Geology 310 Structural Geology

Gregory C. Herman, PhD

Email: gherman@rider.edu

Lectures: Science Hall Rm. 112

Tuesday and Thursday 8:30 – 9:30 am

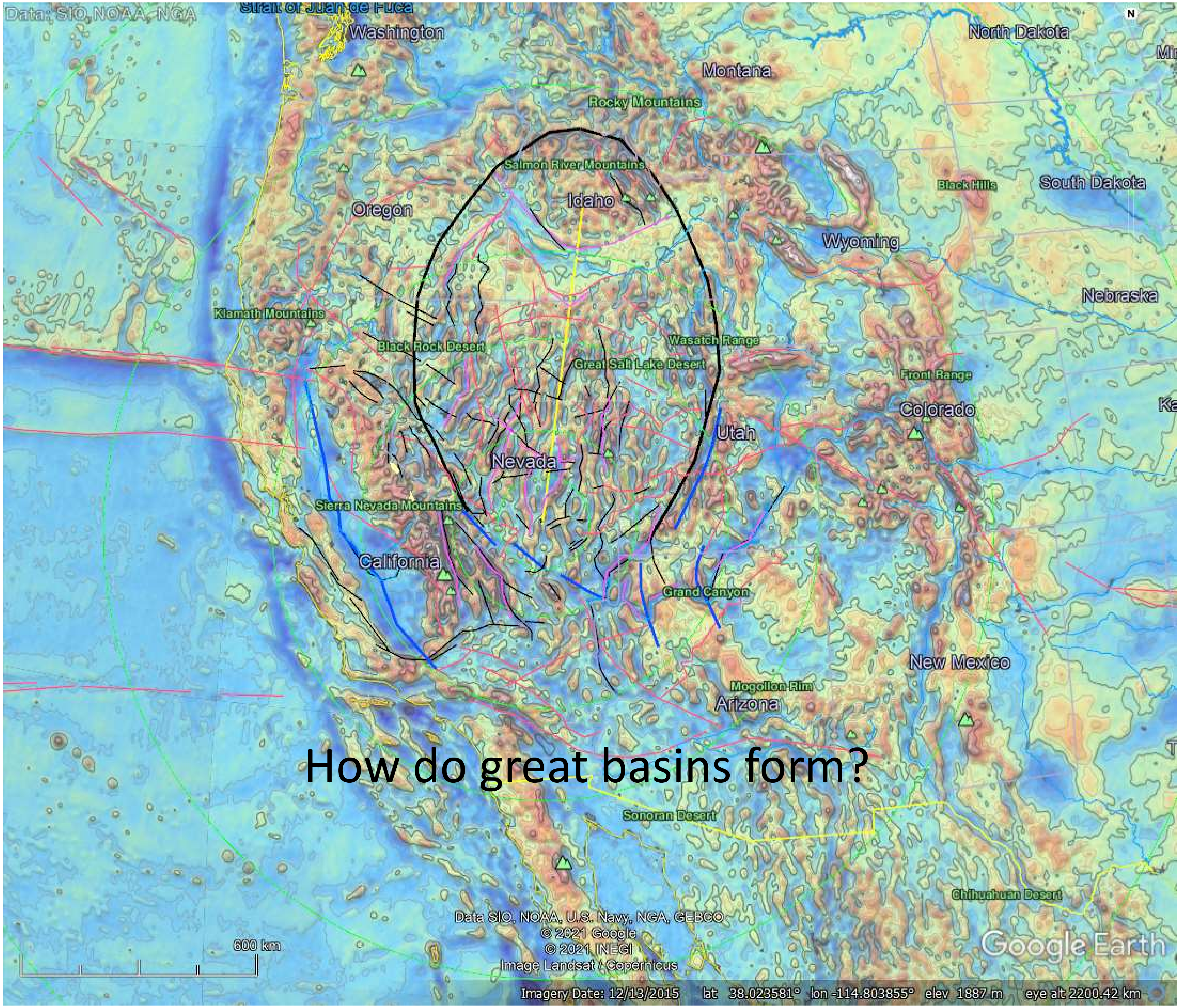
LABS Thursday 10:00-12:30 pm

Office Tue or Thurs after lectures by appointment

WEBSITE: http://www.impacttectonics.org/GEO310/

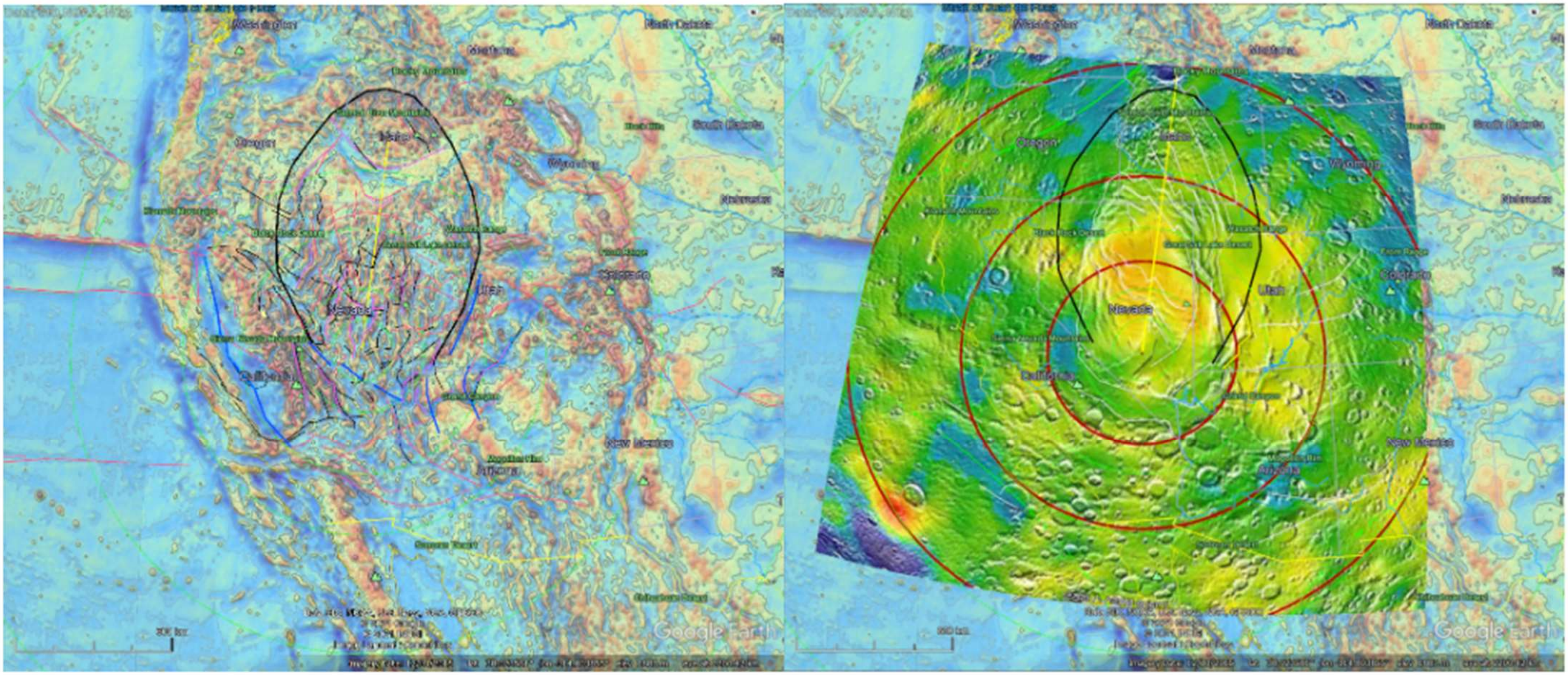
How do mountains rise and fall?

Image: http://i.imgur.com/poKTTTq.jpg



How do great basins form?

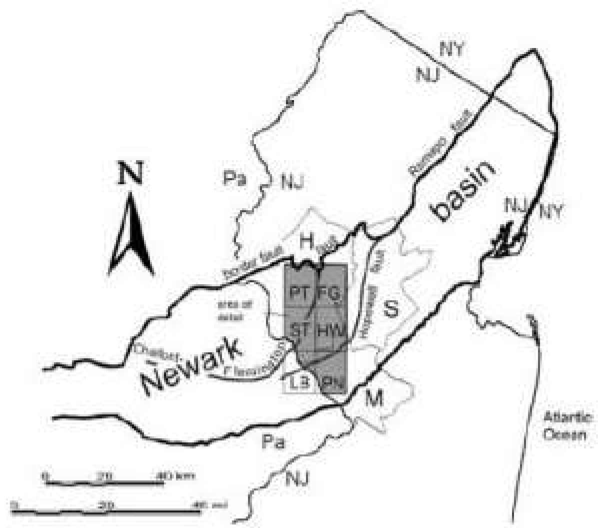
Size and structural comparison of two, similar-sized astroblemes on Earth (Alamo) and Mars (South Pole) using their gravity signatures

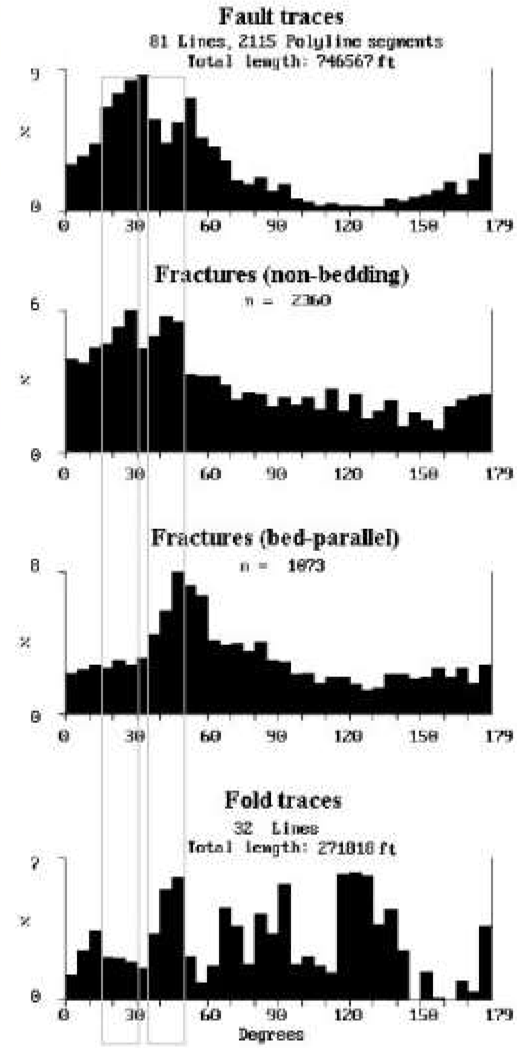


Structural Geology

Wikipedia - **Structural geology** is the study of the three-dimensional distribution of rock units with respect to their deformational histories. The primary goal of structural geology is to use measurements of present-day rock geometries to uncover information about the history of deformation (strain) in the rocks, and ultimately, to understand the stress field that resulted in the observed strain and geometries. This understanding of the dynamics of the stress field can be linked to important events in the regional geologic past; a common goal is to understand the structural evolution of a particular area with respect to regionally widespread patterns of rock deformation (e.g., mountain building, rifting) due to plate tectonics.

Structural Geology Laboratory.





“The whole point of geology is to figure out what happened in the past based on the rocks from that time which are still around today. It isn’t actually about the rocks. It’s about the story. The rocks are just the publishing medium. And the craft of geology is learning to read the language of stones.”

Lounge of the Lab Lemming blog

Geology sub disciplines

Name	Subject of Study
Engineering geology	The stability of geologic materials at the Earth's surface, for such purposes as controlling landslides and building tunnels, dams, mines, roads, or foundations
Environmental geology	Interactions between the environment and geologic materials, and the contamination of geologic materials
Geochemistry	Chemical compositions of materials in the Earth and chemical reactions in the natural environment
Geochronology	The age (in years) of geologic materials, the Earth, and extraterrestrial objects
Geomorphology	Landscape formation and evolution
Geophysics	Physical characteristics of the whole Earth (such as Earth's magnetic field and gravity field) and of forces in the Earth
Hydrogeology	Groundwater, its movement, and its reaction with rock and soil
Mineralogy	The chemistry and physical properties of minerals
Paleontology	Fossils and the evolution of life as preserved in the rock record
Petrology	Rocks and their formation
Sedimentology	Sediments and their deposition
Seismology	Earthquakes and the Earth's interior as revealed by earthquake waves
Stratigraphy	The succession of sedimentary rock layers
Structural geology	Rock deformation (bending and breaking) in response to the application of force
Tectonics	Regional geologic features (such as mountain belts) and plate movements and their consequences
Volcanology	Volcanic eruptions and their products

A few things that shouldn't have to be said, … but nevertheless,

- Please arrive to class on time
- Cheating and plagiarism are not acceptable!
- PC laptops or tablets that you can take notes on or conduct lab exercises are permitted.
- Social media sites can only distract you. Please refrain from opening or using them during class.
- There will be no use of cell phones during class or lab…. please set the ringer to vibrate, for emergencies only.
- Check your messages before, after, or between classes.

- Absences from class are handled between students and instructors.
  I can ask for substantiating documentation for the absence.

- I'll provide make-up opportunities for student absences caused by illness, injury, death in the family, observance of religious holidays, and similarly compelling, personal reasons including physical disabilities.

- Cases of absence for a week or more will be reported by the student to the Office of Records and Registration. The Office will notify the instructor of the student's absence. The notification is not an excuse but simply a service provided by the Office of Records and Registration. Notifications cannot be acted upon if received after an absence.

- For lengthy absences, make-up opportunities might not be feasible and are at the discretion of the instructor.

- Students have the responsibility of notifying the instructors in advance of expected absences.

- In every instance, the student has the responsibility to initiate arrangements for make-up work.

- Email me.

RIDER UNIVERSITY GEO-310 Structural Geology Fall 2020

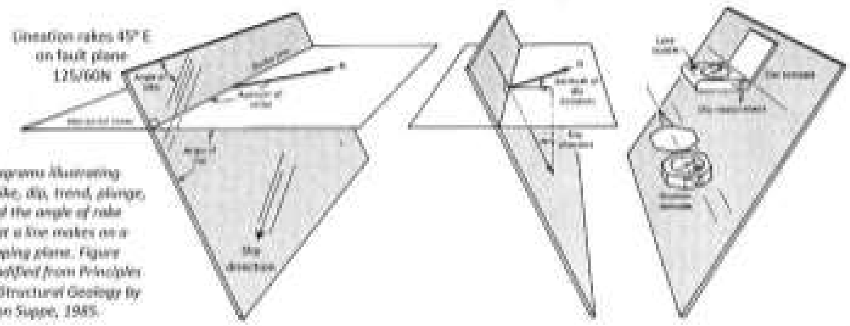
Dr. Gregory C. Herman email: gherman@rider.edu

Science Hall Room 112 Lectures Tuesdays and Thursdays 8:00 - 9:30 am

Labs. Thursdays 10:00 - 12:30 pm. Three field trips in New Jersey

- CALENDAR & GRADING
- SYLLABUS
- TEXTBOOK
- APPARENT DIP
- GREEK ALPHABET
- VISIBLEGEOLOGY.COM
- STRUCTURAL NOTATION
- GEOLOGIC WEB UTILITIES
- GE STRUCTURAL GEO APPS

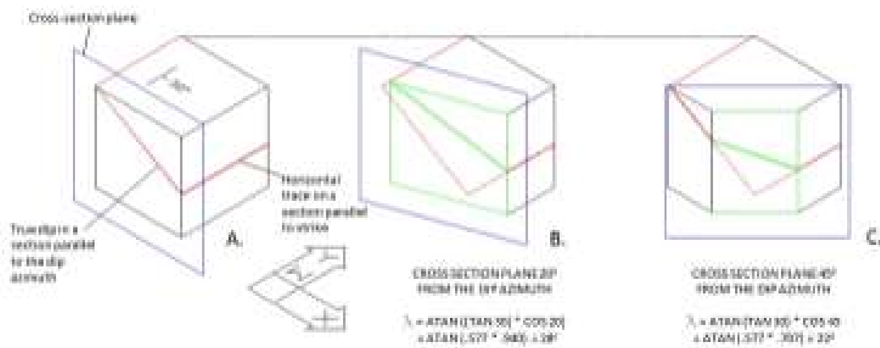
Revised 11/8/2019

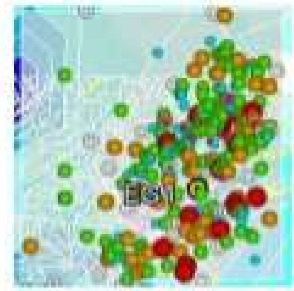


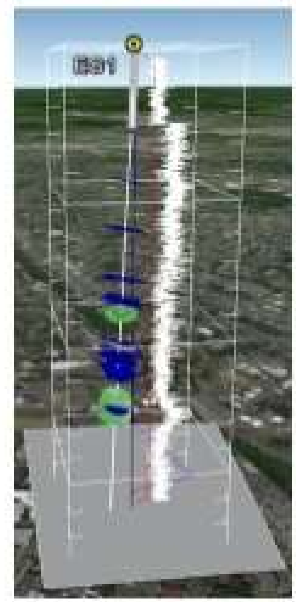
Diagrams illustrating strike, dip, trend, plunge, and the angle of rake that a line makes on a dipping plane. Figure modified from Principles of Structural Geology by John Suppe, 1985.

