

DIGITAL MAPPING TECHNIQUES 2022

The following was presented at DMT'22
May 22 - 25, 2022

The contents of this document are provisional

See Presentations and Proceedings
from the DMT Meetings (1997-2022)

<http://ngmdb.usgs.gov/info/dmt/>

PROPOSAL for

GEMSQLITE

A Third GeMS Publication Format

Jordan T. Hastings
UC Santa Barbara



w/Carlos Gutierrez
CA Resources / CGS



USGS Grant G20AC00014

Good afternoon

As many of you know, my main “shtick” is using relatively simple software - even Excel!
- to assist with geologic maps (GM)
... which continues to lead in fertile, surprising directions

Some of you will have heard parts of this talk before, at DMT Lite last December, or at CDEFG meetings – a shout-out to Jen Athey for advancing that forum

This work is cooperative between USGS/UCSB through a coop there, and my colleague Carlos Gutierrez at CGS.

Thanks to NCGMP for support

BACKGROUND

UC SANTA BARBARA
Geography

GISc Researcher, UCSB

Formerly

Chief Cartographer, NBMG

Long ago / first training

Database Professor, UNR



Leading the integration of natural, social, and information sciences to understand and solve problems of people and the environment

Advanced love / hate relationship with geologic maps in GIS databases

DMT 22 Meeting (Rolla, MO)

24 May 2022

A bit of my background, my bonafides

FOREGROUND



Simplify,
simplify

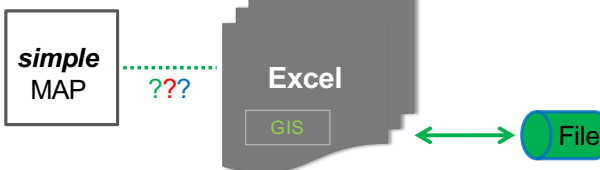
Different focus – the map-user



*Result of six-month
leave from NBMG
ca. 2010, to assist
Magma Energy, a
geothermal startup*

No ArcGIS

*Rockware
and Excel*



DMT 22 Meeting (Rolla, MO)

24 May 2022

In talks at DMT and DMTLite last year, I reported on Excel as a *delivery* mechanism to end-users, Increasingly, I am concerned with the users of our maps, who really need “lite” GIS outside the office.

This concern grew out of my experience with a 6-month leave of absence from NBMG, when I assisted Magma Energy – politely a startup, but really it turned out a Vancouver raider – stimulated by DoE geothermal investments in the wake of the Great Recession 2009-2010

In fairness, Magma did new exploration and new drilling, partially successful, at Soda Lake near Reno. Magma bought and used NBMG maps, it also augmented them borehole analysis and made new field measurements.

I have never forgotten how these maps were used, in particular some of NBMG’s early Open-Files with GIS (in coverages) of the Fallon area. Magma took these to Nevada Blue, rescanned the paper, and redigitized them. We never could make use of Jim Fauld’s mapping-in-progress of the nearby Desert Peak – Brady geothermal area because we had no Esri software for the first year, relying on Rockware instead – and lots of Excel.

We certainly needed a place to store our new geospatial data too: something other

than coverages and shapefiles, some kind of “lighter” data-file.

EXCEL GIS DATA FILE



	Ent/File GDB	Personal GDB	Shapefile	GeoPackage
Raster & Vector	√			√
Editable in situ	√	√	✗	√
ESRI Compatible	√√	✗	√√	√
Standards Support	?		de facto	√

KML is a (wonderful) transport format, but not a data storage format

DMT 22 Meeting (Rolla, MO)

24 May 2022

I looked at various options, ones that were compatible with Esri GIS, which most of us use
Overall, it's apparent that the GeoPackage, based on SQLite with OGC support, is a good, safe choice

BETTER GIS DATA FILE

File



GeoPackage

Non-Esri / Non-MS Personal Geodatabase



An Open Format for Geospatial Data

GeoPackage is an open, standards-based, platform-independent, portable, self-describing, compact format for storing and transporting geospatial data. <https://www.geopackage.org/implementations.html>

