Points (Map Unit)

__ All ptypes are represented in the style (use summary table)

__ No extraneous ptypes are in the style

__ All features are attributed (no null points, they can indicate missing data)

__ Confirm number of points ____ = number of polygons ____

__ All user defined fields are listed in metadata Entity_and_Attribute_Information

__ All ptypes are listed in metadata Entity_and_Attribute_Information (use summary table)

__ Confirm number of points in feature class ____ = number points listed in metadata ____

__ All ptypes (map units) jive with LMU, CMU, DMU, metadata, and polygons

- __ Ensure geologic name changes were incorporated in LMU, CMU, DMU, and metadata
- Optional tool:** LabelPointCheck tool in the Digital Review Toolbox (provided by Joel Robinson, WR)

Map Unit Polygons (required for NCGMP09)

Note: polygons can be made using arcs and label points OR just arcs

- __ All ptypes are represented in the style (use summary table)
- __ No extraneous ptypes are in the style
- __ Make new polygon layer from arcs and points (to ensure polys represent the latest attribution)
- __ All features are attributed (no null polygons, they can indicate missing data)
- __ Confirm number of polygons _____ = number of points _____
- __ No sliver polygons
- __ Check for polygon adjacency problems using an identity layer made in ArcCatalog (see Appendix)
 - __ No invalid internal arcs (certain contacts with same geologic unit on both sides). Exceptions may include, but are not limited to concealed contacts, faults, scarps and levees. (Appendix - Test 1)
 - __ No concealed faults separating polys with different ptypes (Appendix - Test 2)
 - __ Concealed fault validity in units older than Q or T (Appendix - Test 3)
 - __ No certain faults in Q units (Appendix - Test 4)
 - __ No certain faults with Q units on both sides (Appendix - Test 5)
 - __ Confirm null polygons are only associated with the map boundary (Appendix - Test 6)
- Optional tool:** LeftRight tool in Digital Review Toolbox to check for left-right consistency (provided by Joel Robinson, WR)
- __ All user defined fields are listed in metadata Entity_and_Attribute_Information
- __ All ptypes are listed in metadata Entity_and_Attribute_Information (use summary table)
- __ Confirm number of polygons in feature class _____ = number polys listed in metadata _____
- __ All ptypes (map units) jive with LMU, CMU, DMU, metadata, and points
- __ Ensure geologic name changes were incorporated in LMU, CMU, DMU, and metadata

Orientation Points (Bedding, joints)

- __ All ptypes are represented in the style (use summary table)
- __ No extraneous ptypes are in the style
- __ All features are attributed (no null points, they can indicate missing data)
- __ All strike values are between 0-359
- __ All inclined dip values are between 0-90
- __ Other ptypes: strike and dip = 0 (eg. horizontal bedding or foliation)
- __ Vertical features: dips = 90 (eg. vertical joints, bedding or foliation)
- __ All user defined fields are listed in metadata Entity_and_Attribute_Information
- __ All ptypes are listed in metadata Entity_and_Attribute_Information (use summary table)
- __ Confirm number of points in feature class ____ = number points listed in metadata _____
- __ All ptype metadata definitions jive with map explanation

Axial Traces of Folds

- __ All ltypes are represented in the style (use summary table)
- __ No extraneous ltypes are in the style
- __ All features are attributed (no null arcs, they can indicate missing data)
- __ No invalid short arcs (use map scale to determine validity)
- __ Check line directionality (confirm right-hand rule on decorated lines)
- __ Create topology, check for errors
 - __ No un-expected pseudonodes

- _ Create identity layer with polys to check that concealed folds are valid
- _ All user defined fields are listed in metadata Entity_and_Attribute_Information
- _ All arcs are listed in metadata Entity_and_Attribute_Information (use summary table)
- _ Confirm number of arcs in feature class ____ = number arcs listed in metadata ____
- _ All ltype metadata definitions jive with map explanation

Other Line Layers (ie., Dikes, Cross sections, Cartographic layers, leaders, etc.)

