



Location
Grottoes,
Virginia



Scanned
Grand
Caverns



Scan size
500
meters



Scan time
12
minutes



Industry
Education

History, geotourism & science

Discovered in 1804 by Bernard Weyer in the heart of Virginia, Grand Caverns (formerly Weyer's Cave) is the oldest show cave in the USA. During the US civil war, the cave was used by both Confederate and Union soldiers as part of the Valley campaign, during which time over 230 soldiers signed their names on to the cave walls. More recently, the cave has become a huge tourist attraction, due to its beauty, location and being surrounded by scenic trails for hiking, running, and biking, but it has also captured the attention of the scientific community because of recent discoveries of new passages and the rock formation changes over time.

The town of Grottoes (where the show cave is located) partnered with Angel A. Garcia Jr. and his students from James Madison University to create a 3D map of the cave. The 3D point cloud is being used to measure Speleothems, monitor the human impact on the cave, create 3D printed models and to celebrate the

show cave's extensive history, shining a light on its geoheritage. In addition, it is a fantastic opportunity for the undergraduate students of JMU to get hands on experience with the handheld LiDAR scanner and the data it outputs.

Angel A. Garcia Jr. chose GeoSLAM's **ZEB Horizon** scanner to take on the task of mapping both the parts of the cave open to the public and the recently discovered, vast passages. He and his students capitalise on the speed of capture and accuracy of the scanner to review and analyse data in a quick and efficient manner.

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With the LiDAR we'll be able to get into corners and see what hasn't been looked at for a long time.

Lorelei Dellavedova | JMU geology student and research assistant





It's going to be able to detect the stalagmites, the stalactites and it's even going to be able to detect the cave shield because it's that precise.

Professor Garcia | Assistant Professor

Scanning with the ZEB Horizon

Having originally purchased the **ZEB Horizon** back in February 2021 to collaborate and share data with partners scanning caves using ZEB devices in Puerto Rico, Professor Garcia began to see the potential and opportunities the scanner offered. Fast, accurate and handheld data capture opens a way to map an area without the need to GPS or complicated setups. In addition, the scanners ease of use means that undergraduate students can be involved in the project with limited to no training.

Since beginning to use the **ZEB Horizon**, interest in Professor Garcia's work with the SLAM scanner has escalated, and he has subsequently been invited to other universities to run workshops. In April 2021, he was approached by Grand Caverns to map the historic show cave.

The public area of the cave is approximately 500 meters in length, 30 meters high and has stairways in places, so it is quite a large area to capture. Professor Garcia and his students were able to capture the entire public area in approximately 12-15 minutes, by simply walking and scanning. He pointed out that a terrestrial laser scanner would be able to capture the public part of the cave, but it would take days, not minutes, and due to the uneven surfaces of the non-public area of the cave, it would be impossible to get a tripod-based system down there. Alternatively, you could measure a cave using a distometer, but this could take months, if not years to complete.

The **ZEB Horizon** was able to give them a quick accurate scan in 12 minutes, so the students could get to work reviewing the data for their various projects.

The data is being processed using **GeoSLAM HUB**, and **GeoSLAM Draw** is being utilised by the team to accurately measure the speleothems over time. The students can see the orientation, thickness and gather measurements using the LiDAR information alone. They are also hoping to use **GeoSLAM Draw** to understand accurate dimensions of the cave. Furthermore, the 3D point cloud is being used as a base to 3D print the cave within a rectangular block, for further research purposes.

The team continued to scan the cave over the Summer, and Professor Garcia is working with the caving/spelunking community of experts to begin capturing the more problematic and recently discovered new passages of the cave. These areas have not been designed for the public at the moment, so there are uneven surfaces and narrow corridors, but due to the **ZEB Horizons** mobility, capturing previously unseen parts of cave will be quick and safe.

Professor Garcia concludes by saying that the 3D model will provide an opportunity for those who can't physically enter the caverns, to learn what they are all about.



Zach Thomas, Lorelei Dellevedora, Lily Whitman and Angel A. Garcia Jr.

