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Central Texas GIS Geologic Map Project: Phase I

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Abstract

Detailed geologic maps are the foundation for any geologic, hydrogeologic, and engineering studies. However, consistent, seamless, detailed geologic maps are lacking for central Texas. In order to manage its groundwater resources with the best available data the District has embarked on a long-term project to produce a digital seamless Geographic Information System (GIS) geologic map. This report summarizes the data sources, procedures, and results of Phase 1. Principle activities include scanning, data conversion to (raster) digital map formats and georeferencing. The final product of Phase I is hosted by the University of Texas at Austin's Texas ScholarWorks, University of Texas Libraries. http://www.lib.utexas.edu/geology/research-guide/maps/texas-gis-geologic-map-project

Introduction

The Barton Springs/Edwards Aquifer Conservation District (District) is tasked with managing the aquifers within its jurisdiction. Detailed geologic maps are the foundation for any geologic, hydrogeologic, and engineering studies. However, consistent, seamless, detailed geologic maps are lacking for central Texas. Within the District a variety of geologic maps representing scales that vary from the Geologic Atlas of Texas (1:250,000) to quadrangle (1:24,000). Those maps represent different levels of geologic details and differing stratigraphic nomenclature. In order to provide the best foundation for hydrogeologic and engineering studies to manage our limited natural resources, a detailed digital geologic map is needed. Additional benefits from the map include its use as geosciences education tool for students and the public.

The District has embarked on a long-term project to produce a digital seamless Geographic Information System (GIS) geologic map. The map would contain an explanation and geodatabase with relevant geologic and hydrogeologic data for central Texas that compiles the best available existing mapping (Figure 1). This report summarizes the data sources, procedures, and results of Phase 1. Principle activities include scanning, data conversion to (raster) digital map formats and georeferencing. The final product of Phase I is hosted by the University of Texas at Austin's Texas ScholarWorks, University of Texas Libraries.

Acknowledgments

Phase I was primarily completed by Chase Svoboda (UT Austin student) that was working as a District intern. Dr. Mark Helper provided oversight and guided the project to completion. Cathy Brown, Eddie Collins, and Amanda Masterson of the Bureau of Economic Geology provided data and helped this project to completion. Dennis Trombatore (Librarian UT Austin's Walter Geology Library) was instrumental in getting these maps and data online and hosted by the University of Texas at Austin's Texas ScholarWorks.

