

# Using ESRI ArcPad to Inventory Cave Features

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## Abstract

Many locations of findings, project activities, and research in the caves have been lost due to a lack of a good system for organizing spatial data. Using a georeferenced map of the Timpanogos Cave System, significant features throughout the cave such as electrical wiring, historic artifacts, rare formations, biology sightings, and monitoring stations are being mapped and inputted in the field using ESRI ArcPad and a Pocket PC iPAQ. This system will be created so that spatial relations can be studied, data can be quickly found through hotlinks, and management activities can be documented.



## Portable GIS solution

Cave researchers have the problems of large inventory, monitoring, and restoration projects that occur in the most unthinkable places. The documentation of these projects has been performed using paper maps and notes that leave a confusing and labor intensive amount of computer input. Carrying laptops loaded with GIS applications created complete and accurate datasets, but was very cumbersome and limited in where you could go. The solution was using a very portable iPAQ Pocket PC running ArcPad.

A Pocket PC had many advantages for being used in a cave. The HP iPAQ 3970 is compact. It is 5.3 by 3.3 by 0.6 inches and weighs only 6.5 ounces. Used with the rugged case accessory, the iPAQ is reasonably protected. With a fast XScale 400 Mhz processor without a bootup sequence, the iPAQ is a fast, efficient field platform. The battery life far exceeds the life of laptop batteries. The 1,400 mAh Lithium polymer battery with Power Management features will last a full work shift—up to 10 hours of continuous use. And the best part is a rechargeable, auto-sync cradle that automatically recharges and synchronizes your shapefiles so they can immediately be used in desktop GIS applications.

ESRI created ArcPad as a simple mobile mapping solution. The software allows creation and

editing of points, lines, and area features with associated attributes. It is very similar in use and function as the better-known ArcView. ArcPad makes data collection fast, easy, and significantly improved with immediate data validation and availability.

## Cave GIS Setup

Setting up ArcPad from existing layers is



*Inventorying signatures with ArcPad*

simple. The shapefiles can just be added to the synchronized <Pocket PC My Documents> directory. Large raster images, such as georeferenced cave maps, may need to be converted to work under the Pocket PC system. ArcPad

comes with an extension that allows views to be exported into a georeferenced JPEG image supported by ArcPad.

For Timpanogos Cave National Monument, a cave inventory was already in process using a georeferenced map of the cave. Others will find creating the layer of the cave map is the most difficult task in creating a mobile cave GIS. First, the survey data and map of the cave must be available. The line plot of the cave is then imported using CaveTools (<http://www.mindspring.com/~bszukalski/cavetools/cavetools.html>). This line plot then is registered to survey station with a high-accuracy GPS location. The cave map is then scanned, arranging the map so true north is up. One needs to be sure that the data has been adjusted correctly to account for magnetic declination. In a photo editing software, the image is cleaned and the background painted to a different color than the passage fill. Later in ArcView, the Image Editor is used to adjust the Color Map so that the image's background is transparent. This transparent background will allow other layers to be seen with the cave map layer. Save the image into a format that can be recognized by ArcView, such as a 256-color TIFF image. Using the Image Georeferencing Tool (<http://arcscripsts.esri.com/details.asp?dbid=11140>),

painstakingly adjust the image until it best matches the line plot.

The map of Timpanogos Cave is being completely reworked by Brandon Kowallis using Adobe Illustrator. This new map will include all of the detail collected from the original survey by Rod Horrocks. The map will then be imported as a layered vector map.

Jasper3 - Sample of Cave Inventory Map

## Cave Inventory

Most of the knowledge of cave features and past management actions is known only by that park's cave managers. GIS technologies can be used to preserve the knowledge about the cave resources. The Science and Resource Management division at Timpanogos Cave National Monument is using ArcPad to inventory types of cave formations, the history of monitoring efforts, biological sampling and sightings, cave infrastructures, and management actions. These mapped features will be created so that spatial relations can be studied, data can be quickly found through hotlinks, and management activities can be documented.

The following list shows some the features that are being or are planned to be mapped:

### Formations

- Tubules

- Helictites
- Anthodites
- Frostwork
- Flowstone
- Shields/welts

### Formation Coloration

- Green
- Yellow
- Red

### Recording Stations

- TMP/rH
- Drip rates
- Past Stations

### Hydrology

- Pools
- Streams
- Drips
- Water sampling

### History

- Artifacts
- Signatures
- Place names

### Biology

- Wildlife sightings
- Bones
- Vouchers
- DNA sampling
- Suitable habitats
- Middens

### Electrical System

- Lights
- Fuses
- Electric lines
- Switches
- Outlets
- Old systems

### Infrastructure

- Doors
- Catwalks
- Handrails
- Old infrastructure

### Interpretation Needs

- Switches
- Lighted areas
- First Aid locations
- Accidents
- Incidents

### Cave Potential

- Leads
- Airflow
- Walled passages
- Digs
- Sumps
- Roots/Crickets/ debris

### Management Actions

- Cave cleaning
- Algae removal
- Development
- Proposed actions
- Restricted areas
- Drainage problems

### Routes

- Tour routes
- Historic routes
- Wild tours

### Geology

- Faults
- Strike/Dip
- Scallops
- Geologic Units