The following was presented at DMT'11 (May 22-25, 2011).

The contents are provisional and will be superseded by a paper in the DMT'11 Proceedings.

See also earlier Proceedings (1997-2010)
http://ngmdb.usgs.gov/info/dmt/

Digital Mapping Techniques 2011
NPS Geologic Resources Inventory

NPS GRI Development of Digital Geologic Data

for Use in Google Earth

by

Stephanie O'Meara, James Chappell

and Heather Stanton

Williamsburg, Virginia

May 22-25, 2011

Outline of Our Talk

Part I: GRI Development of Digital Geologic Data for Use in Google Earth

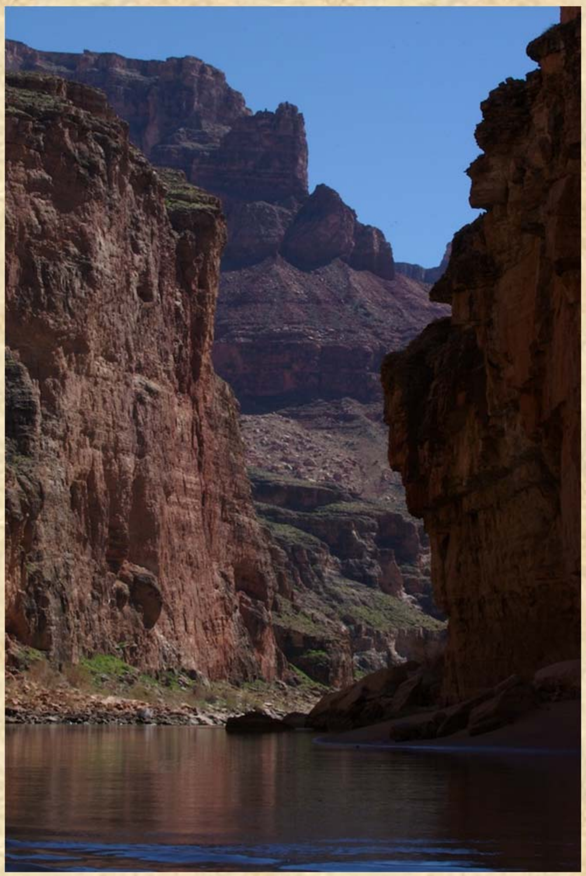
- Making our maps more usable and base design requirements
- Google Earth overview
- GRI product overview

Part II: The GRI Google Earth Product

- KML/KMZ format
- GRI Google Earth Product
- Problems, issues and product considerations

The Geologic Resources Inventory (GRI) Program

- The GRI is tasked with producing geologic information for 270 National Park Service (NPS) park units with natural resources.
    - For each park the GRI provides a digital geologic map and a geology report.
- The GRI relies heavily upon cooperative relationships with other agencies and institutions such as the U.S. Geological Survey, state geologic surveys, and academia to produce our products.
- Colorado State University (CSU) is an integral partner in designing and producing GRI products.



Grand Canyon NP (photo by Ron Karpilo)

Producing More User-Friendly Geologic Maps

- A goal put forth by the GRI program last fall was to develop a digital map product that is more user-friendly, and would help better facilitate the use of our digital geologic map data.

- Existing GRI digital geologic maps are GIS datasets (ESRI geodatabase and shapefile formats).

  - Requires users to have ESRI ArcGIS or ArcReader software (NPS wide ESRI license but ..)

  - Users frequently won't use our data as this requires some knowledge of ArcGIS software.

"Can you print me a copy of this map?" – common NPS request

Producing More User-Friendly Geologic Maps (cont.)

- Our Base Requirements for Developing a New Digital Map Product.
  - The software (and data format) be,
    - easy to acquire and install.
    - easy to use (i.e., is user-friendly)
    - incur no cost to users (i.e., is free or essentially free)
    - require no custom tools or software other than Adobe Acrobat Reader to use.
  - Ideally prefer software that users already have and are familiar with using (either pertaining to work or personal use).
  - That the new product be developed and produced with limited time and effort on our part, and with limited to no impact on our existing digital data workflow and GIS product.

Overview of Our Research Efforts

- We evaluated Google Earth, ESRI ArcGIS Explorer, GeoPDFs, and several on-line map services software including ESRI's ArcGIS.com Map Viewer.

- As digital geologic data producers, we didn't want to now also be required to create (and maintain) an on-line map service to distribute and/or view our data.

- Google Earth met all of our design requirements including the preference that users may already be using the software.

    - We also evaluated several existing Google Earth geology maps developed by others (e.g., UGS, San Diego State University), as well as attending several talks at GSA on Google Earth pertaining to geology.

- We didn't discount other evaluated software or data formats we just agreed to develop and create a Google Earth product!

Google Earth

- Software is a widely (globally) used virtual 3-D geographic/map display software program.
- Is free, and extremely easy to download (on-line), install and use!
- Portrays digital geographic data spectacularly in 3-D complete with panning, zooming, and rotation of view, as well as touring capabilities.
- Supports use in Google Maps, is available as a browser plugin, and as a mobile device app.
- Data can distributed as either a file users download, or by accessing the data on-line via a provided map service.

Google Earth (cont.)