DMT 22 Meeting (Rolla, MO)

24 May 2022

For those who aren't familiar with GeoPackage – as I wasn't back in June'21 – here is the elevator pitch
... in Esri-speak it's kinda/sorta a “personal geodatabase”, but without the Microsoft baggage

BETTER GIS DATA FILE



GeoPackage

Non-Esri / Non-MS Personal Geodatabase



An Open Format for Geospatial Data

GeoPackage is an open, standards-based, platform-independent, portable, self-describing, compact format for storing and transporting

geospatial data. <https://www.geopackage.org/implementations.html>



<https://sqlite.org/>

*Small. Fast. Reliable.
Choose any three.*

A small, fast, high-reliability, full-featured, SQL database engine.

And GeoPackage is built atop SQLite, which is a true software jewel.

What is SQLite

- **Small, fast, reliable, *complete* SQL implementation**
- Bit-for-bit compatible cross-platform (PCs, Macs, unices)
- Backward- *and forward*-compatible (to 2050+) data structure
- Patiently maintained & exhaustively tested by old-school programmers
- *Already* installed on (almost) [every computer](#) near you
every iPhone, every Android, Firefox, both ArcGIS & ArcPro (.stylx files)
- Source code backed-up around the world

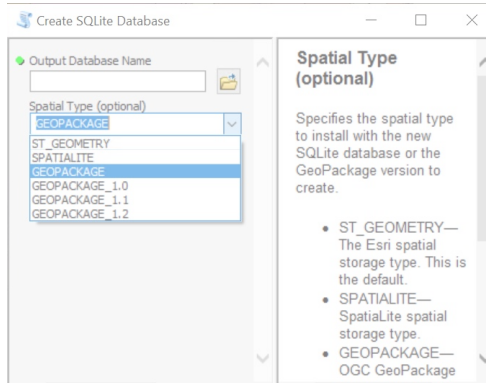
DMT 22 Meeting (Rolla, MO)

24 May 2022

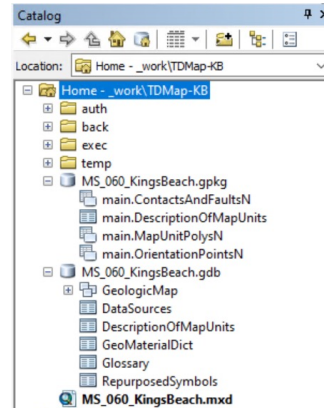
So working back up...
Here are the “Cliff notes” for SQLite

Esri for SQLite

DM Workspace Toolbox



Directly in GUI



DMT 22 Meeting (Rolla, MO)

24 May 2022

This slide just shows where SQLite/GeoPackage appears in the ArcMap Data Management Toolbox

Once a GeoPackage has been created, feature classes can be copy&pasted – even drag&dropped – into the GeoPackage (top) from an Esri geodatabase (bottom)

What is GeoPackage

- Schema for geospatial data in SQLite, with R-Tree spatial indexes
- Single-file implementation of vector and raster data – impressive!
- Built-in support for datums and projections – critical
- Allows non-spatial data, optional persistent joins (RTE)
- Mechanism for special-purpose *extensions*
- Full (read/write) Python and GDAL support [see also SpatiaLite]

DMT 22 Meeting (Rolla, MO)

24 May 2022

And building on SQLite ...
Here are the “Cliff notes” for GeoPackage

Support of GeoPackage



LIBRARY OF CONGRESS

ii. GIS Vector and Raster Combined

ii. GIS Vector and Raster Combined

	Preferred	Acceptable
A. Formats	<p>In order of preference:</p> <ol style="list-style-type: none">1. Most complete data (all layers, appendices), even if proprietary, with a preference for preserving the native format and projection of the data2. Vector and raster formats compatible with widely adopted GIS including:<ol style="list-style-type: none">a. Esri File Geodatabaseb. OGC GeoPackagec. Formats compatible with recommendations and tools from geospatial open source and open data communities; formats supported by well supported open source software libraries such as GDAL, OGR and GeoTools	<ul style="list-style-type: none">> TerraGo GeoPDF> Geospatial PDF

