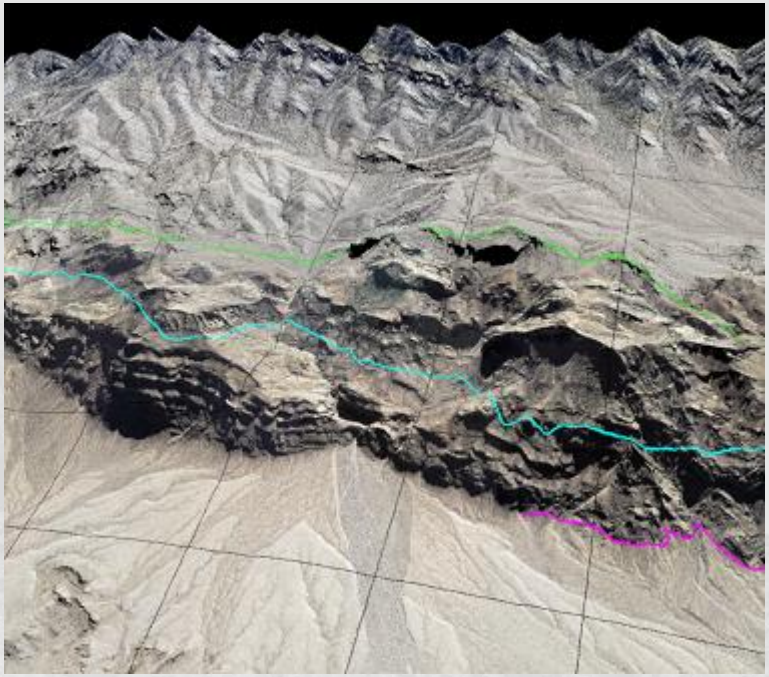


USING 3D GIS TO REVEAL EXTENSIONAL FAULT AND MEGABRECCIA GEOMETRY, WEST SIDE OF THE SHEEP RANGE, NEVADA

Professor Peter L. Guth
Department of Oceanography
United States Naval Academy
Annapolis MD, USA
pguth@usna.edu

T92. Open Data, Open Access: Trends in Geoscience Publications and Data Sources

25-28 SEPTEMBER
GSA 2016
Denver, Colorado, USA

Megabreccias of the Sheep Range Clark County, Nevada

Nevada Petroleum & Geothermal Society 2016 Field Trip Guidebook

Don E. French
Peter L. Guth

NEVADA PETROLEUM & GEOTHERMAL SOCIETY
1986

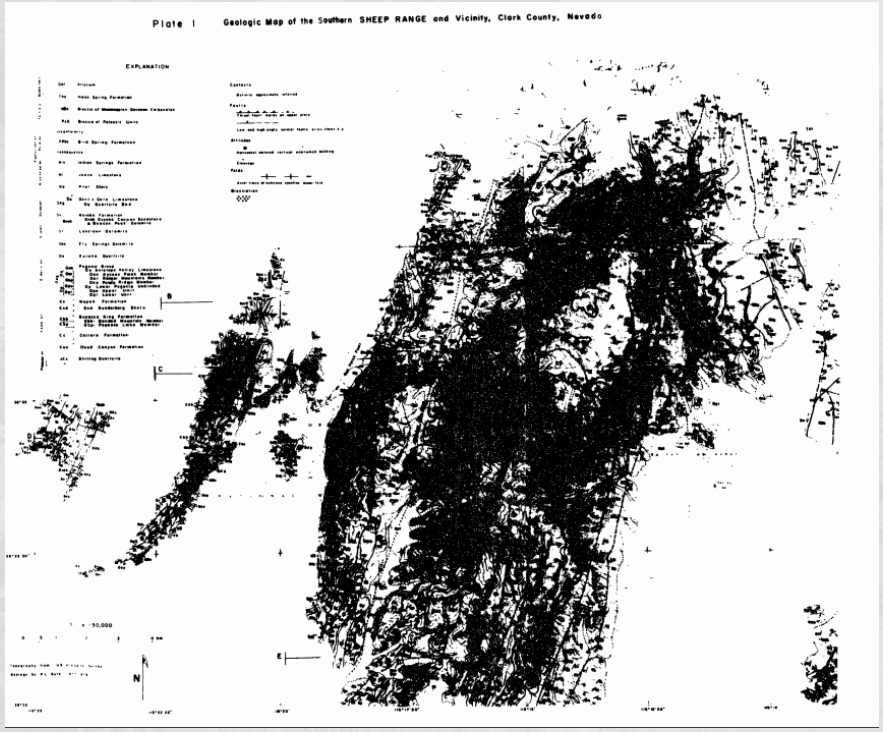
- New look at old data

Publisher:
Nevada Petroleum and Geothermal Society, Inc.
P.O. Box 11526
Reno, Nevada, 89510-1526

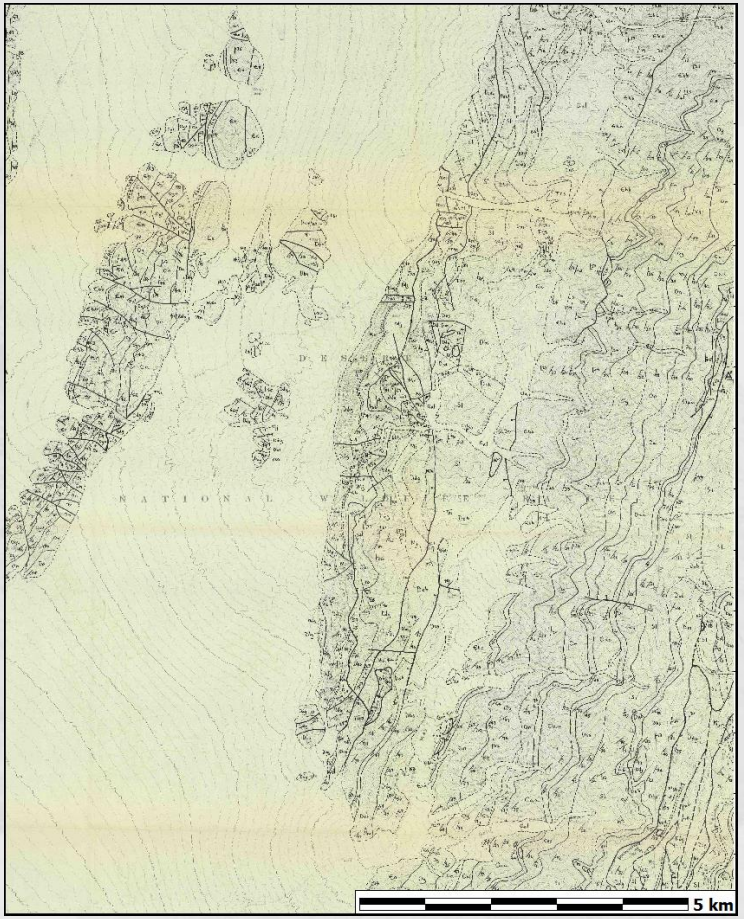
Volume citation:
French, Don E., and Guth, Peter L., 2016, Megabreccias of the Sheep Range, Clark County, Nevada: 2016 Field Trip Guidebook, Nevada Petroleum and Geothermal Society, 50 p.

Field Mapping—Pre GIS, Pre DEMs

- 1977-1979, PhD Mapping
- 1984-1987, unpublished mapping
- GSAB paper, 3 field trip guidebooks

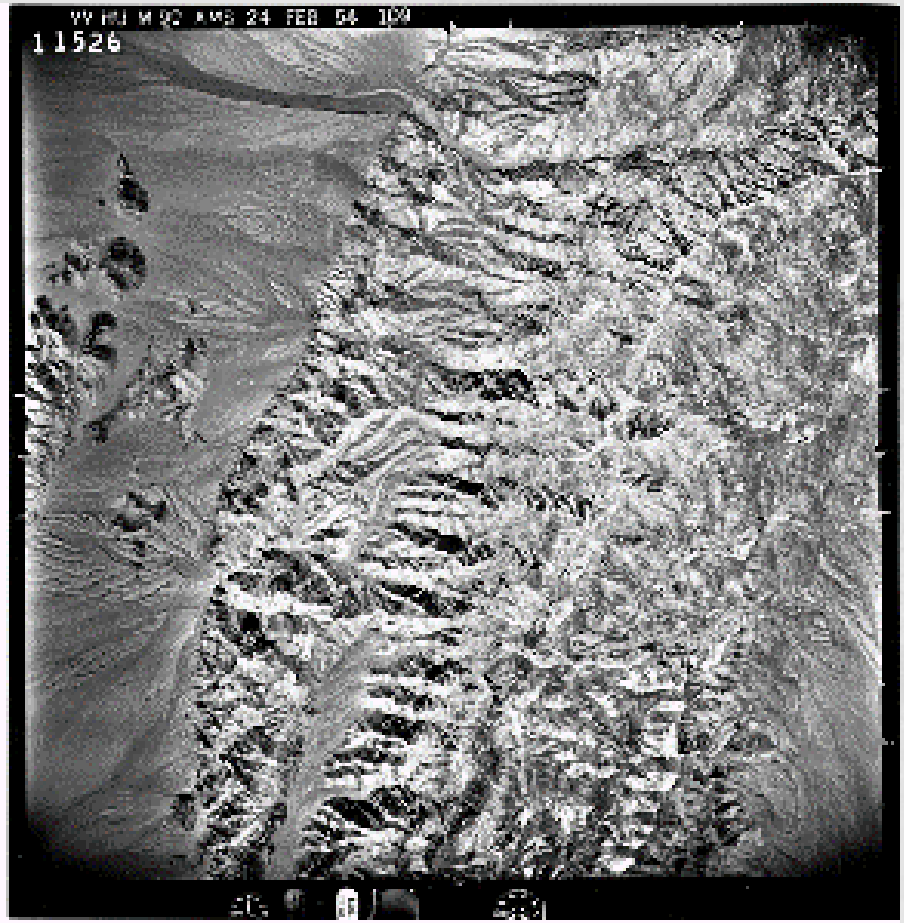


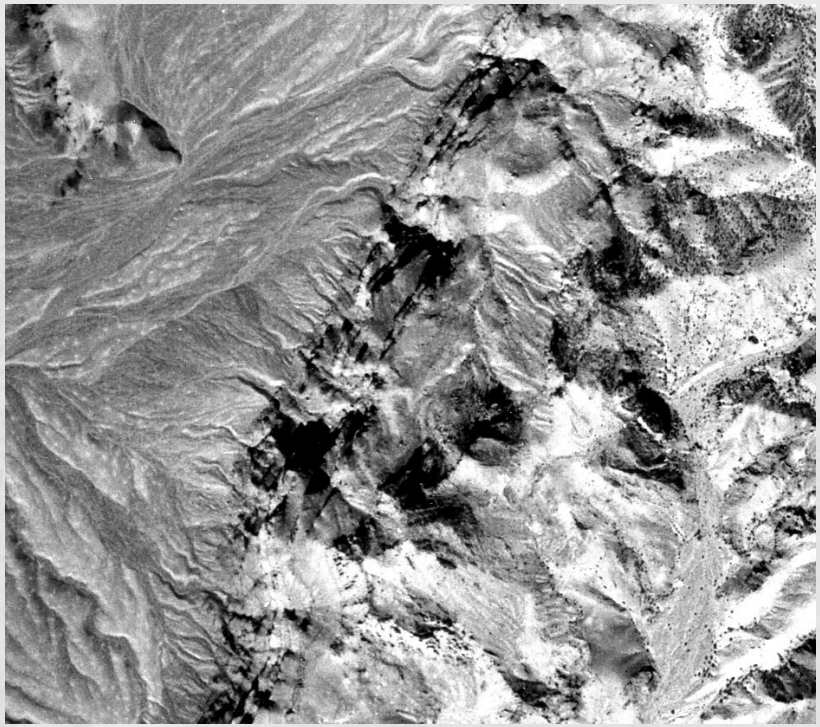
Guth, 1980 (illegible mess)



Guth, 1986 (KMZ online)