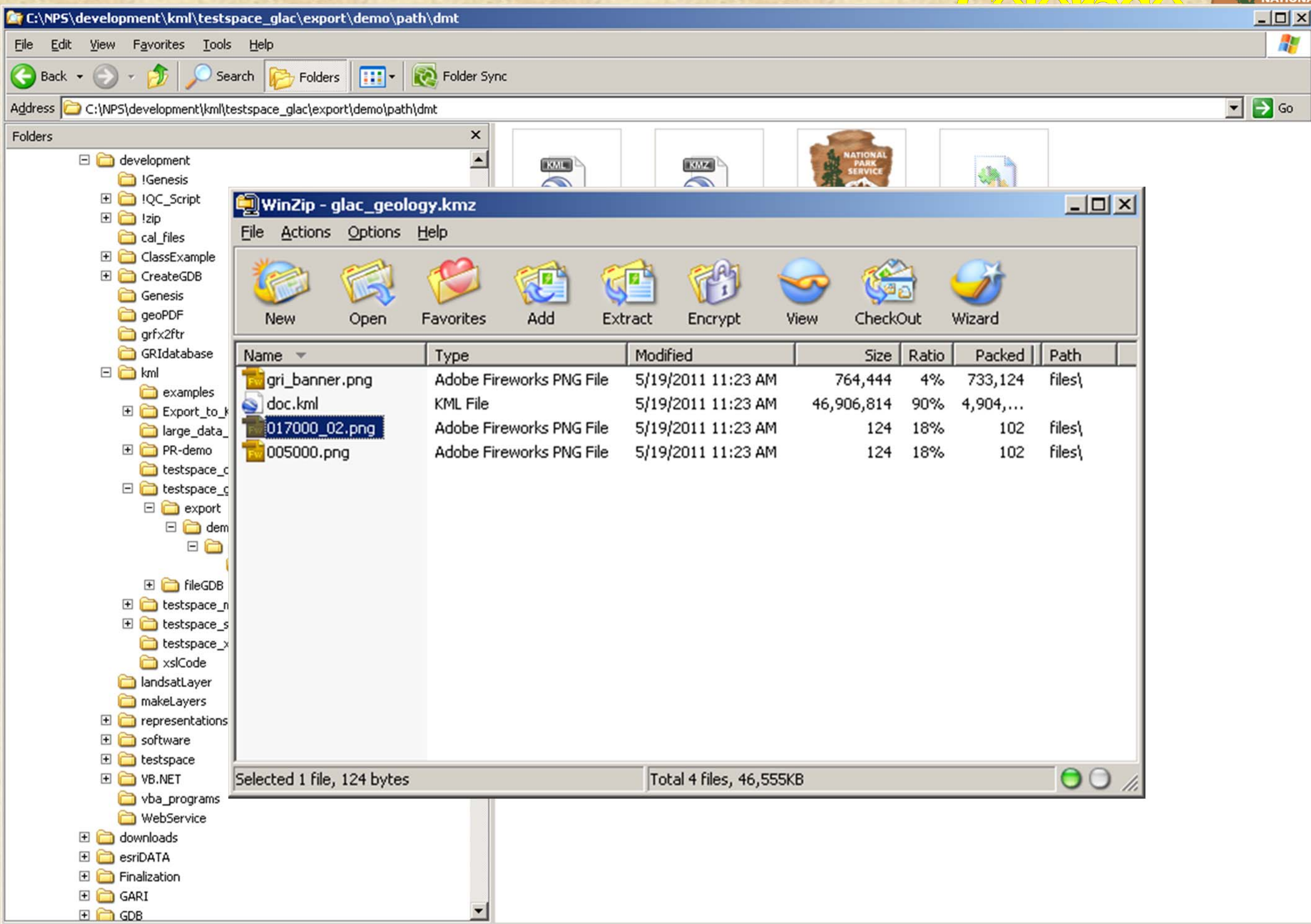
- Base data layers such as 3-D topography and imagery, as well as common geographical themes (e.g., places, roads) are provided by Google on-line.
- The KML data format supported in Google Earth is easily exported from ESRI ArcGIS, several geographic data viewers and on-line map services can display the format.
- Software has limited to no GIS functionality (e.g. no GIS analysis or querying capabilities, and feature/table relationships aren't present).
- Often doesn't fully communicate information about and related to the displayed data without customization (e.g., no displayed map legend, and often limited connection to related map documents including metadata).

GRI Google Earth Product Overview

- Digital map deployed as a single KMZ (KML) data file from NPS Natural Resources Information Portal (http://nrinfo.nps.gov).
- Data is presented in a vector (discrete feature) format complete with attribution.
- The GRI product facilitates easy access to ancillary map components, as well as information concerning the GRI, our sources, data use constraints, access to GRI GIS products and reports, the map's readme file and metadata.
- Is a slightly modified from our distributed GIS product.
  - Modifications include limited data layers and symbology, and appended attribute fields to communicate basic geologic unit and source map information.
- KMZ/KML file is produced as a derivative product at the end our digital GIS production process using VB.NET tools that automate much of the process

GRI Google Earth Product Overview (cont.)

- Responsibly communicates information about the data (i.e., metadata), as well as use constraints for using the data.
  - Use constraints are extremely important especially considering many users aren't aware of the limitations of using the digital data of varying map scale, and how this relates to the positional accuracy of features.
- Our Google Earth product isn't intended to replace the GIS data, but hopefully serve as a gateway for users to acquire and use our GIS data.
  - We want to encourage the eventual use our GIS products!
- The GRI Google Earth product and our present digital GIS datasets, along with newly developing on-line map services (e.g., ESRI ArcGIS Explorer or ArcGIS.com Map Viewer) are the planned means to communicate our data to a diverse and technically wide user base.