DMT 22 Meeting (Rolla, MO)

24 May 2022

GeoPackage is an accepted, actually preferred, standard for Library of Congress

WHY GeoPackage/SQLite



LIBRARY OF
CONGRESS

- Preeminent FOSS for *portable* GIS data **Small. Fast. Reliable**
- OGC endorsement, DHS reliance, LoC archival recommendation
- Broad GIS support, including Esri (both Map and Pro), QGIS, others
- Built-in support on all mobile devices: tablets, smartphones, etc.
- Directly accessible in Excel (both desktop and Web)
- Other Web-friendly tools available



DB Browser for SQLite

<https://sqlitebrowser.org/>



SQLiteStudio

<https://sqlitestudio.pl/>

DMT 22 Meeting (Rolla, MO)

24 May 2022

Not only standards bodies and archivists, but the broadly through the military, too
If this were a marketing talk, this slide would be titled “Features & Benefits”

PROPOSAL (from DMTLite Dec'21) **for GeMSQLite**

The Proposal

- **What:** Recognize GeoPackage as a third GeMS publication format
- **Why:** Address interoperability and archival stability of GeMS data
- **When:** Quickly! To be presented for discussion at DMT-22 (Rolla)
- **How:** As a draft addendum to the GeMS standard (for now)

DMT 22 Meeting (Rolla, MO)

24 May 2022

I am aware, from CDEFG meetings and elsewhere, that there's interest in non-Esri GIS, notably QGIS
That certainly is the case for "field" users of our maps – and why I continue to explore Excel in the field

But there's even more reason IMO to adopt GeoPackage as a third publication format, which I dub "GeMSQLite", for NCGMP GeMS publications:
+ stays in the Esri "camp" and/but opens-up our product to the GIS world beyond
+ achieves interoperability and archival stability at the same time (a worry with .gdb)
+ can be done quickly, since GeoPackage is already ubiquitous, and it supports everything in GeMS
+ easy implementation for map-makers, as a final step in whatever process they are using – just as it is an addendum to the GeMS standard

PURPOSE **for GeMSQLite**

- **Serve our customers (exploration, geotech, resource managers)**
- **Software they already have, use (from Esri and others)**
- **Access to entire map product, vector and raster, in one file**
- **Publish in one convenient, portable, stable deliverable**

Geological Map "RTE", joined-up and slimmed-down

DMT 22 Meeting (Rolla, MO)

24 May 2022

Here's a summary of what we accomplish with GeMSQLite

{ RTE is Marine-speak for "Ready-to-Eat", as in field rations: "Meals Ready-to-Eat". My grandson is in the Marines. }

PACKAGING for GeMSQLite



Within TerraGo GeoPDF (ISO 32000, LoC support)

- **Provides customizable access to the “paper” product
with “brushable” digital data in (say) an Excel workbook**

Optional, free TerraGo Toolbar for Adobe Acrobat

- **Provides advanced selection, measurement capabilities
includes offline markup and online collaboration**

DMT 22 Meeting (Rolla, MO)

24 May 2022

But wait, there's even more...