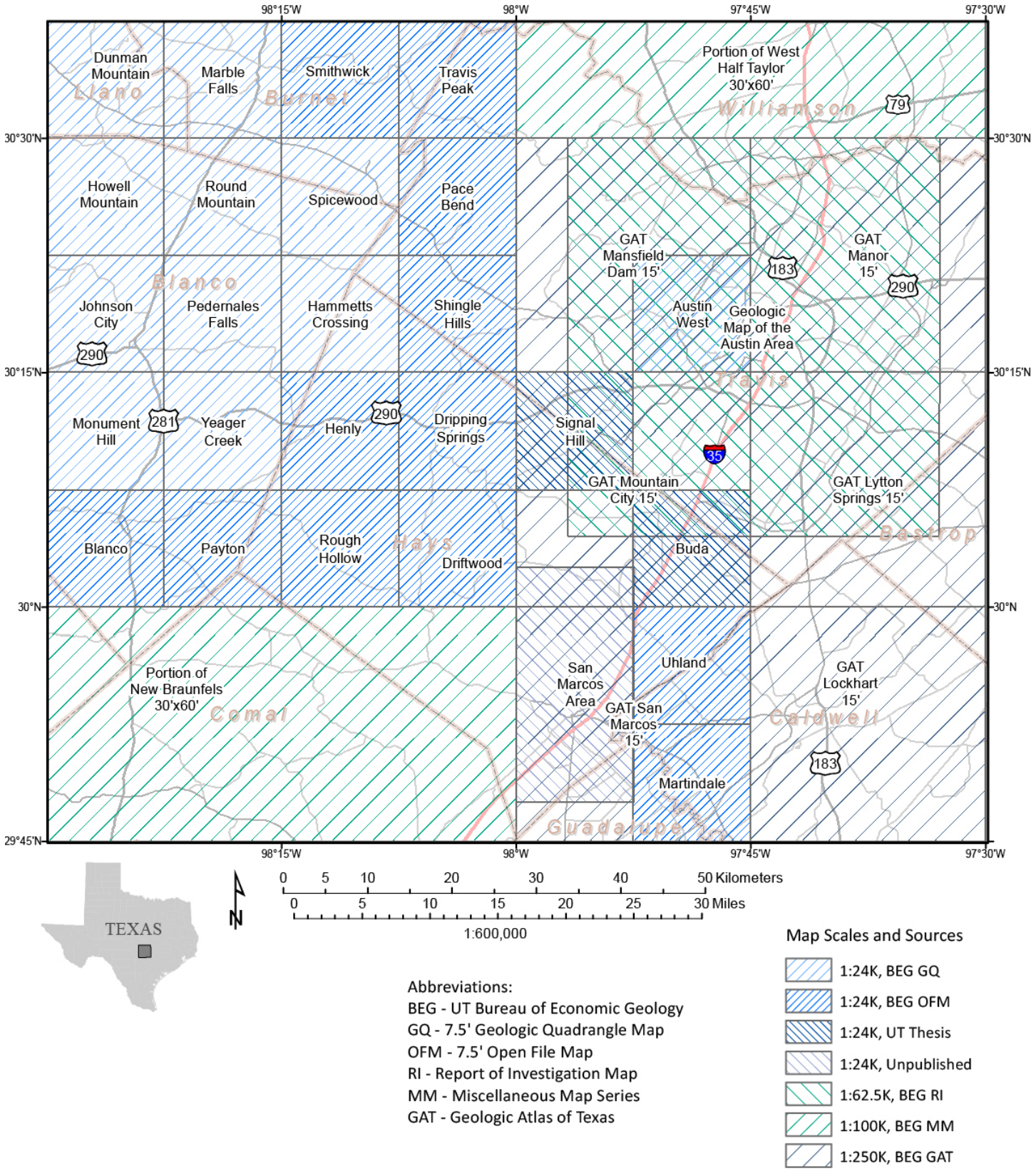

Figure 1. *Study area and index map of best available geologic maps.*

Data Sources

Geologic maps at various scales are available from the Texas Bureau of Economic Geology (BEG; published GQ series and unpublished Open File maps) and the UT-Austin Walter Geology Library, which houses maps of the U.S. Geological Survey (USGS), BEG, UT maps from student theses and other sources. A list of geologic maps in the study are provided in **Appendix A and B**.

Prior to this work, existing 7.5 minute quadrangle maps were available in either: 1) paper format; 2) scanned images of the same (PDF or Tiff formats) or 3) vector GIS format (geodatabases or shapefiles; **Table 1**). Areas that have not been mapped as 7.5 minute quadrangles are covered by the 1:250,000 Geologic Atlas of Texas, available as both a digital geodatabase and scanned versions of the paper map sheets.

Table 1. *Summary of quadrangles and available format (prior to this study)*

	Count
GIS	20
Paper	15
GIS_partial	10
PDF (scanned map)	7
GAT only	4
Total Quads	56

Procedures

An outline of the procedures and tasks in Phase I is given in **Table 2** and further described in the section below.

Table 2. *Phase I outline of tasks*

Task	Description
1	Locate and gather paper maps from the Walter Geology Library and scanned map files from the BEG
2	Scan paper maps and convert existing scanned maps to a uniform format
3	Scan GQ-series map pamphlets and convert to PDF format
4	Crop scanned maps to remove "collars", the white space and ancillary explanatory information around the map edges
5	Georeference scanned maps. This creates coordinate files that GIS software can use to place the maps where they belong on the surface of earth
6	Create metadata for scanned map
7	Convert scanned, collarless maps to KML and GeoPDF formats

Task 1. Locating and Gathering Maps

Previously identified maps (**Appendix A and B**) were located at the Walter Geology Library or from inquiries to Cathy Brown at the Bureau of Economic Geology (BEG). The BEG ultimately provided a large number of the maps in digital (PDF or Tiff) format.

Task 2. Scanning of Paper Maps

Paper copies of maps listed for which there were not already digital copies were scanned on the Walter Geology Library Contex SD4490 map scanner with NextImage software at a resolution of 200 dpi and saved as either uncompressed Index Color (color originals) or panchromatic (gray-scale; blue-line or black and white original) in Tagged Image File Format (.tif).

Already scanned maps from the BEG, were converted to 8-bit color TIFF format via the Export option in Adobe Acrobat Professional. These were then brought into Adobe Photoshop, converted to Indexed Color mode, and saved in TIFF format.

Maps were stored with file names that correspond to either the USGS quadrangle name or the quadrangle name and the source if from a source other than the GQ series (Geologic Quadrangle from the BEG) Scans of maps that were not subsequently georeferenced (see below) were stored in a folder named "Other_Maps".

Task 3. Scanning of Map Pamphlets

All of the published GQ series maps are accompanied by an explanatory pamphlet. These pamphlets were scanned in the Walter Library with an Epson GT-2000 "flat bed" scanner at default resolution and saved in PDF format with file names that correspond to the quadrangle name.

Task 4. Cropping Maps for Use with GIS Software

Collarless versions of all scanned maps were created with the rotation and cropping tools in Adobe Photoshop. Results were saved as Indexed Color TIFF files. Because the spatial reference for all map originals is the North American Datum 1927 (NAD27) Universal Transverse Mercator Zone 14 (UTM) projection, the map neat lines are neither horizontal nor vertical. Upon cropping, all collarless maps thus contain "no data" pixels along their edges (cropping tools only produce a rectangle or square result with horizontal and vertical edges).

Task 5. Georeferencing

Georeferencing is the process of assigning real-world geographic or projected coordinates to the scanned map files. The collared and collarless scanned maps were georeferenced with a GIS tool designed for such (the Georeferencing Toolbar) in ESRI ArcMap 10.2 software.

Collared maps were georeferenced to geographic ("unprojected") North American Datum 1927 (NAD27) coordinates by manually entering the four map corner latitudes and longitudes. Results are stored in the "Collared>Georef_collared" folder.