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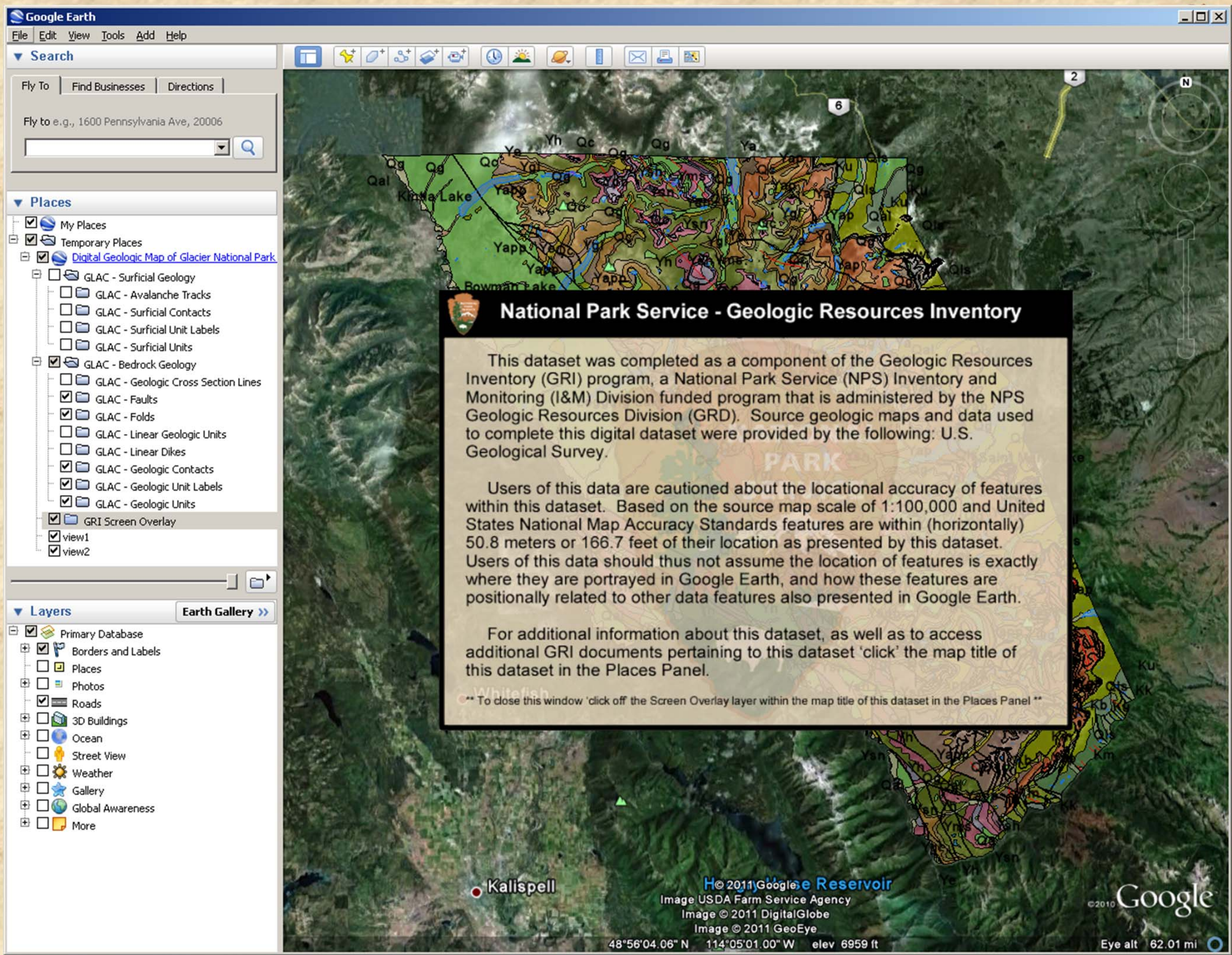
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Primary Database
Borders and Labels
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Weather
Gallery
Global Awareness
More
National Park Service - Geologic Resources Inventory
This dataset was completed as a component of the Geologic Resources Inventory (GRI) program, a National Park Service (NPS) Inventory and Monitoring (I&M) Division funded program that is administered by the NPS Geologic Resources Division (GRD). Source geologic maps and data used to complete this digital dataset were provided by the following: U.S. Geological Survey.
Users of this data are cautioned about the locational accuracy of features within this dataset. Based on the source map scale of 1:100,000 and United States National Map Accuracy Standards features are within (horizontally) 50.8 meters or 166.7 feet of their location as presented by this dataset. Users of this data should thus not assume the location of features is exactly where they are portrayed in Google Earth, and how these features are positionally related to other data features also presented in Google Earth.
For additional information about this dataset, as well as to access additional GRI documents pertaining to this dataset 'click' the map title of this dataset in the Places Panel.
** To close this window 'click off' the Screen Overlay layer within the map title of this dataset in the Places Panel **
Kintla Lake
Bowman Lake
Kalispell
© 2011 Google
Image USDA Farm Service Agency
Image © 2011 DigitalGlobe
Image © 2011 GeoEye
48°56'04.06" N 114°05'01.00" W elev 6959 ft
Eye alt 62.01 mi
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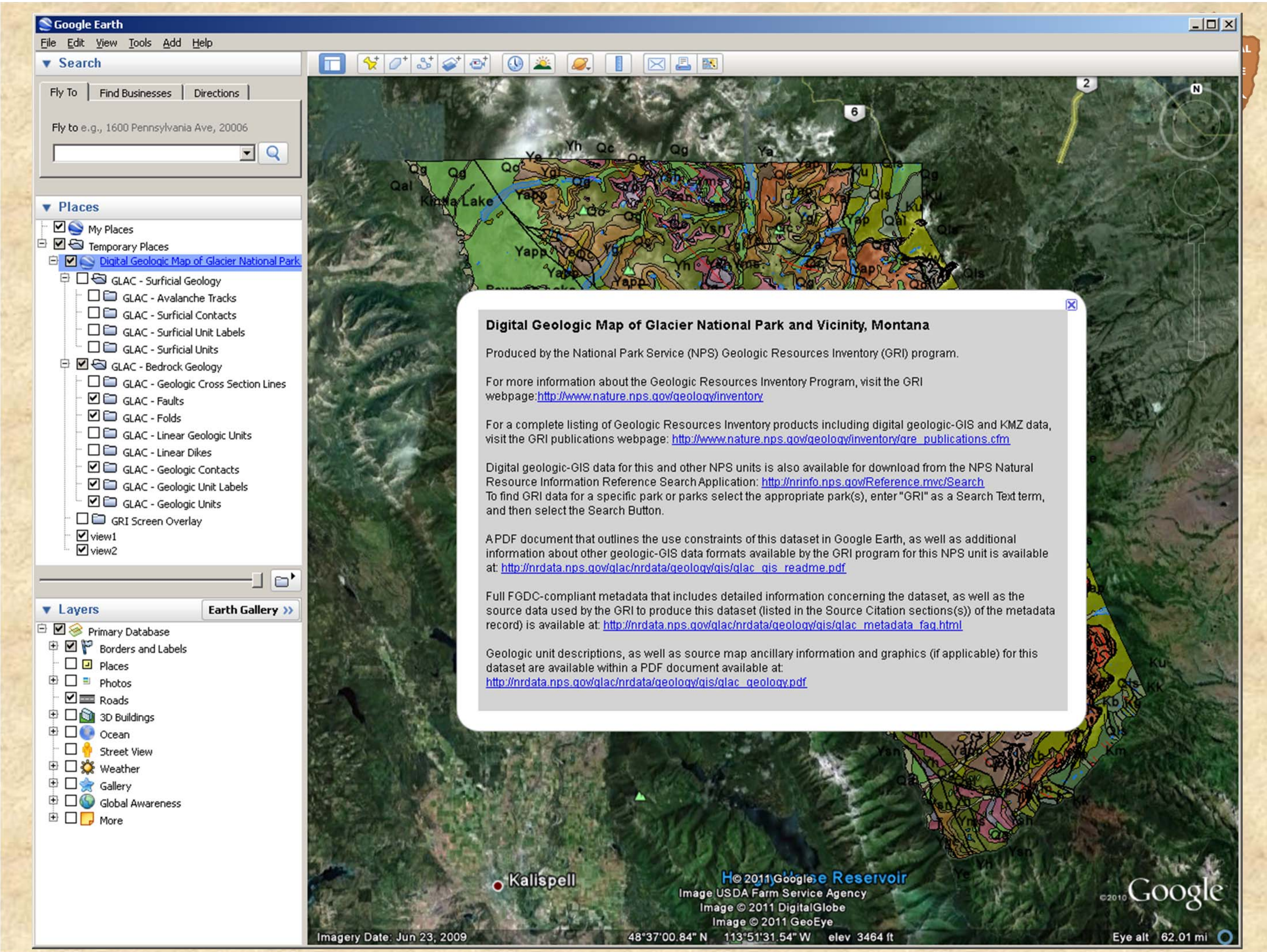
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Digital Geologic Map of Glacier National Park and Vicinity, Montana
Produced by the National Park Service (NPS) Geologic Resources Inventory (GRI) program.
For more information about the Geologic Resources Inventory Program, visit the GRI webpage: http://www.nature.nps.gov/geology/inventory
For a complete listing of Geologic Resources Inventory products including digital geologic-GIS and KMZ data, visit the GRI publications webpage: http://www.nature.nps.gov/geology/inventory/gre_publications.cfm
Digital geologic-GIS data for this and other NPS units is also available for download from the NPS Natural Resource Information Reference Search Application: http://nrinfo.nps.gov/Reference.mvc/Search
To find GRI data for a specific park or parks select the appropriate park(s), enter "GRI" as a Search Text term, and then select the Search Button.
A PDF document that outlines the use constraints of this dataset in Google Earth, as well as additional information about other geologic-GIS data formats available by the GRI program for this NPS unit is available at: http://nrdata.nps.gov/glac/nrdata/geology/gis/glac_gis_readme.pdf
Full FGDC-compliant metadata that includes detailed information concerning the dataset, as well as the source data used by the GRI to produce this dataset (listed in the Source Citation sections(s)) of the metadata record) is available at: http://nrdata.nps.gov/glac/nrdata/geology/gis/glac_metadata_faq.html
Geologic unit descriptions, as well as source map ancillary information and graphics (if applicable) for this dataset are available within a PDF document available at:
http://nrdata.nps.gov/glac/nrdata/geology/gis/glac_geology.pdf
Kintla Lake
Kalispell
© 2011 Google
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Image © 2011 DigitalGlobe
Image © 2011 GeoEye
Imagery Date: Jun 23, 2009
48°37'00.84" N 113°51'31.54" W elev 3464 ft
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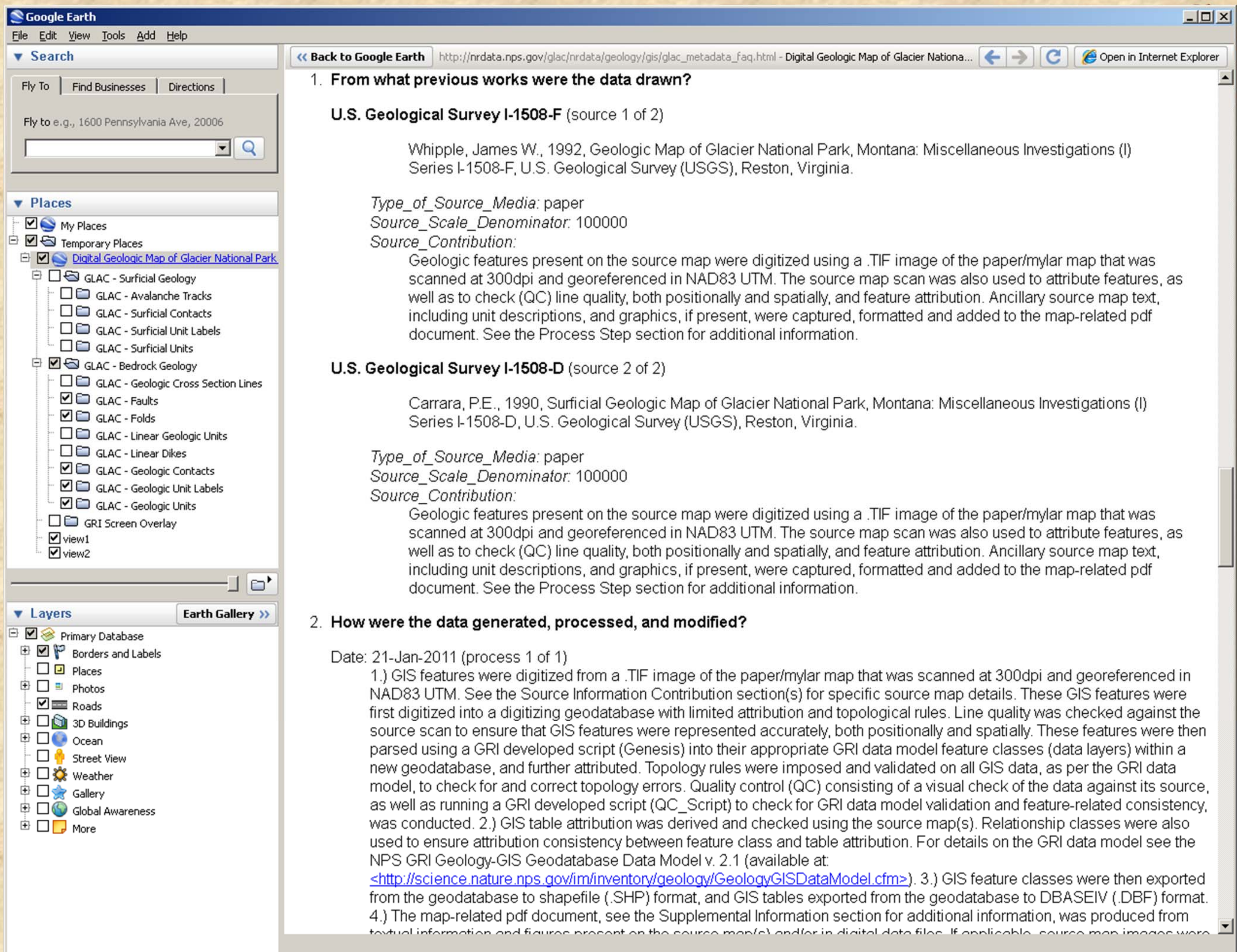


