

Creation of Digital Geologic Data for Pecos National Historical Park

By Andrea Croskrey and Georgia Hybels

National Park Service, Geologic Resources Division
P.O. Box 25287
Denver, CO 80225
Telephone: (303) 969-2148 and (303) 969-2173
Fax: (303) 987-6792
email: andrea_croskrey@nps.gov, georgia_hybels@nps.gov

GEOLOGIC RESOURCES INVENTORY

The Geologic Resources Inventory (GRI) is one of 12 natural resource inventory efforts within the National Park Service (NPS) Inventory and Monitoring Program. The GRI aims to raise awareness about geology and the role geologic features and processes play in the environment. The Inventory and Monitoring Program serves natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel.

The GRI team, working closely with the Colorado State University Earth Science Department and a variety of other partners, provides each of the 270 natural area parks with a geologic scoping meeting, digital geologic map data, and park specific geologic report. These products are designed to enhance stewardship of park resources by providing valuable information about geologic formations, hazards, and links between geology and other natural resources.

The digital geologic maps prepared for the GRI reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps may be used by the GRI as sources of information to create digital data in order to meet a Park's specific needs and assist with resource management issues. As of May, 2009, the GRI program has scoped 234 parks, completed digital datasets for 143, and has written reports for 50. All the GRI products are available on the GRI products web site (http://www.nature.nps.gov/geology/inventory/gre_publications). Digital geologic maps are posted on the NPS Data Store (<http://science.nature.nps.gov/nrdata>).

This paper describes our methods for processing the geologic map information for a Park, and producing the various products needed. Methodologies are summarized in Figure 1.

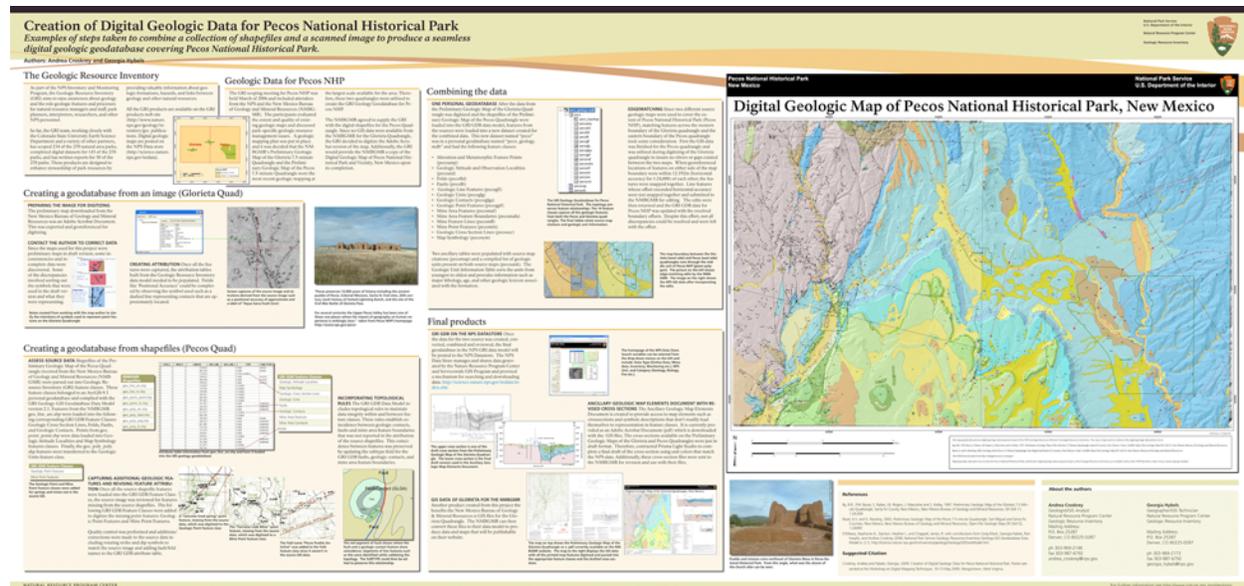


Figure 1. Creation of digital geologic data for Pecos National Historical Park (a full-resolution copy of this figure is available at http://ngmdb.usgs.gov/Info/dmt/docs/DMT09_Croskrey.pdf).

