Applications for Cave Surveys

Jon Jasper

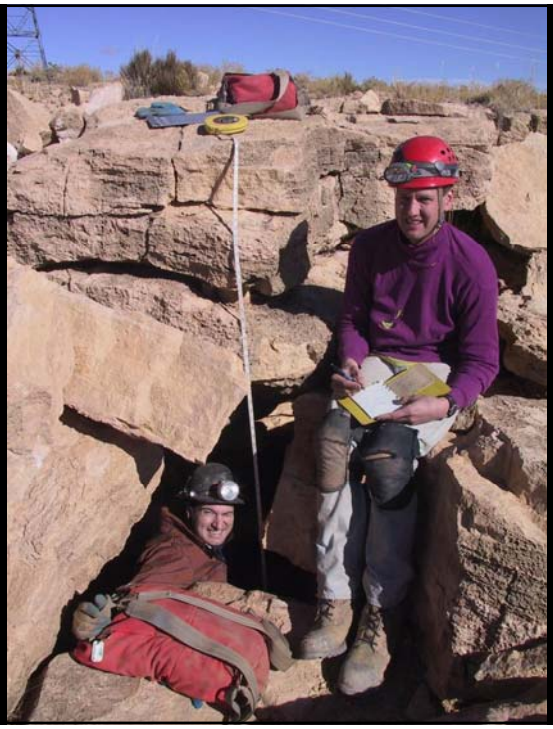
Cave & Karst Management Workshop 2007

Why survey a cave?

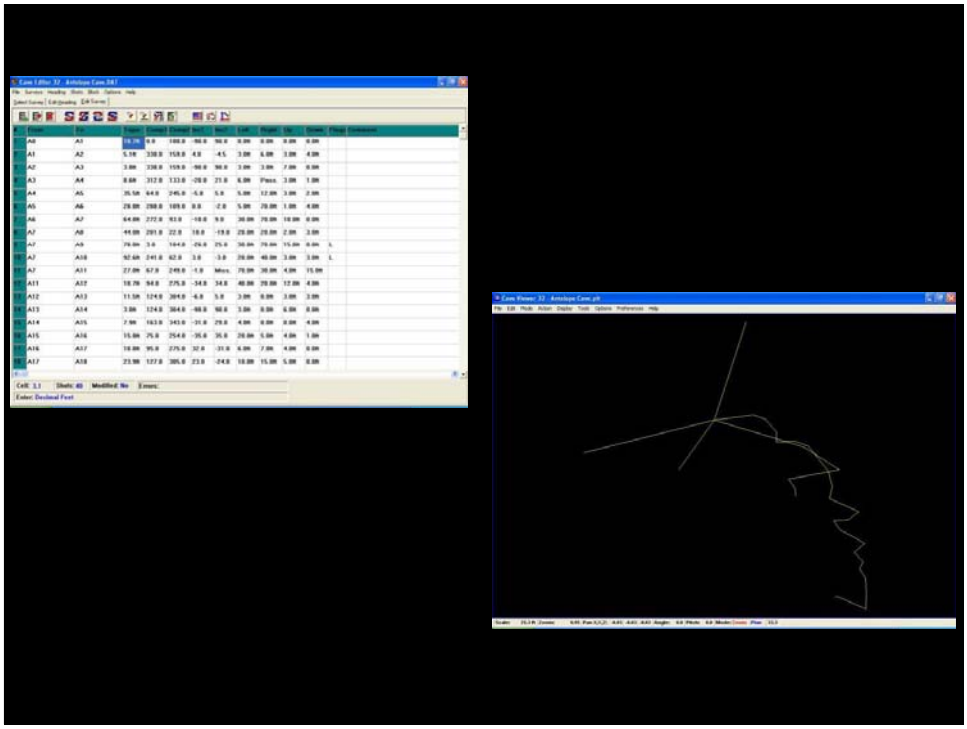
- To measure where it goes (length, depth, direction)
- To record what it contains (biology, geology, cave formations, archeology, hydrology)
- To understand how it forms (geology, hydrology, structure, chemistry, time)
- To aid in its management and science (interactions with human activities and surface morphology)
- For planning (tour development, trails, rescues, restoration, science)
- To discover more cave passages

How are caves surveyed?

- Tape (disto), compass, inclinometer
- Creating sketches and notes to symbolize and record passage features
- (Completing cave inventory)
- Data reduction
- Drafting the cave map




PETZL



Cave Inventory

Carlsbad Cavern National Park
Cave Inventory Form

Cave Name_____
Stations Inventoried _____
(Example: XJ1-23, XJ4A-G, XJ60-81, A1-10)

Recorder _____
Other Personnel _____
Inventory Date _____

Instructions:
Inventory information is tied to the nearest survey station. At each survey station to be inventoried, scan the area halfway between the last station and the next station for any of the inventory items. Work your way through the inventory sheet recording which station the inventory items are located at. The first time there is an entry for a category, record the pre-fix (example: XJ3). When entering another station to a category that has a previous entry there is no need to use the pre-fix unless a new prefix has been selected (example XJ4,5,8, A3,9). If you have numerous stations that have an item, instead of writing A1,2,3 you can record them as A1-3. Only use commas and dashes between numbers.

Contents by Page
1 Cover Sheet
2 Miscellaneous
3 Formations 1
4 Formations 2
5 Geology 1
6 Geology 2
7 Biology
8 Cultural

Computer entry date _____
Data entry person _____

Miscellaneous

Water
Surface Moisture _____
Dripping _____
Flowing _____
Pool (note size)
- < 1cubic foot_____
- > 1cubic foot_____

Paleo-Waterline _____

Airflow
Airflow _____
(Indicate direction and velocity. Example: B45 to B46, faint)

Floor (!note every station must have at least one floor feature!)
Sediment/Soil _____
Breakdown _____
Bedrock _____
Secondary Deposits _____
Pit _____

Conservation
Flowstone shoes required_____
Gloves off area_____
Restoration projects _____
Other_____

Obstacles
Crawl (anything difficult for a rescue) _____
Un-roped Climb or Chimney_____
Pit Requiring Rope (describe rigging, rope length, pit depth, quality of rope)
_____
_____
Other_____

Notes
_____
_____
_____

Cave data reduction software

- Compass
  - Accepts multiple measurement units
  - Easy loop error identification features
  - Exports to 3D formats and ESRI shapefiles
  - Contains a 3D modeler
- Walls
  - Warps cave maps to new loop closures
  - Fast, straight forward loop closures
  - Programmer-like interface
- Auriga
  - Portable Palm OS version

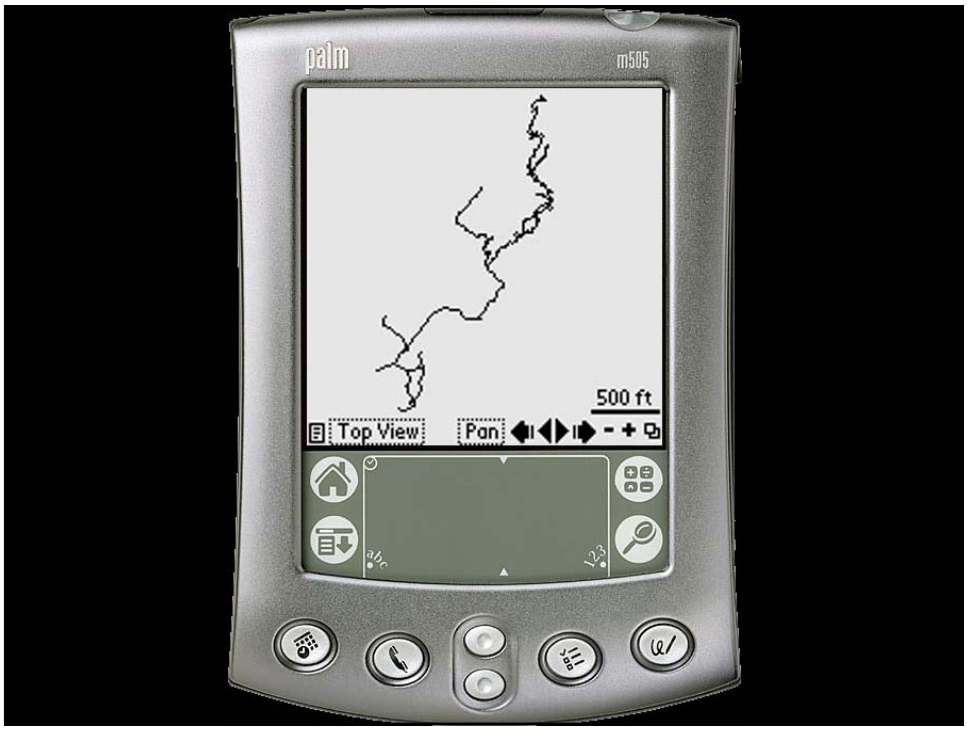

palm
m515
12:08 pm
All
Address
Auriga
Calc
Card Info
Clock
Date Book
Expense
HotSync
Mail
Memo Pad
Note Pad
Prefs

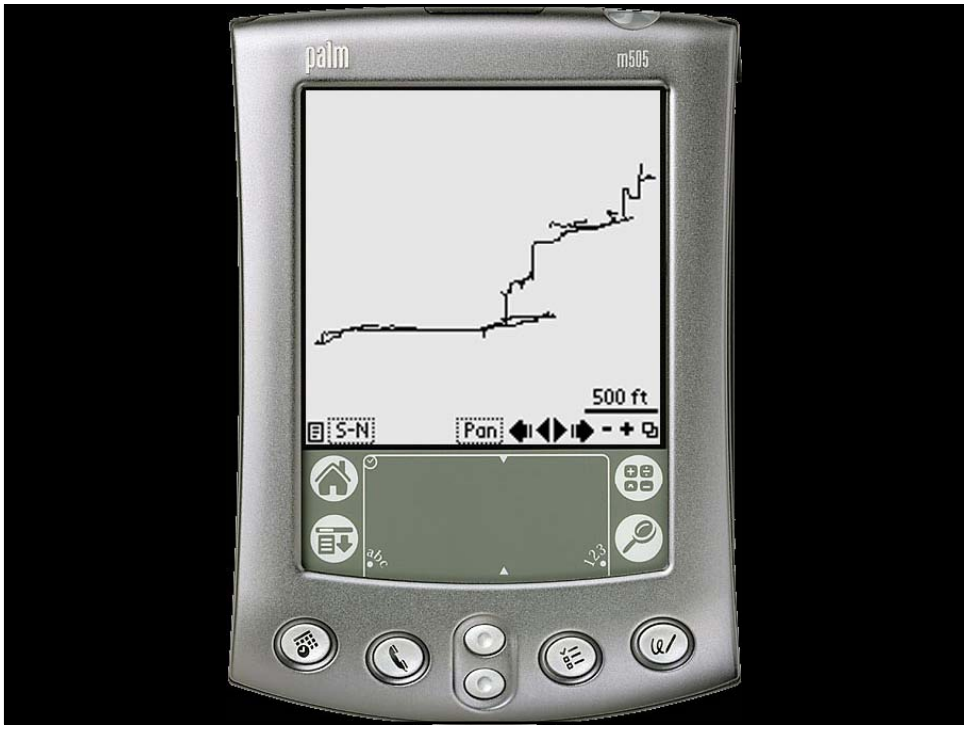

palm
m515
Auriga
Caves
All
Fairy Cave
Kiamika
Main Drain


palm
m505
Main Drain Cave
Assistant
25.67
25.11
57.0
237.0
Direct
12.00
-12.0
Direct
2.00
$4
1.00
1.20
1.50
$5
Session: 1