1954 Photos, for 1:62.5K Quads

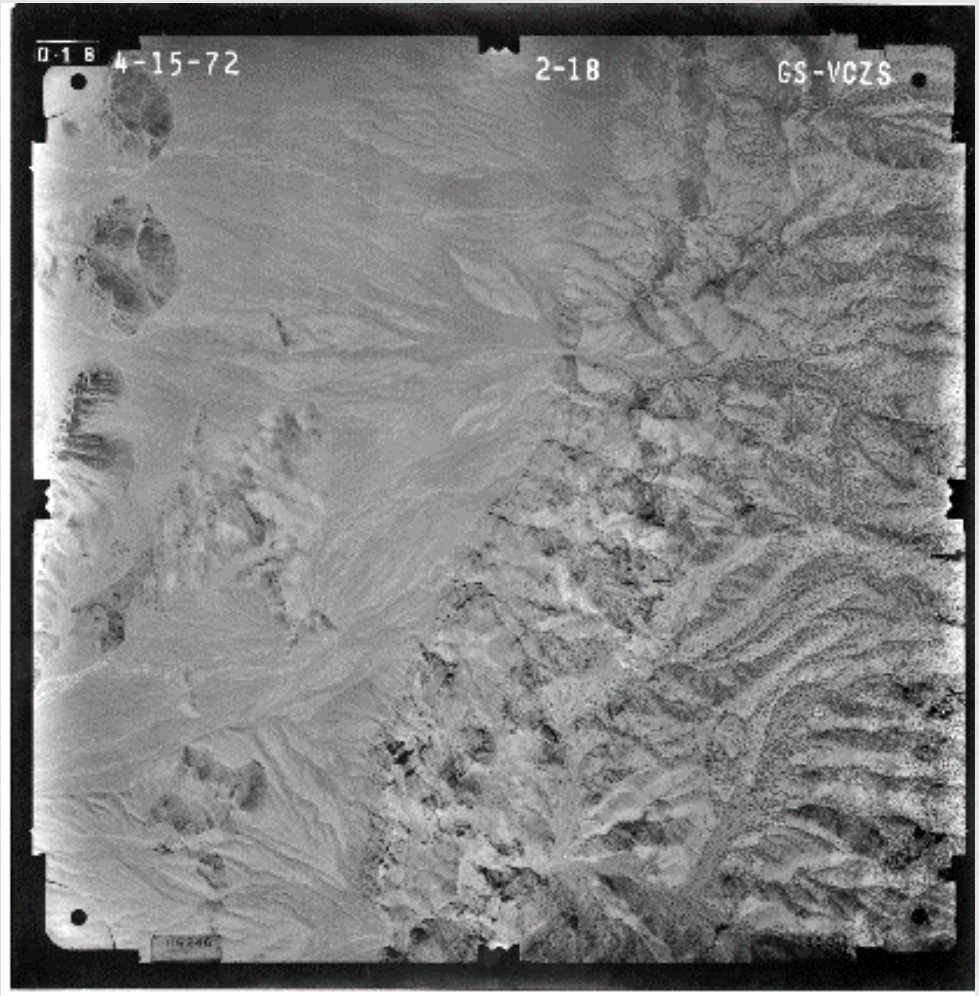


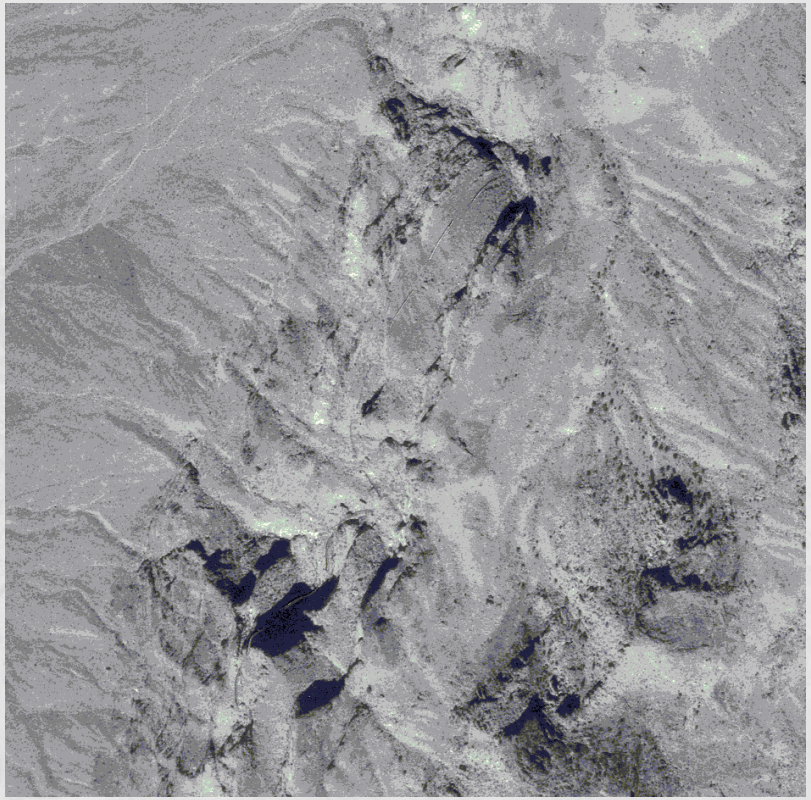


600 dpi scans, full resolution

Not free, then or now

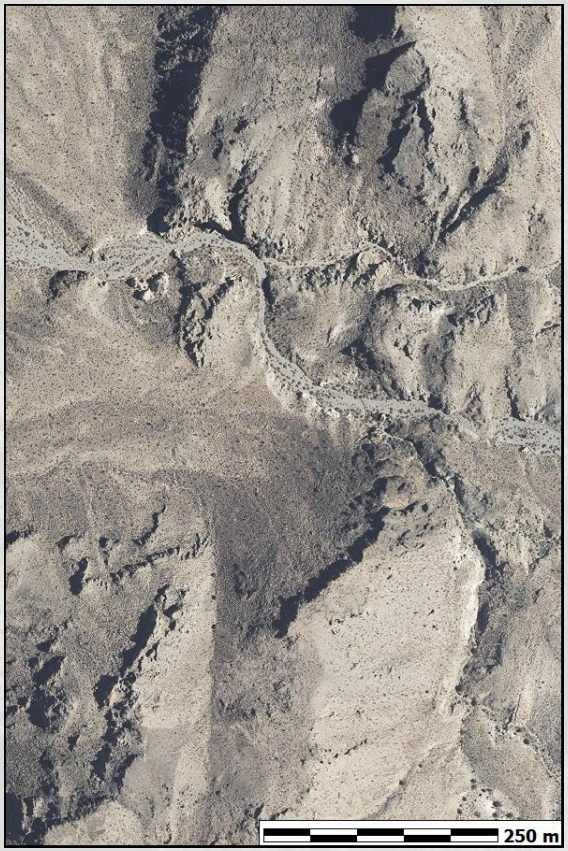
1972 Photos for 1:24K Quads

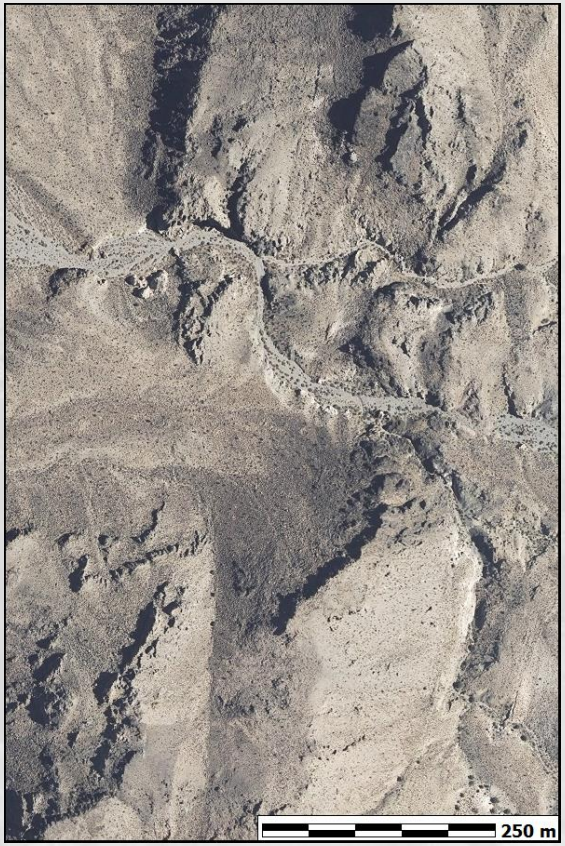


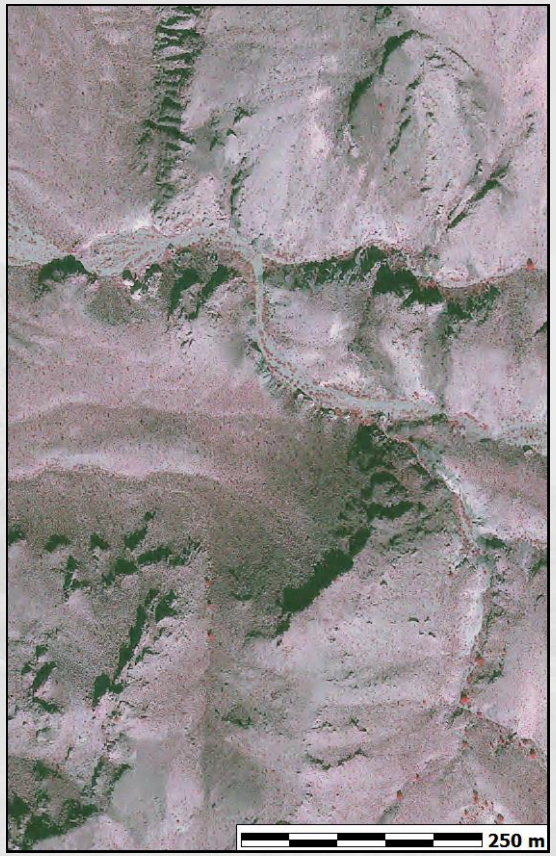


Not free, then or now

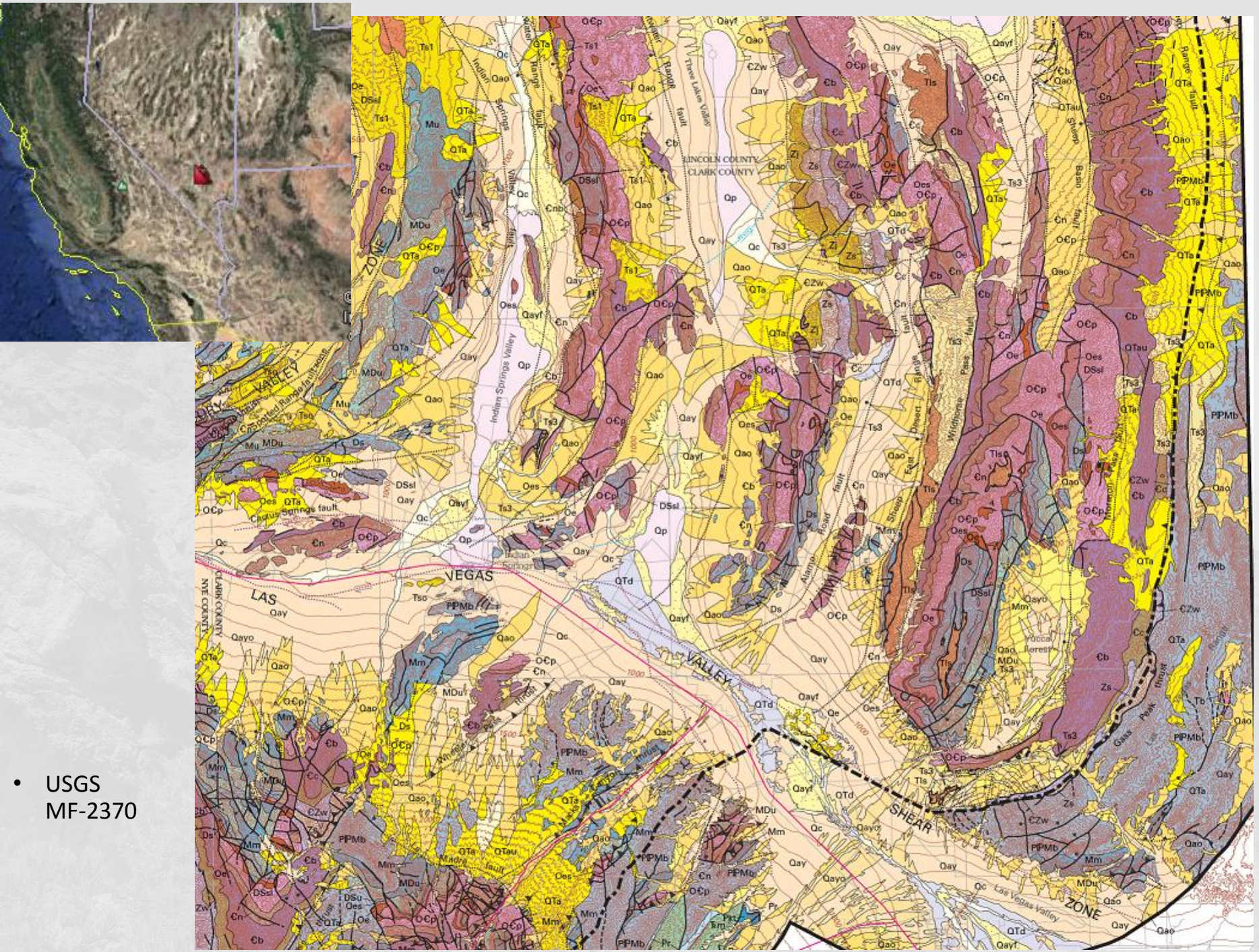
Today's Free 1m True and False Color







Download (about 5 GB) or WMS delivery (parts missing because of Nellis flight restrictions)
Multiple looks have different shadows