Add additional review checks as needed

- _ All ltypes are represented in the style (use summary table)
- _ No extraneous ltypes are in the style
- _ All features are attributed (no null arcs, they can indicate missing data)
- _ No invalid short arcs (use map scale to determine validity)
- _ Check line directionality (confirm right-hand rule on decorated lines)
- _ All user defined fields are listed in metadata Entity_and_Attribute_Information
- _ All ltypes are listed in metadata Entity_and_Attribute_Information (use summary table)
- _ Confirm number of arcs in feature class ____ = number arcs listed in metadata ____
- _ All ltype metadata definitions jive with LMU, DMU, and metadata

Other Point Layers (ie., Karst, Mines, Sample locations, Geochron, Fossils, Stations, etc.)

Add additional review checks as needed

- _ All ptypes are represented in the style (use summary table)
- _ No extraneous ptypes are in the style
- _ All features are attributed (no null points, they can indicate missing data)
- _ All user defined fields are listed in metadata Entity_and_Attribute_Information
- _ All ptypes are listed in metadata Entity_and_Attribute_Information (use summary table)
- _ Confirm number of points in feature class ____ = number points listed in metadata ____
- _ All ptype metadata definitions jive with map explanation

Metadata - general

- _ Print a copy of each metadata report to mark up, reviewer does not make any changes to the database
- _ Does projection info for each map element match coordinate system in ArcCatalog?
- _ Run mp.exe on each metadata file
 - _ Check for errors (ignore altitude errors)
- _ Check for textual completeness and consistency across all metadata reports
 - _ Pick one good report and use it as a comparison tool for all others
 - _ Scan reports top to bottom and make sure all fields used in the good report are present in others
 - _ If other fields are used, are they necessary and/or helpful?
- _ Read the abstract and purpose
 - _ If they are cut and pasted from the report, do they match the final copy?
 - _ If they are unique to metadata, review as a peer reviewer
- _ Check everything for typos
- _ Check for fields cut and pasted from other metadata reports wherein direct reference to prior data may not have been updated
- _ Is free text included in supplemental_information appropriate since this can become a trash can for all kinds of information that has appropriate fields elsewhere

- __ Check bounding coordinates. These fields can show the intended coordinates (38.00), not the exact coordinates (38.0013678652)
- __ Appropriate keywords used?
- __ Correct contact information?
 - __ Author
 - __ Distribution
 - __ Metadata
- __ Data_quality_info should be read closely and checked for appropriateness and accuracy. For example, if z data is included then vertical_positional_accuracy should be included.
- __ Is horizontal_positional_accuracy within reason?
- __ Just using boiler plate text for the attribute accuracy, logical consistency, and completeness reports may miss opportunities to address specific issues with a given dataset.
- __ If a source is cited directly in the metadata document, it should be listed, or if data sources were directly used in the compilation or published programs or processes used, they should also be listed and referenced in the appropriate process steps.
- __ Distribution_info should be checked for the specific map since printing press, print-on-demand, and web only maps can differ.

Annotation

- __ All units are annotated at least once
- __ Annotation labels jive with LMU, CMU, DMU, metadata, points and polygons
- __ FGDCGeoFont symbolizes correctly

LMU Table

- __ All map units jive with those listed on map or in pamphlet

Style

- __ Check for symbols not represented in database
- __ Check for usage of FGDC Cartographic Standard symbols

Base

- __ No need for metadata other than stating 'previously published'
- __ Include link or reference to source
- __ Provide as part of deliverable package if custom base was created

Finalizing the Digital Review

The review process should result in clearly marked copies of the metadata reports, original map product and all the elements, either in paper or electronic/digital format. Make sure that you have used standard editing and proofing marks and that all comments are clear. Good reviews include a summary memorandum that outlines your major findings—remember that positive feedback, tactful criticism, and measured thoughtful comments are the hallmark of a professional review.

