Geog 126: Maps in Science and Society

Terrain Mapping: A History

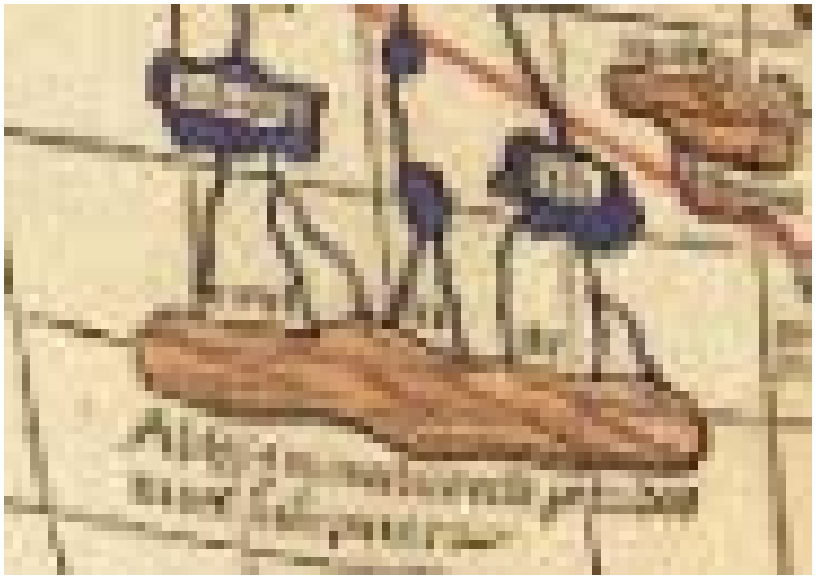
Terrain

- Basic function of topographic mapping
- Shows differences in elevation, slope
- Old mapping tradition, predating Ptolemy
- Major importance to military mapping
- Can be pictorial or metric
- Post triangulation favored metric and contours
- Contemporary trend toward shading methods

Ptolemy: East Caspian Sea. Cosmographia 1467

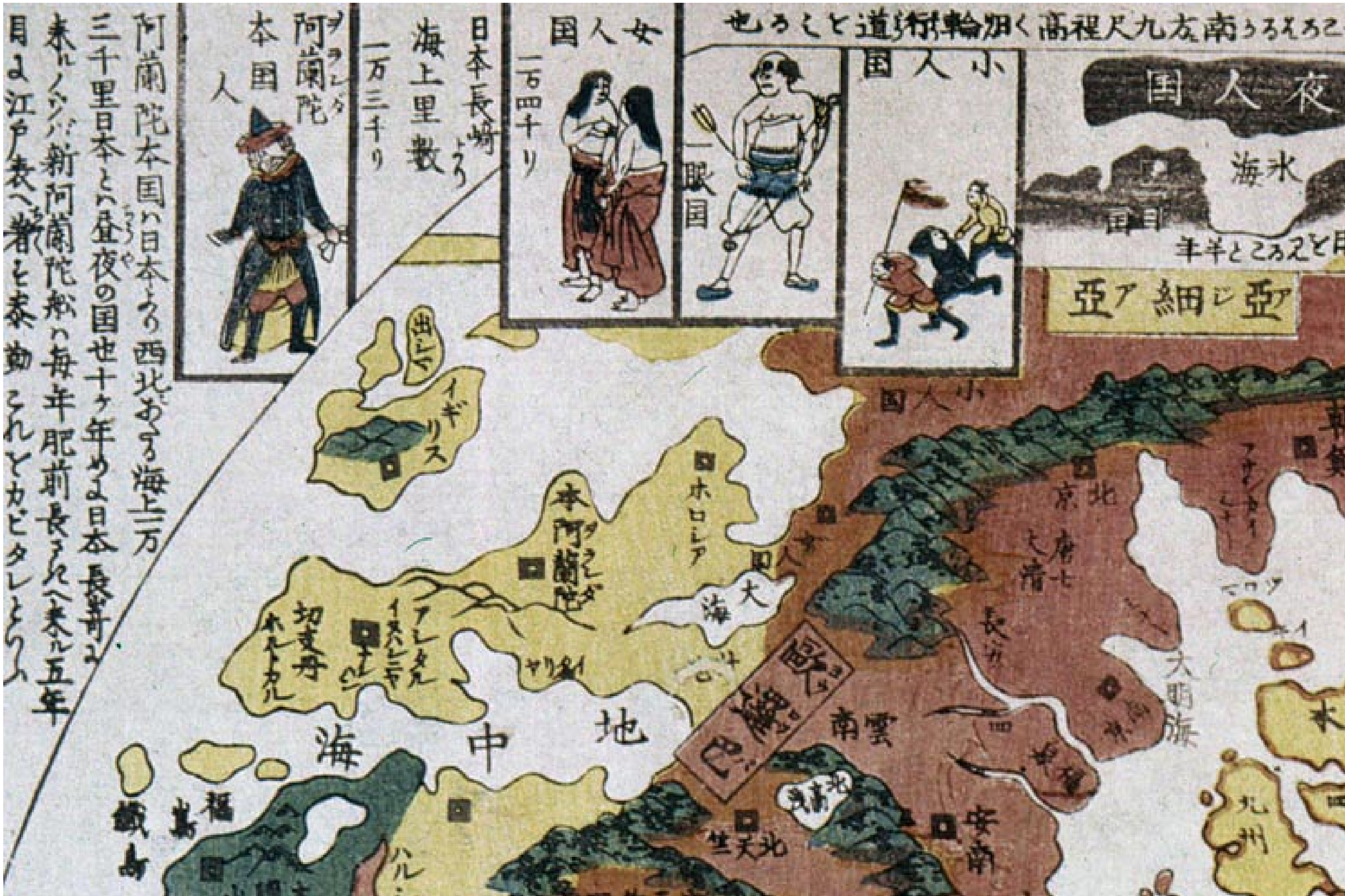
Ptolemy: Terrain Depiction

Molehills



Worms

Pictorial



The Waldseemuller world map of 1507. “Universalis cosmographia secundum Ptholomaei traditionem et Americi Vespucii alioru[m]que lustrationes.” Detail showing Northwest Africa. Source: Library of Congress, Geography and Map Division.

Ortelius Atlas of 1572, detail of terrain depiction in Slovakia on the sheet for Slovenia and the Upper Adriatic Sea.

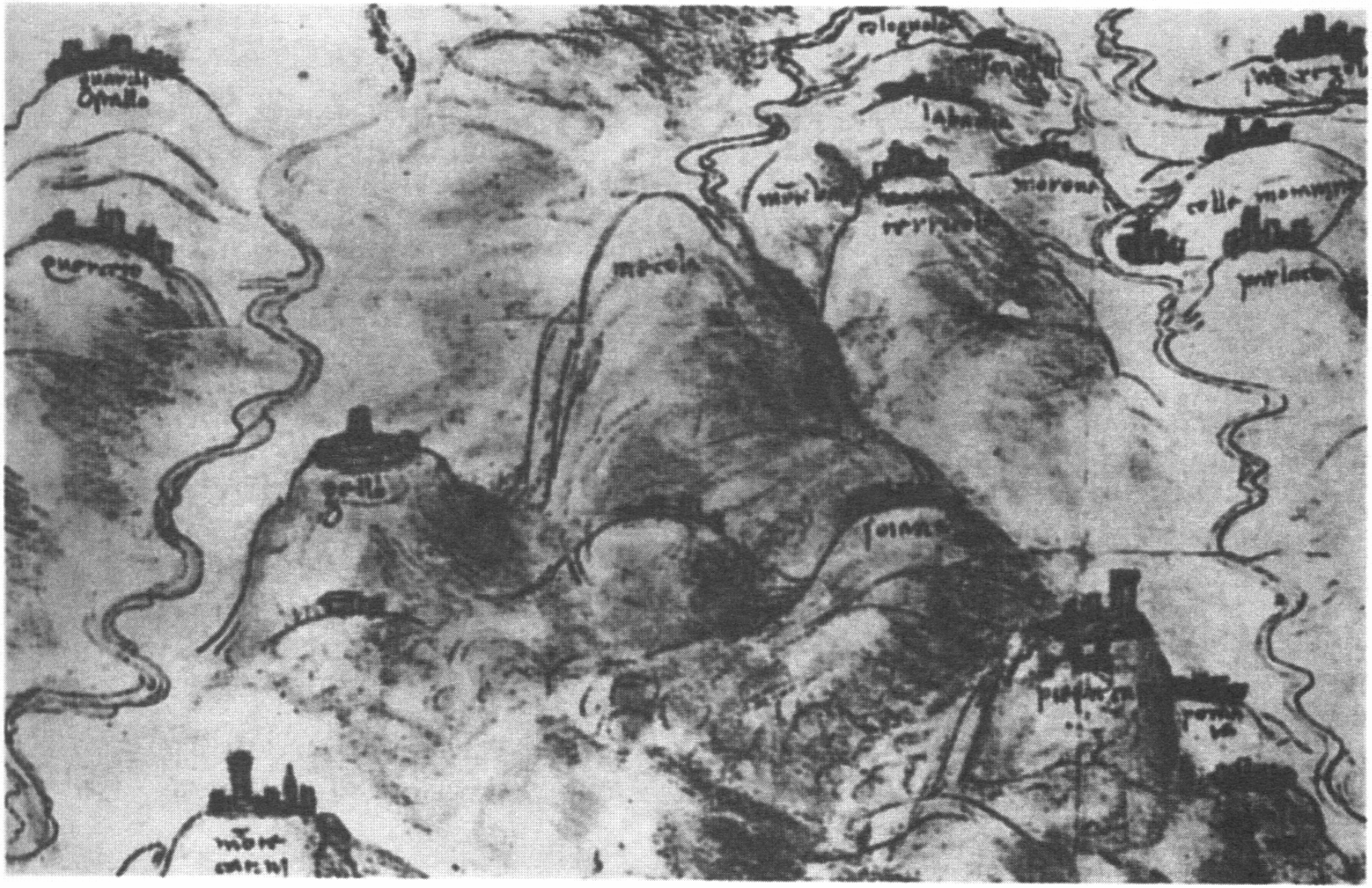


Figure 8. Leonardo da Vinci's map of Tuscany, 1502–1503, at half original scale. Relief features individually depicted and continuously related. Original in the Royal Library at Windsor.

Figure 9. Jost Murer's map of Zürich Canton, 1566. Scale approximately 1:56,000. Section of the map showing the Lagern spur of the Jura Mountains near Baden (original size).

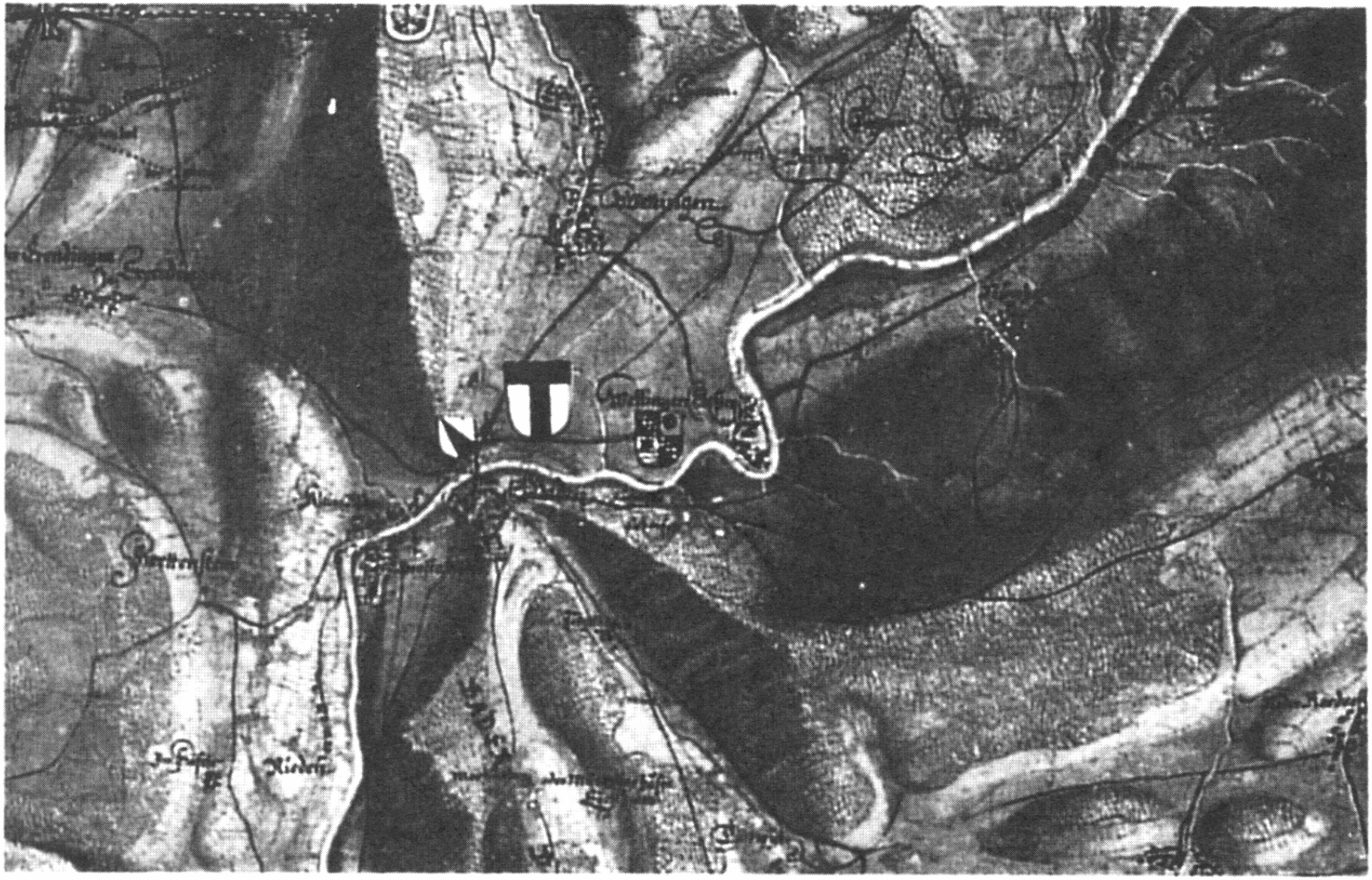


Figure 10. A section of Hans Conrad Gyger's map of the canton of Zürich in 1667; 1:32,000. Shown here at half scale. The Limmat River water gap near Baden is depicted. Top margin is east. Earliest map showing relief features in planimetric detail and three-dimensional shading. The original in the Haus zum Rechberg in Zürich is a painting done in color and in a naturalistic style. The topography represented in figure 10 covers the same area as that shown in the lower part of figure 9.

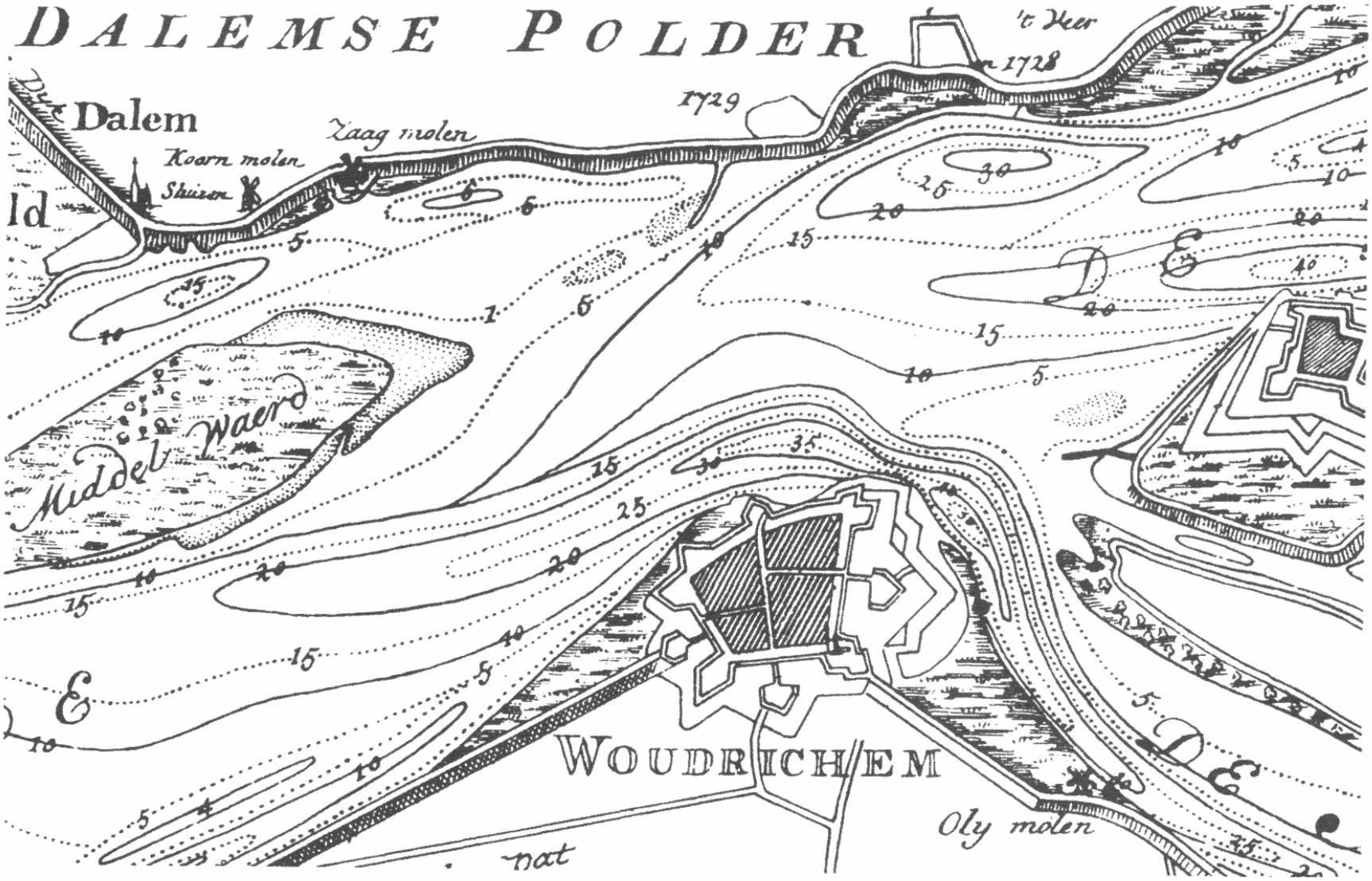


Figure 11. A section of N. S. Cruquius' map of the Merwede river bed at original size (joint estuary of the Maas and Waal rivers). Scale 110,000. Published in Leiden in 1730. One of the earliest isobathic charts. The isobaths were constructed from soundings taken at low tide in July 1729.

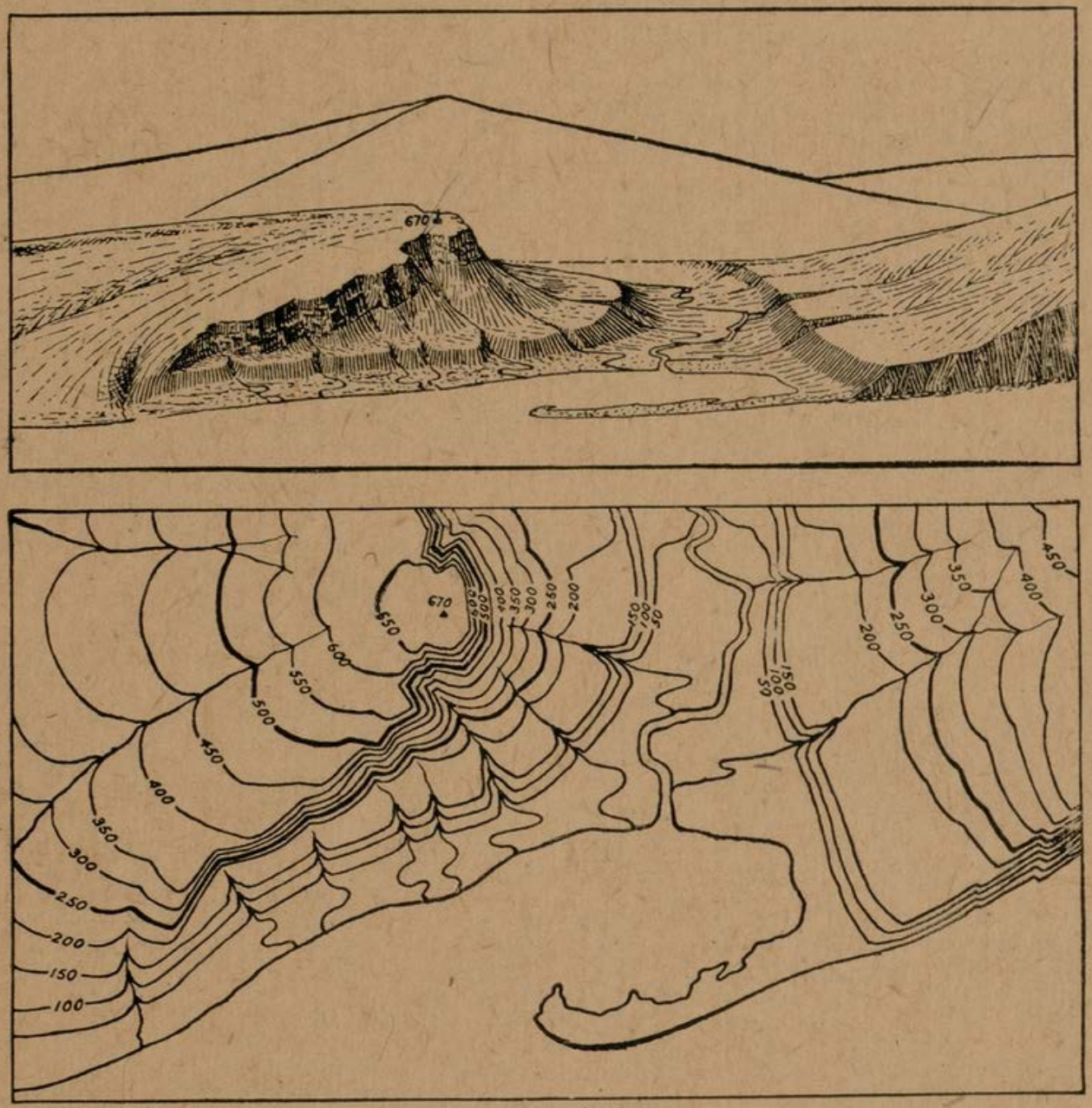


Fig. 1.—Ideal sketch and corresponding contour map.

