GEOLOGIC MAPPING WITH GOOGLE EARTH: A GIS ALTERNATIVE



Abstract

Google Earth is widely used for map applications due to its extensive database of satellite magery, roads, and other geographic features. Although the vast majority of users rely on the software for simple routing and recent satellite data, it has powerful functionality as a tool for creating custom geologic maps as KML files. Coupled with Earth Point, a free online Excel to KML converter, large geologic datasets can be quickly added to Google Earth as point files and represented by a variety of clickable icons complete with station data (e.g., station name, lithology, stratigraphy, structural, geochemical). Using custom icons created from any image file, Earth Point's Excel conversion tools allow for bulk insertion of structural symbols rotated according to strike/bearing and noted with dip/plunge data. Although lacking the powerful querying abilities of more widely used GIS software (e.g. ESRI and Autodesk products), Google Earth coupled with Earth Point is far easier to learn, can be used free of charge, and doesn't require significant computing power. Google Earth can be used to create boundaries and polygons based on the distribution of incorporated point data, and can be used to link map features and web data. Image overlay tools make georeferencing raster maps (e.g., topographic, geologic) a simple task and facilitate creation of KMLbased geologic maps using historical and new geologic datasets. Additionally, use of a laptop/tablet computer with Google Earth software, a GPS device, and internet connection (e.g., a tethered smart phone or wireless hot spot) allows the software to be used in the field as a real-time mapping tool. The ability to quickly locate stations, utilize satellite imagery and recent road data, and add-manipulate geologic data onto a digital map in real-time has significant advantages over traditional pen and paper mapping, especially in typical "roadside" geologic mapping activities. Although some aspects of Google Earth limit its ability to create finished geologic maps (e.g., inability to create fault ornamentation), the advantages of Google Earth make it a functional alternative to expensive and difficult to learn GIS software when the full capabilities of such software is not essential to a project.

Google Earth...

- Is a free program that can run on most devices, including smart phones, tablets, and laptops.
- Requires far less computing power than ArcGIS or AutoCAD Map/Civil
- Provides free access to recent/historical satellite imagery and up-to date roads.
- Can be linked with a GPS device to provide real-time or post-processing location information.
- Allows for insertion of customizable placemarks and embedded data.
- Allows construction of customized points, lines, and polygons.
- Allows map elements to be hyperlinked to images, local files, and web pages.
- Allows for simple insertion and georeferencing of imagery overlays, including topographic and geologic maps.
- When used in conjunction with an Excel spreadsheet and Earth Point, large station and structural datasets can be added to the map as placemarks with embedded information.

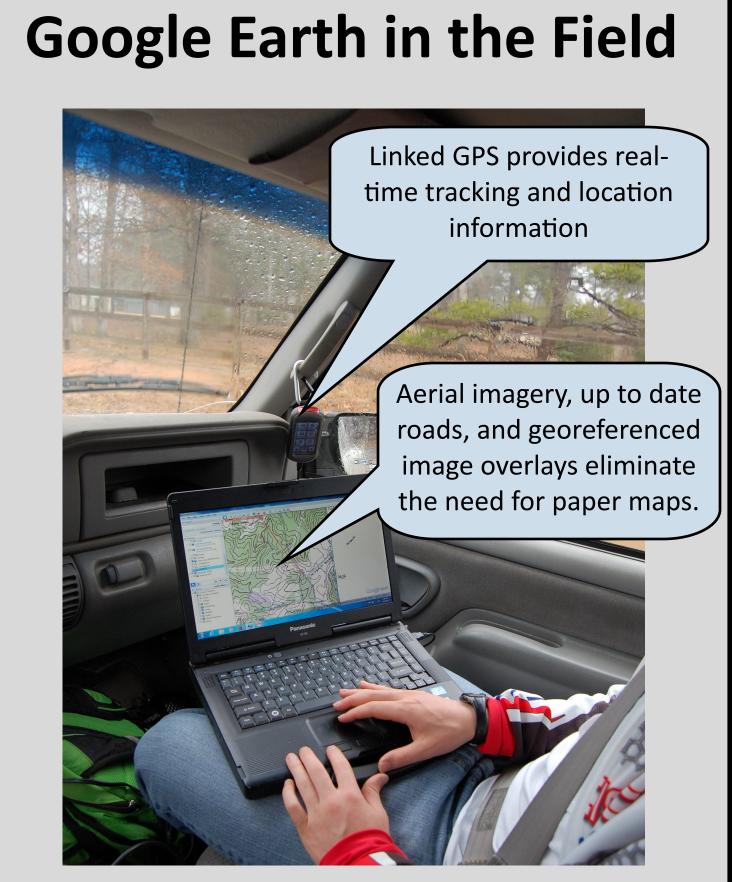
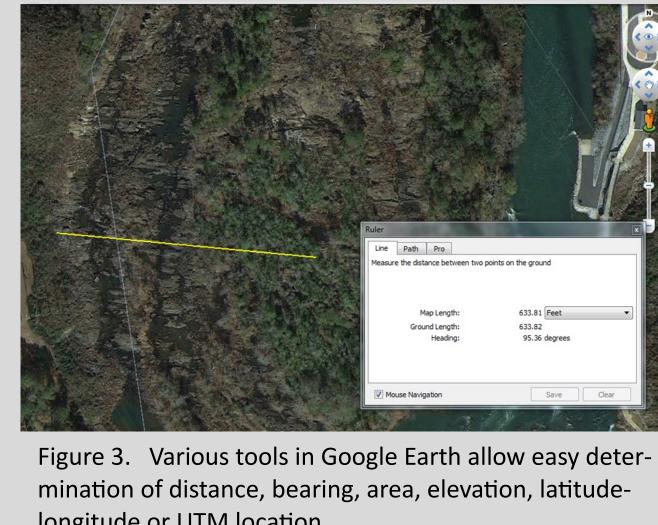


