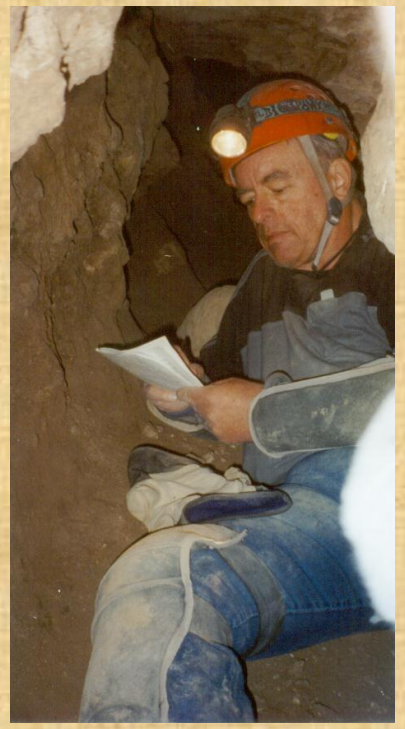
Discovery, Exploration, Surveying, and Cartography in Fort Stanton Cave

John J Corcoran III

April 7, 2022

First Fort Stanton Cave Science Conference

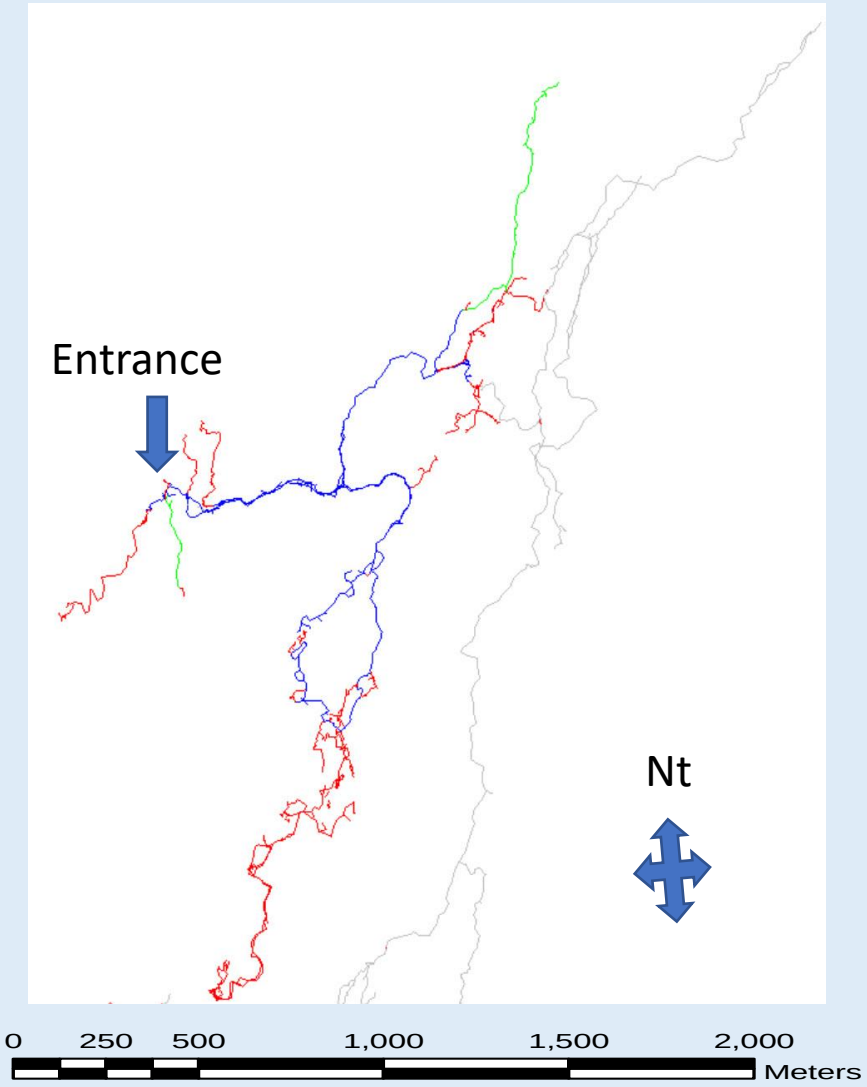


CAVE-RELATED GEOLOGIC HISTORY HIGHLIGHTS

- **Host Rock - Permian San Andres Formation, Guadalupian, Leonardian Epochs – 259-273 Million yrs**
- **Sierra Blanca Happens (29-36 MYBP), Oligocene, Eocene. Providing Future Major Water Source for Development of Fort Stanton Cave.**
- **Cave Origin – 0.5-5.0 Million yrs+ BP ?? (Pleistocene - Pliocene).**
- **Cave generally oriented along the strike of the beds (SW to NE) for most of the system. (Along the west limb of the Mescalero Arch anticline, dipping NW.)**
- **Holocene (8-30 Thousand yrs BP) Bones found throughout cave system (from paleo-entrances)**
- **Current Entrance formation – 850-1000 yrs BP?**
- **Snowy River formation age – 850 yrs?**

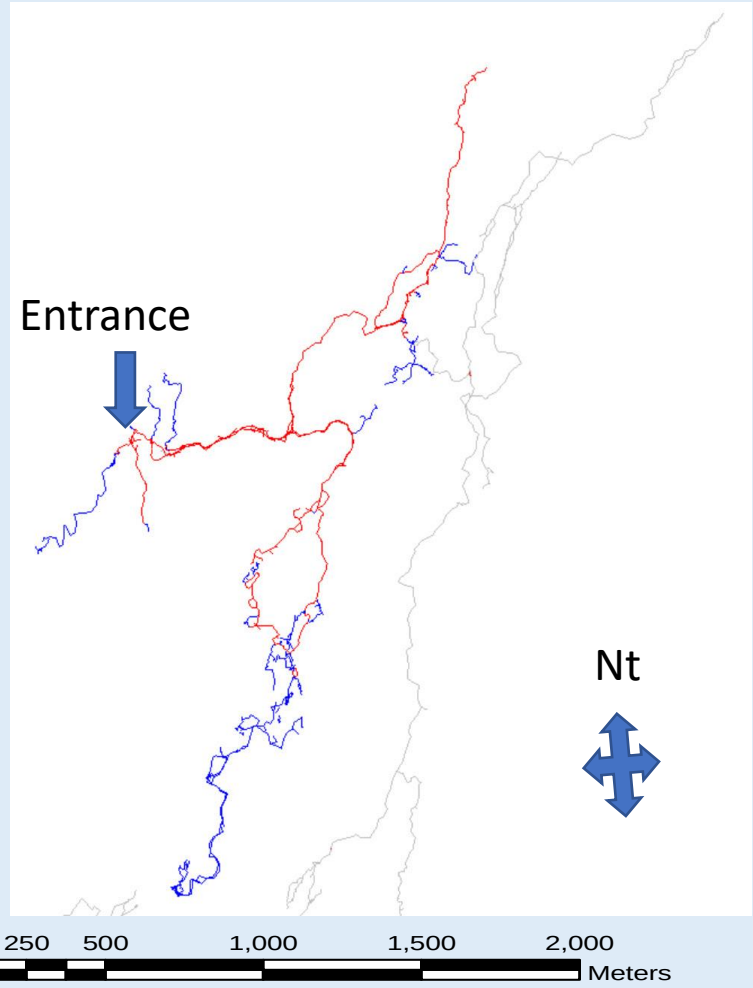
HUMAN HISTORY HIGHLIGHTS

- Native Americans – 1100 AD(?) – 1850(?) AD
- Europeans and Americans – 1855 – present
- First documented “cavers” – 1855 – (Soldiers from Fort Stanton)
- Historic Caving Era After 1860 – Until 1955
  - Historic Sections – 1855 – 1877 (Wheeler) (BLUE)
  - Hell Hole #2 - 1865 (GREEN)
  - Snowflake Passage – 1900? (GREEN)



Modern Caving 1955 – 2001, Selected Discoveries (BLUE)

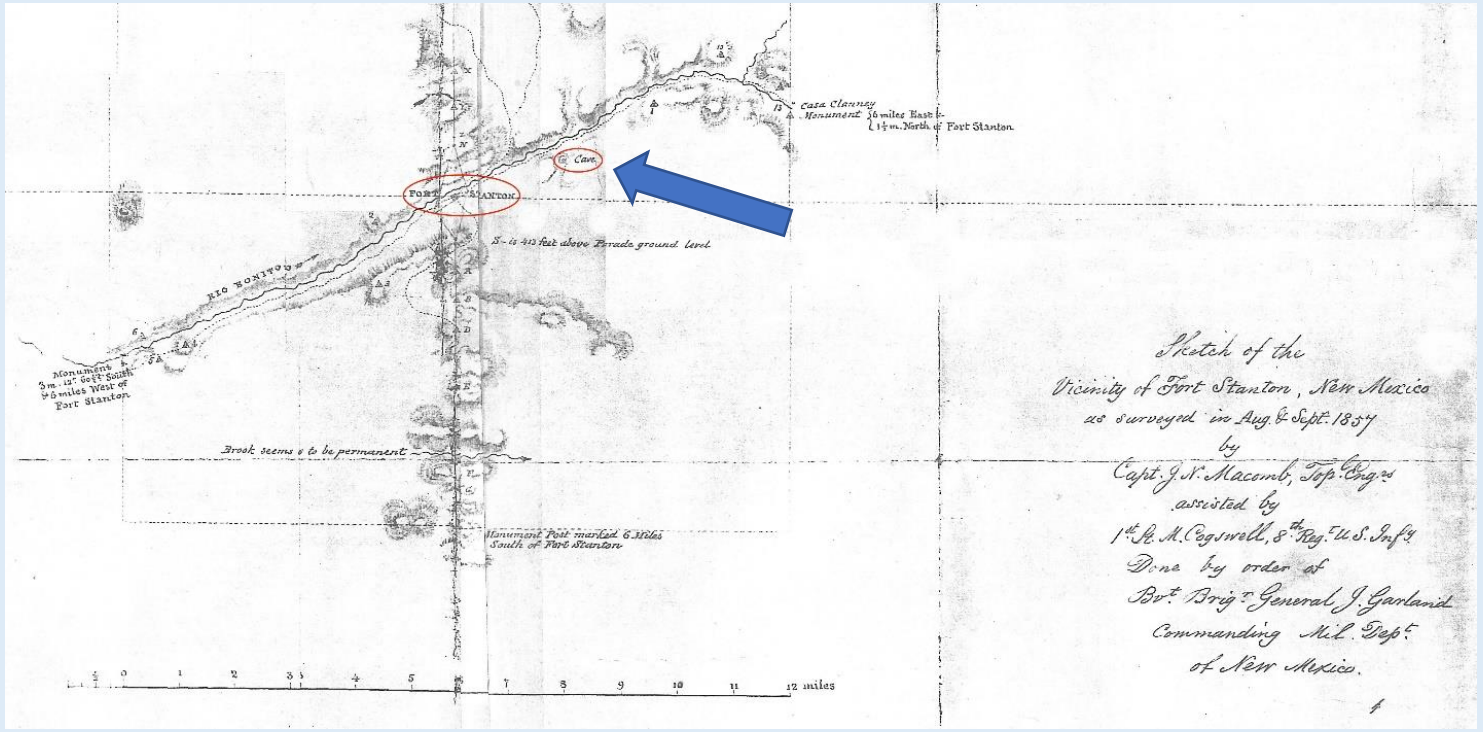
- New Section 1958 – Cararra
- Russell's Crawl, Hoeman's Passage, 1962 – Russel, Skinner
- Heinz Schwinge Memorial Hall., 1963 - Skinner
- Lincoln Caverns, Bat Cave Extension, 1969 – Skinner, Corcoran
- Don Sawyer Memorial Hall, Carol's and Promise Passages, 1971 - Skinner
- Hell of a Thousand Pinches – 1984 - Hummel
- Snowy River Discovered! – 2001 - McLean
- ***Exploration of Snowy River Complex Begins! - 2003***