Contouring

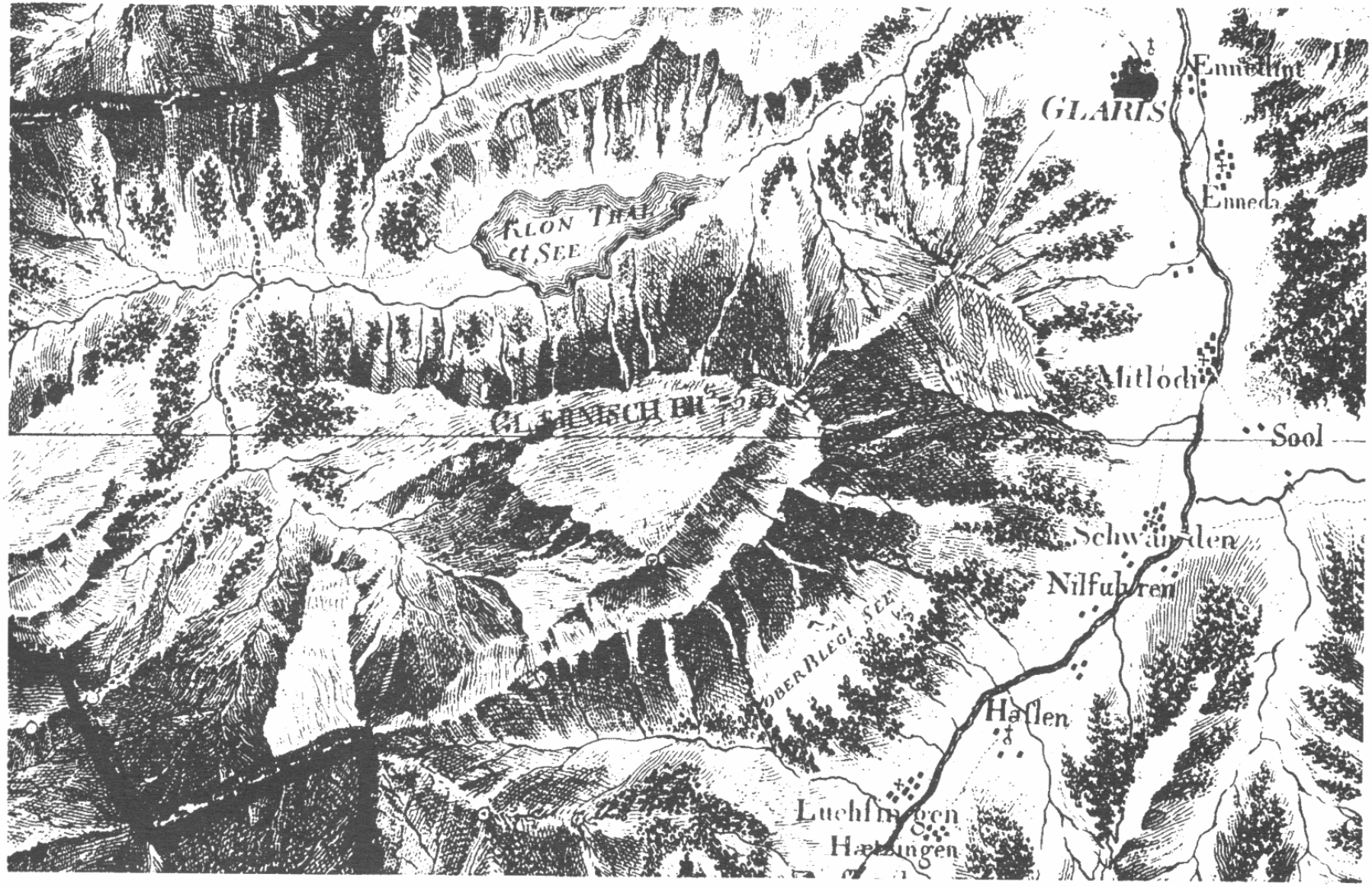


Figure 12. A section, at original scale, of the *Atlas de la Suisse* surveyed and drawn during the period 1786–1802 by J. H. Weiss and J. E. Muller on behalf of J. R. Meyer of Aarau. Scale 1:108,000. The Glärnisch mountain region in the canton of Glarus. Terrain representation by irregular random hachuring.

Figure 13. "Drawing of a high and steep mountain region viewed and illuminated vertically." Scale approximately 1:30,000. From a portfolio published in Dresden and Leipzig in 1843, map supplement to the *Lehre der Situationszeichnung* (Art of Topographic Drawing) by J. G. Lehmann, Plate IV. Section of the map shown here at original scale. Terrain representation by means of hachuring using the principle "the steeper, the darker."

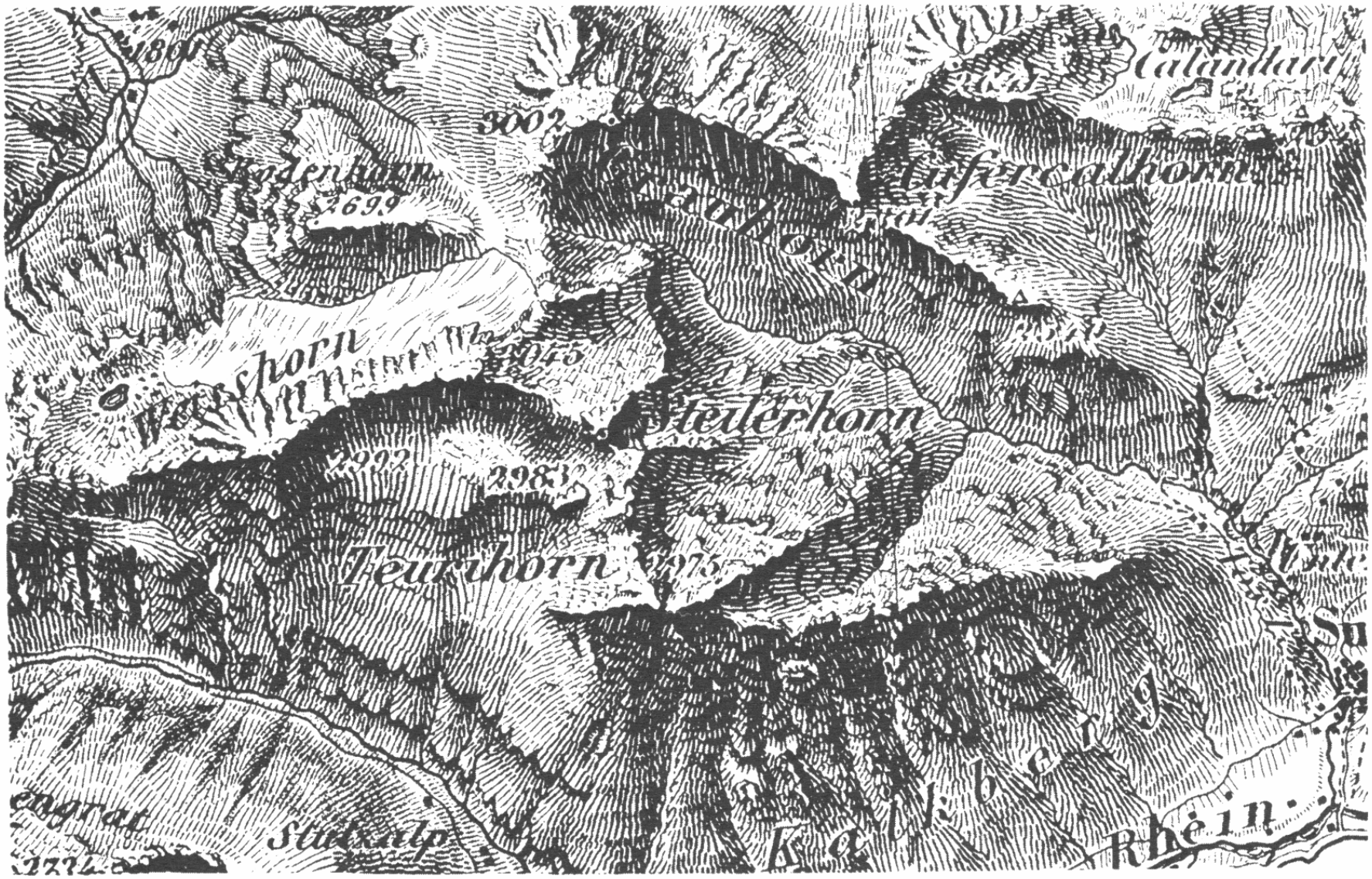
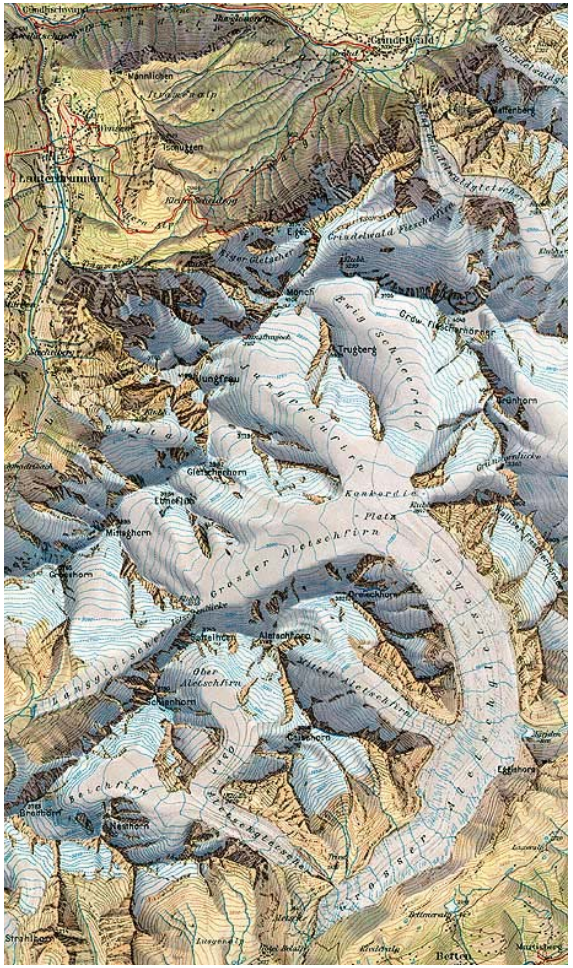


Figure 14. Topographic Map of Switzerland. Scale 1:100,000. Known as the "Dufour Map." First published by the Eidgenössischen Topographischen Bureau (Swiss Topographic Bureau) during the period 1842–1864. Section of Sheet XIV enlarged to twice the original size. Area north of Splügen. Terrain representation by means of hachuring with oblique illumination from the upper left (northwest).

Civil War Battle of Cedar Creek: Hachures



"Jungfraugruppe und Aletschgletscher" made for the "Schweizer Mittelschulatlas" from an addendum to "Die Alpen", 6th edition, by Imhof 1932.

School wall map 1:100,000 and school map 1:250,000 "Graubünden" (Canton of Grisons) (Ticino section) by E. Imhof and H. Leuzinger 1963.

Imhof: Everest

Colored/Shaded

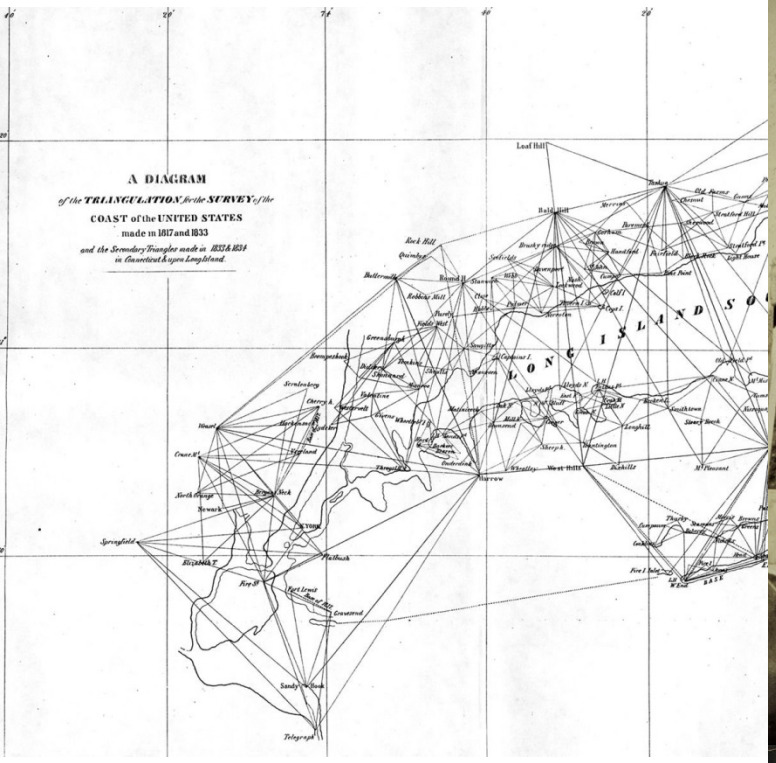
"Die Welt ist bunt" (section), 1963 © Falk Verlag. 1:40 mio (original size 48 x 138 cm). Relief shading by F. Hölzel, colors by W. Dylewski.

Natural color/Hillshading

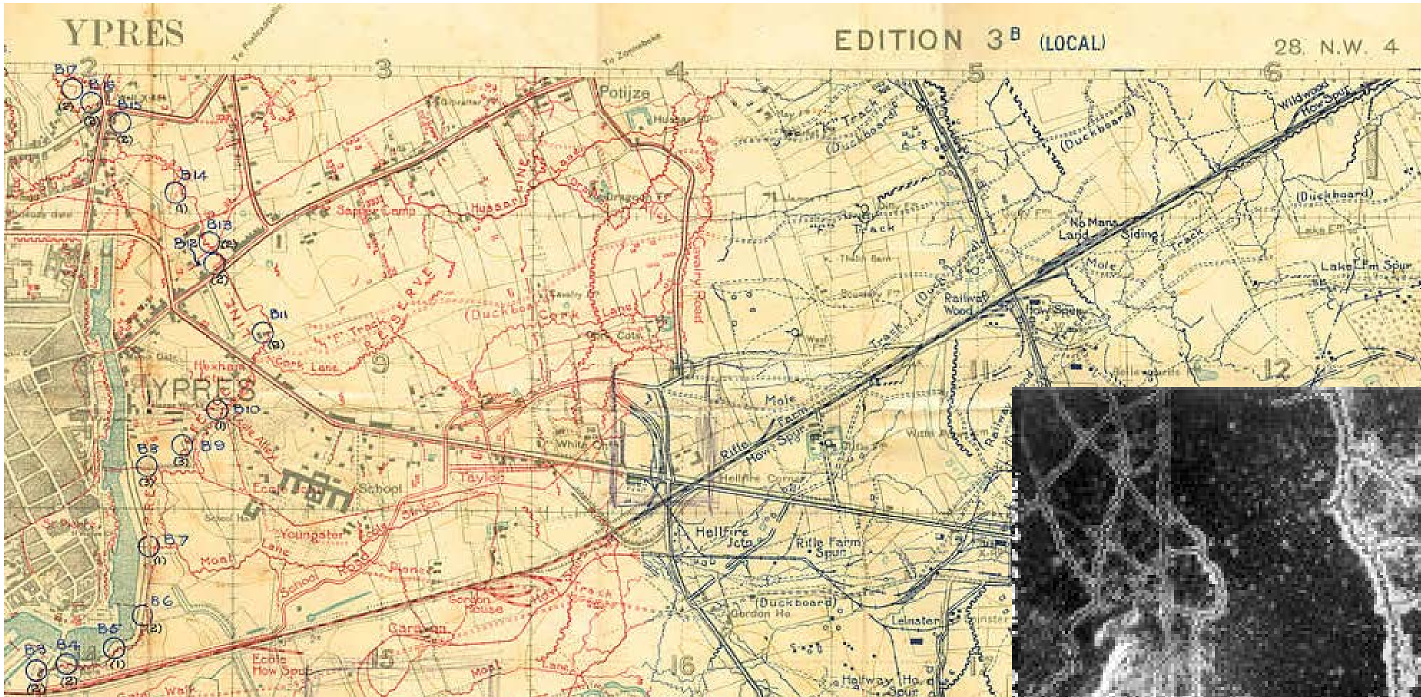
Time Magazine: Richard Harrison

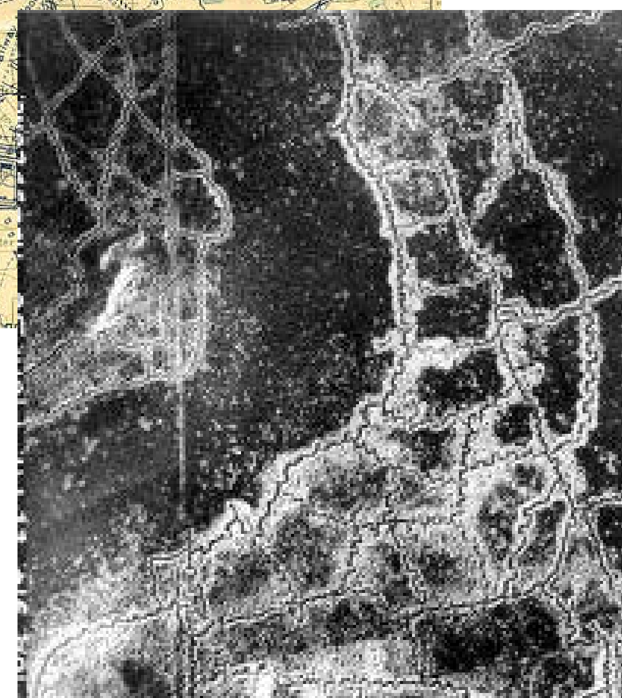
Tanaka contours

Mapping terrain

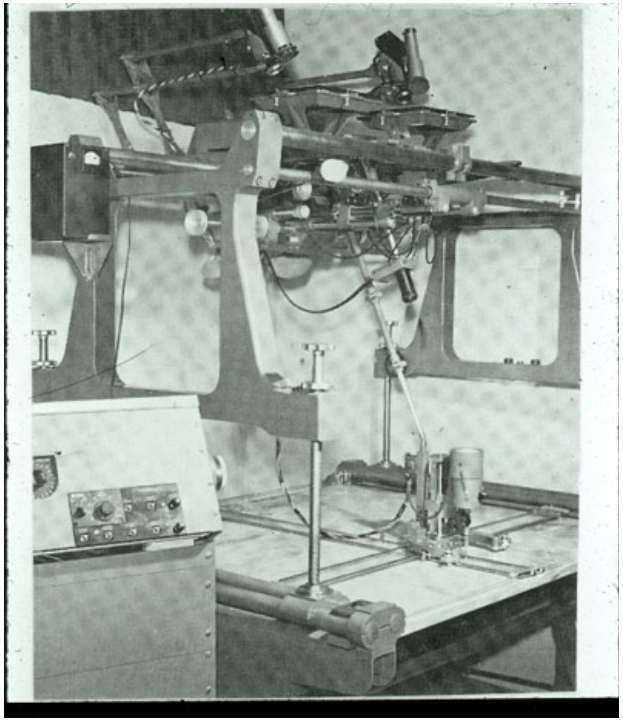


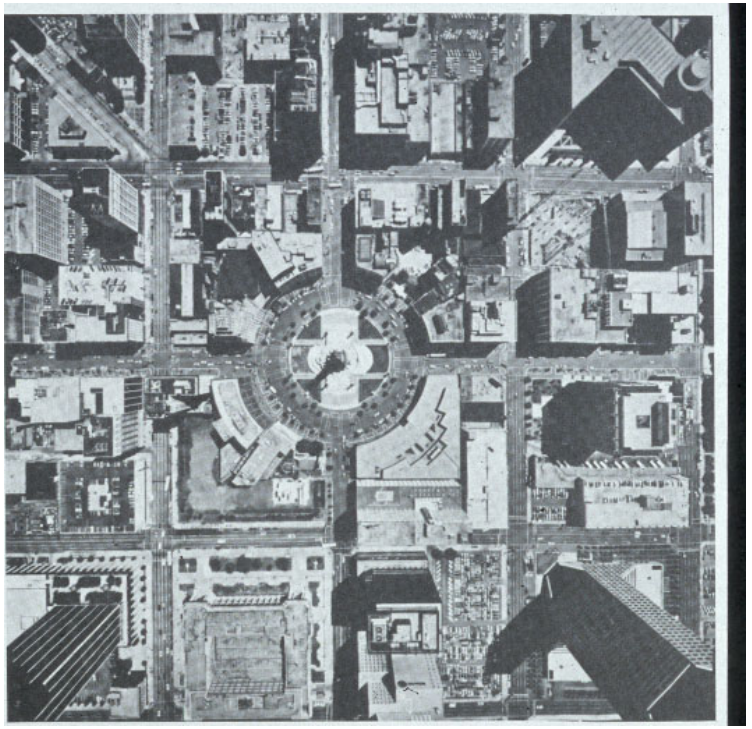
WW1


YPRES
EDITION 3B (LOCAL)
28. N.W. 4
Potijze
YPRES
Hellfire Jctn
Rifle Farm Spur
(Duckboard)
No Mans Land
Lake Fm Spur
Railway Wood
School
Caravan



Photogrammetry and stereo



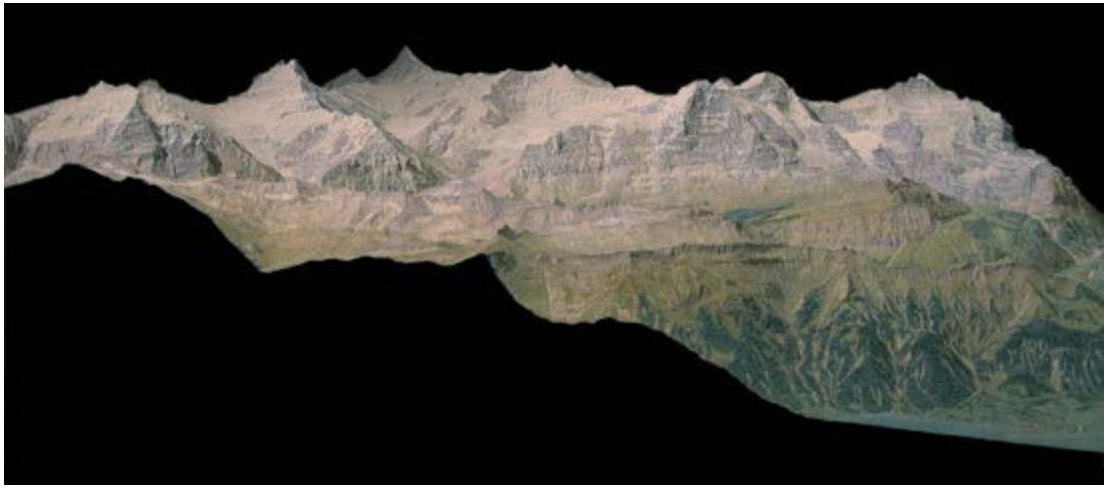


Terrain models

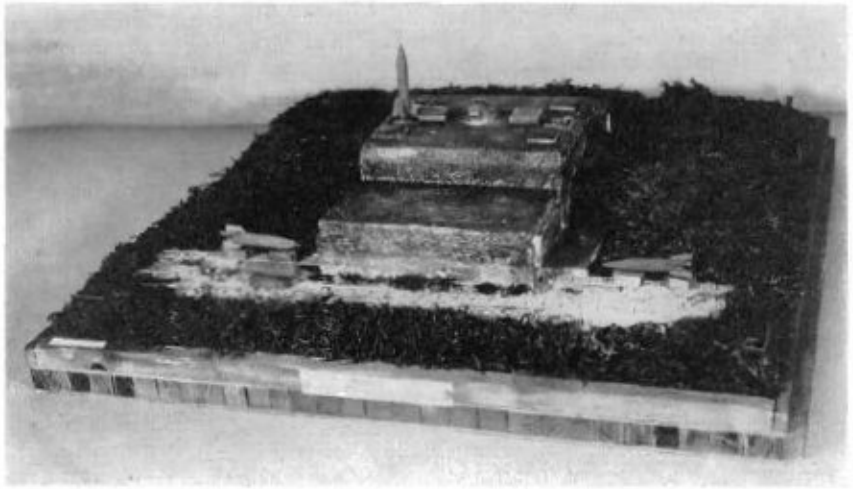
- Maximilian I. (1459 – 1540) induced the manufacturing of four primitive terrain models of the eastern Alps during 1500 – 1540 by P. Dax
- Pope Clemens VII used a cork model of Florence created by Benvenuto di Lorenzo della Volpaia and Niccolò Tribolo to plan his siege of 1529/30
- Nearly 200 models were created to depict the possessions of the Venetian Doges in the Levant.
- In Germany, duke Albert V of Bavaria produced four reliefs of towns by Jakob Sandtner between 1568 and 1574.