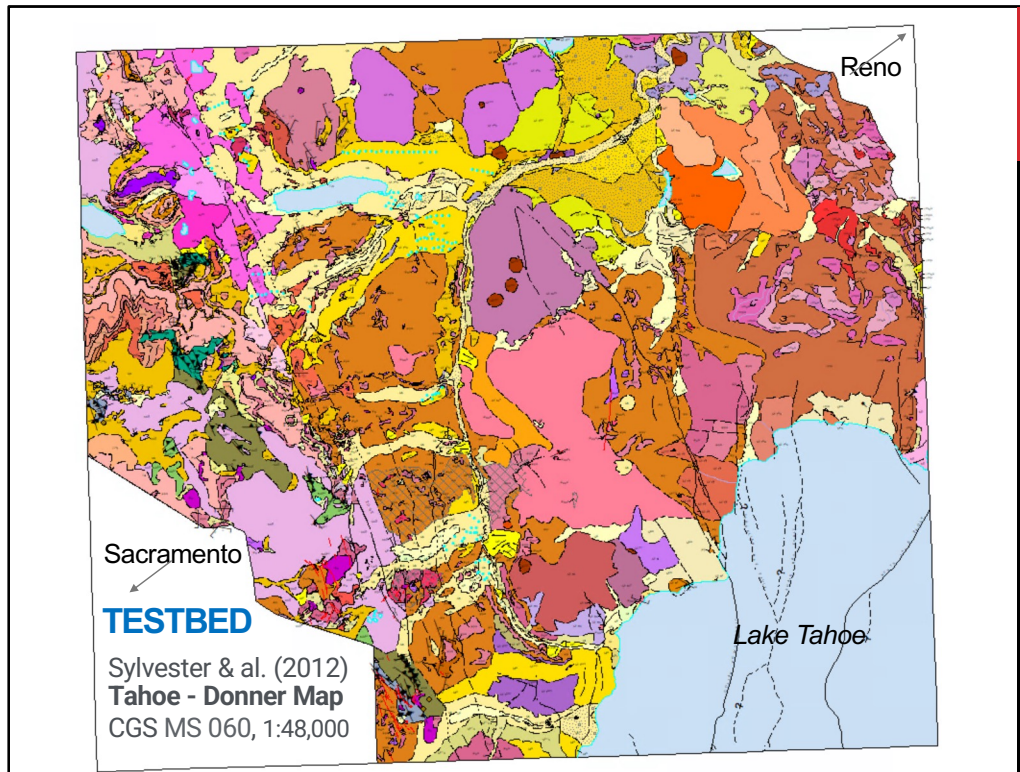
GeoPackage is the data structure of vector data embedded in TerraGO's GeoPDF and the GeoPackage inside a GeoPDF is accessible to other software, e.g. Excel(!), via ODBC so

Users of GeMSQLite could search, analyze, format, print etc. vector data attributes in Excel, and see them highlighted (“brushed”) on the GeoPDFmap
TerraGo's free Toolbar of Adobe Acrobat already goes the other way: reporting attributes for features selected on the GeoPDF map

And one more fillip:

TerraGo's Toolbar also allows making free-form annotations on GeoPDF, both ad hoc and on existing features

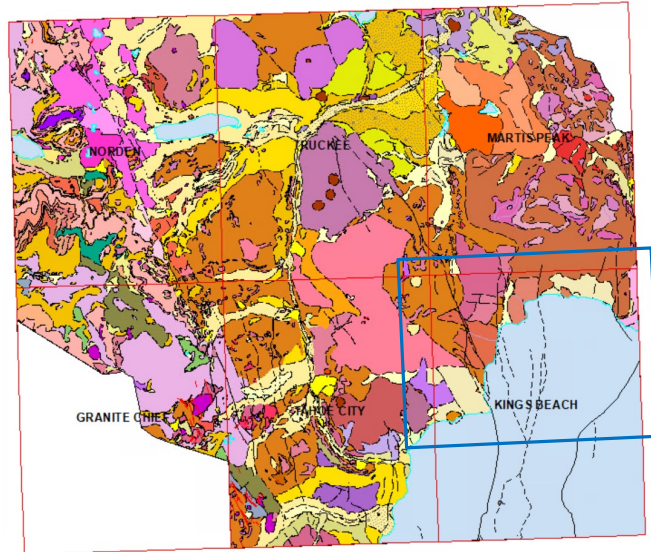
– great for fieldwork, no other software or Internet required