Figure 1. Geologic mapping with a laptop allows for instant access to aerial imagery, georeferenced maps, and up to date road information. A linked GPS device provides location information in real-time.



Figure 2. Aerial imagery can be accessed "on the fly" with a wireless hot spot or tethered smart phone—or can be cached when working in regions without wireless service.



longitude or UTM location.

Google Earth Pro

As of January 20, 2015, Google Earth Pro can be freely downloaded. The professional version includes...

- Advanced measurements including area of polygons.
- Image printing up to 4800x3200 resolution.
- Additional data layers.
- Ability to import up to 2500 stations from a spreadsheet.
- Ability to import ArcGIS shapefiles.

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Google Earth in the Field



Figure 4. Recent aerial imagery, roads, and a linked GPS allow for instant determination of location and real-time correction of low resolution GPS data.

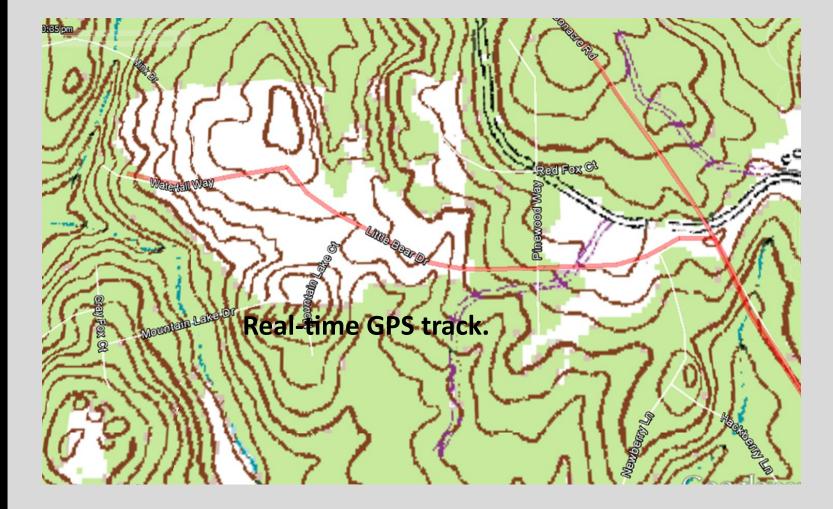
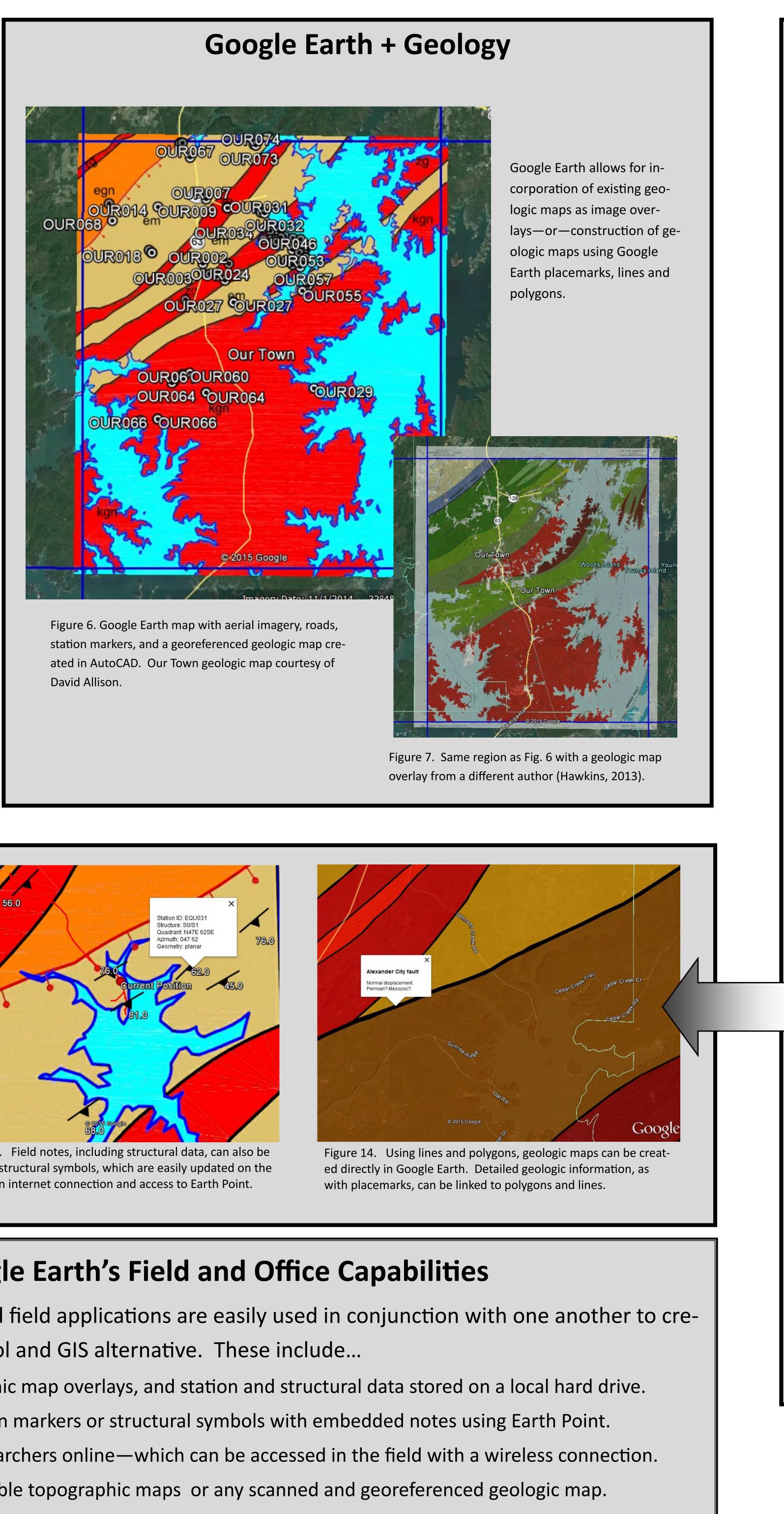
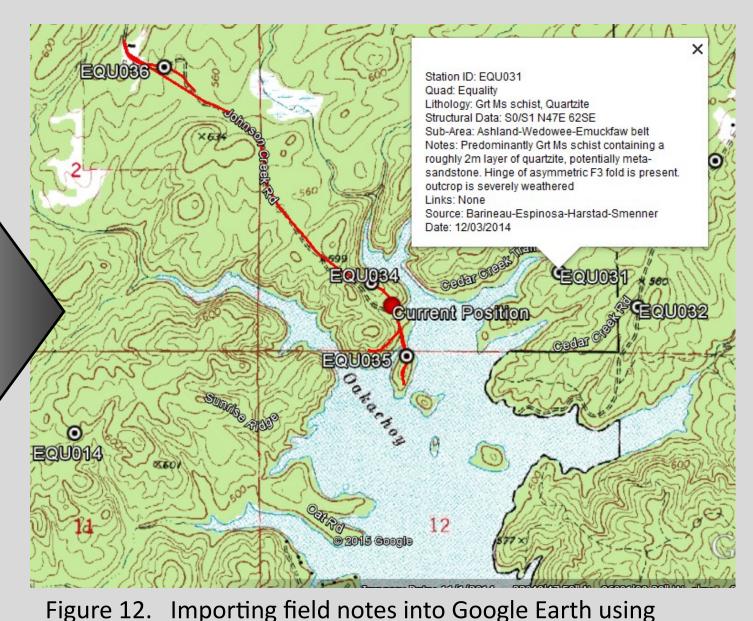
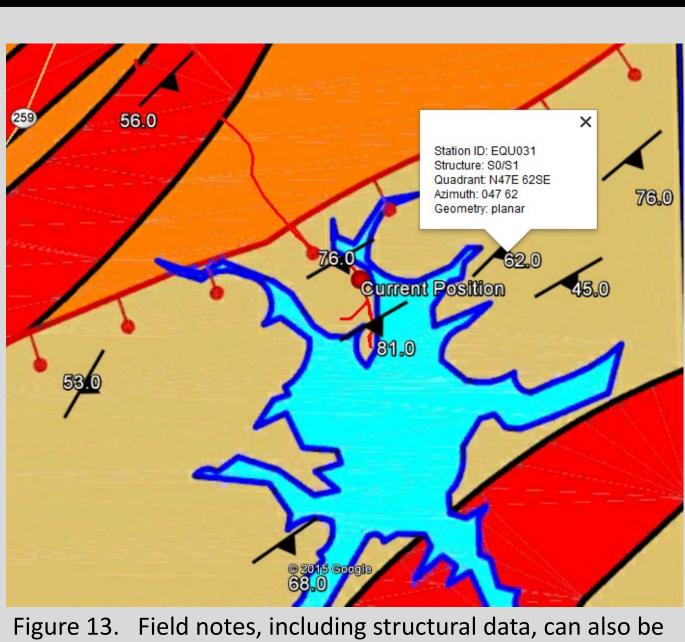