Early models

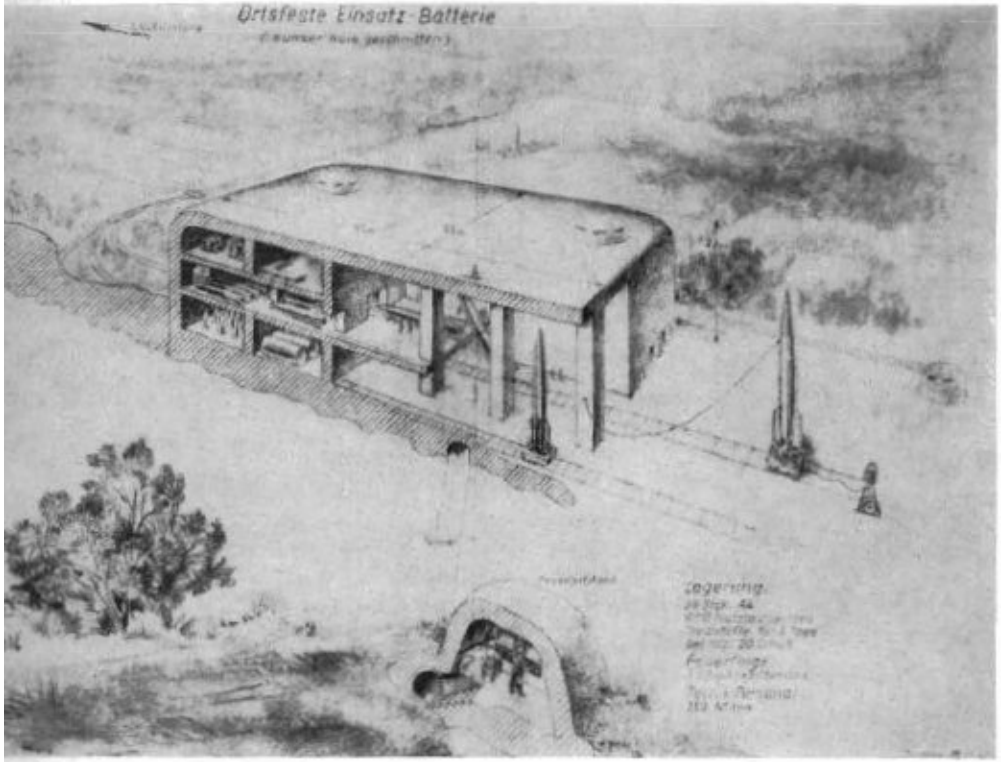
Model of Munich (Germany) 1:616, 186 x 200 cm, painted linden wood, Jakob Sandtner, 1572



Relief of the Bernese Oberland (Switzerland) 1:25,000, 76 x 100 cm, Xaver Imfeld, 1908



Das Modell eines ursprünglich geplanten Bunkers sah Aufzüge für die startklaren Raketen vor. Bei anderen Bunkern sollten sie einfach aus der Deckung ins Freie gerollt werden



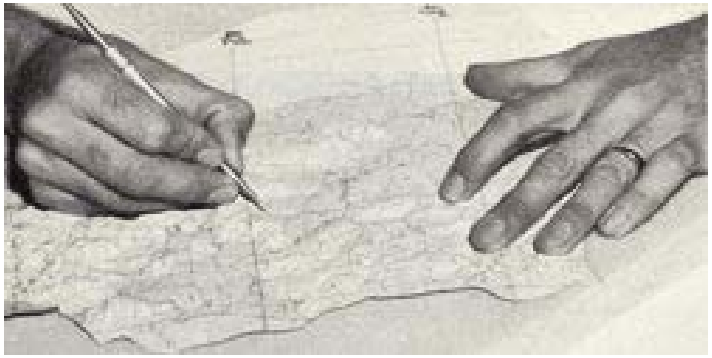
Peenemunde, Operation Crossbow

Plaster model of the Grosse Windgälle, 3187 m (Switzerland) 1:2,000,

163 x 307 cm, Eduard Imhof, 1938

3D modeling methods

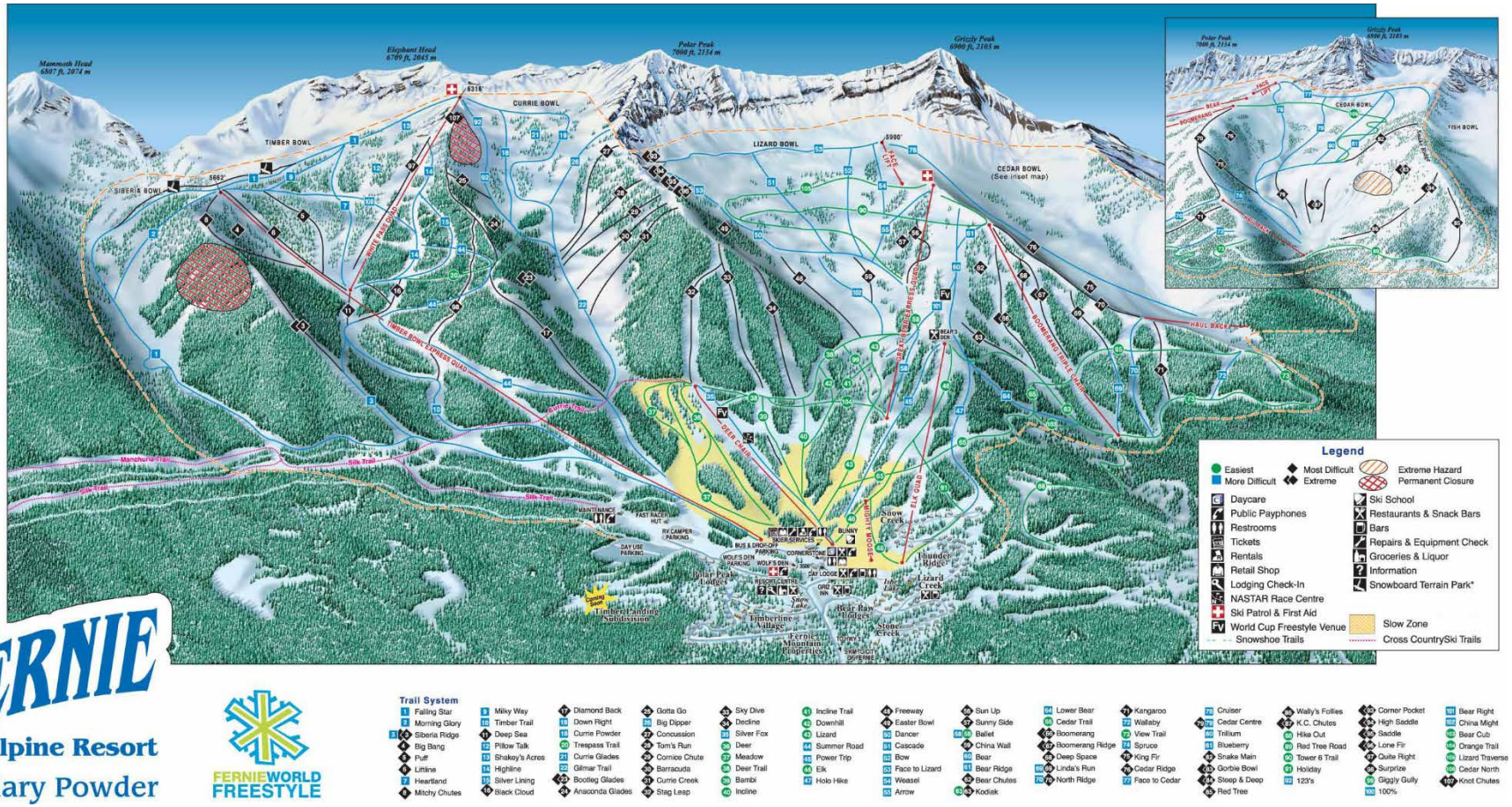
- Plaster models
- Pantograph
- Wenschow
- Vacuum forming
- Terrain embossing
- Computer based



Methods

Cartographer Karl Mayek at work, "Schweiz" 1:350,000

Perspective-Realistic



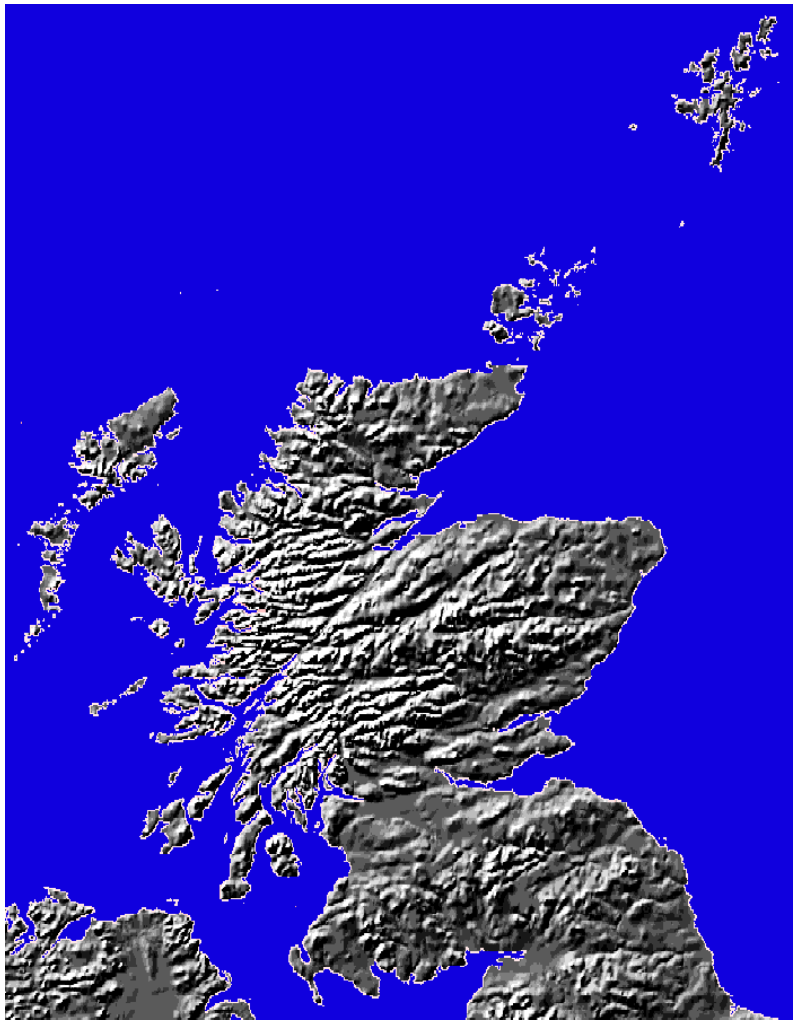
FERNIE
Alpine Resort
Legendary Powder

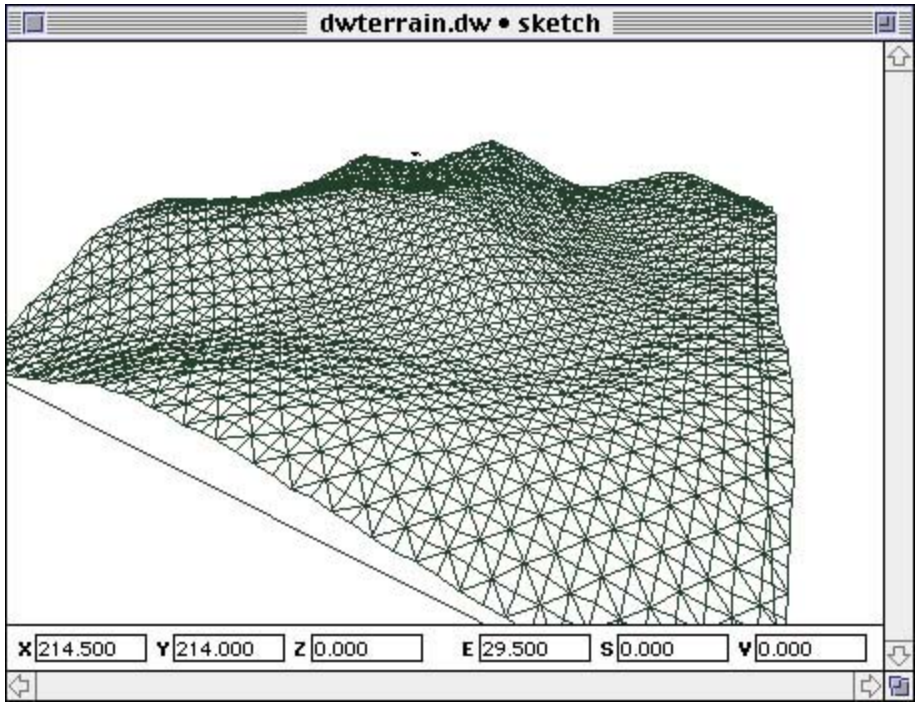
FERNIEWORLD FREESTYLE

Trail System

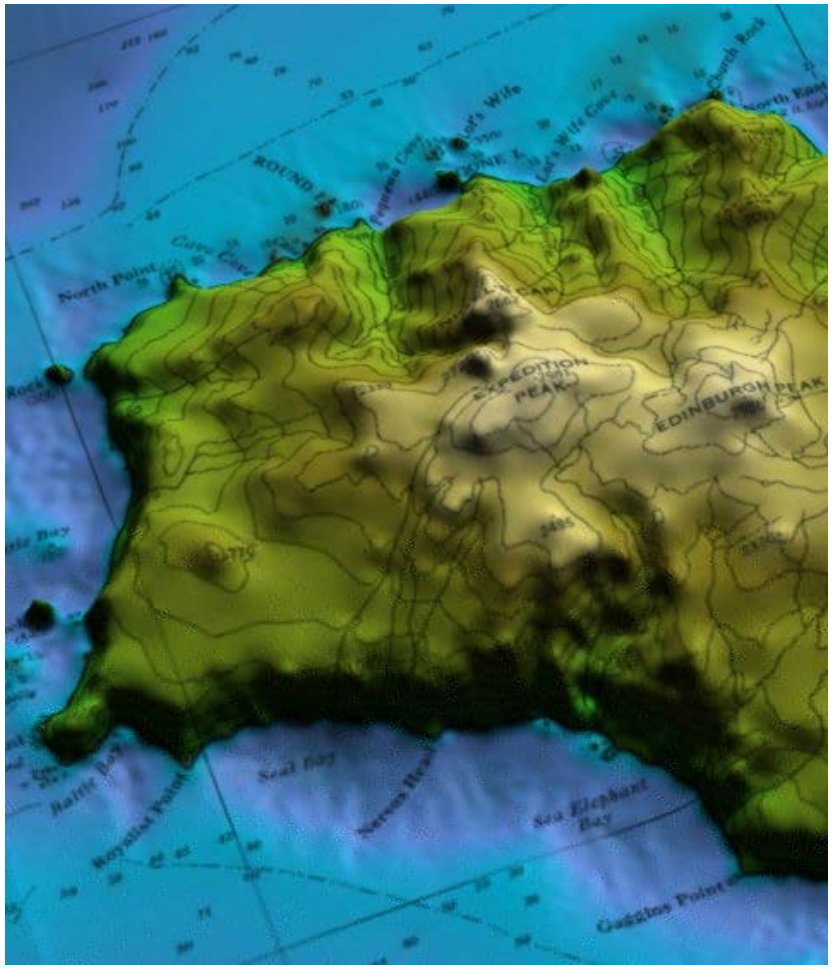
1 Falling Star
2 Morning Glory
3 Siberia Ridge
4 Big Bang
5 Puff
6 Littline
7 Heartland
8 Mitchy Chutes
9 Milky Way
10 Timber Trail
11 Deep Sea
12 Pillow Talk
13 Shakey's Acres
14 Highline
15 Silver Lining
16 Black Cloud
17 Diamond Back
18 Down Right
19 Currie Powder
20 Trespass Trail
21 Currie Glades
22 Gilmar Trail
23 Bootleg Glades
24 Anaconda Glades
25 Gotta Go
26 Big Dipper
27 Concussion
28 Tom's Run
29 Cornice Chute
30 Barracuda
31 Currie Creek
32 Stag Leap
33 Sky Dive
34 Decline
35 Silver Fox
36 Deer
37 Meadow
38 Deer Trail
39 Bambi
40 Incline
41 Incline Trail
42 Downhill
43 Lizard
44 Summer Road
45 Power Trip
46 Elk
47 Holo Hike
48 Freeway
49 Easter Bowl
50 Dancer
51 Cascade
52 Bow
53 Face to Lizard
54 Weasel
55 Arrow
56 Sun Up
57 Sunny Side
58 Ballet
59 China Wall
60 Bear
61 Bear Ridge
62 Bear Chutes
63 Kodiak
64 Lower Bear
65 Cedar Trail
66 Boomerang
67 Boomerang Ridge
68 Deep Space
69 Linda's Run
70 North Ridge
71 Kangaroo
72 Wallaby
73 View Trail
74 Spruce
75 King Fir
76 Cedar Ridge
77 Face to Cedar
78 Cruiser
79 Cedar Centre
80 Trillium
81 Blueberry
82 Snake Main
83 Gorbie Bowl
84 Steep & Deep
85 Red Tree
86 Wally's Follies
87 K.C. Chutes
88 Hike Out
89 Red Tree Road
90 Tower 6 Trail
91 Holiday
92 123's
93 Corner Pocket
94 High Saddle
95 Saddle
96 Lone Fir
97 Quite Right
98 Surprize
99 Giggly Gully
100 100%
101 Bear Right
102 China Might
103 Bear Cub
104 Orange Trail
105 Lizard Traverse
106 Cedar North
107 Knot Chutes