LINCOLN COUNTY
CLARK COUNTY
NYE COUNTY
LAS VEGAS VALLEY
SHEAR ZONE
Indian Springs Valley
Cactus Springs fault
Las Vegas Valley

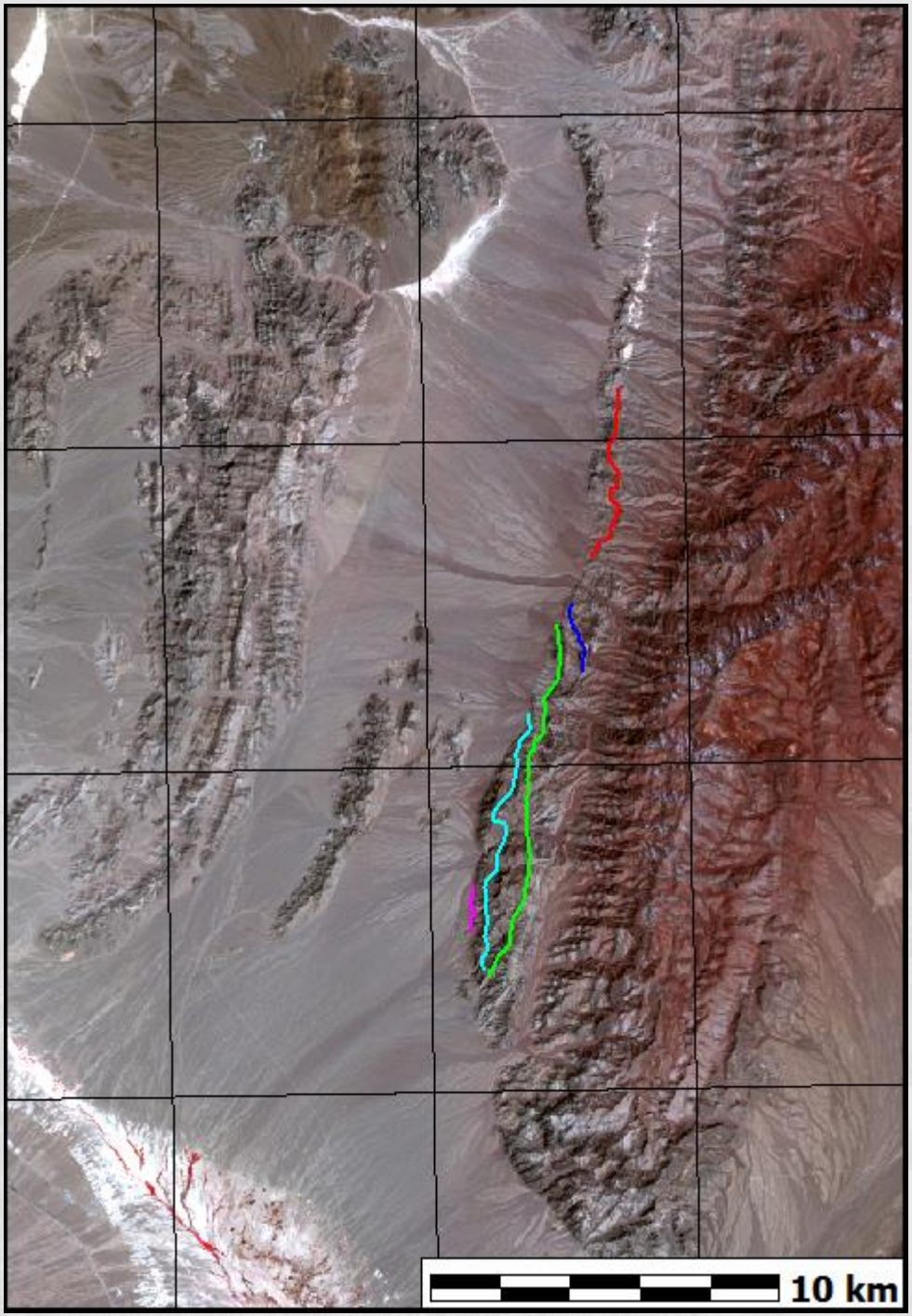
- USGS MF-2370

GIS

- Map based, visual
- Interactive analysis
- Common data formats
  - Rasters in Geotiff or KML/KMZ
  - Vectors in shapefile or KML/KMZ
  - Easily use multiple programs

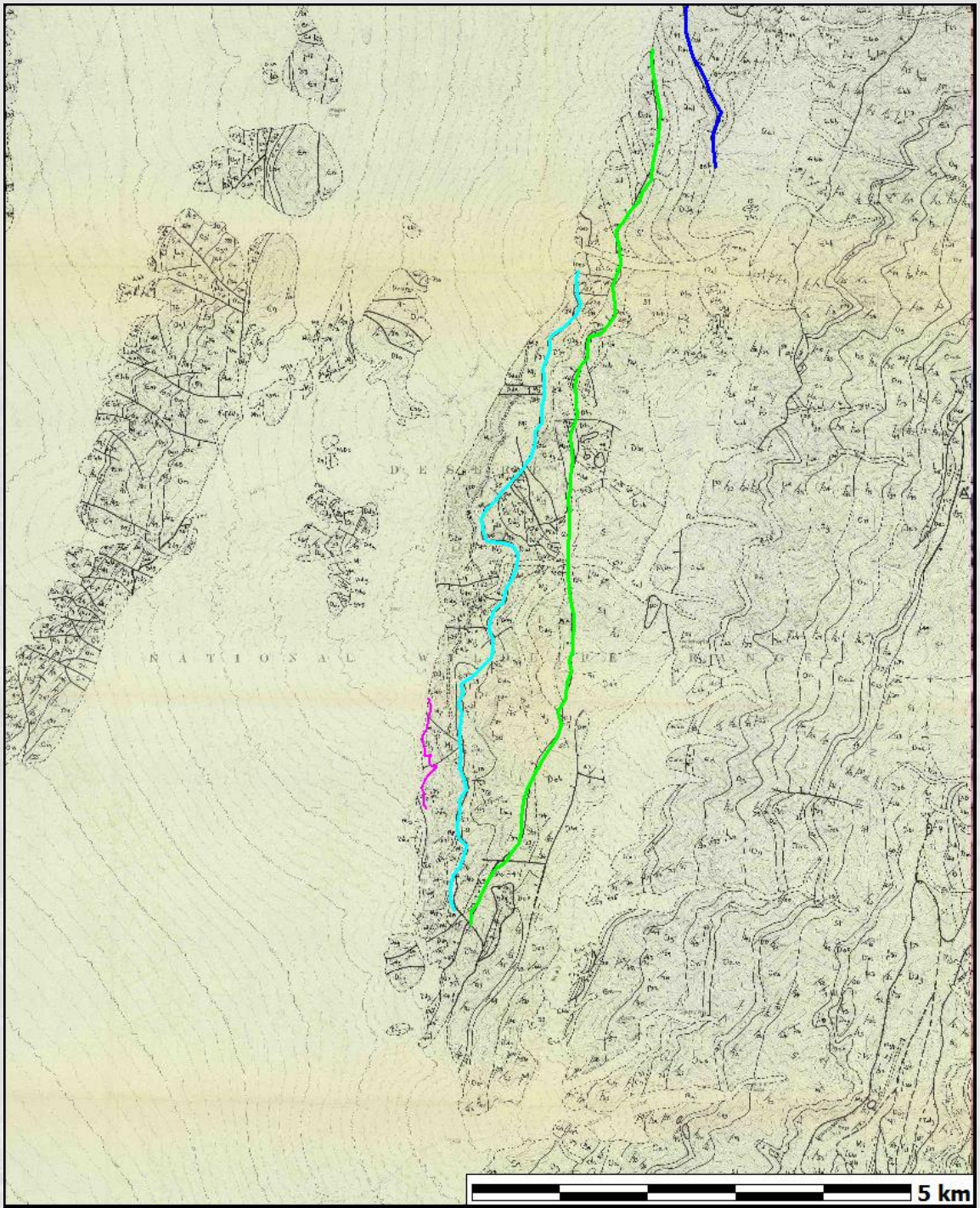
Google Earth

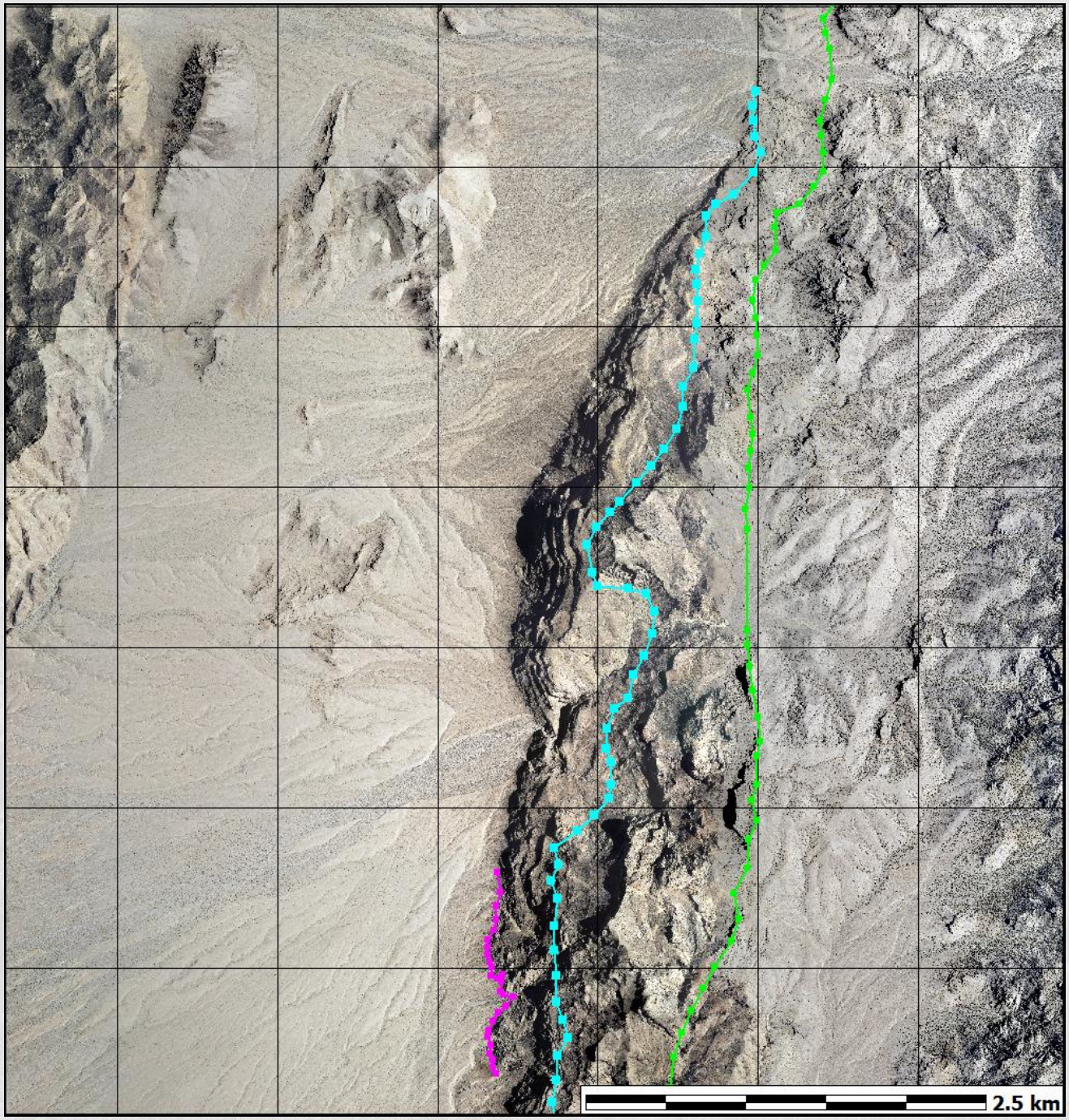
- Simplicity
- Cost (some license restrictions)
- Digitize
- Display
- Not analysis