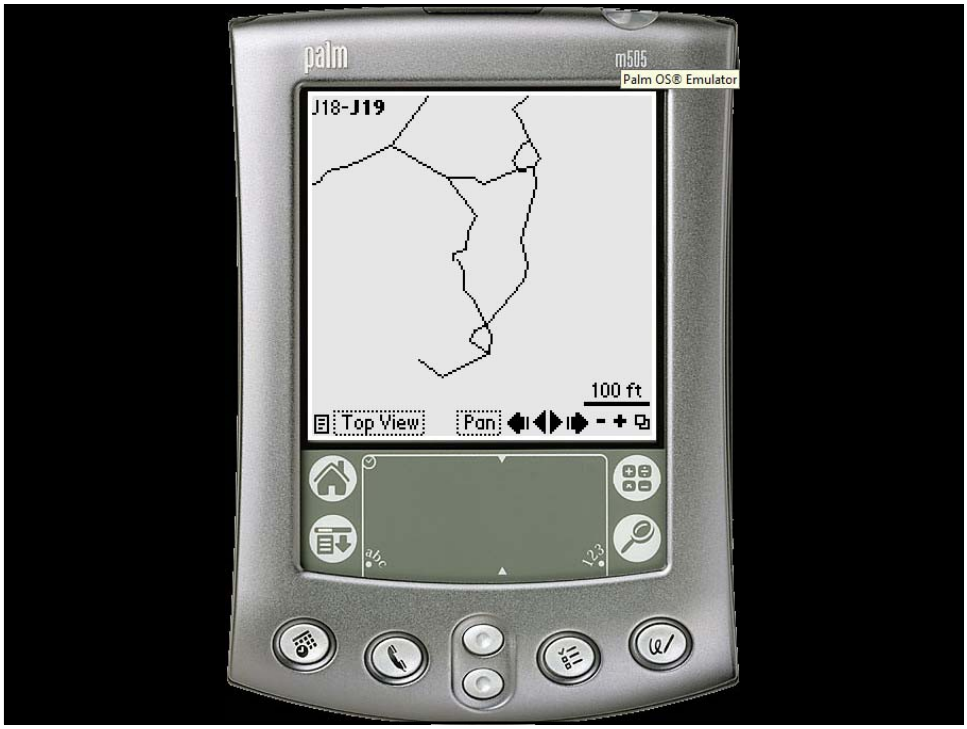

palm
m505
Azimuth (°)
Direct
57.0
1
2
3
4
5
6
7
8
9
.
0
OK

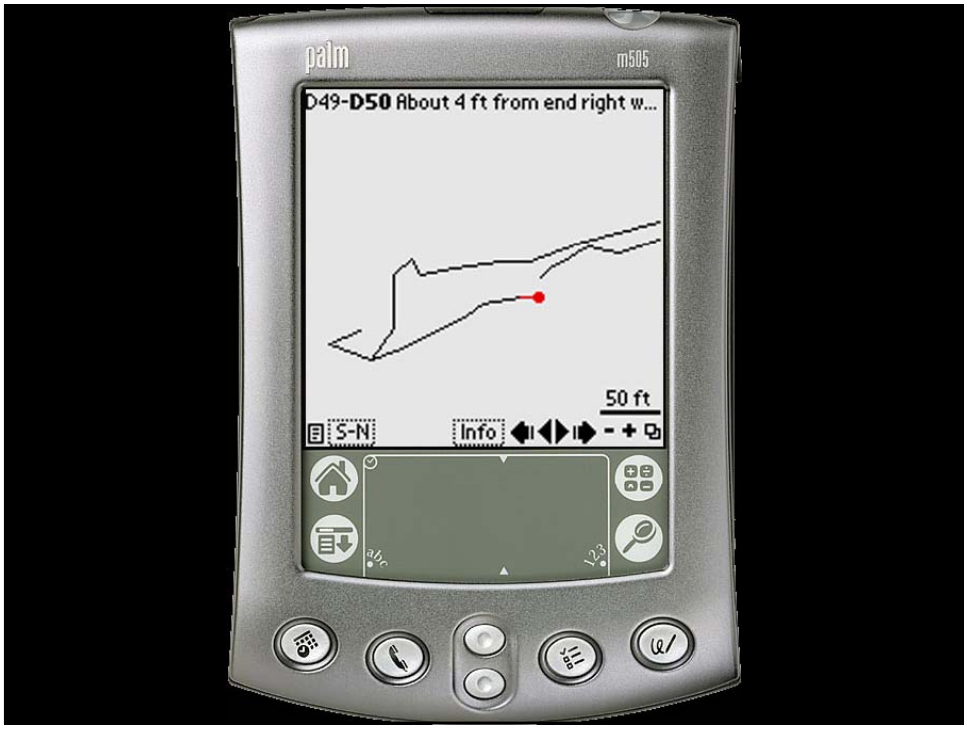

palm
m505
Sketch 1:240 (0.1 in grid)
S4 - S5
dX: 11
dY: 7
dZ: 3
dC: 13
dX: 0
dY: 0
dX: 0
dY: 0
dZ: 1
-1
OK
Shot...
Relative


palm
m505
500 ft
Top View
Pan


palm
m505
500 ft
S-N
Pan


palm
m505
Statistics
Development: 9,509.9 ft
Mapped length: 9,509.9 ft
Horizontal extent: 8,021.4 ft
Vertical extent: 1,226.9 ft
Survey shots: 385
Stations: 385
Sessions: 19
X min: -1168.6 max: 124.8
Y min: -2205.2 max: 87.4
Z min: -1226.9 max: 0.0
Computation: 3 s; 27.3 Kb
OK


palm
m505
Palm OS® Emulator
J18-J19
100 ft
Top View
Pan


palm
m505
D49-D50 About 4 ft from end right w...
50 ft
S-N
Info

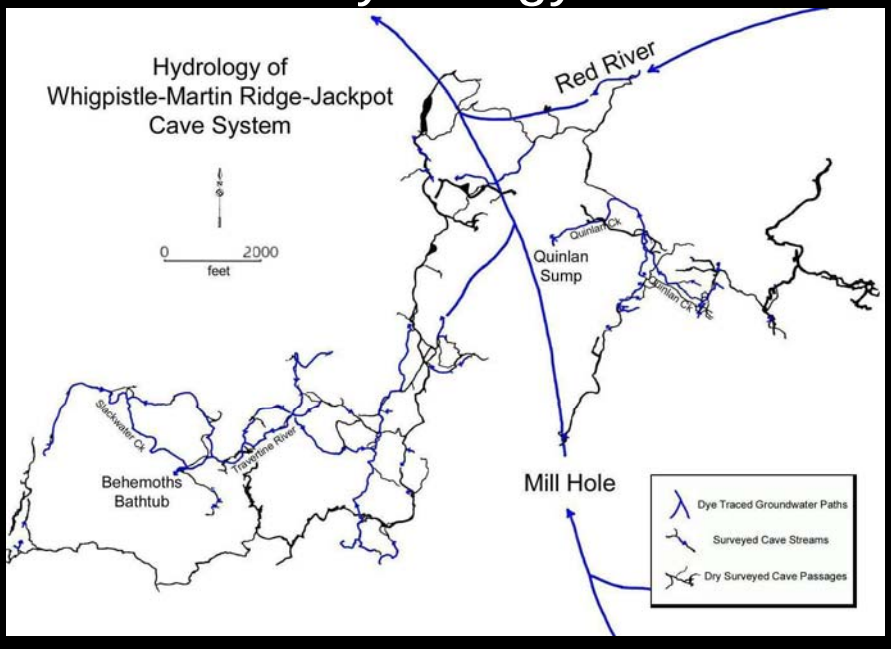

palm
m505
D47-D48
10 ft
285° 6.5 ft dX=6.3 ft dY=1.7 ft


palm
m515
Cave Options
Statistics...
Details... /D
Sessions...
Shot Errors...
Closure Errors...
Maintenance...
Export...
Close
Beam... /B

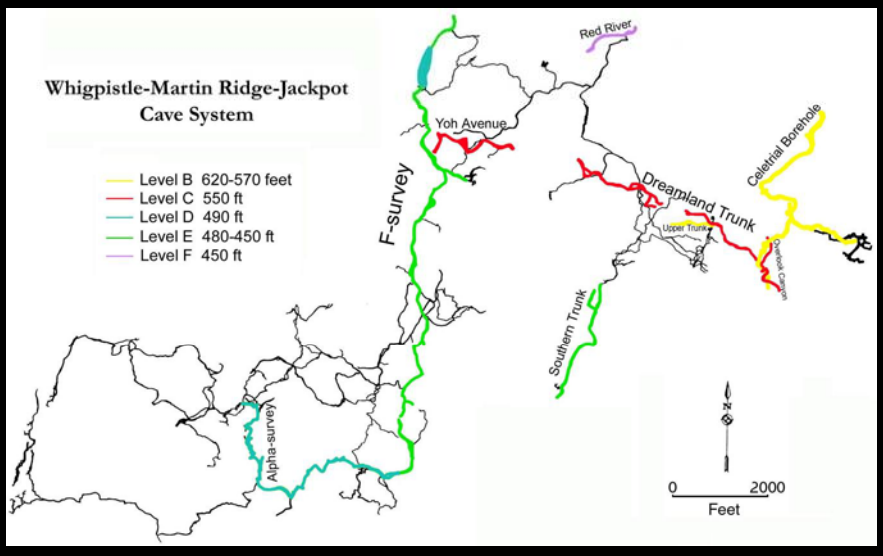

palm
m515
Export
Entire Cave
Current Session
Current Session + Shots
Current Series (Shots)
Survey Shots between
6/23/05 and 6/23/05
Current Survey Shot
Target Cave Name:
Main Drain
OK
Cancel


palm
m505
Main Drain Cave
Assistant
24.10
296.00
115.00
Direct
20.00
-20.00
Direct
6.00
D47
4.00
Pit Sounder
3.7 s
193 ft
Rock!
2 in
OK

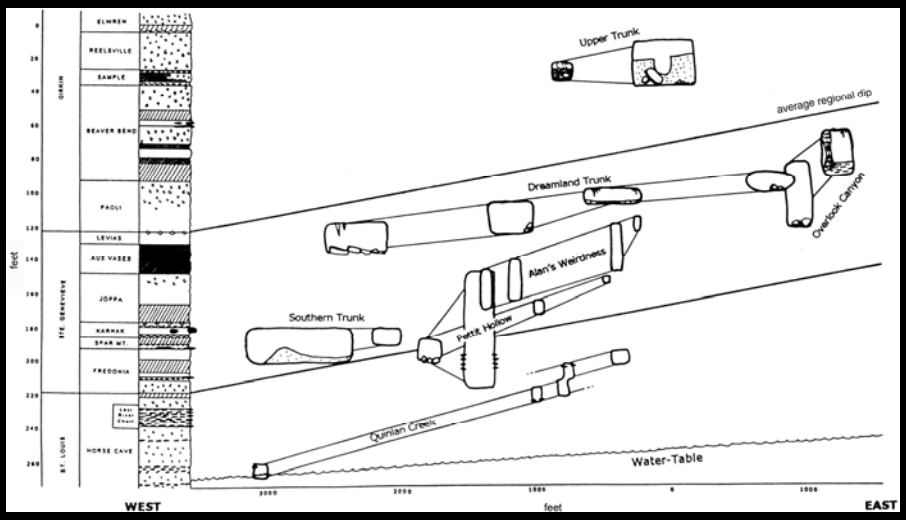
Hydrology



Cave Levels



Geology

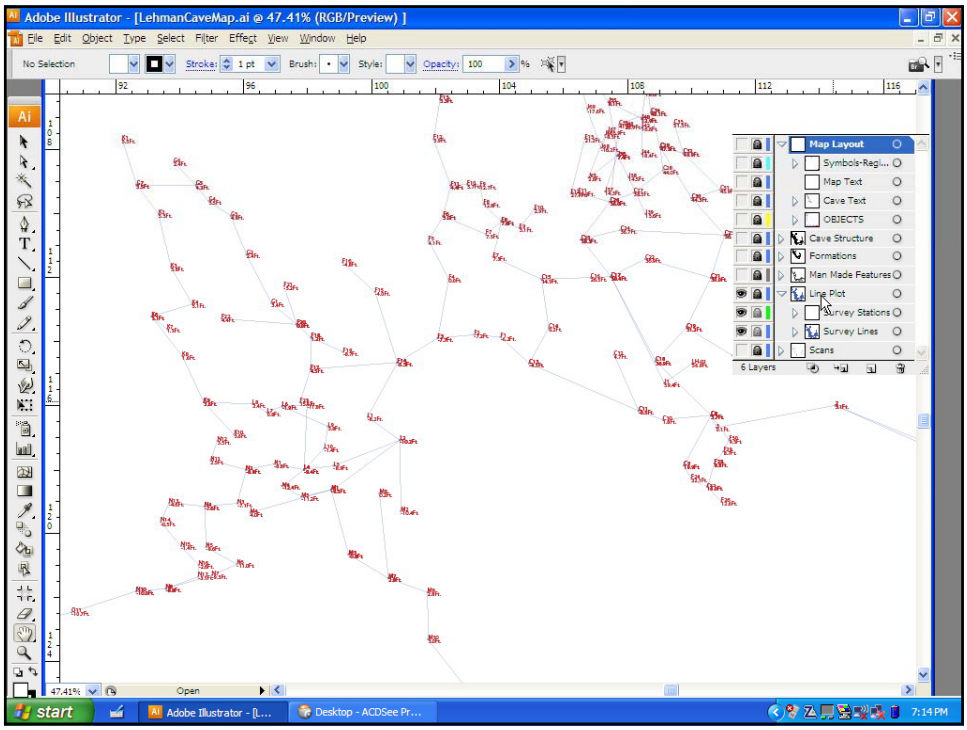


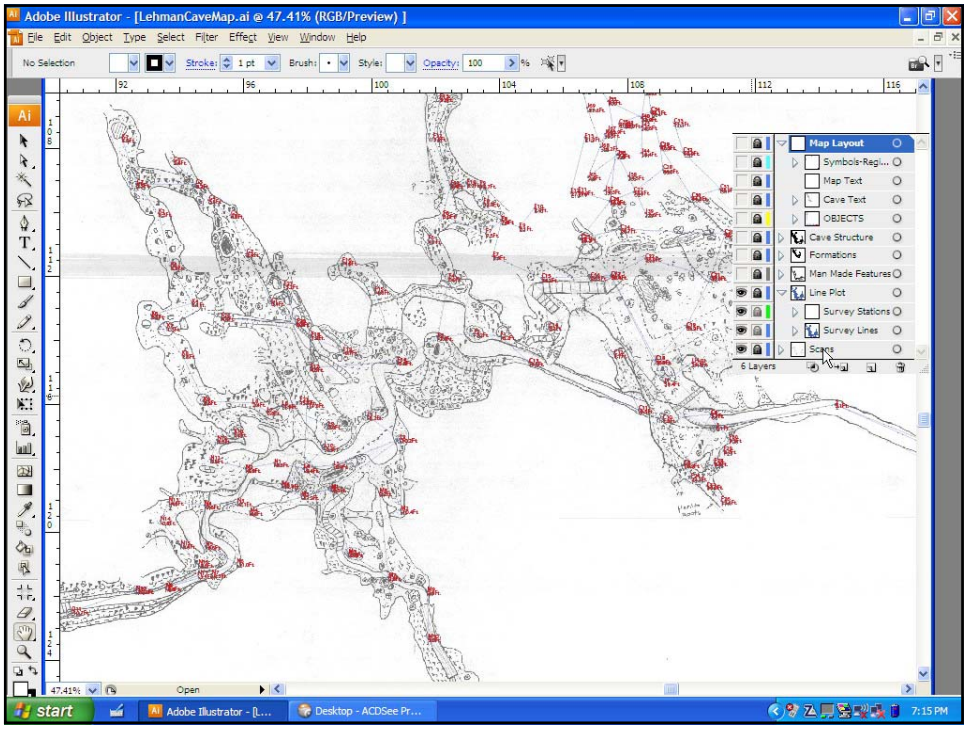
CAD vs Design

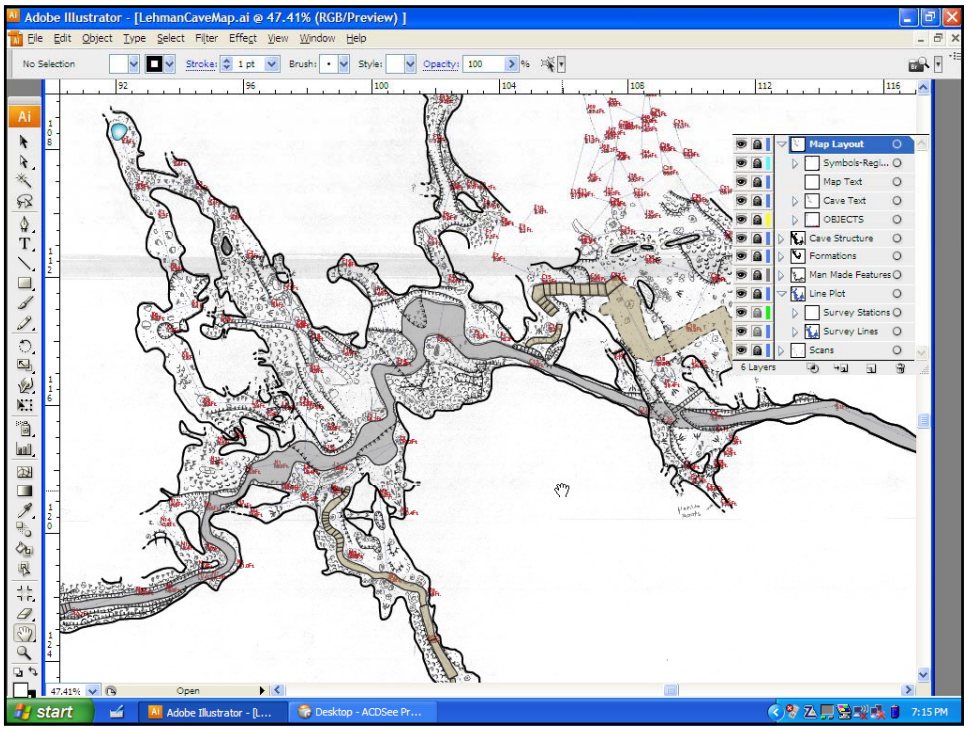
- Design drawing programs are easier to learn
- CAD programs have features for precise measurements