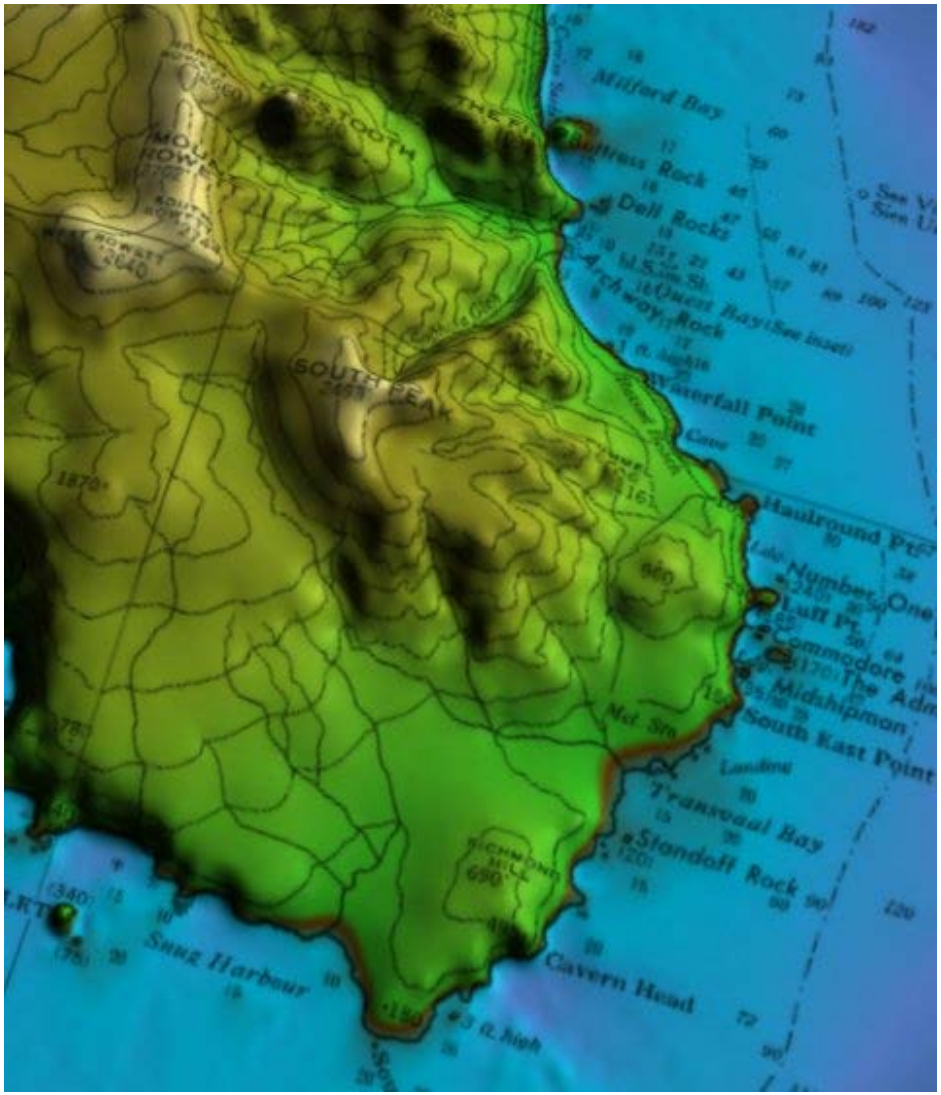
Hillshading and Grids



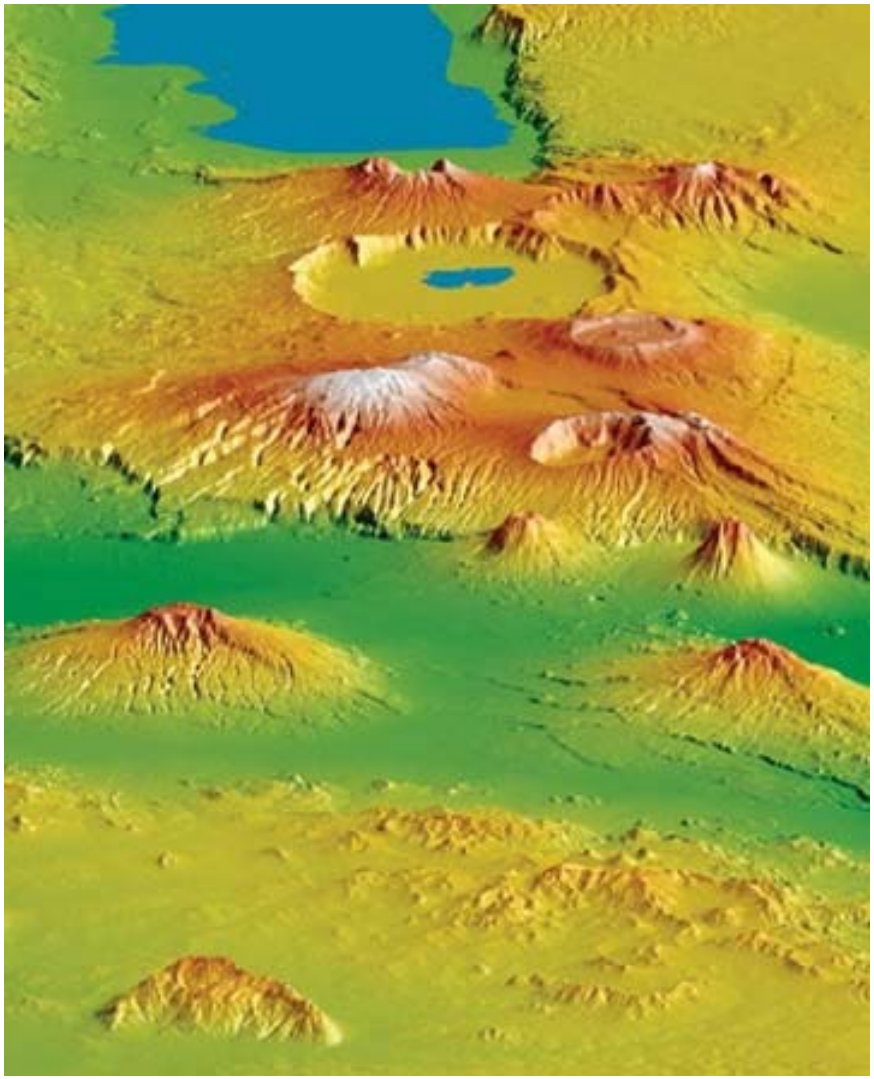


Software views from maps

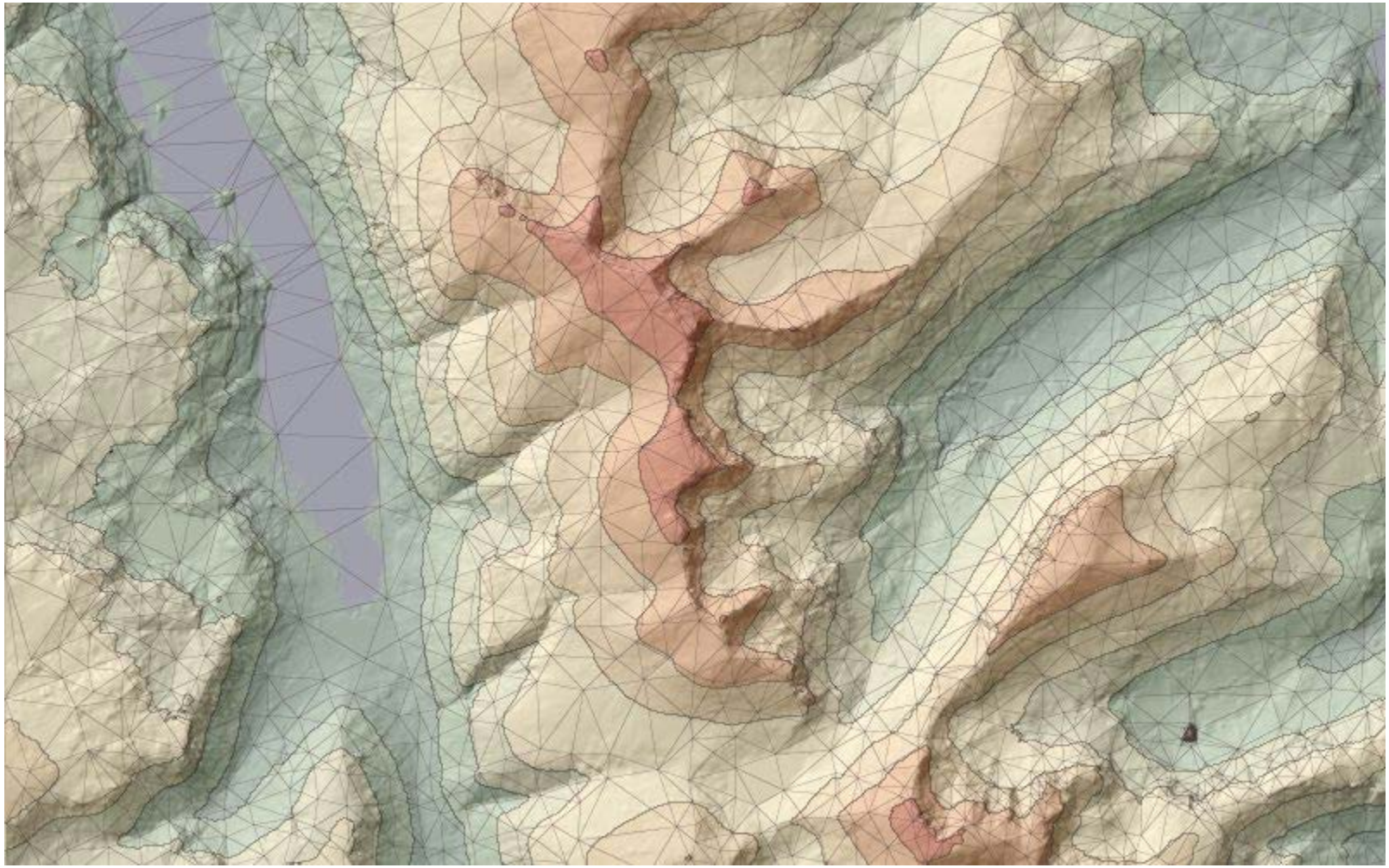




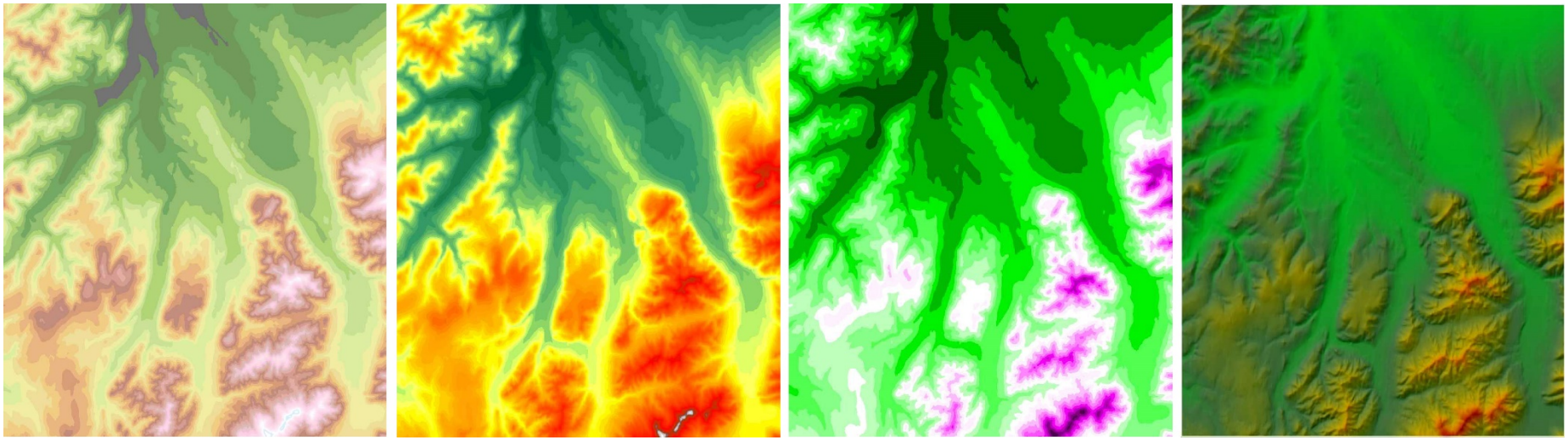
Colored/Shaded



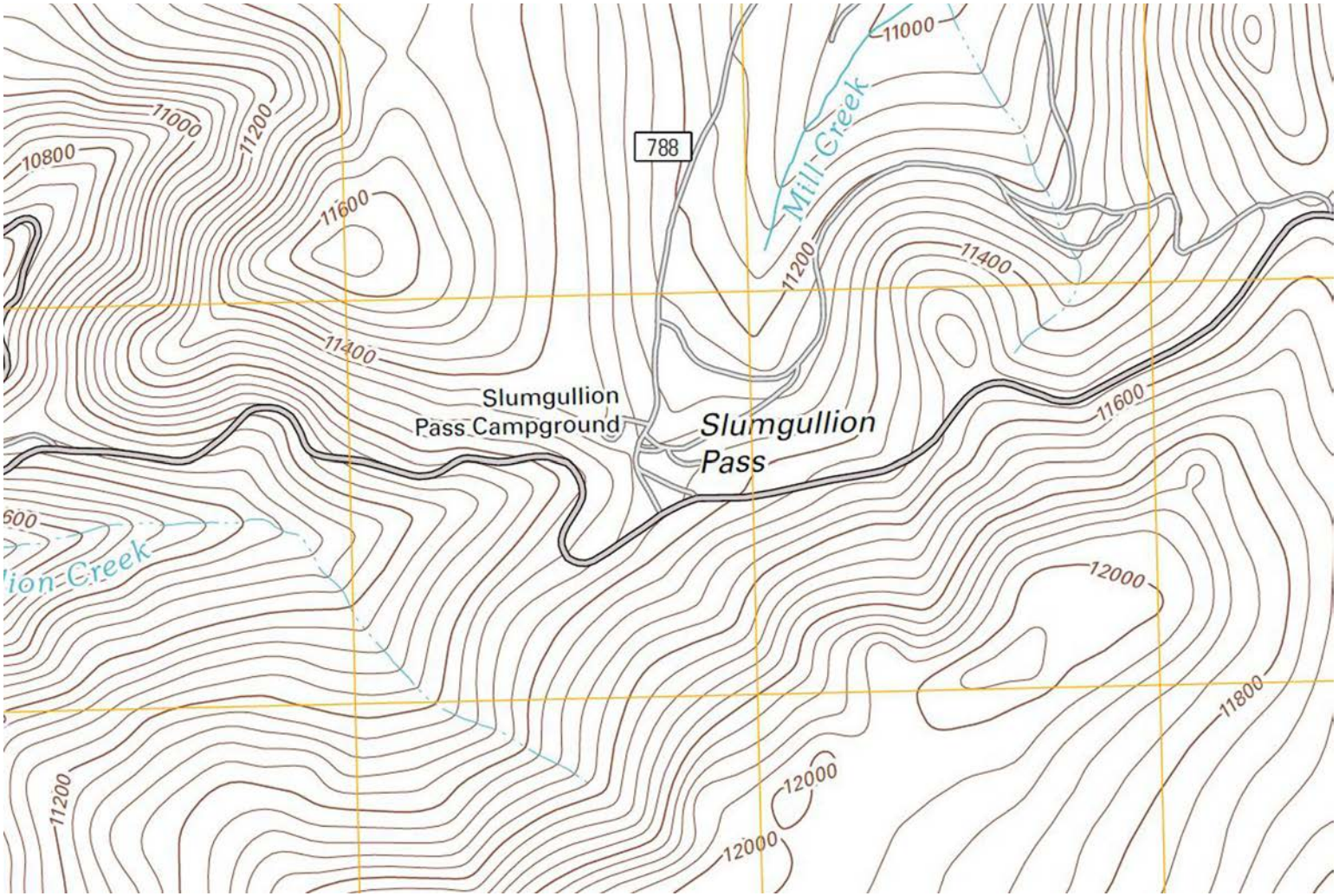
Jo Wood: Landserf



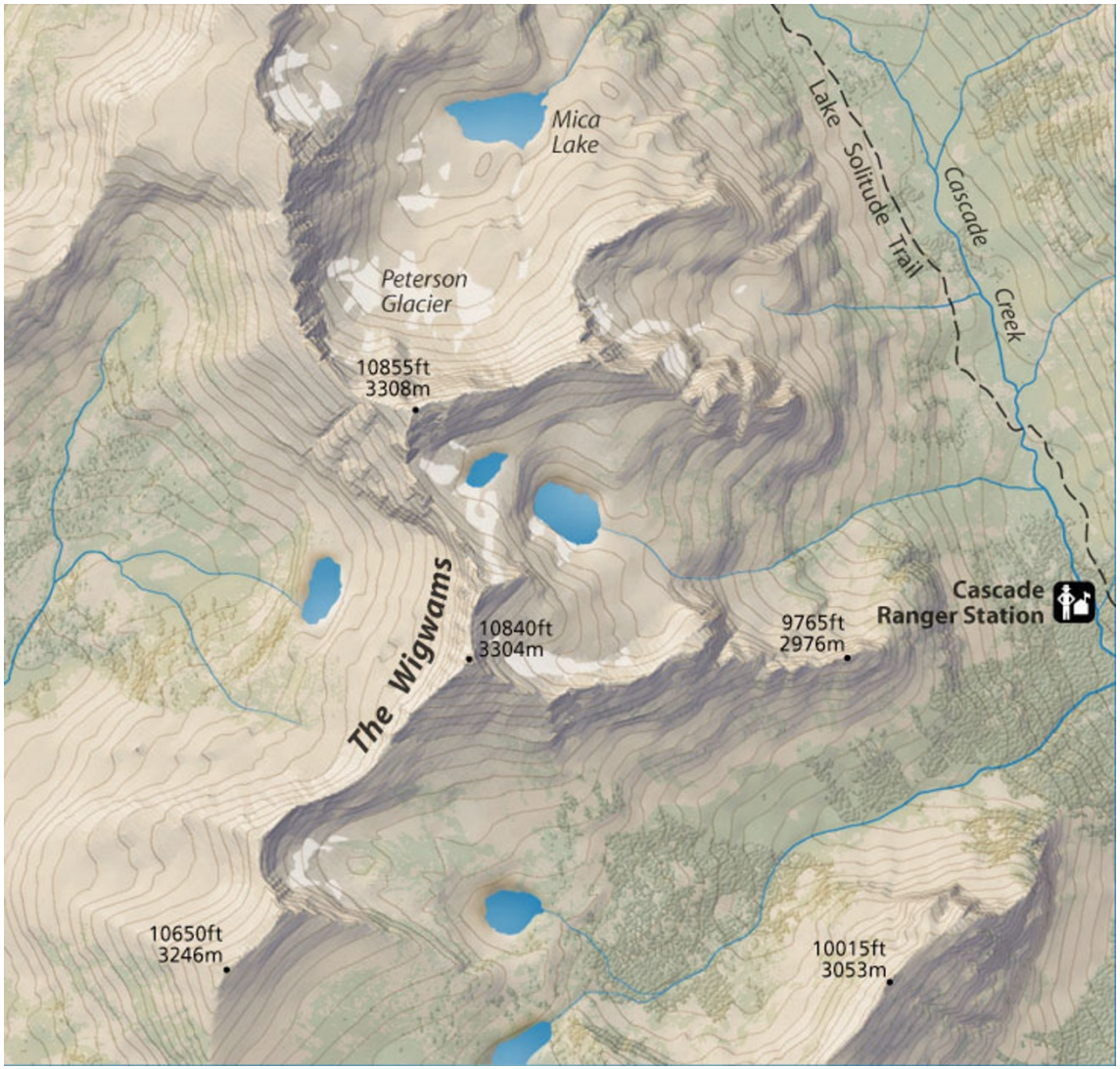
Global Mapper/MicroDEM



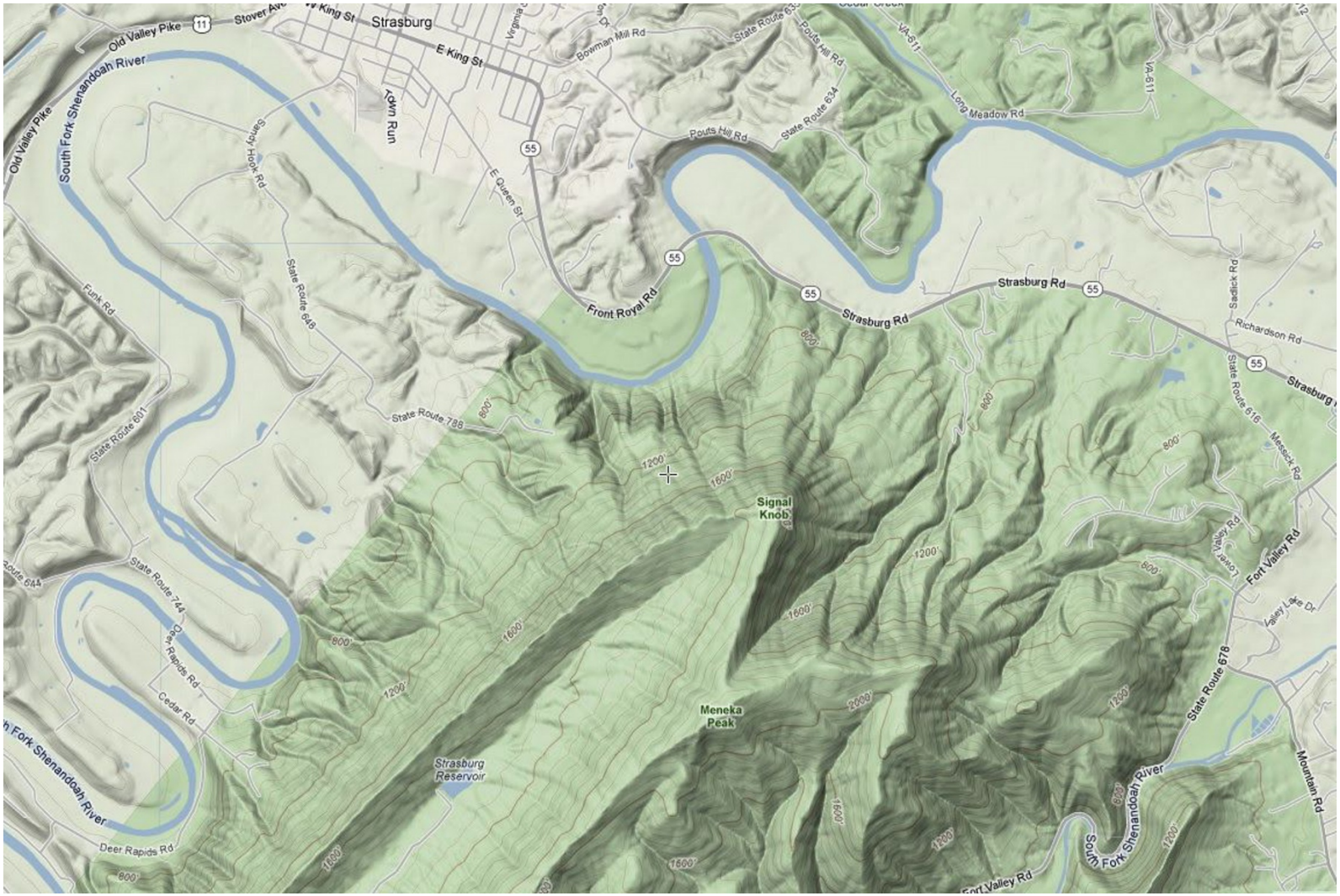
GeoPDF contours



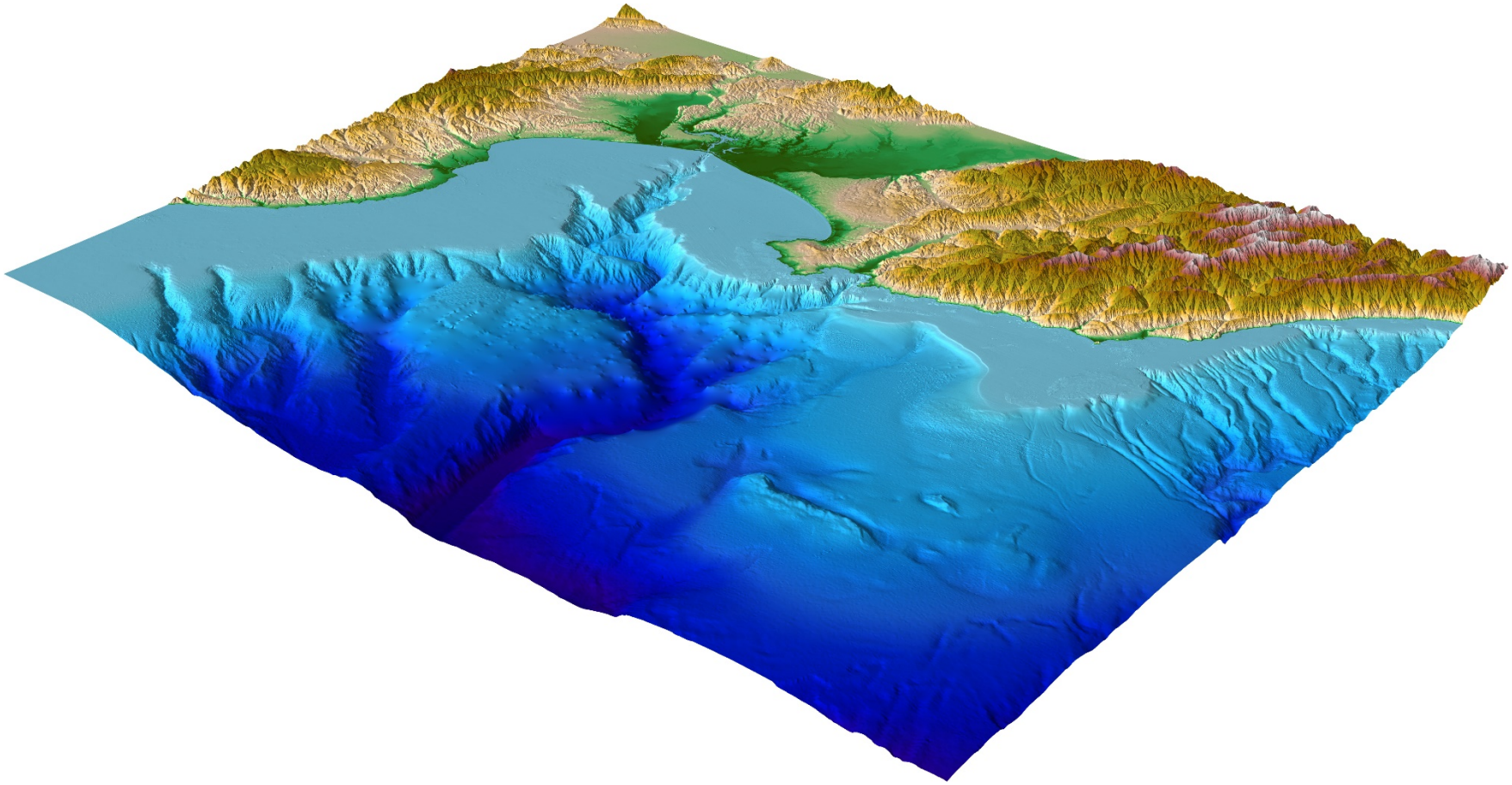
NPS: Photoshop



AcmeMapper

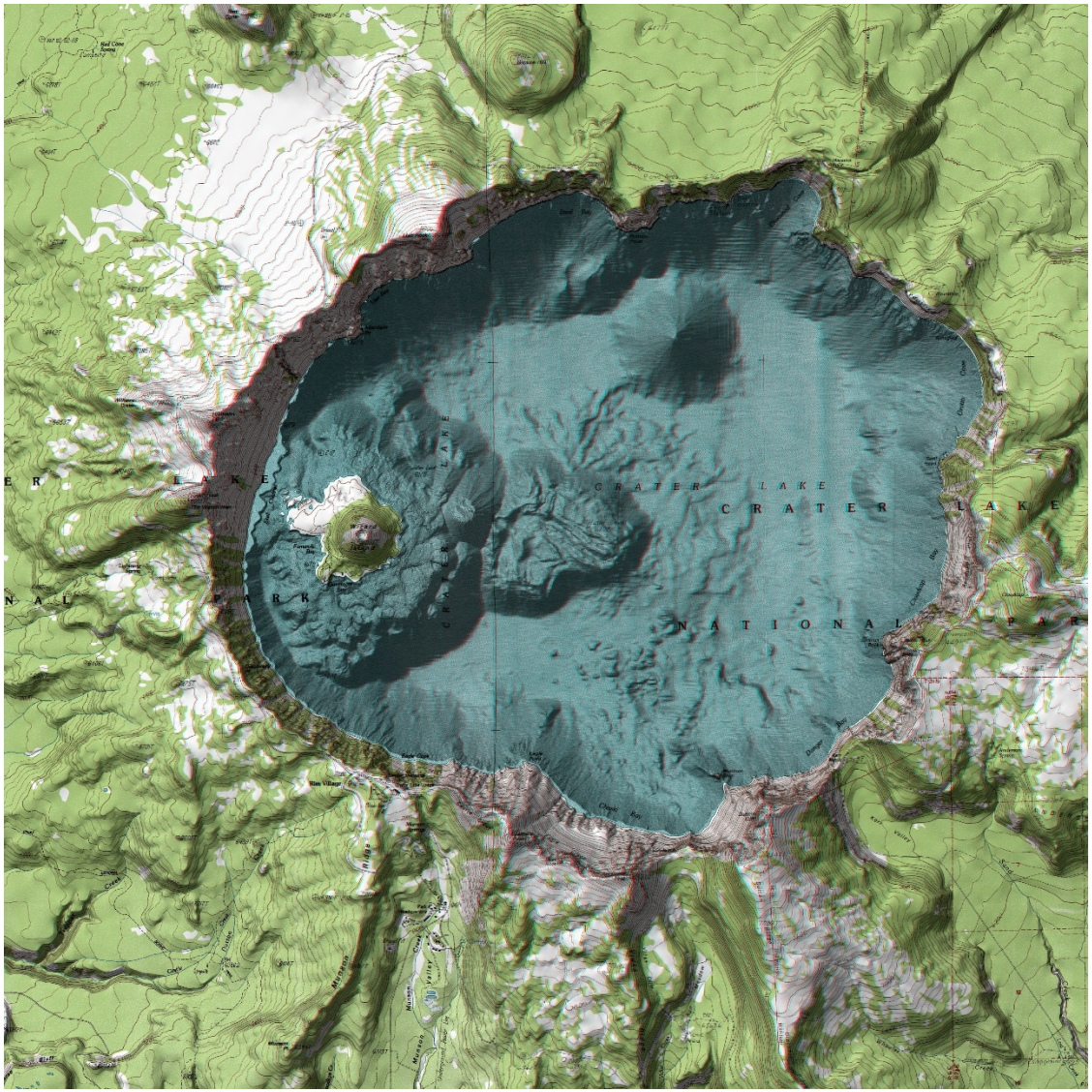

Strasburg
E King St
Old Valley Pike
South Fork Shenandoah River
Town Run
Bowman Mill Rd
Pouts Hill Rd
State Route 634
Long Meadow Rd
VA-611
Sandy Hook Rd
E Queen St
Front Royal Rd
Strasburg Rd
Sadlick Rd
Richardson Rd
Funk Rd
State Route 648