Appendix – Polygon Adjacency tests

Check for **polygon adjacency issues** using an identity layer made in ArcCatalog

- In ArcCatalog, Open ArcToolbox
- Select Analysis Tools/Overlay/Identity
- Input Features = arcs
- Identity Features = polygons
- Output Feature Class = xx_arc_Identity
- Check 'Keep relationships'
- OK
- This produces a new arc feature class that contains LEFT/RIGHT polygon PTYPE information across arcs

Test 1 – Internal contacts (arcs tagged as contacts but with the same ptype on both sides)

- Load <_Identity> layer into ArcMap
- Select arcs with same ptype on both sides
 - Selection/Select By Attributes/Layer = _Identity/Method = Create a new selection
 - [LEFT_PTYPE] = [RIGHT_PTYPE]
- Narrow the selection to just those arcs tagged as contacts
 - Selection/Select By Attributes/Layer = _Identity/Method = Select from current selection
 - select for - [LTYPE] LIKE 'contact*'
- Check selection in attribute table
- If needed, save selection as new feature class so you can correct as needed
 - Right click __Identity/Selection/Create Layer from Selected Features

Test 2 – Concealed faults separating polys with different ptypes

- Load <_Identity> layer into ArcMap
- Select fault_concealed arcs
 - Select for [LTYPE] = 'fault_concealed'
 - might need a wildcard (LTYPE LIKE '*_concealed')
- Narrow selection to only arcs with different polys on each side
 - Select from current selection - [LEFT_PTYPE] <> [RIGHT_PTYPE]
- Check selection in attribute table
- If needed, save selection as new feature class so you can correct as needed
 - Right click __Identity/Selection/Create Layer from Selected Features

Test 3 – Confirm concealed fault validity if in unit older than Q or T

- Load <_Identity> layer into ArcMap
- Select fault_concealed arcs

- Select for [LTYPE] = 'fault_concealed'
 - might need a wildcard (LTYPE LIKE '*_concealed')
- Narrow selection to only arcs with same poly on each side
 - Select from current selection - [LEFT_PTYPE] = [RIGHT_PTYPE]
- Open attribute table and sort on [LEFT_PTYPE] or [RIGHT_PTYPE]
- If needed, save selection as new feature class so you can correct as needed
 - Right click __Identity/Selection/Create Layer from Selected Features

Test 4 – Find certain faults in Q units

- Load <_Identity> layer into ArcMap
- Select fault_certain arcs
 - Select for [LTYPE] = 'fault_certain'
 - might need a wildcard (LTYPE LIKE '*_certain')
- Narrow selection to only arcs with adjacent Q unit
 - Select from current selection - [LEFT_PTYPE] LIKE 'Q*' OR [RIGHT_PTYPE] LIKE 'Q*'
- Check selection in attribute table
- If needed, save selection as new feature class so you can correct as needed
 - Right click __Identity/Selection/Create Layer from Selected Features

Test 5 – Find certain faults with Q units on both sides

- Load <_Identity> layer into ArcMap
- Select fault_certain arcs
 - Select for [LTYPE] = 'fault_certain'
 - might need a wildcard (LTYPE LIKE '*_certain')
- Narrow selection to only arcs with adjacent Q units on both sides
 - Select from current selection - [LEFT_PTYPE] LIKE 'Q*' AND [RIGHT_PTYPE] LIKE 'Q*'
- Check selection in attribute table
- If needed, save selection as new feature class so you can correct as needed
 - Right click __Identity/Selection/Create Layer from Selected Features

Test 6 – Confirm null LEFT/RIGHT_PTYPEs are associated only with map boundary

- Load <_Identity> layer into ArcMap
- Open attribute table
- Sort on [LEFT_PTYPE]
- Visually check that [LTYPE] = map boundary for the blank values
- Repeat for [RIGHT_PTYPE]