DIGITAL MAPPING TECHNIQUES 2015

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The contents of this document are provisional

See Presentations and Proceedings
from the DMT Meetings (1997-2015)

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

DGGS Publications Process *for* Geologic Maps

In 2008, the State Geologist established a committee to review the process by which DGGS collects and publishes geologic data and to make recommendations for means to streamline the process. An analysis of time spent completing common tasks showed that DGGS staff was overcommitted with projects and that the time needed to facilitate publication needed to come from streamlining the publications process and by hiring additional support staff (Athey, 2009). In 2010, a technician was hired to manage logistical tasks, such as field safety equipment, and serve as a GIS technician/cartographer. Having a dedicated cartographer to create map layouts and to manage, edit, and QC data saves geologist significant time. Additionally, the DGGS publications process was significantly revised and streamlined. Below is the streamlined publications process.

1. **Pre-publication Meeting**
   - Claifies product
   - Discuss timeline and priority level
   - Organize who needs what from who
2. **Author compleates analytical interpretation and GIS work**
   Authors use NCGMP09 Workflows and coordinate with GIS team for assistance
3. **Author gives NCGMP09 files to Cartographer and manuscript to Publications Specialist for editing**
   Map Sheet Checklist assures nothing is missed
4A. **Publications Specialist completes first edit of text**
4B. **Cartographer creates preliminary layout**
   Checks for topological errors, NCGMP09 and FGDC compliance
5. **Section Chief approves text and preliminary map sheet, makes comments**
   Author updates manuscript
6. **Author makes corrections based on edits from Publications Specialist and Section Chief**
   Cartographer updates map sheet to include corrections
7. **Map is sent to peer review, Reviewers make comments**
   Reviewers are given a month to make comments
8. **Author addresses comments and corrections from Reviewers**
   Author accepts corrections or justifies not doing them
9. **Publications Specialist completes second edit of text and map**
10. **Corrections are made**
    Author updates manuscript
    Cartographer updates map sheet to include corrections
11. **Final comments from Author, Section Chief, Publications Specialist, and Division Director**
12. **Final corrections are made**
    Author updates manuscript
    Cartographer updates map sheet to include corrections
13. **Publication number is assigned and added to map sheet**
    QR code is generated and added if necessary
14. **PDF version of map sheet is published**
15. **Map Package is create or geodatabase is converted to shapefiles for release**
16. **Metadata is completed by Metadata Manager with input from Author**
17. **Final Digital Data Distribution (D3) package is reviewed and approved**
18. **Final D3 package is released**
    DONE!

References

Athey, Jennifer, 2009, Shepherding Geologic Data from the Outcrop to Publication (and Beyond?), in Soller, D.R., ed., 2011, Digital Mapping Techniques '09 — Workshop Proceedings, Morgantown, West Virginia, May 10–13, 2009: U.S. Geological Survey Open-File Report 2010–1335, 260 p. http://pubs.usgs.gov/of/2010/1335/

Converting Non-NCGMP09 data

It is often necessary to convert existing data to NCGMP09 format. I am often given a heap of shapefiles and asked to recreate a map that was completed in a drawing program like Adobe Illustrator. Using a few tools, some elbow grease, and a lot of teleconferences with project geologists, a basic workflow has evolved.

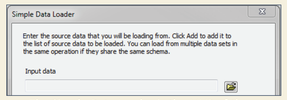
1. Determine what shapefiles need to be loaded into which NCGMP09 feature class. For example, often faults and contacts are separate shapefiles, but can be combined into one NCGMP09 feature class.
2. Determine what fields (if any) you want to preserve in your NCGMP09 feature class. Make sure that the important fields aren't null (for example, Map Unit can not have null values). Loading only the geometry is OK – such as in the example at right.
3. Use the Simple Data Loader (right click NCGMP09 feature class --> Load --> Load Data) to load the data into the desired feature class.
4. Attribute the NCGMP09 fields using whatever information you have. Often, the symbol on a map sheet is the only information you have to go on. But, most things can be inferred at the very least. For example solid line = certain confidence level. Editing tools, the field calculator and advanced slection will help things progress faster.
5. Communication is key! Keep an open dialog with project geologists and ask if there is something that doesn't look right. Sometimes data needs to be "bounced back" to project geologists so they can fill in the appropriate fields.

Table

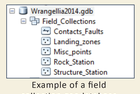
LINES_5_2_14_LSG_DPS

FID	Shape *	LEFT_FID	RIGHT_FID
0	Polyline	-1	14
1	Polyline	-1	9
2	Polyline	-1	10
3	Polyline	-1	0
4	Polyline	14	0
5	Polyline	-1	0

An example of a cryptic shapefile waiting to be converted

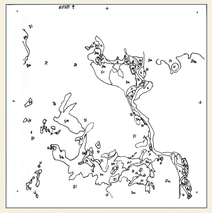


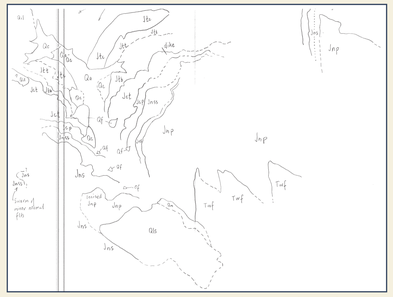
The Simple Data Loader is the MVP of the converstion workflow



Example of a field collection geodatabase

The Eternal Question: Digitize Polygons or Lines first?