As part of my PhD at UCSB, I took several courses in the (then) Geology Dept. Among other delights there was a 6-quad hand-colored paper compilation of the North Lake Tahoe – Donner Pass area of Northern Sierra Nevada (in my neck of the woods!) posted prominently on Art Sylvester’s office wall. Art kindly mentored me through his field mapping and summer field courses, and eventually nominated me a co-author on this map. I originally prepared it at NBMG (because it includes 100 feet of NV territory at far E edge of quads overlapping the CA/NV boundary). Subsequently my co-author on this talk took over publication via CGS.

The most prominent geologic feature(s) on this map (a couple thousand polygons), include remnant pyroclastic cones and debris from several major eruptions of Miocene age the heavy faulting of the graben on the W. side – oblique normal faults with up ½ km strike-slip, still considered active, along the N. end of the Sierra Nevada mountains – over I-80 Donner Pass, between Reno and Sacramento.

A TESTBED TAHOE-DONNER MAP

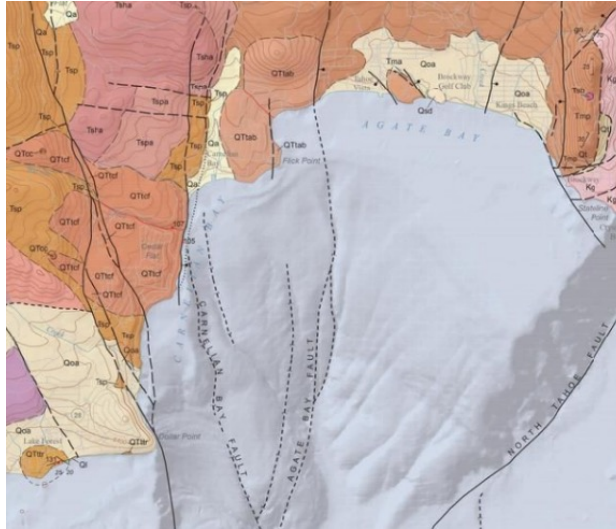


DMT 22 Meeting (Rolla, MO)

24 May 2022

This cartoon identifies the six 1:24K quads, of which our immediate focus is the relatively simple geology at the top of the Lake, the north half of the Kings Beach quad – blue box

TAHOE-DONNER MAP Kings Beach Quad



Relatively simple geology

- Surficial and Igneous units
- Fault structure “in your face” still active and well studied -- even in the lake
- Intra-unit contacts (from lava flows)
- Six station points
- Fine cartography

DMT 22 Meeting (Rolla, MO)

24 May 2022

Here I have zoomed in on that box, the North part of the Kings Beach quad, showing both its relatively simple geology and fine cartography.

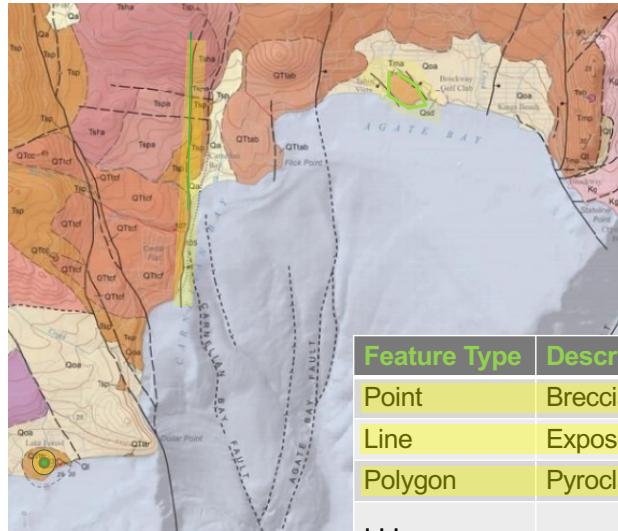
I had – have – been arguing for years that this group needs a “case example” geological map – which always gets objections – but here was one ready to go, with something for ~every geological taste