APPARENT DIP (λ) = ATAN ((TAN (DIP) * COS (α)) where ATAN=1/TAN or TAN^-1

where α = the angle between the dip azimuth and the profile trace







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RIDER UNIVERSITY GE

Science Room 112, Tue. and

Professor Gregory C. Herma

Sylla

Tue. Oct. 6	**EXAM 1**	
Thu. Oct. 8	Lecture 8	Geologic faults.pdf (10.6 MB)
	LAB 4	4A Borehole_3-Point_Problems.ppt (3.04 MB) 4B-Outcrop_Pattern_Cross-Section_Profiles.ppt (1.32 MB) 4C NASA WorldWind 3-pt problem solver

Tue. Nov. 10	**EXAM 2**	Review questions
Thu. Nov. 12	Lecture 16	Caledonian-Appalachian Mountains (9.7 MB) Mid-Atlantic tectonics (13.8 MB)
	LAB 8	8A-Hope to Jenny Jump cross section.ppt (9.53 MB) 8B-Hope to Jenny Jump Fieldata.xls (41 KB) 8C-Jenny Jump Mt.kmz (929 KB) Homework 8 Jenny Jump joint analysis.pptx (8.0 MB)
Tue. Nov. 17	Lecture 17	Oblique and Strike-slip Tectonics (9.9 MB) and Introduction to borehole geophysics.
Thu. Nov. 19	**Field Trip 3**	**Moore's Creek compound transtentional structures and Byram Lockatong Fm., Jurassic diabase, and shattercones**
Tue. Nov. 24	Lecture 18	Earth Structure and Plate Tectonics (20.3 MB)
Thu. Nov. 26	**No class**	**Thanksgiving Recess**
Tue. Dec. 1	Lecture 19	Neotectonics and GANJ 32 Data
Thu. Dec. 3	Lecture 20	Unconformities & Igneous rocks (2.7 MB) Balanced_Cross_Sections.pdf (6.0 MB)
	LAB 9	9A-Unconformities_and_Igneous_Rocks.ppt (5.0 MB) 9B_Structural profiling (5.3 MB) GANJ33 Teacher'sWorskshop (8.3 MB)
Tue. Dec. 8	Lecture 21	Impact Tectonics
Thu. Dec. 10	Lecture 22	Borehole geophysics and fractured aquifers.pdf (10.0 MB)
	LAB 10	Dolostone aquifer (44 MB PDF) Basalt and shale aquifer (14.7 MB PDF) Granite_and_gneiss_aquifer (22MB PDF)
Thu. Dec. 17	**FINAL EXAM**	9:00-11:00 am. Final exam review questions.pdf (332 KB)

Thu. Sep. 30	Lecture	
	LAB 7	7C-Herman_Monteverde_1989.pdf (6.19 MB) Homework 7 Cleavage diagram.ppt (6.66 MB)
	Field Tri	
Tue. Nov. 10	**EXAM 2**	Review questions

Tue. Oct. 5	**EXAM 1**	

RIDER UNIVERSITY GEO-310 Attendance and Grading Policy Fall semester 2016

- **Lectures attendance is kept.**
  23 lectures count for 7% of your grade
- **Laboratory attendance is mandatory and there are no makeups.** *If you miss a Lab, it's up to you to gather and cover the material that you missed and submit any assignments.*
- *Field labs are not mandatory for student athletes that are in season, but attendance is strongly encouraged.*
- **The final grade for the student is determined using the point system and grading scale listed to the right.**
- *The laboratory points are heavily weighted toward the final grade (>1/2 of the class).*
- The exams will include True/False, Multiple Choice, and Problem solving.
- Assignments and tests results will be presented to students the following week after their completion.
- Students will have the opportunity in class to ask questions on individual test questions and concepts.
- Students will have the opportunity at the end of the course to evaluate the instructor and course by college standardized evaluation questionnaires.

Point System	Points
11 Inside Labs (10 pts. Each xcpt L1)	104
3 Field-Trip Labs (10 pts each)	30
2 interim exams (25 pts. each)	50
Comprehensive final exam	50
Lecture attendance	46
TOTAL	280

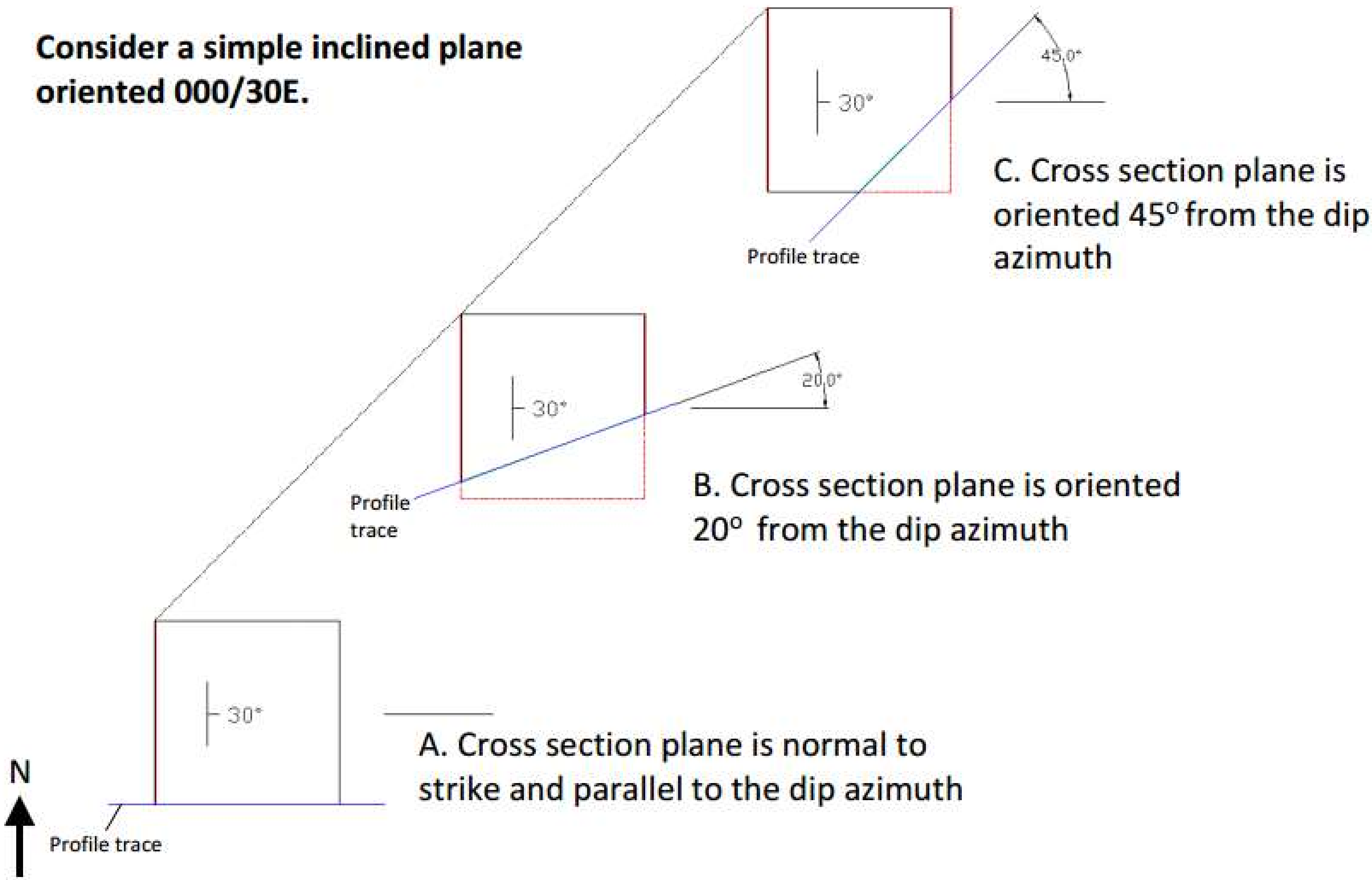
Grading scale (%)

A = 95 - 100	C = 73 - 76
A- = 90 - 94	C- = 70 - 72
B+ = 87 - 89	D+ = 67 - 69
B = 83 - 86	D = 65 - 66
B- = 80 - 82	F = 64 or less
C+ = 77 - 79	

GC Herman Rev. 08/19/2016

APPARENT DIP OF SIMPLY INCLINED PLANES

Consider a simple inclined plane oriented 000/30E.

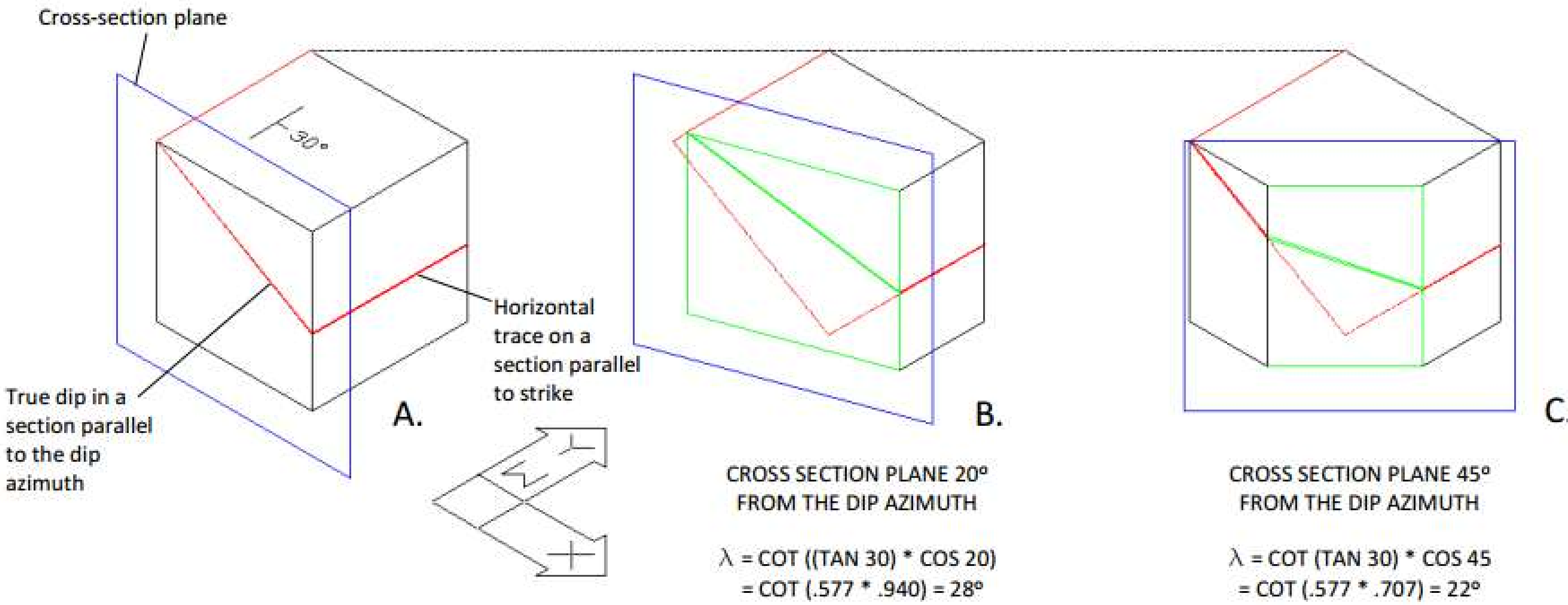


A. Because the plane of cross section is parallel to the dip azimuth, the plane dips in profile at its true value of 30º. Also notice that the trace of the dipping plane in the plane of section that is parallel to strike is horizontal.

B. and C. For the cross section planes oriented 20º and 45º relative to the dip azimuth, the plane has an apparent dip less than the true dip:

$$\textbf{APPARENT DIP } (\lambda) = \textbf{COT } ((\textbf{TAN } (\textbf{DIP})) * \textbf{COS } (\alpha))$$

where α = the angle between the dip azimuth and the profile trace



www.impacttectonics.org/GEO310/GCH_Fall-2014_Lines-planes.GIF

Apps Weather GDaddy email Rider Email Spotify GEO-310 PHY-120C Yahoo Mail TCNJ CBS FO30FF ESPN FFF GCH »

LINE AND PLANE RECORDING CONVENTIONS

POINT: Xn, Yn, Zn where n is 1.....to infinity and beyond
(Remember that Latitude is a Y-coordinate, and Longitude is an X-coordinate)

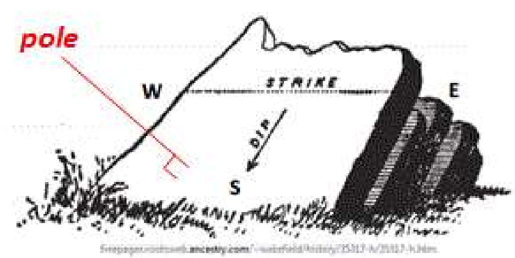
LINE: Plunge (0-90°) and Trend (000-359°) (ex. 45/287)

PLANE: Strike (000-179°), Dip (0-90°), and Dip Direction (N-S-E-W)

This is the ***Strike, Dip, and Dip Direction notation***

example: 125/79 SW *that is the same as* 79/215 in line notation as a *dip line* (0-90/000-359°) .
other examples: plane 003/89 SE = 89/093 dip line, and plane 015/33 NW = 33/285 dip Line

The latter is ***dip-azimuth notation*** for a plane, that is easiest for computer systems to read as it discretely describes the plane orientation as numbers, as does the planes pole (normal vector to the plane)



Some geologist prefer to record planes in outcrop using dip azimuth but we will use strike, dip, and dip direction to reduce the chance of mixing plane and line readings when noting both or multiple readings at one location.

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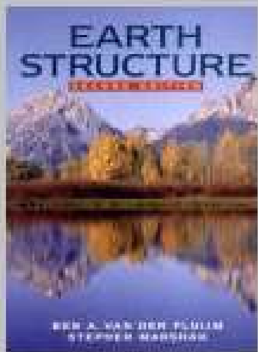
www.globalchange.umich.edu/Ben/ES/



Earth Structure
An Introduction to Structural Geology and Tectonics

Ben van der Pluijm and Stephen Marshak

WW Norton & Company
Second Edition, 2004
ISBN 0-393-92467-X

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http://globalchange.umich.edu/ben/ES/#powerpoints

About the Authors

Ben A. van der Pluijm is Bruce R. Clark Collegiate Professor of Geology and Professor of the Environment at the University of Michigan, Ann Arbor. He is (co-)author of more than 140 research articles and editor/board member of several international journals. His research focuses on fault rocks and processes, crustal architecture of collisional belts, intraplate deformation, microstructures and textures, and geochronology, with main field areas in North America, South America and Europe. In addition to teaching undergraduate and graduate courses in Geological Sciences and Program in the Environment, he directs U-M's interdisciplinary Global Change Program and is involved in various technology-supported educational initiatives.
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Stephen Marshak is Professor of Geology and Director of the School of Earth Society and Environment at the University of Illinois, Urbana-Champaign. He holds a Ph.D. from Columbia University, an M.S. from the University of Arizona, and a B.A. from Cornell University. He has served as Chair of the Division of Structural Geology and Tectonics of the Geological Society of America. He has written numerous research articles on topics in structural geology and tectonics, and has authored or co-authored three other books: *Basic Methods of Structural Geology*; *Earth: Potrait of a Planet*; and *Essentials of Geology*.
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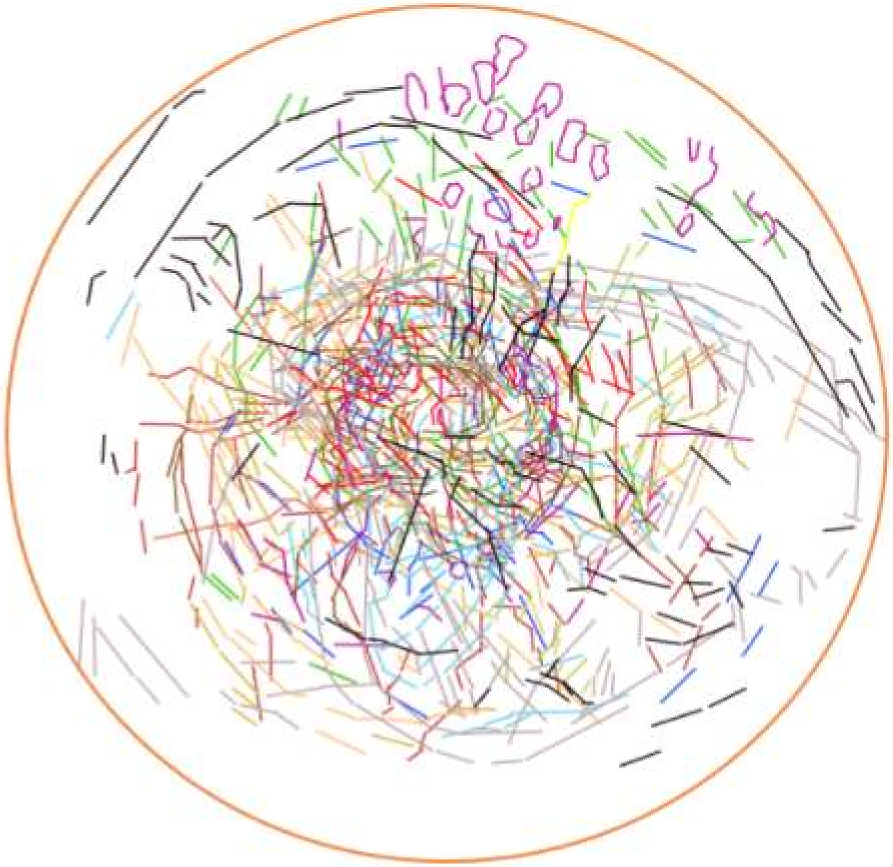