State Route 601
State Route 788
Signal Knob
State Route 616
Messick Rd
Fort Valley Rd
Valley Rd
Lower
Valley Lake Dr
State Route 744
Deer Rapids Rd
Cedar Rd
Meneka Peak
Strasburg Reservoir
State Route 678
Mountain Rd
South Fork Shenandoah River

Rendered perspective

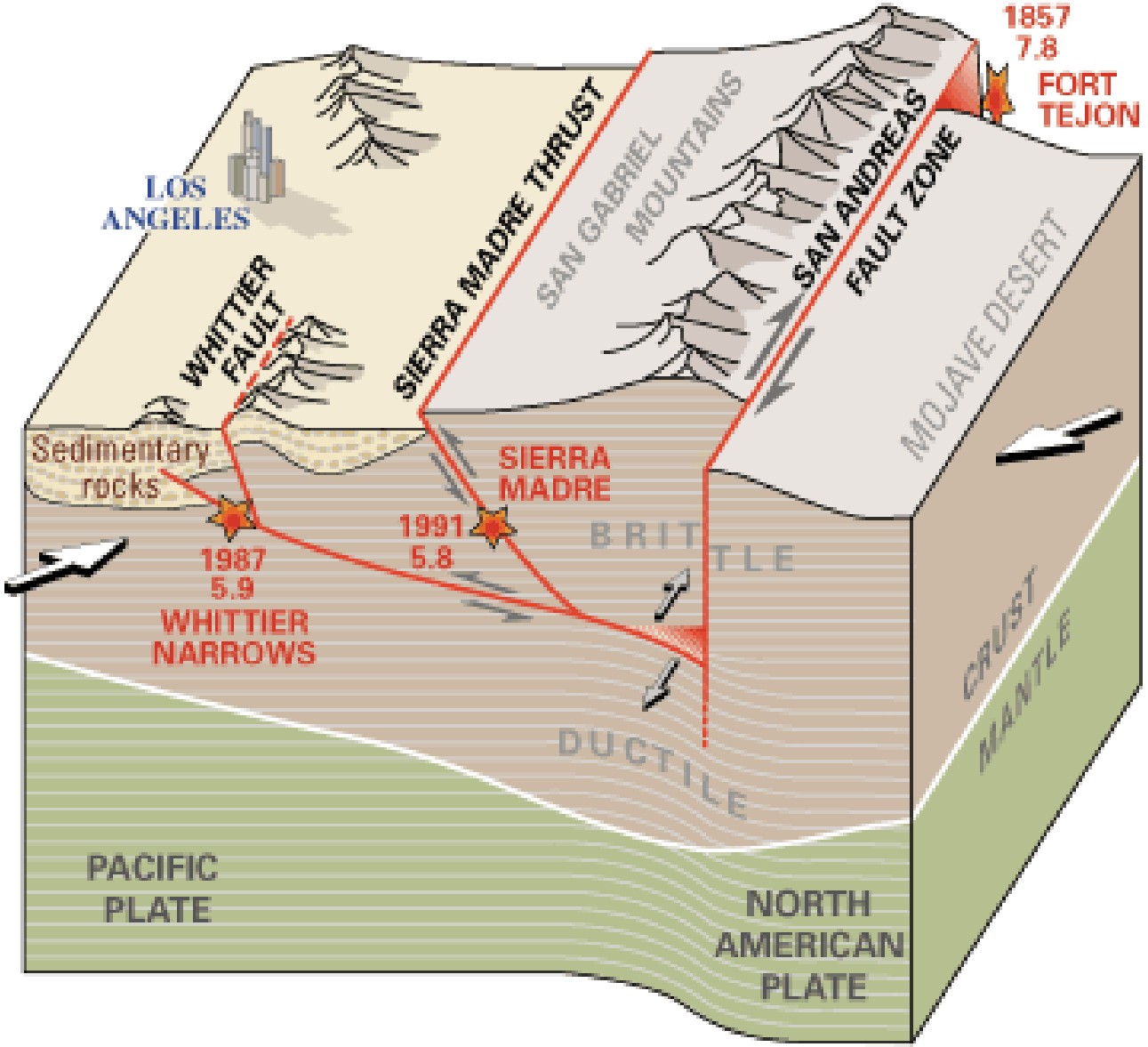


Satellite image drape

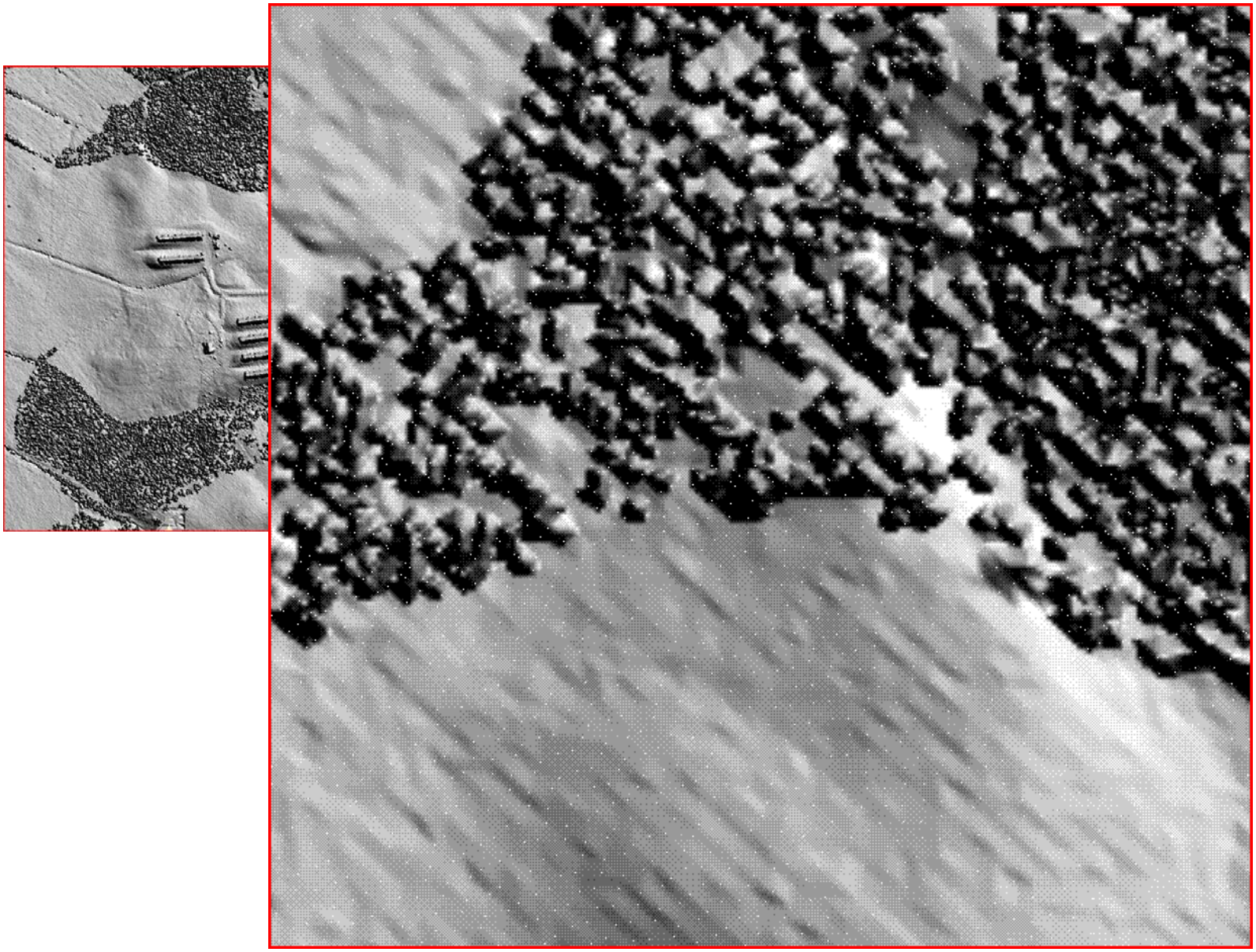
Anaglyph



3D graphics/model

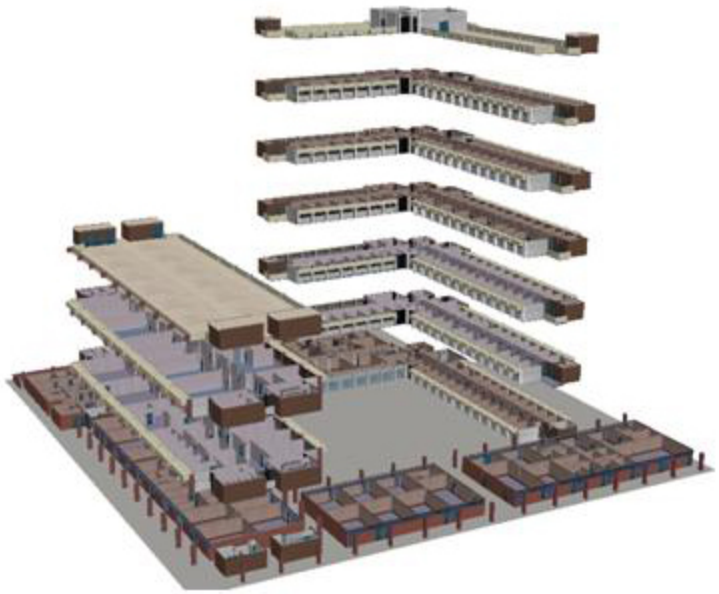


LiDAR

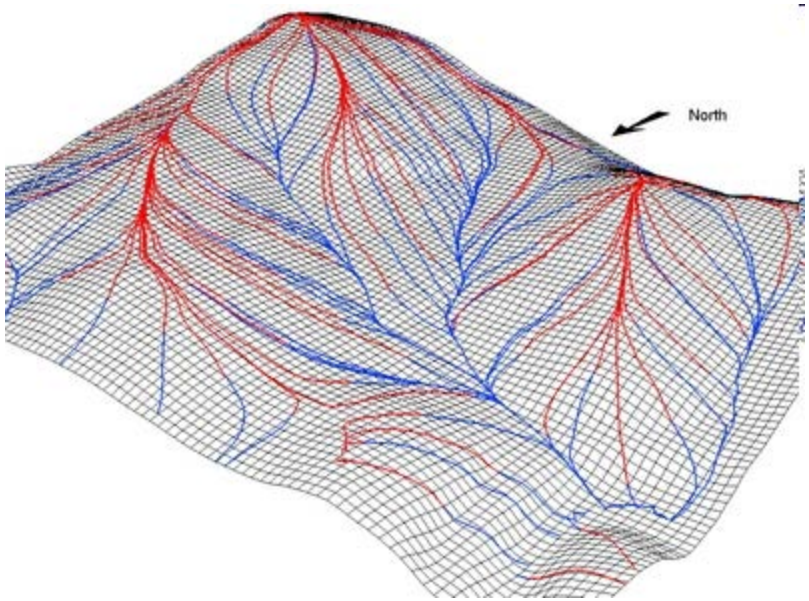


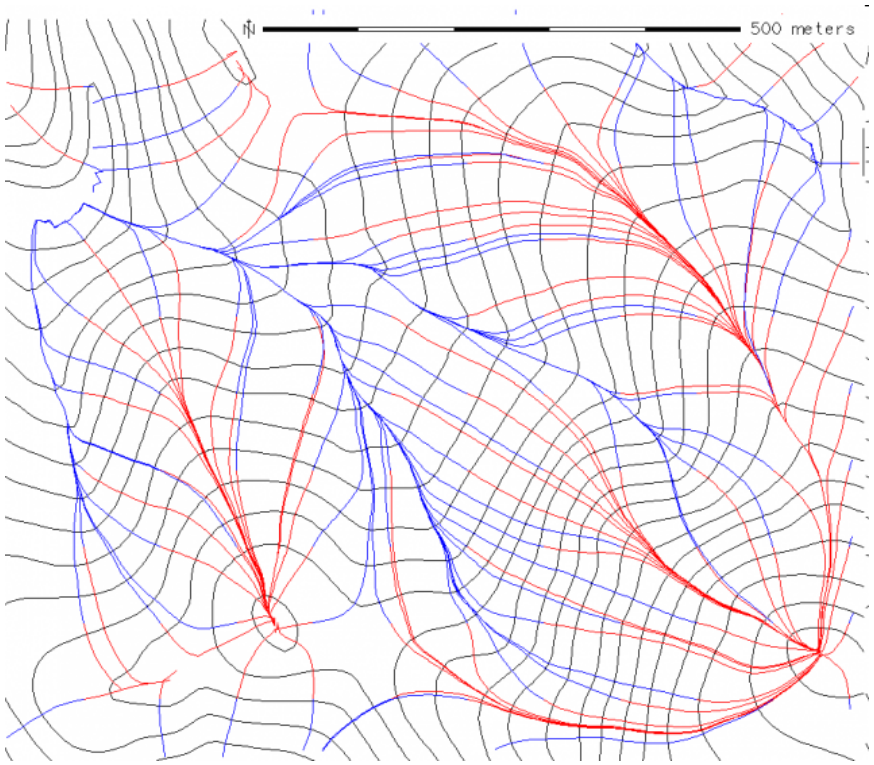
Voxels

True 3D models



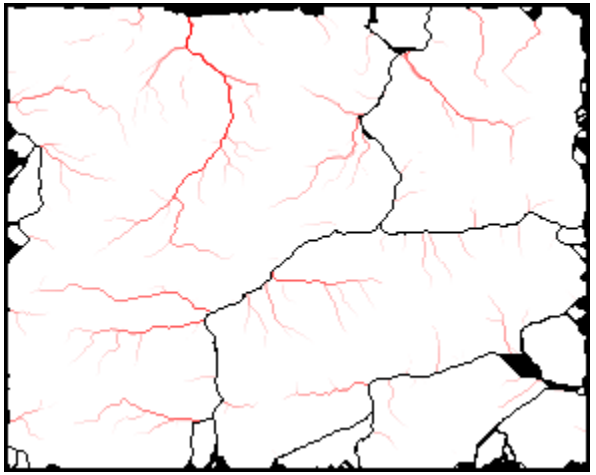
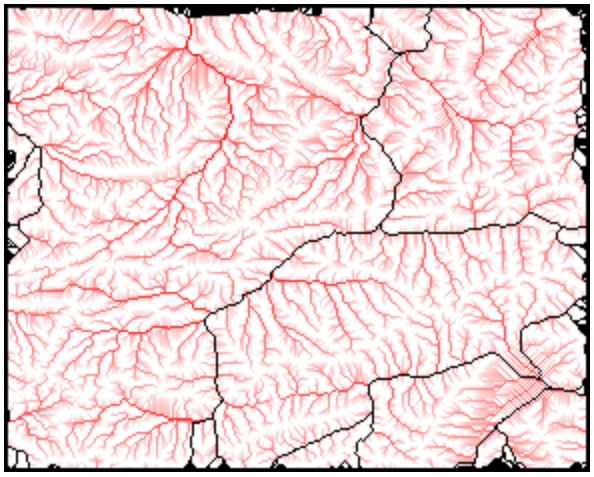
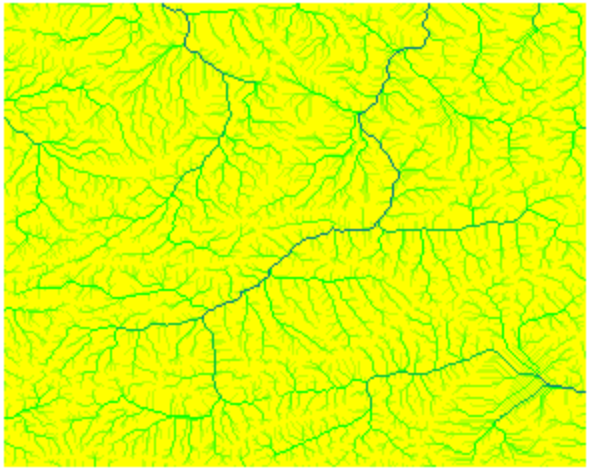
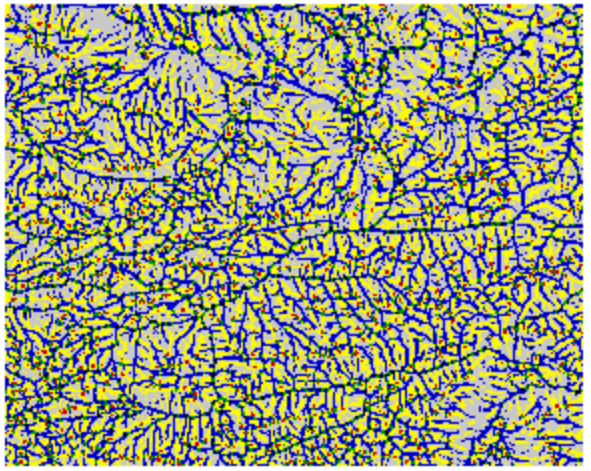
Terrain “skeleton” Warntz network Surface network



