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The contents are provisional and will be
superseded by a paper in the
DMT'09 Proceedings.

See also earlier Proceedings (1997-2008)
<http://ngmdb.usgs.gov/info/dmt/>

Creation of Digital Geologic Data for Pecos National Historical Park

Examples of steps taken to combine a collection of shapefiles and a scanned image to produce a seamless digital geologic geodatabase covering Pecos National Historical Park.

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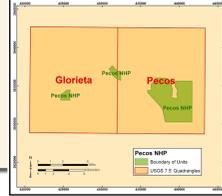
The Geologic Resource Inventory

As part of the NPS Inventory and Monitoring Program, the Geologic Resource Inventory (GRI) aims to raise awareness about geology and the role geologic features and processes for natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel.

So far, the GRI team, working closely with the Colorado State University Earth Science Department and a variety of other partners, has scoped 234 of the 270 natural area parks, completed digital datasets for 143 of the 270 parks, and has written reports for 50 of the 270 parks. 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.

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/nrd>).



Geologic Data for Pecos NHP

The GRI scoping meeting for Pecos NHP was held March of 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. A geologic mapping plan was put in place and it was decided that the NMBGMR's Preliminary Geologic Map of the Gloriaeta 7.5-minute Quadrangle and the Preliminary Geologic Map of the Pecos 7.5-minute Quadrangle were the most recent geologic mapping at

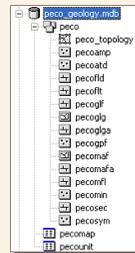
the largest scale available for the area. Therefore, these two quadrangles were utilized to create the GRI Geology Geodatabase for Pecos NHP.

The NMBGMR agreed to supply the GRI with the digital shapefiles for the Pecos Quadrangle. Since no GIS data were available from the NMBGMR for the Gloriaeta Quadrangle, the GRI decided to digitize the Adobe Acrobat version of the map. Additionally, the GRI would provide the NMBGMR a copy of the Digital Geologic Map of Pecos National Historical Park and Vicinity, New Mexico upon its completion.

Combining the data

ONE PERSONAL GEODATABASE After the data from the Preliminary Geologic Map of the Gloriaeta 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 dataset named "peco" was in a personal geodatabase named "peco_geology.mdb" and had the following feature classes:

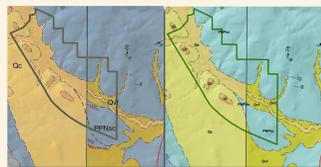
- Alteration and Metamorphic Feature Points (pecoamp)
- Geologic Attitude and Observation Localities (pecoatd)
- Folds (pecofld)
- Faults (pecoflt)
- Geologic Line Features (pecoglf)
- Geologic Units (pecoglg)
- Geologic Contacts (pecoglc)
- Geologic Point Features (pecogpf)
- Mine Area Features (pecomaf)
- Mine Area Feature Boundaries (pecomafa)
- Mine Feature Lines (pecomfl)
- Mine Point Features (pecomin)
- Geologic Cross Section Lines (pecosec)
- Map Symbology (pecosym)



The GRI Geology Geodatabase for Pecos National Historical Park. The topology preserves feature relationships. The 14 feature classes capture all the geologic features from both the Pecos and Gloriaeta quadrangles. The final tables retain source map citations and geologic unit information.

EDGEMATCHING Since two different source geologic maps were used to cover the extent of Pecos National Historical Park (Pecos NHP), matching features across the western boundary of the Gloriaeta quadrangle and the eastern boundary of the Pecos quadrangle took some consideration. First the GIS data was finished for the Pecos quadrangle and was utilized during digitizing of the Gloriaeta quadrangle to insure no slivers or gaps existed between the two maps. When georeferenced locations of features on either side of the map boundary were within 12.192m (horizontal accuracy for 1:24,000) of each other, the features were snapped together. Line features whose offset exceeded horizontal accuracy were not snapped together and submitted to the NMBGMR for editing. The edits were then returned and the GRI GDB data for Pecos NHP was updated with the resolved boundary offsets. Despite this effort, not all discrepancies could be resolved and were left with the offset.

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 sorts the units from youngest to oldest and provides information such as major lithology, age, and other geologic lexicon associated with the formation.



The map boundary between the Gloriaeta (west side) and Pecos (east side) quadrangles runs through the middle unit of Pecos NHP (green polygon). The picture on the left shows edge-matching edits by the NMBGMR. The image on the right shows the NPS GIS data after incorporating the edits.

Creating a geodatabase from an image (Glorieta Quad)

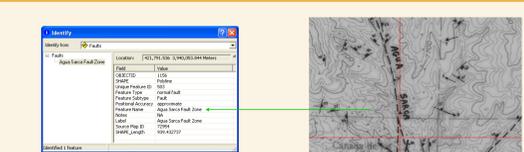
PREPARING THE IMAGE FOR DIGITIZING

The preliminary map downloaded from the New Mexico Bureau of Geology and Mineral Resources was an Adobe Acrobat Document. This was exported and georeferenced for digitizing.