The same technique for collarless maps resulted in files that did not tile seamlessly, often showing small, unacceptable gaps between maps. A successful second attempt georeferenced the collarless scans to a NAD27 UTM 7.5' quadrangle grid for Texas that was downloaded from the Texas Natural Resources Information Service (TNRIS). Quadrangle map corners were directly referenced to the corresponding grid intersections. The result is a truly seamless tiling of the scanned collarless maps. The spatial reference of these collarless maps is NAD27 UTM zone 14 north. The process used for retaining the georeferencing information relied upon the "Update Georeferencing" tool in the Georeferencing Toolbar, or in a few instances, "Rectify". The Update tool creates two new small files with the original file name but with the extensions ".tfwx" and ".tif.aux.xml" and retains the original map scan for display. The Rectify tool creates a new georeferenced Tiff file of the scanned map that stores the georeferencing coordinates internally. Georefenced collarless maps are stored, along with the original collarless scans, in the "Collarless >UTM_georef" folder.

The NAD27 UTM zone 14 north collarless georeferenced maps described above were subsequently converted to World Geodetic System 1984 (WGS84) geographic coordinates, a necessary step prior to creating KML formatted files. The results of this step are stored in the "Collarless>GCS_georef_WGS84" folder.

Task 6. Metadata

Metadata (data about data, e.g. source, location, referencing tags, descriptions), were created in ArcCatalog and stored as ArcGIS metadata XML files that are available for viewing with ESRI ArcGIS software, or with any internet browser. To facilitate use by more general audiences and to conform with established metadata standards, ESRI ArcGIS-created metadata was exported to Federal Geographic Data Committee (FGDC) CSDGM format files. These files, also in XML, can be viewed in Microsoft Word or other word processing software. They are denoted by the inclusion of "FDGC_metadata" at the end of the file name and are stored in the same folders as the georeferenced maps that they describe.

Task 7. KML File Creation and GeoPDF file creation

Keyhole Markup Language (KML) files are viewable in Google Earth, GIS software that is free, simple to use and widely available. KML versions of the GCS WGS84 collarless maps were created in ArcMap 10.2 by saving each map as a "layer file" and using the ArcGIS "Layer to KML" conversion tool. Parameters for the tool Output Images Properties were 8000 pixels and 150 dpi (**Figure 2**). Once in Google Earth, maps locations were adjusted very slightly to more precisely align with roads in Google Earth satellite imagery and then saved as new KMZ files. Prior to this final step, metadata were copy and pasted from the original Tiff files into the KML files. The final KML files were stored in the "Collarless>KMLs" folder with file names that correspond to the Tiff originals.

GeoPDF files can be used by mobile device software capable of reading and displaying georeferenced PDFs. Conversion to GeoPDF is accomplished in ArcMap by the File "Export Map" option. An option in the Export interface allows export of georeferencing information. Using Print Setup and Layout mode, maps were laid-out at 1:24,000 at a page size that corresponded to the paper original. They were then exported as a PDFs at 200 dpi. Results are saved in the "Collarless>GeoPDFs" folder.

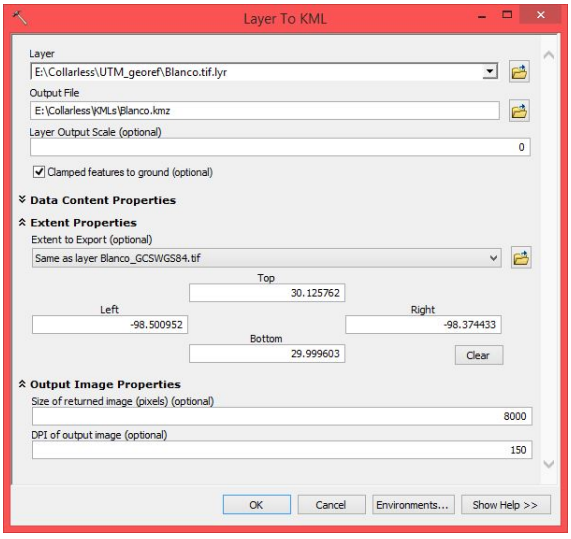

Figure 2: *This is an example of how the Blanco quadrangle was successfully converted into a KML file from a TIFF.*

Files and Folder Organization

Table 3 shows the hierarchy of folders that contain the original results of Phase 1 and were delivered to the District and the University of Texas Libraries.

Folder Name	Description
24k_Index	Files for the 7.5' quadrangle grid used to georeference the scanned, collarless maps.
Collared	File for all scanned and downloaded maps that have been converted to their final Tiff form and georeferenced. These are contained in a sub-folder called "Georef_collared"
Collarless	File for maps from the "Collared" folder that have been cropped and stored with different formats and spatial references in the following subfolders: o *GCS_georef_WGS84* - contains maps that are georeferenced relative to geographic coordinates of the WGS84 datum o GeoPDFs – contains all maps in GeoPDF format o KMLs – the KML version of all maps o UTM_georef – contains all maps that are georeferenced to the NAD27 datum and the UTM zone 14 north projection
GIS_maps	Files for maps that were available in GIS form; provided by the BSEACD.
GQ_Pamphlets	PDF files of the scanned pamphlets that accompanied the GQ maps.
Other_Maps	Scanned maps that were not georeferenced for this project, organized in the following subfolders: o BSEACD_provided_duplicates- PDF or Tiff files provided by B. Hunt at the inception of the project. Georeferenced versions of these OFMs are available in the "Collared" and "Collarless" folders o Miscellaneous – files and subfolders of scanned maps that were not used in the final compilation o Theses_maps – maps from two UT student theses
Scope of Work	File for BSEACD outline of overall project.