13 Martian astroblemes superimposed

Argyre

Cassini

Chryse

Greely

Hellas

Hyugens

Isidis

Margaritifer Chaos

North Pole

Promethei

Secchi

Syria & Sinai Planum

Utopia

G.C. Herman, PhD

NEW Google Mars version 2.0; 13 Large astroblemes with a 0-m sea

Not secure | impacttectonics.org/gcherman/Index.html

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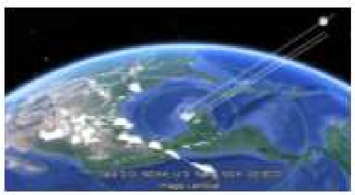
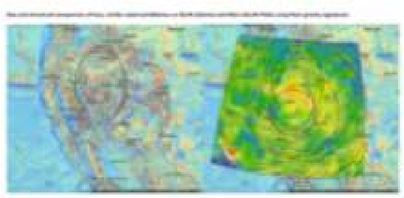
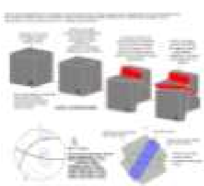
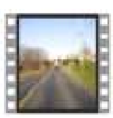
CV **PUBLICATIONS LIST WITH LINKS**

RIDER U. GEO-310 STRUCTURAL GEOLOGY
RVCC GEOL-157 INTRO GEOLOGY * RVCC ENVI-201 ENVIRONMENTAL APPS

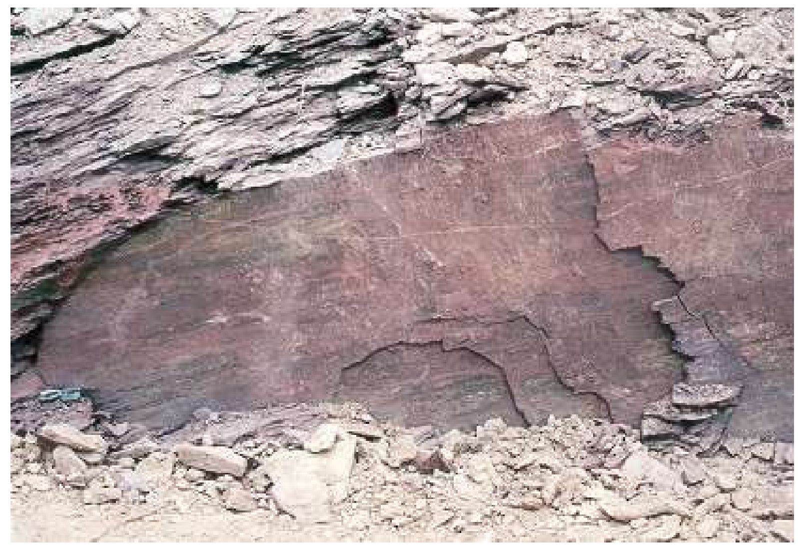
 IMPACTTECTONICS.ORG  2021 Earth Day Video

 TECTONICS BLOG  GEOARCHEOLOGY BLOG

 STRUCTURAL GEOLOGY AND OTHER STUFF

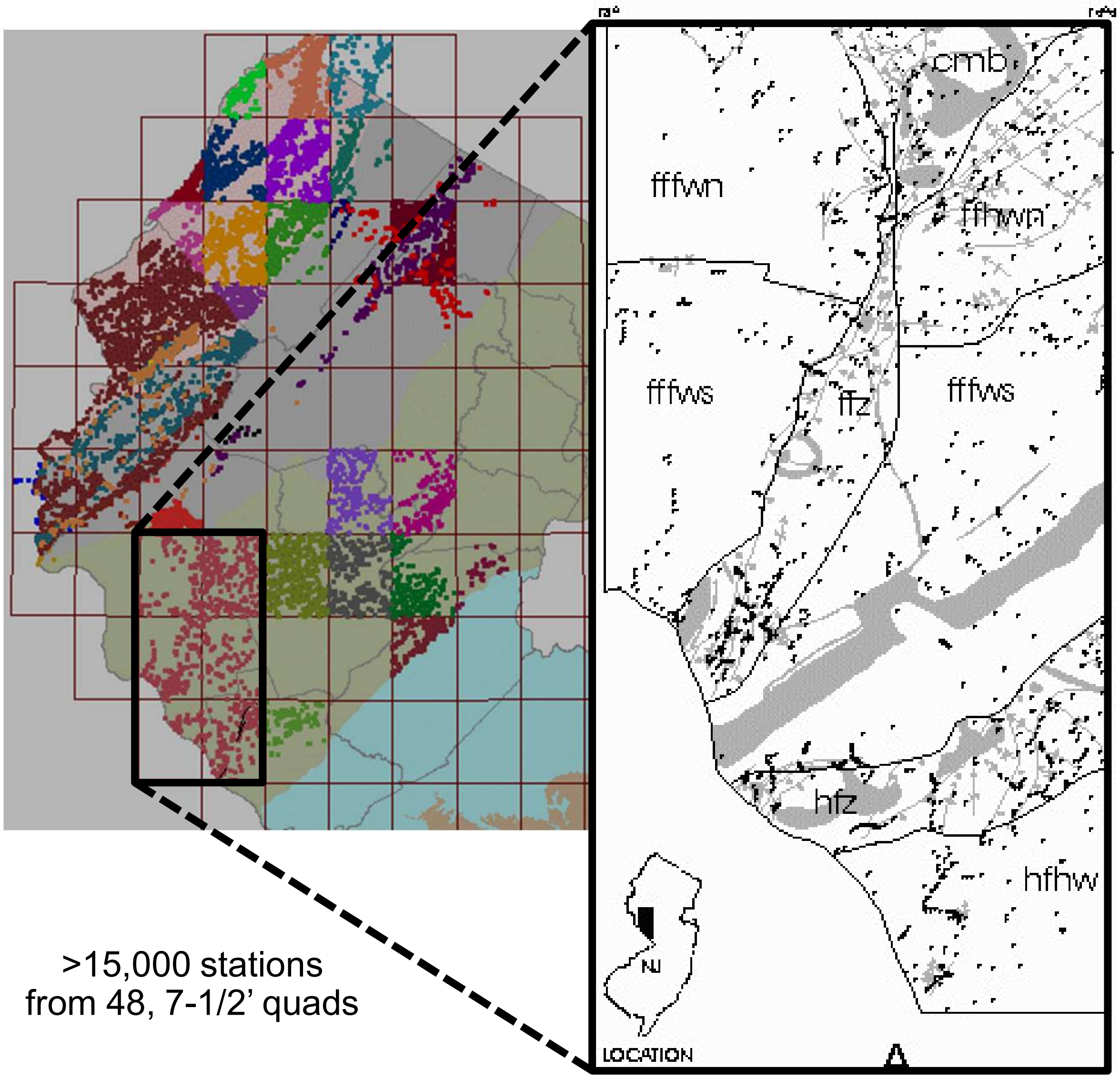
  HYDROGEOLOGY/GEOPHYSICS


GHSK55B

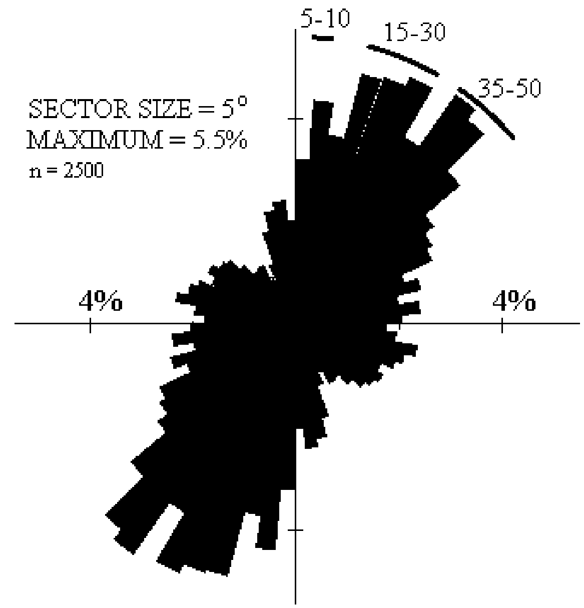


STRUCTURAL HETEROGENEITY AND AQUIFER ANISOTORPY

Bedrock Mapping and Structural Analysis of Fractured-Bedrock Aquifers



>15,000 stations
from 48, 7-1/2' quads



1073 Bed-parallel fractures

2360 Non-bedding fractures

1339 Stations

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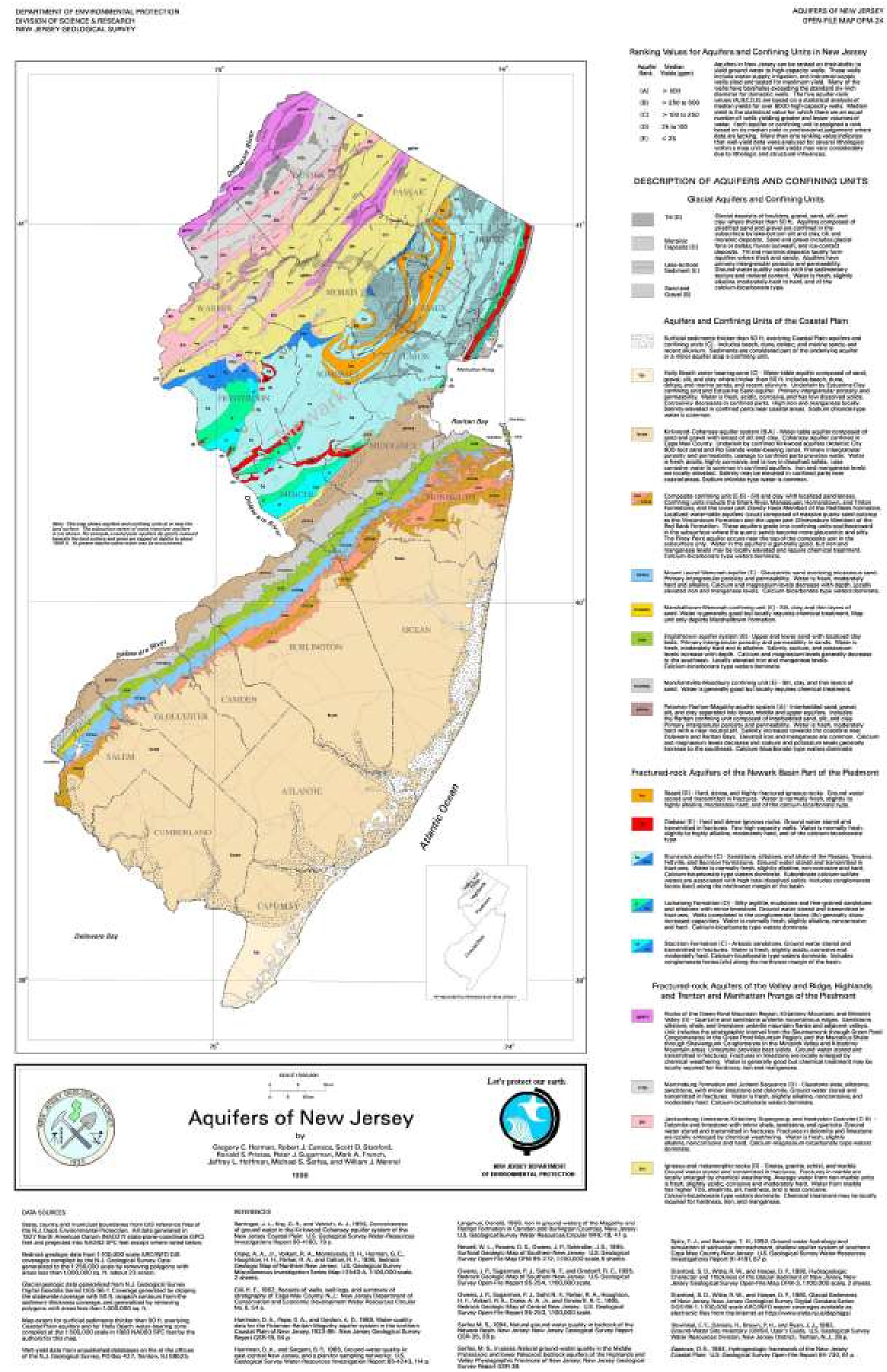
ATLANTIC OCEAN
Digital Shaded-Relief Map of New Jersey
by
Gregory C. Herman
NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION


Atlantic Ocean
Aquifers of New Jersey
by
Let's protect our earth
DESCRIPTION OF AQUIFERS AND CONFINING UNITS

ALT & Mt. Sopris System 2011- ~ $66,000

800 m 4MX2 Winch with
1/8” single conductor cable

Matrix data processor

Optical Borehole Image
(OBI-40) Tool

Heat-Pulse Flowmeter
HPFM-2293

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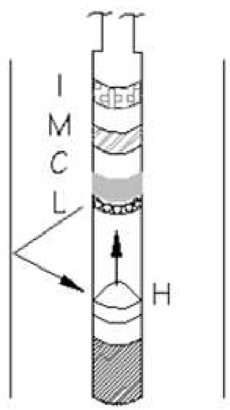
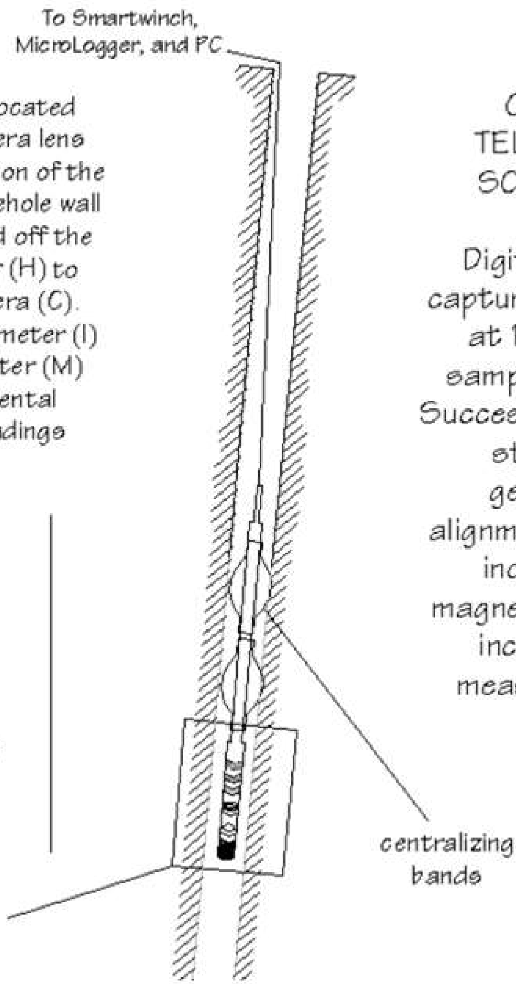
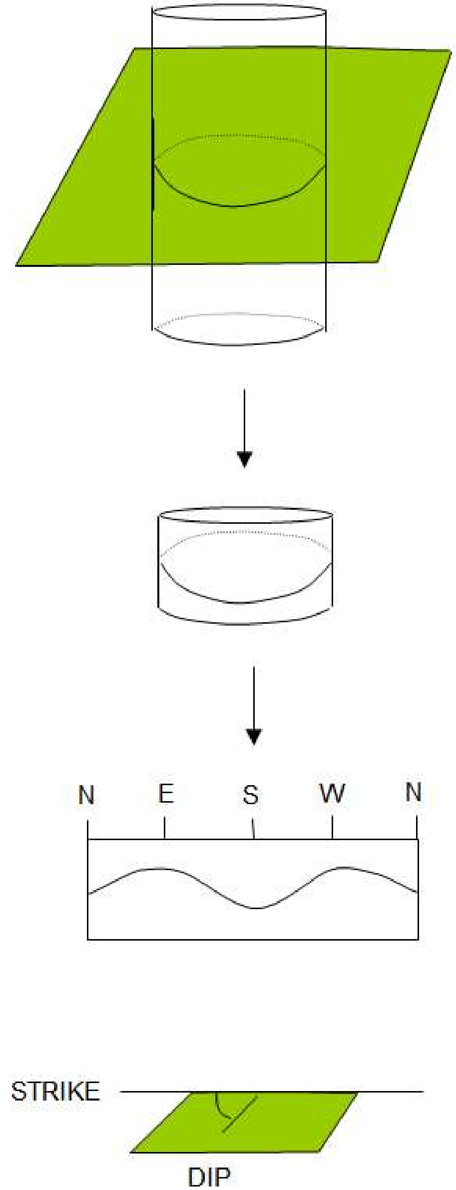
A LED ring (L) located around the camera lens illuminates a section of the borehole wall. Borehole wall image is reflected off the hyperboloid mirror (H) to the digital camera (C). Three-axis inclinometer (I) and magnetometer (M) collect incremental orientation readings