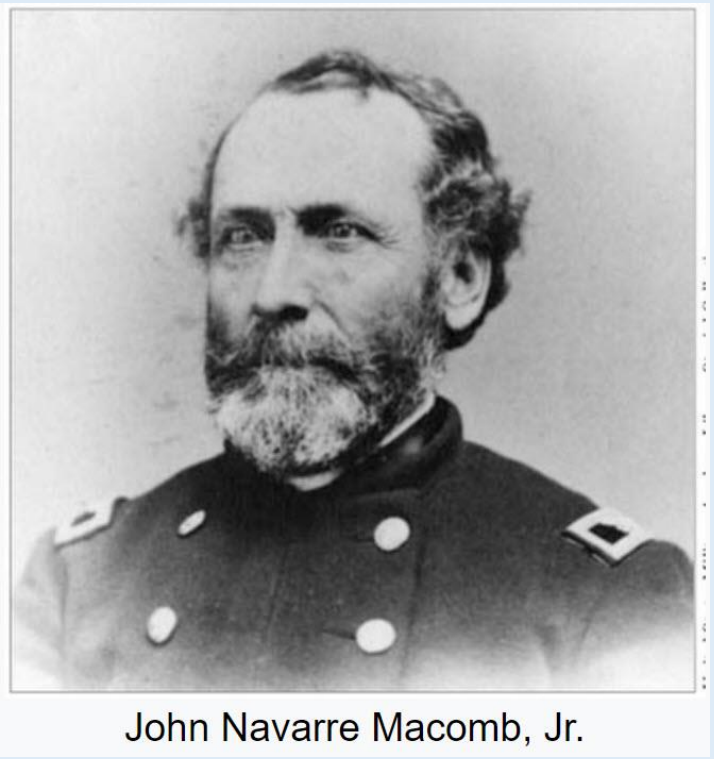


Fort Stanton Cave Discovery By Native Americans (1100AD? - ?)

- Native Americans – “Petrified” (calcite covered?) river reed torches found in Main Corridor by first explorers (up to ½ mile from Entrance).
- Very little evidence of visitation unlike Feather Cave and other nearby shelter caves which have pictographs, ceremonial items.

U.S. Army 1857, Capt. McComb, Topographic Engineer

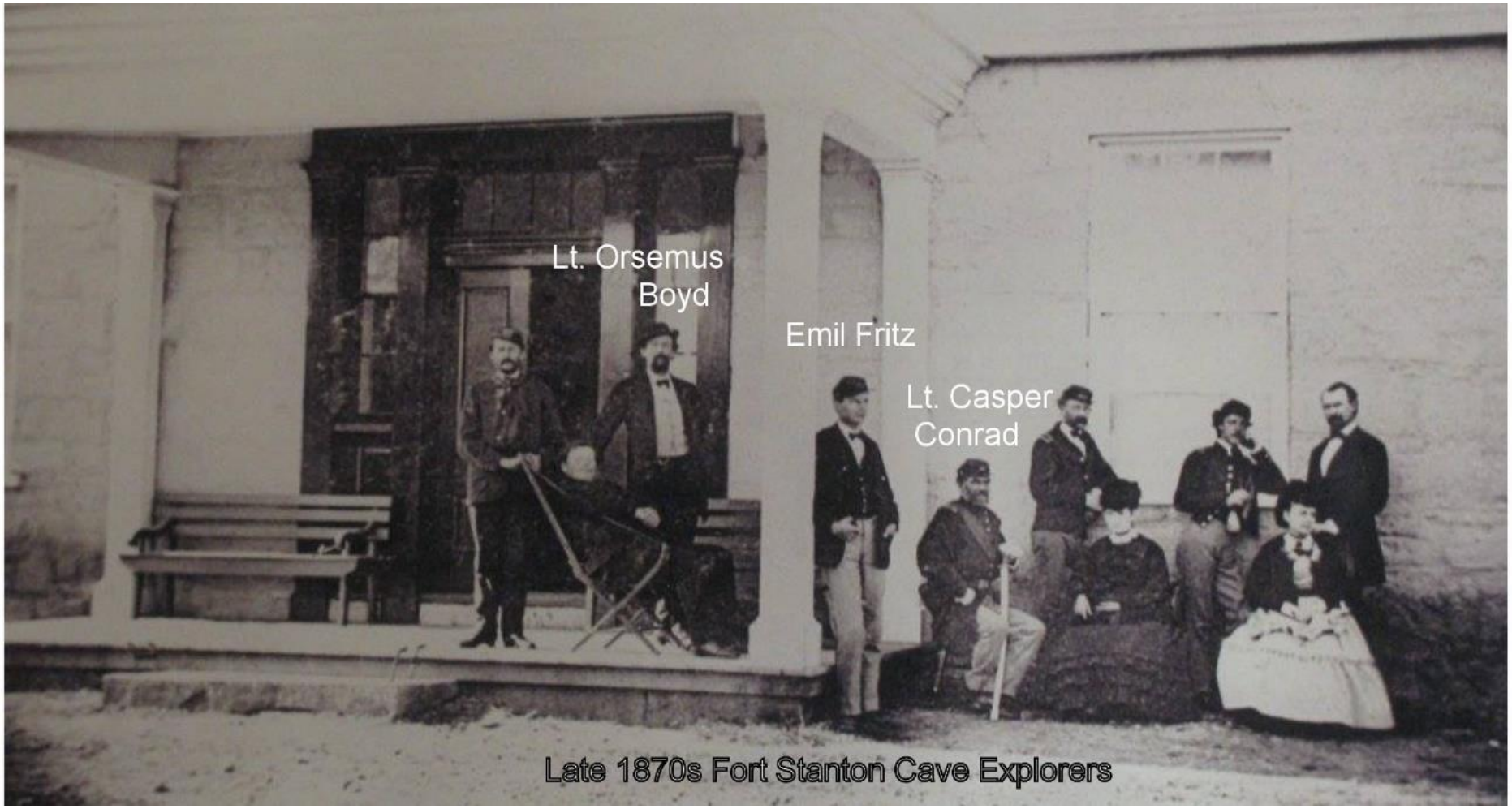




John Navarre Macomb, Jr.

US Army survey for area around Fort Stanton showing the Fort Stanton Cave Entrance. Not long after its discovery in 1855 by Army patrol.

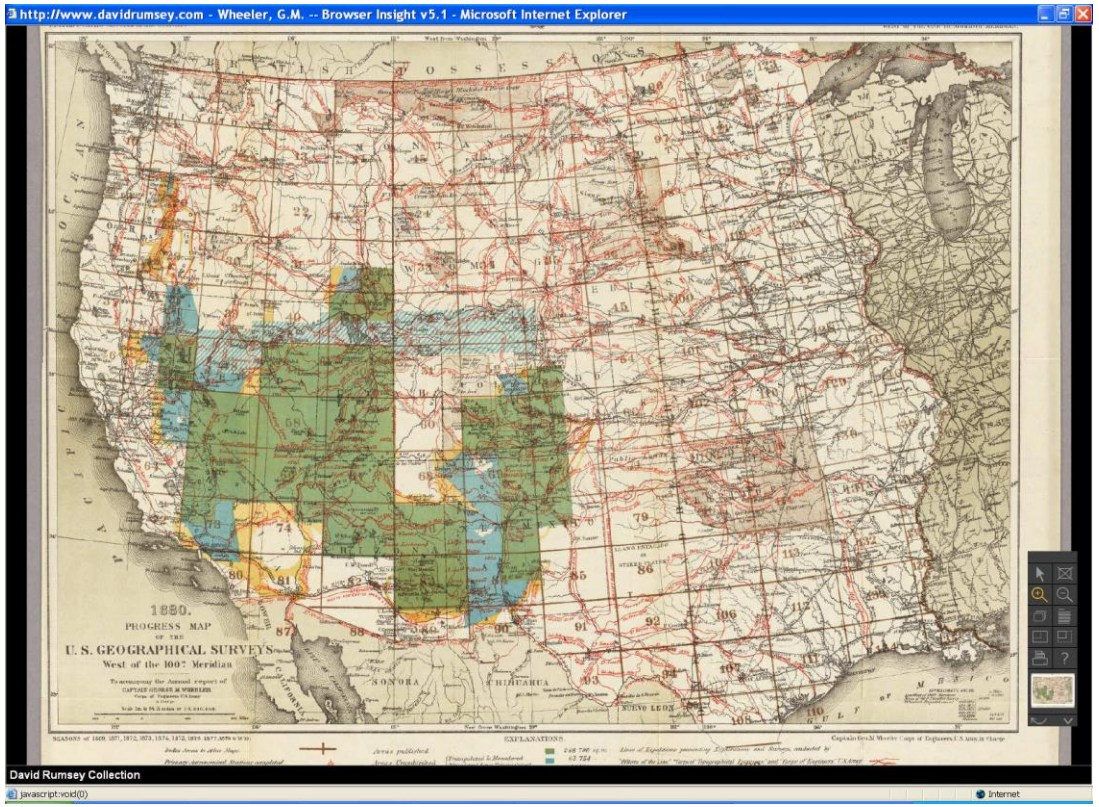
Early Exploration by Soldiers from Fort Stanton



These explorers left their names inscribed in Fort Stanton Cave.

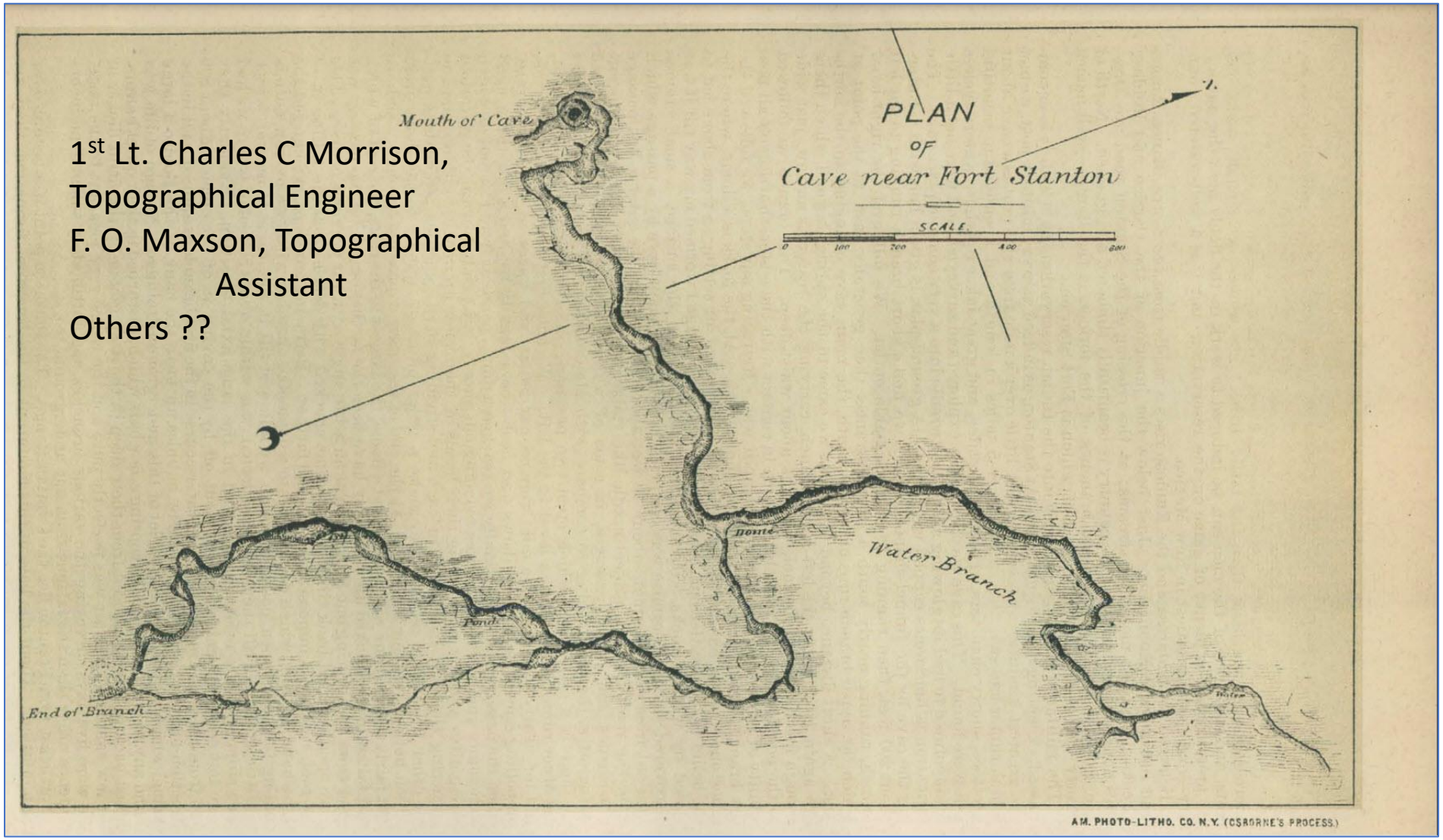
WHEELER EXPEDITION

Four groups were tasked with mapping the Western United States from 1871 thru 1879.. These were known as the Wheeler, Hayden, King, and Powell organizations which worked concurrently. In 1879, these four groups were discharged and the Geological Survey was founded. Lt. (later Capt.) George Montgomery Wheeler led the US Army group – the other three organizations were civilian, not military.