ACQUIRING GEOLOGIC DATA FOR PECOS NATIONAL HISTORICAL PARK

The GRI Scoping meeting for Pecos National Historical Park (NHP) was held in March 2006, and included attendees from the NPS and the New Mexico Bureau of Geology and Mineral Resources (NMBGMR). The participants evaluated the extent and quality of existing geologic maps and discussed park-specific geologic resource management issues. Participants agreed that the NMBGMR's Preliminary Geologic Map of the Glorieta 7.5-minute Quadrangle (Ilg and others, 1997) and the Preliminary Geologic Map of the Pecos 7.5-minute Quadrangle (Read and Rawling, 2002) provided the most recent geologic mapping at the largest scale available for the area. Accordingly, these two quadrangles were utilized to create the GRI Geology Geodatabase for Pecos NHP. The NMBGMR agreed to supply the GRI with the digital shapefiles for the Pecos Quadrangle. Since no GIS data were available for the Glorieta Quadrangle, the GRI decided to digitize it, using the Adobe Acrobat version of the map. Additionally, the GRI agreed to provide the NMBGMR with a copy of the Digital Geologic Map of Pecos National Historical Park and Vicinity, New Mexico upon its completion.

DIGITIZING GEOLOGIC DATA FOR THE GLORIETA 7.5' QUADRANGLE

The preliminary map downloaded from the New Mexico Bureau of Geology and Mineral Resources was an Adobe Acrobat Document (Ilg and others, 1997). This map was exported and georeferenced for digitizing in ESRI ArcMap. The maps used for this project were preliminary maps in draft version, consequently some inconsistencies and incomplete data were discovered. Some of the discrepancies involved incomplete map boundaries, inconclusive map labels, and difficult-to-read symbology that lacked a symbol key with definitions.

Once all the features were captured, the attribution tables built from the GRI Geology-GIS Geodatabase Data Model version 2.1 were populated with information from the map. Fields, such as 'Positional Accuracy', were attributed by interpreting the symbols used on the source image and the description of that symbol in the legend; such as a dashed line representing contacts that are approximately located. Other line types represented on the source image and attributed in the table included: known or certain, concealed, inferred, approximate and queried, quadrangle boundary, and water or shoreline.

CONVERTING DIGITAL GEOLOGIC DATA FOR THE PECOS 7.5' QUADRANGLE

Assess Source Data

Shapefiles of the Preliminary Geologic Map of the Pecos Quadrangle received from the NMBGMR were parsed out into GRI feature classes. These feature classes were in an ArcGIS 9.3 personal geodatabase, and complied with the GRI Geology-GIS Geodatabase Data Model version 2.1 (O'Meara and others, 2008). Geologic line features from the NMBGMR `geo_line_arc.shp` were loaded into the following corresponding GRI Geodatabase Feature Classes: Geologic Cross Section Lines, Folds, Faults, and Geologic Contacts. Point data from `geo_point_point.shp` were loaded into Geologic Attitude Localities and Map Symbology features classes. Finally, the `geo_poly_poly.shp` features were transferred to the Geologic Units feature class.

Capturing Additional Geologic Features and Revising Feature Attribution

Once all the source shapefile features were loaded into the GRI Geodatabase feature classes, the source image (Read and Rawling, 2002) was reviewed in order to identify any features present on the source image but missing from the source shapefiles. Geologic Point Features (`gpf`) and Mine Point Features (`min`) then were added to the geodatabase, and missing point features were digitized into these feature classes. Quality control was performed and additions/corrections were made to the source data, including the rotation of strike and dip symbols to match the source image and addition of fault and fold names to the GRI Geodatabase attribute table.