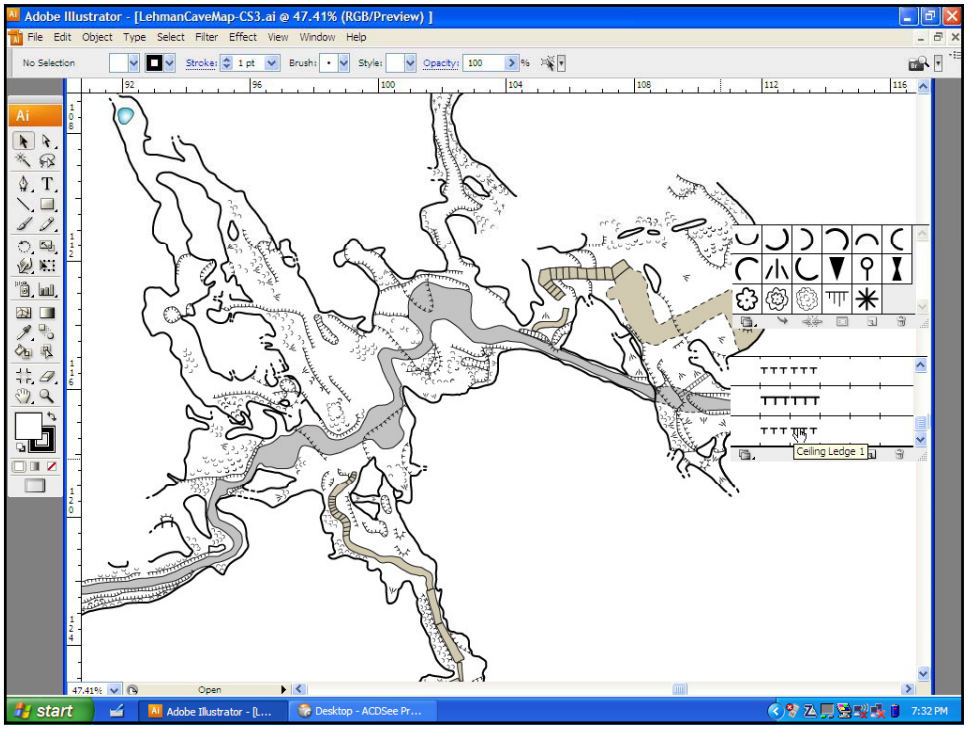
Benefits of Electronic Maps

- Scalable
- Easy to change or update
- Benefits of layers
- Cloning and drawing tools
- Easier product to share and continue to use



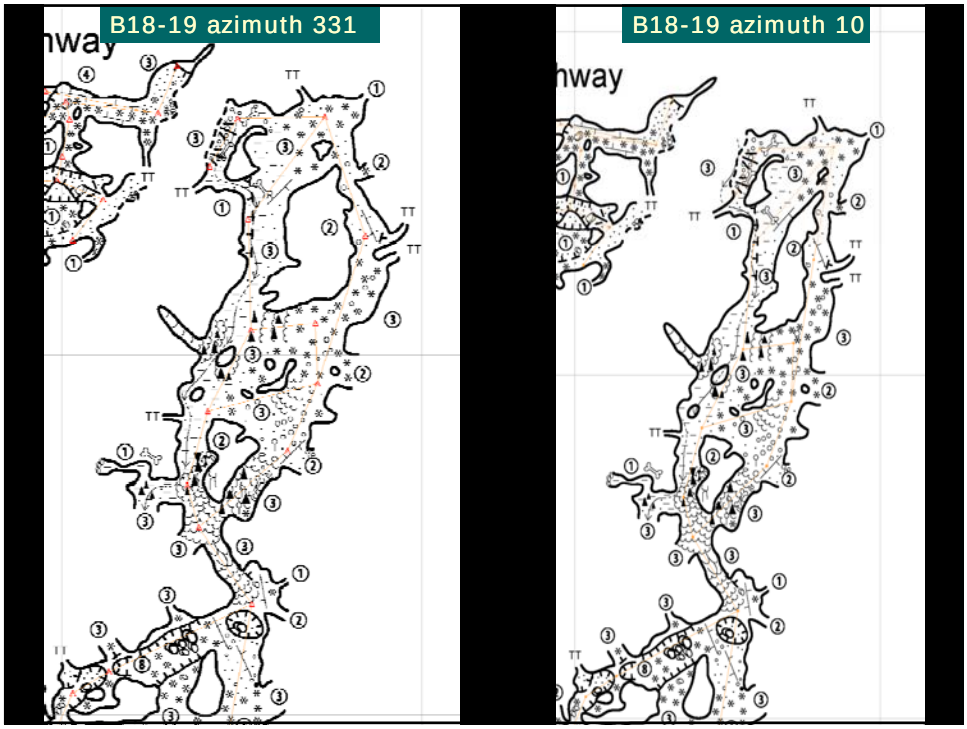

Adobe Illustrator - [LehmanCaveMap.ai @ 47.41% (RGB/Preview)]
File Edit Object Type Select Filter Effect View Window Help
Map Layout
Symbols-Regi...
Map Text
Cave Text
OBJECTS
Cave Structure
Formations
Man Made Features
Line Plot
Survey Stations
Survey Lines
Scans
6 Layers
start
Adobe Illustrator - [L...
Desktop - ACDSee Pr...
7:15 PM


Adobe Illustrator - [LehmanCaveMap.ai @ 47.41% (RGB/Preview)]
File Edit Object Type Select Filter Effect View Window Help
Map Layout
Symbols-Regi...
Map Text
Cave Text
OBJECTS
Cave Structure
Formations
Man Made Features
Line Plot
Survey Stations
Survey Lines
Scans
6 Layers
start
Adobe Illustrator - [L...
Desktop - ACDSee Pr...
7:15 PM



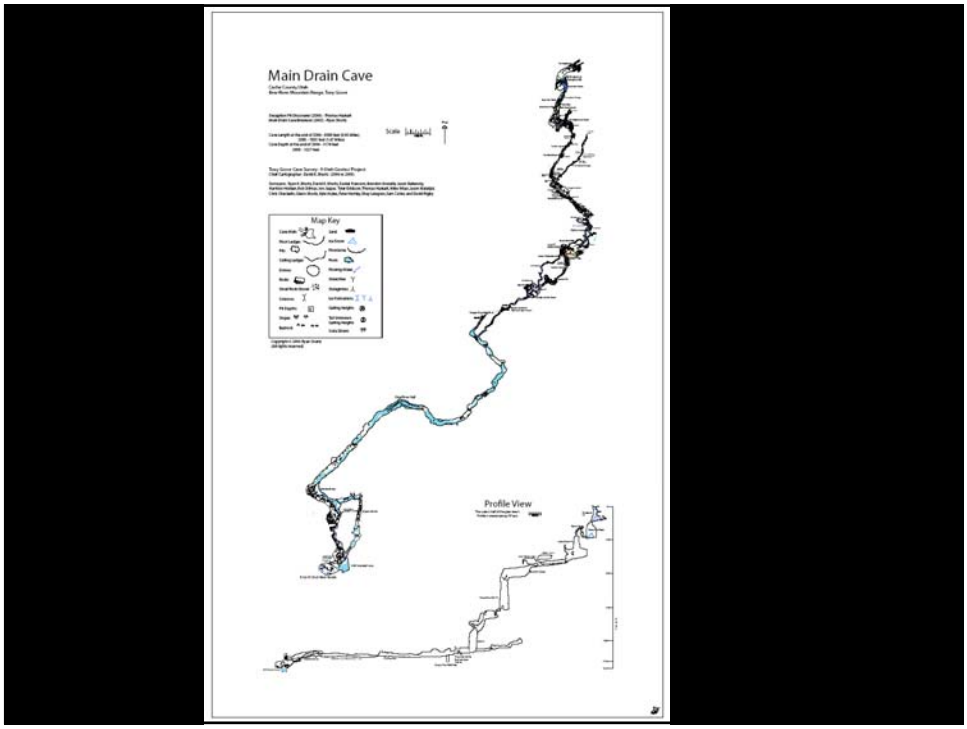
Roundtripping

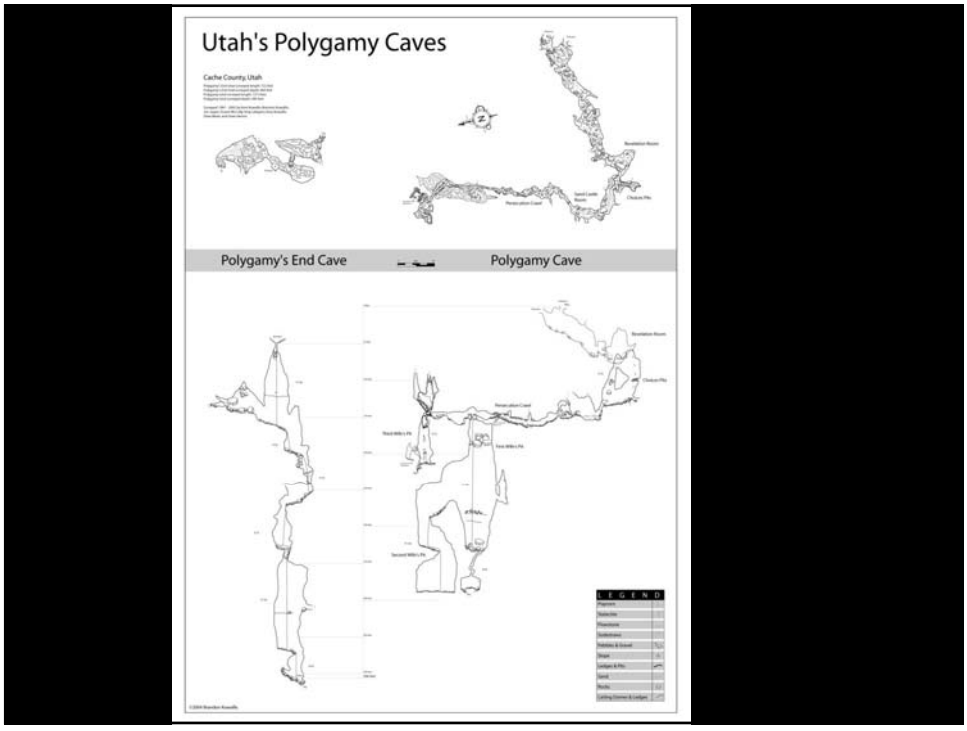
- Lineplot exported from Walls as a Scalable Vector Graphic (SVG) into Adobe Illustrator
- Map created in Adobe Illustrator using scanned survey notes
- Map saved from Illustrator as SVG
- New survey data added to Walls new loop closures created and lineplot shifts
- Walls modifies map from Illustrator SVG to match new survey data and exports the new data and map into Illustrator