Results

All the geologic maps in Phase I are now available online at the University of Texas Libraries Texas ScholarWorks (**Figures 3 and 4)**.

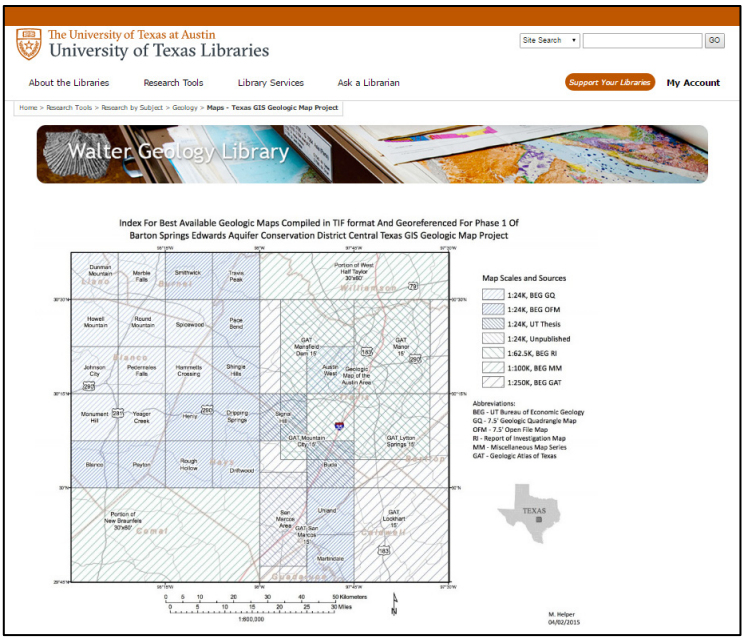

Figure 3. *Screen capture of the main website page where the map data can be accesses.*

Figure 4. *Example screen capture the data that is available on the University of Texas Libraries database and website.*

Future Work

Phase 2 of the project to produce will use the results of Phase I to construct seamless GIS polygons and attributes. Tasks associated with Phase 2 will include:

- Development of GIS schema and database;
- Digitizing;
- Geologic/GIS technical review and attribute standardization committee

Appendix A. Inventory and reference list of Geologic Maps by Quadrangle in the Central Texas Area.

No.	NAME	Primary_Map	Primary BEG Map No	Second Map	Best Available	Comment	Primary Citation
1	ANHALT**	Collins	MM0039		GIS		Collins, E.W., 2000, Geologic Map of the New Braunfels, Texas, 30x60 Minute Quadrangle: University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map MM-39, scale 1:100,000
2	AUSTIN EAST*	Garner et al., 1992, BEG	GB0016		GIS		Garner, L.E. and Young, K.P., 1976, Environmental geology of the Austin area: an aid to urban planning: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations RI-86, scale 1:62,500.
3	AUSTIN WEST*^	Garner et al., 1992, BEG	GB0016	Rodda et al., 1979 GQ-38; USGS SIM 2873	GIS		Garner, L.E. and Young, K.P., 1976, Environmental geology of the Austin area: an aid to urban planning: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations RI-86, scale 1:62,500.
4	DEVILS BACKBONE**	Collins, 2000	MM0039	OFM0031	GIS		Collins, E.W., 2000, Geologic Map of the New Braunfels, Texas, 30x60 Minute Quadrangle: University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map MM-39, scale 1:100,000
5	FISCHER**	Collins, 2000	MM0039		GIS		Collins, E.W., 2000, Geologic Map of the New Braunfels, Texas, 30x60 Minute Quadrangle: University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map MM-39, scale 1:100,000
6	HUNTER**	Collins, 2000	MM0039		GIS		Collins, E.W., 2000, Geologic Map of the New Braunfels, Texas, 30x60 Minute Quadrangle: University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map MM-39, scale 1:100,000
7	HUTTO***	Collins 2005	MM0043	OFM0014	GIS		Collins, E., 2005, Geologic Map of the West Half of the Taylor, Texas, 30 x 60 Minute Quadrangle: Central Texas Urban Corridor Encompassing Round Rock, Georgetown, Salado, Briggs, Liberty Hill, and Leander, Oversize color map, scale 1:100,000
8	JOLLYVILLE*	Garner et al., 1992, BEG	GB0016		GIS		Garner, L.E. and Young, K.P., 1976, Environmental geology of the Austin area: an aid to urban planning: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations RI-86, scale 1:62,500.
9	LEANDER***	Collins 2005	MM0043		GIS		Collins, E., 2005, Geologic Map of the West Half of the Taylor, Texas, 30 x 60 Minute Quadrangle: Central Texas Urban Corridor Encompassing Round Rock, Georgetown, Salado, Briggs, Liberty Hill, and Leander, Oversize color map, scale 1:100,000
10	MONTOPOLIS*	Garner et al., 1992, BEG	GB0016		GIS		Garner, L.E. and Young, K.P., 1976, Environmental geology of the Austin area: an aid to urban planning: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations RI-86, scale 1:62,500.
11	MOUNTAIN CITY^	Grimshaw, in progress		BSEACD, 2008; Garner et al., 1992, BEG; USGS SIM 2873	GIS		Grimshaw T. W., 2013, Geologic Map of the San Marcos North Quadrangle and Adjacent Portions of the Mountain City and San Marcos South Quadrangles, Hays, Caldwell and Guadalupe Counties, Texas: University of Texas at Austin, Jackson School of Geosciences, University of Texas at Austin, in review.scale 1:24,000.
12	NAMELESS***	Collins 2005	MM0043		GIS		Collins, E., 2005, Geologic Map of the West Half of the Taylor, Texas, 30 x 60 Minute Quadrangle: Central Texas Urban Corridor Encompassing Round Rock, Georgetown, Salado, Briggs, Liberty Hill, and Leander, Oversize color map, scale 1:100,000
13	OAK HILL*^	Garner et al., 1992, BEG	GB0016	BSEACD, 2008; USGS SIM 2873	GIS		Garner, L.E. and Young, K.P., 1976, Environmental geology of the Austin area: an aid to urban planning: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations RI-86, scale 1:62,500.