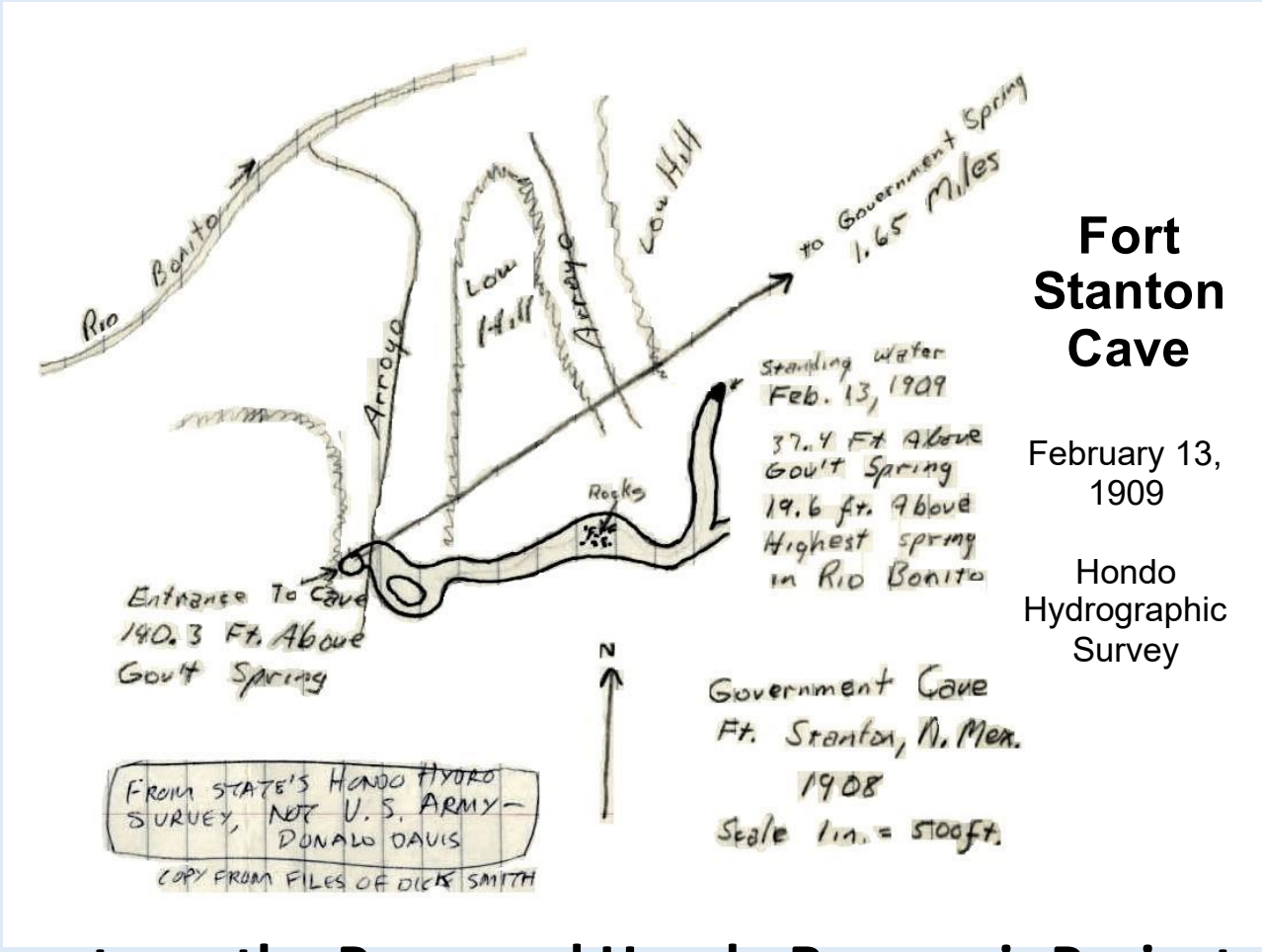
Records of the Office of U.S. Geographical Surveys West of the 100th Meridian ("Wheeler Survey")

Wheeler Expedition 1877, ~2.2 miles of survey. Second cave surveyed west of 100th Meridian.



1st Lt. Charles C Morrison, Topographical Engineer
F. O. Maxson, Topographical Assistant
Others ??

HONDO HYDROGRAPHIC SURVEY 1909



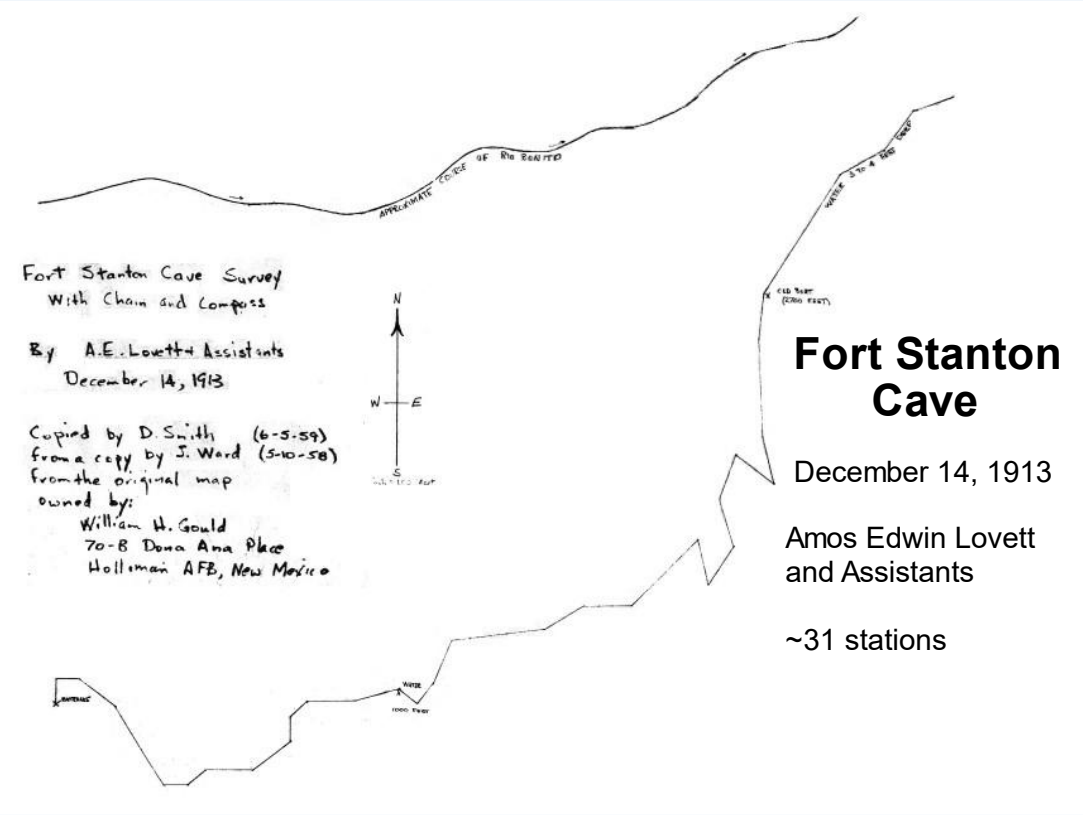
Fort Stanton Cave

February 13, 1909

Hondo Hydrographic Survey

Reports on the Proposed Hondo Reservoir Project near Roswell, New Mexico by the Federal Reclamation Service.

AMOS EDWIN LOVETT, 1913



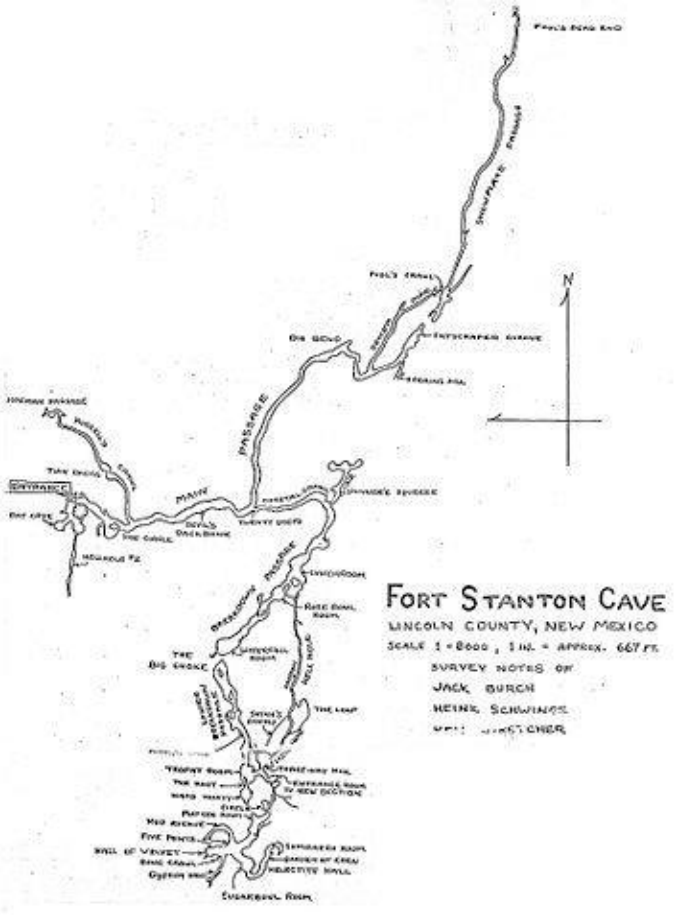
Worked at Oklahoma State University, Agricultural Extension

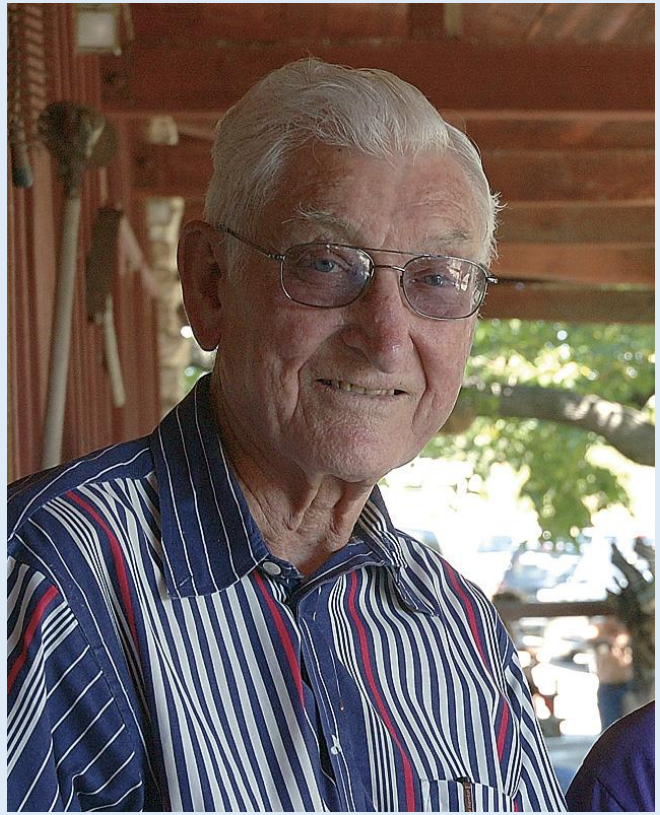
Dick Smith Map, 1962

A. Richard “Dick” Smith, 22 September 1939 – 4 July 2001, 61, NSS 3708 FE

- He was the author of numerous articles in the caving media and was highly regarded as a Karst and groundwater **geologist** by all his peers
- Texas Caver who did various cave and karst investigations in Fort Stanton Cave in the early 1960s.