Incorporating Topological Rules

The GRI Geodatabase Data Model includes topological rules designed to maintain data integrity within and between feature classes (O'Meara and others, 2008). These rules establish coincidence between geologic contacts, faults, and mine area feature boundaries that were not reported in the attribution tables of the source shapefiles. This coincidence between features was preserved by updating the subtype field for the GRI GDB faults, geologic contacts, and mine area feature boundaries.

COMBINING THE DATA FROM THE QUADRANGLES

One Personal Geodatabase

After the data from the Preliminary Geologic Map of the Glorieta Quadrangle was digitized and the shapefiles of the Preliminary Geologic Map of the Pecos Quadrangle were loaded into the GRI GDB data model, features from the sources were loaded into a new dataset created for the combined data. This new personal geodatabase named "peco_geology.mdb" contains the following feature classes: Alteration and Metamorphic Feature Points (pecoamp), Geologic Attitude and Observation Localities (pecoatd), Folds (pecofld), Faults (pecoflt), Geologic Line Features (pecoglf), Geologic Units (pecoglg), Geologic Contacts (pecoglgc), Geologic Point Features (pecogpf), Mine Area Features (pecomaf), Mine Area Feature Boundaries (pecomafa), Mine Feature Lines (pecomfl), Mine Point Features (pecomin), Geologic Cross Section Lines (pecosec), and Map Symbology (pecosym).

Two ancillary tables were populated with source map citations (pecomap) and a compiled list of geologic units present on both source maps (pecounit). The Geologic Unit Information Table (pecounit) sorts the units from youngest to oldest, and provides information associated with each formation such as major lithology, age ranges, and geologic keywords.

Edge-matching

Since two different source geologic maps were used for Pecos NHP, the matching of features across the western boundary of the Glorieta quadrangle and the eastern boundary of the Pecos quadrangle required some consideration. First, the GIS data were finalized for the Pecos quadrangle, and then were utilized while digitizing the Glorieta quadrangle in order to ensure that no slivers or gaps were created between the two maps during the digitizing process. When georeferenced locations of features on either side of the map boundary were within 12.192 m (U.S. National Map Accuracy Standards for 1:24,000 scale) of each other, the features were snapped together. Line features whose offset exceeded this horizontal accuracy were not snapped together; they were instead submitted to the NMBGMR for editing. When the edits were returned to us, the peco_geology.mdb for Pecos NHP was updated with the resolved boundary offsets. Despite this effort, not all discrepancies could be resolved, and some offsets remain. This was the case for some Quaternary deposits that were subdivided on the Pecos quadrangle but lumped on the Glorieta quadrangle.

FINAL PRODUCTS

GRI GDB in the NPS Data Store

When the combined data from the two sources has been reviewed, the final geodatabase will be posted to the NPS Data Store. The NPS Data Store manages and shares data generated by the Natural Resource Program Center and Servicewide GIS Program, and provides a publicly accessible mechanism for searching and downloading data (<http://science.nature.nps.gov/nrdata/index.cfm>).

Ancillary Geologic Map Elements Document with Revised Cross Sections

The Ancillary Geologic Map Elements Document provides access to map elements such as cross sections and symbol descriptions that don't readily lend themselves to representation in feature classes. It's currently provided as an Adobe Acrobat Document (pdf) downloadable with the GIS files. The cross sections, available on the Preliminary Geologic Maps of the Glorieta and Pecos Quadrangles, were in draft format (Ilg and others, 1997; Read and Rawling, 2002). The GRI contracted with Prisma Light Studio to complete a final draft of the cross section using geologic unit colors that match the NPS data. Additionally, these cross section files were sent to the NMBGMR for revision and use in their projects.

GIS Data of Glorieta for the NMBGMR

Another product created from this project that benefits the New Mexico Bureau of Geology and Mineral Resources is the GIS files for the Glorieta Quadrangle. The NMBGMR can convert these files to their data model, to produce data and maps that will be publishable on their website.

REFERENCES

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