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The contents are provisional and will be
superseded by a paper in the
DMT'13 Proceedings.

See also earlier Proceedings (1997-2012)
http://ngmdb.usgs.gov/info/dmt/

Publishing Concepts to Derive Multiple Digital Data Formats Using ArcGIS

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The Geologic Resources Inventory

The Geologic Resources Inventory (GRI) is one of 12 inventories funded under the National Park Service (NPS) Natural Resource Challenge and is administered by the Geologic Resources Division (GRD) of the Natural Resource Stewardship and Science Directorate (NRSS). The goal of the GRI is to increase understanding of the geologic processes at work in parks and provide accurate geologic information for use in park decision-making. Sound park stewardship relies on understanding natural resources and their role in the ecosystem, of which geology is the foundation. The GRI relies heavily on partnerships with Colorado State University (CSU), the U.S. Geological Survey, individual state geological surveys, and other organizations in developing its products. CSU research associates work side-by-side with NPS GRD GRI staff to facilitate a scoping meeting that identifies park mapping needs, as well as park-specific geologic issues, features, and processes. For each park the GRI then creates a summary of the scoping meeting, produces digital geologic map products, and writes a geologic report for use by park staff.

Introduction

Digital geologic-GIS data and maps are increasingly being used by planners and policy makers to influence and guide decisions concerning the management and protection of geologic resources. Additionally, GIS and spatial visualization software have become more accessible with functionality targeted at a much broader group of users.

To ensure that GRI digital geologic-GIS data is accessible to a diverse user group, from basic users to advanced GIS users, the GRI now publishes digital geologic-GIS data in multiple data formats. These product formats are: 1.) ESRI 10.0 file geodatabase and accompanying ArcMap document for use with ESRI ArcGIS software, 2.) KML/KMZ file for use with Google Earth, and 3.) ESRI map service product for use with ESRI online software viewers, as well as custom online viewers such as the NPS NRMapViews viewer.

To accomplish the task of providing digital GIS spatial data in multiple formats, we evaluated both the ESRI map service and KML data formats to better understand the capabilities and limitations of each format and associated software. Our objective was to maintain a focus on production of our GIS file geodatabase product as the core deliverable with the goal of deriving other data formats from our GIS file geodatabase product. During this process we learned how an ESRI file geodatabase and accompanying ArcMap document (for data presentation) can be leveraged to customize output to other data formats, and how base ESRI ArcMap publishing and ArcToolbox KML tools can be used to produce these derivative products.

This poster presents an overview and assessment of each GRI product format with a focus on design considerations relative to format properties and software requirements and limitations, as well as commenting on the adopted GRI solution (figure 1a to 1c, 2a to 2c and 3a to 3c). The basic steps of how the GRI produces map service and KML products, again both derived from our final GIS file geodatabase and ArcMap document, are also presented (figures 4a to 4d and 5a to 5d).

American Memorial Park, Saipan. Photo: Stefan Krasowski/Flickr

Banzai Cliff, Saipan. Photo: Dennis Vander Tuig/NPS

GRI Digital Geology-GIS Data in ArcMap

The southern portion of the GRI Digital Geologic Map of American Memorial Park and Vicinity, Saipan presented in ArcMap with ESRI world imagery (figure 1a).

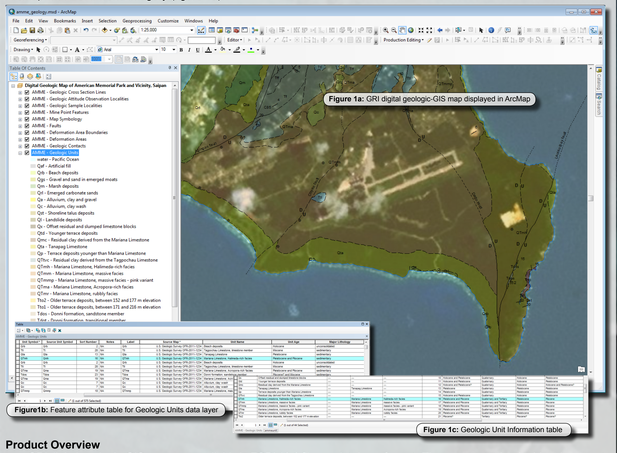


Figure 1a: GRI digital geologic-GIS map displayed in ArcMap

Figure 1b: Feature attribute table for Geologic Units data layer

Figure 1c: Geologic Unit Information table

Product Overview

GRI digital geologic-GIS maps are available in ESRI 10.0 file geodatabase format. The accompanying ArcMap document displays the map's geologic data layers showing feature attribution (e.g., Geologic Units, figure 1b), symbology, labeling and providing access to ancillary GIS tables (e.g., the Geologic Unit Information table, figure 1c). Furthermore, the product includes map layer (.lyr) files that also convey symbology, labeling and other display properties so individual layers can be added to new or existing ArcMap documents. Ancillary map documents and metadata are included with the GIS product download file.