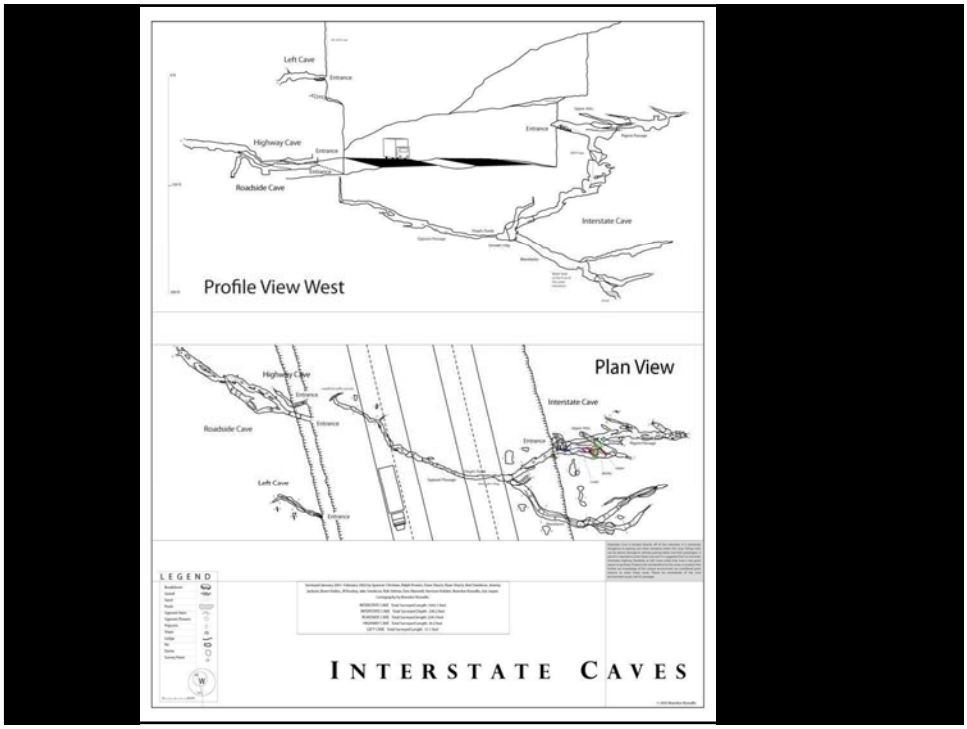


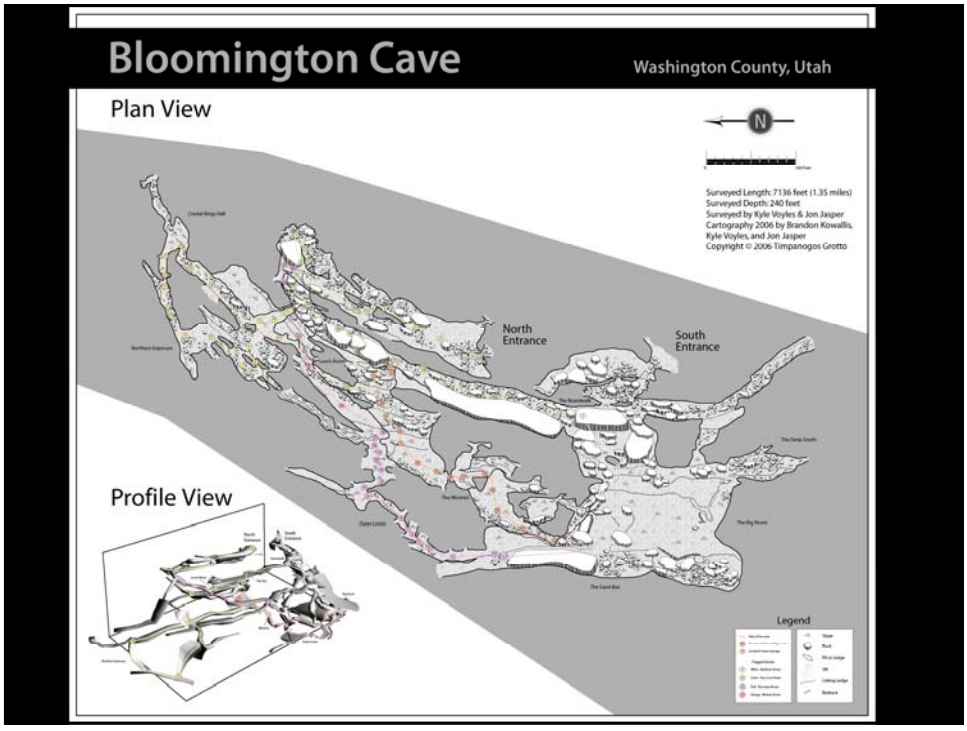
Uses of Cave Maps

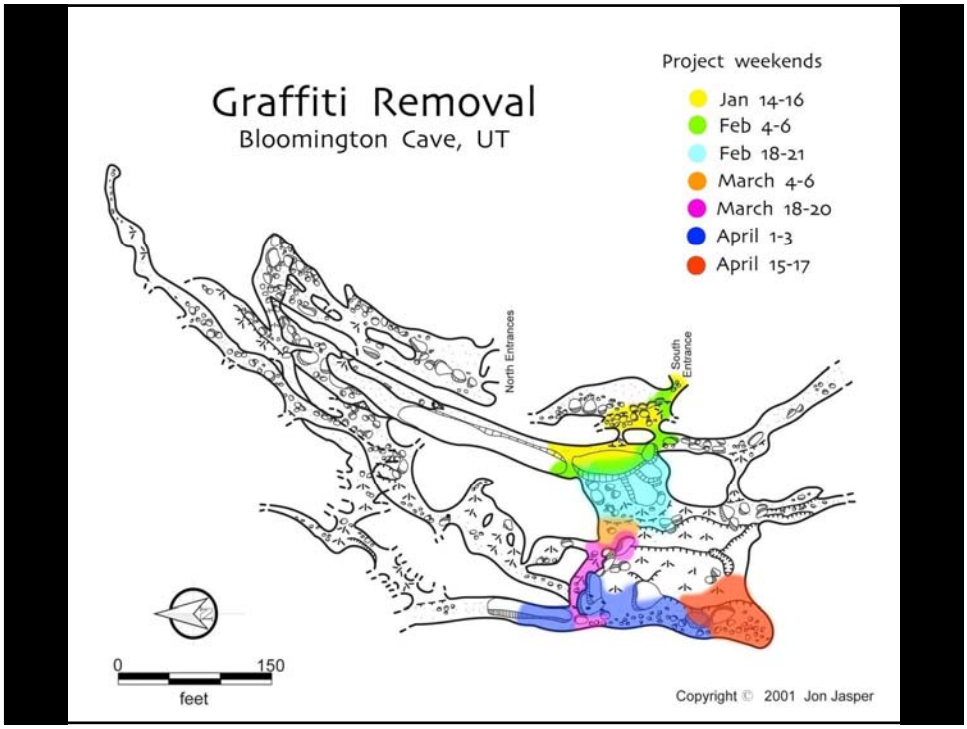
- Show extent of known/explored passages
- Show how passages are related
- Show how surface is related
- Outline trails
- Show management actions
- Interpretative Exhibits
- Aid in inventories

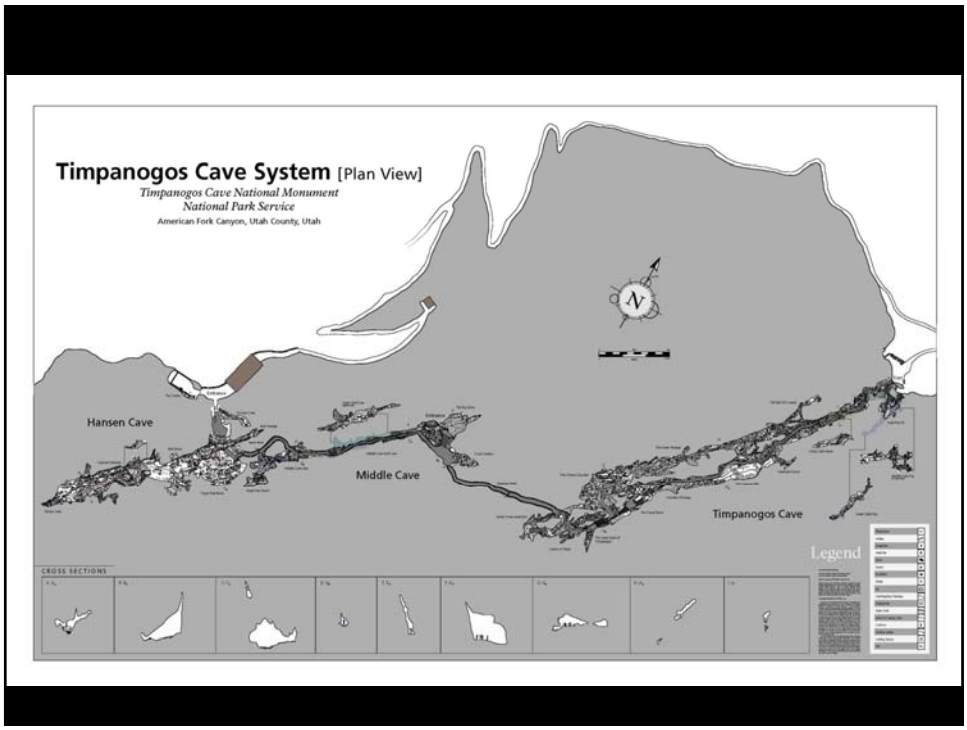

Main Drain Cave
Map Key
Profile View

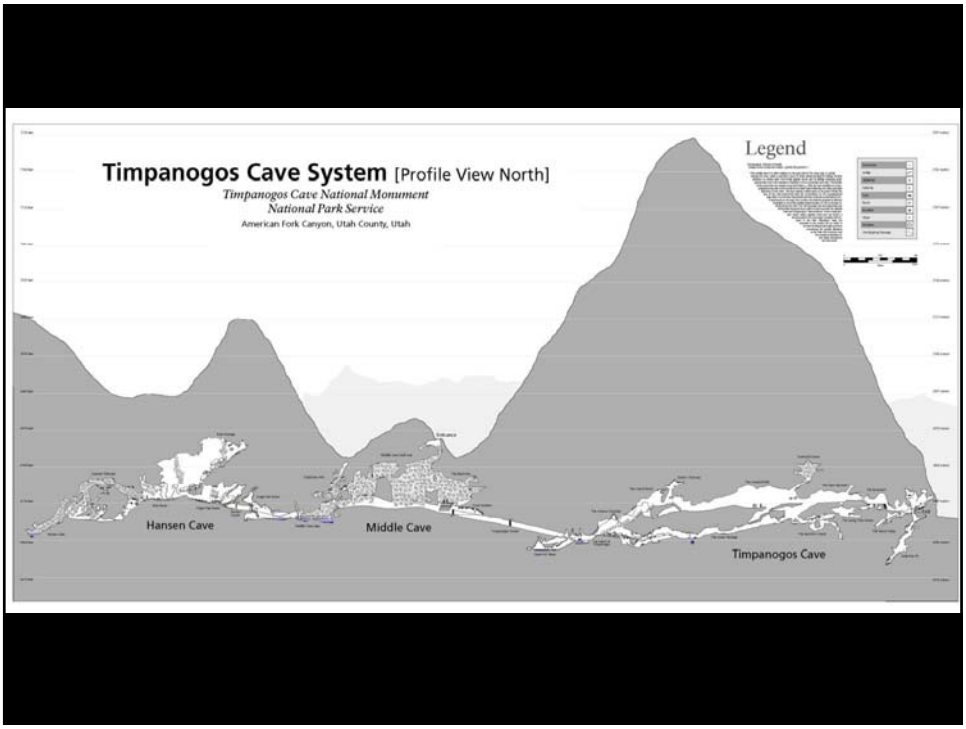

Utah's Polygamy Caves
Cache County, Utah
Polygamy's End Cave
Polygamy Cave
LEGEND


Left Cave
Entrance
Highway Cave
Entrance
Entrance
Roadside Cave
Entrance
Interstate Cave
Profile View West
Plan View
Highway Cave
Entrance
Roadside Cave
Entrance
Interstate Cave
Entrance
Left Cave
Entrance
LEGEND
INTERSTATE CAVES

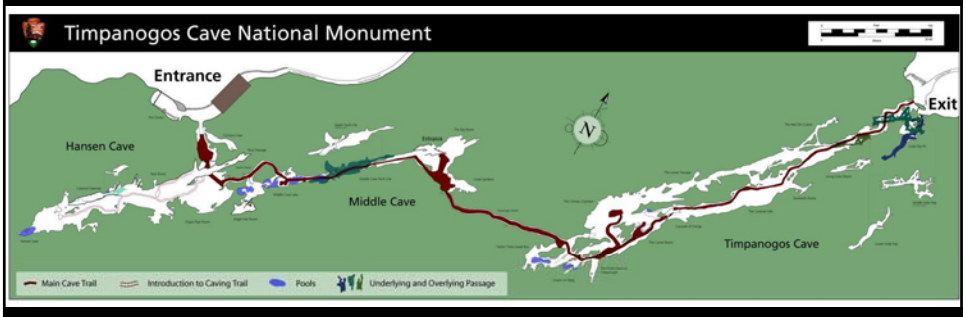

Bloomington Cave
Washington County, Utah
Plan View
N
Surveyed Length: 7136 feet (1.35 miles)
Surveyed Depth: 240 feet
Surveyed by Kyle Voyles & Jon Jasper
Cartography 2006 by Brandon Kowallis,
Kyle Voyles, and Jon Jasper
Copyright © 2006 Timpanogos Grotto
North Entrance
South Entrance
Profile View
Legend


Graffiti Removal
Bloomington Cave, UT
Project weekends
Jan 14-16
Feb 4-6
Feb 18-21
March 4-6
March 18-20
April 1-3
April 15-17
North Entrances
South Entrance
0
150
feet
Copyright © 2001 Jon Jasper

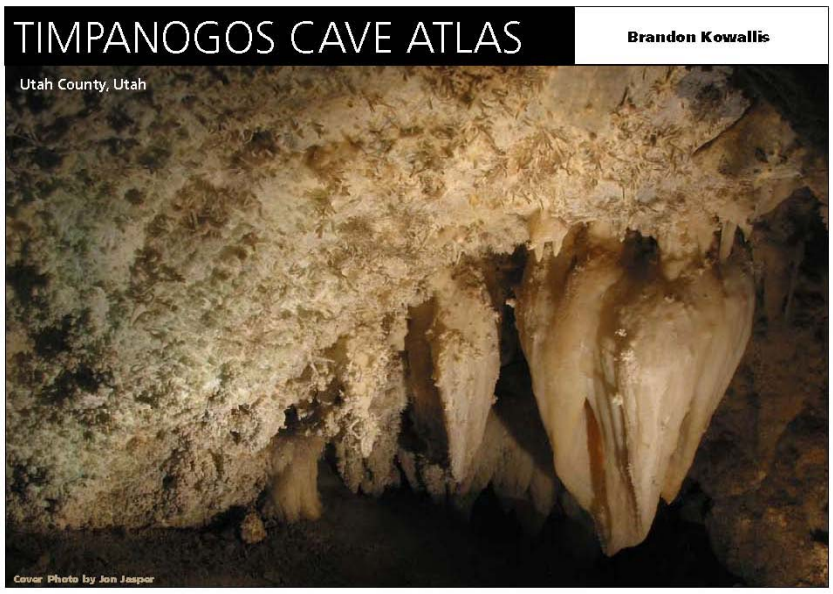

Timpanogos Cave System [Plan View]
Timpanogos Cave National Monument
National Park Service
American Fork Canyon, Utah County, Utah
Hansen Cave
Middle Cave
Timpanogos Cave
Legend
CROSS SECTIONS