- Digitized from 1:24K maps (scan mylars)
- Limited photo revision (continuing)
- 5x28 km
- All bedrock to south
- Mostly lake to north

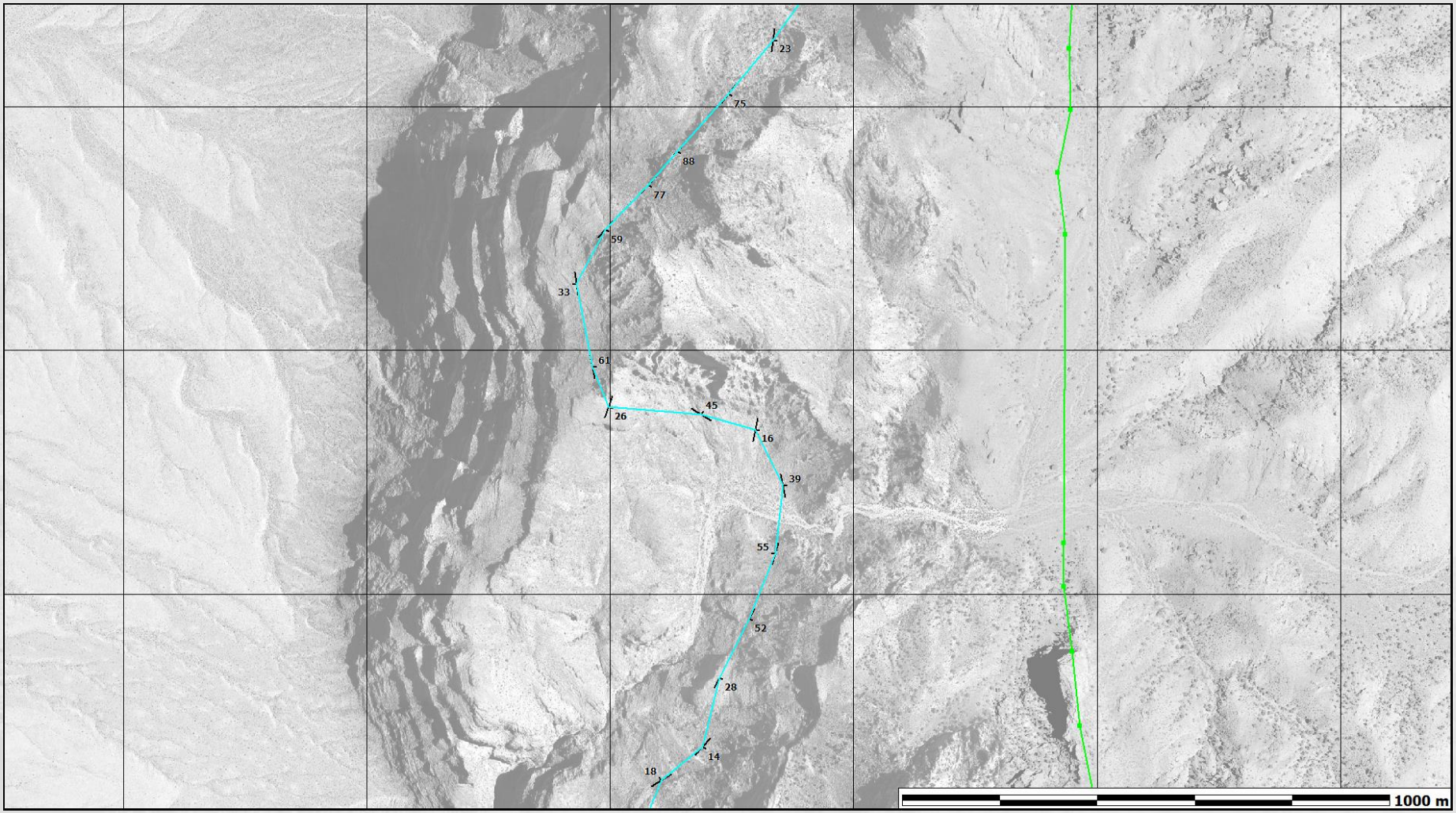
Pine Canyon Fault
Deadman Canyon Fault
Wagon Canyon Fault
Rye Patch Fault
Corral Canyon Fault


Pine Canyon Fault
Deadman Canyon Fault
Wagon Canyon Fault
Rye Patch Fault
Corral Canyon Fault
5 km

