

Creating a Multi-Sourced, Ultra-High Resolution 3-D Karst Aquifer Model Using LADAR, SONAR, and Earth Resistivity Datasets.

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Channelized karst aquifers represent some of the most complex hydrogeological features known. Charting such three dimensional labyrinths and interpreting the various geological and hydrological relationships, particularly between sub-surface and surficial features, has been extraordinarily difficult. Two recent technologies – LADAR and phased array sonar – and improved earth resistivity techniques, promise the ability to model such features in detail in a fully three-dimensional capacity and to link metadata to the model through the use of immersive interactive graphics.

Zacatón, likely the deepest cenote in the world, has a sub-aquatic void space exceeding 7.5×10^6 cubic meters, and likely much larger is the focus of this study in which we are creating a detailed 3D map of the entire system. The interactive map, when completed, will include data from above the ground surface, beneath the water table, and in the rock matrix itself, and will be used to gain more accurate knowledge of the extent of these immense karst features and to interpret the geologic processes that formed them.

Phase 1 of the research, completed in January of 2002, involved high resolution (20 mm) LADAR scanning of surficial features, including four of the largest cenotes in the complex. Advantages to using LADAR, a ground-based, static mount equivalent to aerial platform based LIDAR imagery, include imaging under tree canopies, manmade structures, or within overhung rock structures. Scan locations -- selected to achieve full feature coverage once registered -- were established atop surface benchmarks whose UTM coordinates were established using GPS and Total Stations. The combined datasets will be meshed to form a geo-registered TIN that will represent surface features down to water level inside the cenotes.

Phase 2 is to begin in January 2003 and will entail subsurface imaging using Earth resistivity geo-physical methods. Spatial data from this technique will identify other void spaces isolated from open flow conduits and large variations in water chemistry. The most innovative aspect of this project will be Phase 3, during which the team will acquire high-resolution imagery of the underwater voids. We plan to modify the 3D Digital Wall Mapper used to image the deep Floridian aquifer in 1999 during a National Geographic expedition, and produce a detailed TIN of the Zacatón phreatic zone.