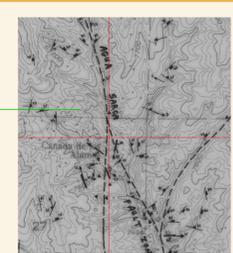
CONTACT THE AUTHOR TO CORRECT DATA

Since the maps used for this project were preliminary maps in draft version, some inconsistencies and incomplete data were discovered. Some of the discrepancies involved sorting out the symbols that were used in the draft version and what they were representing.

Notes created from working with the map author to clarify the intentions of symbols used to represent point features on the Gloriaeta Quadrangle



CREATING ATTRIBUTION Once all the features were captured, the attribution tables built from the Geologic Resource Inventory data model needed to be populated. Fields like "Positional Accuracy" could be completed by observing the symbol used such as a dashed line representing contacts that are approximately located.



Screen captures of the source image and attributions derived from the source image such as a positional accuracy of approximate and a label of "Aqua Sarca Fault Zone".



"Pecos preserves 12,000 years of history including the ancient pueblo of Pecos, Colonial Missions, Santa Fe Trail sites, 20th century ranch history of Forked Lightning Ranch, and the site of the Civil War Battle of Gloriaeta Pass."

For several centuries the Upper Pecos Valley has been one of those rare places where the impact of geography on human experience is strikingly clear." taken from Pecos NHP's homepage: <http://www.nps.gov/peco/>

Creating a geodatabase from shapefiles (Pecos Quad)

ASSESS SOURCE DATA Shapefiles of the Preliminary Geologic Map of the Pecos Quadrangle received from the New Mexico Bureau of Geology and Mineral Resources (NMBGMR) were parsed out into Geologic Resource Inventory (GRI) feature classes. These feature classes belonged to an ArcGIS 9.3 personal geodatabase and compiled with the GRI Geology-GIS Geodatabase Data Model version 2.1. Features from the NMBGMR geo_line_arc.shp were loaded into the following corresponding GRI GDB Feature Classes: Geologic Cross Section Lines, Folds, Faults, and Geologic Contacts. Points from geo_point_point.shp were data loaded into Geologic Attitude Localities and Map Symbology feature classes. Finally, the geo_poly_poly.shp features were transferred to the Geologic Units feature class.

GRI GDB Feature Classes

- Geologic Point Features
- Mine Point Features

The Geologic Point and Mine Point Feature classes were added for springs and mines not in the source GIS.

CAPTURING ADDITIONAL GEOLOGIC FEATURES AND REVISING FEATURE ATTRIBUTION Once all the source shapefile features were loaded into the GRI GDB Feature Classes, the source image was reviewed for features missing from the source shapefiles. The following GRI GDB Feature Classes were added to digitize the missing point features: Geologic Point Features and Mine Point Features.

Quality control was performed and additions/corrections were made to the source data including rotating strike and dip symbols to match the source image and adding fault/fold names to the GRI GDB attribute table.

LPOLY	RPOLY	LENGTH	GEO_LINE	GEO_LINE_I	TYPE	FAULTTYPE
0	0	214.43	10	0	fault	normal
0	0	121.36	11	0	cross section	
0	0	104.43	12	0	fault	normal
0	0	369.30	14	0	fault	normal
0	0	109.82	15	0	fault	normal
0	0	114.90	16	0	contact	
0	0	152.84	17	0	contact	
0	0	109.56	18	0	contact	
0	0	268.44	19	0	contact	
0	0	269.76	20	0	contact	
0	0	327.98	21	0	contact	
0	0	197.36	22	0	fault	undefault
0	0	222.22	23	0	undefault	
0	0	269.27	24	0	fault	undefault
0	0	912.79	25	0	contact	
0	0	696.10	26	0	contact	
0	0	169.36	27	0	fault	normal
0	0	269.54	28	0	fault	undefault
0	0	61.19	29	0	fault	undefault
0	0	719.76	30	0	fault	undefault
0	0	131.87	31	0	fault	undefault
0	0	269.81	32	0	fault	undefault
0	0	109.36	33	0	contact	
0	0	222.98	34	0	undefault	
0	0	78.27	35	0	fault	undefault
0	0	31.87	36	0	undefault	
0	0	185.74	37	0	undefault	

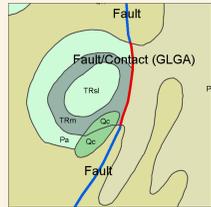
Attribute table information from geo_line_arc.shp and how it loaded into the GRI geology geodatabase

- GRI GDB Feature Classes
- Geologic Attitude Localities
- Map Symbology
- Geologic Cross Section Lines
- Geologic Units
- Faults
- Geologic Contacts
- Mine Area Features
- Mine Area Contact
- Folds

INCORPORATING TOPOLOGICAL RULES The GRI GDB Data Model includes topological rules to maintain data integrity within and between feature classes. These rules establish coincidence between geologic contacts, faults and mine area feature boundaries that was not reported in the attribution 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.