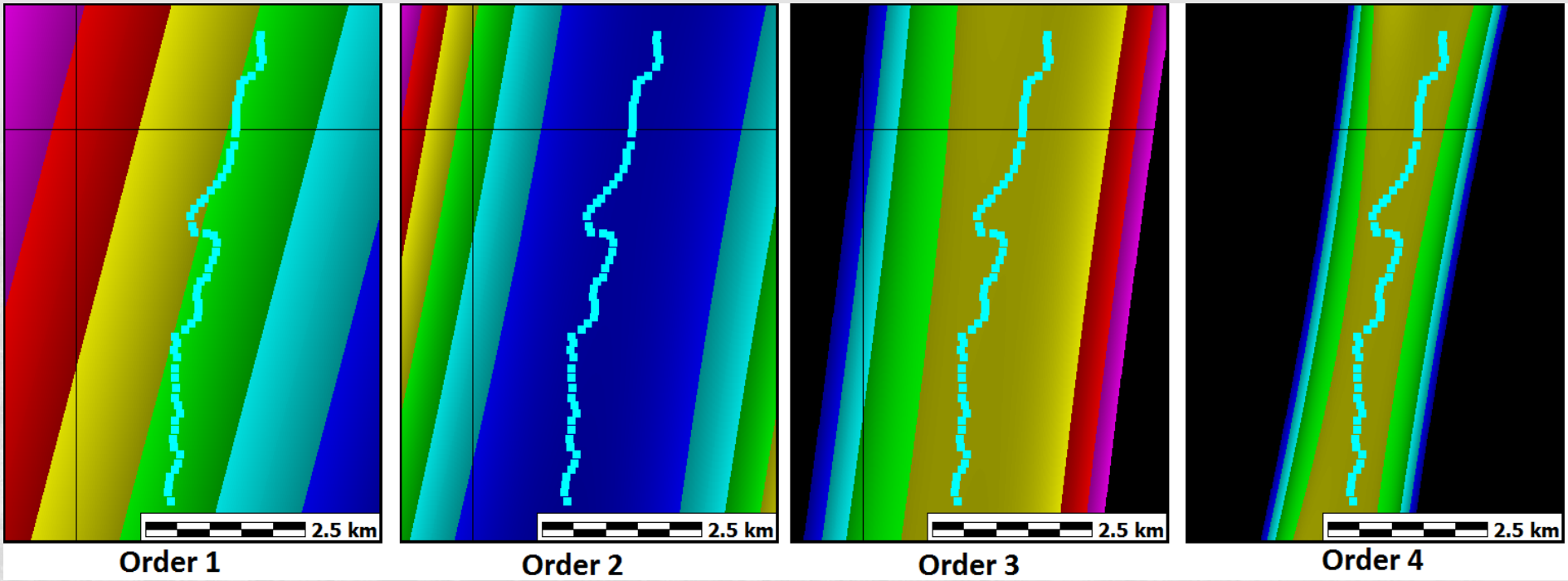


- Points
- Lines

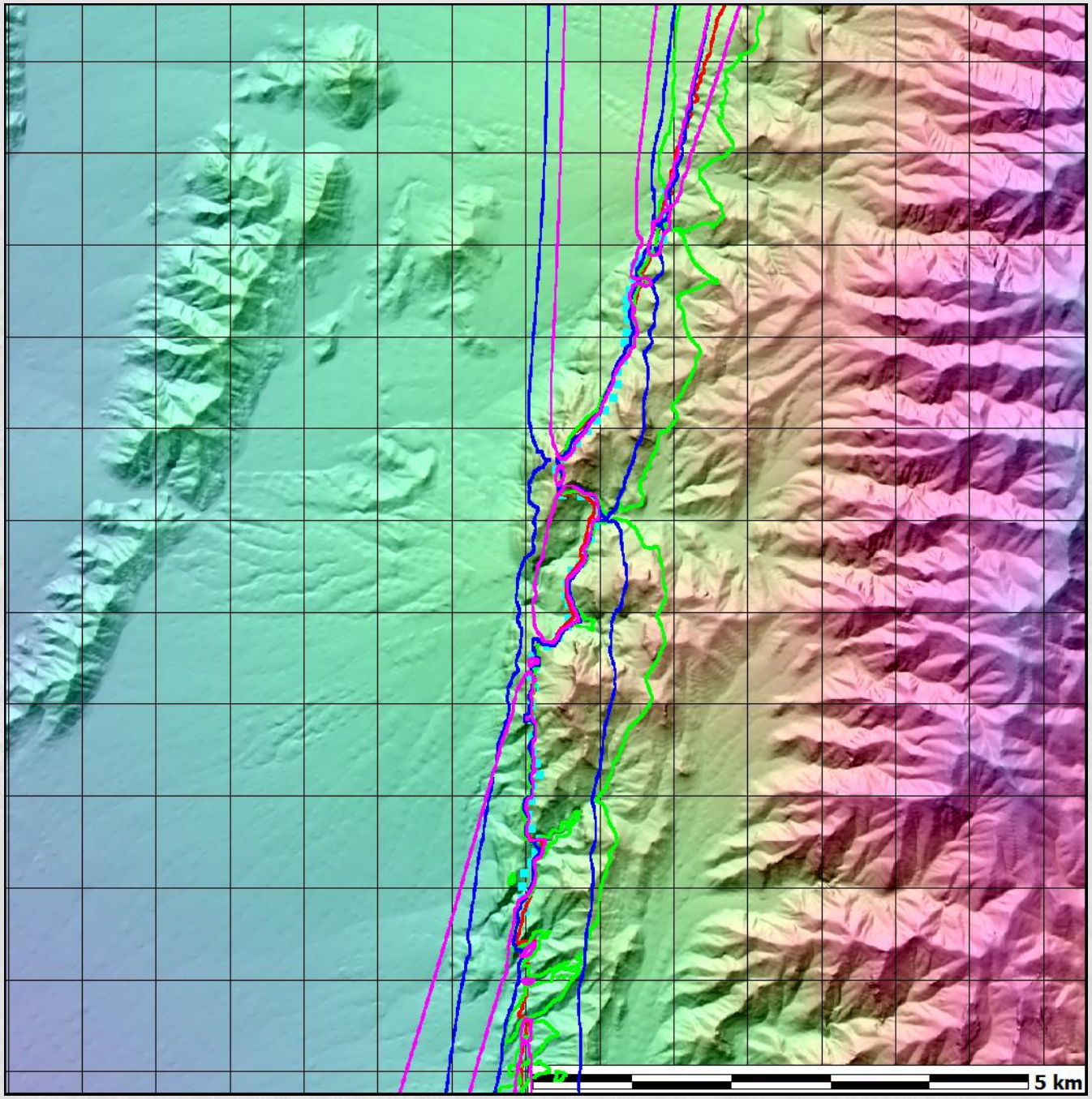
- 1 m photo resolution

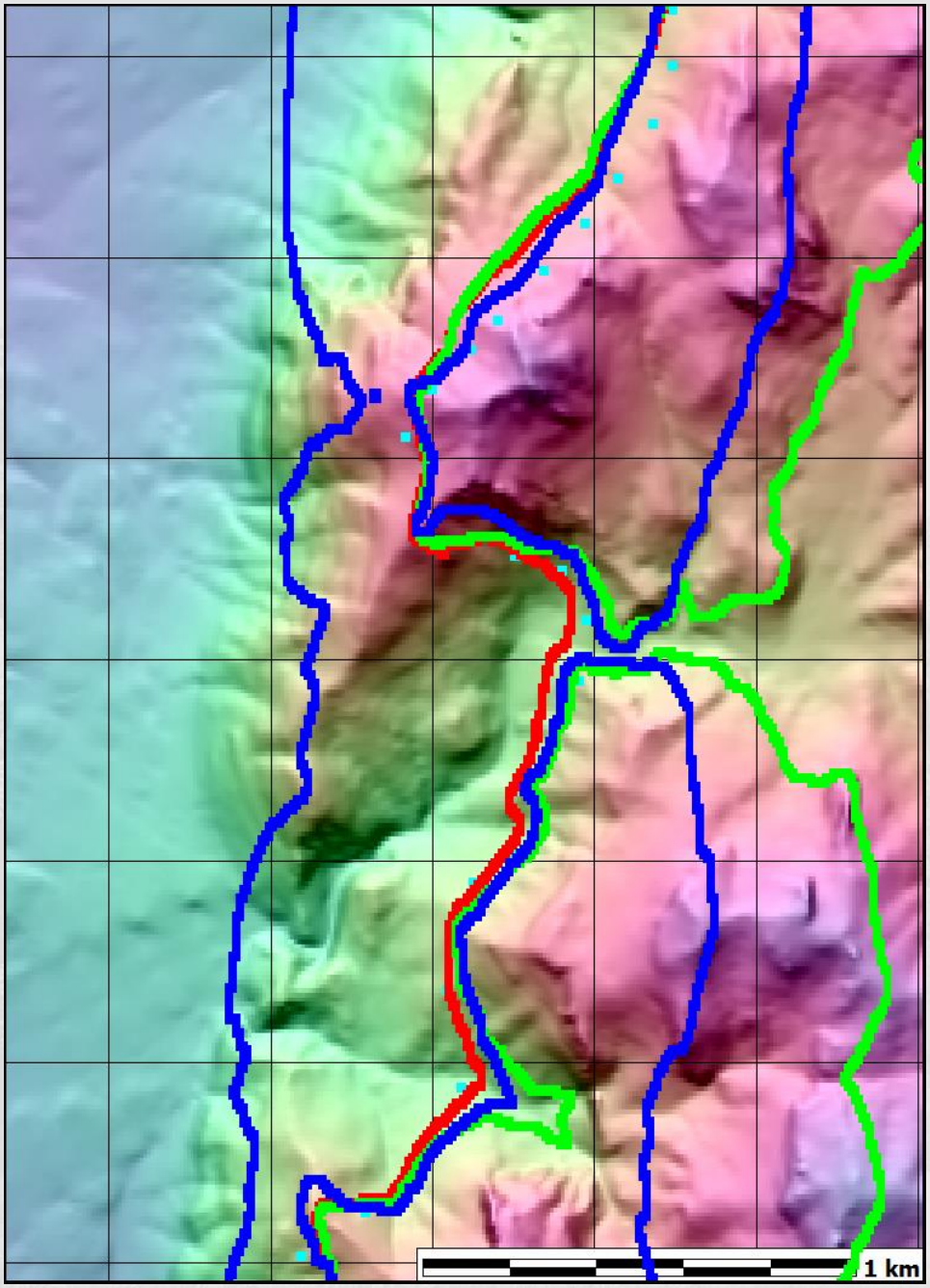


- Sequential three point problems along contact



- Trend surface, best fit to all points along profile
- Narrow elevation range for fault trace
- Inflection points in higher order surfaces mostly parallel fault trace
- Deviations grid can be used for parallel planes (formation boundaries)


5 km



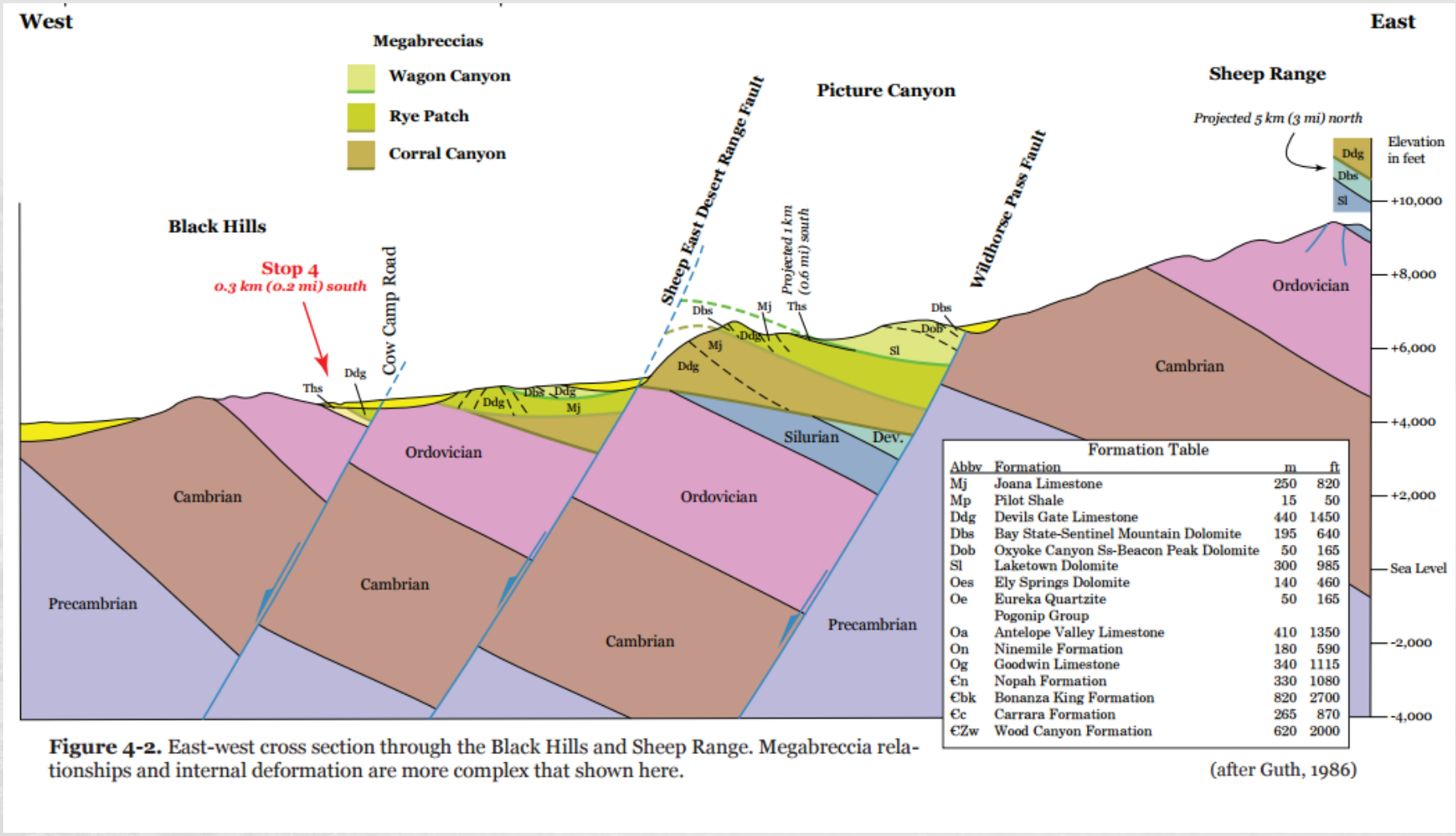
Trend surfaces

- **Order 1 (best?)**
- **Order 2**
- **Order 3**

Table 1. Major fault blocks, Hoodoo Hills Havoc

Fault	Long	Fault trend	Age of upper plate	Notes
Pine Canyon Fault (?)	9 km	N23E 5NW	Ordovician to Silurian	Limited ground control, and may be part of the Deadman Canyon block
Deadman Canyon Fault	5 km	N50E 8NW	Ordovician to Silurian	
Wagon Canyon Fault	11 km	N9E 20W	Ordovician to lower Devonian	Correlated with Cow Camp Road Fault
Rye Patch Fault	8 km	N14E 24E	Ordovician to Mississippian	Correlated with Black Hills Gap fault
Corral Canyon Fault	2 km	N11W 17W	Devonian-Mississippian	
Bedrock or unexposed fault			Devonian-Mississippian	

Low angle, intial movement to west, some rotated back to east



Formation Table

Abbv	Formation	m	ft
Mj	Joana Limestone	250	820
Mp	Pilot Shale	15	50
Ddg	Devils Gate Limestone	440	1450
Dbs	Bay State-Sentinel Mountain Dolomite	195	640
Dob	Oxyoke Canyon Ss-Beacon Peak Dolomite	50	165
Sl	Laketown Dolomite	300	985
Oes	Ely Springs Dolomite	140	460
Oe	Eureka Quartzite	50	165
	Pogonip Group		
Oa	Antelope Valley Limestone	410	1350
On	Ninemile Formation	180	590
Og	Goodwin Limestone	340	1115
€n	Nopah Formation	330	1080
€bk	Bonanza King Formation	820	2700
€c	Carrara Formation	265	870
€Zw	Wood Canyon Formation	620	2000

Figure 4-2. East-west cross section through the Black Hills and Sheep Range. Megabreccia relationships and internal deformation are more complex that shown here.

(after Guth, 1986)

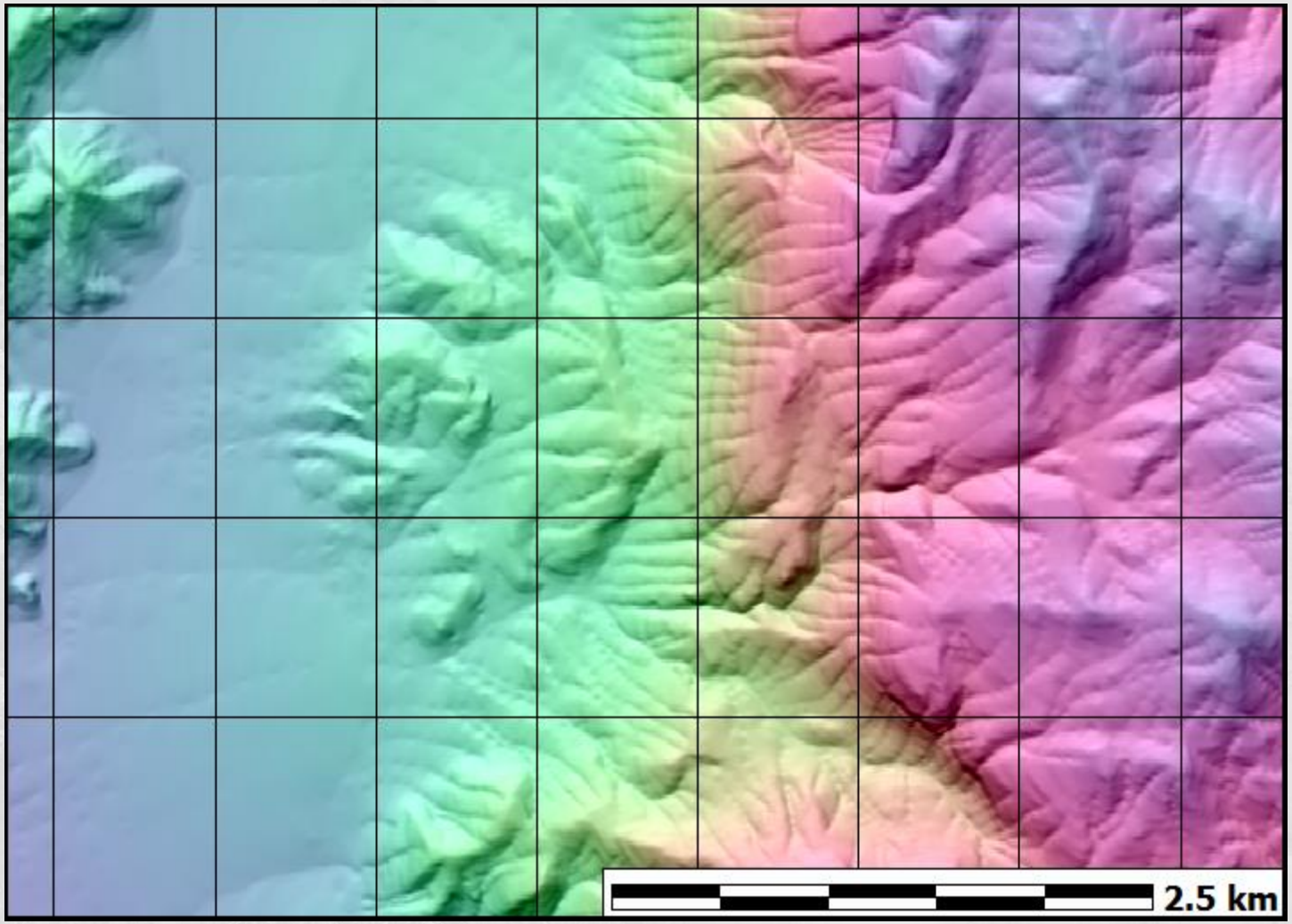
- Down to west motion
- Crossing higher angle faults
- Later rotation of faults to the east