1. **From what previous works were the data drawn?**

U.S. Geological Survey I-1508-F (source 1 of 2)

Whipple, James W., 1992, Geologic Map of Glacier National Park, Montana: Miscellaneous Investigations (I) Series I-1508-F, U.S. Geological Survey (USGS), Reston, Virginia.

Type_of_Source_Media: paper
Source_Scale_Denominator: 100000
Source_Contribution:
Geologic features present on the source map were digitized using a .TIF image of the paper/mylar map that was scanned at 300dpi and georeferenced in NAD83 UTM. The source map scan was also used to attribute features, as well as to check (QC) line quality, both positionally and spatially, and feature attribution. Ancillary source map text, including unit descriptions, and graphics, if present, were captured, formatted and added to the map-related pdf document. See the Process Step section for additional information.

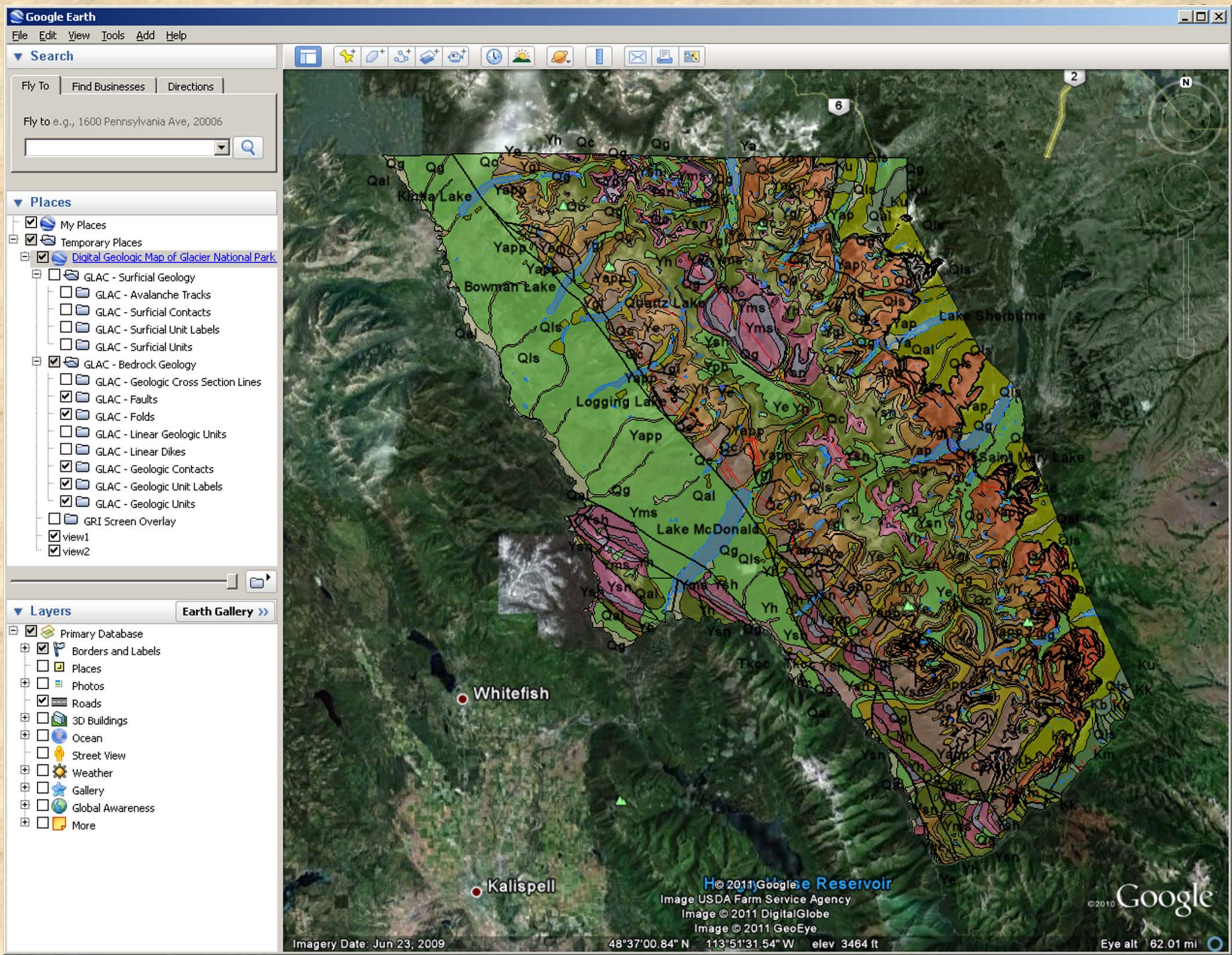
U.S. Geological Survey I-1508-D (source 2 of 2)