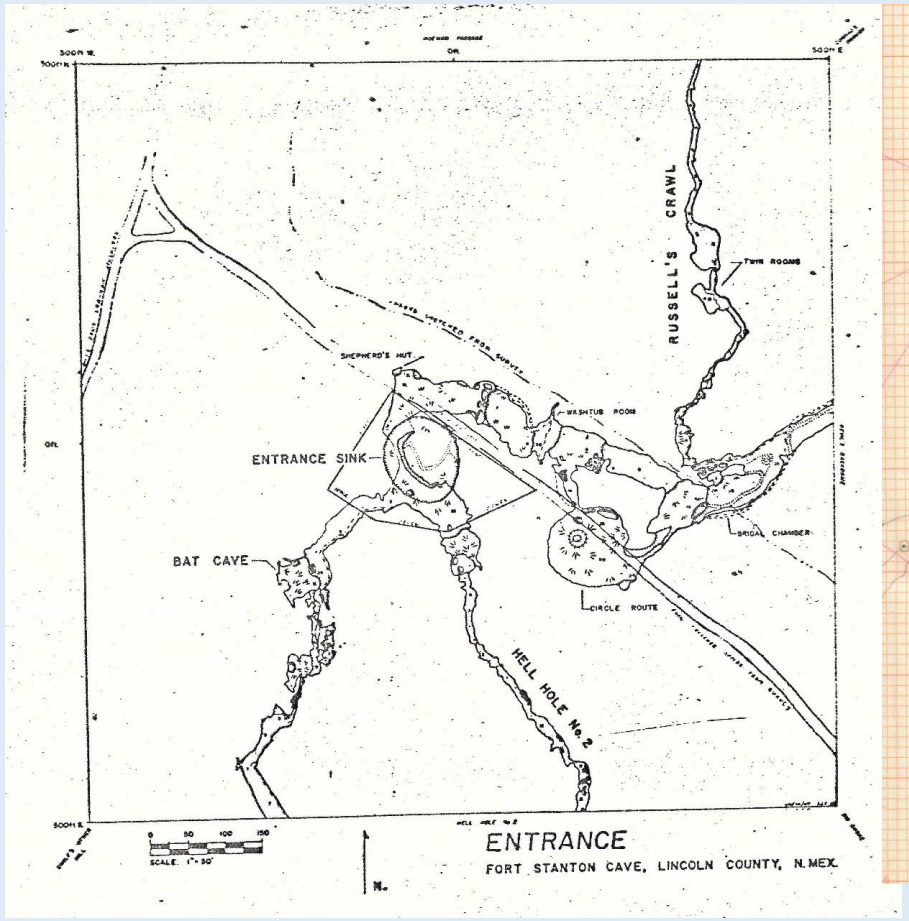
Jack Burch FSC Map (1963-1964)



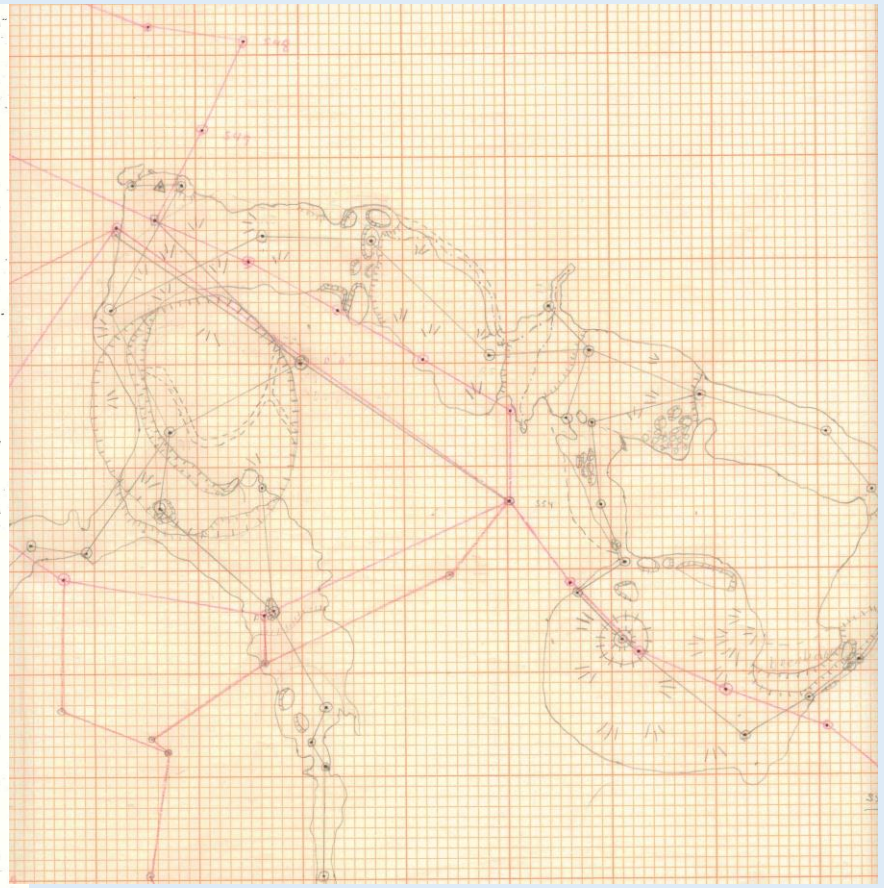


- November 11, 1922 - June 16, 2009.
- Developer of Caverns of Sonora, Texas in 1959
- Was considering FSC for development in early 1960s
- Survey team members
  - Heinz Schwinge
  - Ken Streicher

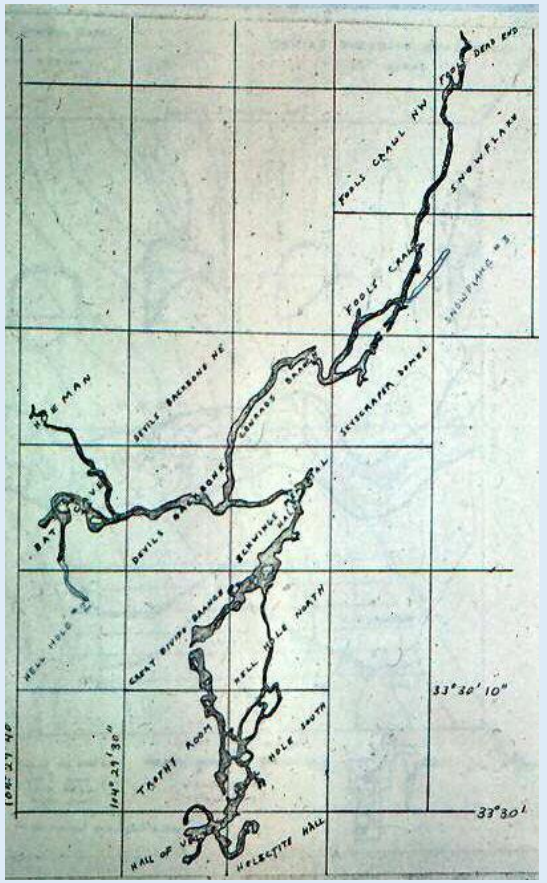
FSCSP Quadrangle maps (1967 – 1977) - Corcoran