Compare

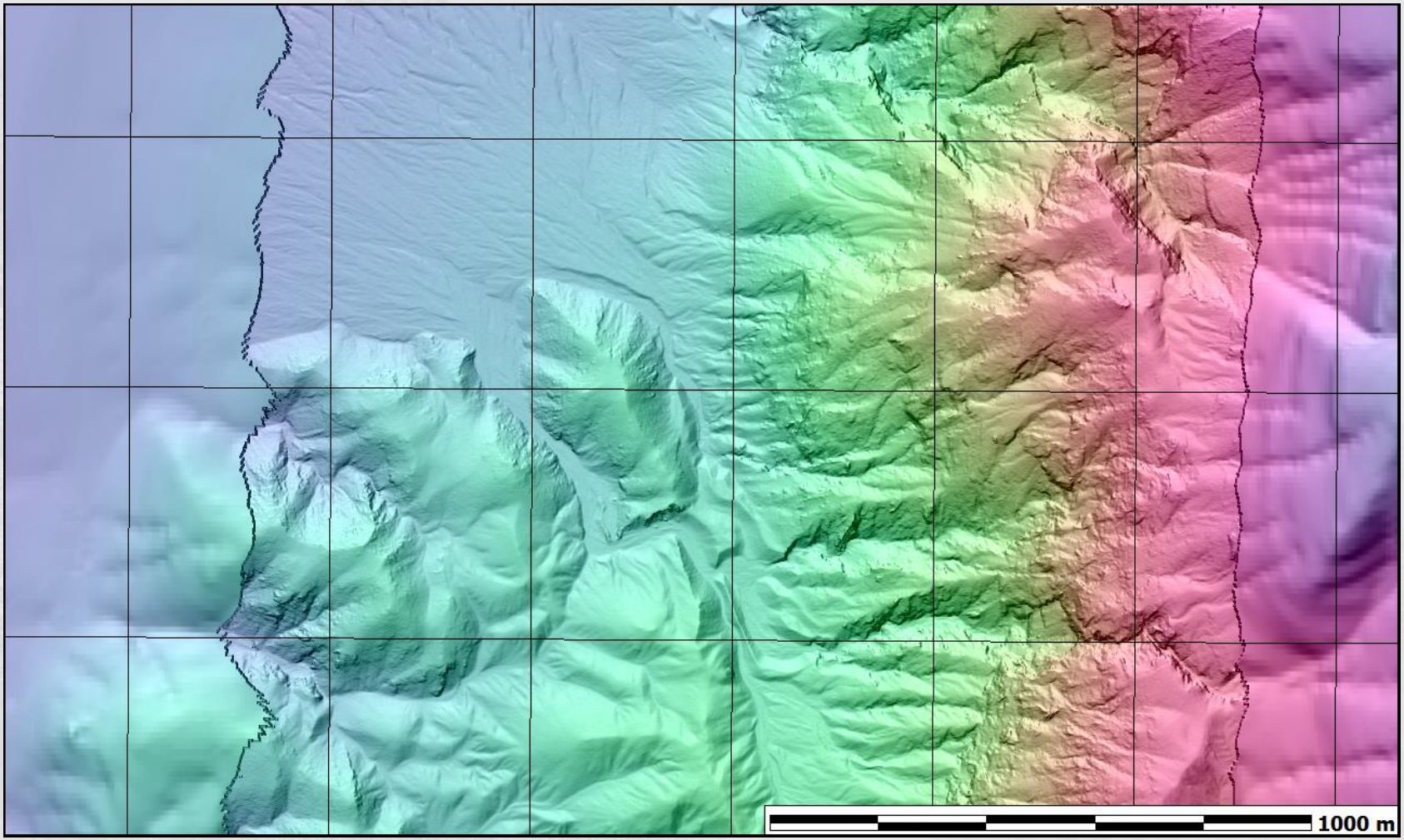
Table 2. Selected megabreccia deposits, western Great Basin

Location	Extent, length x width	Vertical drop	Slide Thickness	Age	References
Blackhawk	8 km x 3.2 km	~1200 m	10-30 m	~6.5–31 k.y.	Shreve, 1968 Nichols and others, 2006
Eureka Valley	1.7 km x 0.4 km	~700 m	20 m	8.2 – 9.5 k.y.	Wrucke and Corbett, 1990 Watkins and others, 2012 Watkins and others, 2015
Tin Mountain (4 scars)	Overall 4 km x 8.5 km	900-1100 m	40-120 m		Burchfiel, 1966
Sheep Range (at least 5 blocks)	Overall 5 km x 28 km; individual blocks to ~10 km wide	~1000-3000 m (?); depends on bedding dip at time, and position along strike		Miocene (?)	

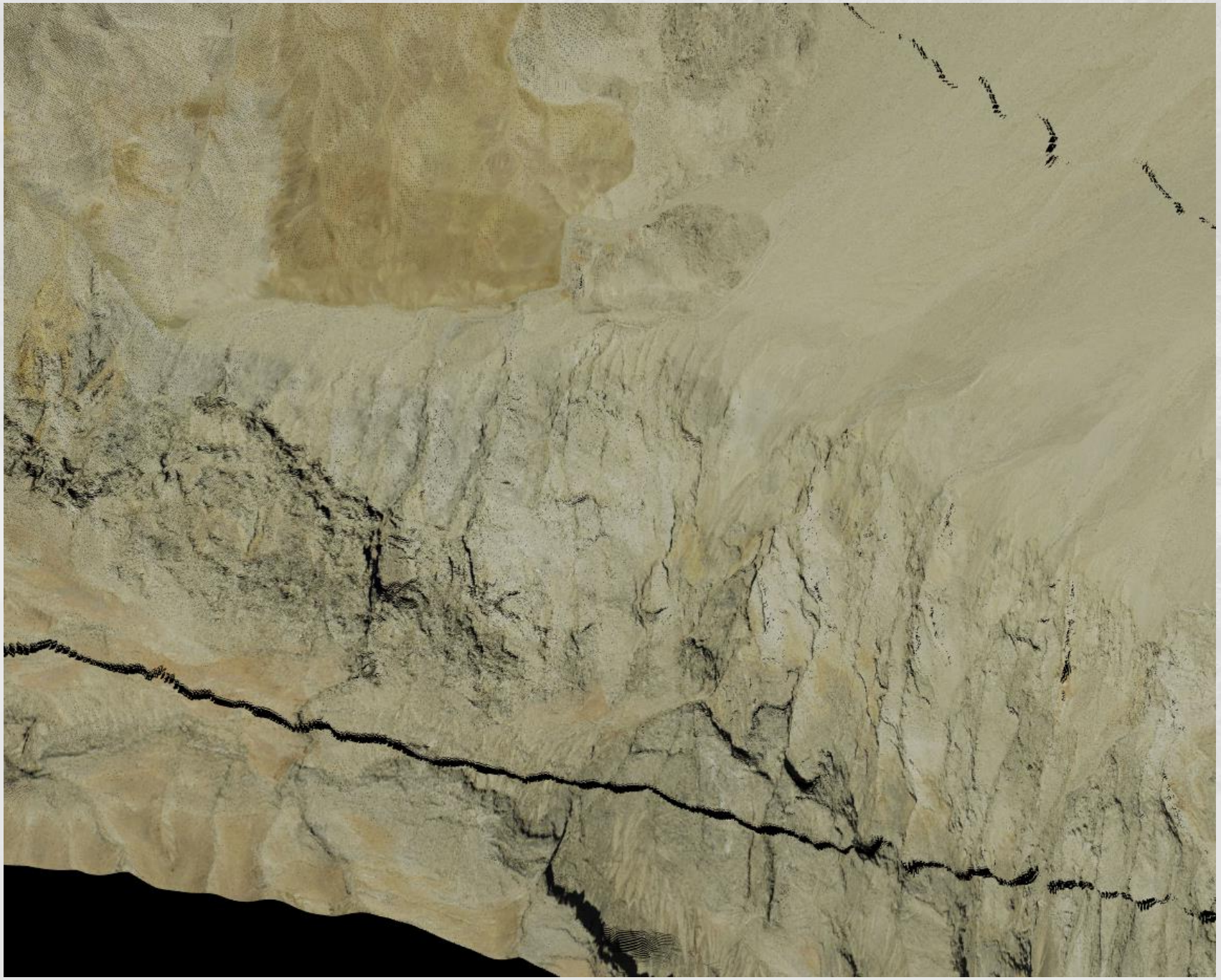
Tin Mountain, 1/3” (~10 m) 3DEP



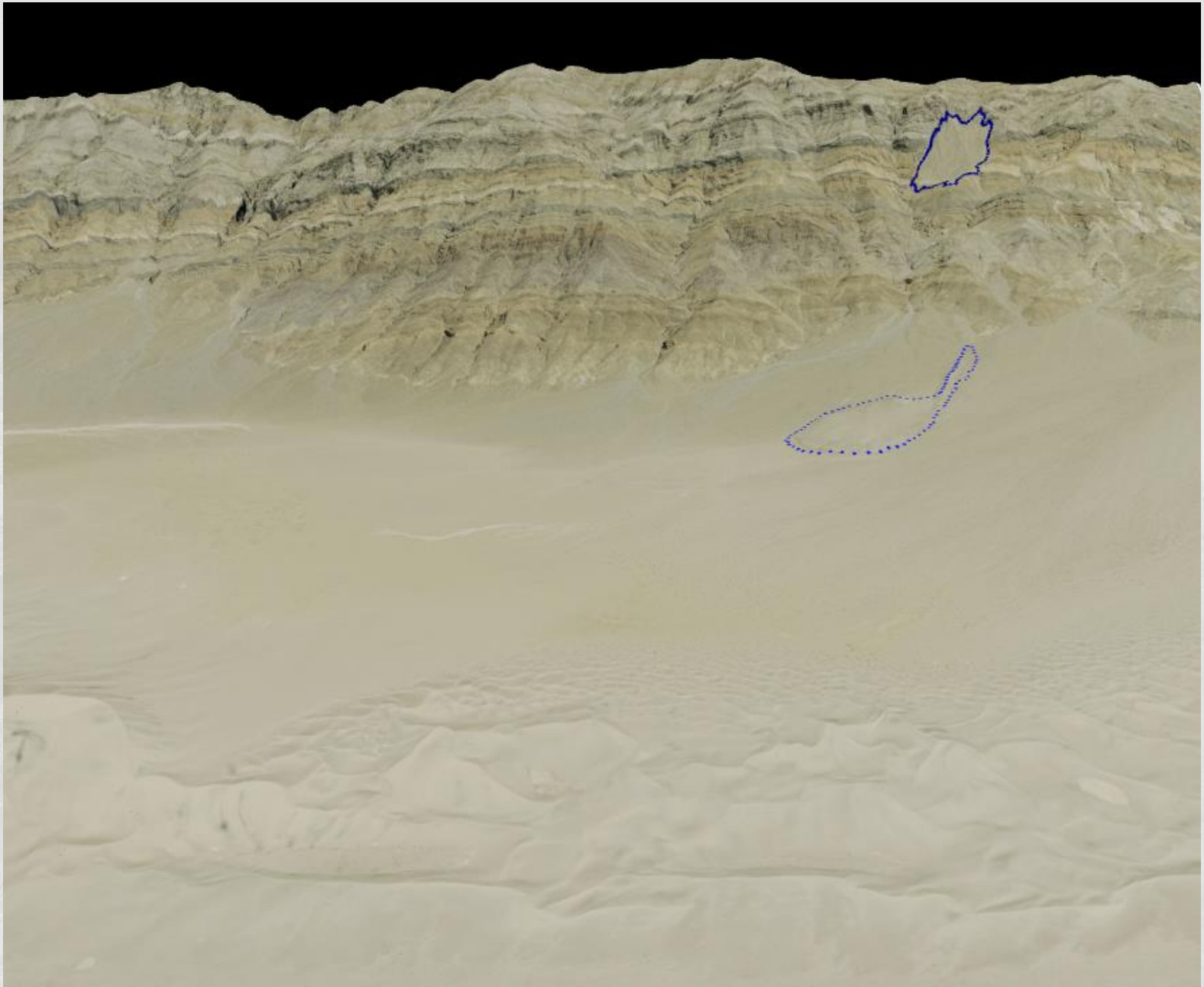
Tin Mountain, 2 m lidar with 1/3” 3DEP hole fill along edges