In the basic workflow outlined in phase 3, polygons are the primary feature digitized first. This works well in situations where there is a fairly reasonable knowledge of where units will be drawn. The Engineering Section at DGGS, which uses a lot of imagery during the map making process, almost always digitizes polygons first. This works particularly well in situations where a senior geologist has drawn specific geologic units onto an air photo overlay, which is georeferenced for digitizing (as in the example above left). In this sort of situation, where units are pre-defined and known, an intern or junior geologist can use feature templates with default values to quickly digitize into the NCGMP09 format. Additionally, the overall workflow is simplified when polygons are converted to lines. In the case of air photo interpreted contacts, all lines will share the same attributes and symbol and the values can be quickly populated using the Field Calculator.

In other cases (such as the example above right), there are significant gaps in the interpretation of the scanned field map. Additionally, there are many types of line symbols that will need to be generated. In this example, digitizing lines first (perhaps with only the FGDC symbol populated) would be the best option. Digitizing lines first can also simplify things because when a modification needs to be made, you do not have to worry as much about gaps and overlaps, especially if you are using Snapping.

Phase 4 - Revisions and Review

DGGS publications undergo a thorough review process (see DGGS Publications Process for Geologic Maps section). During this process, project co-authors look at and revise the interpretation before the polished NCGMP09 geodatabase is handed off to the cartographer. The Cartographer produces a map layout that conforms to FGDC standards before the map is seen by external reviewers. Doing so ensures that reviewers see a clean and thoughtful product. After scientific review is completed and corrections are made, the map (and text) get another review from the Publications Specialist, Section Chief, and Division director. The final step is compiling metadata, which is greatly streamlined due thanks to the NCGMP09 format.

NCGMP09 Workflows

There is no standard or perfect workflow for creating new data in the NCGMP09 format. Typically, the process of creating and publishing a geologic map has four basic phases – Pre-field Work; Field Work and Data Collection; Office GIS Work and Interpretation/Analysis; and the Revisions/Review phase. Each phase has its own basic workflow and challenges.

Workflow Phases:
1. Pre-feild Work
2. Field Work and Data Collection
3. Office GIS Work and Interpretation/Analysis
4. Revisions and Review

Phase 1 - Pre-field Work

During this phase, geologists compile literature and previous map products of the chosen or proposed area. Air photos, satellite imagery, and appropriate base maps are also gathered. Preliminary interpretation of air photos and imagery may be done if time permits. Field Logistics and contracts are organized and acquired.

Before people go out into the field, they are encouraged to create a blank NCGMP09 geodatabase. Currently we use the 10.1 script tool available from the NCGMP09 website. In the future, we will have a DGGS specific "master template" of an empty NCGMP09 geodatabase that has domain values and pick lists available. It will be much simpler for geologists to copy and paste this master template rather than have to run the script tool themselves. This empty geodatabase gives geologists an opportunity to look at the standard design and think about what information they need to collect – such as location confidence in meters. They are also encouraged to think about how to integrate NCGMP09 required fields into what they already collect.

Phase 2 - Field Work and Data Collection

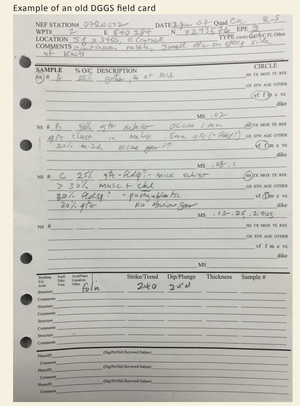
The methods geologists use to collect data while in the field have undergone many changes in the last few years. This past field season, geologists from the minerals section used Trimble Juno T41/5 handheld computers to aid in data collection. The Juno runs ArcGIS for Mobile with a custom geodatabase was designed for collection of field data. This field geodatabase is intended to gather information analogous to the old DGGS field cards. It is important to note that the field geodatabase does not include any NCGMP09 fields. It is the general consensus of DGGS geologists that the NCGMP09 format is better suited to hold the final interpretation of the map, rather than the raw data itself.

The field collection geodatabase is unique to each project and contains 5 feature classes. Rock_Station and Structure_Station are primarily used. Data from each individual Juno is downloaded and synced to the other devices nightly. Although some lines can be drawn using the Juno devices, it was found to be problematic during the nightly syncing.