No.	NAME	Primary_Map	Primary BEG Map No	Second Map	Best Available	Comment	Primary Citation
14	PFLUGERVILLE WEST*	Garner et al., 1992, BEG	GB0016		GIS		Garner, L.E. and Young, K.P., 1976, Environmental geology of the Austin area: an aid to urban planning: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations RI-86, scale 1:62,500.
15	ROUND ROCK***	Collins 2005	MM0043	OMF0013	GIS		Collins, E., 2005, Geologic Map of the West Half of the Taylor, Texas, 30 x 60 Minute Quadrangle: Central Texas Urban Corridor Encompassing Round Rock, Georgetown, Salado, Briggs, Liberty Hill, and Leander, Oversize color map, scale 1:100,000
16	SAN MARCOS NORTH	Grimshaw, 2013		USGS SIM 2873; BSEACD, 2008	GIS		Grimshaw T. W., 2013, Geologic Map of the San Marcos North Quadrangle and Adjacent Portions of the Mountain City and San Marcos South Quadrangles, Hays, Caldwell and Guadalupe Counties, Texas: University of Texas at Austin, Jackson School of Geosciences, University of Texas at Austin, in review.scale 1:24,000.
17	SATTLER**	Collins, 2000	MM0039	western portion of quad	GIS		Collins, E.W., 2000, Geologic Map of the New Braunfels, Texas, 30x60 Minute Quadrangle: University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map MM-39, scale 1:100,000
18	SMITHSON VALLEY**	Collins, 2000	MM0039		GIS		Collins, E.W., 1992, Geologic map of the Smithson Valley quadrangle, Texas: University of Texas at Austin, Bureau of Economic Geology, Open-File Map OFM0106, scale 1:24,000
19	SPRING BRANCH**	Collins, 2000	MM0039		GIS		Collins, E.W., 2000, Geologic Map of the New Braunfels, Texas, 30x60 Minute Quadrangle: University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map MM-39, scale 1:100,000
20	WIMBERLEY**	Collins, 2000	MM0039	USGS SIM 2873	GIS		Collins, E.W., 2000, Geologic Map of the New Braunfels, Texas, 30x60 Minute Quadrangle: University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map MM-39, scale 1:100,000
21	BEE CAVE*	Garner et al., 1992, BEG	GB0016		GIS_partial	eastern half	Garner, L.E. and Young, K.P., 1976, Environmental geology of the Austin area: an aid to urban planning: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations RI-86, scale 1:62,500.
22	BUDA*^	Garner et al., 1992, BEG	GB0016	BSEACD, 2008; USGS SIM 2873	GIS_partial	northern portion of quad	Garner, L.E. and Young, K.P., 1976, Environmental geology of the Austin area: an aid to urban planning: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations RI-86, scale 1:62,500.
23	CREEDMOOR*	Garner et al., 1992, BEG	GB0016		GIS_partial	northern portion of quad	Garner, L.E. and Young, K.P., 1976, Environmental geology of the Austin area: an aid to urban planning: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations RI-86, scale 1:62,500.
24	LYTTON SPRINGS*	Garner et al., 1992, BEG	GB0016		GIS_partial	NW corner; See Collins 2005 east of quad	Garner, L.E. and Young, K.P., 1976, Environmental geology of the Austin area: an aid to urban planning: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations RI-86, scale 1:62,500.
25	LYTTON SPRINGS*	Garner et al., 1992, BEG	GB0016		GIS_partial	western half; See Collins 2005 east of quad	Garner, L.E. and Young, K.P., 1976, Environmental geology of the Austin area: an aid to urban planning: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations RI-86, scale 1:62,500.
26	LYTTON SPRINGS*	Garner et al., 1992, BEG	GB0016		GIS_partial	eastern half	Garner, L.E. and Young, K.P., 1976, Environmental geology of the Austin area: an aid to urban planning: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations RI-86, scale 1:62,500.
27	LYTTON SPRINGS*	Garner et al., 1992, BEG	GB0016		GIS_partial	western half	Garner, L.E. and Young, K.P., 1976, Environmental geology of the Austin area: an aid to urban planning: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations RI-86, scale 1:62,500.