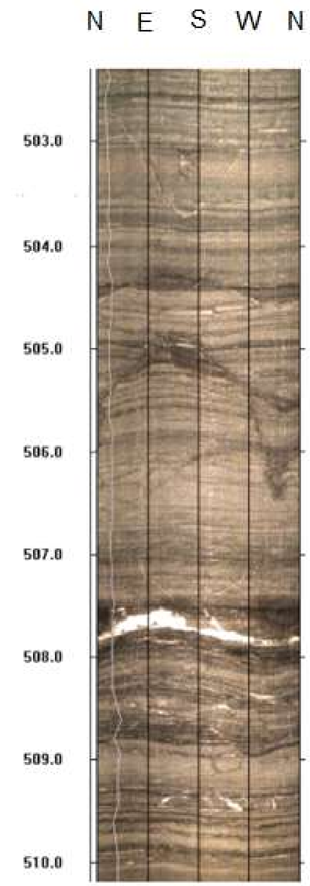




OPTICAL TELEVIEWER SCHEMATIC

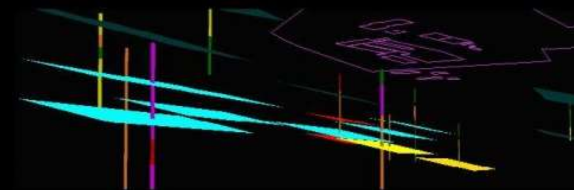
Digital camera captures 360° ring at 1mm-depth sample intervals. Successive rings are stacked in geographic alignment based on incremental magnetometer and inclinometer measurements.



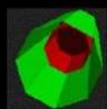


3D Well-Field Generation and Visualization

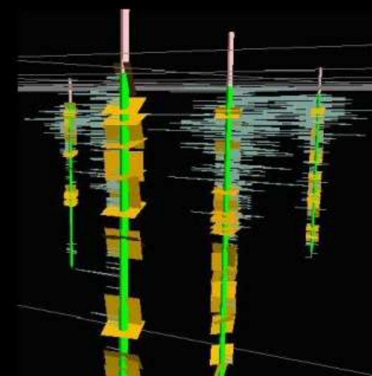
with ESRI ArcView® 3D Analyst™



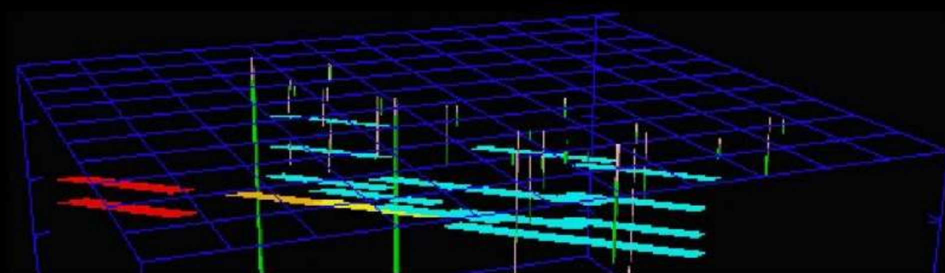
Inclined water-bearing zones indexed by estimated yield and packer-test results indexed by MTBE concentrations



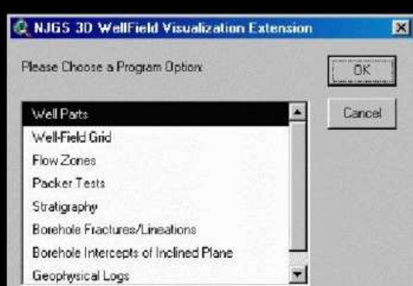
Well parts use Multipatch PolygonZ planes centered about the borehole in an octagonal arrangement

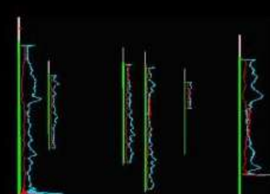


Borehole fractures and fluid-temperature-differential records from acoustic televiewer and fluid-temperature logs.



Well-field grid, inclined water-bearing zones (indexed by yield), water-production wells, and monitoring wells (pink - cased intervals, green open/screened intervals)





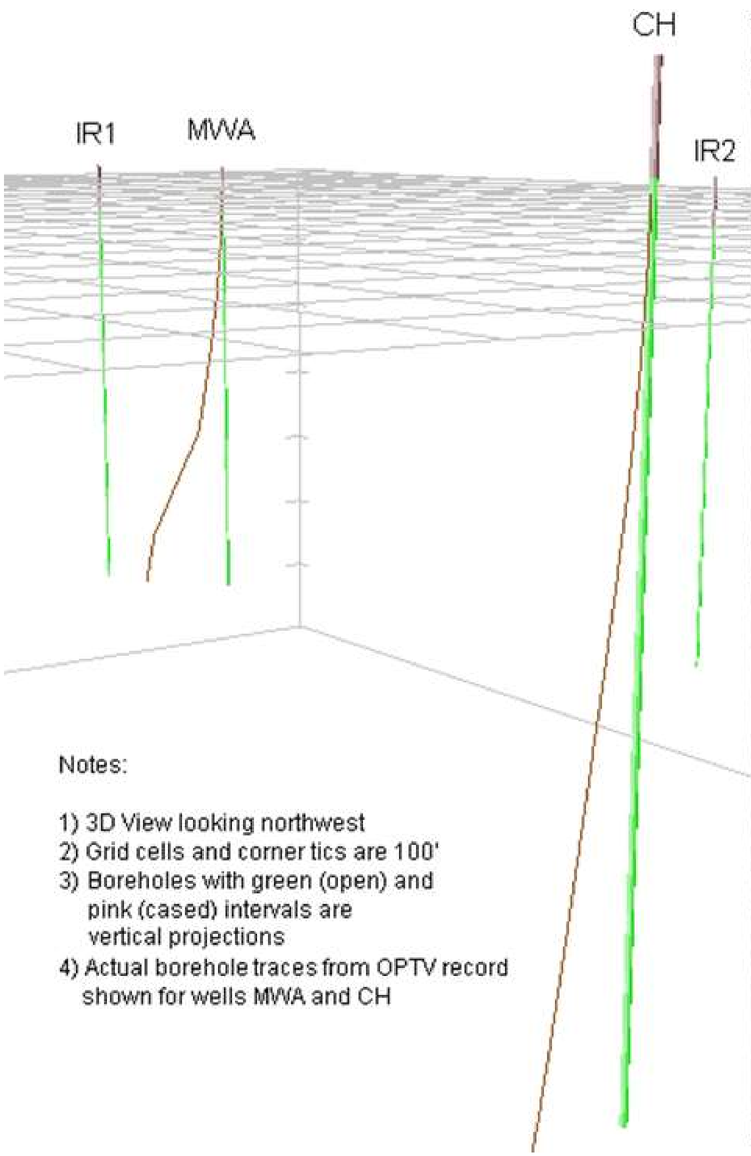
Electromagnetic Resistivity (red) and Conductivity Geophysical Logs

3D generation and visualization of

- *Well-field well-construction parts*
- *Inclined planes*
- *Packer-test results*
- *Borehole-fractures*
- *Borehole geophysical logs*

An ArcView ® 3DWellField Extension written by the N.J. Geological Survey for use with ESRI ArcView ® 3D Analyst™

3D VIEW OF PART OF THE RIDGE GOLF COURSE WELL FIELD,
EAST AMWELL TWP., HUNTERDON COUNTY, NEW JERSEY,
N.J. GEOLOGICAL SURVEY, G.C. HERMAN, 2003 SEPTEMBER 19

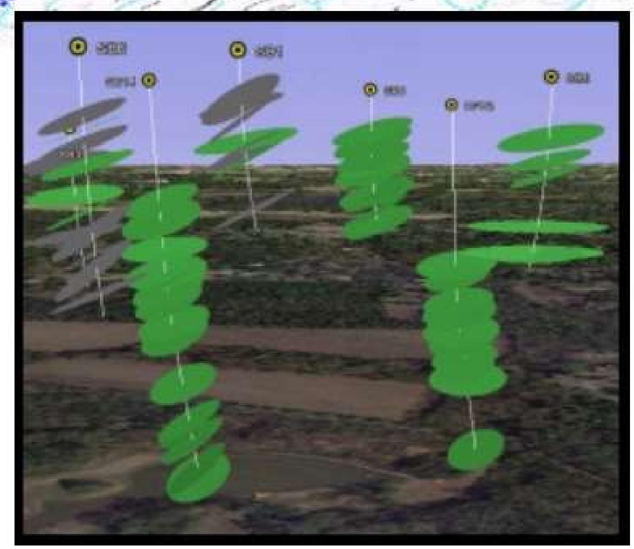


Notes:

1) 3D View looking northwest
2) Grid cells and corner tics are 100'
3) Boreholes with green (open) and pink (cased) intervals are vertical projections
4) Actual borehole traces from OPTV record shown for wells MWA and CH

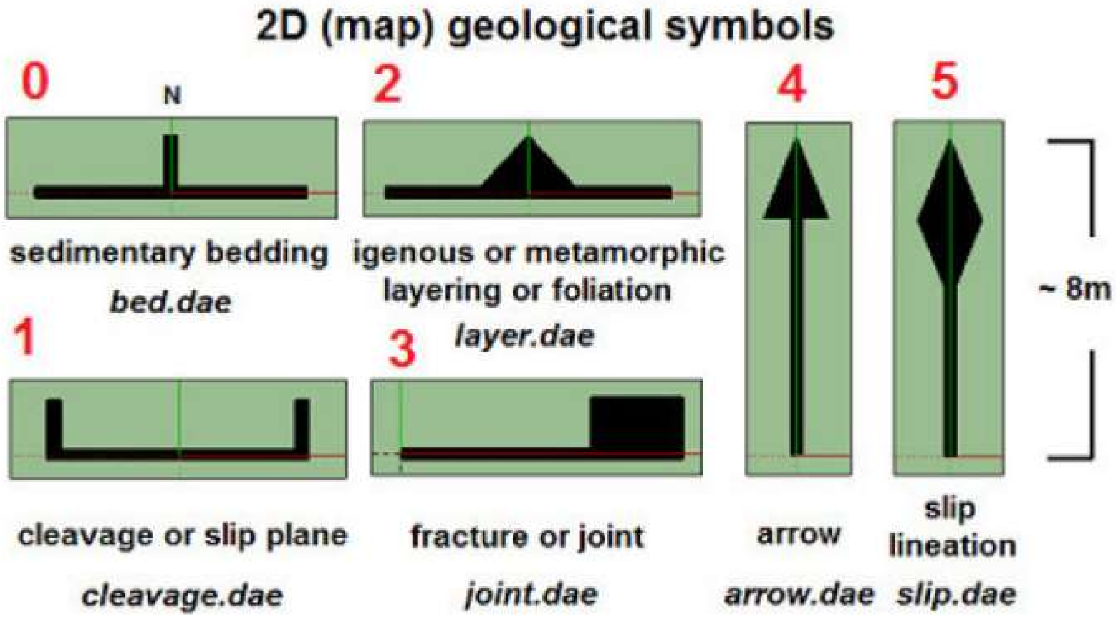
• The New Jersey Geological and Water Survey uses Google Earth (GE) to help research the physical properties of fractured-bedrock aquifers.

• GE provides a flexible, practical, and popular software platform to help organize, display, and share 2D and 3D geological data collected in outcrop and with borehole geophysical logging tools.



• Computerized 2D geological symbols and 3D models are generated in Trimble SketchUp, then georegistered, scaled, and annotated utilizing Microsoft Excel to generate GE keyhole-markup-language (KML) files.

2D geological map symbols are available for stratigraphic layering, cleavage, joints, fractures, faults, and lineation, utilizing an approach based on Whitmeyer's on-line orientation-symbol generator.

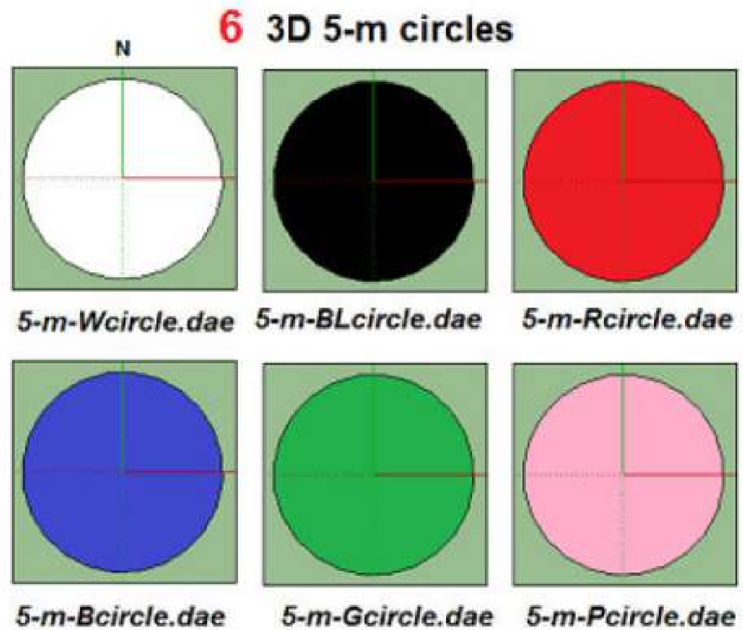


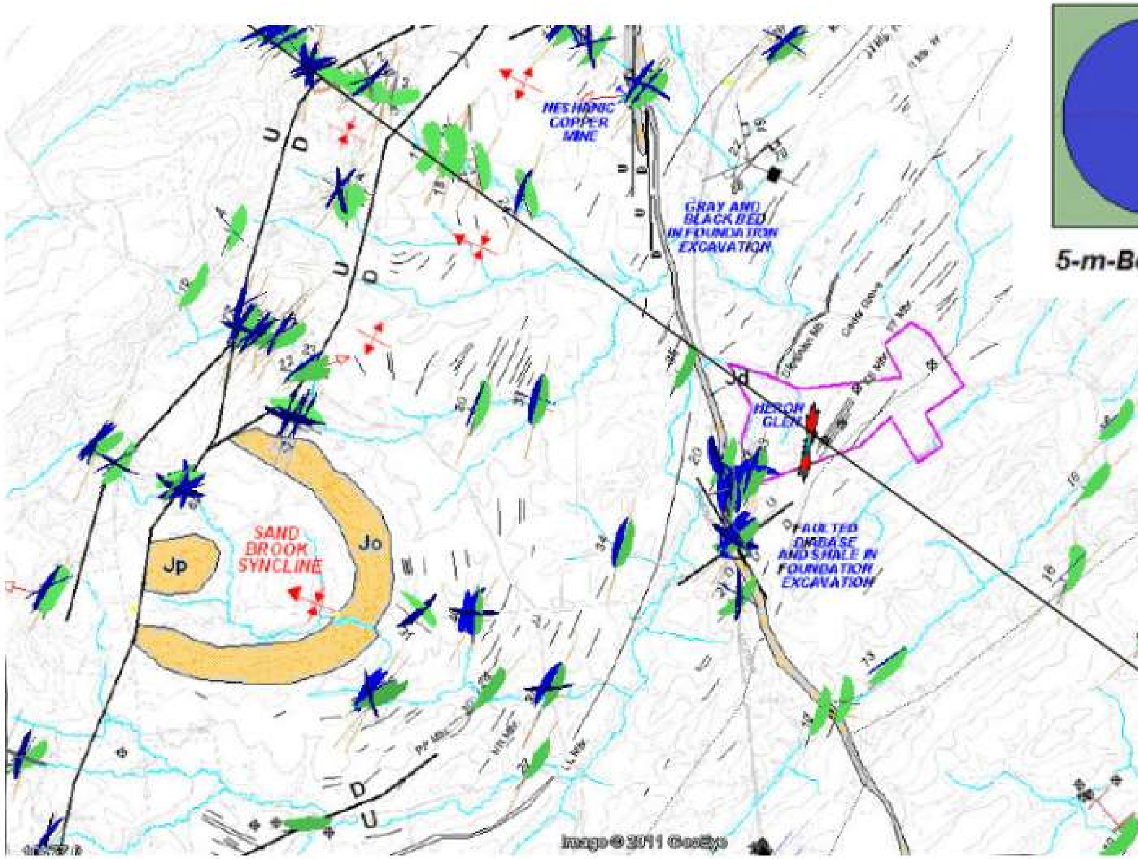
2D geological symbols and 3D colored circles (next page) are plotted in GE using KML output from Excel Worksheets shown below.