Figure 5. Free georeferenced topographic maps allow for traditional visual spatial analysis of topography, without the disadvantage of outdated road information.

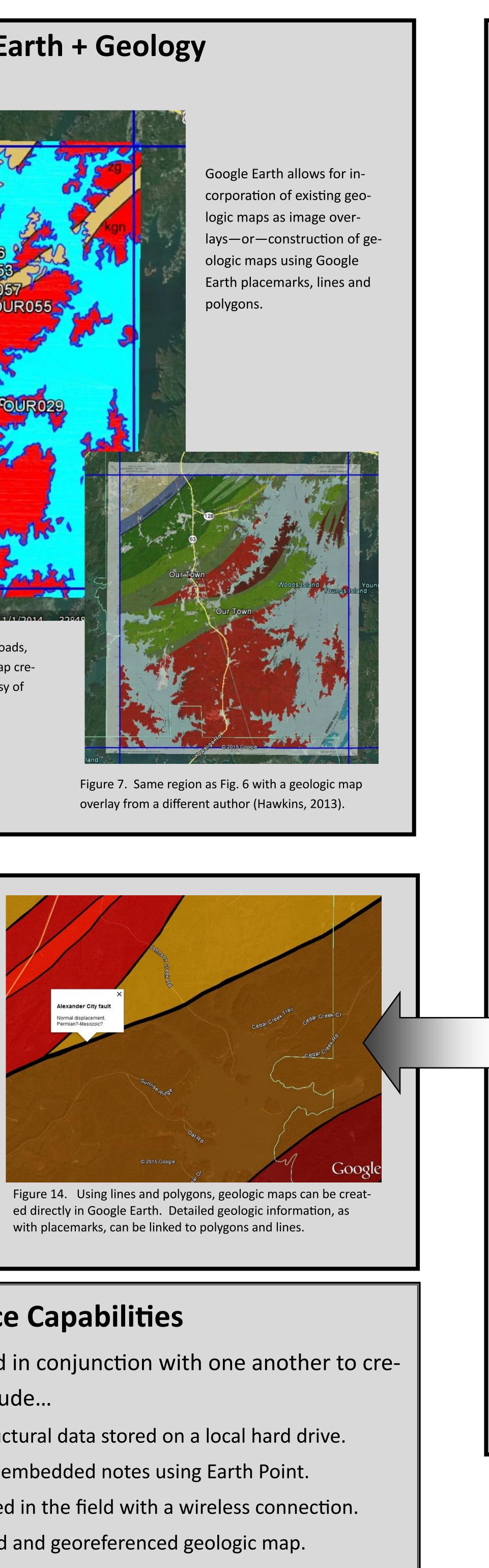




placemarks created with Earth Point allows for quick acce field notes in spatial context—all while in the field.