No.	NAME	Primary_Map	Primary BEG Map No	Second Map	Best Available	Comment	Primary Citation
28	SAN MARCOS SOUTH	Grimshaw, 2013		USGS SIM 2873	GIS_partial	northern portion of quad	Grimshaw T. W., 2013, Geologic Map of the San Marcos North Quadrangle and Adjacent Portions of the Mountain City and San Marcos South Quadrangles, Hays, Caldwell and Guadalupe Counties, Texas: University of Texas at Austin, Jackson School of Geosciences, University of Texas at Austin, in review.scale 1:24,000.
29	LYTTON SPRINGS*	Garner et al., 1992, BEG	GB0016	BSEACD, 2008; USGS SIM 2873	GIS_partial	eastern half	Garner, L.E. and Young, K.P., 1976, Environmental geology of the Austin area: an aid to urban planning: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations RI-86, scale 1:62,500.
30	LYTTON SPRINGS*	Garner et al., 1992, BEG	GB0016		GIS_partial	eastern half; See Collins 2005 east of quad	Garner, L.E. and Young, K.P., 1976, Environmental geology of the Austin area: an aid to urban planning: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations RI-86, scale 1:62,500.
31	BLANCO	Collins, 2002	OFM0137		paper		Collins, E.W., 2002, Geologic map of the Blanco quadrangle, Texas: University of Texas at Austin, Bureau of Economic Geology, Open-File Map STATEMAP Study Area 3, scale 1:24,000.
32	DUNMAN MOUNTAIN	Barnes, 1978	GQ0044		paper		Barnes, V.E., 1978, Geology of the Dunman Mountain quadrangle, Llano, Burnet, and Blanco Counties, Texas: University of Texas at Austin, Bureau of Economic Geology, Geologic Quadrangle Map GQ-0044, scale 1:24,000
33	HAMMETTS CROSSING	Barnes, 1982	GQ0051		paper		Barnes, V.E., 1982, Geology of the Hammetts Crossing Quadrangle, Blanco, Hays, and Travis Counties, Texas: University of Texas at Austin, Bureau of Economic Geology, Geologic Quadrangle Map GQ-0051, scale 1:24,000
34	HOWELL MOUNTAIN	Barnes, 1978	GQ0046		paper		Barnes, V.E., 1978, Geology of the Howell Mountain quadrangle, Blanco and Llano Counties, Texas: University of Texas at Austin, Bureau of Economic Geology, Geologic Quadrangle Map GQ-0046, scale 1:24,000
35	JOHNSON CITY	Barnes, 1963	GQ0025		paper		Barnes, V.E., 1963, Geology of the Johnson City Quadrangle, Blanco County, Texas: University of Texas at Austin, Bureau of Economic Geology, Geologic Quadrangle Map GQ-0025, scale 1:24,000.
36	MARBLE FALLS	Barnes	GQ0048		paper		Barnes, V.E., 1982, Geology of the Marble Falls quadrangle, Burnet and Llano Counties, Texas.: University of Texas at Austin, Bureau of Economic Geology, Geologic Quadrangle Map GQ-0048, scale 1:24,000.
37	MARTINDALE	Collins, 2002	OFM0141		paper		Collins, E.W., 2002, Geologic map of the Martindale quadrangle, Texas: University of Texas at Austin, Bureau of Economic Geology, Open-File Map STATEMAP Study Area 8f, scale 1:24,000.
38	MONUMENT HILL	Barnes, 1965	GQ0033		paper		Barnes, V.E., 1967, Geology of the Monument Hill Quadrangle, Blanco County, Texas: University of Texas at Austin, Bureau of Economic Geology, Geologic Quadrangle Map GQ-0033, scale 1:24,000.
39	PEDERNALES FALLS	Barnes, 1982	GQ0049		paper		Barnes, V.E., 1982, Geology of the Pedernales Falls quadrangle, Blanco County, Texas: University of Texas at Austin, Bureau of Economic Geology, Geologic Quadrangle Map GQ-0049, scale 1:24,000
40	ROUND MOUNTAIN	Barnes, 1978	GQ0047		paper		Barnes, V.E., 1978, Geologic map of the Round Mountain quadrangle, Blanco, Burnet, and Llano counties. Texas: University of Texas at Austin, Bureau of Economic Geology, Geologic Quadrangle Map GQ-0047, scale 1:24,000.

