DIVERSE CHEMICAL ENVIRONMENTS IN AN EXTREMOPHILE SULFIDE CAVE SYSTEM: TERRESTRIAL ANALOGS FOR A EUROPAN OCEAN.
Michael J. Malaska[1], Hilary S. Kelly[2], Penelope J. Boston[2], Mike Spilde[3], Laura Rosales-Lagarde[4], [1]Jet Propulsion Laboratory / California Institute of Technology, Pasadena, CA. [2]New Mexico Institute of Mining and Technology, Socorro, NM. [3]University of New Mexico, Albuquerque, NM. Georgia Southern University, Statesboro, GA. (Michael.J.Malaska@jpl.nasa.gov).

Introduction: The sulfide-rich waters of the Cueva de Villa Luz cave near Tapijlapa, Tabasco, Mexico harbor diverse communities of organisms supported by the microbial oxidation of hydrogen sulfide (H_2S) [1]. In this cave, H_2S-rich spring waters mix with oxygenated spring waters (Figure 1). This chemical environment allows microbes such as *Thiobacillus* sp. to form large colonies (Figure 1). Their metabolism is driven by the oxidization of hydrogen sulfide to sulfuric acid: $H_2S + 2O_2 \rightarrow H_2SO_4$.

Figure 1. Underground stream waters in Cueva de Villa Luz . Flow on the left is from an H_2S spring, while flow on the right is from oxygenated waters. Note lack of rimstone dam in acidic H_2S-laden waters. Inset: Cave "phlegmball"composed of an H_2S-oxidizing bacterial community sampled from underwater muds immediatedly downstream from the main image.

Previous exploration and characterization of the water chemistry at Cueva de Villa Luz suggested that there were two types of springwaters: those that were sulfide-rich and those that were oxygenated [2]. As part of a multi-pronged scientific expedition to further examine the cave system and it's implications for astrobiology, we carried out a systematic and detailed mapping of the characteristics of the springs and waters of the cave system.

The waters of Cueva de Villa Luz can be compared to subsurface oceanic environments of Jupiter's moon Europa. On Europa, hydrothermal vents could disgorge H_2S into the ocean from the bottom, while subduction of UV-photolyzed ice could inject oxygenated species into the ocean from the top [3].

Methods: Using a KOR EXO-1 chemical sonde, we systematically tested the waters at over 70 locations inside the cave and at two locations near the exterior resurgence of the cave.

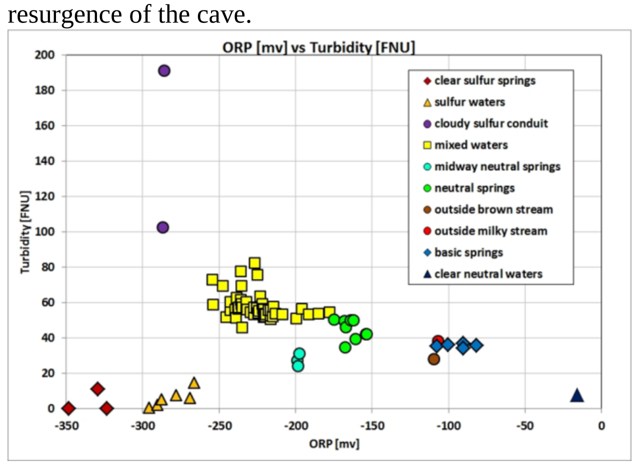

Figure 2. Plot showing characteristics of classified sampled water plotted as ORP vs. Turbidity.

Results: We clustered the sampled characteristics (Figure 2), and classified over 8 aqueous environments in the cave. We found that the different classes were spatially localized within the cave. In particular, a previously unidentified H_2S spring type, the cloudy sulfur conduits, had very high turbidity, and was located physically away from the other sulfur-rich springs which suggested an alternate H_2S source.

Our work has identified several chemical environments in the waters of Cueva de Villa Luz. Each of these chemical environments has the potential to be an analog for an extraterrestrial ocean on an icy world such as Jupiter's moon Europa. Characterization of these chemical environment and their associated microbial communities can help refine parameters for habitable environments on Europa.

Acknowledgements: This research was supported by an appointment to the NASA Postdoctoral Program at the Jet Propulsion Laboratory, administered by Oak Ridge Associated Universities through a contract with NASA. The expedition to Cueva de Villa Luz was supported by the National Geographic Foundation.

References: [1] Hose and Pisarowicz, (2000) *Journal of Cave and Karst Studies*, 61, 13-21. [2] Hose et al., (2000) *Chemical Geology*, 169, 399-423. [3] Greenberg, (2009) Astrobiology, 10, 275-283.