The red numbers are the symbol numbers used in the worksheet.

The Collada object files (*.dae files) must reside in the directory that the KML script is opened from in order for GE to be able to read them.

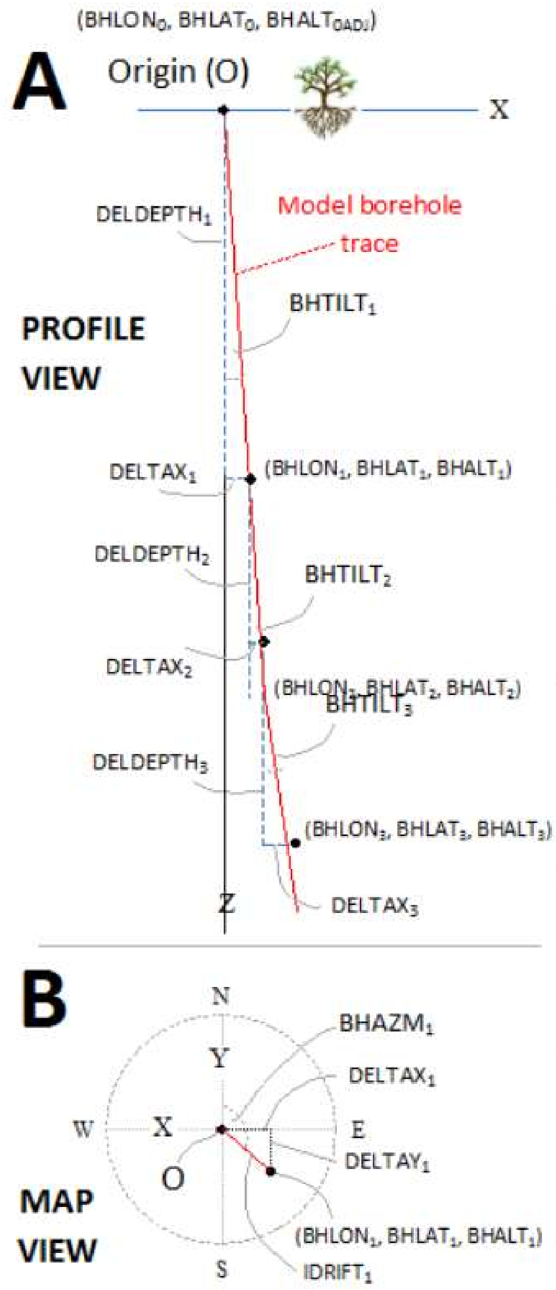
3D map symbols use circular or elliptical planes centered on outcrop locations that help tie geological structures to crustal physiography.





Excel worksheets are currently designed for groups of as much as 50 structures, and have been successfully used in structural geology laboratory exercises to help students visualize their field work.

Interpreted borehole televiewer (BTV) records provide incremental structural orientation readings, associated borehole telemetry, and a measure of plane aperture, or thickness.



C MS Excel Worksheet variables and formulas for calculating the 3D model borehole vertices and traces in decimal degrees

BHLON$_0$ – Borehole longitude

BHLAT$_0$ – Borehole latitude

BHALT$_0$ – Borehole altitude

ADEPTH$_n$ = BTV feature depth

BHAZM$_n$ = BTV incremental borehole azimuth

BHTILT$_n$ = BTV incremental borehole tilt

DELDEPTH$_n$ = Incremental vertical depth

IDRIFT$_n$ [INCREMENTAL DRIFT] =
IF (BHAZM>180, DELDEPTH *-1 * SIN (RADIANS (BHTILT)),
[ELSE] DELDEPTH * SIN (RADIANS (BHTILT)))

DELTAX$_n$ = IDRIFT$_n$ * SIN (RADIANS (BHAZM$_n$))*0.000009

DELTAY$_n$ = IDRIFT$_n$ * COS (RADIANS (BHAZM$_n$))*0.000009

BHLON$_n$ = BHLON$_{n-1}$ + DELTAX$_n$

BHLAT$_n$ = BHLAT$_{n-1}$ + DELTAY$_n$

BHALT$_n$ = BHALT$_{n-1}$ + DELDEPTH$_n$

TDEPTH [TOTAL DEPTH] = Sum total of DELDEPTH(s)

for the map example, BAZM$_1$ = 130°

2) 1 meter $\simeq$ 0.000009 degree

GC Herman Rev. 09/13/2014

THE GEOLOGICAL SOCIETY OF AMERICA®

Session No. 52
T22. Innovations in Geoscience Education and Research Using Google Earth and Related Digital Technologies
Tuesday, 19 March 2013: 1:30 PM-5:40 PM

Northeastern Section - 48th Annual Meeting (18–20 March 2013)

UTILIZING GOOGLE EARTH FOR GEOSPATIAL, TECTONIC, AND HYDROGEOLOGICAL RESEARCH AT THE NEW JERSEY GEOLOGICAL AND WATER SURVEY

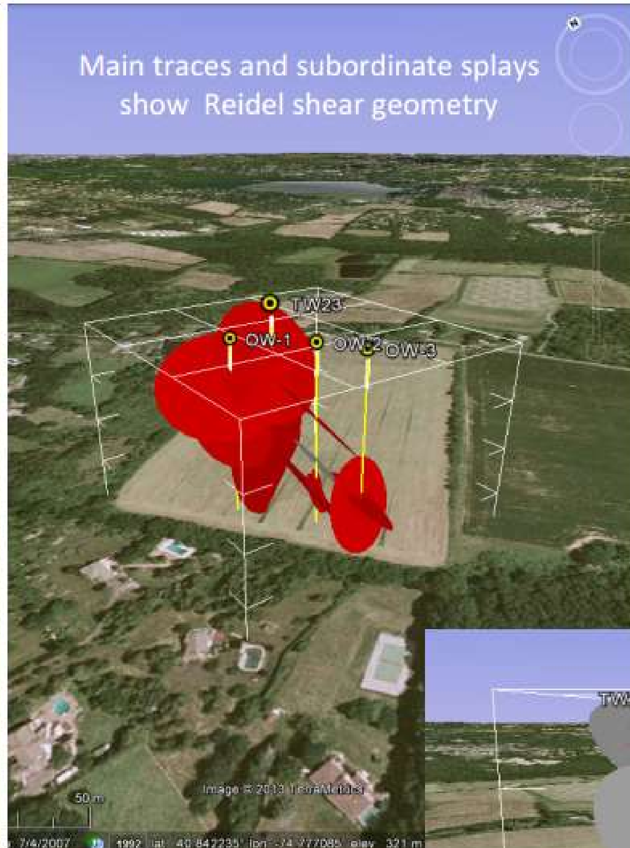
Geological Society of America *Abstracts with Programs*. Vol. 45, No. 1, p.110

HERMAN, Gregory C., NJ Department of Environmental Protection, NJ Geological & Water Survey, PO Box 420, 29 Arctic Parkway, Trenton, NJ 08822, greg.herman@dep.state.nj.us

The New Jersey Geological and Water Survey uses Google Earth (GE) to help research the physical properties of fractured-bedrock aquifers. GE provides a flexible, practical, and popular software platform to help organize, display, and share 2D and 3D geological data collected in outcrop and with borehole geophysical logging tools. Computerized 2D geological symbols and 3D models are generated in Trimble SketchUp, then georegistered, scaled, and annotated utilizing Microsoft Excel to generate GE keyhole-markup-language (KML) files. 2D geological map symbols are available for stratigraphic layering, cleavage, joints, fractures, faults, and lineation, utilizing an approach based on Whitmeyer's on-line orientation-symbol generator. 3D map symbols use elliptical planes centered on outcrop locations that help tie geological structures to crustal physiography. Excel worksheets are currently designed for groups of as much as 50 structures, and have been successfully used in structural geology laboratory exercises to help students visualize their field work. As GE is designed for viewing the Earth's surface, 3D well-field visualization requires lifting well-field components above land surface by a distance exceeding the deepest well. Well-head positions are established utilizing global-positioning systems (GPS) and digital elevation models. Interpreted borehole televiewer (BTV) records provide incremental structural orientation readings, associated borehole telemetry, and a measure of plane aperture, or thickness. Well-field components include borehole traces with cased and open intervals, geophysical logs, and 3D ellipses representing structural planes that can be dynamically viewed with graduated reference grids. Availability of BTV data on multiple wells in close proximity facilitates comparison of complex stratigraphic and structural relationships. Comparative thickness values for sets of planar features, such as branching and interconnecting faults within a fault zone, can be variably scaled in a model to help assess complex structures in multiply-tectonized terrains. These approaches have proven useful for linking geological heterogeneity, such as cross stratification, to aquifer anisotropy. Assessments are planned of the dimensional accuracy of the 3D well-field models.

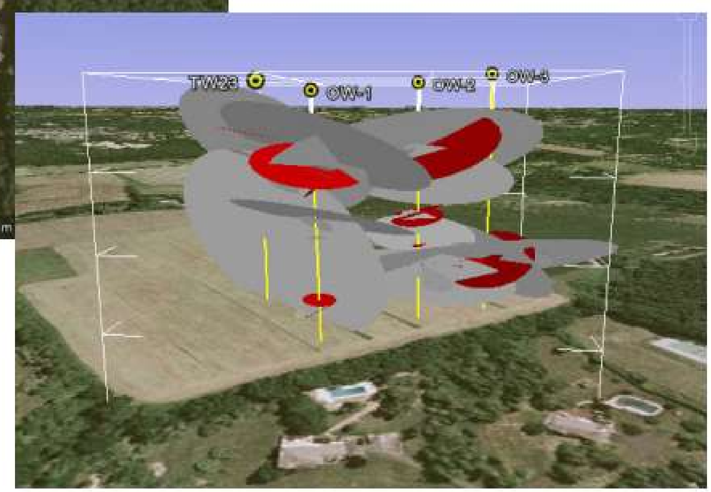
Handouts
- GCH_52-11_NEGSA2013.pdf (8.4 MB)

Comparative thickness values for sets of planar features, such as branching and interconnecting faults within a fault zone, can be variably scaled in a model to help assess complex structures in multiply-tectonized terrains.



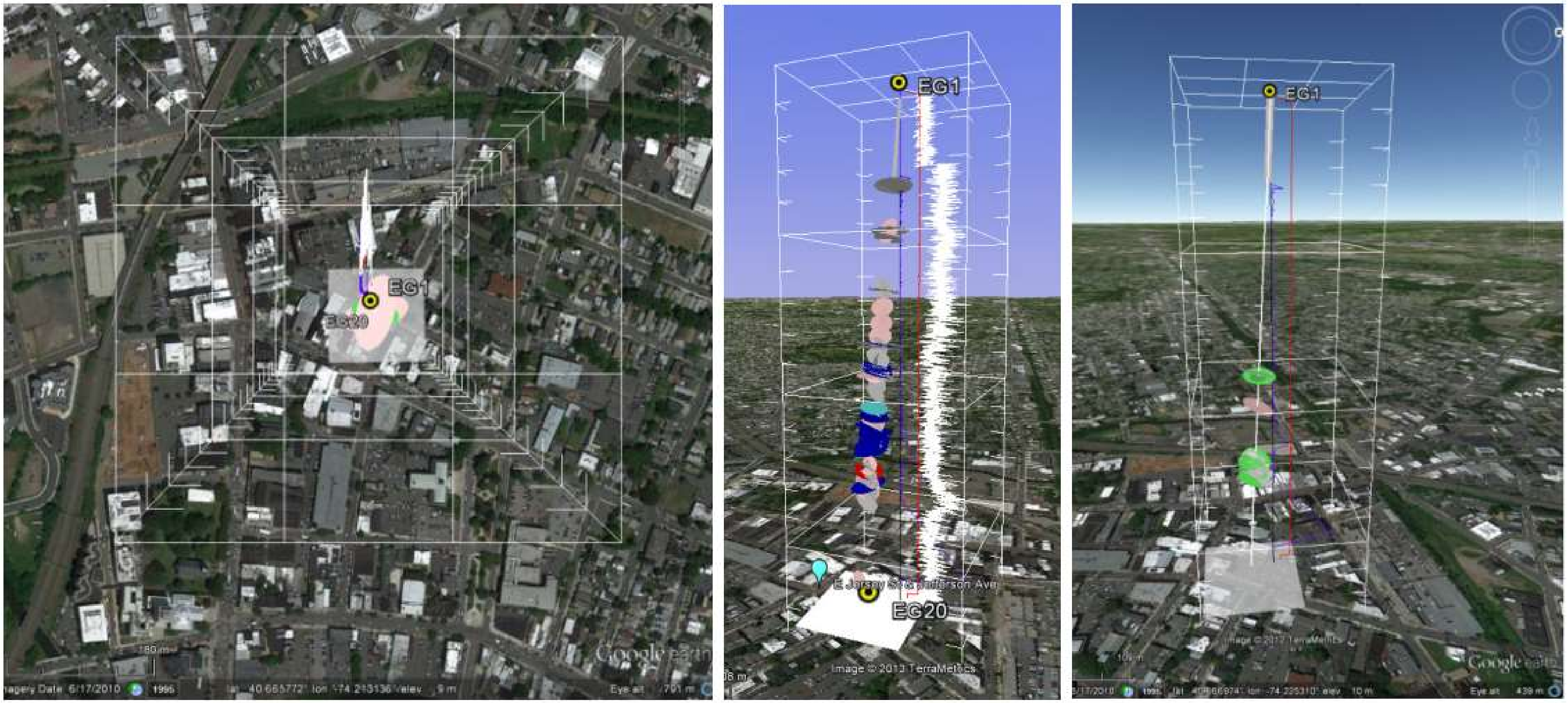
Red – faults are variable scaled using aperture thickness

Green –metamorphic layering



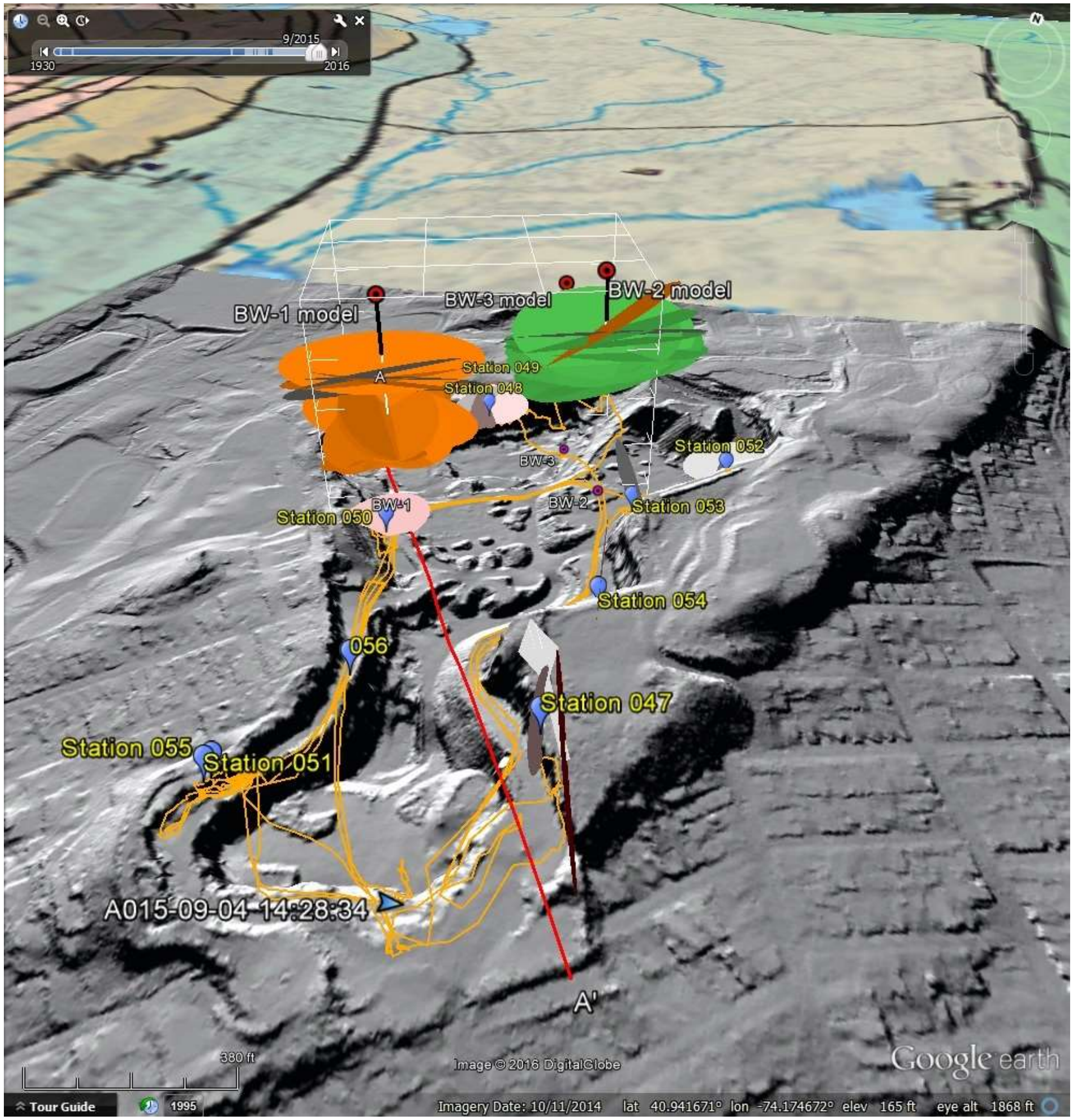
A water-supply well and three observation wells drilled into a fault zone.