nked to structural symbols, which are easily updated on the fly with an internet connection and access to Earth Point



Synthesizing Google Earth's Field and Office Capabilities

Because of Google Earth's portability, office and field applications are easily used in conjunction with one another to create a simple but powerful geologic mapping tool and GIS alternative. These include...

- Easy access to photographs, geologic and topographic map overlays, and station and structural data stored on a local hard drive.
- The ability to quickly incorporate new data as station markers or structural symbols with embedded notes using Earth Point.
- The ability to easily share map data with other researchers online—which can be accessed in the field with a wireless connection.
- GPS tracking in real time relative to free downloadable topographic maps or any scanned and georeferenced geologic map.

Google Earth in the Office

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Figure 9. Earth Point creates Google Earth placemarks using data from an Excel spreadsheet.

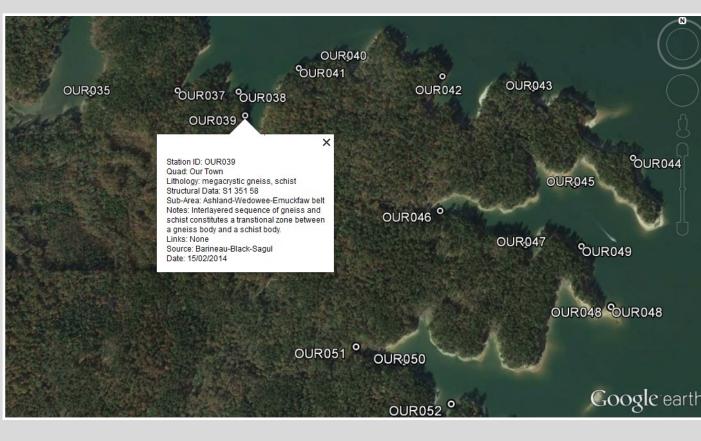
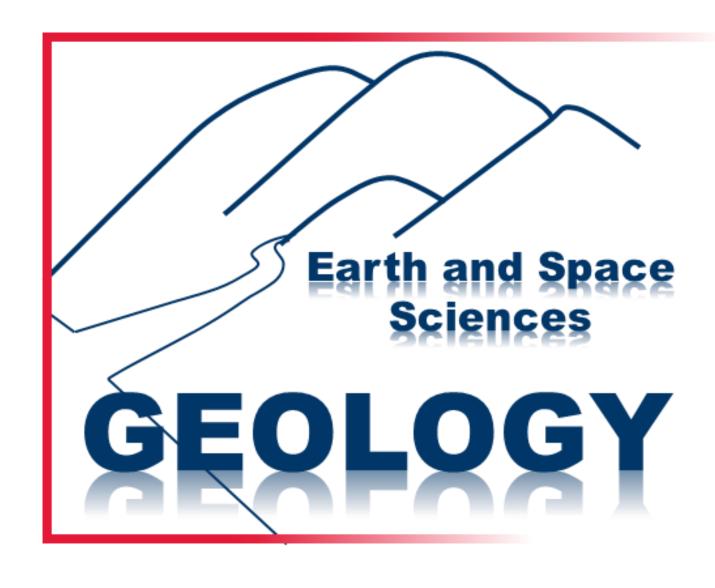


Figure 10. Google Earth placemarks created using Earth Point. Each station can include information on lithology. stra tigraphy, structure, field notes, or any other data from an



Figure 11. Custom placemarks, such as these strike and dip symbols, can be created from any raster image and bulk inserted from an Excel spreadsheet. By incorporating azimuth information, structural symbols can be rotated into their prop er orientation.





