A MULTI-SENSOR PAYLOAD CONCEPT FOR THE EXPLORATION OF PLANETARY UNDERWATER HYDROTHERMAL SYSTEMS. P. Sobron[1], L. M. Barge[2], J. Amend[3], M. Church[4], L. Dubord[2], K Fristad[5], B. Kirkwood[6], A. Misra[4], K. Nealson[3], M. Parente[7], R. Price[8], M. Russell[2], M. Smith[9], K. Zacny[10], R. Leveille[11], B. Reese[3], B. Thornton[12], K. Takai[13]. [1]SETI Institute Carl Sagan Center, [2]Jet Propulsion Laboratory, [3]U. South California, [4]U. Hawaii, [5]NASA Ames, [6]MBARI, [7]U. Massachussetts, [8]Stony Brook U., [9]Citrus College, [10]Honeybee Robotics, [11]McGill U., [12]U. Tokyo, [13]JAMSTEC. Contact: psobron@seti.org

Science and Technology Motivations: Underwater hydrothermal systems (UHS) are produced by volcanic activity (e.g. black smokers) or directly by water-rock reactions (e.g. serpentinization and production of alkaline vents). The supply of reduced chemical substrates from hydrothermal vents in these environments—and perhaps in analogous environments on icy worlds—enables the growth of diverse biological communities that are capable of harnessing energy from ambient geochemical gradients. The hydrothermal fluids, mineral precipitates, and type of metabolism that could thrive in a particular vent are therefore highly specific to the geological setting. To develop strategies for exploring vents on worlds where we lack knowledge of environmental specifics, we must first develop instruments and adaptive exploration concepts that are conducive to analyzing a variety of vent conditions and possible types of life.

In response, we have developed a new concept for a robotic payload for UHS exploration. It utilizes high-resolution 3D mapping and laser Raman, laser-induced breakdown spectroscopy, and laser-induced native fluorescence (LRS+LIBS+LINF) to perform integrated, context preserving, stand-off, *in-situ* characterizations of vent fluids and mineral precipitates (Figure 1).

Our concept puts forward three transformative innovations for the *in-situ* exploration of vents. First, it takes advantage of the high resolution 3D mapping enabled by LIDAR and Imaging and the synergistic data return of LRS, LIBS, and LINF, to perform integrated, context-preserving, stand-off, *in-situ* characterizations of vent fluids and precipitates. Second, it leverages the capability of a coring tool & robotic manipulator to acquire cores of hydrothermal precipitates and reveal them to the LRS/LIBS/LINF sensor, thus enabling *in-situ* spectroscopic depth profiling of mineral precipitates and sediments. Third, it implements adaptive multi-sensor data processing and automated interpretation routines for real-time integrated data management and extraction of scientific information. The unique data-collection abilities of this concept have the potential to inform the selection of drill targets, determine their astrobiological potential, and inform decisions about whether a core should be cached and returned. Our concept is designed around moderate-cost, high-heritage technologies to reduce program cost, risk, and time-to-flight. Here, we describe our concept and an early-stage prototype, and discuss a proof-of-concept demonstration of our payload.

Feasibility Study: The samples are mineral precipitates from the chimney wall of a deep-sea black smoker at the mid-Okinawa Trough (see companion abstract in this session). We simulate underwater operation by immersing solid samples in a seawater tank and measuring LRS+LIBS+LINF from the outside of the tank (Figure 2). The microimages and the LRS/LIBS spectra show features consistent with sulfides, mainly chalcopyrite, a common metal sulfide mineral in acidic hydrothermal systems. The LINF peaks indicate the presence of organic material. The data obtained so far demonstrate the feasibility of using LRS+LIBS+LINF for detecting minerals and organics in black smoker precipitates *in-situ* and in near real time.

Significance: Our innovations promise to be extremely valuable tools in the exploration of hydrothermal vents and to inform future mission planning. These tools will simplify operational strategies for identifying, characterizing, and collecting samples of interest.

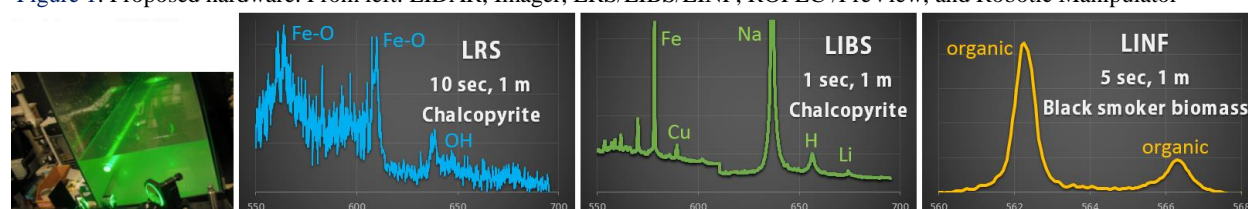Figure 1. Proposed hardware. From left: LIDAR, Imager, LRS/LIBS/LINF, ROPEC /PreView, and Robotic Manipulator

Figure 2. LRS/LIBS/LINF proof of concept setup and results obtained from a black smoker sample. Horizontal axes in nm