• Well-field components include borehole traces with cased and open intervals, geophysical logs, and 3D ellipses representing structural planes that can be dynamically viewed with graduated reference grids.



• As GE is designed for viewing the Earth's surface, 3D well-field visualization requires lifting well-field components above land surface by a distance exceeding the deepest well.

• Well-head positions are established utilizing global-positioning systems (GPS) and digital elevation models.


9/2015
1930
2016
BW-1 model
BW-3 model
BW-2 model
Station 049
Station 048
Station 052
BW-3
BW-2
BW-1
Station 050
Station 053
Station 054
056
Station 047
Station 055
Station 051
A015-09-04 14:28:34
A
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380 ft
Image © 2016 DigitalGlobe
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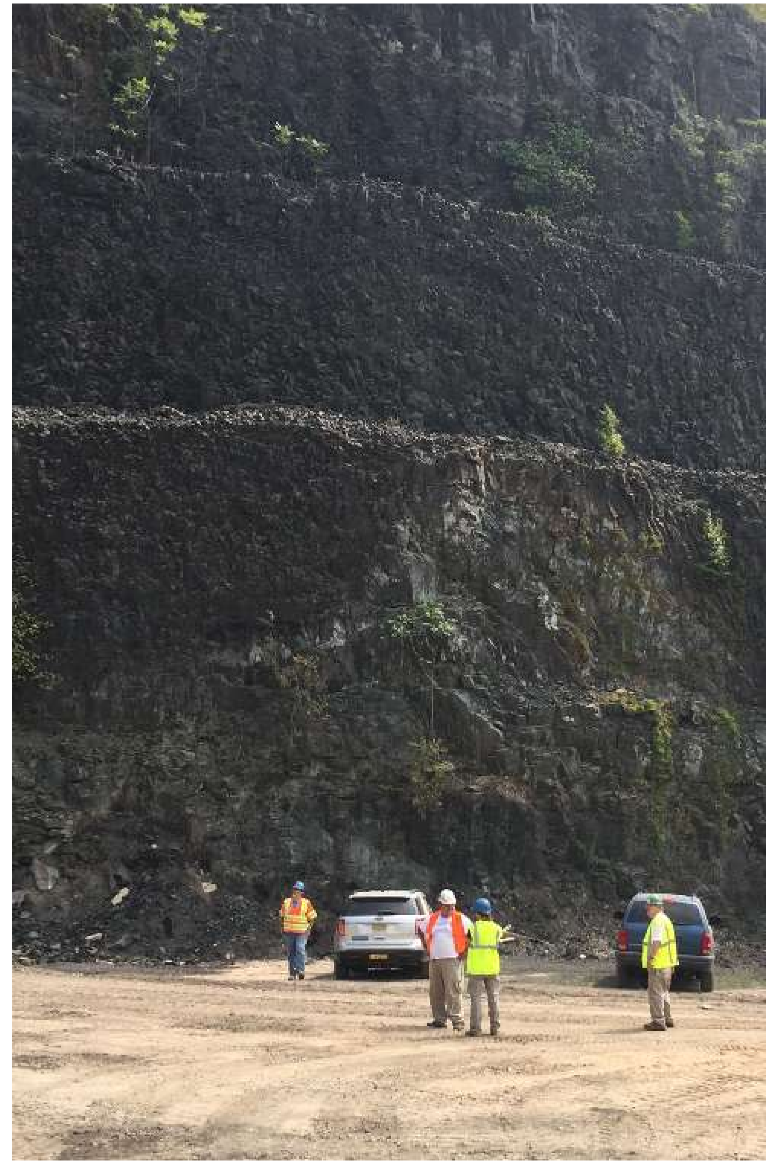
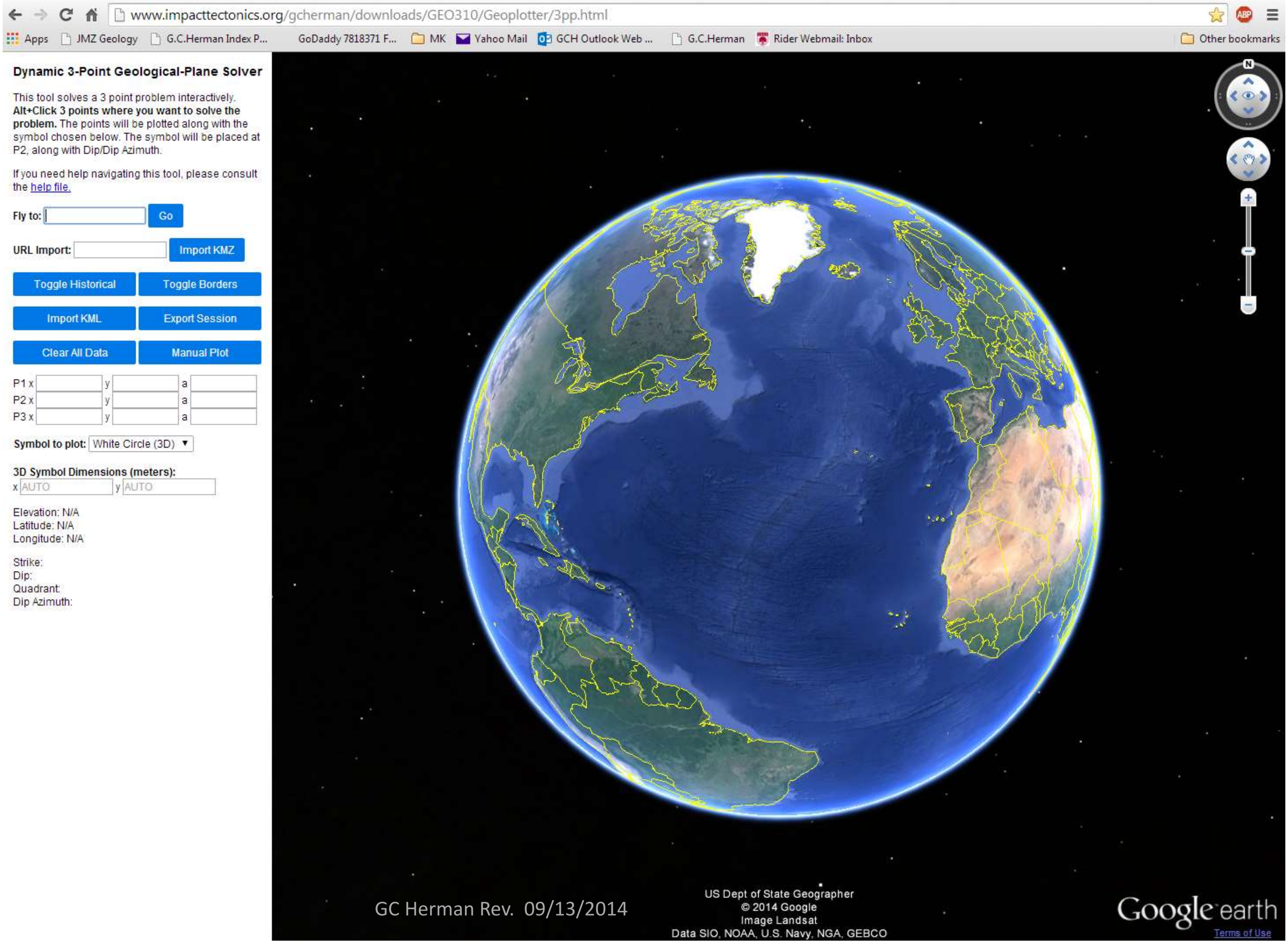
Tour Guide
1995
Imagery Date: 10/11/2014 lat 40.941671° lon -74.174672° elev 165 ft eye alt 1868 ft




www.impacttectonics.org/gcherman/downloads/GEO310/Geoplotter/3pp.html
Apps JMZ Geology G.C.Herman Index P... GoDaddy 7818371 F... MK Yahoo Mail GCH Outlook Web ... G.C.Herman Rider Webmail: Inbox Other bookmarks
Dynamic 3-Point Geological-Plane Solver
This tool solves a 3 point problem interactively. Alt+Click 3 points where you want to solve the problem. The points will be plotted along with the symbol chosen below. The symbol will be placed at P2, along with Dip/Dip Azimuth.
If you need help navigating this tool, please consult the help file.
Fly to: Go
URL Import: Import KMZ
Toggle Historical
Toggle Borders
Import KML
Export Session
Clear All Data
Manual Plot
P1 x y a
P2 x y a
P3 x y a
Symbol to plot: White Circle (3D)
3D Symbol Dimensions (meters):
x AUTO y AUTO
Elevation: N/A
Latitude: N/A
Longitude: N/A
Strike:
Dip:
Quadrant:
Dip Azimuth:
GC Herman Rev. 09/13/2014
US Dept of State Geographer
© 2014 Google
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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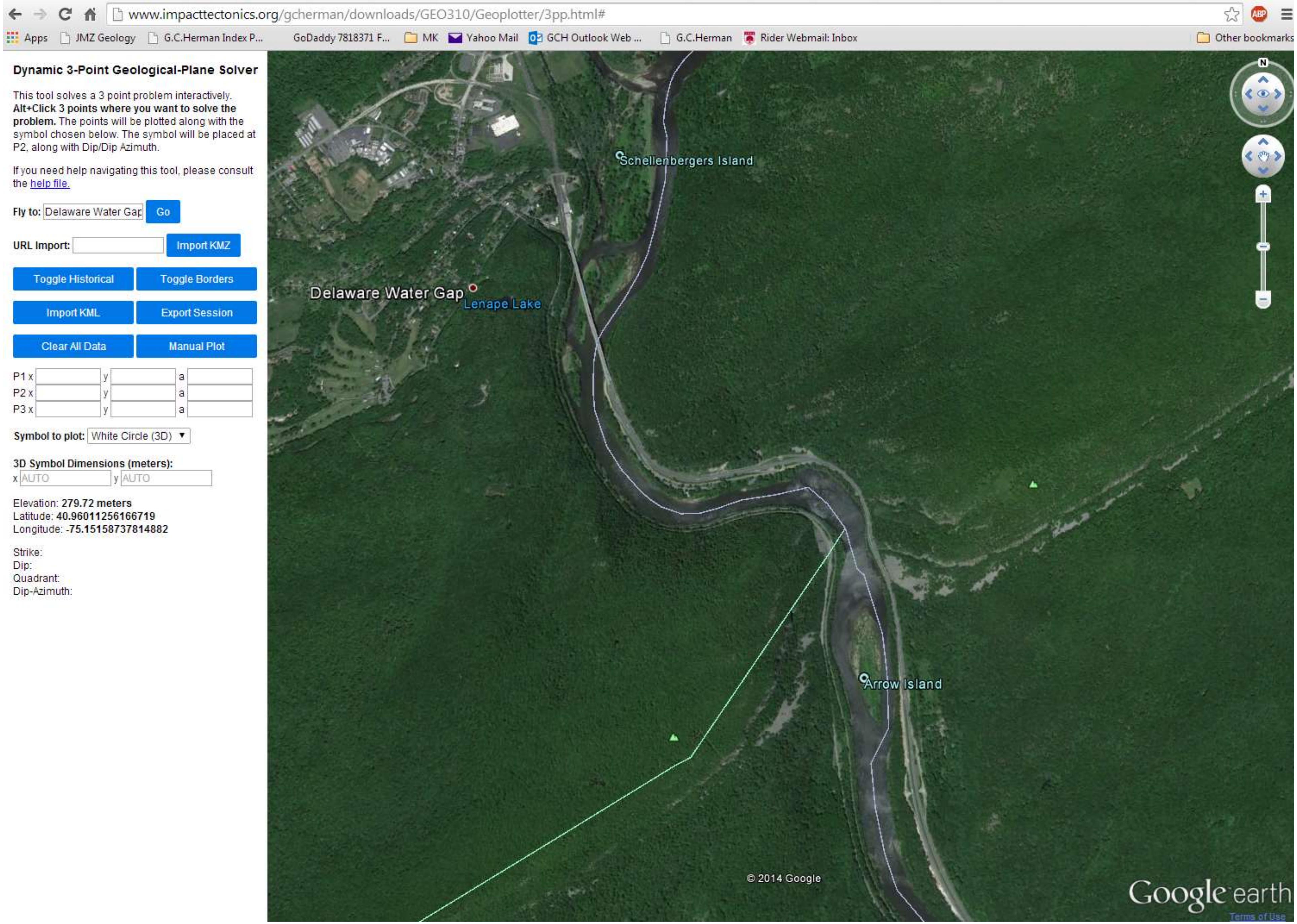
www.impacttectonics.org/gcherman/downloads/GEO310/Geoplotter/3pp.html#
Apps
JMZ Geology
G.C.Herman Index P...
GoDaddy 7818371 F...
MK
Yahoo Mail
GCH Outlook Web ...
G.C.Herman
Rider Webmail: Inbox
Other bookmarks
Dynamic 3-Point Geological-Plane Solver
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Fly to: Delaware Water Gap
Go
URL Import:
Import KMZ
Toggle Historical
Toggle Borders
Import KML
Export Session
Clear All Data
Manual Plot
P1 x y a
P2 x y a
P3 x y a
Symbol to plot: White Circle (3D)
3D Symbol Dimensions (meters):
x AUTO y AUTO
Elevation: 279.72 meters
Latitude: 40.96011256166719
Longitude: -75.15158737814882
Strike:
Dip:
Quadrant:
Dip-Azimuth:
Schellenbergers Island
Delaware Water Gap
Lenape Lake
Arrow Island
© 2014 Google
Google earth

Dynamic 3-Point Geological-Plane Solver

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Fly to: Delaware Water Gap [Go]

URL Import: [Import KMZ]

[Toggle Historical] [Toggle Borders]

[Import KML] [Export Session]

[Clear All Data] [Manual Plot]

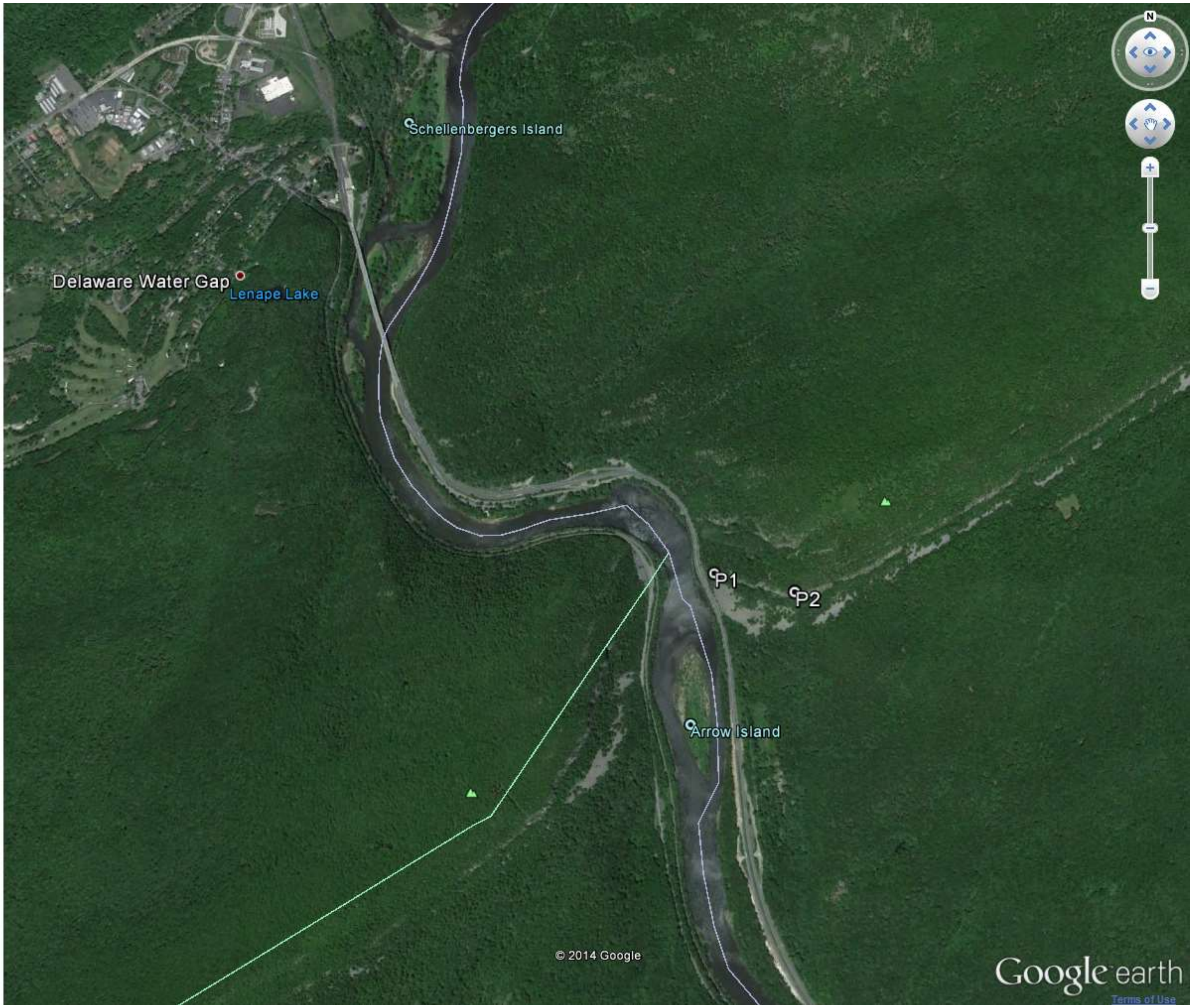
P1 x ___ y ___ a ___
P2 x ___ y ___ a ___
P3 x ___ y ___ a ___

Symbol to plot: White Circle (3D)

3D Symbol Dimensions (meters):
x AUTO y AUTO

Elevation: **305.21 meters**
Latitude: **40.95438559320618**
Longitude: **-75.15116971637616**

Strike:
Dip:
Quadrant:
Dip-Azimuth:



Dynamic 3-Point Geological-Plane Solver

This tool solves a 3 point problem interactively. **Alt+Click 3 points where you want to solve the problem.** The points will be plotted along with the symbol chosen below. The symbol will be placed at P2, along with Dip/Dip Azimuth.