Interpretative Maps



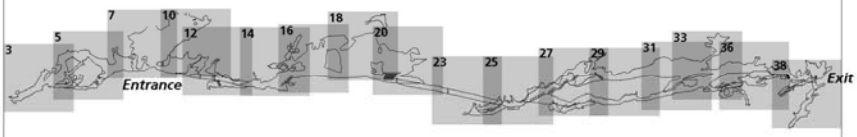
For Interpretative Displays



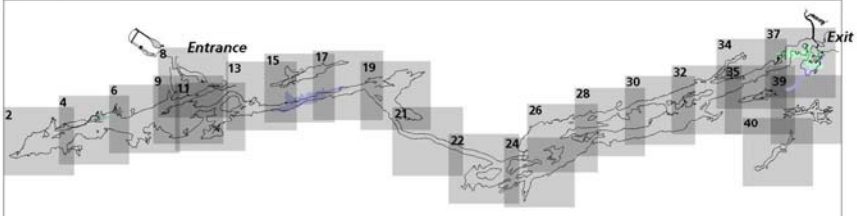
TIMPANOGOS CAVE ATLAS

Brandon Kowallis

Profile View North

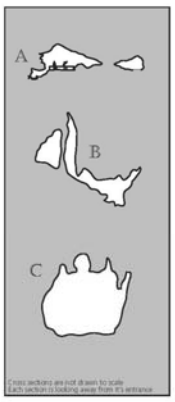


Plan View



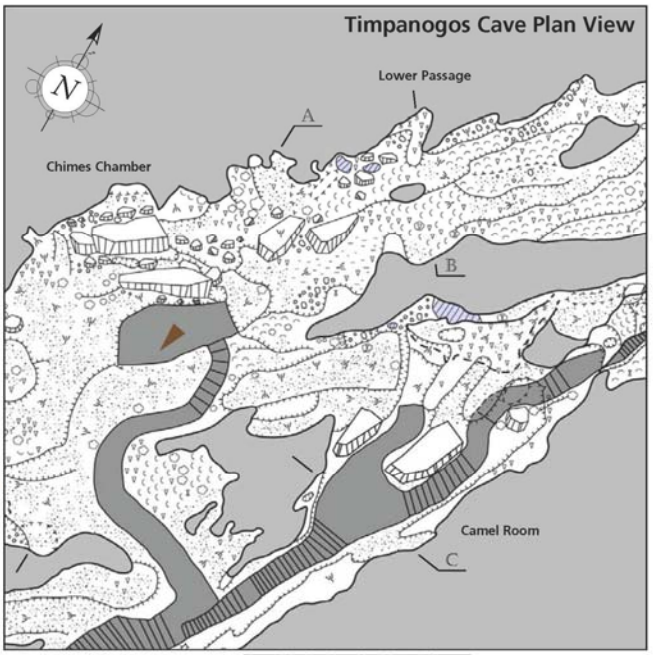
This atlas has been created from the full scale map of theTimpanogos Cave System in order to provide a quick and easy to use reference guide of the cave for resource management and maintenance purposes, as well as to help answer questions regarding the behavior of the many restricted areas. **It is not to be used as a navigation guide for recreational caving. Never venture off the main trail unless you have a good reason that is both approved by the Monument Supervisors and beneficial to the cave.**

Each gray square quadrant above is numbered according to a page in the atlas. The plan view is a birds-eye view and the profile view is a side view. Each page contains the expanded section of the map, a photograph of the area, a scale bar, a north arrow for plan view sections, a small map showing the quadrant you are viewing, and a legend explaining the symbols used throughout the atlas. The Timpanogos Cave System was surveyed by Rodney D. Horrocks from 1991 to 1993 and the map was created, designed, and drafted during the summer of 2003 by Brandon K. Kowallis.



Cross sections are not drawn to scale
Each section is looking away from it's entrance

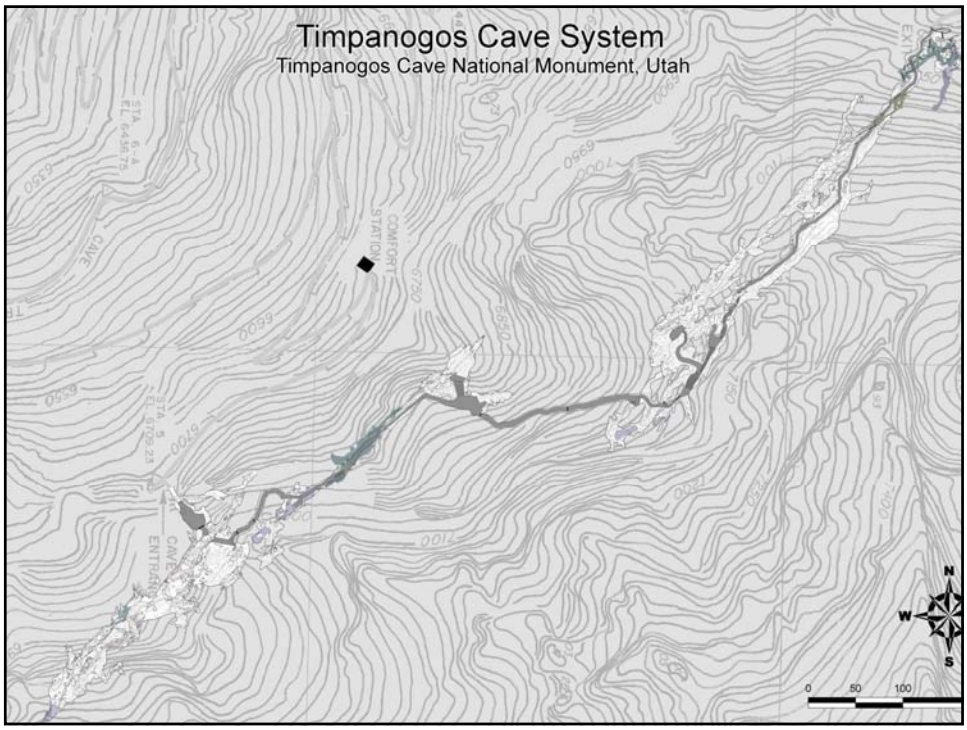
Formation covered ceiling in the Chimes Chamber. NPS Photo.

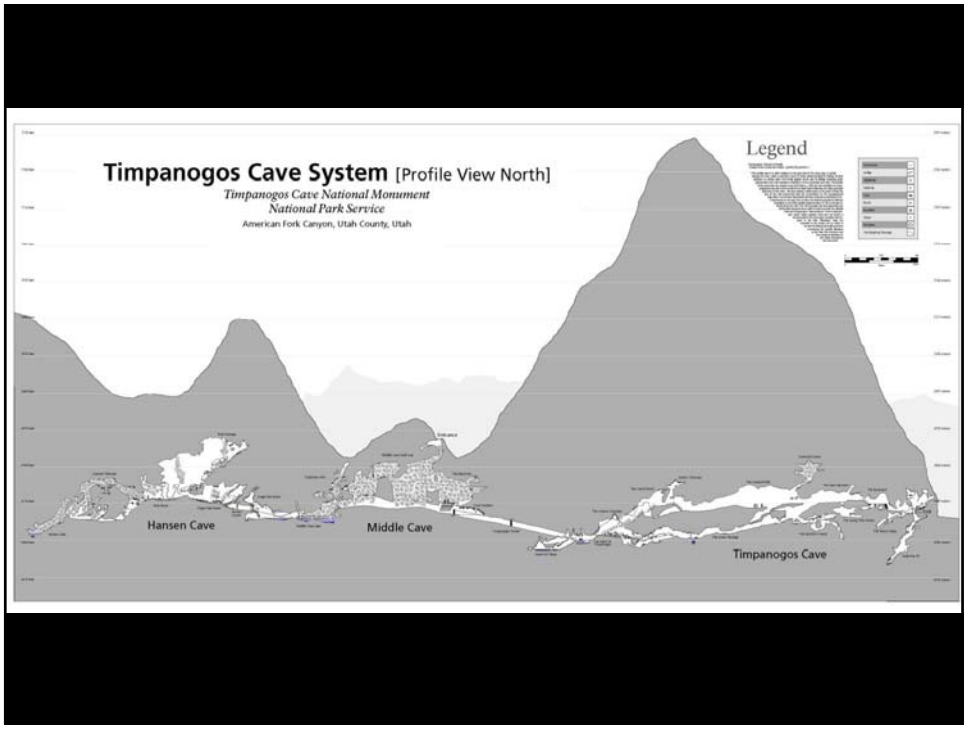


24 < Continued on Page > 28

Using GIS to incorporate multiple sources of data

- Basic topographic overlays
- Inventory caves within GIS - ArcPAD
- Adding other data sources
  - Aerial photos
  - Hydrology
  - Geology
  - Land uses
- Using 3D visualizations




Timpanogos Cave System [Profile View North]
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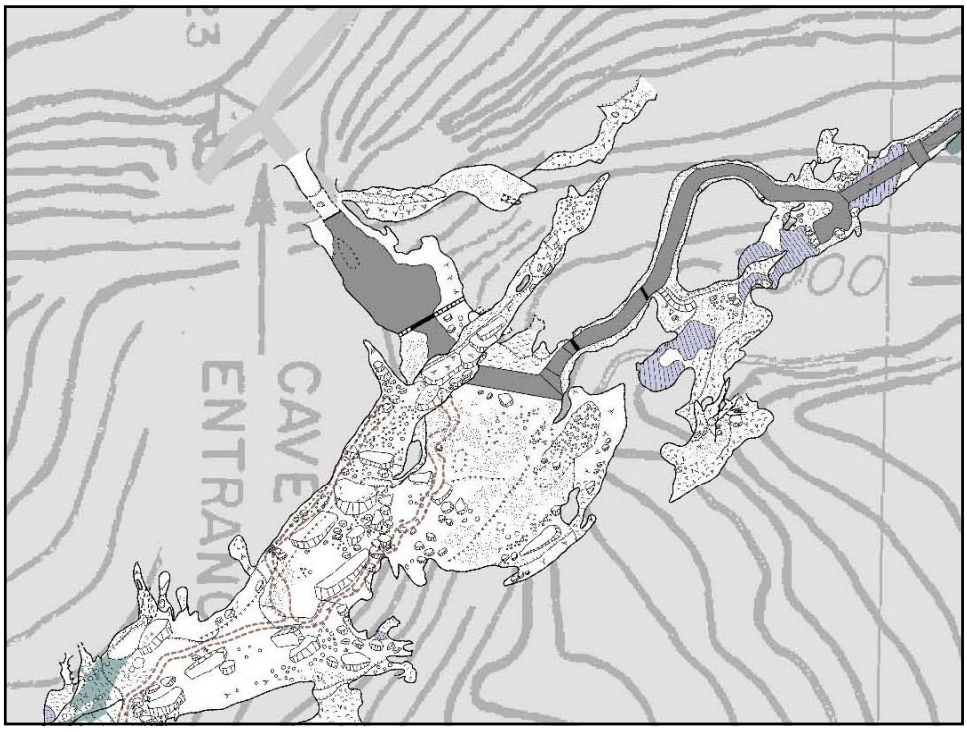
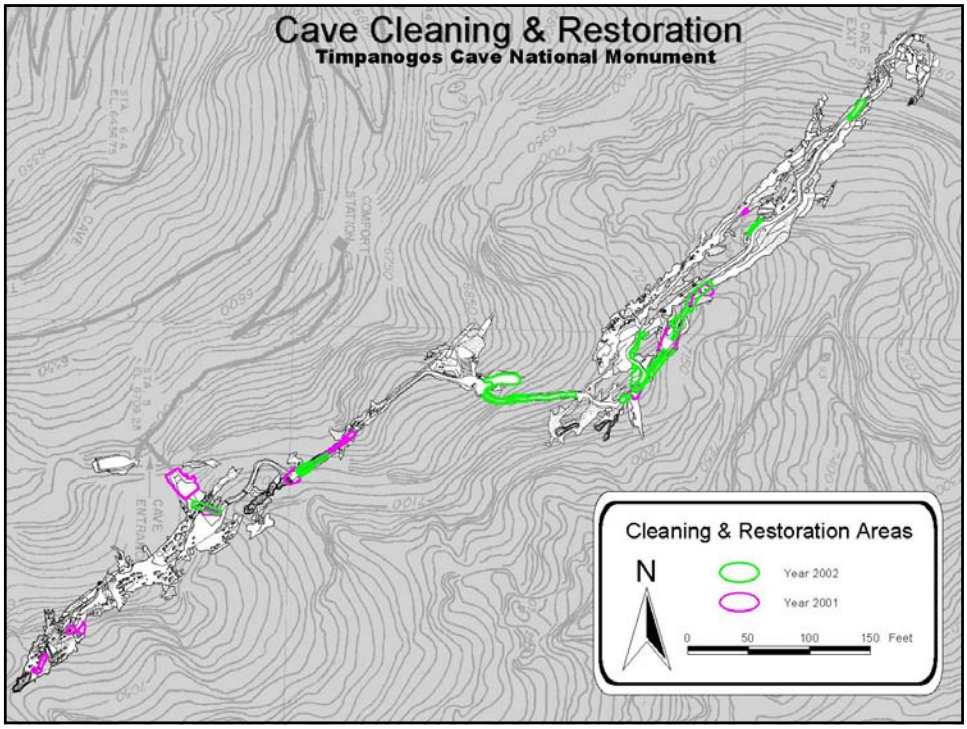
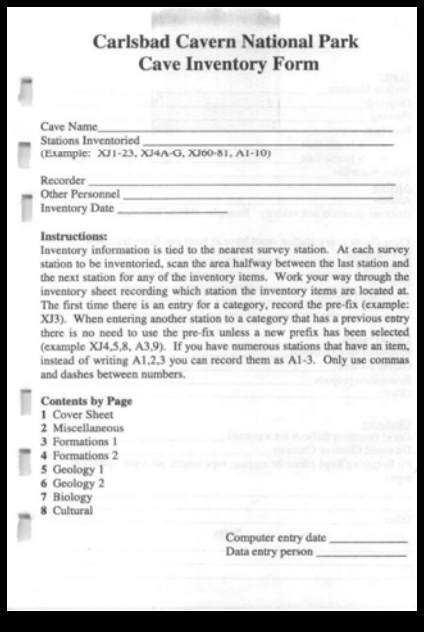

CAVE
ENTRANCE



Cave Inventory



Carlsbad Cavern National Park
Cave Inventory Form

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(Example: XJ1-23, XJ4A-G, XJ60-81, A1-10)

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Data entry person _____

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Dripping _____
Flowing _____
Pool (note size)
- < 1cubic foot_____
- > 1cubic foot_____

Paleo-Waterline _____

Airflow
Airflow _____
(Indicate direction and velocity. Example: B45 to B46, faint)

Floor (!note every station must have at least one floor feature!)
Sediment/Soil _____
Breakdown _____
Bedrock _____
Secondary Deposits _____
Pit _____