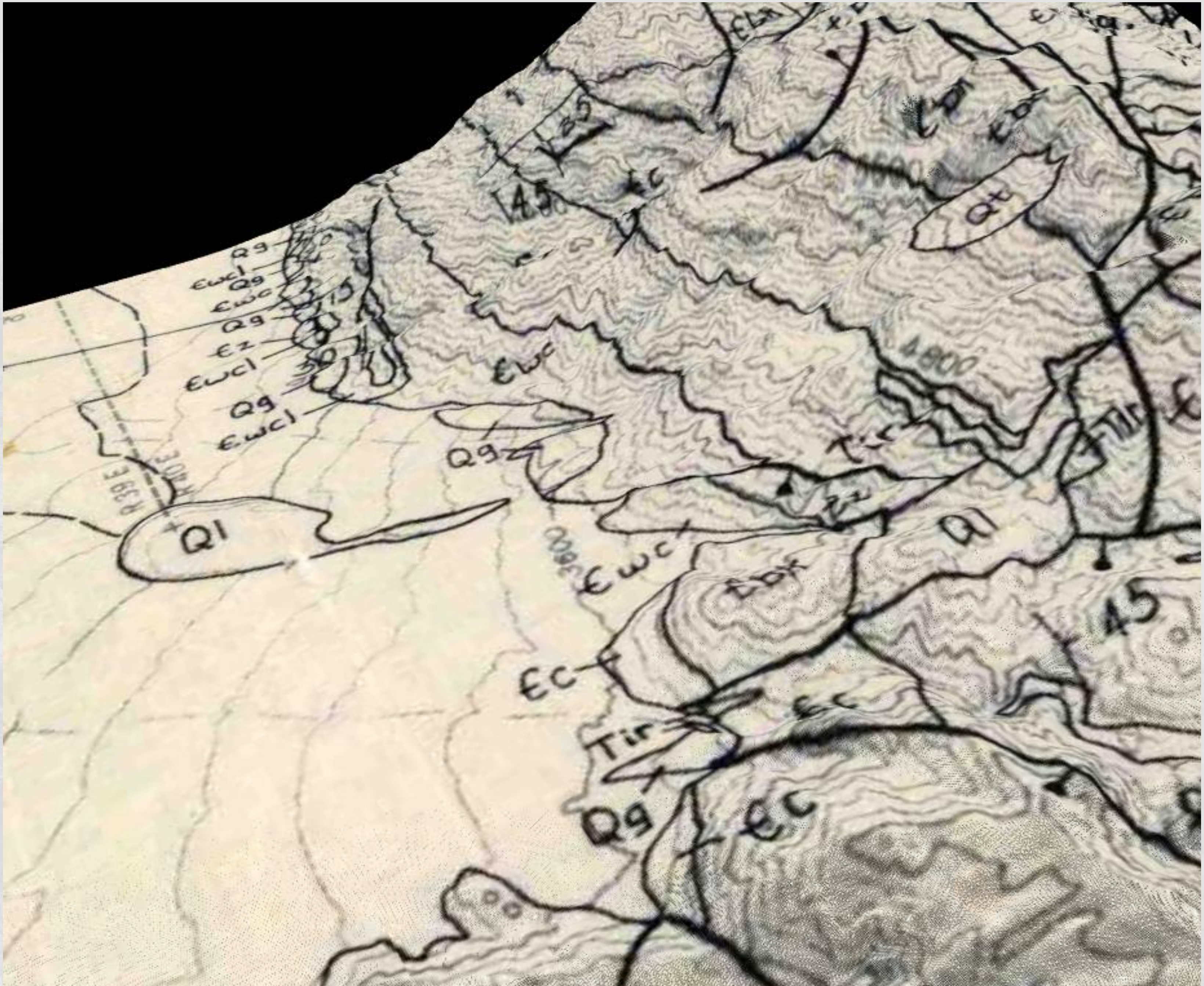


- Vertical datum shift, left in to highlight quality change



Eureka Valley Landslide (Wrucke and Corbett, 1990)





Qg
Ꞓwcl
Qg
Ꞓwc
Qg
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Ꞓwcl
Qg
Ꞓwcl
R39E
R40E
Ql
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Tir
Qg
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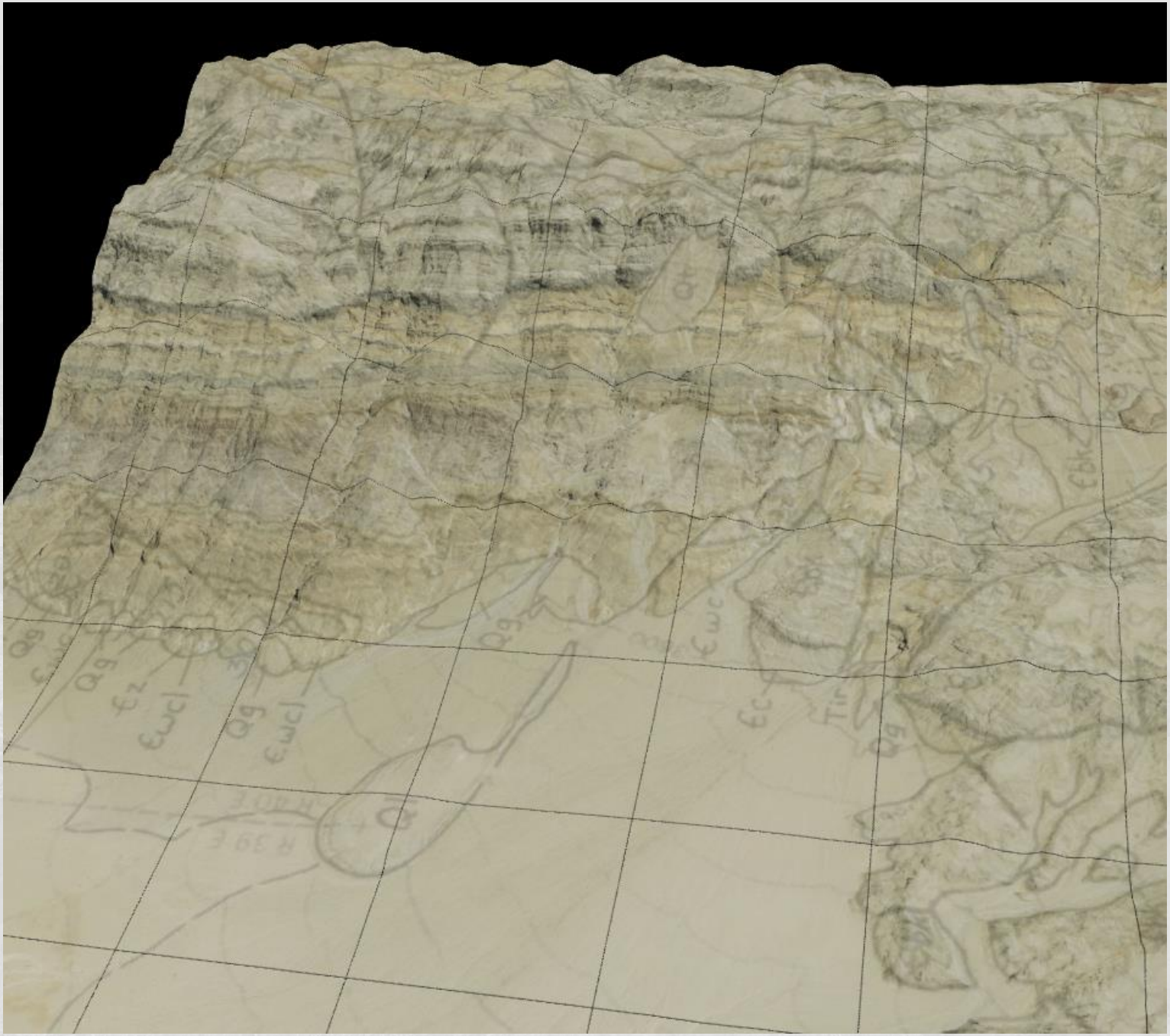
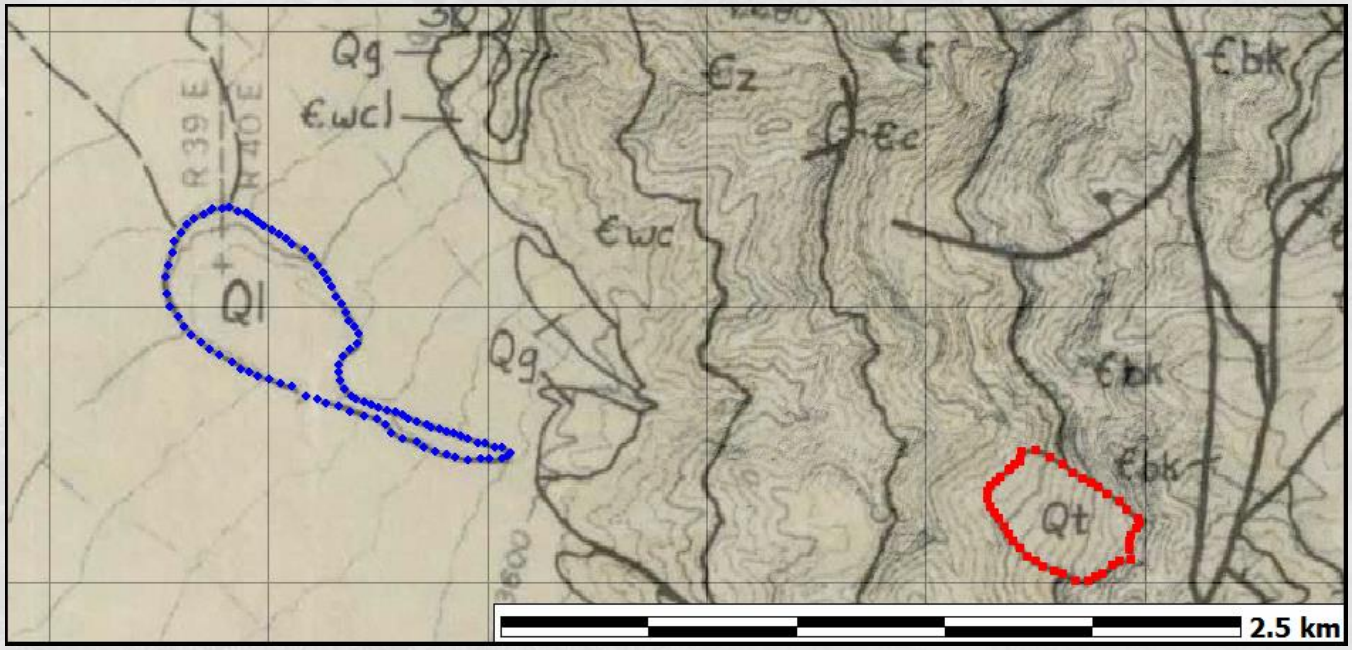
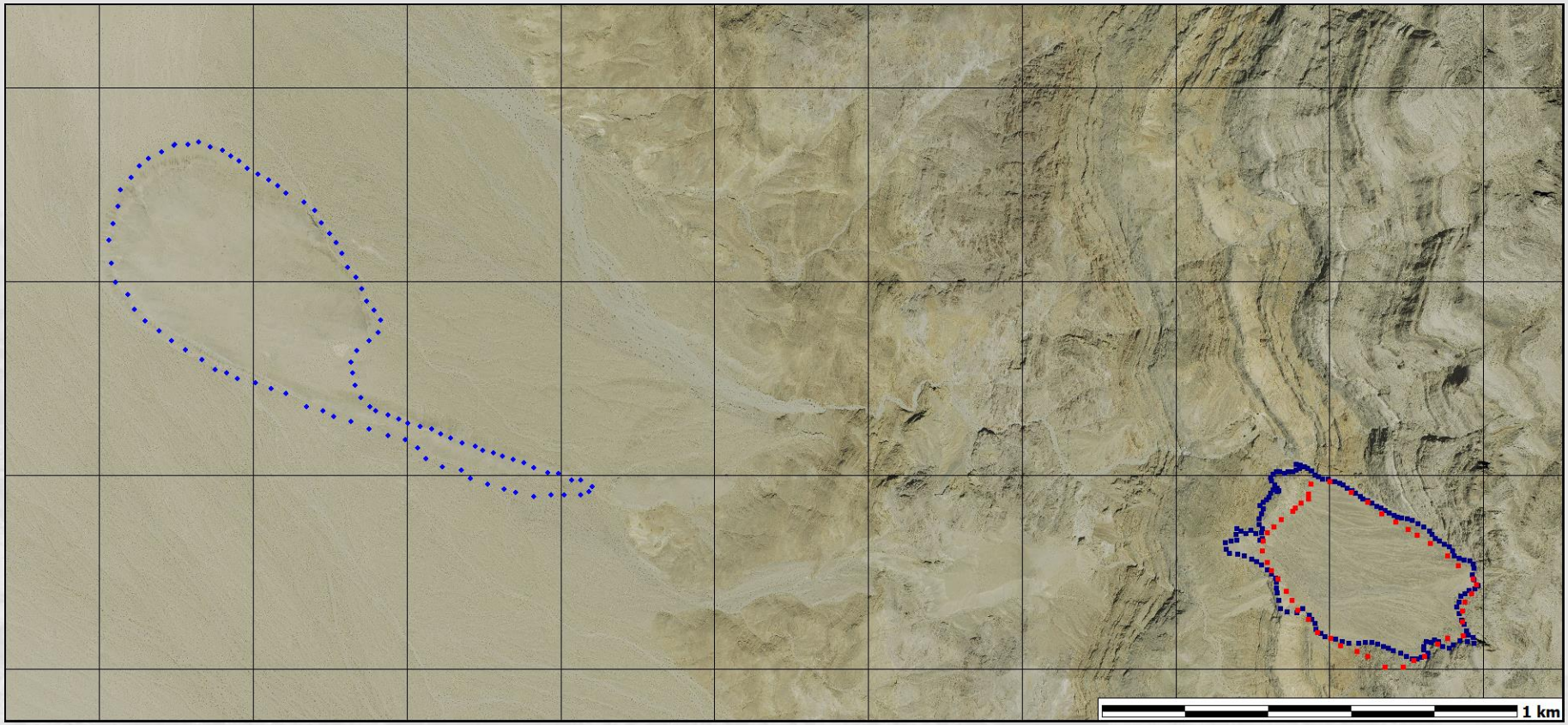
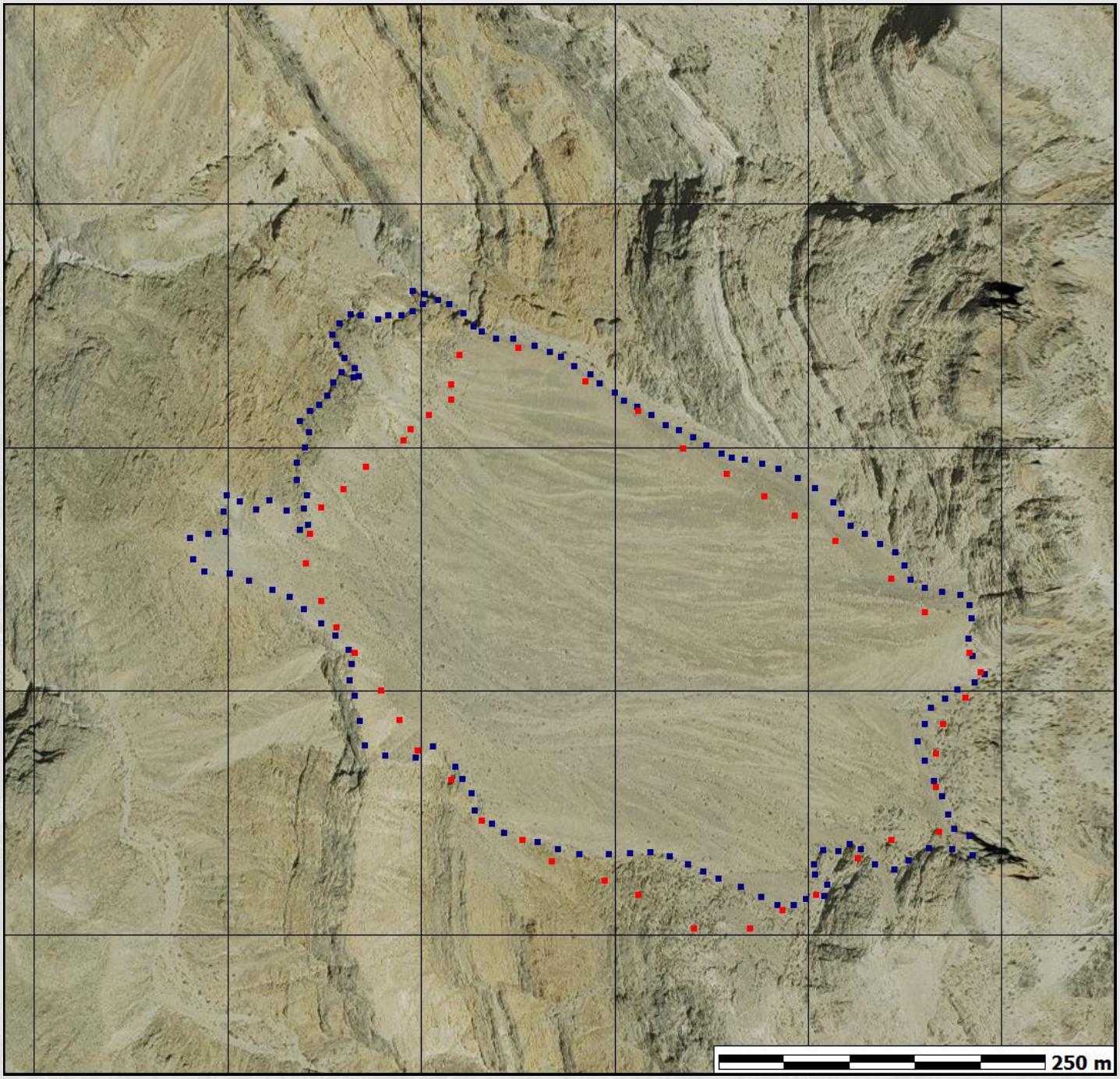