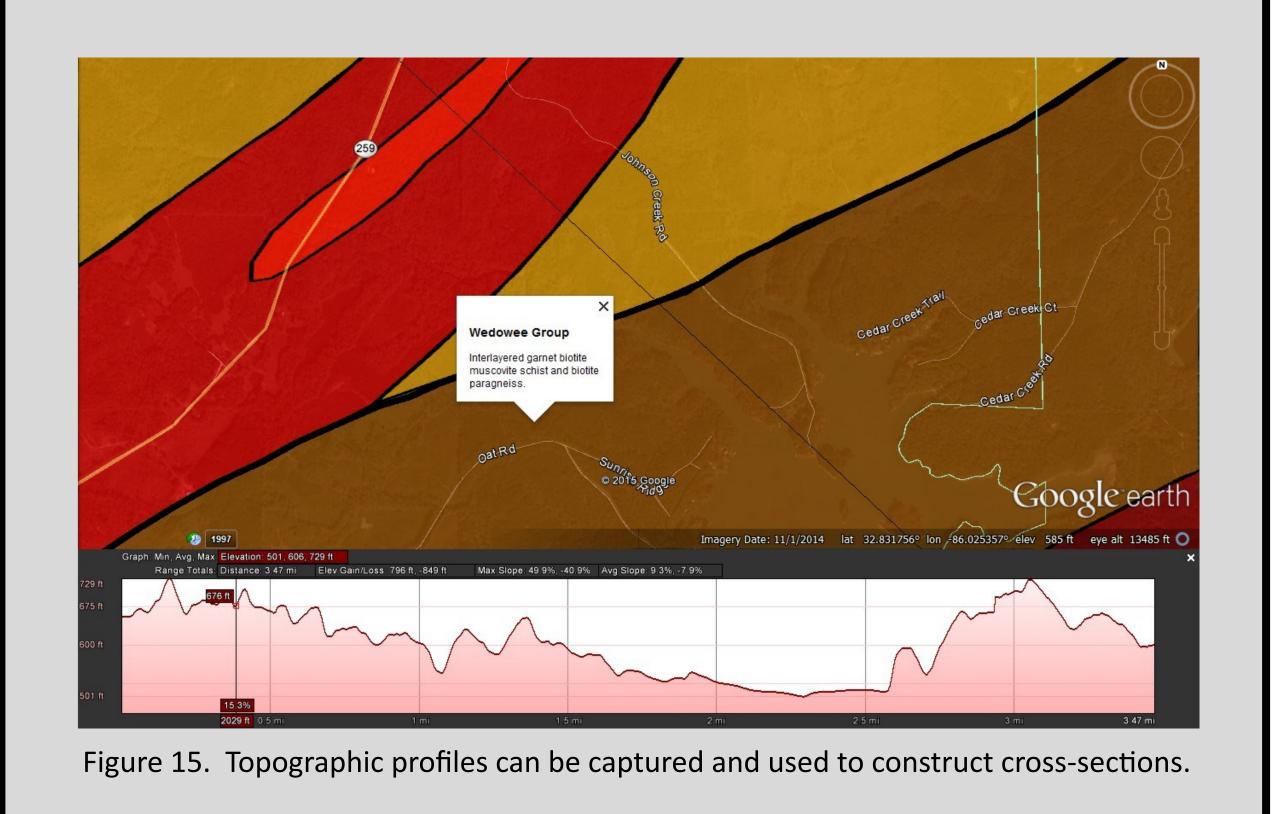
Google Earth and Earth Point

Earth Point is an online software package, free to academic users, which allows large datasets to quickly be converted into Google Earth files. In our applications...

- Station data is stored in a Microsoft Access database, including: latitude-longitude and/or UTM coordinates, lithology, stratigraphic unit, quadrangle data, structural data, and other field notes. Use of Access allows data to be gueried and facilitates extraction of pertinent data for use with Google Earth.
- Queried data is exported to an Excel spreadsheet and formatted according to Earth Point guidelines. Excel columns identify location and placemark details—and include data on lithology, stratigraphy, structure, and notes to be embedded in each placemark.
- Inserted data may also include hyperlinks, images, and any dataset which can be accessed on a local computer or tablet or over the web.
- Custom icons, including structural symbols, can be used as placemarks and may be rotated based on an azimuth value added to the Excel spreadsheet.
- Earth Point allows registered users to plot up to 35,000 data points in a single file. Non-registered users may plot up to 200 points per

Topographic Profiles

 Any line (path) in Google Earth can quickly be used to create a topographic profile, with or without vertical exaggeration.