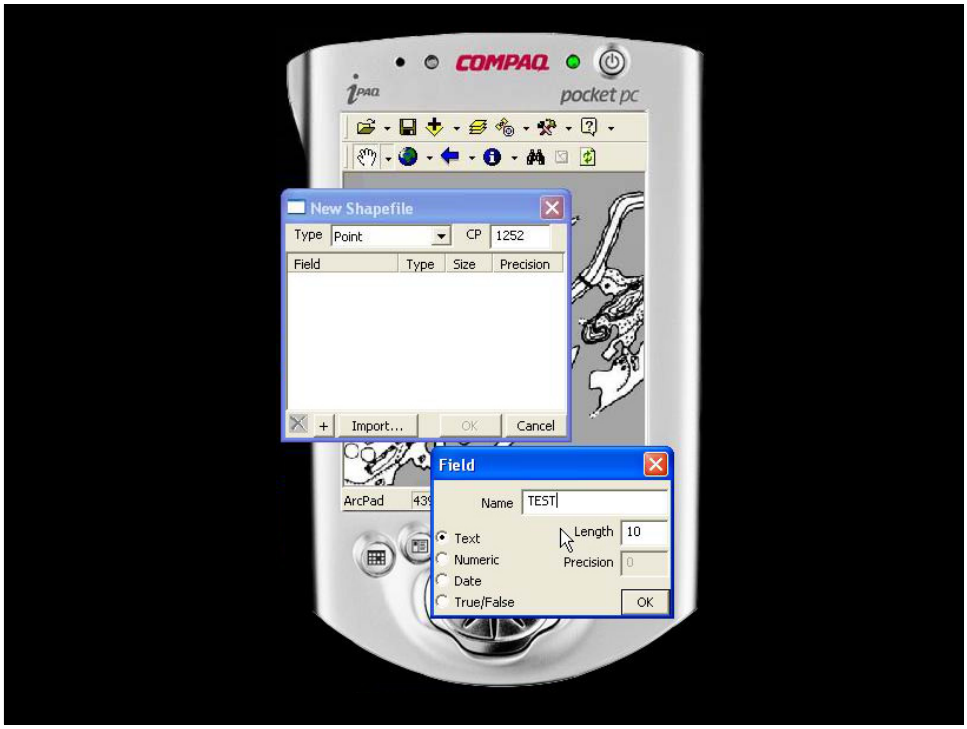
Conservation
Flowstone shoes required_____
Gloves off area_____
Restoration projects _____
Other_____

Obstacles
Crawl (anything difficult for a rescue) _____
Un-roped Climb or Chimney_____
Pit Requiring Rope (describe rigging, rope length, pit depth, quality of rope)
_____
_____
Other_____

Notes
_____
_____
_____


COMPAQ
pocket pc
ArcPad
439731.5 4476360.9 ?
1:542

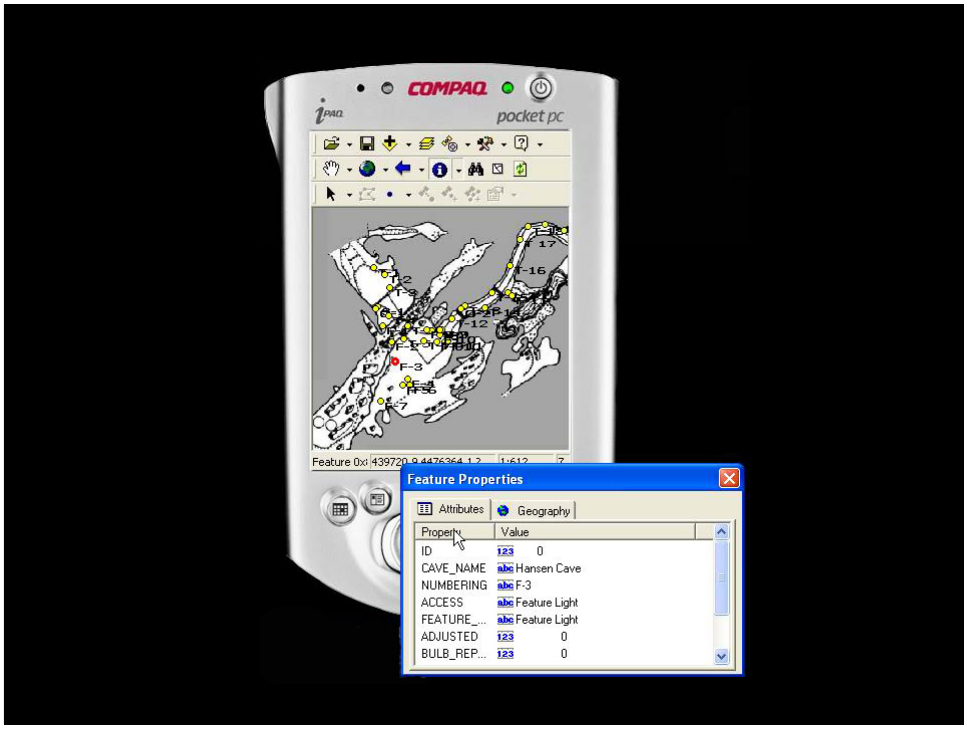

COMPAQ
pocket pc
New Map...
New Layer...
Open Map...
Save Map
Save Map As...
Map Properties...
Recent Maps
Exit Ctrl-Q
Create new
439709.4 4476363.9 ?
1:555

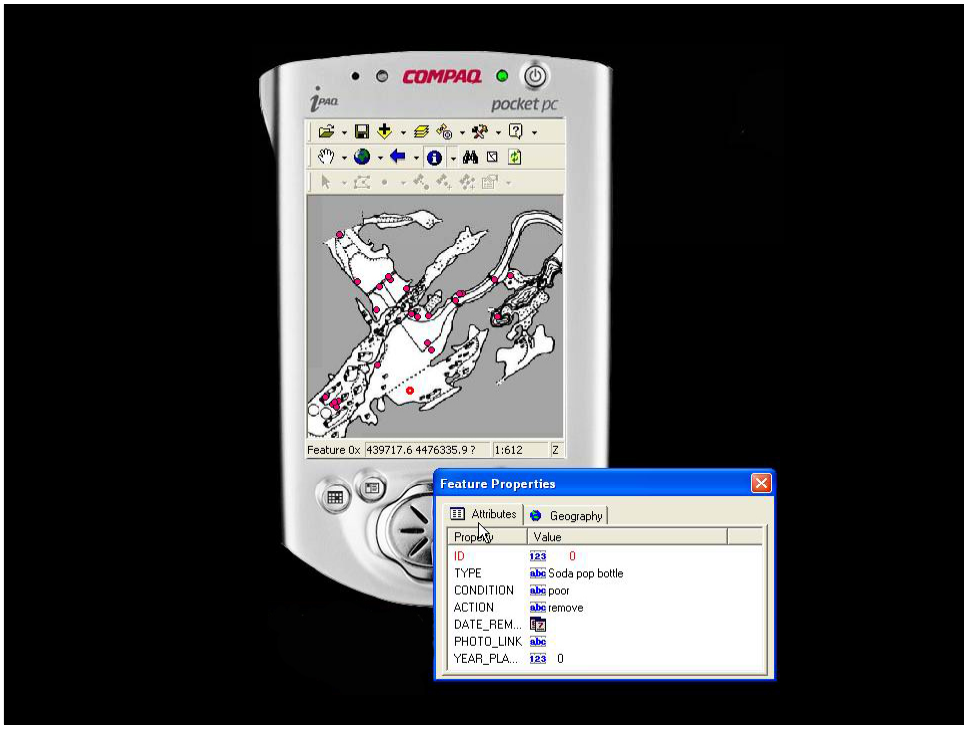

COMPAQ
pocket pc
New Shapefile
Type
Point
CP
1252
Field
Type
Size
Precision
Import...
OK
Cancel
Field
Name
TEST
Text
Numeric
Date
True/False
Length
10
Precision
0
OK
ArcPad

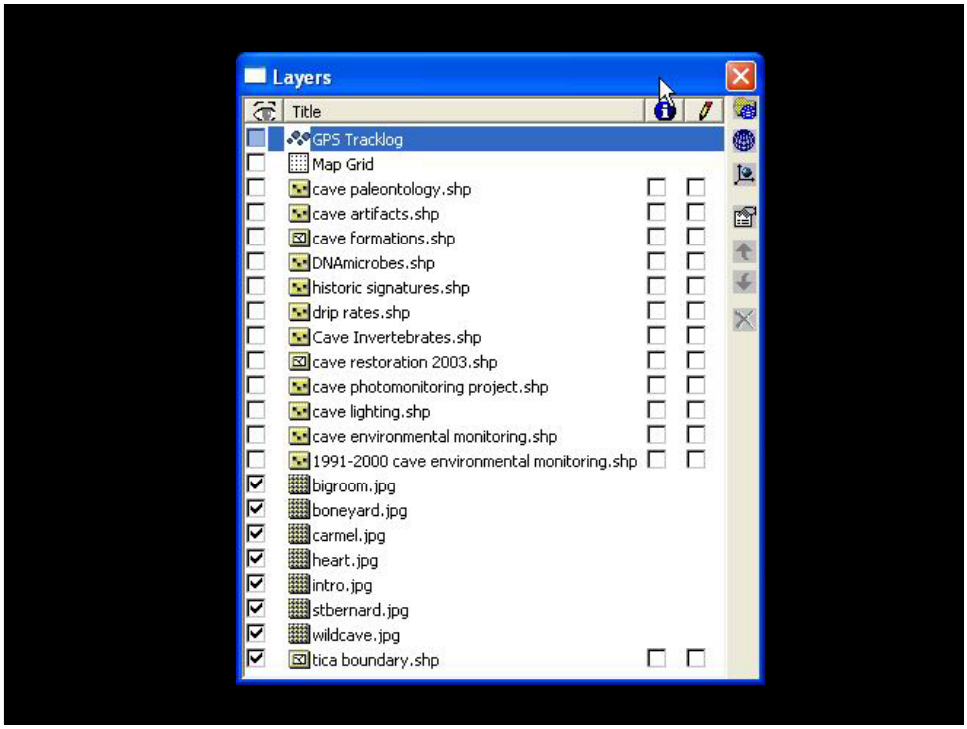

COMPAQ
pocket pc
Layers
Title
GPS Tracklog
Map Grid
Test.shp
cave paleontolog...
cave artifacts.shp
cave formations.shp
DNAmicrobes.shp
ArcPad
439725.7 4476367.7 ?
1:612

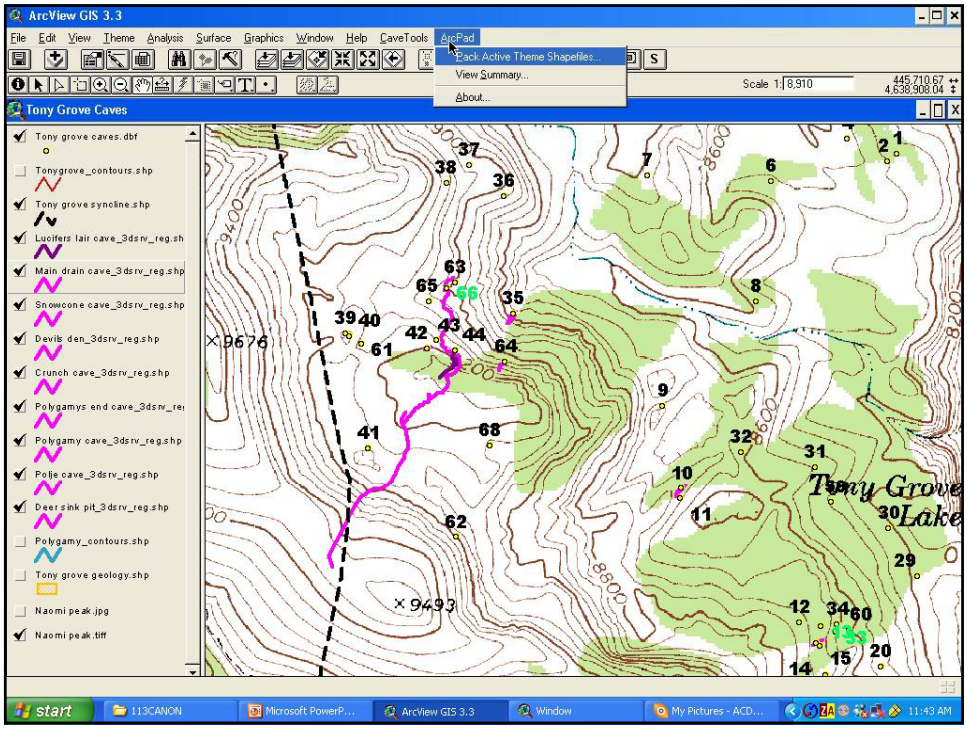

COMPAQ
pocket pc
ArcPad
439718.1 4476343.7 ?
1:612

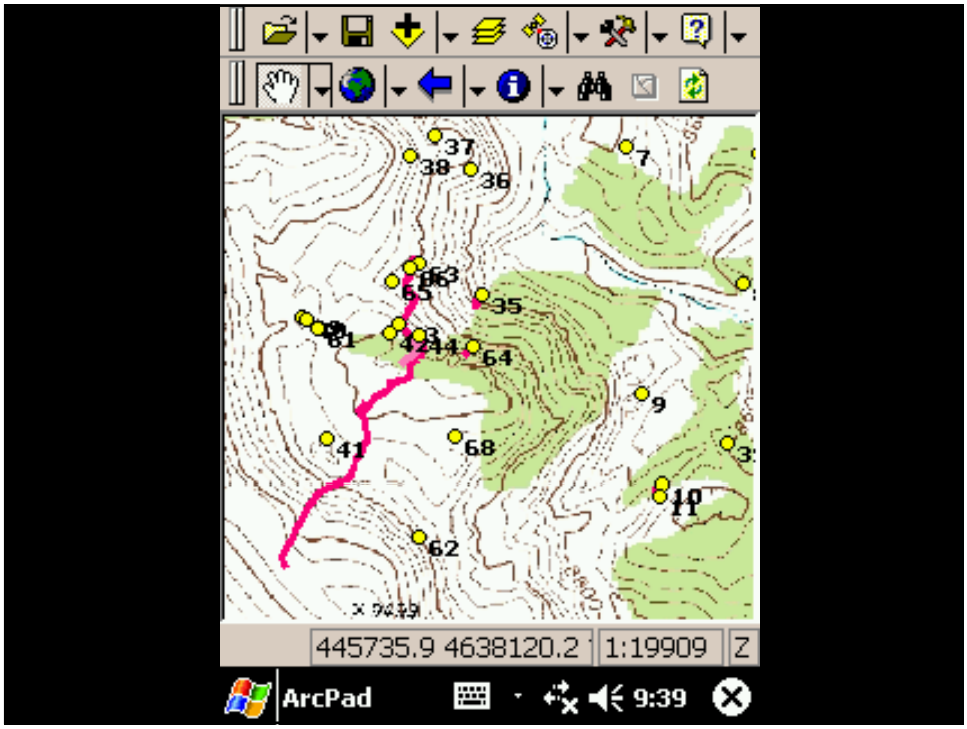

COMPAQ
pocket pc
Feature Properties
Attributes
Geography
Property
Value
TEST
OK
Cancel
ArcPad
439718.8 4476343.0 ?
1:612