Format Properties

- **Geologic Features:** Geologic features are represented and grouped in thematic feature classes within a 10.0 file geodatabase. The GRI data model employs a feature class schema based on spatial representation (i.e., point, line or polygon) and geologic process and/or geologic association. The schema is designed to accommodate new features and/or features classes as needed.
- **Feature Attributes:** Information about a feature (i.e.,, feature attribution) is stored within a feature classes attribute table. The GRI feature class schema uses a standard set of attribute fields with consistent field properties.
- **Feature Symbology:** Symbology, similar to source map symbology, is stored in the ArcMap document. Feature class symbology is also made available with individual layer files for incorporation into existing or new ArcMap documents.
- **Ancillary Tables:** The source map information table is linked to each feature class via a relationship class, whereas the geologic unit information table is linked (via a relationship class) to just geologic unit feature classes. Related table information is accessed via the feature attribute window, or by directly assessing the table in ArcGIS.
- **Ancillary Map Files:** Ancillary map files (FAQ metadata, a GIS readme file and an ancillary map information document) are packaged with the GIS data, and are accessed outside of ArcGIS using applicable software.

GRI Digital Geologic Maps in an Online Map Viewer

The GRI Digital Geologic Map of American Memorial Park and Vicinity, Saipan displayed in the NPS NRSS NRMapViews viewer. The southern region of the island and Saipan International Airport is displayed (figure 2a). Users can access other prominent available online map services; in this case Bing aerial imagery (note the many low clouds).

Figure 2a: GRI digital geologic-GIS map displayed in NRMapViews

Figure 2b: Feature information window for a geologic unit

Figure 2c: Dataset details window for the presented map

Product Overview

The GRI is collaborating with the NPS NRSS developers to produce a custom Silverlight viewer to present GRI digital geologic-GIS maps. The viewer interacts with other NPS NRSS online applications to first identify available park-specific GRI map services and then retrieve and display the selected map service(s) in a user-friendly, online interface that is similar to basic ArcGIS, ArcReader, and Google Earth software. Feature attribution is available using the viewer's Identify tool (figure 2b). Links to ancillary map documents such as FAQ metadata and the ancillary map information document, as well as digital map product download files, are available to the user via the "Downloads and related files" section of the Dataset Detail window (figure 2c).

Format Properties

- **Geologic Features:** All geologic features present in the GIS data are present in the GRI Viewer. Layer naming, display and organization are all derived from the ArcMap document.
- **Feature Attributes:** Feature attribution is derived from the file geodatabase and ArcMap document, and is displayed through descriptive feature attribution popups. Field names and values match what is displayed in the ArcMap document.
- **Feature Symbology:** Feature symbology is derived from the ArcMap document with no modification requirements.
- **Ancillary Tables:** Two methods are employed to convey table information in the GRI Viewer. 1.) In the source map information table the source map publisher and source map series number fields are converted to a single domain value, and then associated with the source map field in each feature class. 2.) In the geologic unit information table the unit name, unit age and major lithology fields are joined to each geologic unit feature class. The associated domain and joined table fields are then incorporated into the map service product, and are accessible via feature attribute popups.
- **Ancillary Map Files:** Ancillary map files (FAQ metadata, a GIS readme file and an ancillary map information document) are available online and are accessed through online links provided in the GRI Viewer. This functionality is a component of the GRI Viewer, and is not a component of the underlying ESRI map service.

GRI Digital Geologic Maps in Google Earth

The GRI Digital Geologic Map of American Memorial Park and Vicinity, Saipan presented in Google Earth. The southern region of the island of Saipan and Saipan International Airport is displayed (figure 3a).