Ink on Mylar

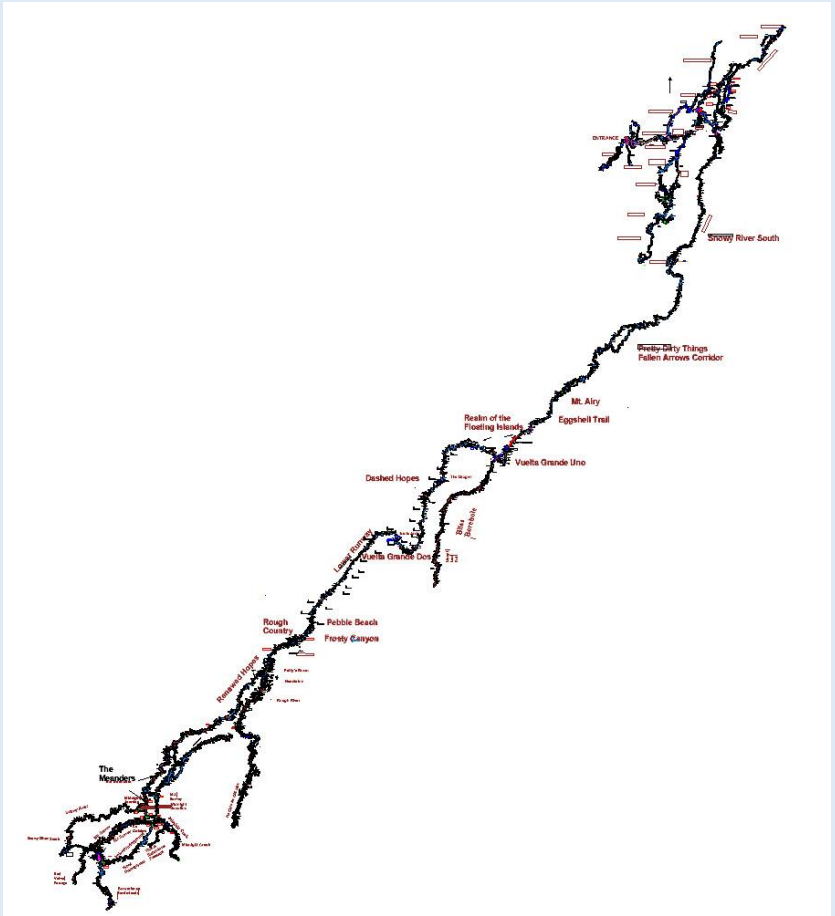


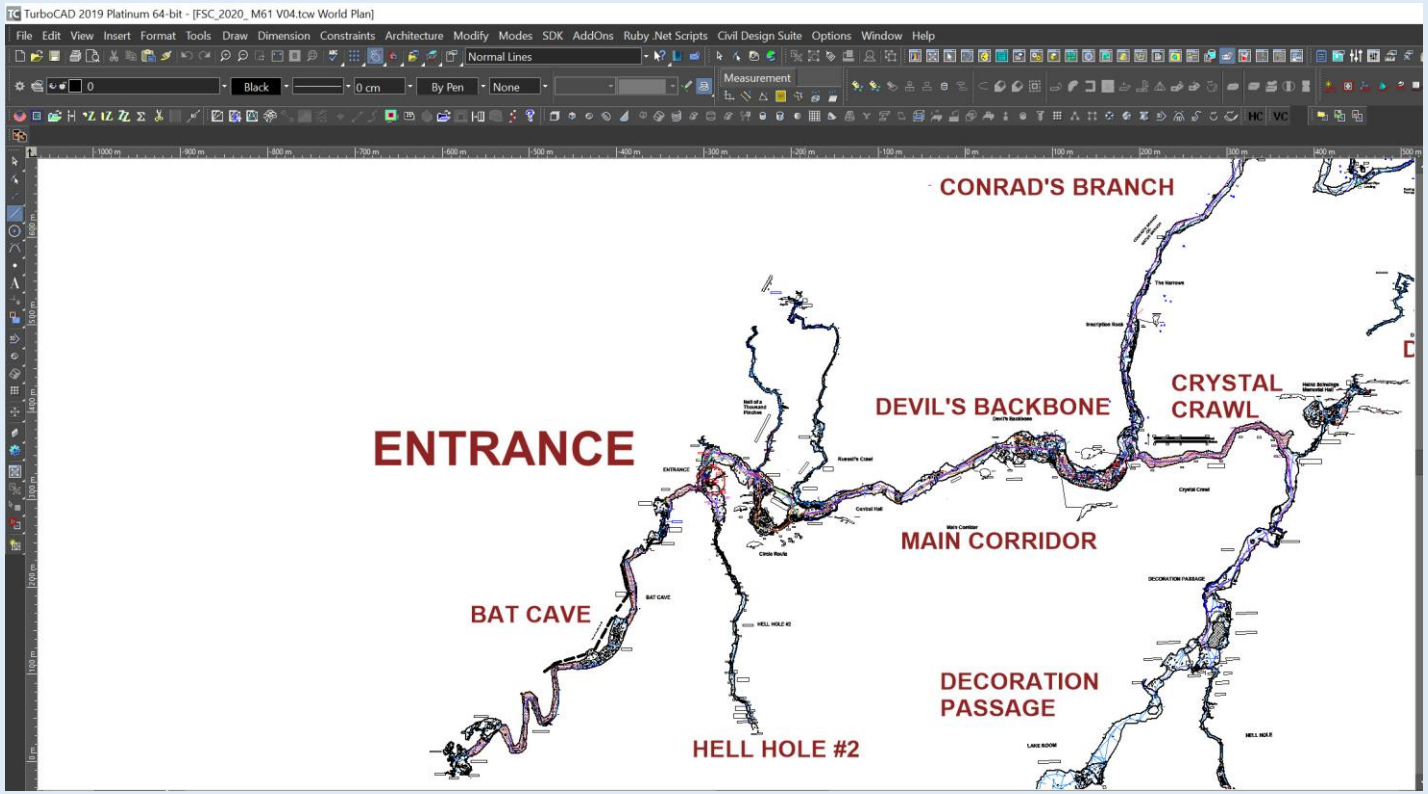
Pencil on Graph Paper



Old Quad Index Sketch

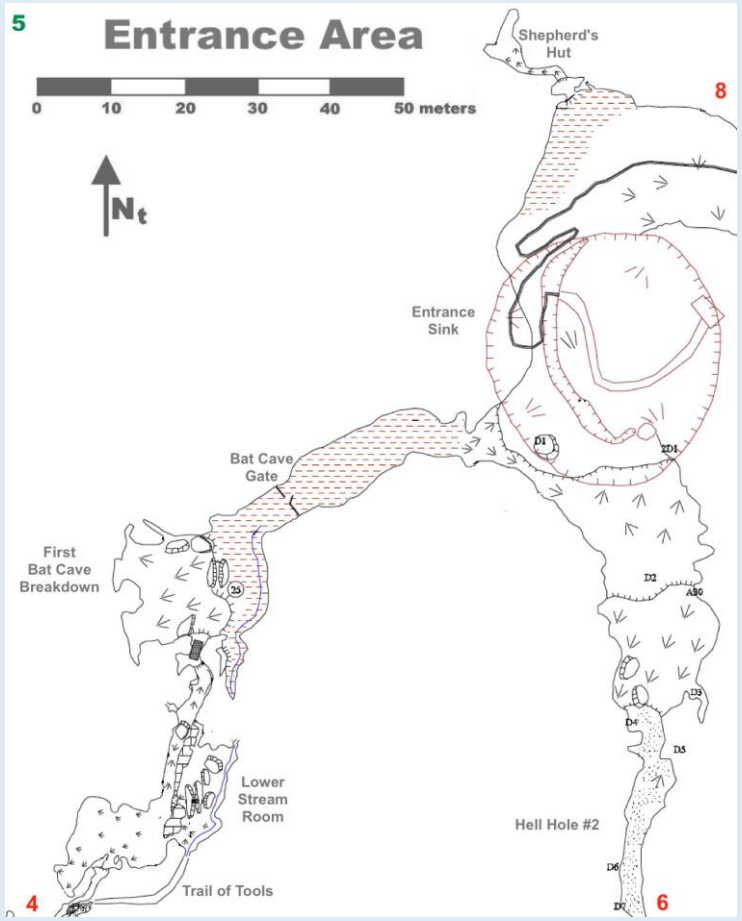
FSCSP TURBOCAD MASTER - CORCORAN



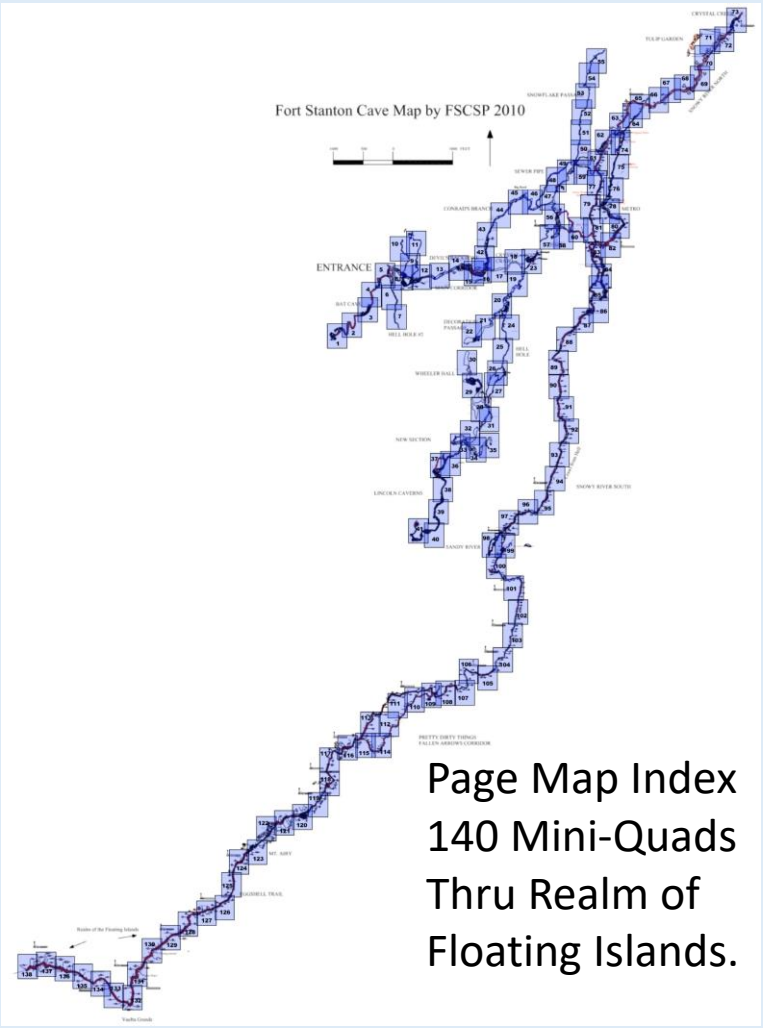


Years 2000 - 2015

FSCSP – PEERMAN, FSC PAGE MAPS, 2010



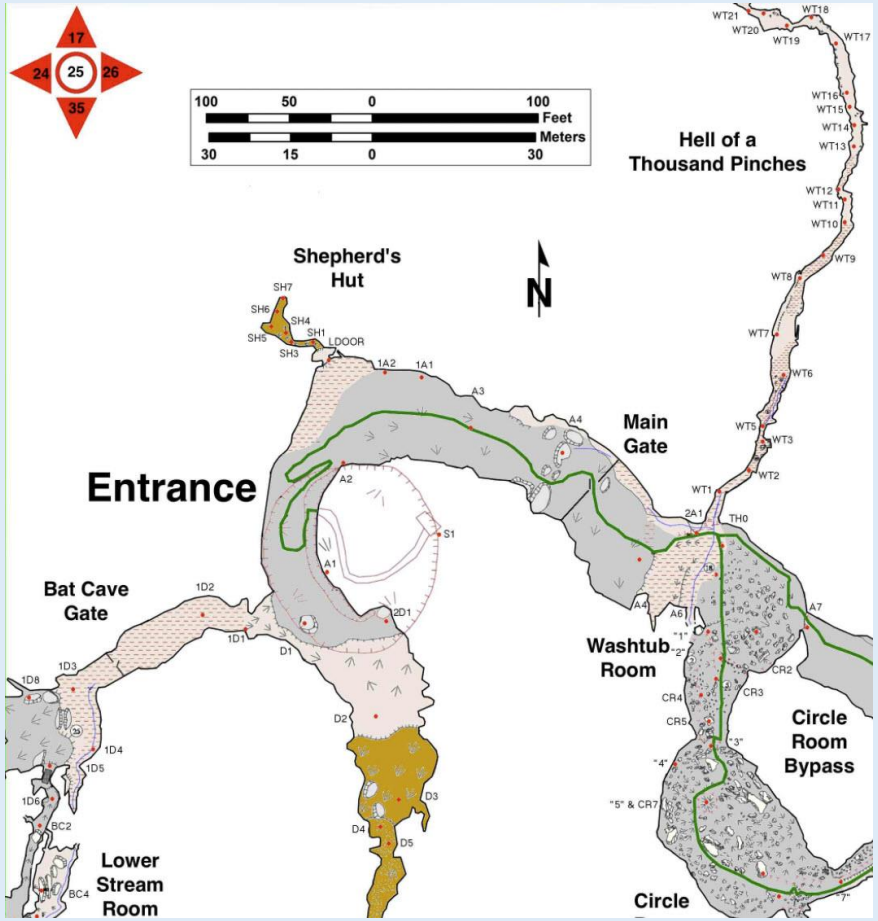
Page Map 5,

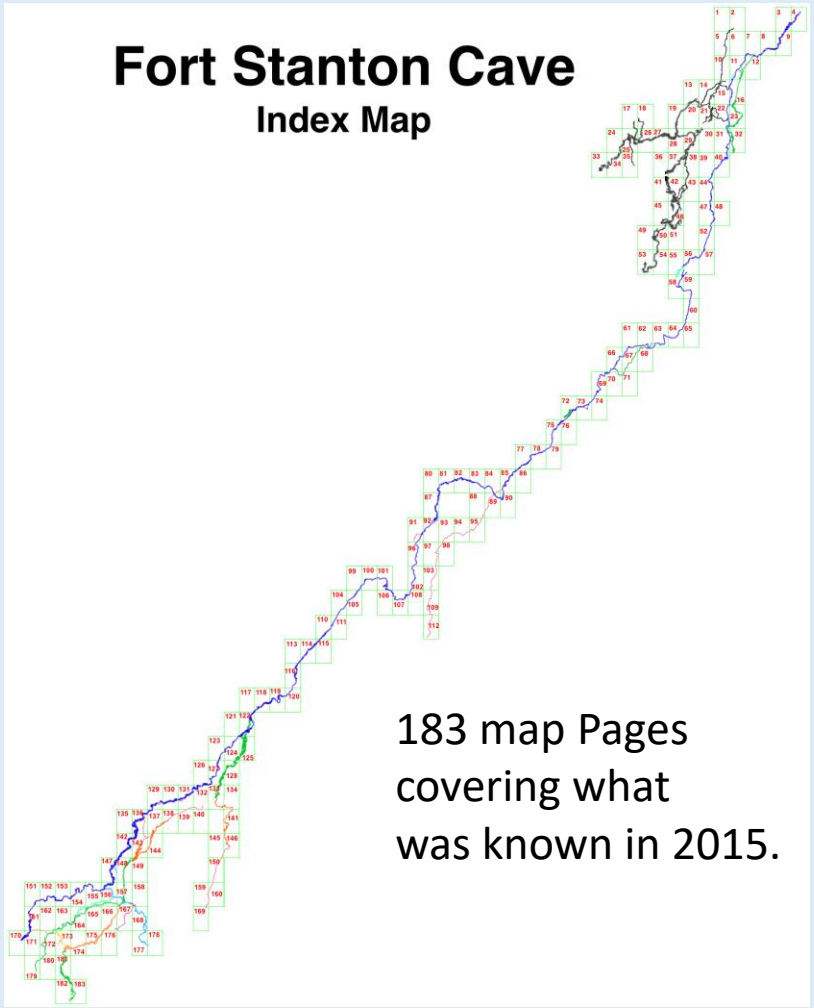


Page Map Index
140 Mini-Quads
Thru Realm of
Floating Islands.

