Southwest Research Institute Investigations of Harsh Environments: Implications for Planetary Science Probes and Astrobiology

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Caves became an extraterrestrial phenomenon in 2006 with their discovery on Mars. In that same year, caves became a major environmental science issue when white nose syndrome (WNS) was discovered in a cave in Schoharie County, New York. In 2009, caves were also discovered on the Moon. As of today, dozens of cave features have been discovered on Mars and over 200 on the Moon, and a fungus well-adapted to cold cave environments has killed over six million bats.

SwRI has conducted numerous investigations in harsh environments, including UAVs for volcanos, submersibles in aquifer and marine environments, and mass spectrometry of cave environments. In 2011, staff from SwRI were the first to take a mass spectrometer into a cave to conduct a survey in real time of the composition and evolution of the atmospheric background gases. That investigation also included the sampling of air from several Texas caves and aquifer wellheads for subsequent GCMS in the lab. Our efforts in prototyping portable analytical chemistry instruments in the field have implications for mass spectrometers designed for planetary science and astrobiology, and vice versa.

Here we review some of the harsh environments explored by SwRI. We also report on development efforts to reduce size, mass and power consumption with prototype instruments which include the Multi-Bounce Time-of-Flight (MBTOF) mass spectrometer and the Cycloidal Focusing Mass Spectrometer (CFMS). Laboratory efforts include GC×GC-MS investigations of cave environments, as well as laboratory systems for atmospheric and space environment simulation. Our goal? The miniaturization of laboratory instrument capabilities for probing not only harsh terrestrial environments, but also the subsurface of extraterrestrial ocean worlds such as Titan and Europa.