COMPAQ
pocket pc
Feature Properties
Attributes
Geography
Property
Value
ID 123 0
CAVE_NAME abc Hansen Cave
NUMBERING abc F-3
ACCESS abc Feature Light
FEATURE_... abc Feature Light
ADJUSTED 123 0
BULB_REP... 123 0


COMPAQ
pocket pc
Feature 0x 439717.6 4476335.9 ? 1:612
Feature Properties
Attributes
Geography
Property
Value
ID 123 0
TYPE abc Soda pop bottle
CONDITION abc poor
ACTION abc remove
DATE_REM...
PHOTO_LINK abc
YEAR_PLA... 123 0


Layers
Title
GPS Tracklog
Map Grid
cave paleontology.shp
cave artifacts.shp
cave formations.shp
DNAmicrobes.shp
historic signatures.shp
drip rates.shp
Cave Invertebrates.shp
cave restoration 2003.shp
cave photomonitoring project.shp
cave lighting.shp
cave environmental monitoring.shp
1991-2000 cave environmental monitoring.shp
bigroom.jpg
boneyard.jpg
carmel.jpg
heart.jpg
intro.jpg
stbernard.jpg
wildcave.jpg
tica boundary.shp


ArcView GIS 3.3
File Edit View Theme Analysis Surface Graphics Window Help CaveTools ArcPad
Tony Grove Caves
Tony grove caves.dbf
Tonygrove_contours.shp
Tony grove syncline.shp
Main drain cave_3dsrv_reg.shp
Polygamy_contours.shp
Tony grove geology.shp
Naomi peak.jpg
Naomi peak.tiff
Tony Grove Lake
start


37
38
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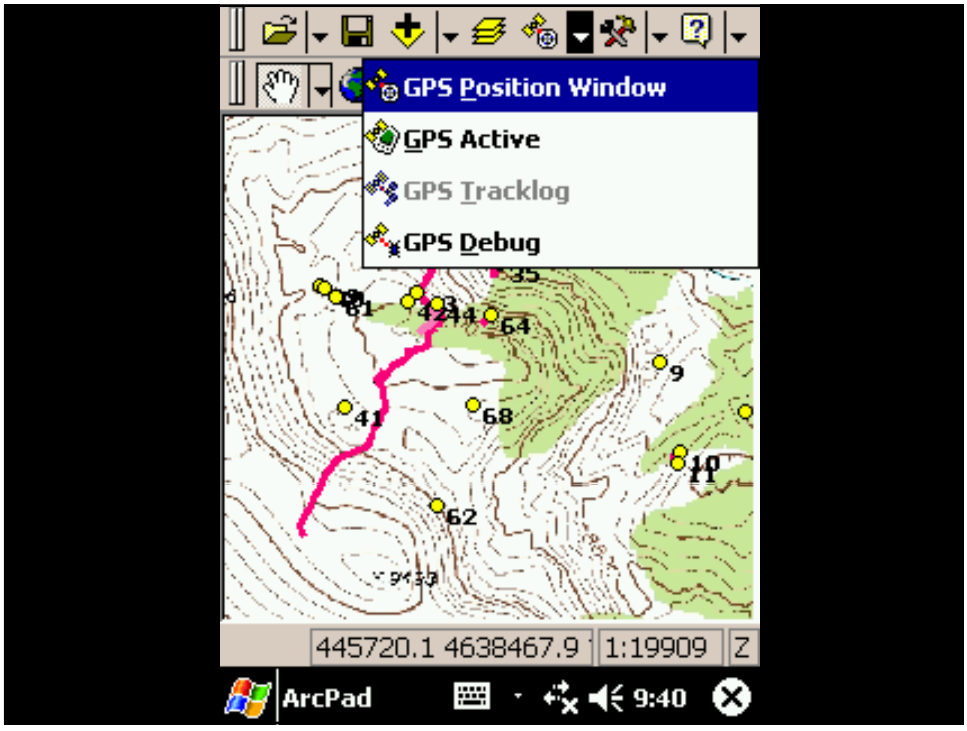
Z
ArcPad
9:39


GPS Position Window
GPS Active
GPS Tracklog
GPS Debug
35
64
9
41
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62
445720.1 4638467.9
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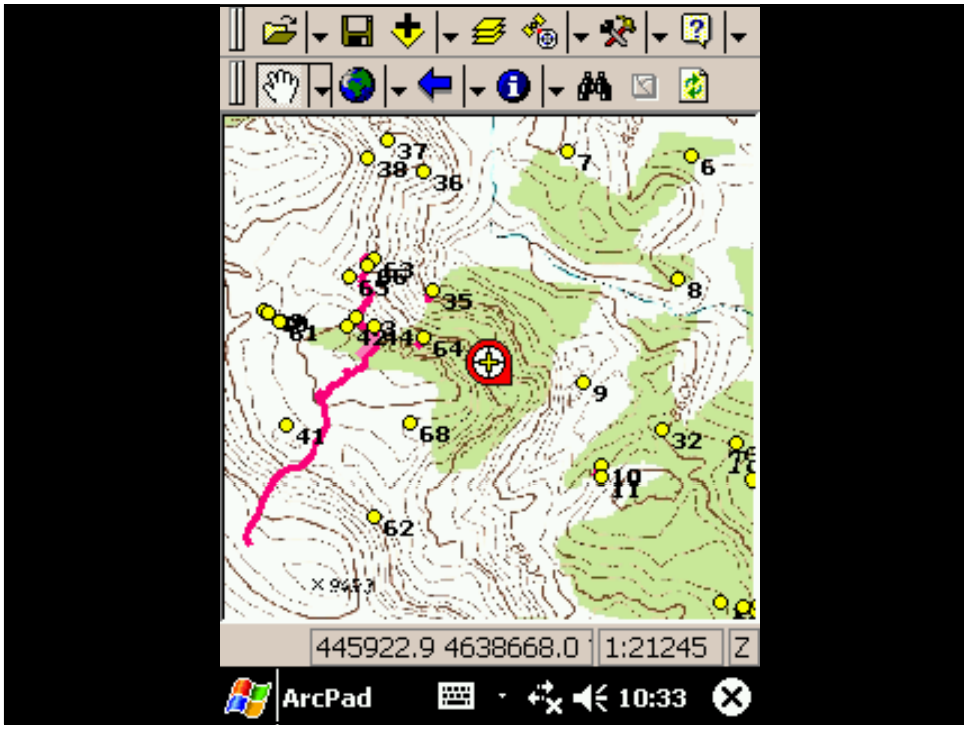
Z
ArcPad
9:40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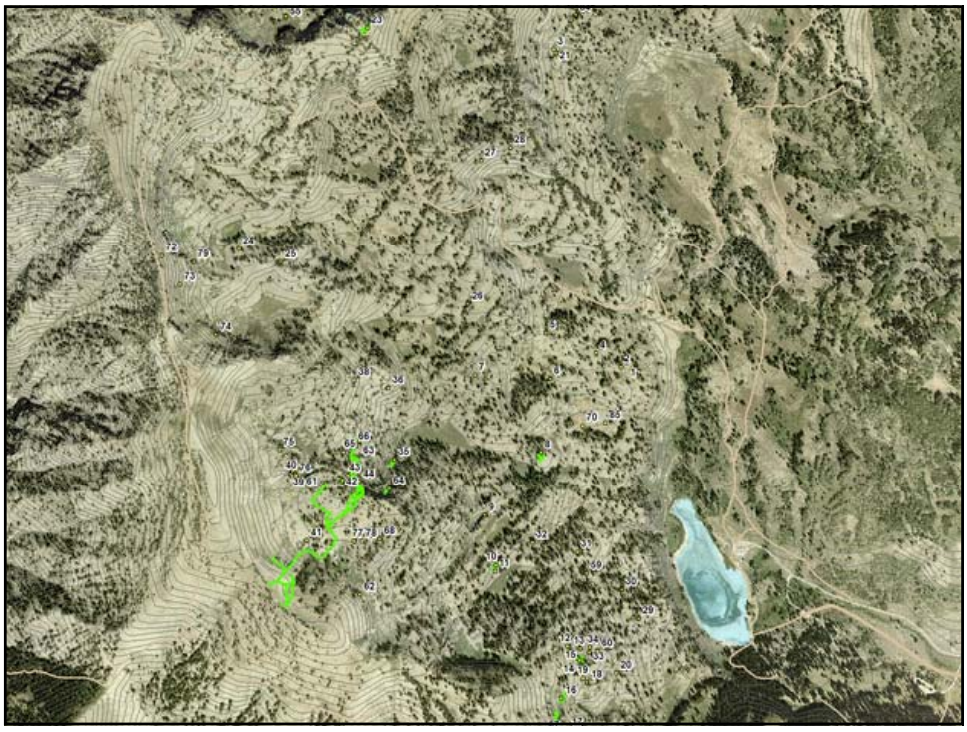
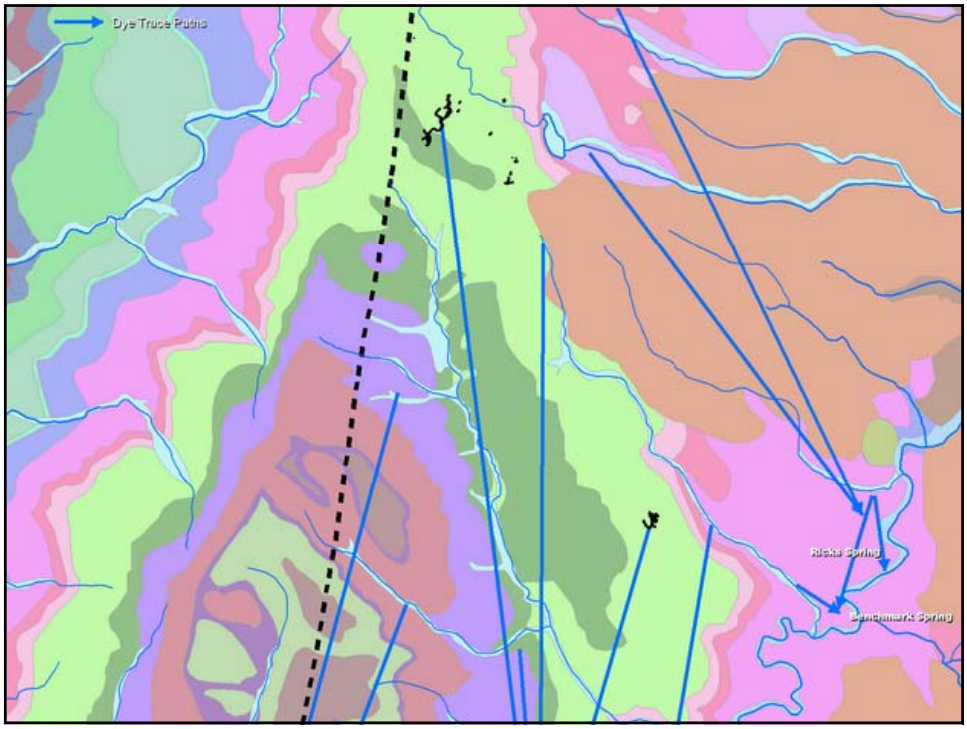
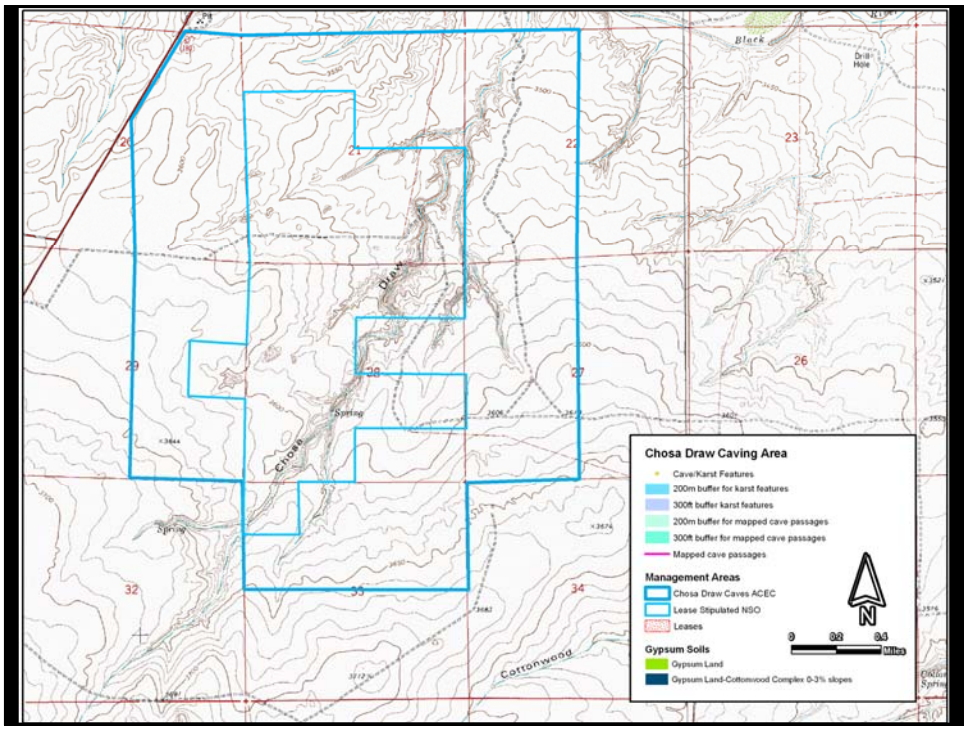
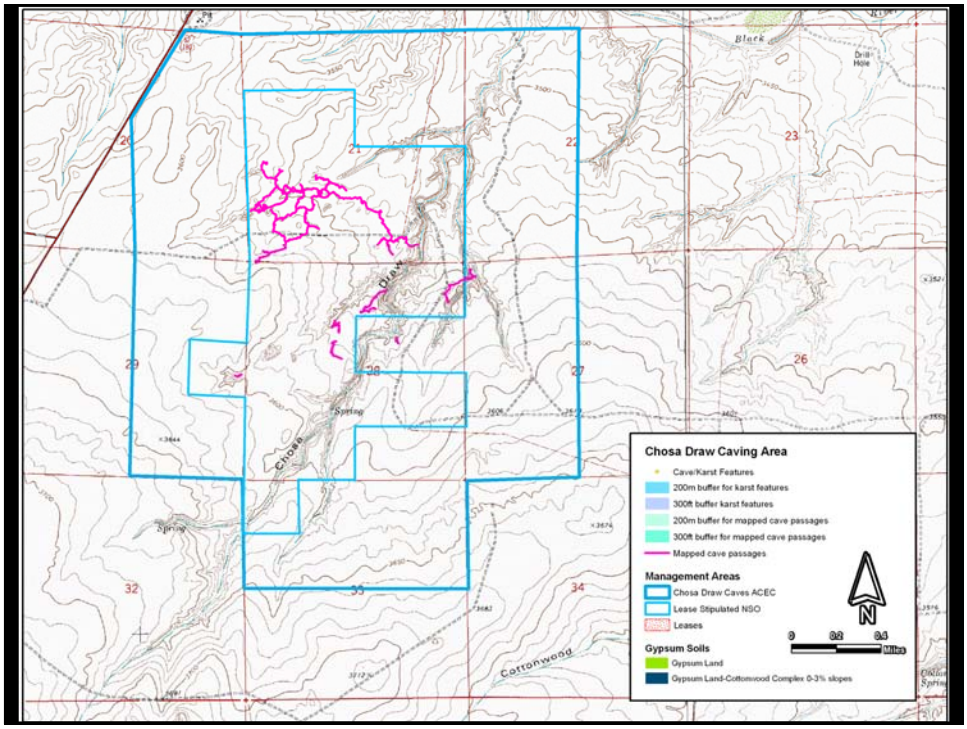
10:33