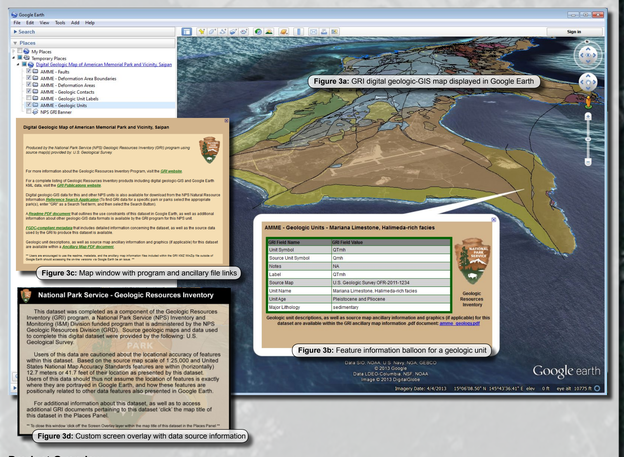


Figure 3a: GRI digital geologic-GIS map displayed in Google Earth

Figure 3b: Map window with program and ancillary file links

Figure 3b: Feature information balloon for a geologic unit

Figure 3d: Custom screen overlay with data source information

Product Overview

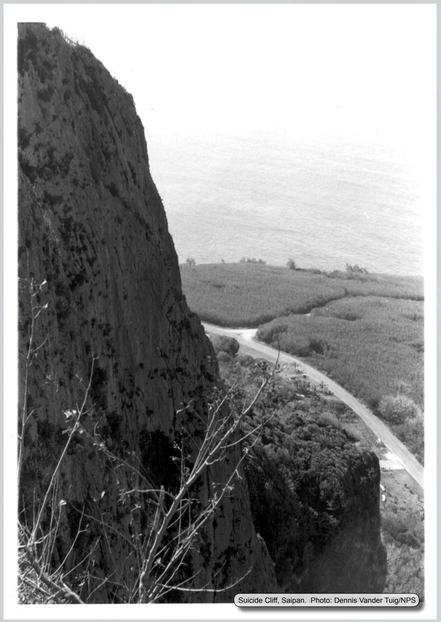
A GRI Google Earth map consists of a single Google Earth (.kmz) file. Feature attributes are obtained by clicking on the desired feature (figure 3b), whereas GRI information and related ancillary map files are accessed through a formatted map pop-up window (figure 3c). A custom screen overlay (figure 3d) presents the agencies responsible for producing the source data, as well as the map's use constraints, and how to access ancillary map files pertaining to the map.

Format Properties

- **Geologic Features**: Due to KML display limitations, certain geologic features such as points are omitted from the KML product, however, thematic layer naming, display and organization in the ArcMap document are preserved within the KML product.
- **Feature Attributes:** Feature attribution is derived from the original file geodatabase and ArcMap document, and is stored in CSS/HTML within the KML file and is accessed via descriptive feature attribution balloons.
- **Feature Symbology:** Symbology is directly translated from the ArcMap document to KML, however, complex polygon fill patterns and line decorations do not display properly in Google Earth. This requires modification of the ArcMap document to remove complex patterns and to generalize line decorations prior to KML export.
- **Ancillary Tables:** Two methods are employed to convey table information in the GRI KML product. 1.) In the source map information table the source map publisher and source map series number fields are converted to a single domain value, and then associated with the source map field in each feature class. 2.) In the geologic unit information table the unit name, unit age and major lithology fields are joined to each geologic unit feature class. Associated domains and joined table fields are written to the final KML file and are accessible in Google Earth via feature attribute balloons.
- **Ancillary Map Files:** Ancillary files (FAQ metadata, a GIS readme file and an ancillary map information document) are made available online and are accessed through links in the map title balloon and in descriptive attribute balloons. These links are made accessible by modifying data frame and feature class properties in the ArcMap document prior to KML export.

Conclusion

Planners and policy makers are increasingly utilizing geospatial data to help guide and influence decisions about the management and protection of geologic resources. In an effort to grow with the expanding availability of spatial visualization software, the GRI now produces the following formats of geospatial data: 1.) an ESRI file geodatabase and Arcmap document, 2.) ESRI map services and the NRMapViews custom viewer, and 3.) KML Google Earth files. By maintaining focus on our GIS base product and by leveraging existing properties within the GIS file geodatabase and related ArcMap document, and by using standard out-of-the-box ArcGIS tools, we have streamlined the production of multiple formats.



Suicide Cliff, Saipan. Photo: Dennis Vander Tuig/NPS

Bird Island, Saipan Photo: Stefan Krasowski/Flickr

Marine Beach, Saipan. Photo: Stefan Krasowski/Flickr

GRI Map Service Production

The GRI map service production process begins with opening a finalized GRI ArcMap document and using the Map Service tool (figure 4a). First, the tool guides the map service publisher through the process of defining the server where the map service will be published. A Service Editor window (figure 4b) permits the publisher to review and edit map service creation settings, as well as the ability to analyze, preview and finally publish the map service. The Analyze window (figure 4c) presents errors, warnings and messages related to map service publication. Publishing errors must be resolved while warnings and messages can be reviewed and marked as permitted exceptions. ArcGIS help provides information, as well as solutions to resolve errors or warnings (figure 4d).