Carrara, P.E., 1990, Surficial Geologic Map of Glacier National Park, Montana: Miscellaneous Investigations (I) Series I-1508-D, U.S. Geological Survey (USGS), Reston, Virginia.

Type_of_Source_Media: paper
Source_Scale_Denominator: 100000
Source_Contribution:
Geologic features present on the source map were digitized using a .TIF image of the paper/mylar map that was scanned at 300dpi and georeferenced in NAD83 UTM. The source map scan was also used to attribute features, as well as to check (QC) line quality, both positionally and spatially, and feature attribution. Ancillary source map text, including unit descriptions, and graphics, if present, were captured, formatted and added to the map-related pdf document. See the Process Step section for additional information.

2. **How were the data generated, processed, and modified?**

Date: 21-Jan-2011 (process 1 of 1)
1.) GIS features were digitized from a .TIF image of the paper/mylar map that was scanned at 300dpi and georeferenced in NAD83 UTM. See the Source Information Contribution section(s) for specific source map details. These GIS features were first digitized into a digitizing geodatabase with limited attribution and topological rules. Line quality was checked against the source scan to ensure that GIS features were represented accurately, both positionally and spatially. These features were then parsed using a GRI developed script (Genesis) into their appropriate GRI data model feature classes (data layers) within a new geodatabase, and further attributed. Topology rules were imposed and validated on all GIS data, as per the GRI data model, to check for and correct topology errors. Quality control (QC) consisting of a visual check of the data against its source, as well as running a GRI developed script (QC_Script) to check for GRI data model validation and feature-related consistency, was conducted. 2.) GIS table attribution was derived and checked using the source map(s). Relationship classes were also used to ensure attribution consistency between feature class and table attribution. For details on the GRI data model see the NPS GRI Geology-GIS Geodatabase Data Model v. 2.1 (available at: <http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm>). 3.) GIS feature classes were then exported from the geodatabase to shapefile (.SHP) format, and GIS tables exported from the geodatabase to DBASEIV (.DBF) format. 4.) The map-related pdf document, see the Supplemental Information section for additional information, was produced from



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Lake McDonald
Lake Sherburne
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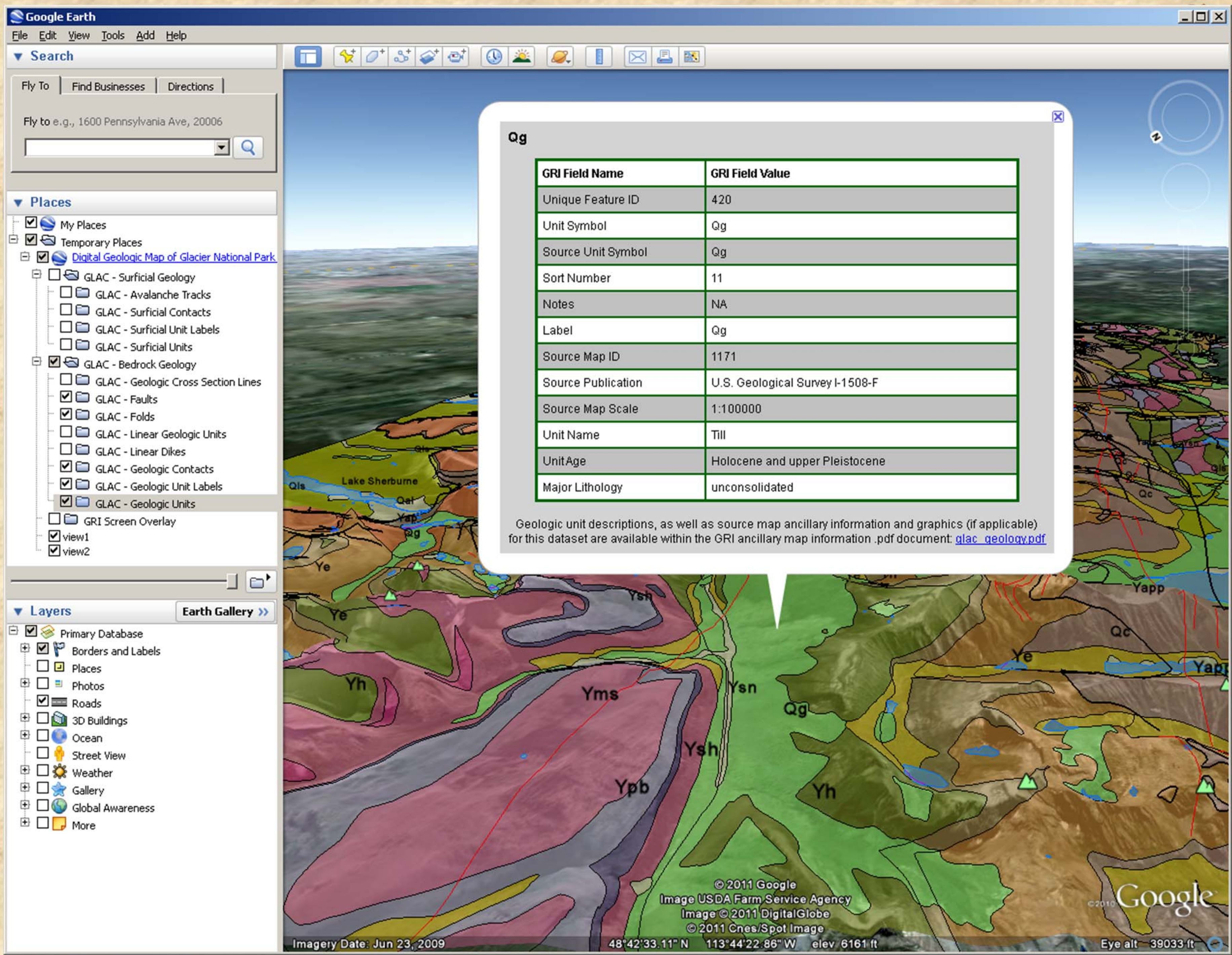