If you need help navigating this tool, please consult the help file.

Fly to: Delaware Water Gap [Go]

URL Import: [Import KMZ]

[Toggle Historical] [Toggle Borders]

[Import KML] [Export Session]

[Clear All Data] [Manual Plot]

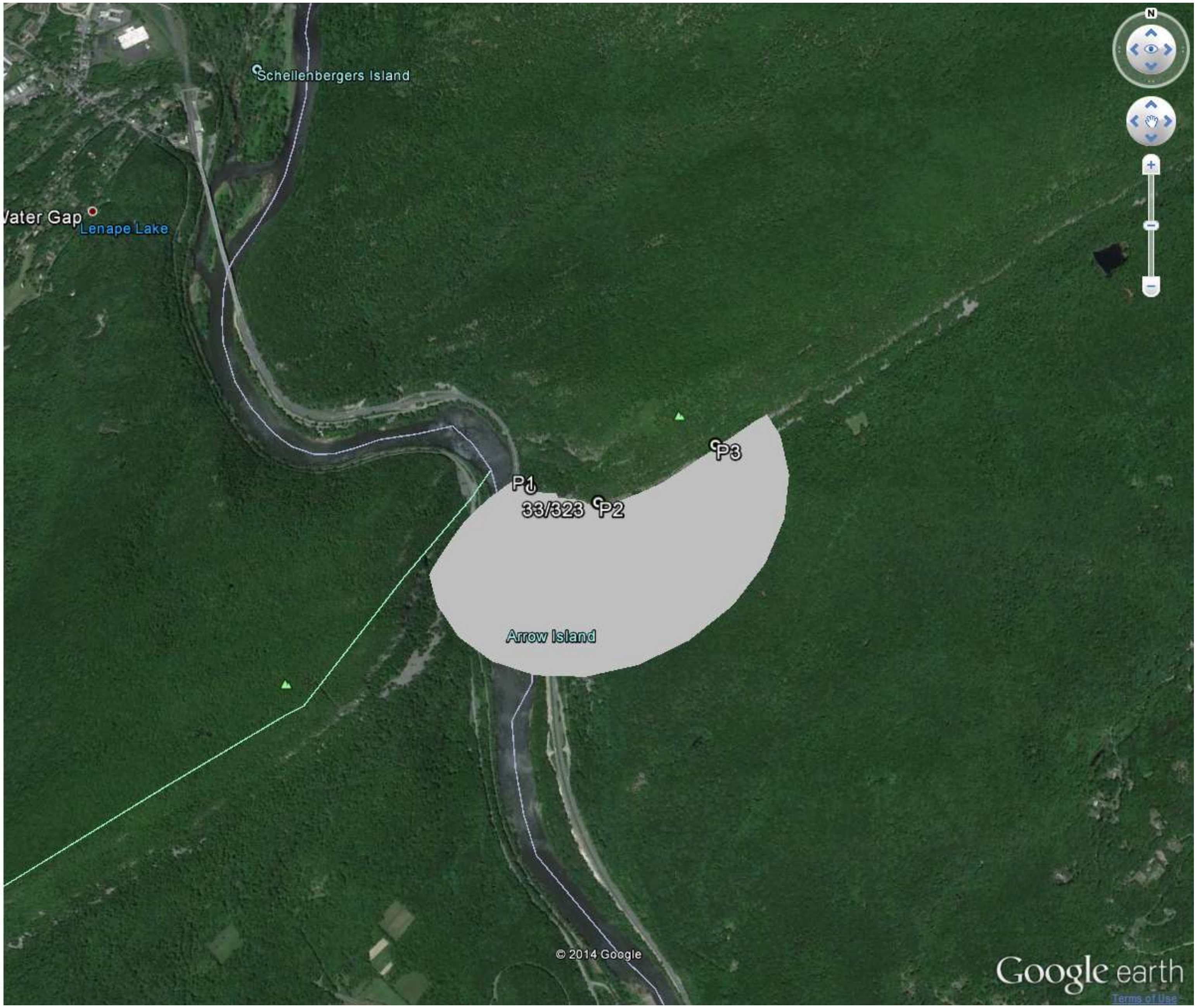
P1 x y a
P2 x y a
P3 x y a

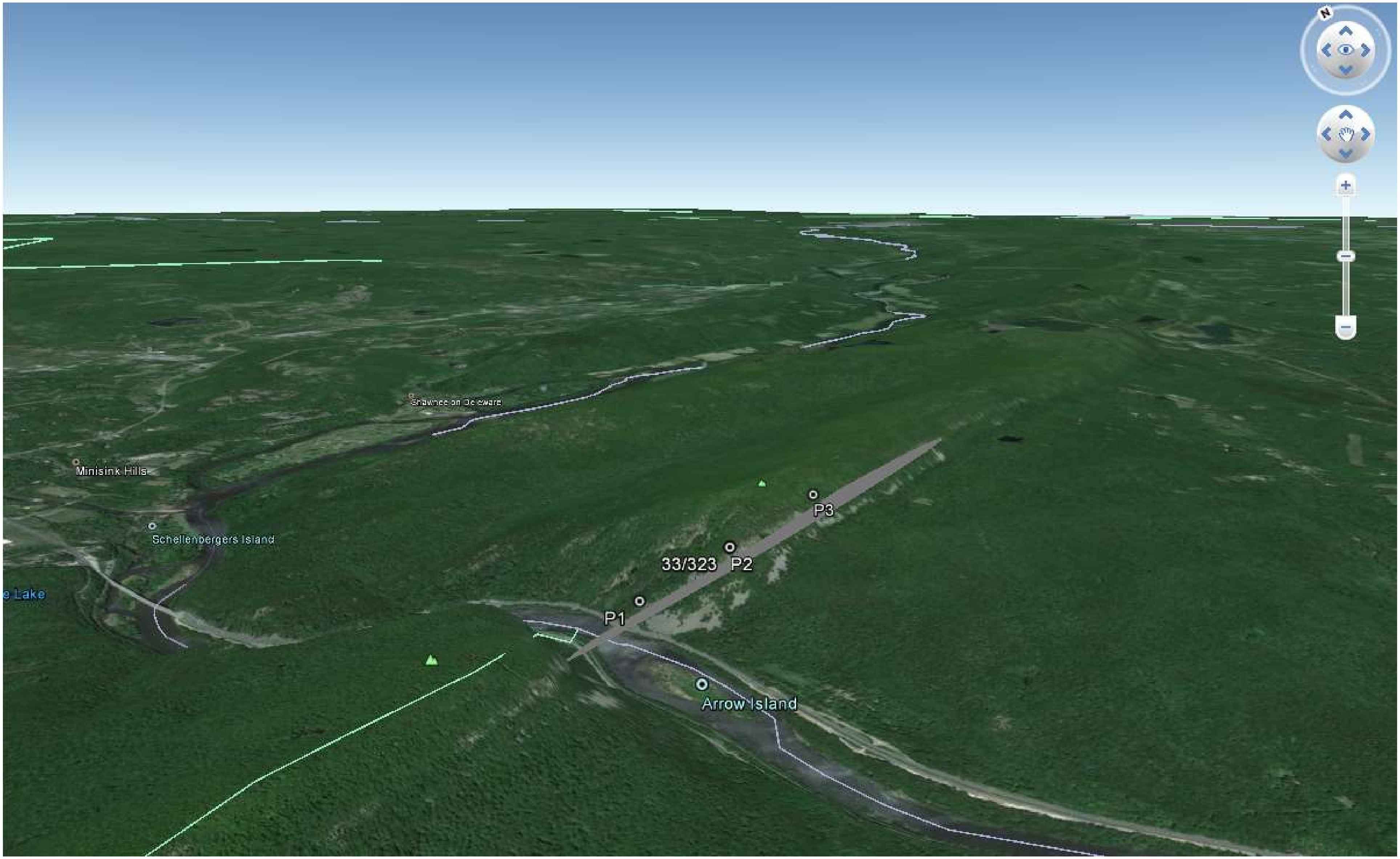
Symbol to plot: White Circle (3D)

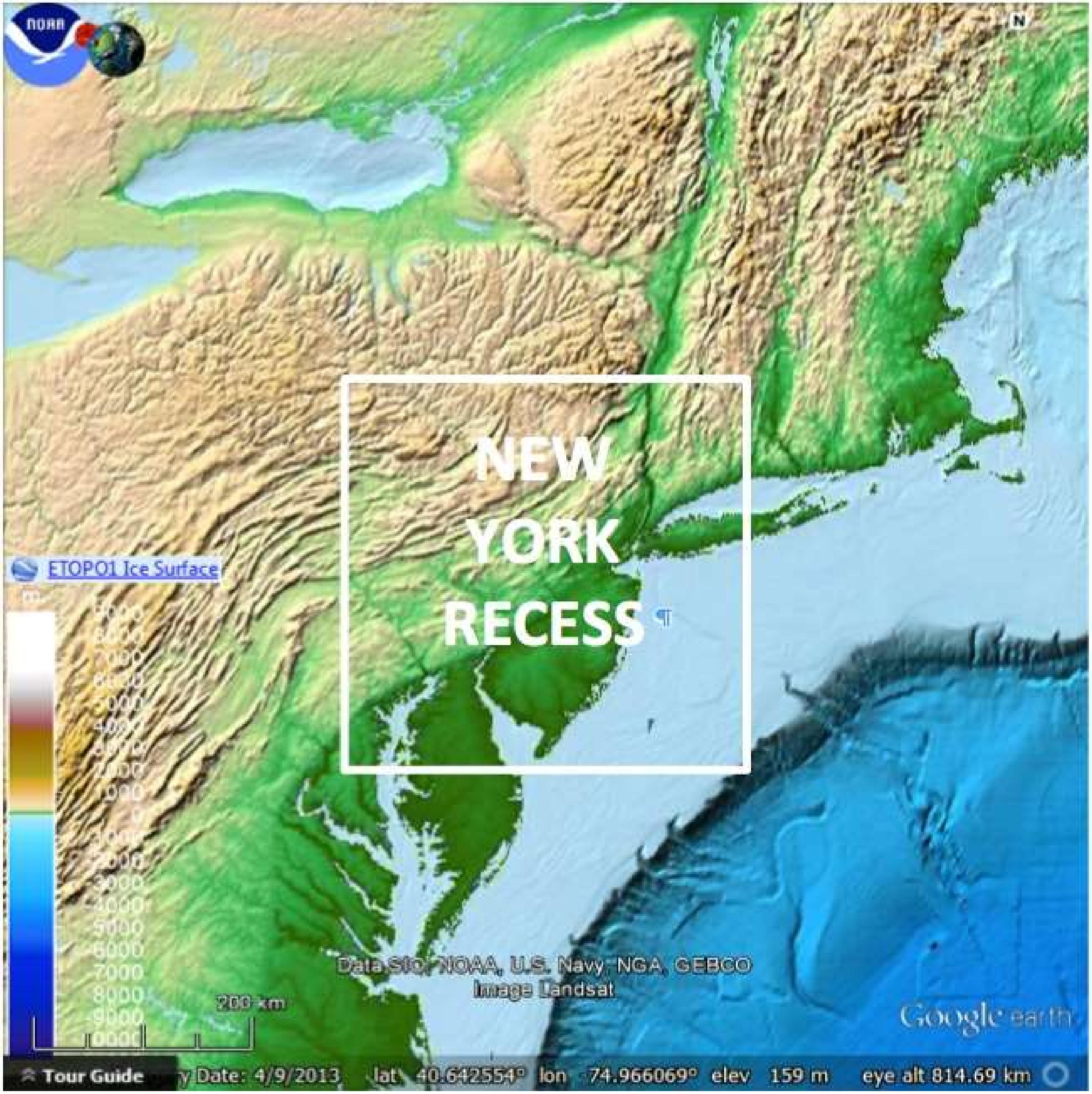
3D Symbol Dimensions (meters):
x AUTO y AUTO

Elevation: **429.02 meters**
Latitude: **40.95338587540719**
Longitude: **-75.14177778145688**

Strike: **53.35765840513042**
Dip: **33.505701478540544**
Quadrant: **W**
Dip-Azimuth: **323.35765840513045**




Shawnee on Delaware
Minisink Hills
Schellenbergers Island
e Lake
P3
33/323
P2
P1
Arrow Island



NEW
YORK
RECESS
ETOPO1 Ice Surface
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat
200 km
Google earth
Tour Guide
Date: 4/9/2013 lat 40.642554° lon 74.966069° elev 159 m eye alt 814.69 km

