

# DEPTHX Autonomous Underwater Robot

Image analysis systems and a robotic arm developed by Southwest Research Institute® (SwRI®) engineers helped a NASA-funded, deep-diving robot seek out and collect biological samples from the bottom of one of the world's deepest water-filled sinkholes.

The DEep Phreatic THERmal eXplorer (DEPTHX), an autonomous underwater robot, descended 1,099 feet to the bottom of the Zacaton sinkhole near Tampico, Mexico. The May 2007 mission tested technology that could be used to explore Europa, the fifth moon of Jupiter, which is believed to contain an ocean of liquid water beneath its icy crust.

The distance and isolation of ice-covered oceans on Europa will require a robot that can operate independently, much like a human explorer. The Zacaton mission demonstrated that the robot can explore and search for life completely autonomously.

Future tests of the DEPTHX navigation and autonomous operation methods will be done by NASA in conjunction with the National Science Foundation in Antarctica. There, an upgraded DEPTHX will study Lake Bonney, a permanently ice-covered lake that more closely resembles Europa than the warm waters of Zacaton.

## Sample Collection

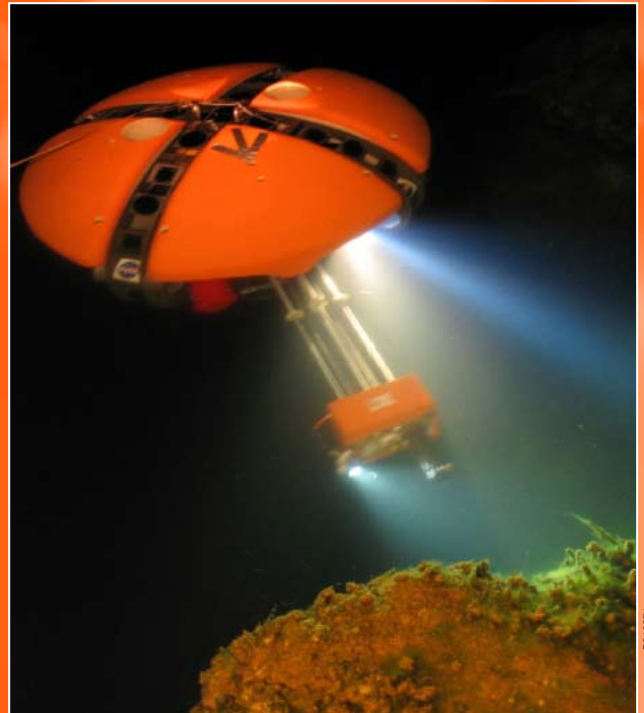
DEPTHX has more than 100 sensors, 36 onboard computers, video cameras and a hydraulically operated robotic arm that reaches six feet beyond the vehicle edge. The SwRI-developed robotic arm carries a video camera, a tube for collecting water samples and a replaceable coring tube. The hollow coring tube is driven about an inch into a surface and automatically rotates, retracts and closes to secure the sample.

## Sample Analysis

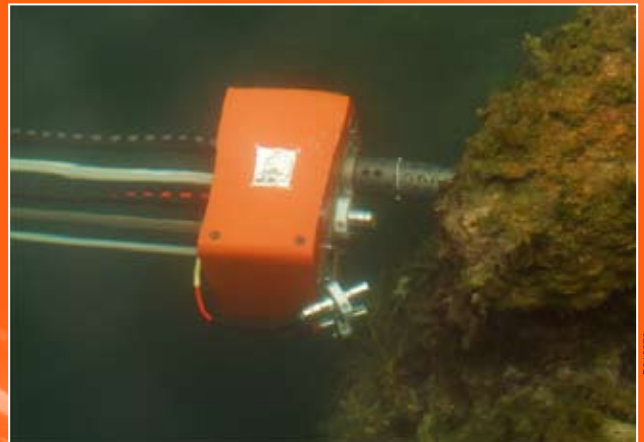
- A water sample is pumped into a flow cell and a sequence of images is analyzed to detect the motion and frequency of microorganisms.
- Color images of the wall are analyzed to characterize the color and texture of wall surface regions.
- Image analysis algorithms developed by SwRI are used to identify patterns associated with living organisms.
- Samples are then obtained from locations with a high microbe concentration or unusual image attributes.

## Project Team

Funded by NASA's Astrobiology Science and Technology for Exploring Planets program, the DEPTHX project was led by Stone Aerospace and included participation by SwRI, Carnegie Mellon University, The University of Texas at Austin, Colorado School of Mines, and the University of Arizona.



*DEPTHX successfully navigated 1,099 feet to the bottom of the Zacaton sinkhole, collected water and solid samples, and returned to the surface. The samples are undergoing analysis, and scientists hope to discover entirely new strains of bacteria and algae. (Photo compliments of David Wettergreen/Carnegie Mellon University)*



*The SwRI-developed hydraulically operated robotic arm carries a video camera, a tool for collecting water samples and a replaceable coring tube for collecting solid samples of algae mat or other growth on the sinkhole wall.*



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