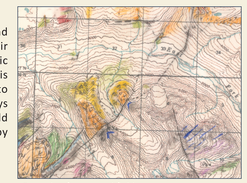
The 71 fields in the Rock_Station feature class

OBJECTID *	Texture_1	Min_4_pct	MOX	PIC4
SHAPE *	Texture_2	Min_texture_4	GX	GlobalID *
Date	Grainsize_Lower	Mineralization_style	XRF	UTM_N_NAD27
Geologist	Grainsize_Upper	Alteration_style	HXRF	UTM_E_NAD27
Station *	Mineral_1	Rock_notes	Ar_Ar	LAT_WGS84
OC_type	Min_1_pct	Rock_notes2	DZ	LONG_WGS84
Station_notes	Min_texture_1	Rock_type	U_Pb	MapUnit_Final
Mag_min	Mineral_2	Rock_mod	Stain	Pic_Hyperlink
Mag_max	Min_2_pct	OC_pct	Fossil	MapUnit_Symbol
Mag_avg	Min_texture_2	MapUnit_field	PGE	Age
Meter_ID	Mineral_3	Samp_method	REE	Integrated_Age
Rock_color	Min_3_pct	Hand_sample	Geoph_properties	comments
Weathering	Min_texture_3	Thin_section	PIC1	
Rock_form	Mineral_4	Polished_thin_section	PIC2	
Rock_structure	Min_4_pct	Oriented_thin_section	PIC3	

Example of an old DGGS field card



While in the field, geologists spend time each night drawing their traverse and preliminary geologic interpretation on a field map. This consists of using colored pencils to draw on a mylar sheet that overlays the USGS topo of the area. The field map stays in camp and is shared by all geologists.



Example of a scanned field map

Phase 3 - Office GIS Work and Interpretation/Analysis

When everyone is back in the office and the dust settles, the major GIS work begins. This is the phase that has the most variation in workflow depending on what data were collected or available. Workflows can also vary based on personal preference or to suit the needs of each individual project.

1. Assemble data
- a. Export data from Juno devices to a geodatabase
  - DGGS created a custom script to pull data off of the Juno devices and put it into a file geodatabase
- b. Convert geodatabase to an excel spreadsheet
  - This spreadsheet is then divided by the Geologist field and distributed to the author who took the data point. Then, the geologist corrects any spelling or grammar mistakes and writes out any personal abbreviations. Geologists are asked to NOT change any of their interpretations at this time.
- c. Combine corrected excel data
  - When the individual geologists have finished their corrections, the data is merged back into one excel sheet. From this, various fields are concatenated to form a short station description. This is used later to help identify potential map units.
  - Although some fields are concatenated into a station description, the original fields stay intact to facilitate querying later. This becomes the final corrected spreadsheet.
- d. Convert the final corrected excel sheet to a geodatabase
  - This geodatabase is shared as a read-only copy for multiple geologists to view and query while compiling their interpretations.
  - This geodatabase is updated for specific stations as more accurate information is gathered such as results from geochemistry analysis, thin section petrography, age dating or fossil analysis.
- e. Scan and georeference the mylar field map

2. Digitizing and interpreting
- a. The interpretation that will later be turned into the final map is put into the blank NCGMP09 geodatabase that was created during the pre-field work phase.
- b. The read-only geodatabase containing rock stations and structure stations are laid on top of the scanned mylar field map in ArcMap. Topographic base maps, air photos, satellite imagery, or geophysical images may also be used.
- c. Major faults and folds are digitized using the mylar field map as a general guide
  - Minor faults and folds can be added later in the process
- d. Polygons are digitized using the mylar field map and rock stations for reference
  - A "working" color scheme is used until standard FGDC colors are chosen later on
  - Create Feature templates are used during this step, but only the field for MapUnit is filled in during this time because the designated map unit is often a "moving target" and may change one or more times during the interpretation process.
- e. A Geodatabase Topology is created to make sure there are no gaps or overlaps in the polygon featureclass
  - Editing using the topology tools in encouraged
- f. Create Contact Lines
  - The Polygon to Line (Data Management) tool is used to convert the polygons to lines. The tool creates an intermediate featureclass which is then loaded into the NCGMP09 ContactsAndFaults feature class.
  - Once created, the contact lines are split and attributed into confidence classes. LocationConfidenceMeters is often derived from the lines proximity to a rock station or by using the mylar map.
  - Some people prefer to choose the FGDC symbol number and then populate the attributes associated with that symbol. Other people like to populate the attributes, then look up the required symbol.
- g. Orientation Points are loaded into the NCGMP09 from the read-only field geodatabase
  - Points are given the proper FGDC symbol and rotated properly
  - Watch out for measurements that were taken using dip direction!
  - In the case of multiple structure measurements taken at one station, the project manager (with input from field geologists) determines which measurements will be shown on the final map. The PlotAtScale field is populated at this time.
- h. Complete other NCGMP09 feature classes
  - This varies greatly depending on the project
- i. Modify the Geodatabase Topology to include:
  - Polygons must not have gaps or overlap
  - Edges of polygons must have a line overlapping them
  - Lines must not have dangles – except where made an exception
  - Lines must not overlap

3. Create cross sections and correlation of map units
- Both can be done using ArcMap

4. Verify all required NCGMP09 fields are filled in properly. Delete feature classes that are empty.

5. Complete Map Sheet Checklist and Color and Pattern Plan

6. Hand everything over to the Cartographer for the initial layout

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