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Source Publication
U.S. Geological Survey I-1508-F
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Unit Age
Holocene and upper Pleistocene
Major Lithology
unconsolidated
Geologic unit descriptions, as well as source map ancillary information and graphics (if applicable) for this dataset are available within the GRI ancillary map information .pdf document: glac_geology.pdf
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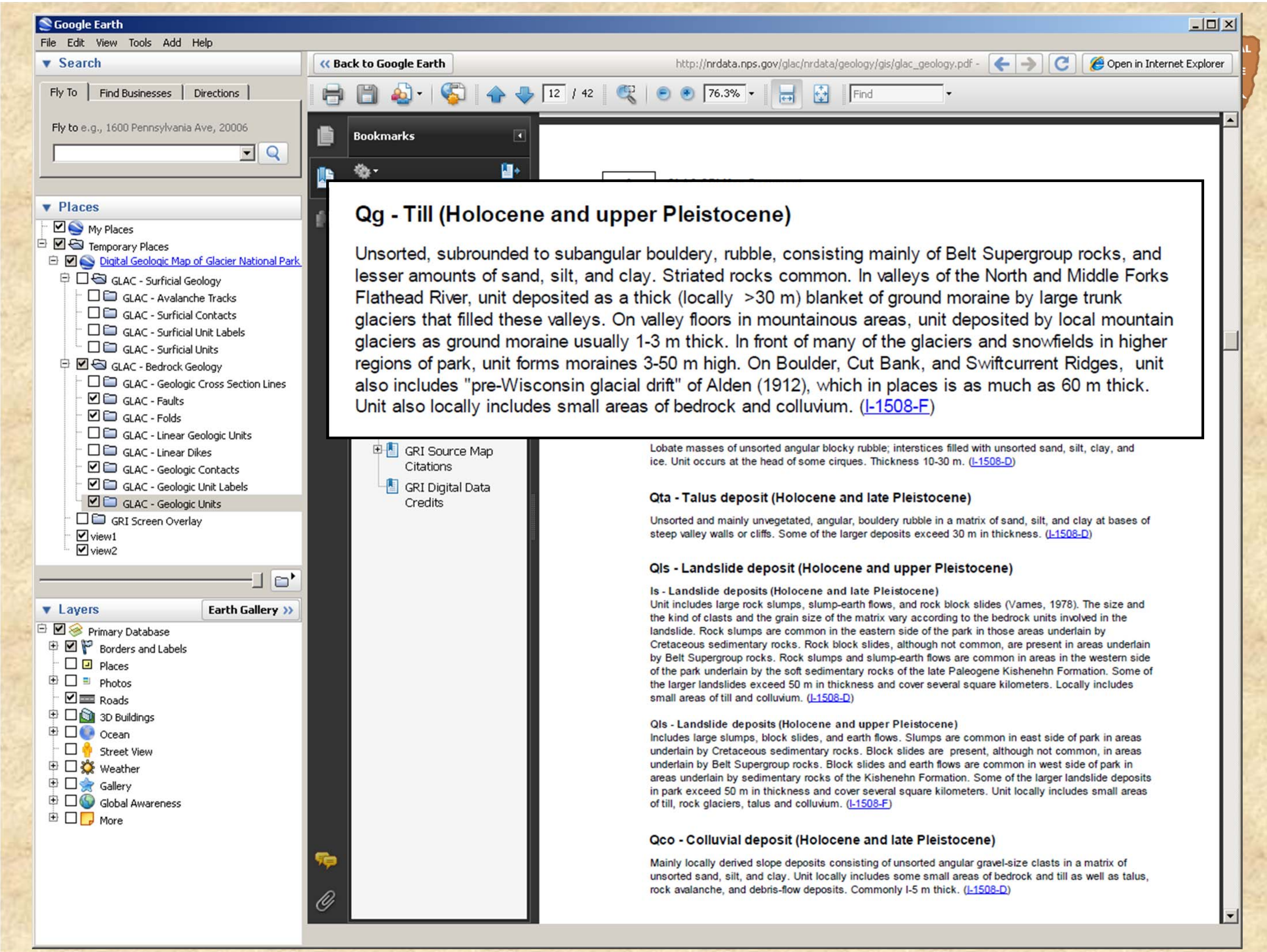