Steve Peerman in 2005

FSCSP – PEERMAN, COLORIZED FLOOR MAP

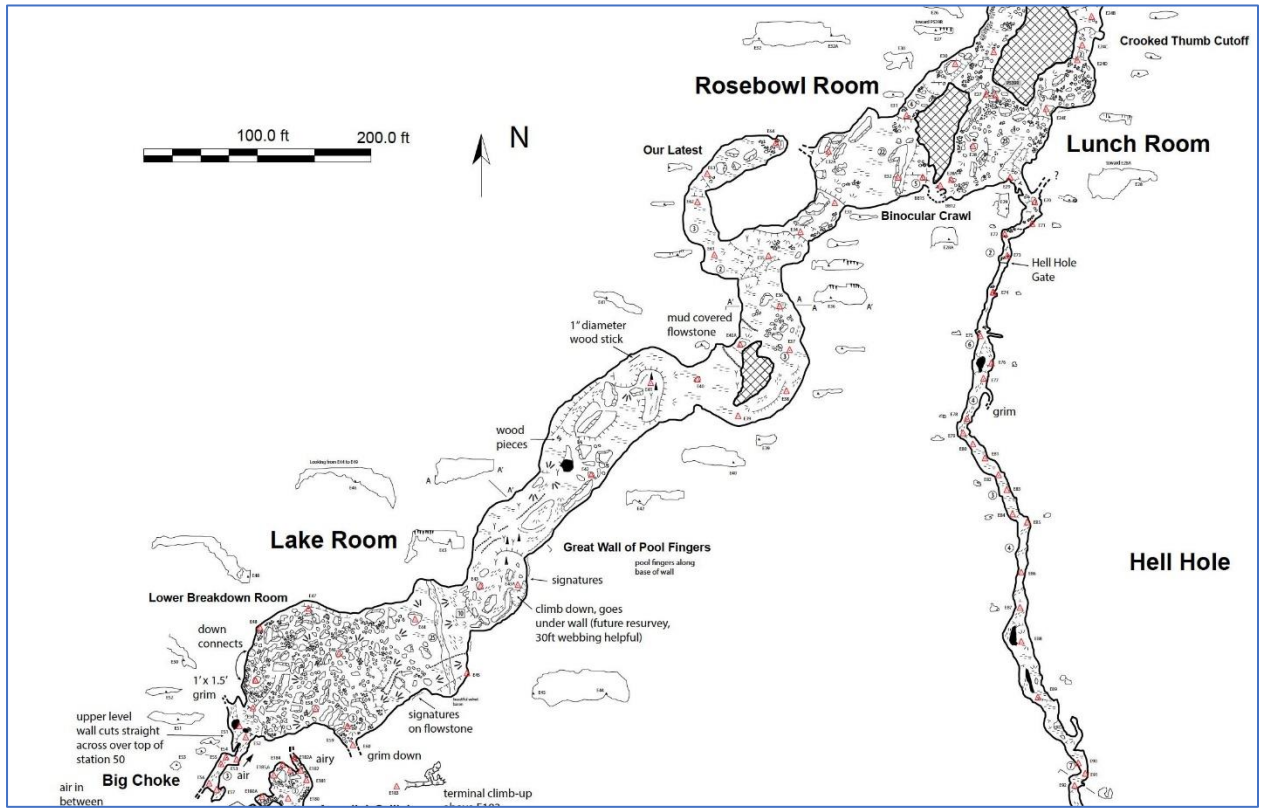




183 map Pages covering what was known in 2015.

FSCSP, ADOBE ILLUSTRATOR - KENDRICK

TurboCAD map database converted to Adobe Illustrator in 2015 to follow the most common drawing tools Used on large cave mapping projects in the USA.

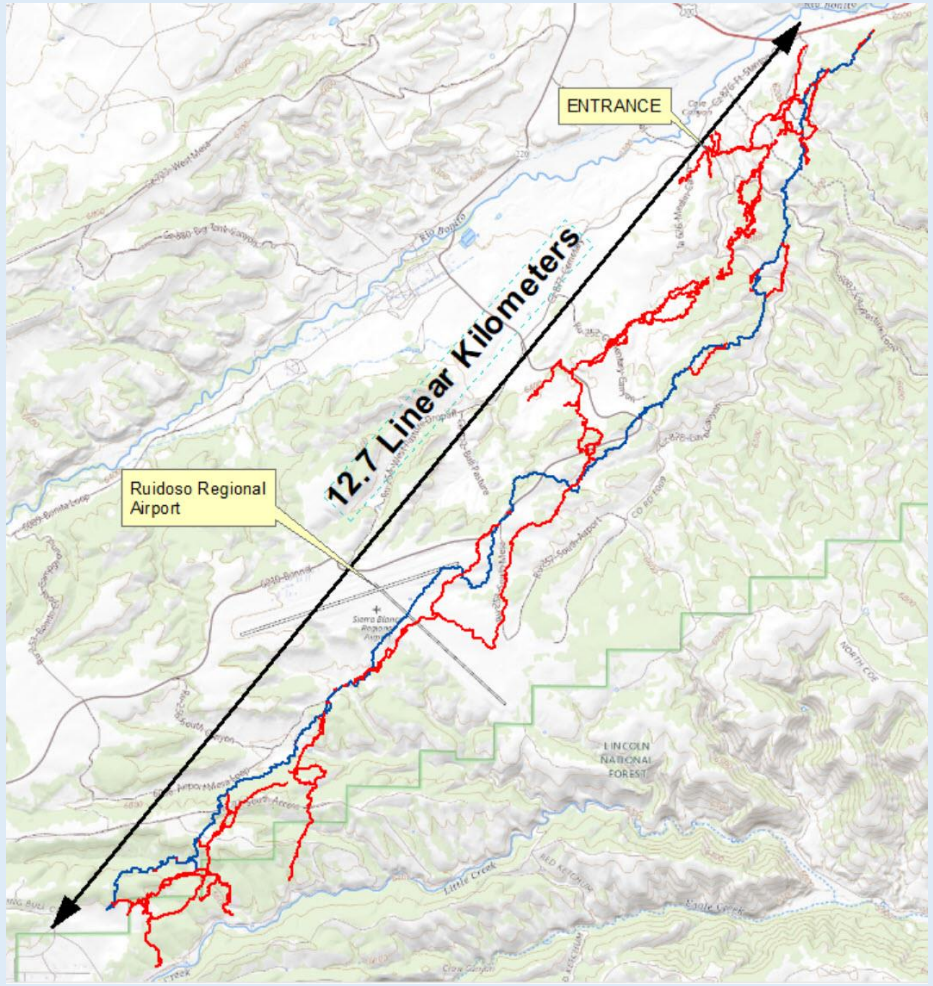


Adobe illustrator Final Map Product

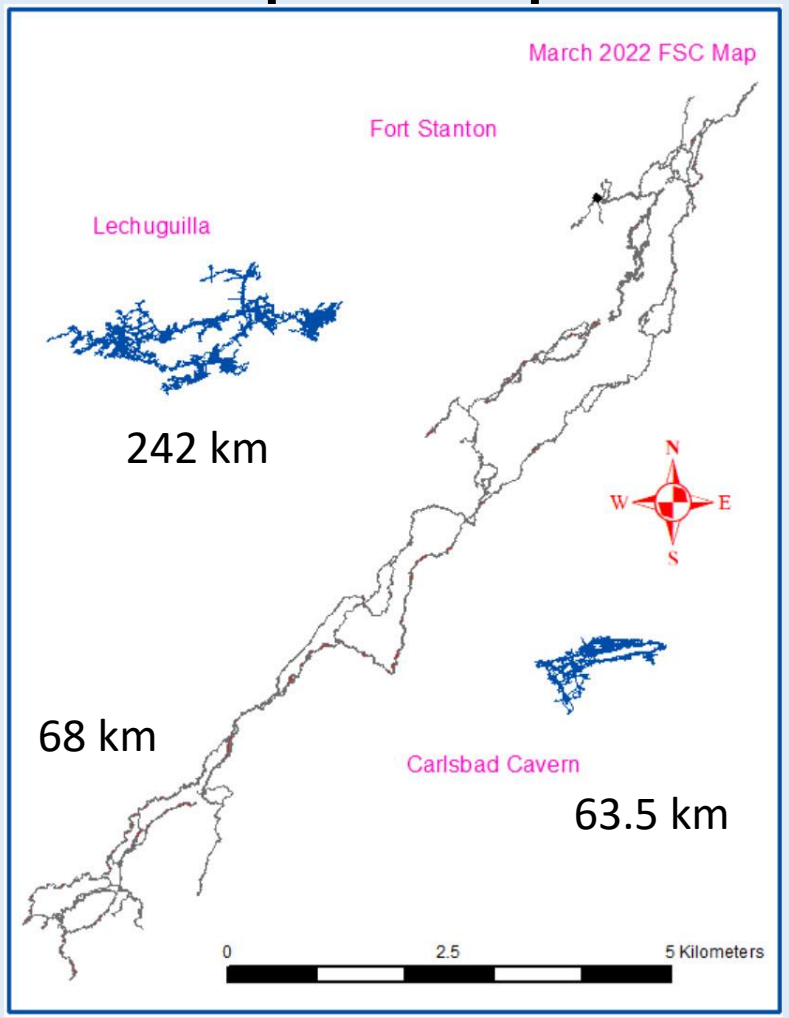
Brian Kendrick in FSC

FSCSP PRESENTATION MAPS

Surface Interpretation

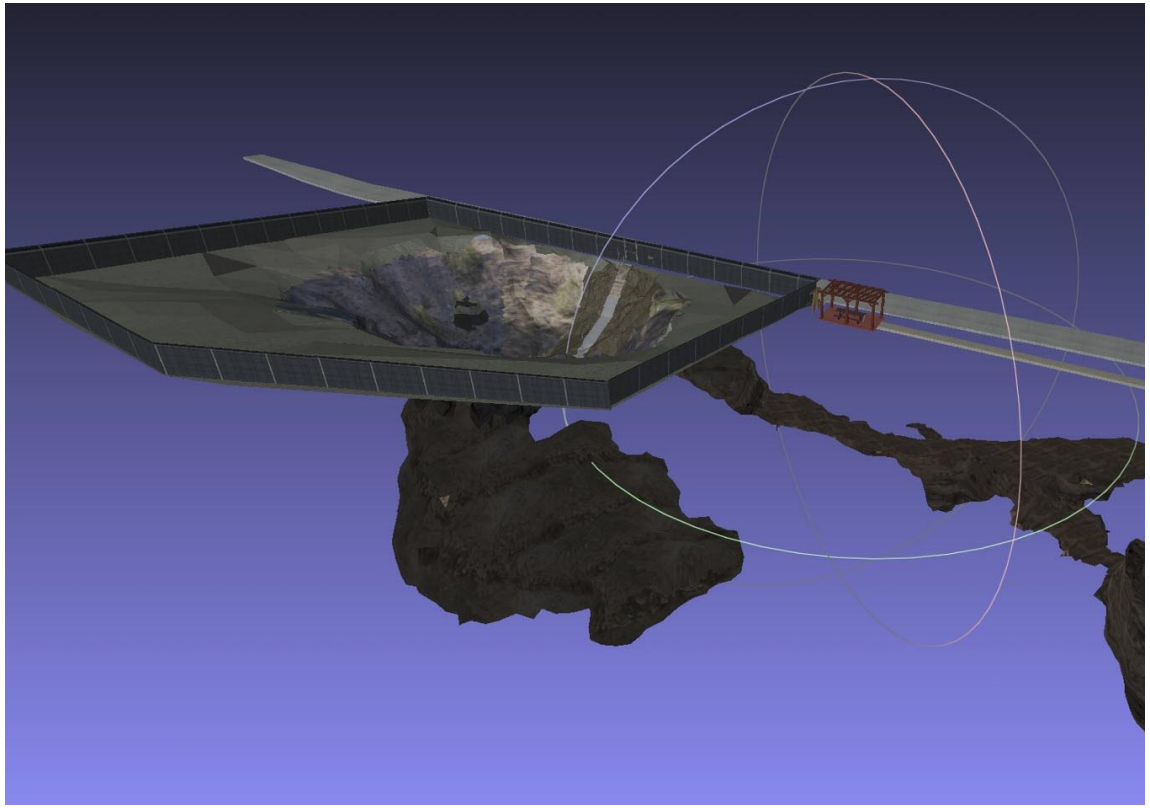


Footprint Comparison



FSCSP CAVERQUEST – LIPINSKI, BASED PRIMARILY ON LIDAR AND OTHER SURVEYS

CaverQuest scene with avatar facing south at Turtle Junction



Processed Lidar data for the cave entrance area. Data starts as point cloud, then a mesh, then a Rendered scene as shown above.