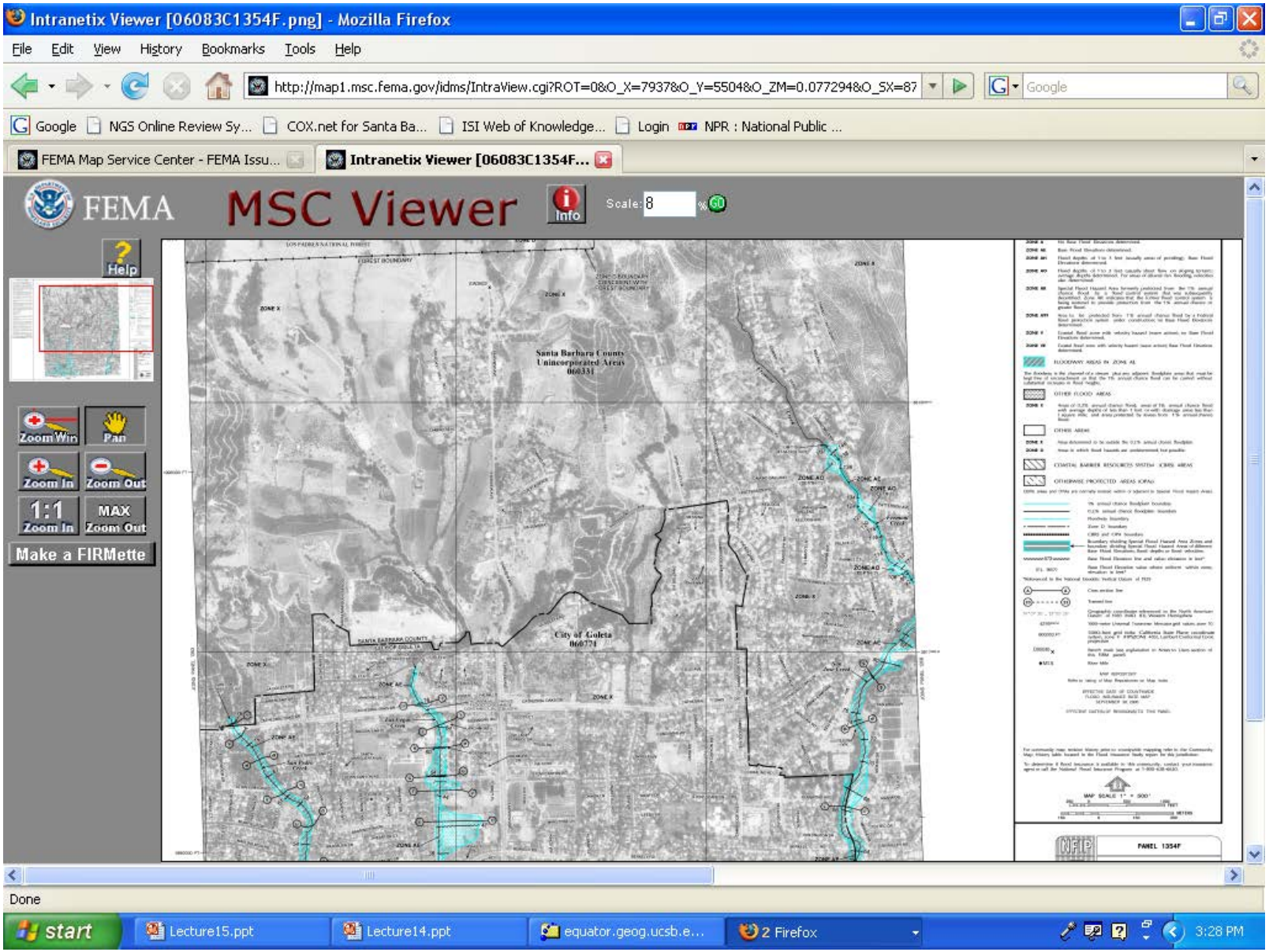


Sequence

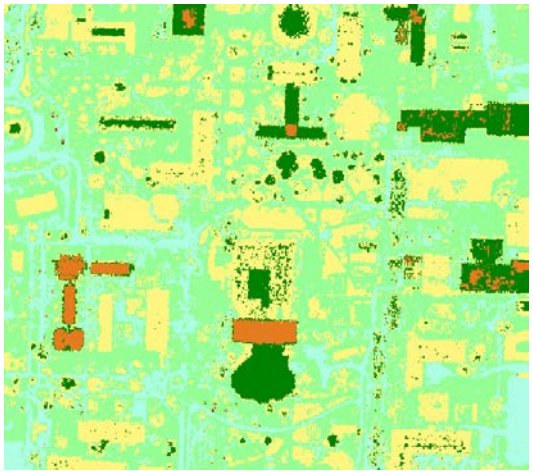


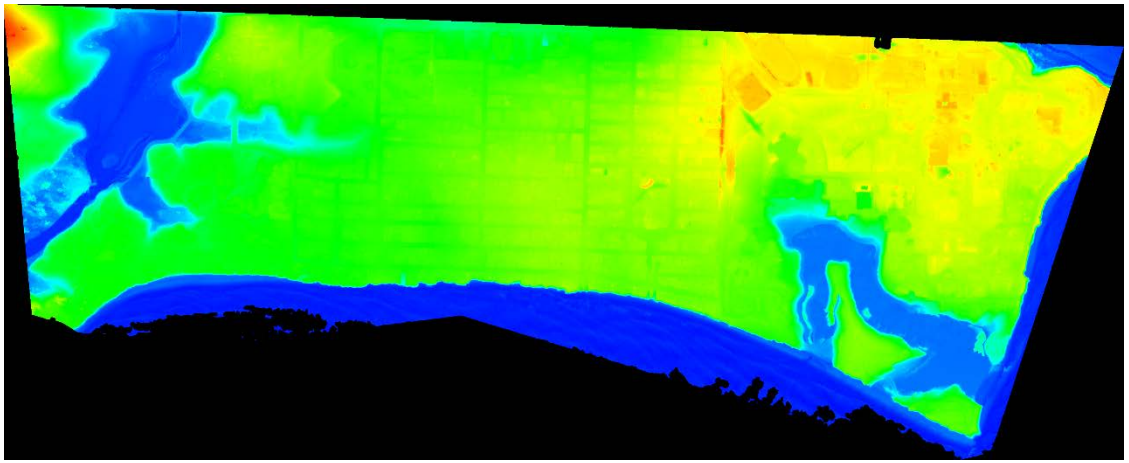





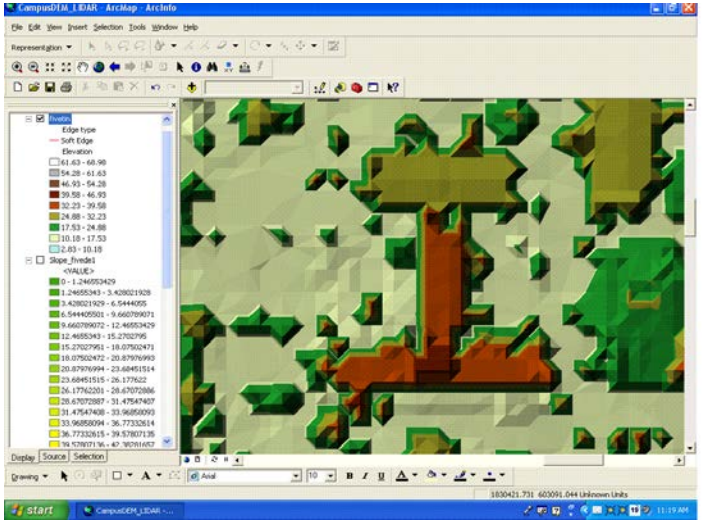
FEMA: D-FIRMs

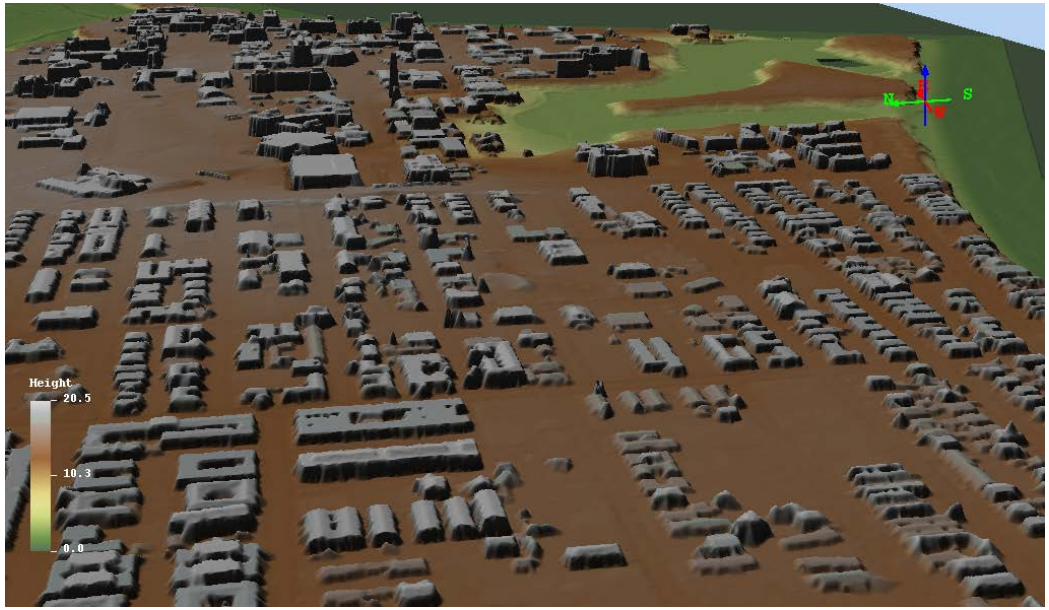

Intranetix Viewer [06083C1354F.png] - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://map1.msc.fema.gov/idms/IntraView.cgi?ROT=0&O_X=7937&O_Y=5504&O_ZM=0.077294&O_SX=87
Google
NGS Online Review Sy... COX.net for Santa Ba... ISI Web of Knowledge... Login NPR : National Public ...
FEMA Map Service Center - FEMA Issu...
Intranetix Viewer [06083C1354F...
FEMA
MSC Viewer
Info
Scale: 8
GO
Help
Zoom Win
Pan
Zoom In
Zoom Out
1:1 Zoom In
MAX Zoom Out
Make a FIRMette
Santa Barbara County Unincorporated Areas 060331
City of Goleta 060774
PANEL 1354F
Done
start
Lecture15.ppt
Lecture14.ppt
equator.geog.ucsb.e...
2 Firefox
3:28 PM

3D Models LiDAR

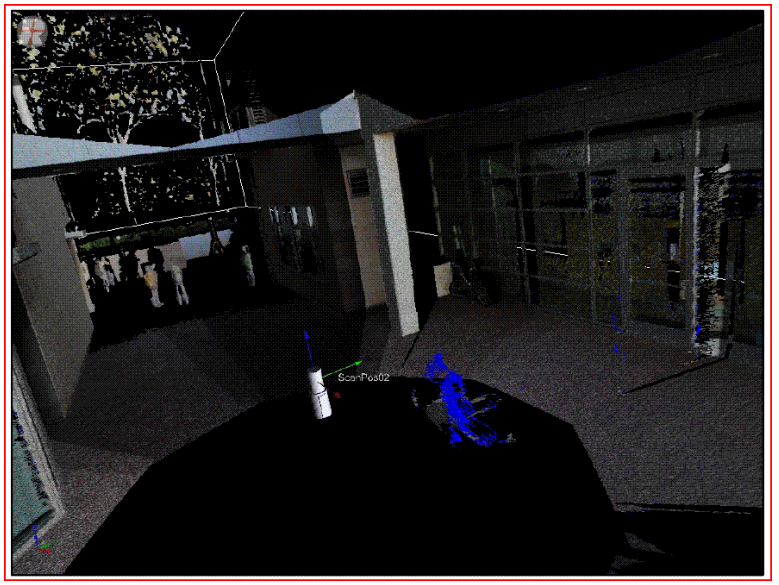


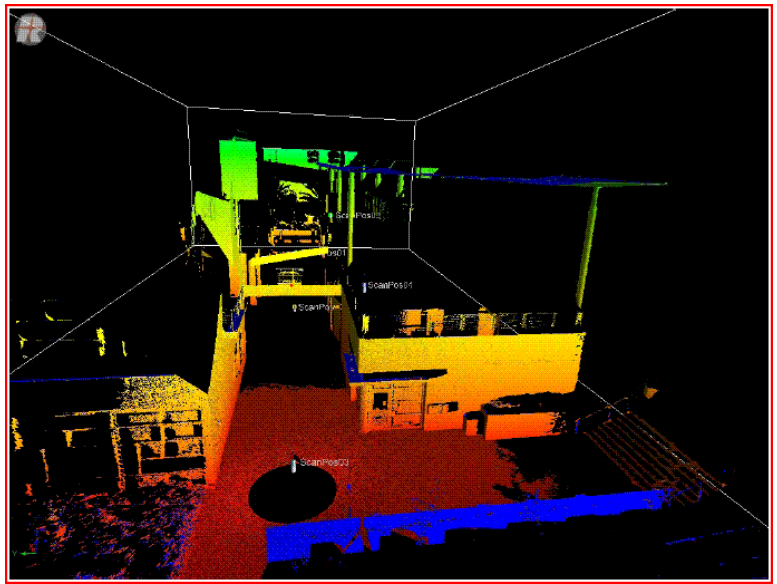






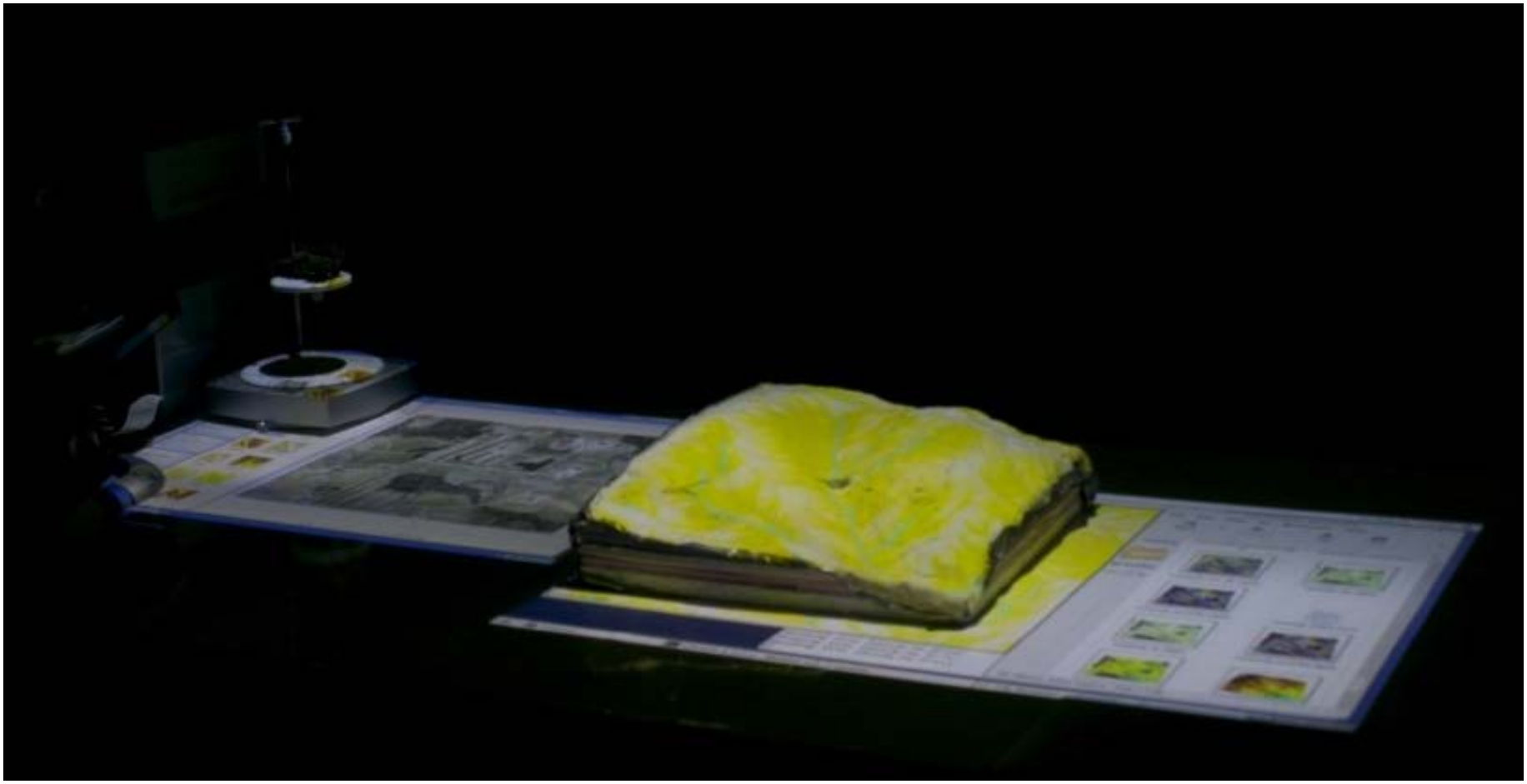
Terrestrial Scanning LiDAR



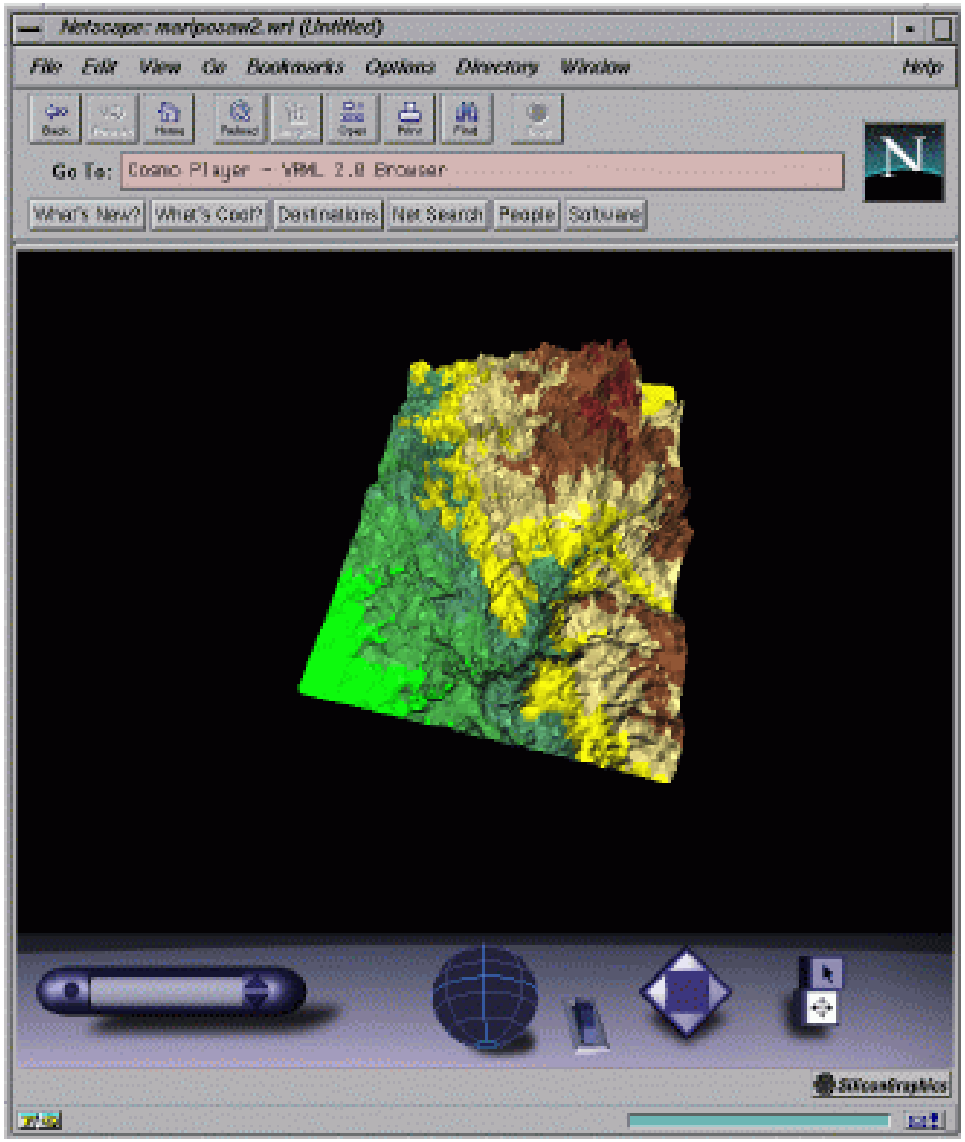


LiDAR Point Cloud

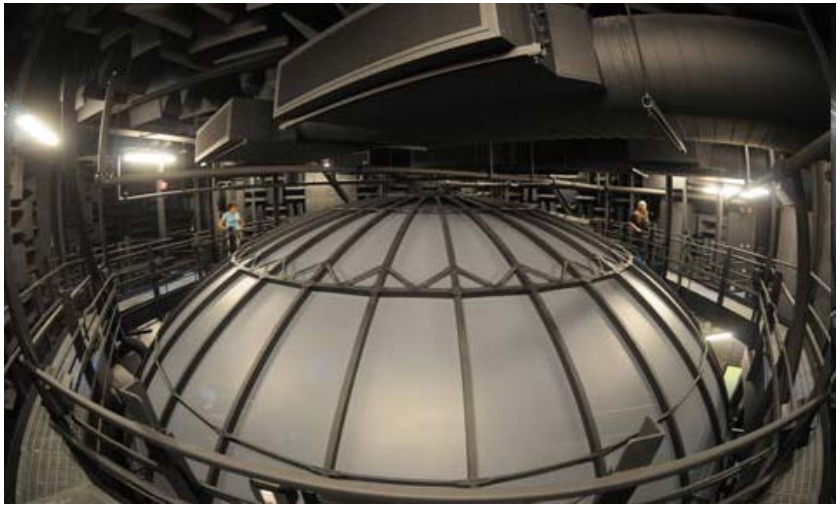
Projection systems (H. Mitasova)