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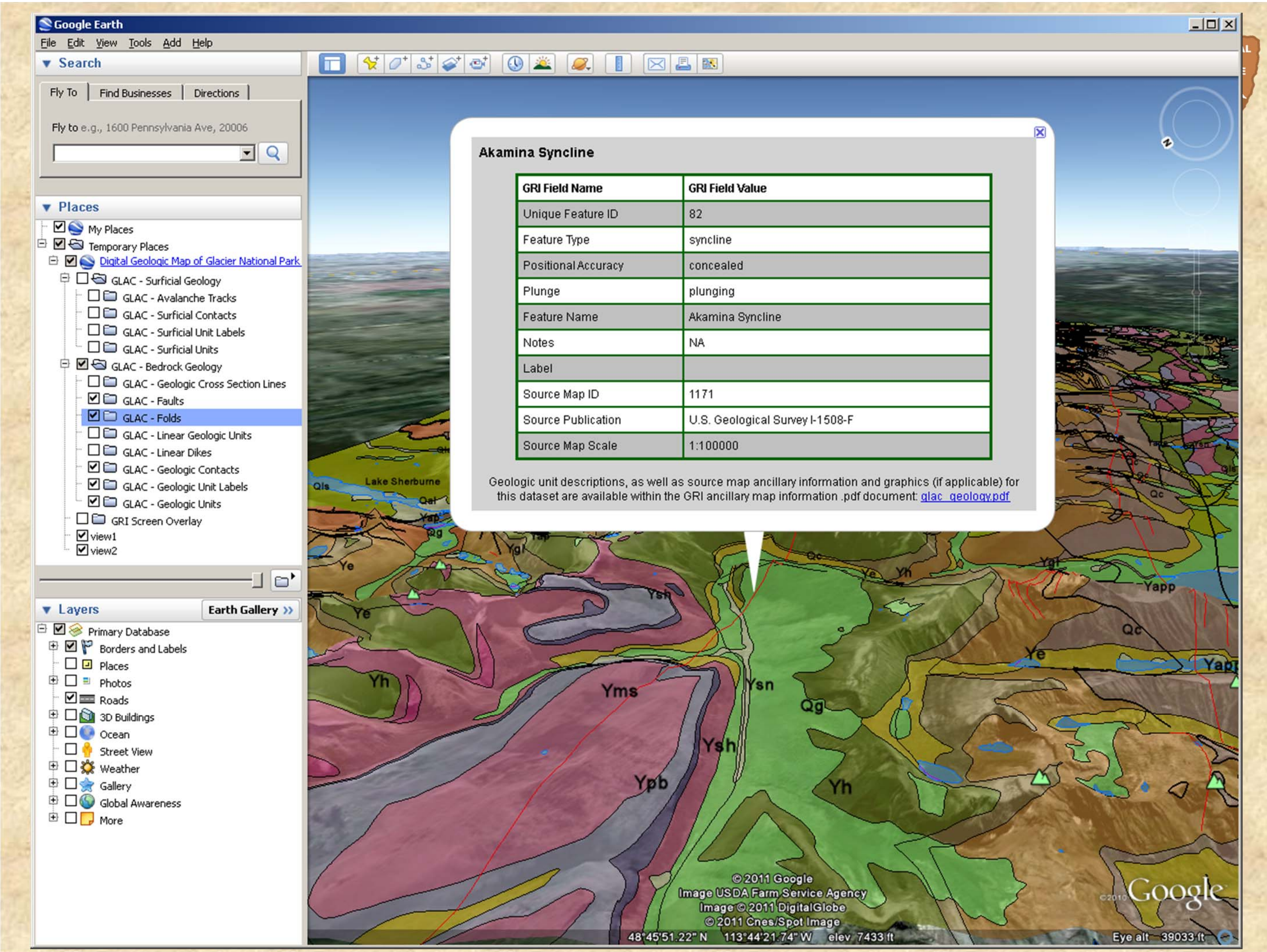
Qg - Till (Holocene and upper Pleistocene)
Unsorted, subrounded to subangular bouldery, rubble, consisting mainly of Belt Supergroup rocks, and lesser amounts of sand, silt, and clay. Striated rocks common. In valleys of the North and Middle Forks Flathead River, unit deposited as a thick (locally >30 m) blanket of ground moraine by large trunk glaciers that filled these valleys. On valley floors in mountainous areas, unit deposited by local mountain glaciers as ground moraine usually 1-3 m thick. In front of many of the glaciers and snowfields in higher regions of park, unit forms moraines 3-50 m high. On Boulder, Cut Bank, and Swiftcurrent Ridges, unit also includes "pre-Wisconsin glacial drift" of Alden (1912), which in places is as much as 60 m thick. Unit also locally includes small areas of bedrock and colluvium. (I-1508-F)
Lobate masses of unsorted angular blocky rubble; interstices filled with unsorted sand, silt, clay, and ice. Unit occurs at the head of some cirques. Thickness 10-30 m. (I-1508-D)
Qta - Talus deposit (Holocene and late Pleistocene)
Unsorted and mainly unvegetated, angular, bouldery rubble in a matrix of sand, silt, and clay at bases of steep valley walls or cliffs. Some of the larger deposits exceed 30 m in thickness. (I-1508-D)
Qls - Landslide deposit (Holocene and upper Pleistocene)
ls - Landslide deposits (Holocene and late Pleistocene)
Unit includes large rock slumps, slump-earth flows, and rock block slides (Vames, 1978). The size and the kind of clasts and the grain size of the matrix vary according to the bedrock units involved in the landslide. Rock slumps are common in the eastern side of the park in those areas underlain by Cretaceous sedimentary rocks. Rock block slides, although not common, are present in areas underlain by Belt Supergroup rocks. Rock slumps and slump-earth flows are common in areas in the western side of the park underlain by the soft sedimentary rocks of the late Paleogene Kishenehn Formation. Some of the larger landslides exceed 50 m in thickness and cover several square kilometers. Locally includes small areas of till and colluvium. (I-1508-D)
Qls - Landslide deposits (Holocene and upper Pleistocene)
Includes large slumps, block slides, and earth flows. Slumps are common in east side of park in areas underlain by Cretaceous sedimentary rocks. Block slides are present, although not common, in areas underlain by Belt Supergroup rocks. Block slides and earth flows are common in west side of park in areas underlain by sedimentary rocks of the Kishenehn Formation. Some of the larger landslide deposits in park exceed 50 m in thickness and cover several square kilometers. Unit locally includes small areas of till, rock glaciers, talus and colluvium. (I-1508-F)
Qco - Colluvial deposit (Holocene and late Pleistocene)
Mainly locally derived slope deposits consisting of unsorted angular gravel-size clasts in a matrix of unsorted sand, silt, and clay. Unit locally includes some small areas of bedrock and till as well as talus, rock avalanche, and debris-flow deposits. Commonly I-5 m thick. (I-1508-D)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Akamina Syncline
GRI Field Name | GRI Field Value
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Feature Type | syncline
Positional Accuracy | concealed
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Notes | NA
Label |
Source Map ID | 1171
Source Publication | U.S. Geological Survey I-1508-F
Source Map Scale | 1:100000
Geologic unit descriptions, as well as source map ancillary information and graphics (if applicable) for this dataset are available within the GRI ancillary map information .pdf document: glac_geology.pdf
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Unresolved Issues and Problems

- Line decorations, polygon labels and polygon patterns don’t display
    - Require edits to map symbology
- Point data
    - Rotation not fixed
    - No reference scale
    - Don’t make the final cut (for now)
- Feature size limits
    - Max number of vertices
    - Split features to reduce vertex count

KML Production Summary

- Not intended to replace GRI GIS dataset
- Minimal cost to create GRI Google Earth product
- Adequately conveys mapping data contained in GIS product with associated use constraints, and includes ancillary map components
- GRI Product still in development

Digital Mapping Techniques 2011
NPS Geologic Resources Inventory

Automation of Google Earth KML Creation and

Display of Geologic Data in ArcGIS

by

Heather Stanton, Jim Chappell and Stephanie O'Meara

Williamsburg, Virginia

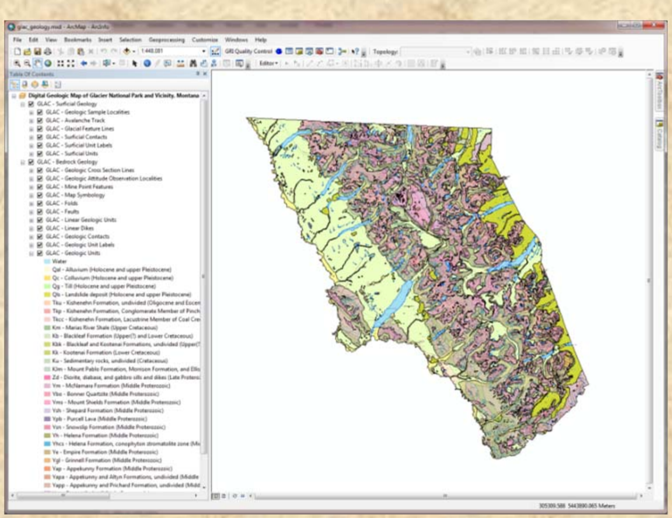
May 22-25, 2011

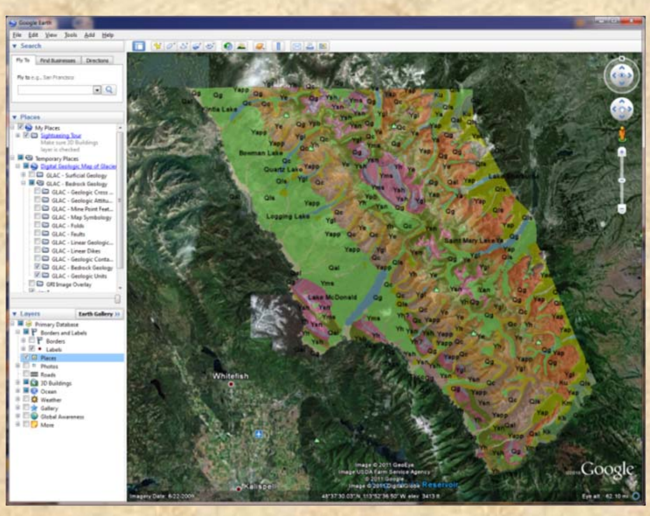
Overview

- Goals of automation of GRI Google Earth product
- Workflow for creating GRI Google Earth products
- Discussion of GRI KML Creation Tool
- Future possibilities for automation