The fold name "Pecos Pueblo Anticline" was added to the Fold feature class since it weren't in the source GIS data.



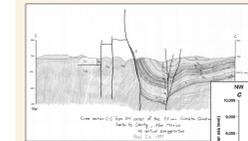
The red segment of fault shows where the fault and a geologic contact feature share coincidence. Segments of line features such as this were identified while validating the topology. The SUBTYPE could then be edited to preserve this relationship.

Final products

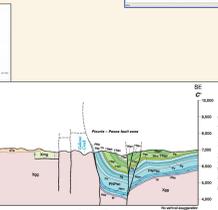
GRI GDB ON THE NPS DATASTORE Once the data for the two source was created, converted, combined and reviewed, the final geodatabase in the NPS GRI data model will be posted to the NPS Datastore. The NPS Data Store manages and shares data generated by the Nature Resource Program Center and Servicewide GIS Program and provided a mechanism for searching and downloading data. <http://science.nature.nps.gov/nrd/data/index.cfm>



The homepage of the NPS Data Store. Search variables can be selected from the drop down menus on the left and include: Data Type (Online Data, Metadata, Inventory, Monitoring etc.), NPS Unit, and Category (Geology, Biology, Fire etc.).

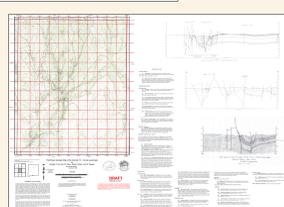


The upper cross section is one of the draft cross section from the Preliminary Geologic Map of the Gloriaeta Quadrangle. The lower cross section is the final draft version used in the Ancillary Geologic Map Elements Document.



ANCILLARY GEOLOGIC MAP ELEMENTS DOCUMENT WITH REVISED CROSS SECTIONS The Ancillary Geologic Map Elements Document is created to provide access to map elements such as crosssections and symbole descriptions that don't readily lead themselves to representation in feature classes. It is currently provided as an Adobe Acrobat Document (pdf) which is downloaded with the GIS files. The cross sections available on the Preliminary Geologic Maps of the Gloriaeta and Pecos Quadrangles were just in draft format. Therefore, contracted Prisma Light Studio to complete a final draft of the cross section using unit colors that match the NPS data. Additionally, these cross section files were sent to the NMBGMR for revision and use with their files.