Survey Instrumentation Used Over Time

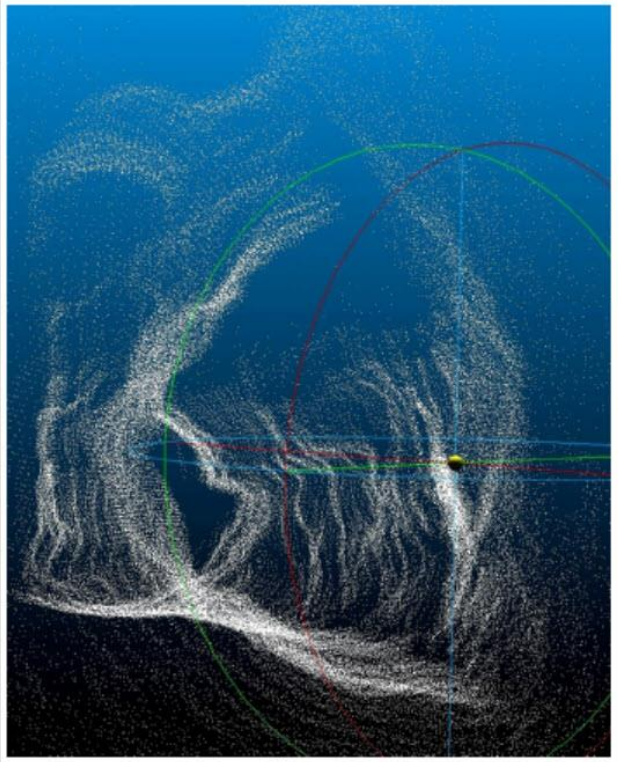
- **Wheeler Expedition and Lt. Morrison – "Mountain Transit" in cave (Third-order survey)**
  - **Topographers transit theodolite 3+ inch 60 seconds (Survey pattern).**
  - **Surveyor's Chain**
- **Sketch only – used to describe small features not surveyed**
- **Compass and pace – somewhat inaccurate (suffers from the "cave mile").**
- **Compass and Tape**
  - **Suuntos – hand-held Clinometer and Compass**
  - **Bruntons – Tripod-mounted as well as hand-held (Compass and Clinometer)**
- **DistoX – Total Station Instrument, hand-held. Typical loop closures <1%.**
- **Caveatron (LiDAR) – Used to create 3D cave passage maps.**
- **Pentax Theodolite – used to set a "backbone" to adjust earlier surveys. (Second-order, Class II survey)**
- **Buecher LiDAR – used to create 3D mesh for input to Caver Quest and Trek**
- **Photogrammetry – used to create 3D scenes and stream channel X-sections**
- **Cave Radio Location Mapping – used to adjust long cave survey traverses in X,Y, and Z**

FSCSP PRECISION BACKBONE SURVEY

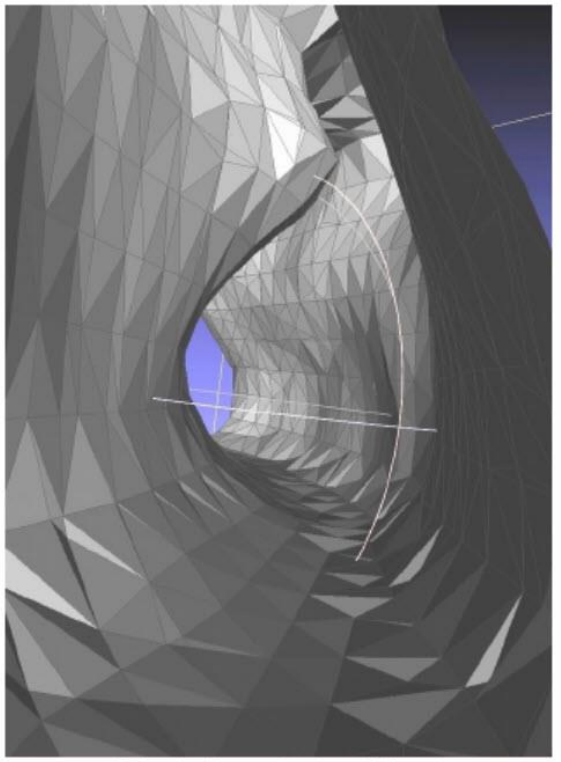
Equipment customized for cave surveying by PENTAX.

CAVEATRON – Walking Lidar Survey System

Joe Mitchell with the Caveatron in the Field House.

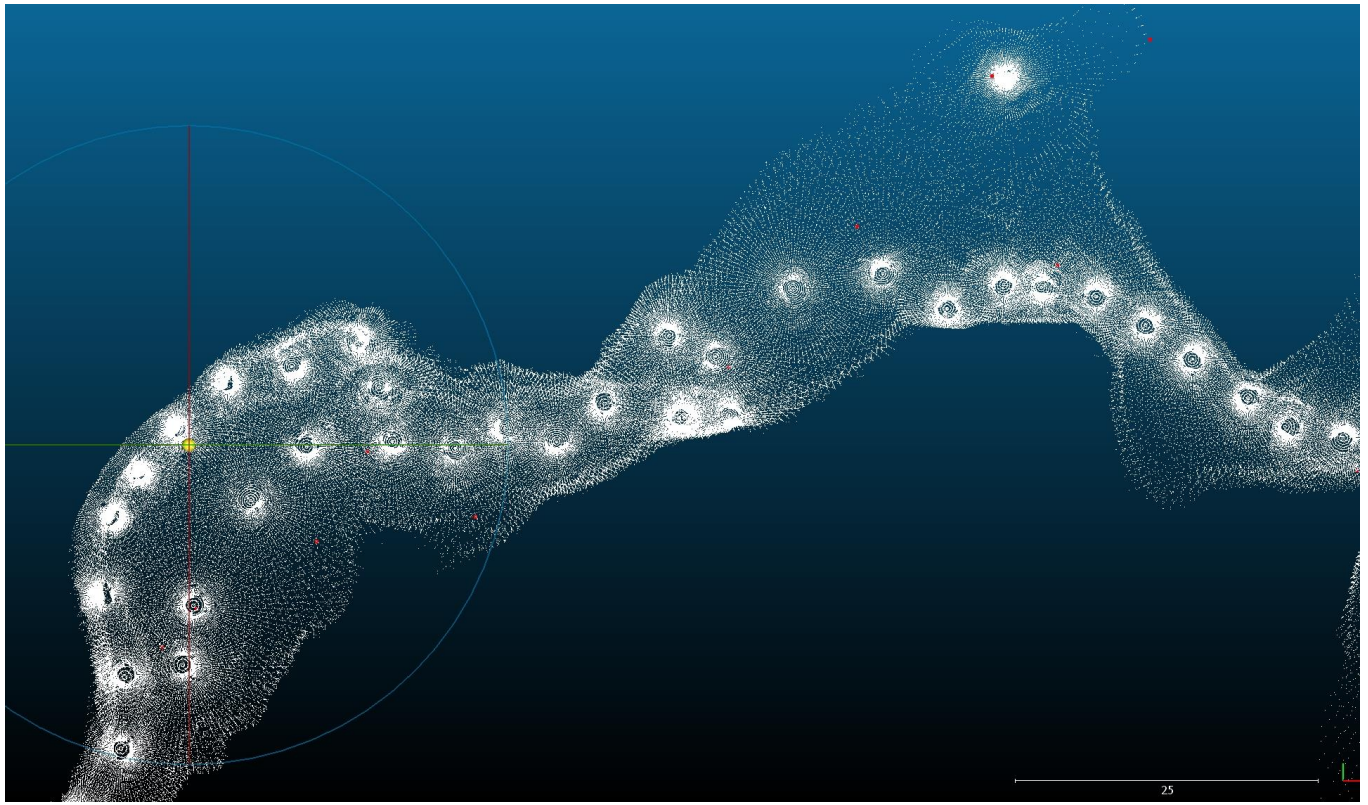


Point Cloud at Z02.



Mesh from Point Cloud

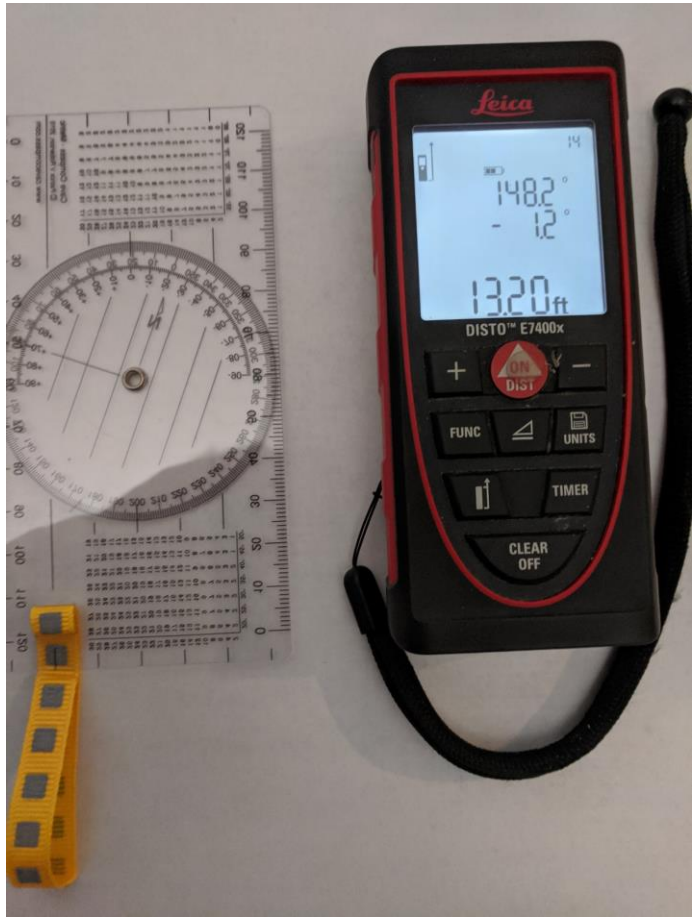
FSCSP Buecher LiDAR



Point Cloud Display from Buecher LiDAR Survey in Cave. 3D mapping used as input to CaverQuest modeling.