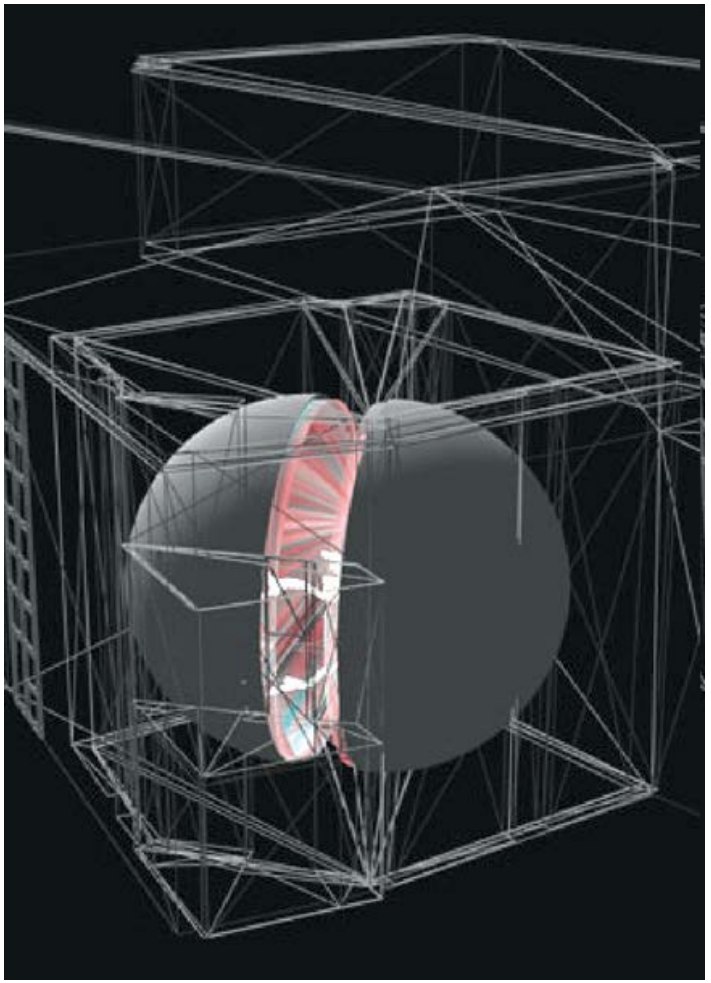


Movement depth: VRML

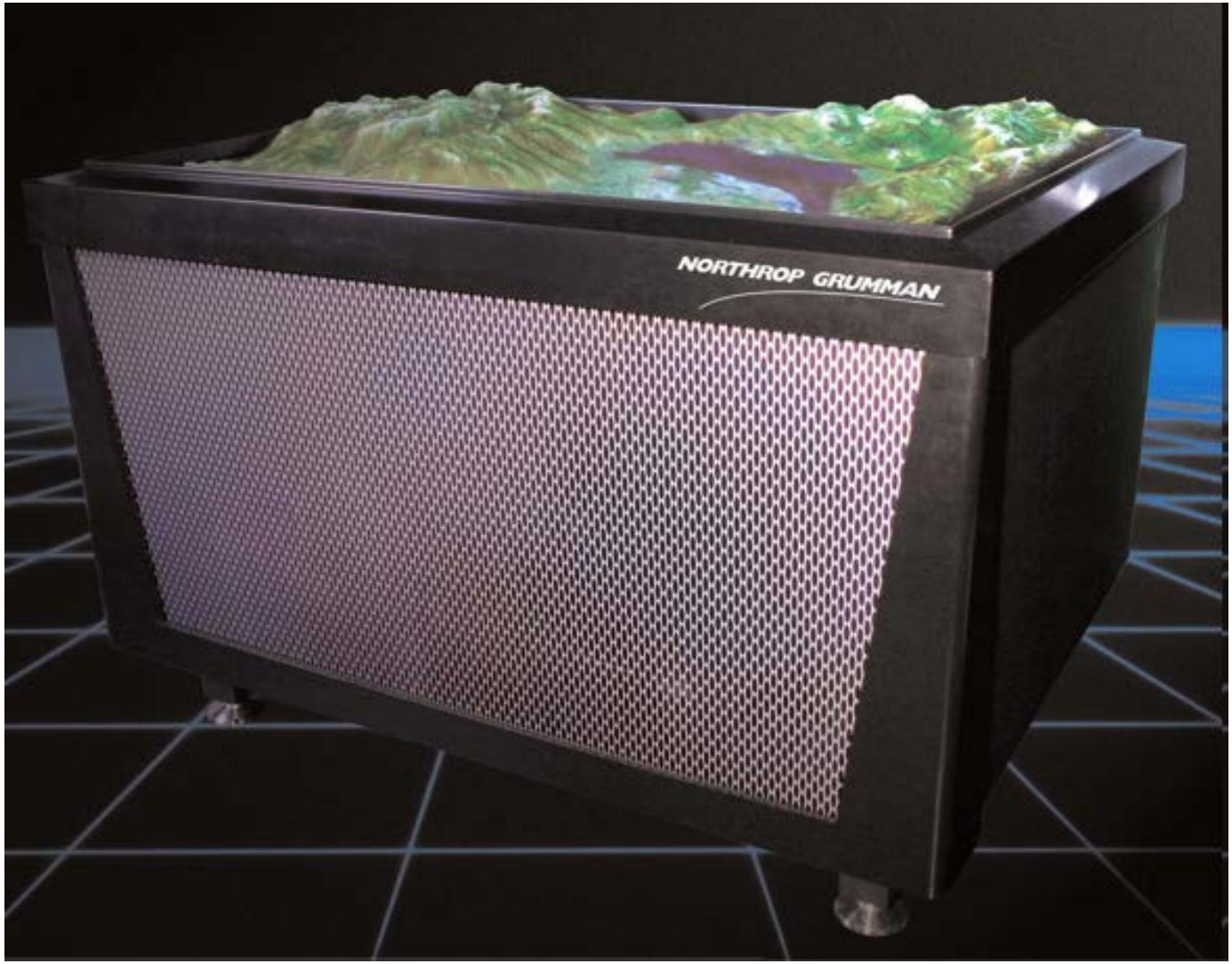


UCSB’s Allosphere



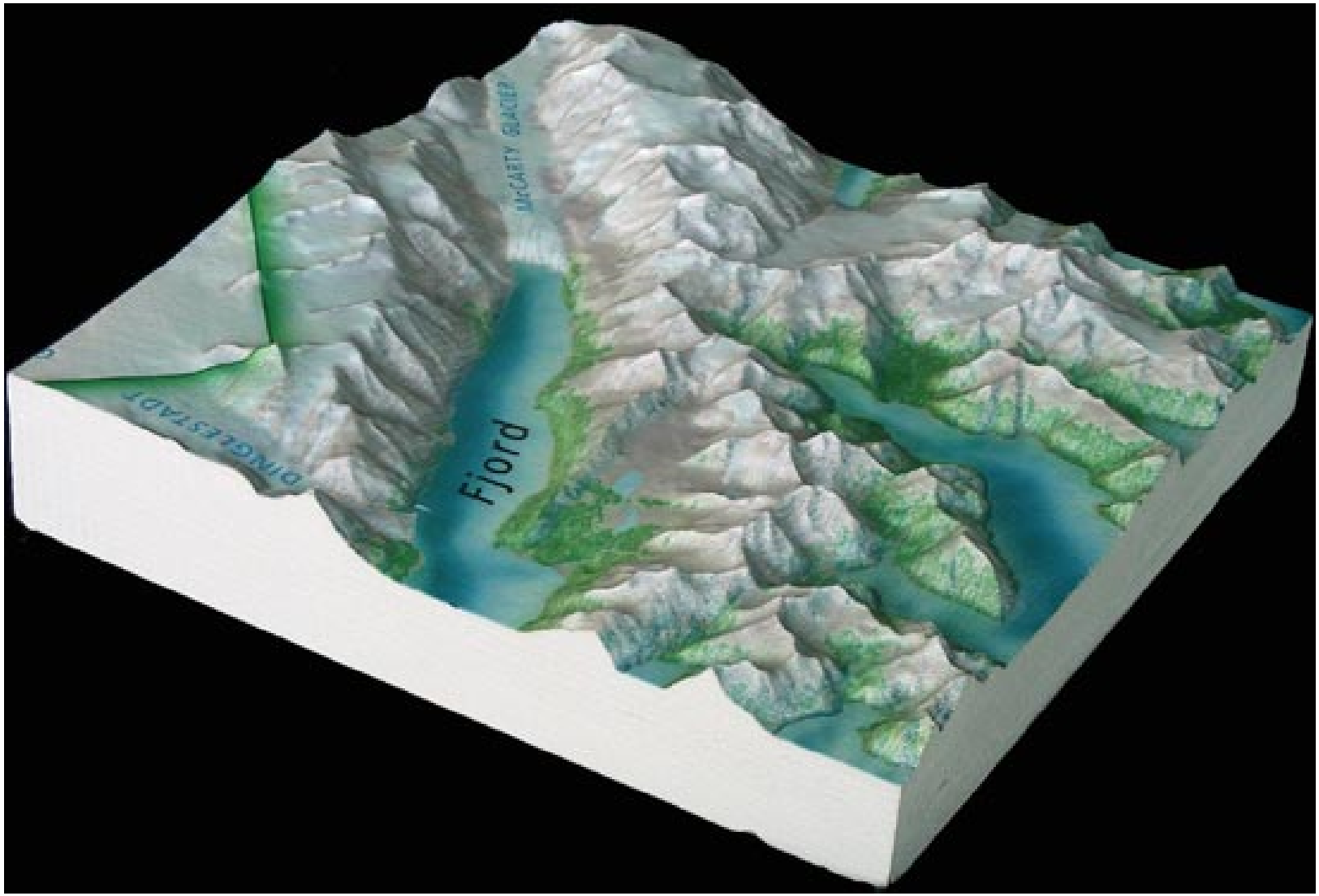


Virtual terrain

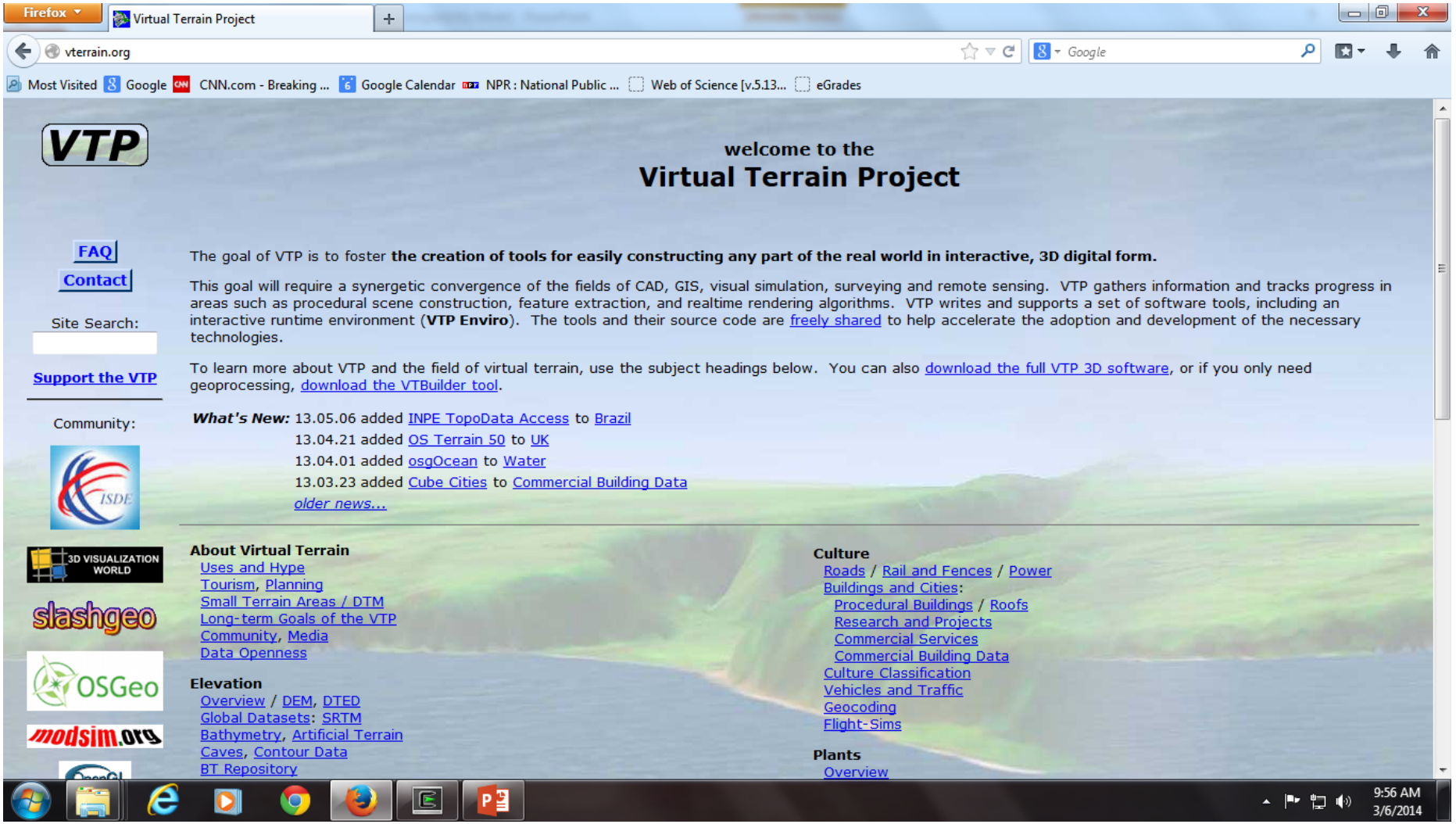


Holographic display

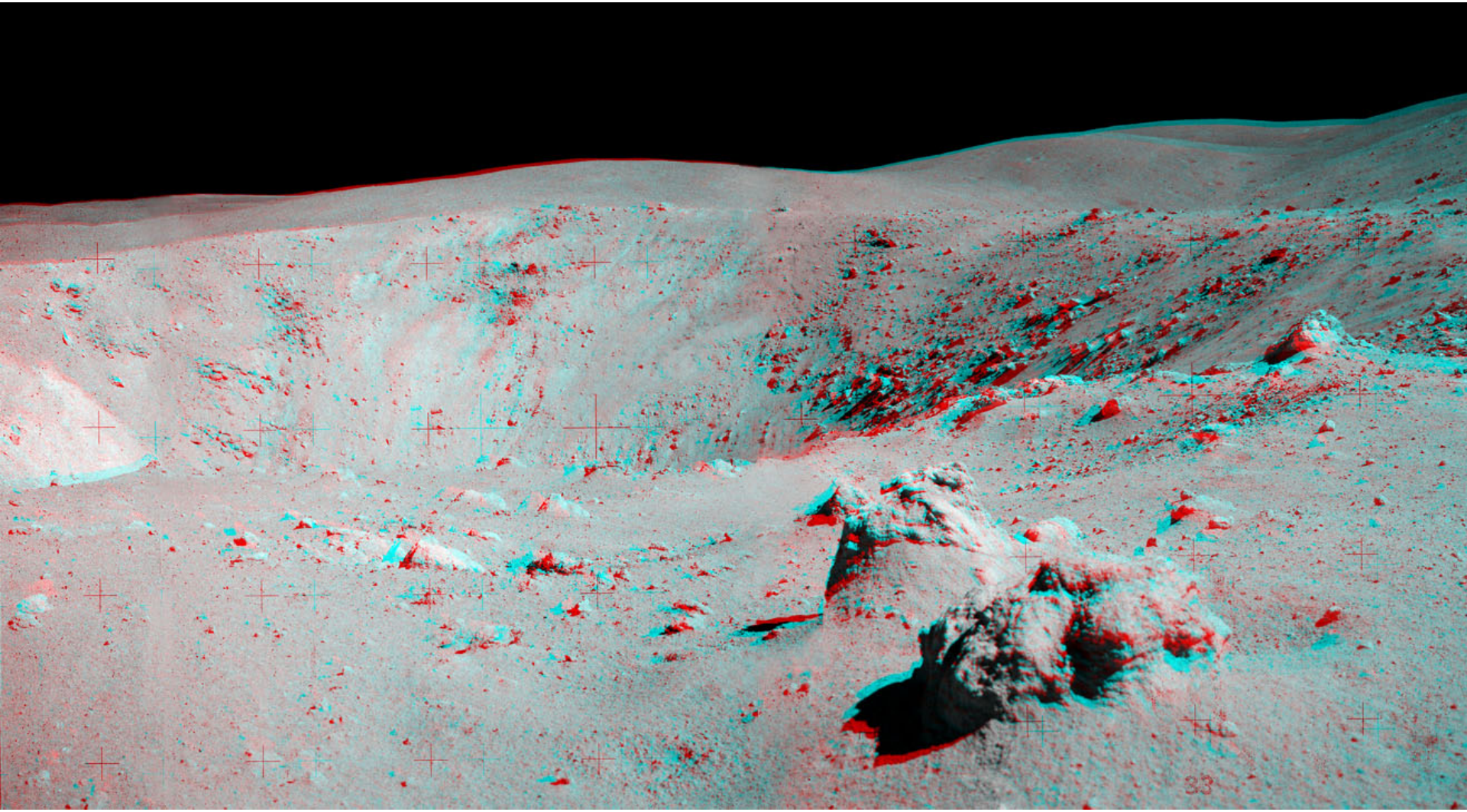
3D Printing



Virtual terrain

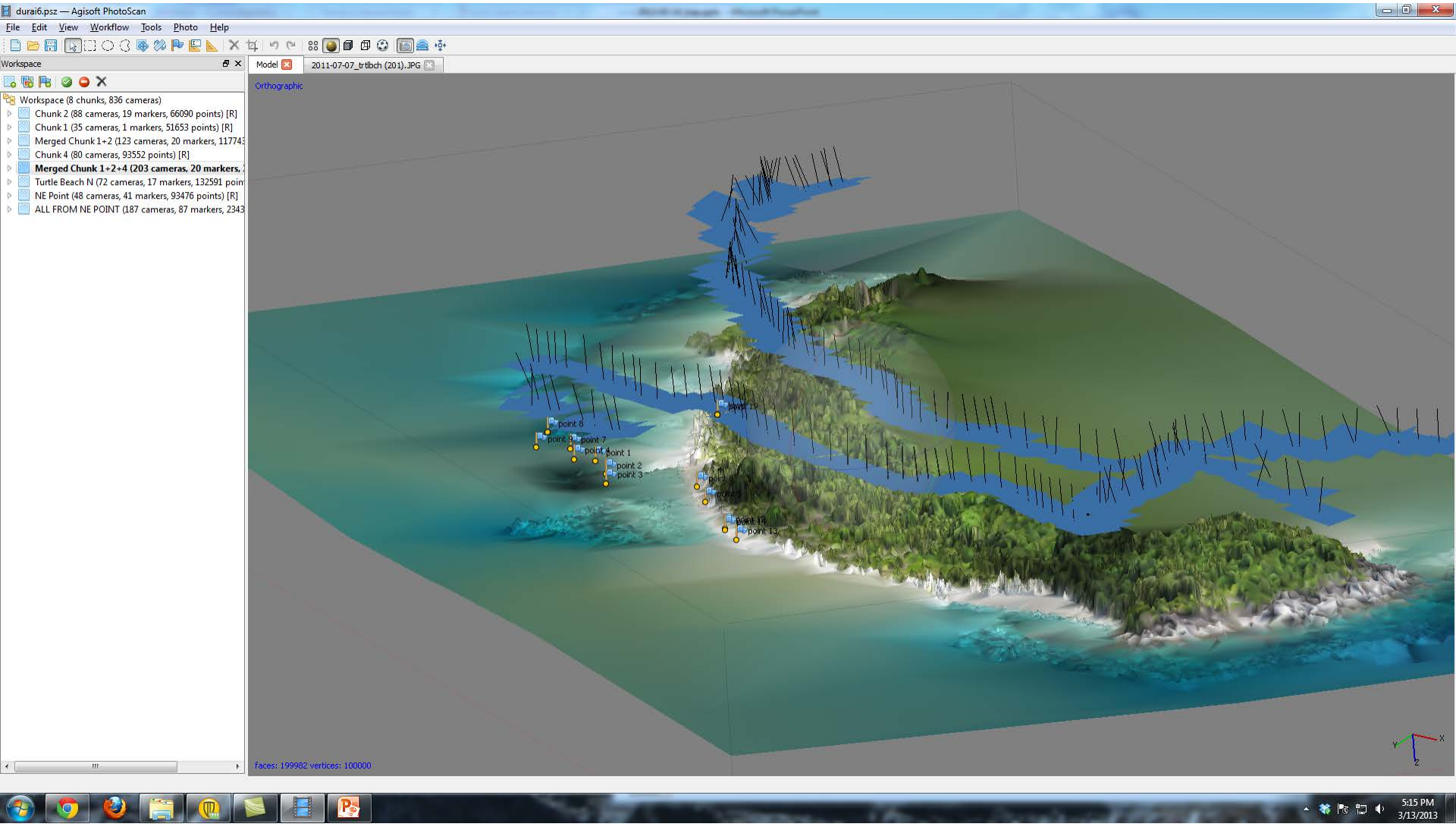


Virtual Mars



Structure from Motion Photogrammetry

Agisoft Photoscan



Centimeter resolution: Gigabyte files, need GPS tie points

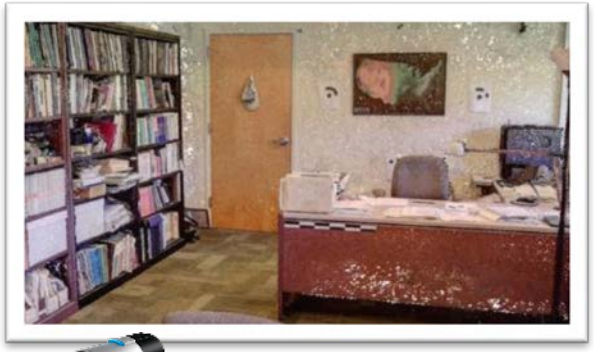
Video Overlay

- Tethered Helium balloon
- Aerostat-based video capture
- Smartphone GPS and video capture
- Native video texturing in X3D

Platforms Tested To Date

(EH Room 1720 Only)

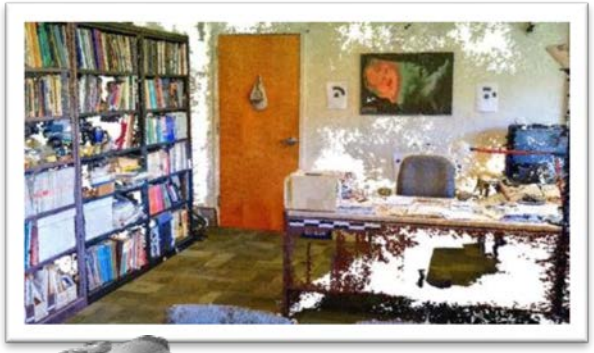
Nikon D3100
(14.2 MP)



Microsoft LifeCam Studio
(2.1 MP)

Logitech QuickCam Deluxe
(0.3 MP)

Sony DSC-TX10
(16.2 MP)



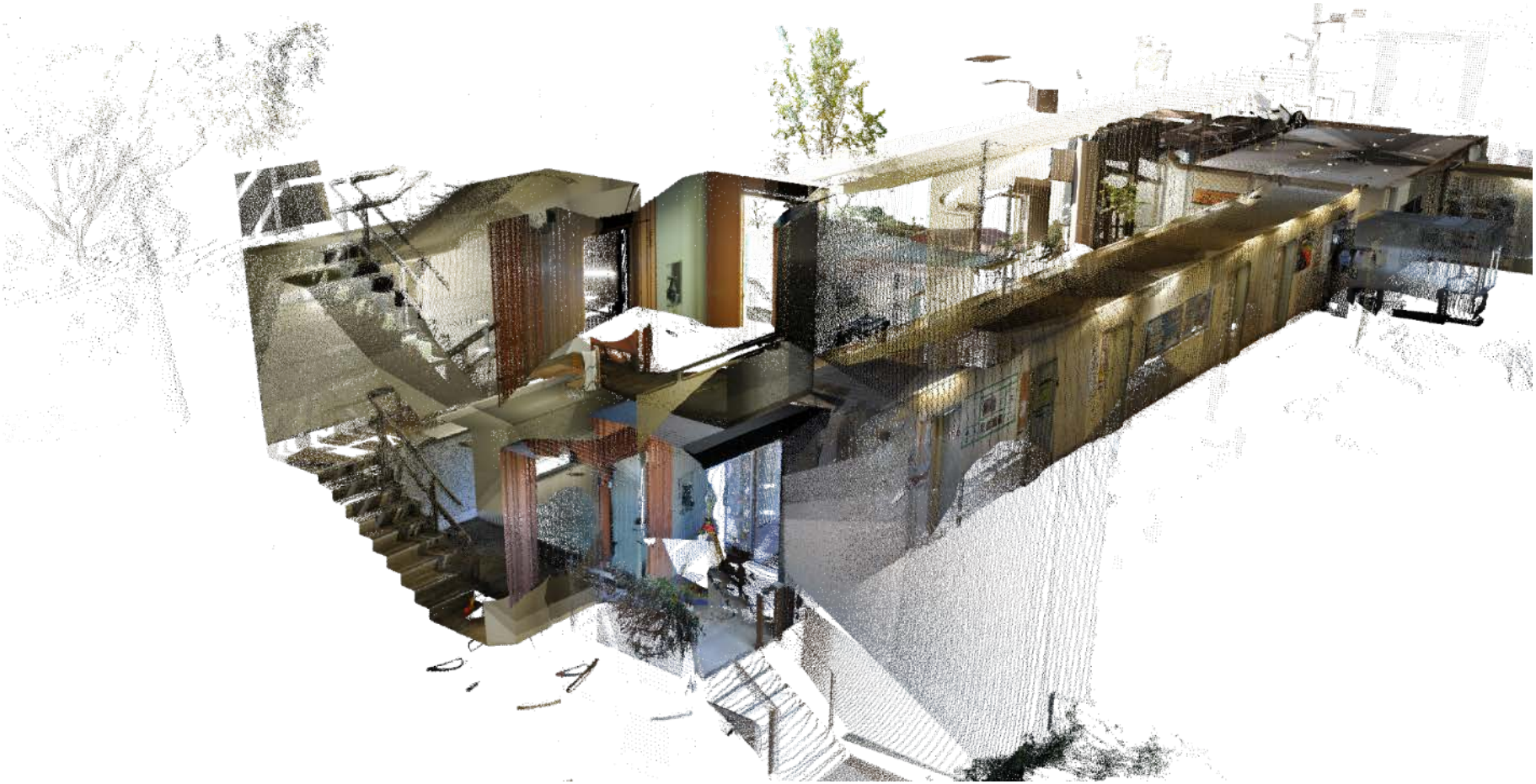
Panasonic DMC-FZ28
(10.1 MP)

Riegl LMS-Z420i Laser Scanner
(Baseline Measurements)