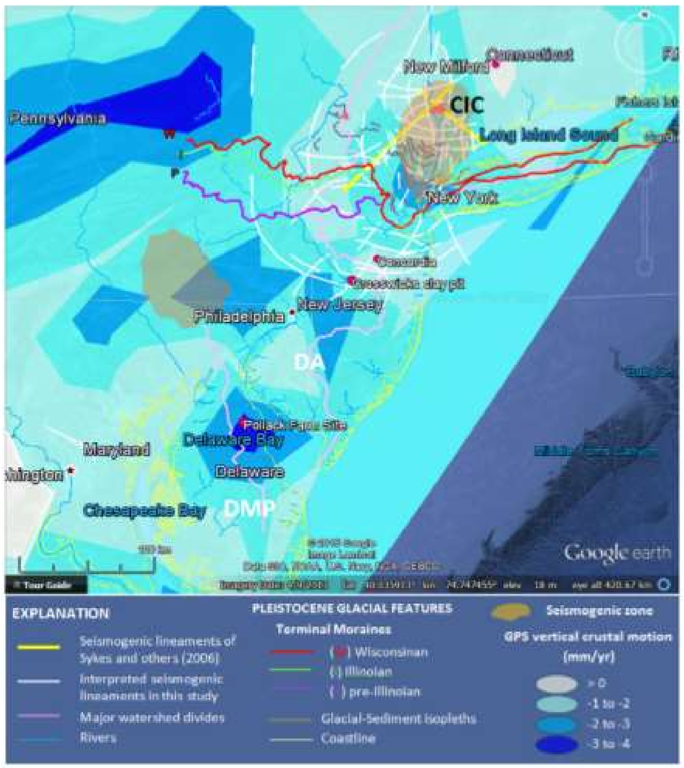
Neotectonics of the New York Recess

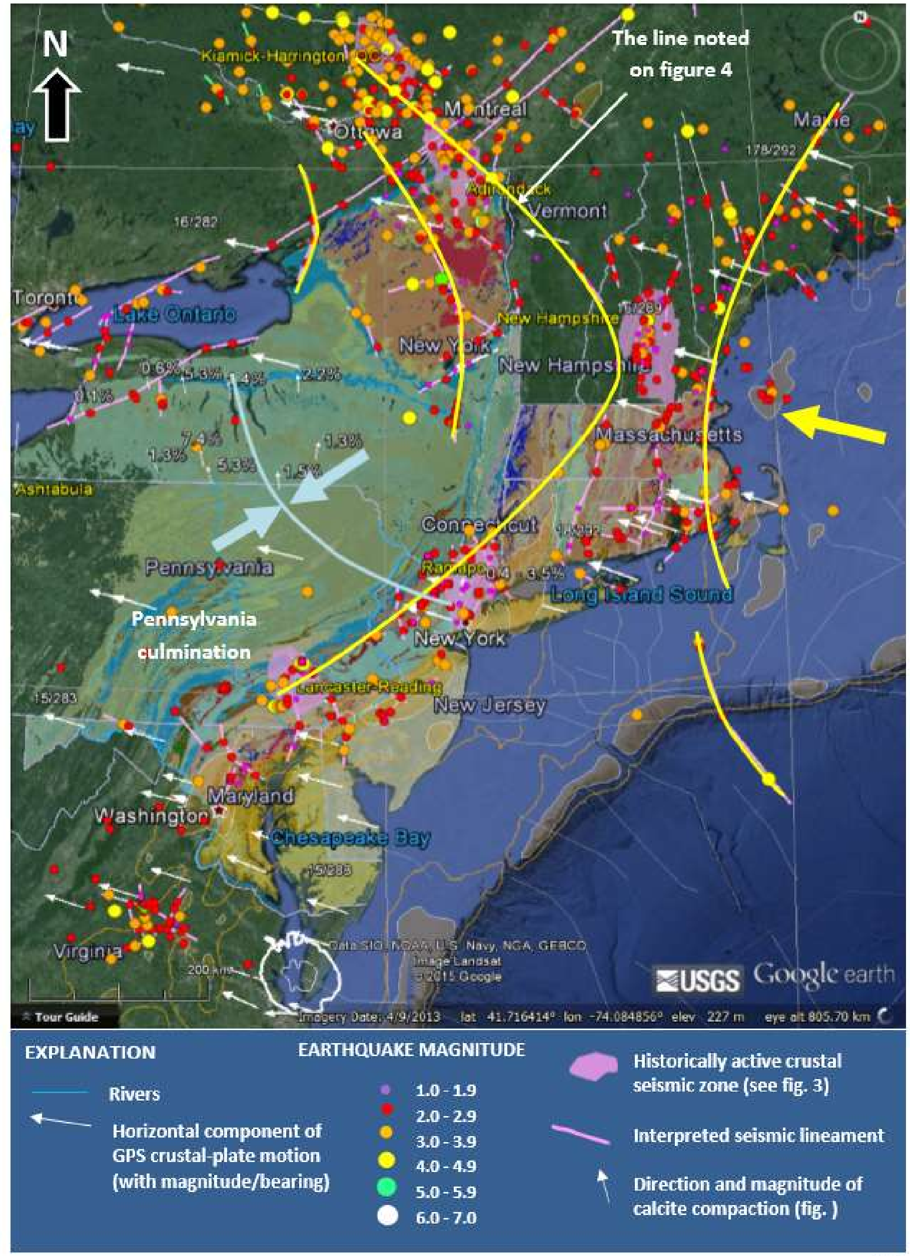
MEETING PROCEEDINGS AND FIELD GUIDE FOR THE 2015 CONFERENCE
OF THE GEOLOGICAL ASSOCIATION OF NEW JERSEY

EDITED BY

Gregory Charles Herman and Suzanne Macaoay Ferguson

NEW JERSEY GEOLOGICAL & WATER SURVEY   PENNJERSEY ENVIRONMENTAL CONSULTING



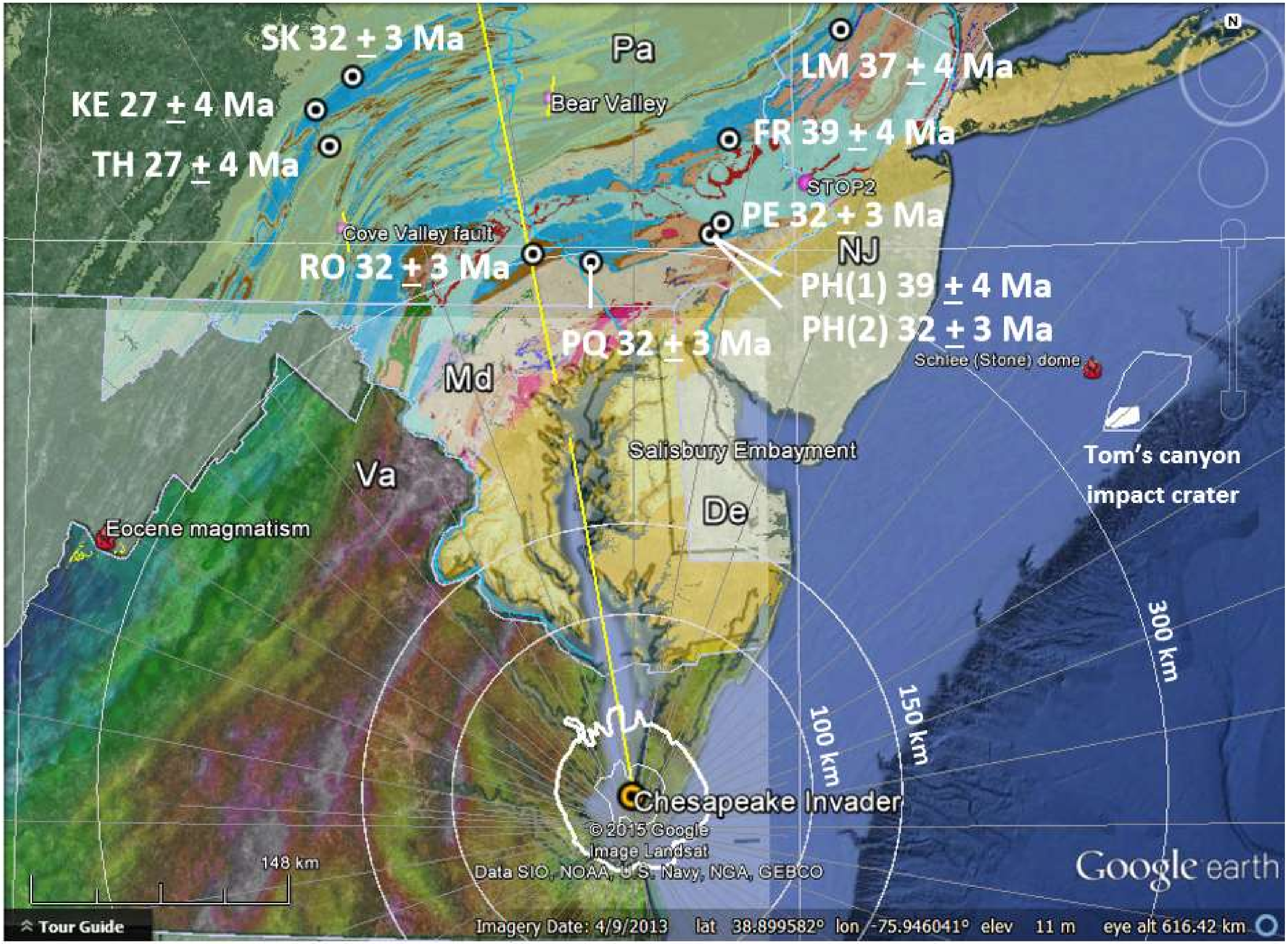


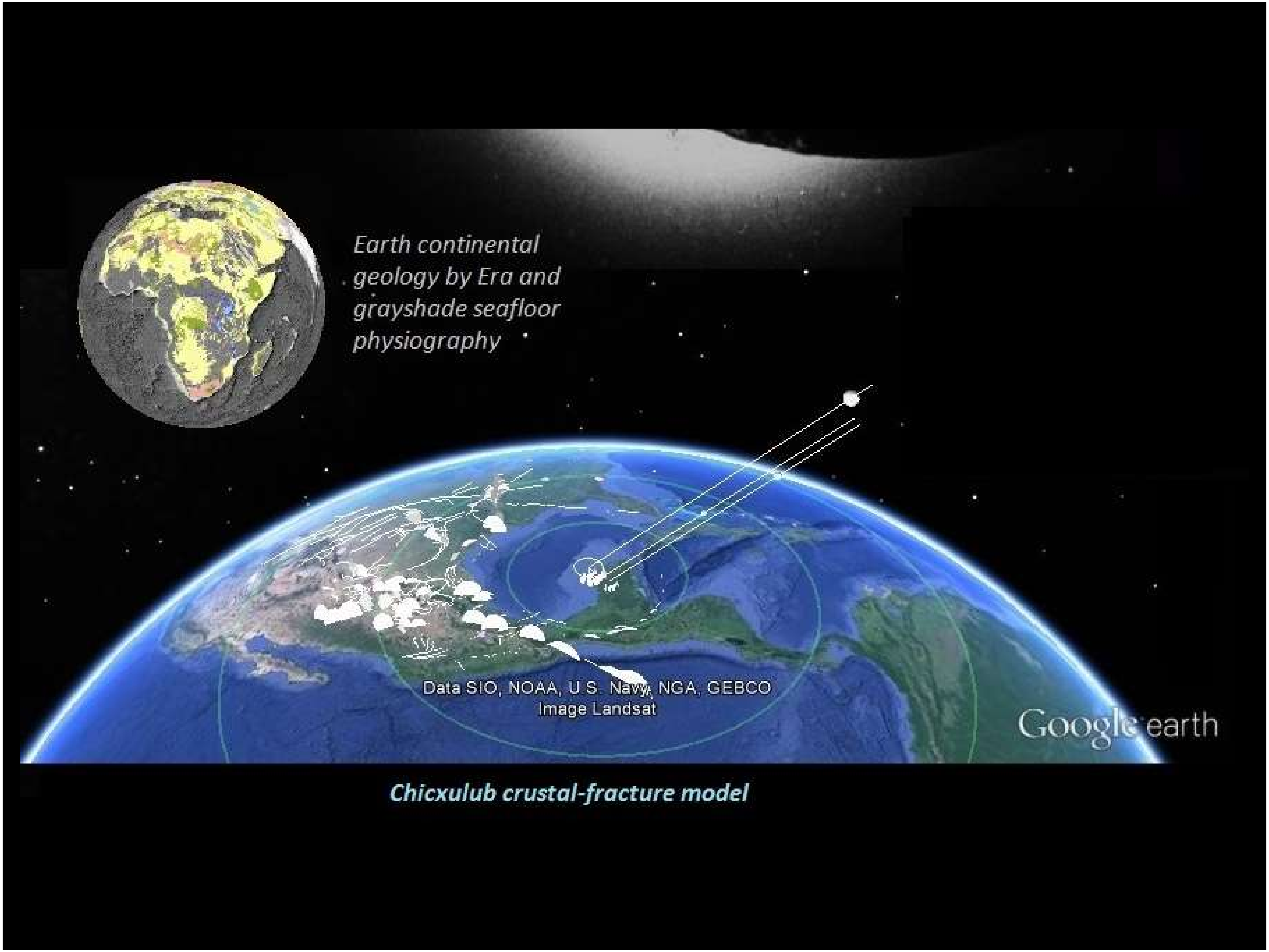
GEOLOGICAL ASSOCIATION OF NEW JERSEY

XXXII ANNUAL CONFERENCE AND FIELD TRIP

OCTOBER 16-17, 2015, LAFAYETTE COLLEGE, EASTON, PENNSYLVANIA

GANJ XXXII Chapter 3. Re-Os isotope evidence an Early Tertiary crustal faulting and sulfide-mineralization in Pennsylvania with probable ties to the Chesapeake Bay bolide impact in Maryland, USA




Earth continental geology by Era and grayshade seafloor physiography
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat
Google earth
Chicxulub crustal-fracture model

2020-20Impact experiments using an air gun, steel projectile, and 60mm glass balls.

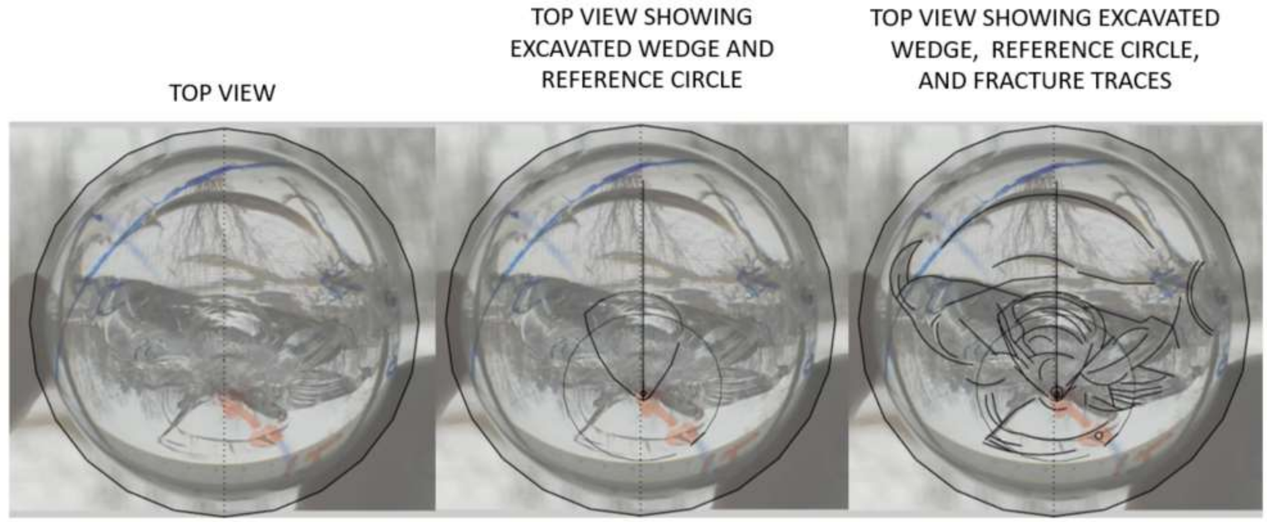


Figure 9. *Mapped results of the strain field resulting from a high-angle impact (85º) near the gun's threshold velocity. The impact conditions were just right to produce a 3D foreland strain field that descends down toward the ball center from the impact point at the surface, then returns upward following an irregular path as further profiled in figure 8.*

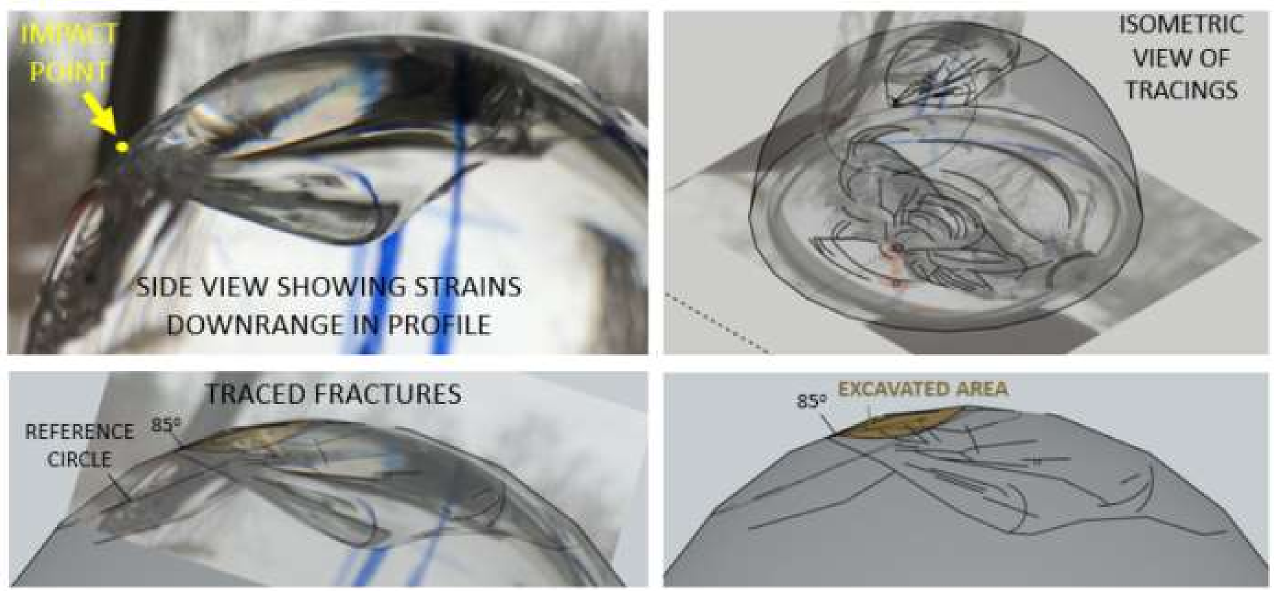


Figure 10. *Test results showing a high-angle impact near the gun's threshold velocity. Three-dimension (3D) line tracings of spherical strain fields including the map depictions in figure 7.*