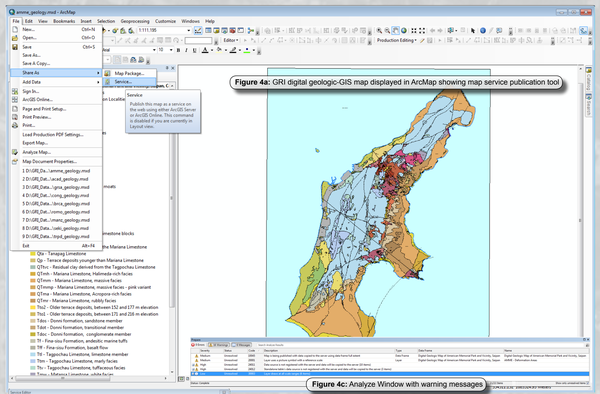


Figure 4a: GRI digital geologic-GIS map displayed in ArcMap showing map service publication tool

Figure 4b: Service Editor Window for map service publication

Figure 4c: Analyze Window with warning messages

Figure 4d: ArcGIS Help window pertaining to a map service publication warning

GRI KML Production

GRI KML production starts with a finalized ArcMap document and File Geodatabase. Symbology is first generalized in the ArcMap document to remove complex symbols including area patterns and fragmented line symbols that are not supported in the KML format. A custom GRI-developed "KML Wizard" tool is utilized to gather and display project and map information (figure 5a), and to select the feature classes (data layers) that will be exported to the GRI KML map product (figure 5b). During processing the tool creates a KML-specific ArcMap document and file geodatabase, and then embeds HTML/CSS code for map title and feature attribution balloons in the derived KML file. Presently, point features are not included with GRI KML map as there are issues with point symbology presentation and rotation. The GRI uses the standard ESRI Map to KML tool to export geologic data to KML/KMZ format (figures 5c and 5d). The resulting KML file is then edited to include the NPS graphic logo and the map's custom GRI banner file.

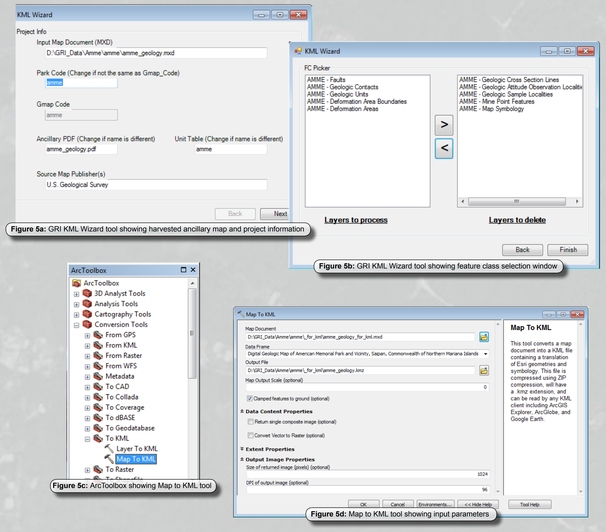


Figure 5a: GRI KML Wizard tool showing harvested ancillary map and project information

Figure 5b: GRI KML Wizard tool showing feature class selection window

Figure 5c: ArcToolbox showing Map to KML tool

Figure 5d: Map to KML tool showing input parameters

Source U.S. Geological Survey Map Publications

Weary, D.J., and Burton, W.C., 2011, Preliminary Geologic Map of the Island of Saipan, Commonwealth of the Northern Mariana Islands, U.S. Geological Survey Open-File Report 2011-1234, 1:25,000 scale, 1 sheet.

Mack, Greg, Chappell, James and O'Meara, Stephanie, 2011, Unpublished Digital Geologic Map of American Memorial Park and Vicinity, Saipan, Commonwealth of Northern Mariana Islands, adapted from a U.S. Geologic Survey Open-File Report map by Weary and Burton (2011), National Park Service Geologic Resources Inventory, AMME digital geologic-GIS dataset, 1:25,000 scale.

Software

ArcGIS 10.X, Environmental Systems Research Institute (ESRI) Inc., 380, New York St., Redlands, CA 92373, http://www.esri.com
Google Earth: Google Inc., http://www.google.com/earth/index.html
National Park Service Geologic Resources Inventory NRMapViews, NRSS Inventory and Monitoring, and Geologic Resources Divisions
Microsoft Silverlight, Microsoft Corporation, http://www.microsoft.com

Geologic Resource Inventory Information and Products

Geologic Resources Inventory Web Site: http://www.nature.nps.gov/geology/inventory

Geologic Resources Inventory Products Web Site: http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

Colorado State University Geologic Resources Inventory Web Site: http://warnercnr.colostate.edu/geo-research/departmental-research/geologic-resources-inventory

Photo Credits

The background image is Google Earth Digital Globe imagery of American Memorial Park on the island of Saipan, Northern Mariana Islands captured on March 24, 2013.

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The two black and white photographs were made by Dennis VanderTuig/National Park Service.