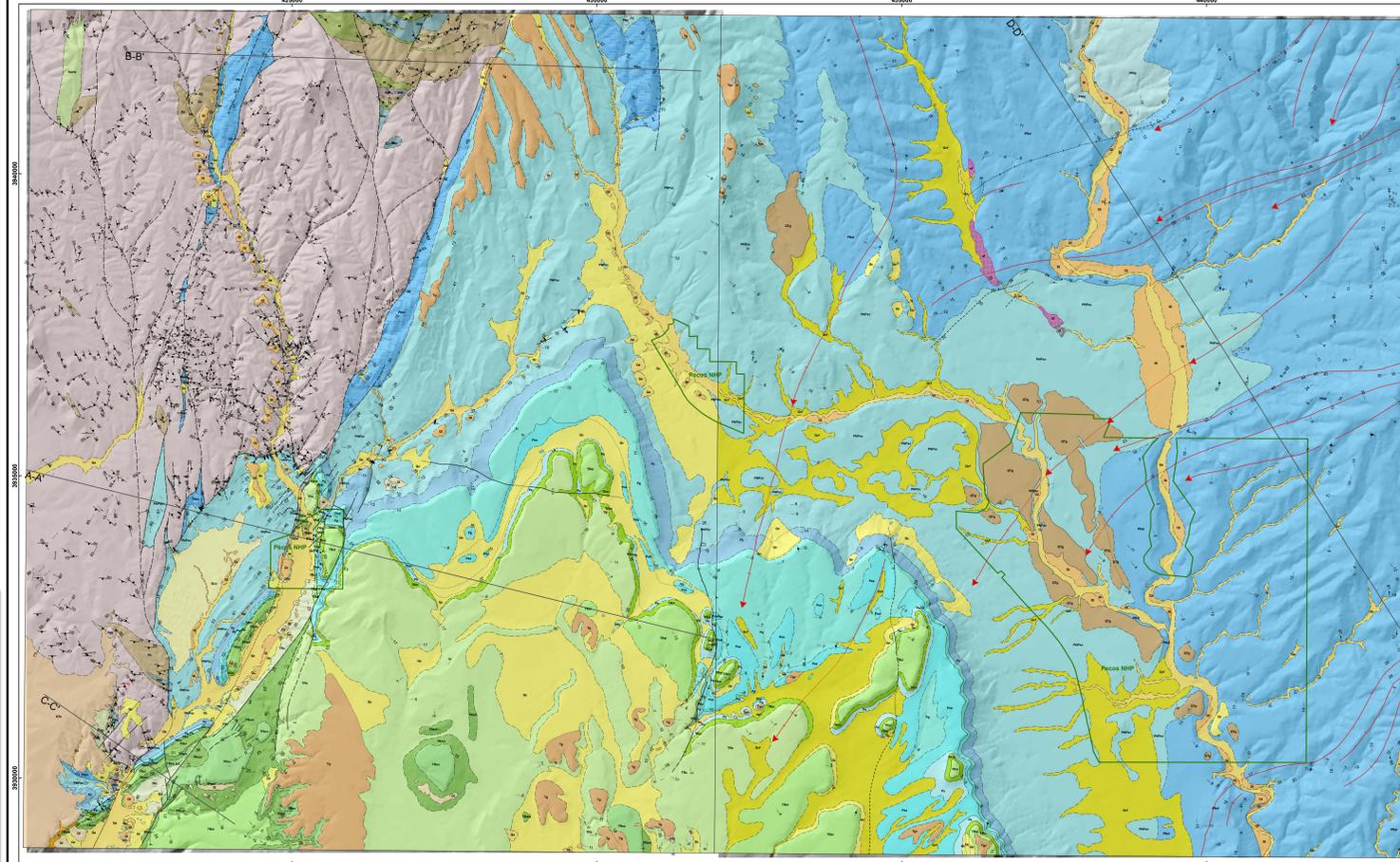
GIS DATA OF GLORIETA FOR THE NMBGMR Another product created from this project benefits the New Mexico Bureau of Geology & Mineral Resources is GIS files for the Gloriaeta Quadrangle. The NMBGMR can then convert these files to their data model to produce data and maps that will be publishable on their website.



The map on top shows the Preliminary Geologic Map of the Gloriaeta Quadrangle as a .pdf currently available on the NMBGMR website. The map to the right displays the GIS data with all the printed map features digitized and parsed into the appropriate feature classes and the drafted cross sections.

Pecos National Historical Park New Mexico

Digital Geologic Map of Pecos National Historical Park, New Mexico



This map graphically presents digital geologic data prepared as part of the NPS Geologic Resources Division's Geologic Resource Inventory. The source maps used in creation of the digital geologic data product were: Ilig, B.R., P.W. Bauer, S. Ralser, J.B. Rogers, J. Marcoline and S. Kelley, 1997, Preliminary Geologic Map of the Gloriaeta 7.5 Minute Quadrangle, Santa Fe County, New Mexico, Scale 1:24,000. Open-File Geologic Map OF-GM 11, New Mexico Bureau of Geology and Mineral Resources. Read, A. and G. Rawling, 2002, Geologic of the Pecos 7.5 Minute Quadrangle, San Miguel and Santa Fe Counties, New Mexico, Scale 1:24,000. Open-File Geologic Map OF-GM 52, New Mexico Bureau of Geology and Mineral Resources. (The DEM downloaded from <http://dmapgis.nps.gov/>) Digital geologic data and cross sections for Pecos National Historical Park, and all other digital geologic data prepared as part of the Geologic Resource Inventory are available online at the NPS Data Store: <http://science.nature.nps.gov/nrd/>

References

- Ilig, B.R., P.W. Bauer, S. Ralser, J.B. Rogers, J. Marcoline and S. Kelley, 1997, Preliminary Geologic Map of the Gloriaeta 7.5 Minute Quadrangle, Santa Fe County, New Mexico, New Mexico Bureau of Geology and Mineral Resources, OF-GM 11, 1:24,000
- Read, A.S. and G. Rawling, 2002, Preliminary Geologic Map of the Pecos 7.5 minute Quadrangle, San Miguel and Santa Fe Counties, New Mexico, New Mexico Bureau of Geology and Mineral Resources, Open-File Geologic Map OF-GM 52, 1:24,000
- O'Meara, Stephanie A., Stanton, Heather L., and Chappell, James, R., with contributions from Greg Mack, Georgia Hybels, Ron Karpilo, and Andrea Croskrey, 2008, National Park Service Geologic Resources Inventory Geology-GIS Geodatabase Data Model (v. 2.1), <http://science.nature.nps.gov/inventory/geology/GeologyGISDataModel.htm>

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