No.	NAME	Primary_Map	Primary BEG Map No	Second Map	Best Available	Comment	Primary Citation
41	SMITHWICK	Woodruff, in press	OFM0216		paper		Woodruff, C. M., 2014, Geologic Map of the Smitwick Quadrangle, Texas: University of Texas at Austin, Bureau of Economic Geology, Open-File Map STATEMAP Study Area 9, scale 1:24,000.
42	SPICEWOOD	Barnes, 1982	GQ0050		paper		Barnes, V.E., 1982, Geology of the Spicewood Quadrangle, Blanco, Burnet, and Travis Counties, Texas: University of Texas at Austin, Bureau of Economic Geology, Geologic Quadrangle Map GQ-0050, scale 1:24,000.
43	TRAVIS PEAK	Woodruff, 2013	OFM0210		paper		Woodruff, C.M., 2013, University of Texas at Austin, Bureau of Economic Geology, Geologic Quadrangle Map GQ-0046, scale 1:24,000
44	UHLAND	Collins, 2002	OFM0140		paper		Collins, E.W., 2002, Geologic map of the Uhland quadrangle, Texas: University of Texas at Austin, Bureau of Economic Geology, Open-File Map STATEMAP Study Area 8e, scale 1:24,000.
45	YEAGER CREEK	Barnes, 1967	GQ0034		paper		Barnes, V.E., 1967, Geology of the Yeager Creek Quadrangle, Blanco and Hays Counties, Texas: University of Texas at Austin, Bureau of Economic Geology, Geologic Quadrangle Map GQ-0034, scale 1:24,000.
46	DRIFTWOOD^	Collins, 2002	OFM0144	BSEACD, 2008	PDF		Collins, E.W., 2002, Geologic map of the Driftwood quadrangle, Texas: University of Texas at Austin, Bureau of Economic Geology, Open-File Map STATEMAP Study Area 9, scale 1:24,000
47	DRIPPING SPRINGS	Collins, 2002	OFM0145		PDF		Collins, E.W., 2002, Geologic map of the Dripping Springs quadrangle, Texas: University of Texas at Austin, Bureau of Economic Geology, Open-File Map STATEMAP Study Area 9, scale 1:24,000.
48	HENLY	Collins, 2002	OFM0138		PDF		Collins, E.W., 2002, Geologic map of the Henly quadrangle, Texas: University of Texas at Austin, Bureau of Economic Geology, Open-File Map STATEMAP Study Area 9, scale 1:24,000.
49	PACE BEND	Collins, 2002	OFM0146		PDF		Collins, E.W., 2002, Geologic map of the Pace Bend quadrangle, Texas: University of Texas at Austin, Bureau of Economic Geology, Open-File Map STATEMAP Study Area 9, scale 1:24,000.
50	PAYTON	Collins, 2002	OFM0136		PDF		Collins, E.W., 2002, Geologic map of the Payton quadrangle, Texas: University of Texas at Austin, Bureau of Economic Geology, Open-File Map STATEMAP Study Area 9, scale 1:24,000.
51	ROUGH HOLLOW	Collins, 2002	OFM0148		PDF		Collins, E.W., 2002, Geologic map of the Rough Hollow quadrangle, Texas: University of Texas at Austin, Bureau of Economic Geology, Open-File Map STATEMAP Study Area 9, scale 1:24,000.
52	SHINGLE HILLS	Collins, 2002	OFM0149		PDF		Collins, E.W., 2002, Geologic map of the Shingle Hills quadrangle, Texas: University of Texas at Austin, Bureau of Economic Geology, Open-File Map STATEMAP Study Area 9, scale 1:24,000.
53	DALE	Proctor Jr., Brown, Waechter, Aronow, Pieper, & Barnes, 1974			GAT -scanned		Proctor Jr. C. V., Brown T. E., Waechter N. B. , Aronow S., Pieper M. K., and Barnes V. E., 1974, Geologic Atlas of Texas, Seguin Sheet, University of Texas at Austin, Bureau of Economic Geology, scale1:250,000
54	LOCKHART NORTH	Proctor Jr., Brown, Waechter, Aronow, Pieper, & Barnes, 1974			GAT-scanned		Proctor Jr. C. V., Brown T. E., Waechter N. B. , Aronow S., Pieper M. K., and Barnes V. E., 1974, Geologic Atlas of Texas, Seguin Sheet, University of Texas at Austin, Bureau of Economic Geology, scale1:250,000
55	LOCKHART SOUTH	Proctor Jr., Brown, Waechter, Aronow, Pieper, & Barnes, 1974			GAT-scanned	Fault map extending from the south into Hays County	Proctor Jr. C. V., Brown T. E., Waechter N. B. , Aronow S., Pieper M. K., and Barnes V. E., 1974, Geologic Atlas of Texas, Seguin Sheet, University of Texas at Austin, Bureau of Economic Geology, scale1:250,000

No.	NAME	Primary_Map	Primary BEG Map No	Second Map	Best Available	Comment	Primary Citation
56	MCMAHAN	Proctor Jr., Brown, Waechter, Aronow, Pieper, & Barnes, 1974			GAT-scanned		Proctor Jr. C. V., Brown T. E., Waechter N. B. , Aronow S., Pieper M. K., and Barnes V. E., 1974, Geologic Atlas of Texas, Seguin Sheet, University of Texas at Austin, Bureau of Economic Geology, scale1:250,000

Notes	Corresponding Map Name
*	Austin_Geologic
**	New_Braunfels
***	West_Half_Taylor
^	Unpublished Map provided:

Appendix B. Inventory of (smaller scale) Geologic Maps in the Central Texas Area.