Development Goals

- Limited additional time added to the creation of our existing products
- Automate repetitive tasks, but don't spend too much time programming
- Some tasks automated, others done by hand, with the possibility of future automation
- Like other GRI products, maintain a consistent look and feel with minimal error

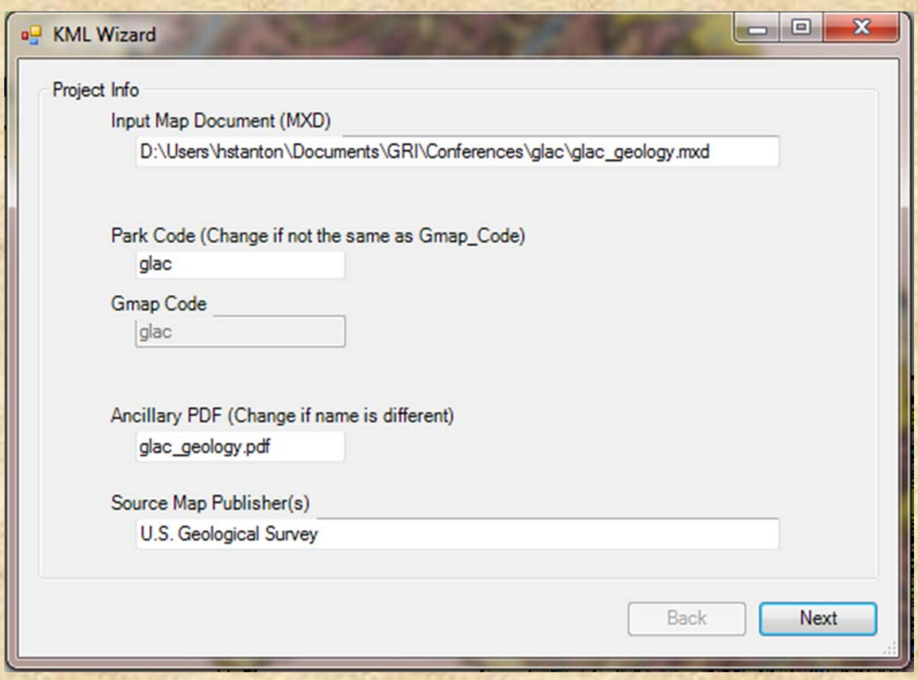




KML Creation Workflow

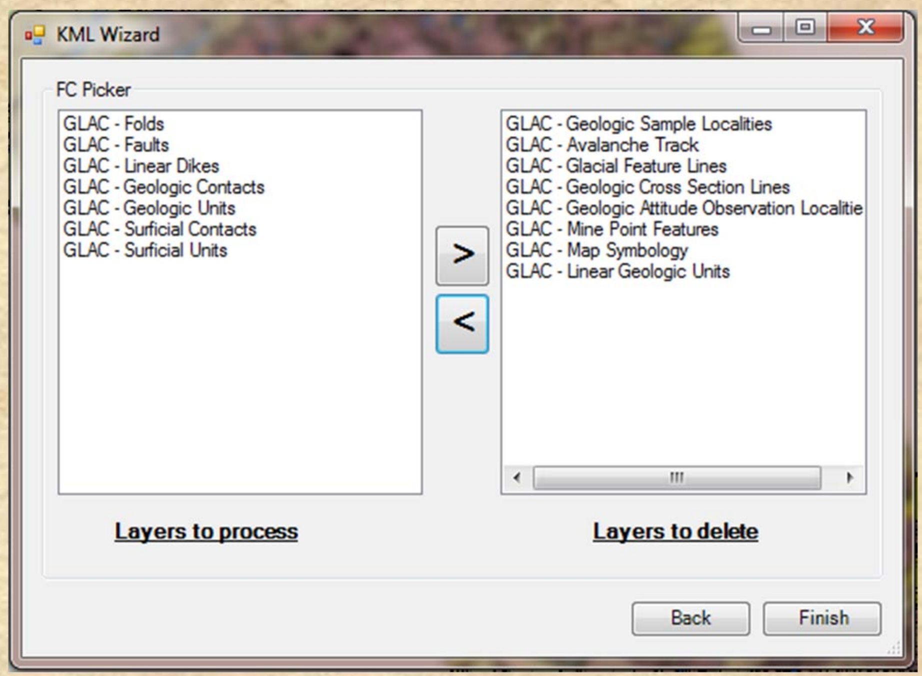
- Complete GRI geodatabase, ArcMap document and additional files using existing protocol
- Open finalized ArcMap document and run GRI KML Creation tool (programmed in VB .NET)
- Manually adjust symbology to be compatible with Google Earth
- Review changes made by GRI KML Creation tool and edit, if necessary
- Export to KMZ using Python tool provided by ArcGIS (looked at other tools, but this one integrated well with workflow)
- Make edits to output KMZ file, including adding screen overlay, grouping layers and making individual objects not visible in table of contents

GRI KML Creation Tool



Information for pop-ups and added fields

Choose which layers will be in output KMZ



GRI KML Creation Tool (cont.)

- Remove data layers from ArcMap document that will not be displayed in Google Earth.
- Copy and repath to create new ArcMap document and geodatabase for KML
- Create HTML pop-ups from XSL templates for map and layer properties allowing for display of pop-up windows in Google Earth and linking of additional documents
- Add and calculate fields on each data layer to incorporate information from linked tables
- Create label points for polygons for display in Google Earth.
- Set layer transparency, if appropriate

Conclusions and Future Development

- Able to produce a Google Earth product as an add-on that does not interfere with existing products and takes limited time to produce
- Simple workflow with some automation and some manual steps
- Possible future work:
  - Automate changes to symbology
  - Create step-by-step toolbar that leverages GRI KML tool and ArcGIS KML Export
  - Automate changes made within Google Earth and creation of screen overlay

GRI Presentation Contact Information

- Stephanie O'Meara (CSU) – Geologist / GIS Specialist / Map Product Lead / Data Manager

  stephanie.omeara@colostate.edu or (970-491-6655)

- Jim Chappell (CSU) – Geologist / GIS Specialist / Map Product Developer

  jim_chappell@partner.nps.gov or (970-491-5147)

- Heather Stanton (CSU) – Geologist / GIS Specialist / Map Product Developer

  heather_stanton@partner.nps.gov or (970-491-5147)