Riegl LMS-Z420i Laser Scanner

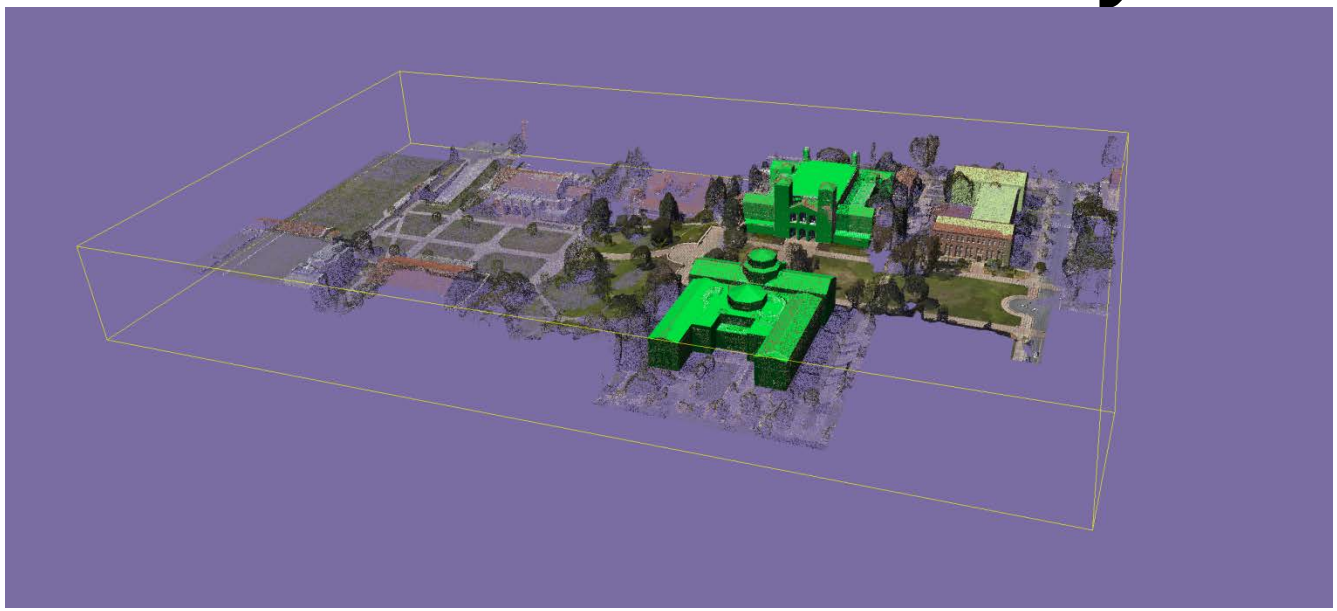
Lidar Point Cloud Data

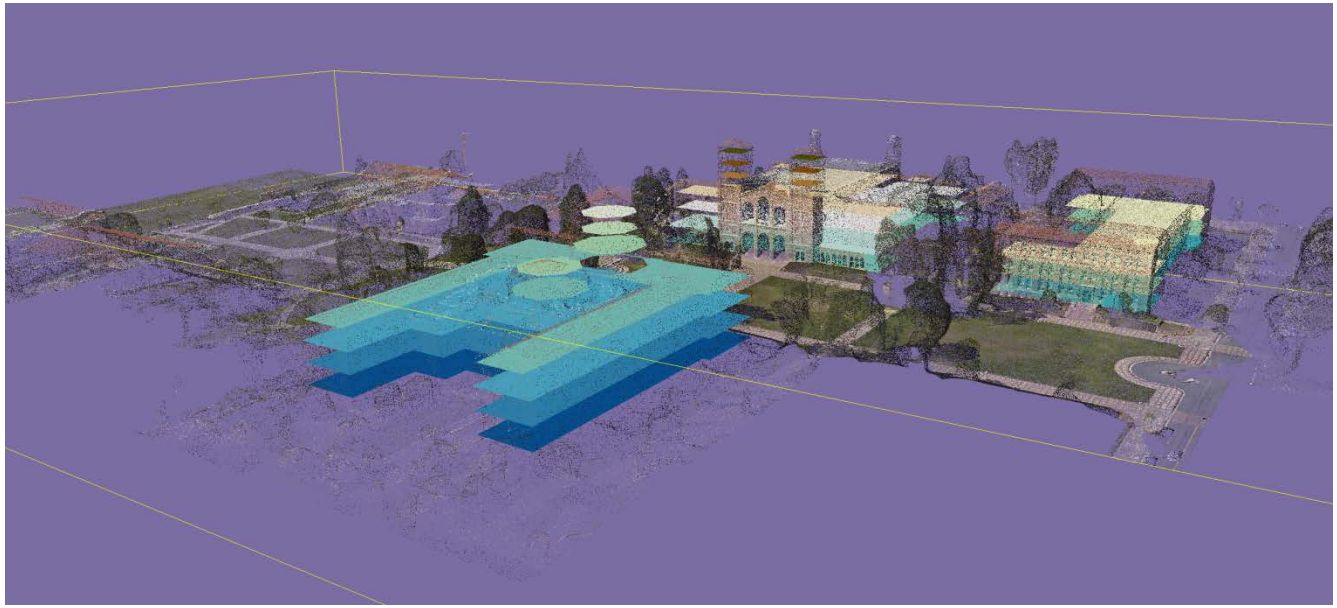
EH East Stairwell, 1st/2nd Floors



Interior scans

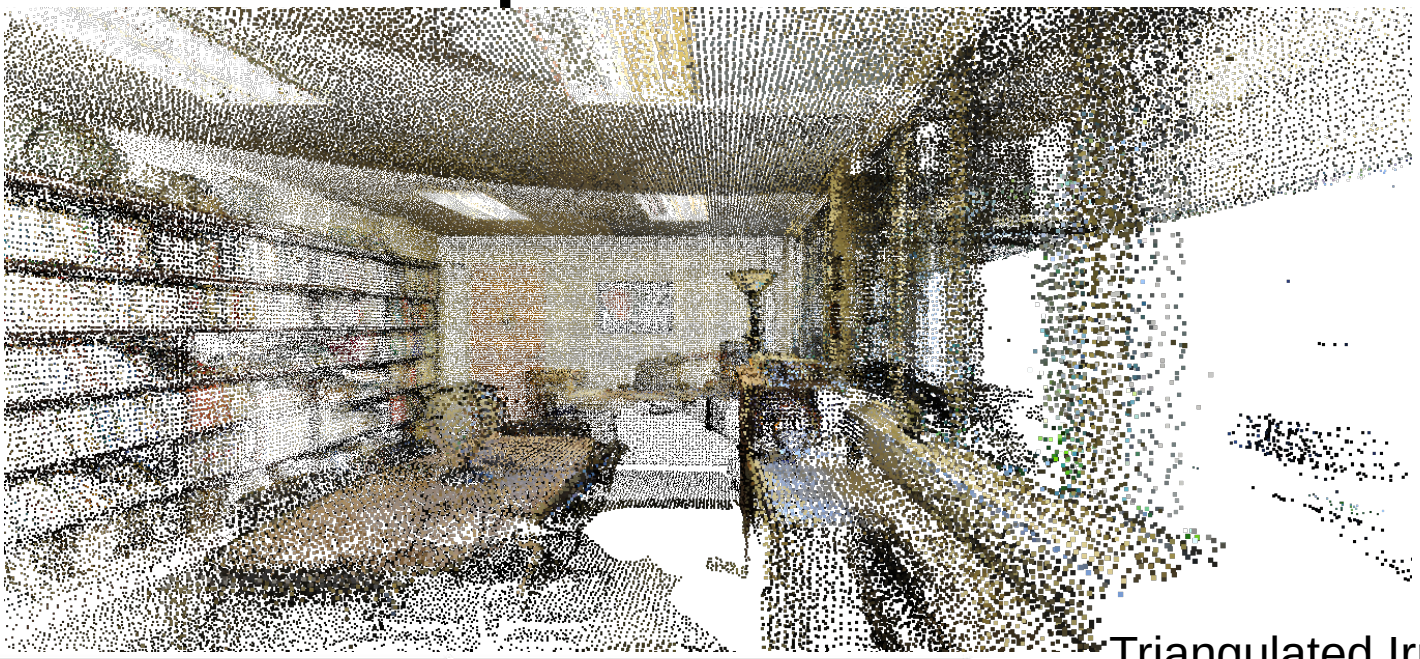
Coordinate systems



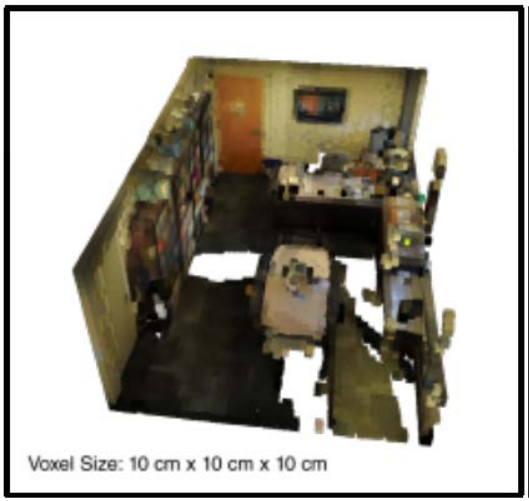


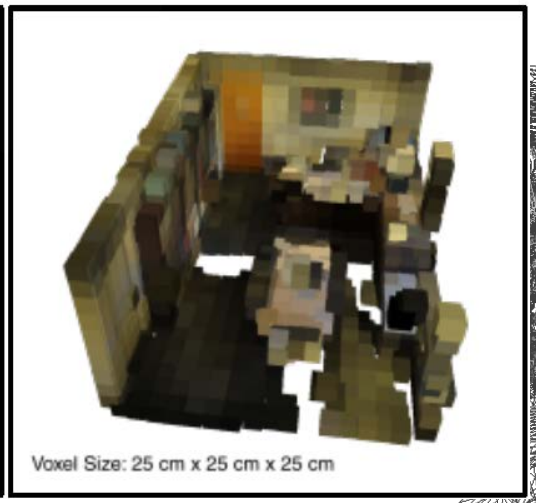
Millimeter based
Uses 3 tie points
False origins with offsets
Can float with object
Implemented forward and inverse transforms

Space abstraction



Point Cloud





Voxels

Triangulated Irregular Network

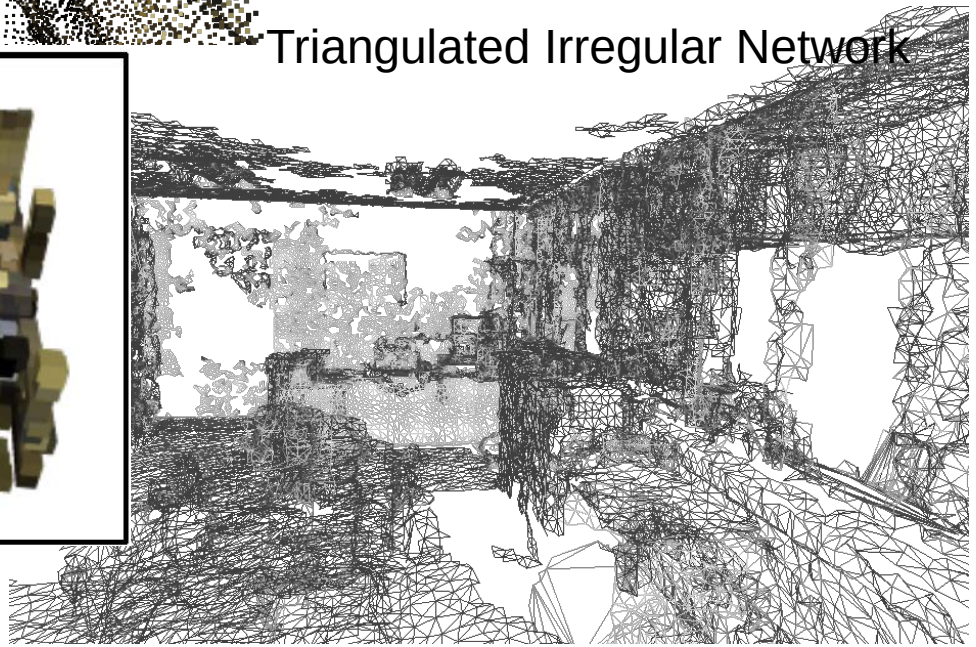
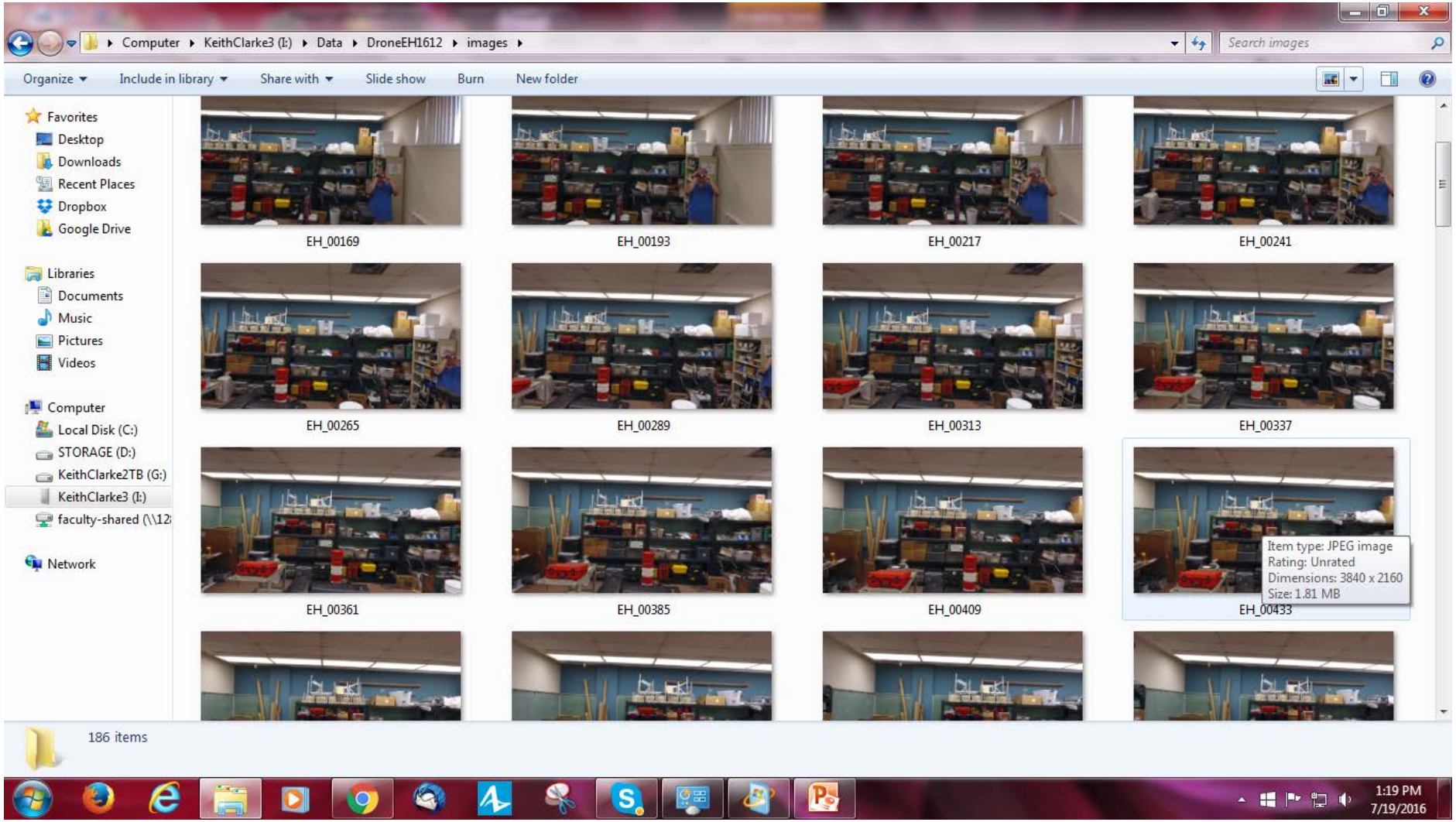
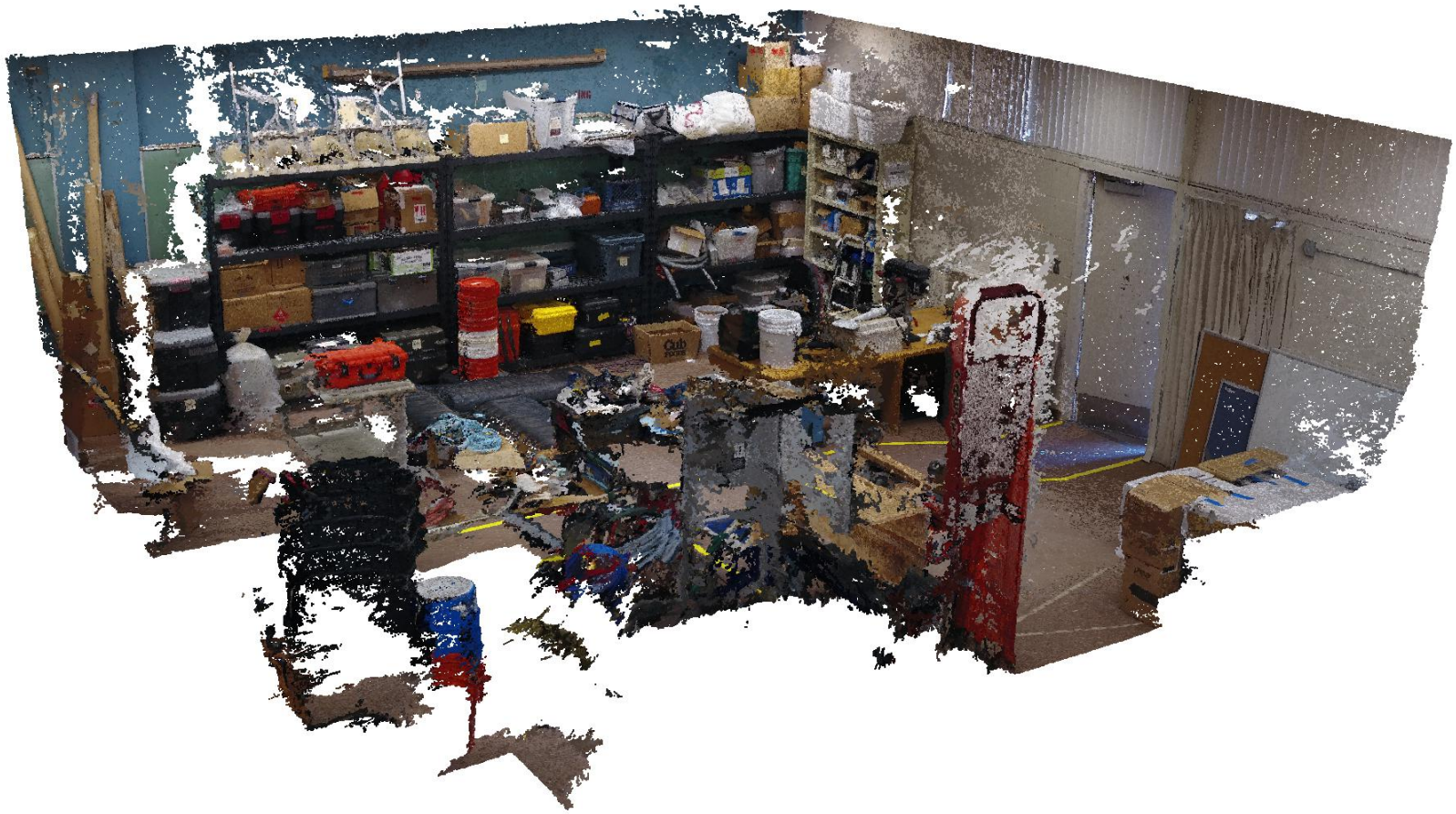


Image capture

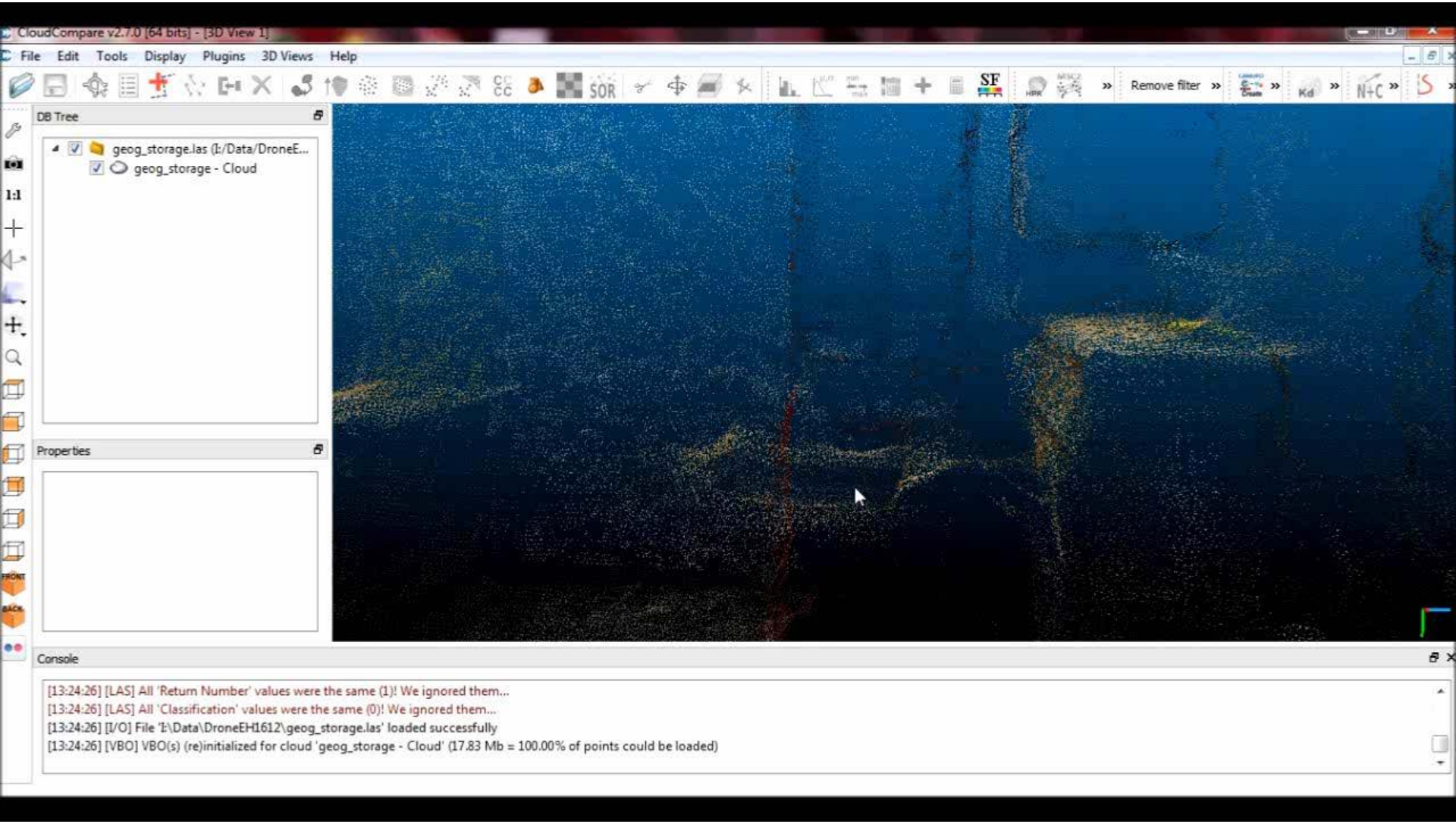


Point Cloud



This is not a photograph

A 3D model from scratch



Summary

- Long tradition of terrain mapping, moving from pictoral to shading to contours
- 2.5D methods: Perspective views first artistic then computer produced
- Many new options expanding 3D mapping
- Virtual and Augmented Reality now commonplace
- 3D printing, projection, etc