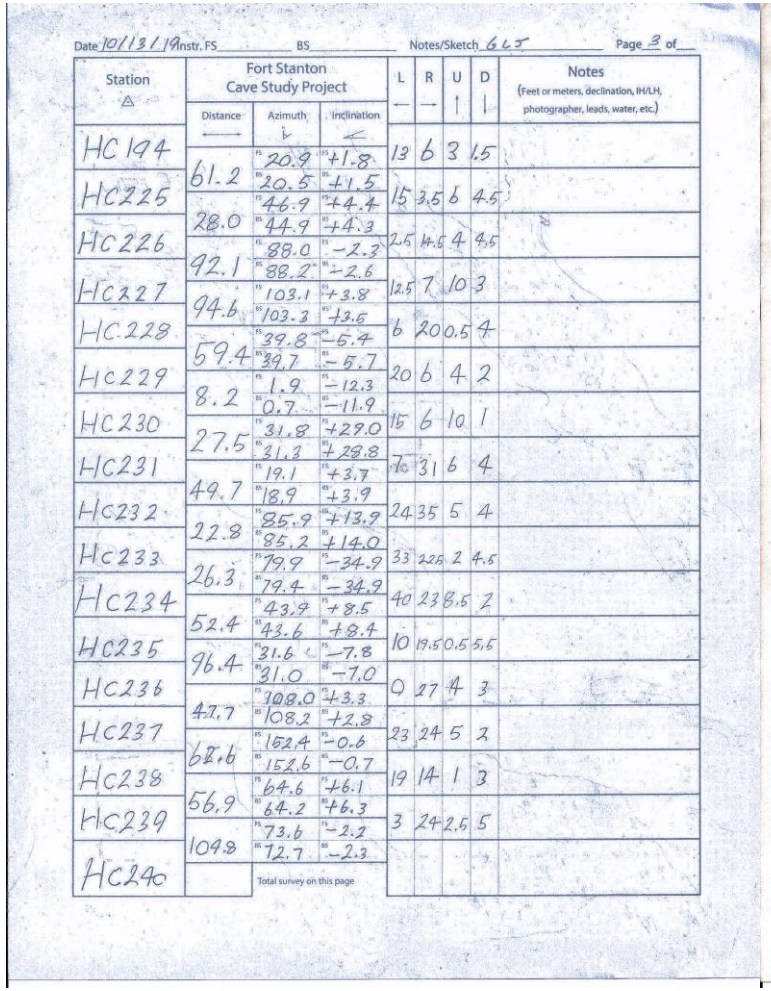
Plot by Ron Lipinski

DISTO-X,X2 HANDHELD TOTAL SURVEY STATION



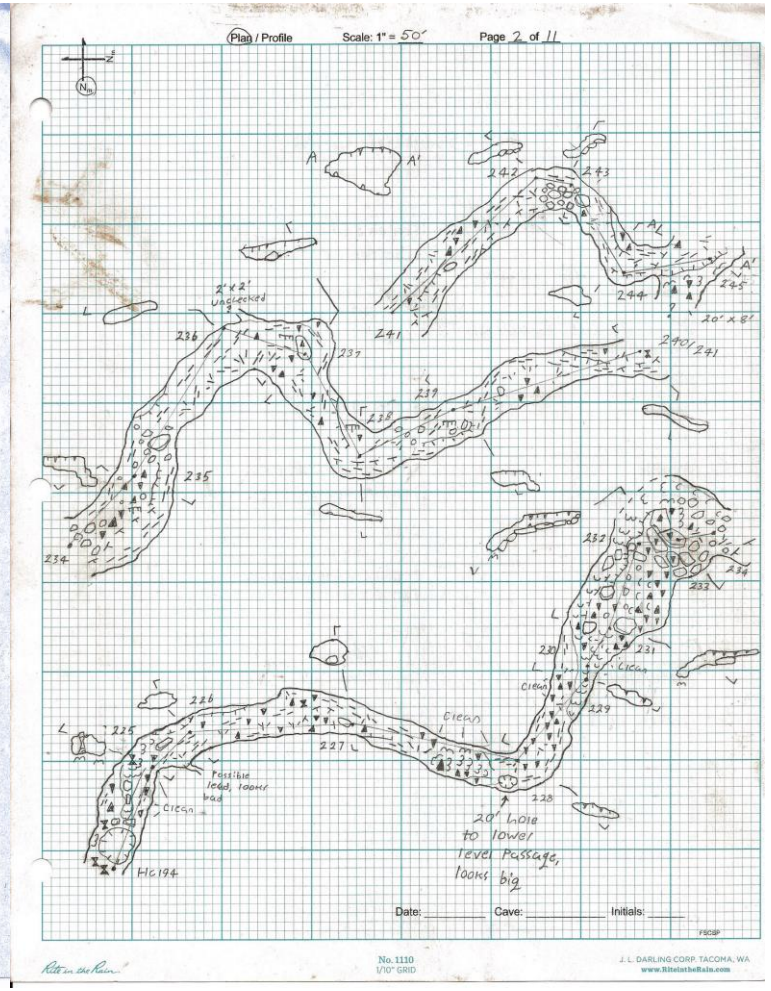
- Off-the-shelf Leica Disto 7400x Plus custom integrated daughter board to add Magnetic Azimuth
- When calibrated, reads azimuth and inclination to 0.1 degrees and distance to 0.01 ft (can also do metric distances).
- Plastic Cave Compass used to help plot sketch in cave.

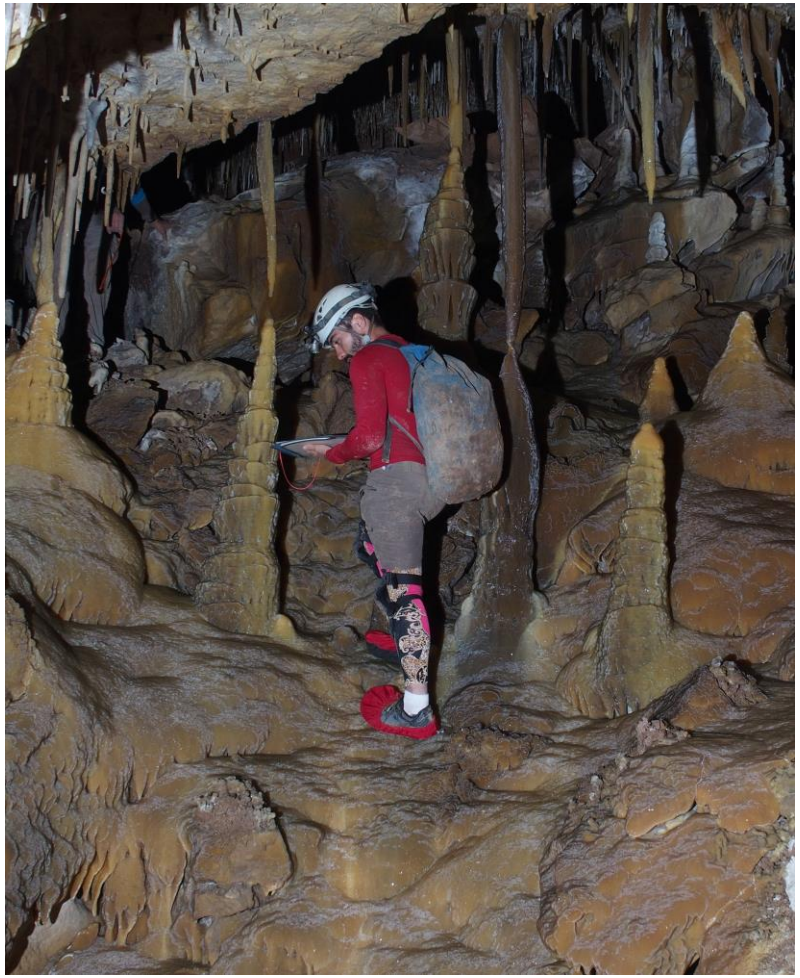
Recording Survey Data in Cave



Date 10/13/19 Instr. FS BS Notes/Sketch GLS Page 3 of

Station	Fort Stanton Cave Study Project			L	R	U	D	Notes (Feet or meters, declination, IH/LH, photographer, leads, water, etc.)
	Distance ⟶	Azimuth ↻	Inclination ⟲	⟵	⟶	↑	↓	
HC 194		ft 20.9	ft +1.8	13	6	3	1.5	
	61.2	m 20.5	m +1.5					
HC225		ft 46.9	ft +4.4	15	3.5	6	4.5	
	28.0	m 44.9	m +4.3					
HC226		ft 88.0	ft −2.3	2.5	14.5	4	4.5	
	92.1	m 88.2	m −2.6					
HC227		ft 103.1	ft +3.8	12.5	7	10	3	
	94.6	m 103.3	m +3.6					
HC 228		ft 39.8	ft −5.4	6	20	0.5	4	
	59.4	m 39.7	m −5.7					
HC229		ft 1.9	ft −12.3	20	6	4	2	
	8.2	m 0.7	m −11.9					
HC230		ft 31.8	ft +29.0	15	6	10	1	
	27.5	m 31.3	m +28.8					
HC231		ft 19.1	ft +3.7	10	31	6	4	
	49.7	m 18.9	m +3.9					
HC232		ft 85.9	ft +13.9	24	35	5	4	
	22.8	m 85.2	m +14.0					
HC233		ft 79.9	ft −34.9	33	22.5	2	4.5	
	26.3	m 79.4	m −34.9					
HC234		ft 43.9	ft +8.5	40	23	8.5	2	
	52.4	m 43.6	m +8.4					
HC235		ft 31.6	ft −7.8	10	19.5	0.5	5.5	
	96.4	m 31.0	m −7.0					
HC236		ft 108.0	ft +3.3	0	27	4	3	
	47.7	m 108.2	m +2.8					
HC237		ft 152.4	ft −0.6	23	24	5	2	
	62.6	m 152.6	m −0.7					
HC238		ft 64.6	ft +6.1	19	14	1	3	
	56.9	m 64.2	m +6.3					
HC239		ft 73.6	ft −2.2	3	24	2.5	5	
	104.8	m 72.7	m −2.3					
HC240	Total survey on this page							





Miscellaneous Surveys and Techniques

- **Palmer-Pole** (water filled tube) leveling
- **Precise Barometric Dataloggers** for leveling, stream channel profiling, etc.
- **Photogrammetry** – stream channel cross-sections, general 3D scene documentation, input to Caver Quest and Caver Trek (Oculus) maps.
- **Resistivity** – McLean, geophysical mapping of subsurface cavities.
- Ground Penetrating Radar – Land (NCKRI).
- **Microgravity Surveys** – McLean – mapping subsurface cavities
- **Seismic Experiments** – McLean -mapping subsurface cavities

RADIO LOCATION MAPPING

Precise Horizontal Coordinates (+ or – 1 ft per 100 feet of depth), Less Precise depth depending on Technique.

NOTE: Differential GPS locates the surface station, subsurface station is carefully leveled.

Surface surveys – GPS, THEODOLITE, LIDAR

- **Cave locations, Karst Features, Springs, Geological Features, Cultural Features**
- **FSCSP – GPS, Differential GPS, Pentax Theodolite, Transit**
- **NCKRI – Differential GPS**
- **BLM – Cadastral Data from various surveys,**
- **USFS – LiDAR data**

SELECTED STATISTICS FROM SURVEYS

Cave Passage Survey Length	68.2 Kilometers (42.32 miles)
Total Number of Survey Teams (1967-2022)	204
Total Number of Survey Team Members (1967-2022)	330+
Total Number of Survey Stations (Included in Length)	5405
Highest Station Elevation	1,972.2 Meters
Lowest Station Elevation	1,826.0 Meters
Volume of Surveyed Cave Passages	2,986,265.9 Cubic Meters
Average Passage Diameter	6.6 Meters

Acknowledgements

- Thanks to FSCSP and the board of Directors for helping manage the Survey Project.
- Thanks to FSCSP Chief Cartographer Brian Kendrick for assuming the burden after my retirement from that responsibility in 2015!
- Thanks to the hundreds of cavers and cave scientists for their contributions to the surveys and cartography.
- **Many thanks to BLM** and especially Knutt Peterson, Chuck Schmidt, and (former BLM Cave Specialist Mike Bilbo) for their support and good will in permitting the extensive cave entries needed over the past 55 years that the cave survey has been working.

Questions?