Map Scale	Primary Map	BEG Map No.	Best Available	Full Citation
62,500	Garner & Young, 1976	RI-86	GIS	Garner, L.E. and Young, K.P., 1976, Environmental geology of the Austin area: an aid to urban planning: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations RI-86, scale 1:62,500.
63,360	Whitney, 1956	MM-16	Paper	Whitney, F.L., 1956, Hunter Quadrangle: University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map MM-16, scale 1:63,360.
63,360	Whitney, 1959	MM-16	Paper	Whitney, F.L., 1959, N.W. San Marcos Quadrangle: University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map MM-16, scale 1:63,360.
63,360	Whitney, 1959	MM-16	Paper	Whitney, F.L., 1959, N.E. Austin Quadrangle: University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map MM-16, scale 1:63,360.
63,360	Whitney, 1959	MM-16	Paper	Whitney, F.L., 1959, S.E. Blanco Quadrangle: University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map MM-16, scale 1:63,360.
63,360	Whitney, 1959	MM-16	Paper	Whitney, F.L., 1959, Smithson Valley Quadrangle: University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map MM-16, scale 1:63,360.
63,360	Whitney, 1959	MM-16	Paper	Whitney, F.L., 1959, Spicewood Quadrangle: University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map MM-16, scale 1:63,360.
63,360	Whitney, 1959	MM-16	Paper	Whitney, F.L., 1959, S.W. Austin Quadrangle Map: University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map MM-16, scale 1:63,360.
75,000	Whitney, 1959	MM-16	Paper	Whitney, F.L., 1959, S.W. Blanco Quadrangle: University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map MM-16, scale 1:63,360.
96,400	Small et al, 1996	WRI 96-4306	GIS	Small, T.A., Hanson, J.A., and Hauwert, N.M., 1996, Geologic framework and hydrogeologic characteristics of the Edwards aquifer outcrop (Barton Springs segment), northeastern Hays and southwestern Travis Counties, Texas: U.S. Geological Survey, Water-Resources Investigations Report 96-4306, scale 1:75,000
100,000	Woodruff, 1975	RI-84	Paper	Woodruff, C.M., 1975, Land capability in the Lake Travis vicinity, Texas -- a practical guide for the use of geologic and engineering data: University of Texas at Austin, Bureau of Economic Geology, Report of Investigations RI-84, scale 1:96,400.
100,000	Collins, 2000	MM-0039	Paper	Collins, E.W., 2000, Geologic Map of the New Braunfels, Texas, 30x60 Minute Quadrangle: University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map MM-39, scale 1:100,000
125,000	DeCook, 1963	WSP 1621	Paper	DeCook, K.J., 1963, Geology and ground-water resources of Hays County, Texas: U.S. Geological Survey, Water-Supply Paper 1612, scale 1:125,000.
125,000	Hill & Vaughn, 1902	Folio GF-76	Paper	Hill, R.T. and Vaughan, T.W., 1902, Austin folio, Texas: U.S. Geological Survey, Geologic Atlas of the United States Folio GF-76, scale 1:125,000
200,000	Blome et al., 2005	SIM-2873	GIS	Blome, C.D., Faith, J.R., Pedraza, D.E., Ozuna, G.B., Cole, J.C., Clark, A.K., Small, T.A., and Morris, R.R., 2005, Geologic map of the Edwards aquifer recharge zone, south-central Texas: U.S. Geological Survey, Scientific Investigations Map SIM-2873, scale 1:200,000.
250,000	Collins & Hovorka, 1997	MM-38	Paper	Collins, E.W. and Hovorka, S.D., 1997, Structure Map of the San Antonio Segment of the Edwards Aquifer and Balcones Fault Zone, South-Central Texas: Structural Framework of a Major Limestone Aquifer: Kinney, Uvalde, Medina, Bexar, Comal, and Hays Counties: University of Texas at Austin, Bureau of Economic Geology, Miscellaneous Map MM-38, scale 1:250,000
896,000	Flawn, 1961	Pub No. 6120	Paper	Flawn, P.T., Goldstein, August, King, P.B., and Weaver, C.E., 1961, The Ouachita System: University of Texas, Austin, Publication No. 6120, scale 1:896,000.
1,000,000	Collins, 2002	MM-47	Paper	Collins, E. W., 2008, Geologic map of the Southeast Part of the Austin, Texas, 30 x 60 Minute Quadrangle; Central Texas Population Corridor Encompassing Bastrop and Smithville: University of Texas at Austin, Bureau of Economic Geology, STATEMAP Project Geologic Maps Miscellaneous Map No. 47, scale 1:1,000,000.

Map Scale	Primary Map	BEG Map No.	Best Available	Full Citation
1,000,000	Moore et al., 1993	USGS MISM 1420	Paper	Moore, D.W., Wermund, E.G., Richmond, G.M., and Christiansen, A.C., 1993, Quaternary geologic map of the Austin 4 degrees x 6 degrees quadrangle, United States: U.S. Geological Survey, Miscellaneous Investigations Series Map I-1420(NH-14), scale 1:1,000,000.
24,000	Smith, 1968		paper	Smith, R. M., 1968, Geology of the Buda-Kyle Area, Hays County, Texas: University of Texas at Austin, upublished MS thesis, scale 1:24,000
24,000	Kolb, 1985		paper	Kolb R., 1985, Geology of the Signal Hill Quadrangle, Hays and Travis Counties, Texas: University of Texas at Austin, upublished MS thesis, scale 1:24,000.
24,000	Grimshaw, 2013		Paper	Grimshaw T. W., 2013, Geologic Map of the San Marcos North Quadrangle and Adjacent Portions of the Mountain City and San Marcos South Quadrangles, Hays, Caldwell and Guadalupe Counties, Texas: University of Texas at Austin, Jackson School of Geosciences, University of Texas at Austin, in review.scale 1:24,000.
250,000	Proctor Jr., Brown, Waechter, Aronow, Pieper, & Barnes, 1974	GAT	Paper	Proctor Jr. C. V., Brown T. E., Waechter N. B. , Aronow S., Pieper M. K., and Barnes V. E., 1974, Geologic Atlas of Texas, Seguin Sheet, University of Texas at Austin, Bureau of Economic Geology, scale1:250,000
250,000	Proctor Jr., Brown, Waechter, &McGowen, 1974	GAT	Paper	Proctor, Jr.C. V., Brown T. E. , McGowen J. H. , and Waechter N. B., 1974, Geologic Atlas of Texas, Austin Sheet, University of Texas, Bureau of Economic Geology, scale 1:250,000