Dye Trace Paths
Ricks Spring
Benchmark Spring


Chosa Draw Caving Area
Cave/Karst Features
200m buffer for karst features
300ft buffer karst features
200m buffer for mapped cave passages
300ft buffer for mapped cave passages
Mapped cave passages
Management Areas
Chosa Draw Caves ACEC
Lease Stipulated NSO
Leases
Gypsum Soils
Gypsum Land
Gypsum Land-Cottonwood Complex 0-3% slopes
Miles
Cottonwood
Chosa
Spring
Black
Drill Hole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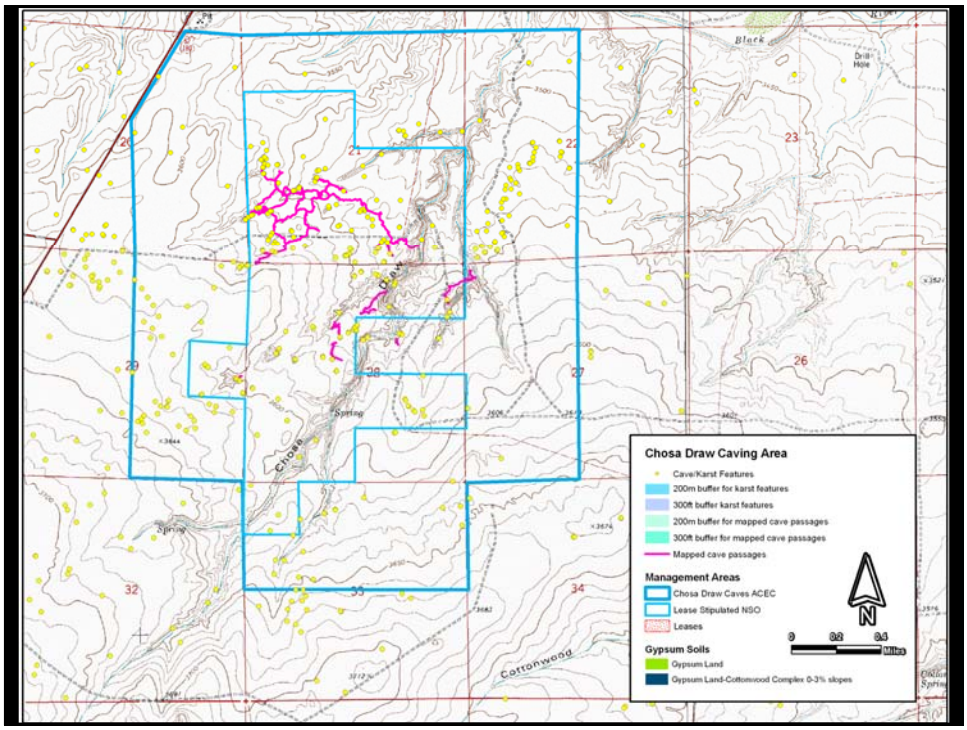
300ft buffer karst features
200m buffer for mapped cave passages
300ft buffer for mapped cave passages
Mapped cave passages
Management Areas
Chosa Draw Caves ACEC
Lease Stipulated NSO
Leases
Gypsum Soils
Gypsum Land
Gypsum Land-Cottonwood Complex 0-3% slopes
N
0 0.2 0.4 Miles
Chosa
Cottonwood
Spring
Black
Drill Hole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300ft buffer for mapped cave passages
Mapped cave passages
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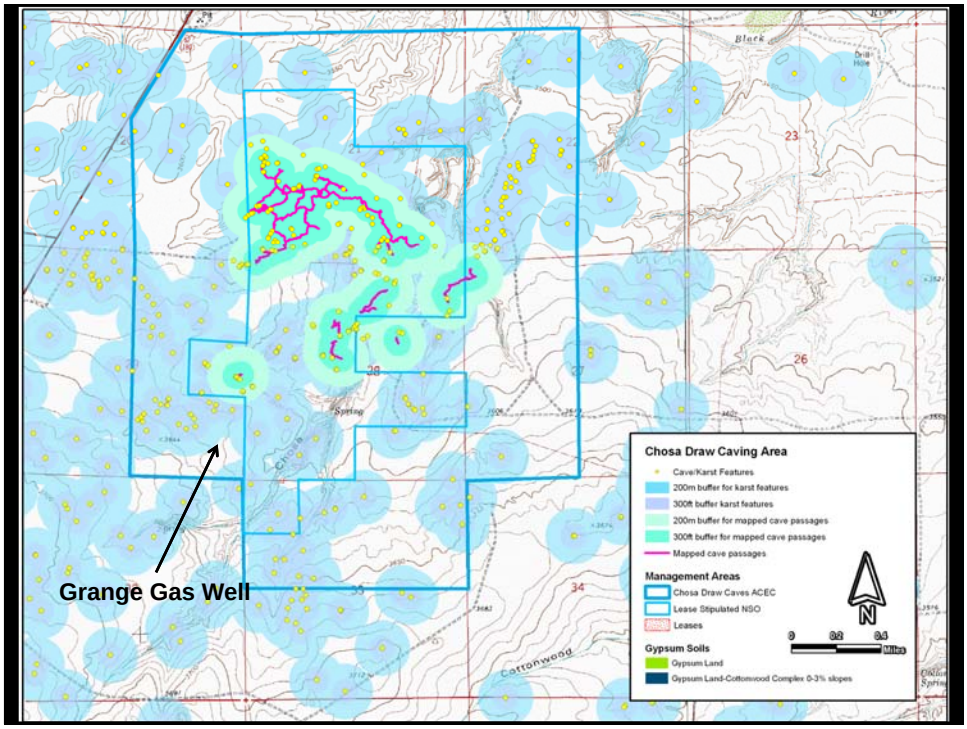
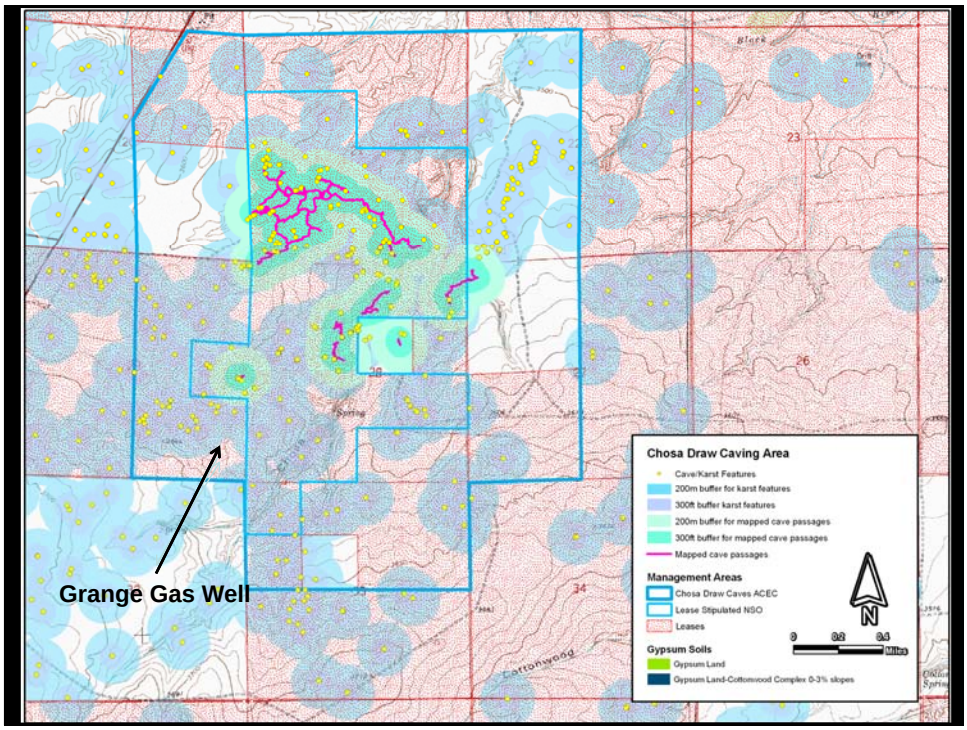
Leases
Gypsum Soils
Gypsum Land
Gypsum Land-Cottonwood Complex 0-3% slopes
N
0 0.2 0.4 Miles
Chosa
Cottonwood
Spring
Black
Drill Hole


Grange Gas Well
Chosa Draw Caving Area
Cave/Karst Features
200m buffer for karst features
300ft buffer karst features
200m buffer for mapped cave passages
300ft buffer for mapped cave passages
Mapped cave passages
Management Areas
Chosa Draw Caves ACEC
Lease Stipulated NSO
Leases
Gypsum Soils
Gypsum Land
Gypsum Land-Cottonwood Complex 0-3% slopes
N
0 0.2 0.4
Miles


Grange Gas Well
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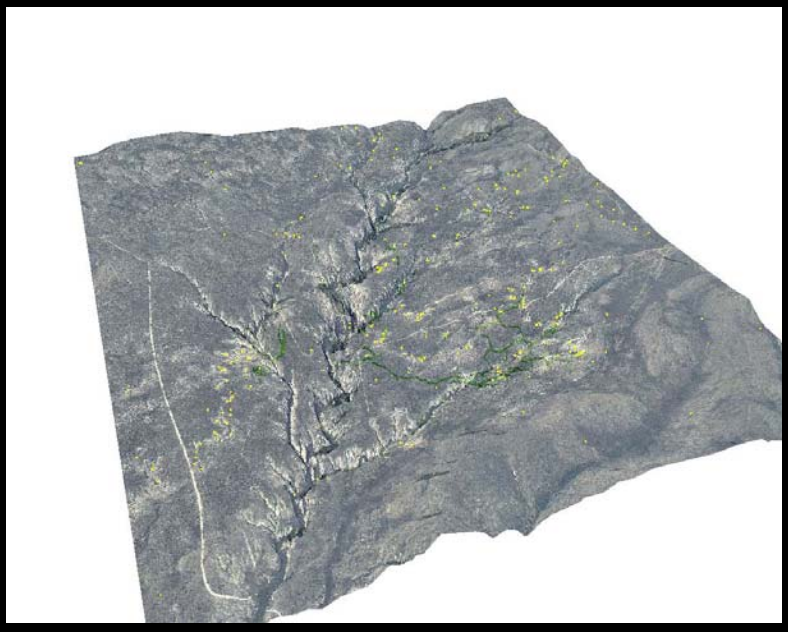
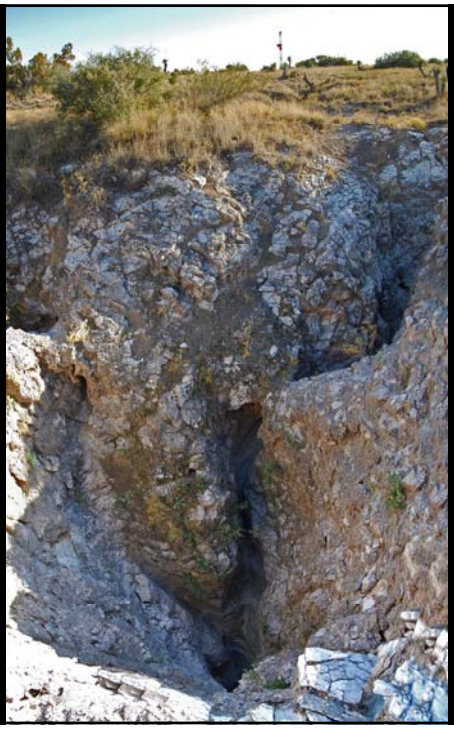
Gypsum Soils
Gypsum Land
Gypsum Land-Cottonwood Complex 0-3% slopes
N
0 0.2 0.4
Miles

Chosa Draw Features





Bloomington Cave

- 3D lineplot
- Lineplot with 3D Surface

Timpanogos Grotto website – CaveVRML

LYDAR scans

FARO Scanner

- $40,000 for 3 months or $120,000 for system
- 76 meter range
- 120,000 points/second

  4 minutes per station
- Can link multiple scans using reference points
- Camera attachment for colored points

Ending Remarks

- Get in contact with Caver Surveyors and use your imagination
- Illustrator and Auriga Video tutorials at … www.BrandonKowallis.com under Video
- For more info contact Jon Jasper 801-368-2272 or jonjasper@softhome.net