	Google Earth	GIS
		ArcGIS/AutoCAD Map or Civil3D
GPS interface for real-	X	X
time tracking		
Free	Χ	
Minimum System Re-	Pentium 3, 500Mhz, 512MB RAM,	Intel Pentium 4, 2.2GHz, 2GB
quirements	500MB free space	RAM, 2.4GB free space
Tablet operation	X	
Embedded spatial data in	X	Χ
map elements		
Digital map construction	Χ	Χ
Easy to Learn	X	
Rotated structural sym-	Χ	Χ
bols		
Edge matched polygons		X
Line ornamentation (e.g.		X
fault teeth)		
Querying of map ele-		X
ments		

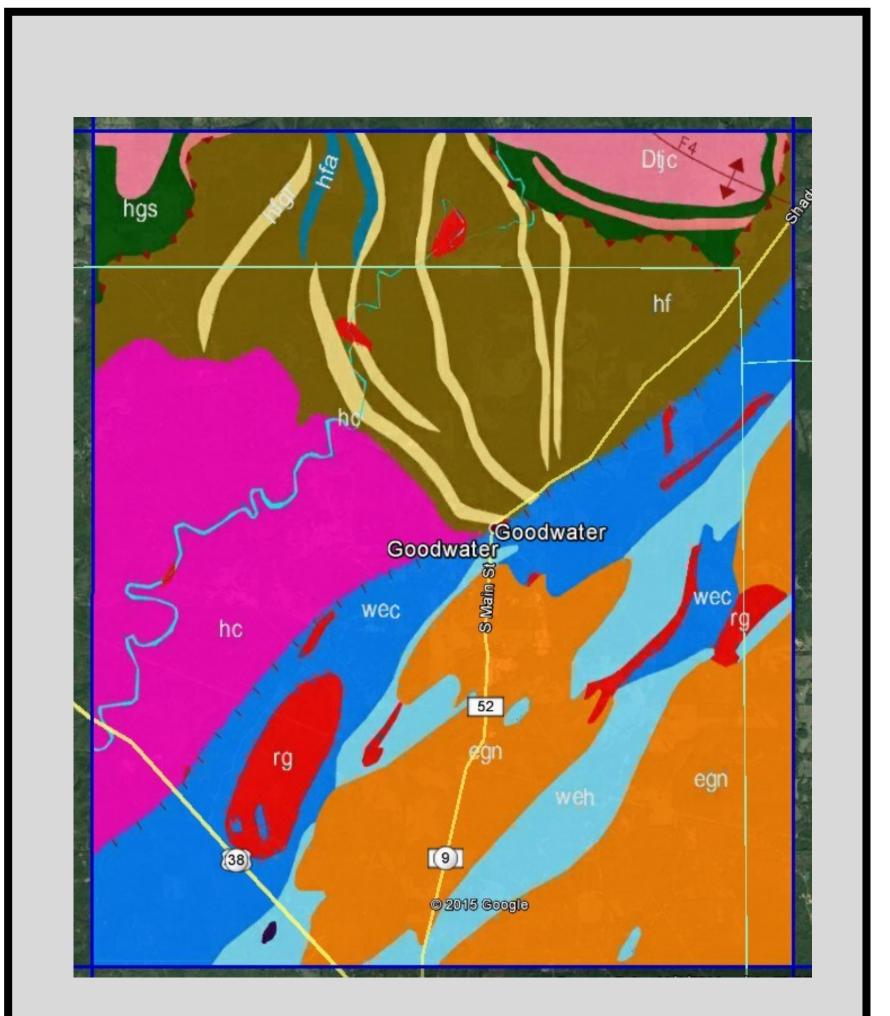


Figure 16. One shortcoming of Google Earth is its inability to ornament fault teeth—unlike this geologic map created in AutoCAD Civil 3D.

Conclusions

The ease of use and functionality of Google Earth make it a "fieldfriendly" software package. Combined with Earth Point, its ability to incorporate large datasets with embedded information compares favorably with GIS software although it lacks the ability to query data tables and has limited functionality with respect to high end geologic map production. We anticipate that Google Earth or a similar product will eventually replace pen and paper mapping, as well as the need for field books in environ ments where electronics can be used in the field.

Acknowledgements and References

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Google Earth vs. GIS