Planar Trend Surface from map/imagery and 1/3” 3DEP

- Talus, geologic quad, N25E 29NW (55.87% slope)
- Talus, 1 m imagery: N27E 29NW (55.12% slope)
- Slide block, N57E 5NW (8.77% slope)




1 km


250 m

Conclusion—Free Data

- High resolution imagery and 10 m DEMs allow geometric tracing and modelling of faults
- 1 m DEMs from 3DEP increasingly available
- OpenTopography and other sources have 1 m DEMs, and point clouds to make your own with sub meter grid spacing
- Improved understanding of Hoodoo Hills Havoc

Following slides were not shown in Denver

Sheep Range References

- French, D.E.., and Guth, P.L.., 2016, Megabreccias of the Sheep Range, Clark County, Nevada: 2016 Field Trip Guidebook, Nevada Petroleum and Geothermal Society, 50 p.
- Guth, P.L., 1980, Geology of the Sheep Range, Clark County, Nevada: unpublished PhD dissertation, Massachusetts Institute of Technology.
- Guth, P.L., 1981, Tertiary extension north of the Las Vegas Valley shear zone, Sheep and Desert Ranges, Clark County, Nevada: Geological Society of America Bulletin, vol.92, no.10, p.763-771.
- Guth, P.L., 1989, "Day 4. Tertiary extension in the Sheep Range Area, Northwestern Clark County, Nevada", p.33-39 in Wernicke, B.P., Snow, J.K., Axen, G.J., Burchfiel, B.C., Hodges, K.V., Walker, J.D., and Guth, P.L., 1989, Extensional tectonics in the Basin and Range Province between the Southern Sierra Nevada and the Colorado Plateau: Field Trip Guidebook T138, 28th International Geological Congress, American Geophysical Union, 80 p
- Guth, P.L., 1990, Superposed Mesozoic and Cenozoic deformation, Indian Springs Quadrangle: in Wernicke, B., ed., Basin and Range extensional tectonics near the latitude of Las Vegas, Geological Society of America Memoir 176, p.237-249.
- Guth, P.L., Schmidt, D.L., Deibert, J., and Yount, J., 1988, Tertiary extensional basins of northwestern Clark County: in Weide, D.L., and Faber, M.L., (eds.), This Extended Land, Geological Journeys in the southern Basin and Range, Geological Society of America, Cordilleran Section, Field Trip Guidebook, p.239-253.

Other References

- Burchfiel, B. C. 1966. Tin Mountain landslide, southeastern California, and the origin of megabreccias. Geol. Soc. Amer. Bull. 77, pp. 95-100. T
- Shreve, R.L., 1968, The Blackhawk Landslide: Geological Society of America Special Paper 108, p. 1-48, doi:10.1130/SPE108-p1.
- Watkins, J., Scully, J.E.C., and Yin, A., 2012, Emplacement and subsequent modification of the Quaternary Eureka Valley landslide, eastern California: Geological Society of America Abstracts with Programs Vol. 44, No. 7, p.419.
- Watkins, J., Scully, J.E.C., Lawson, M., Rhodes, E., Yin, A. Emplacement Mechanisms and Evolution of the Long-runout Quaternary Eureka Valley Landslide in Eastern California. American Geophysical Union Fall Meeting, Abstract #81953, December 2015.
- Wrucke, C.T., and Corbett, K.P., 1990, Geologic map of the Last Chance quadrangle, California and Nevada - 1990: U.S. Geological Survey OF-90-647-A, scale 1:62,500.

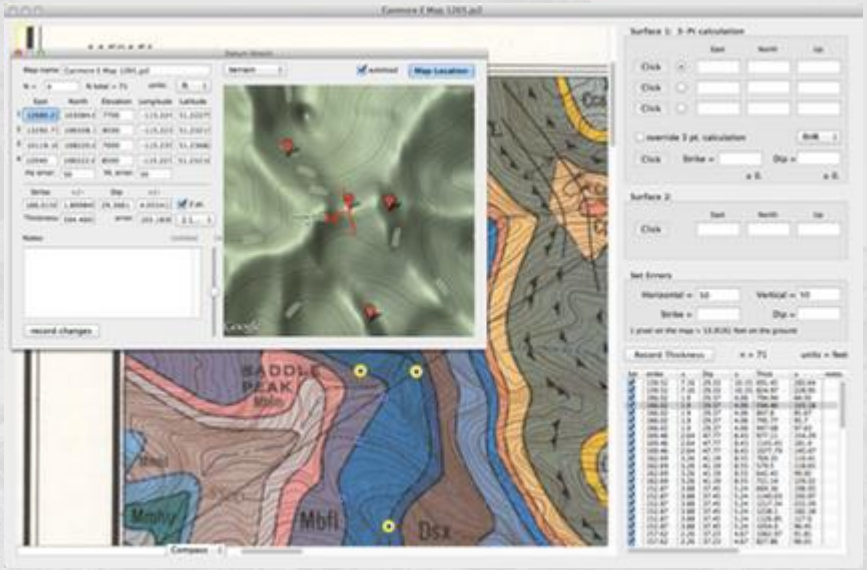
History of DEMs and 3D Problems

- MICRODEM has handled since at least 1999
  - Guth, P.L., 2014, Structural geology geometric operations in a GIS program and Google Earth: Geological Society of America Abstracts with Programs, vol.43, no.3, p.6. [Southeastern section meeting, Blacksburg VA, 10-11 April 2014]
  - Guth, P.L., 2004, Computer manipulation of simple 3D structures: supplement, complement, or replace the field experience? Geological Society of America Abstracts with Programs, vol.36, no.5, p.157. [national meeting Denver, CO, Nov 2004]
- Other options on next two pages
- With standard data formats, programs can work together

Dynamic 3-Point Geological-Plane Solver

- By Jack Jamieson and Gregory C. Herman
- http://impacttectonics.org/geoTools/3ppops.html
- May stop working imminently due to scheduled Google changes
- NASA World Wind 3-Point Problem Solver (Java)

GMDE (GeolMapDataExtractor)



- http://www.geo.cornell.edu/geology/faculty/RWA/programs/strikedipthickness.html