I will finish this talk in two more slides that show SQLite/GeoPackage in practice

As at DMT21 this June, I went back to the T-D map (CGS MS-060, Sylvester & others), which is a compilation of geology for six quads at the North end of Lake Tahoe over Donner Pass

Here I show the just the North half of the Kings Beach quad, arguable some of the least interesting

TAHOE-DONNER MAP Kings Beach Quad



DMT 22 Meeting (Rolla, MO)

24 May 2022

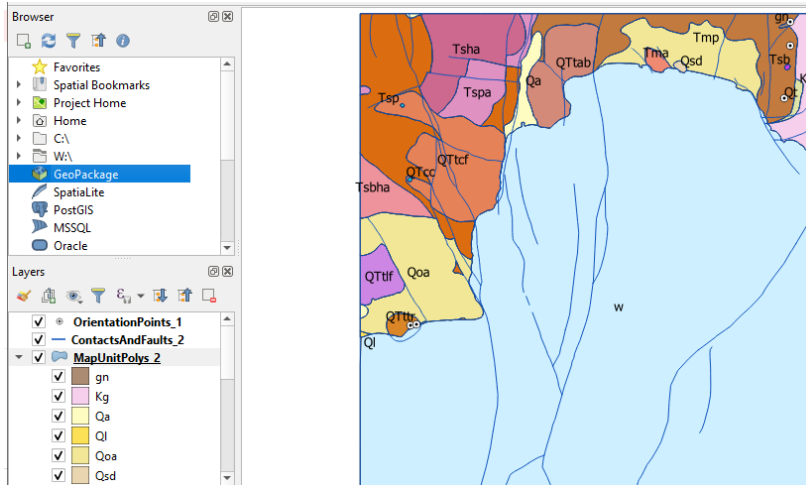
Imagine “brushing” these individual features, one by one, on top of the “fine cartography” .pdf shown before.

I couldn’t get that vision implemented in time for this conference ...but hopefully by DMT Lite this year, a/or at for another CDEFG talk.

TAHOE-DONNER MAP in QGIS Kings Beach Quad



Simplify,
simplify



DMT 22 Meeting (Rolla, MO)

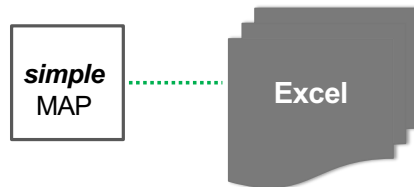
24 May 2022

If the user doesn't have Esri, here is a screen capture of the boxed part of the Kings Beach quad, from the same GeoPackage, displayed in QGIS

BABY STEPS

A crude demo:

Excel by itself as a mapping platform – *who knew?*



DMT 22 Meeting (Rolla, MO)

24 May 2022

Back to my Excel roots now,...

I want to wrap-up with an even simpler – at this point *really crude* – live demo that harks back to my Magma Energy days, a geological map in Excel by itself!

in **EXCEL!**

TAHOE-DONNER MAP

Kings Beach Quad

Simplify,
simplify

DMT 22 Meeting (Rolla, MO) 24 May 2022

Finally, if the user has no GIS at all, here is a screen capture of the boxed part of the Kings Beach quad, from the same GeoPackage, displayed in **Excel!**

Most people have no idea that Excel can make maps, from arbitrary polygons, not just established geography (states, counties, etc.) – but it can!
 Furthermore, that map is actually a miniature version of Google Earth, complete with 3D visualization and flyover

At this time, the cartography is crude, because line feature are not supported, and polygon/unit labels are only not placeable (here I show only pop-ups)

But it is a geological map in Excel.

“The amazing thing is not that the bear dances poorly, but that the bear can dance at all”

THANKS!

[end]

DMT 22 Meeting (Rolla, MO)

24 May 2022

Happy for questions.

DMT 22 Meeting (Rolla, MO)

24 May 2022