WATSON: A WIRELINE ULTRAVIOLET RAMAN AND FLUORESCENCE SPECTROMETER FOR SUBSURFACE ORGANIC DETECTION IN NORTHERN ICE SHEETS. E. Eshelman[1], G. Wanger[1,2], M. Willis[3], B. Carrier[1], W. Abbey[1], M. Malaska[1], L. W. Beegle[1], L. DeFlores[1], J. Priscu[3], A. L. Lane[1], B. Mellerowicz[4], D. Kim[4], G.Paulsen[4], K. Zacny[4], and R. Bhartia[1], [1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena Ca, 91109 (Evan.J.Eshelman@jpl.nasa.gov, Rohit.Bhartia@jpl.nasa.gov), [2]University of Southern California, [3]Montana State University, [4]Honeybee Robotics

Introduction: Organic and life-detection instruments that can investigate the chemical environment in-situ while preserving the spatial context of deposition enable missions to the Mars polar caps, as well as icy worlds including Europa and Enceladus. The Wireline Analysis Tool for Subsurface Observation of Northern ice sheets (WATSON) is an instrument under development at NASA's Jet Propulsion Laboratory in collaboration with USC, MSU, and Honeybee Robotics. The instrument, shown in Figure 1a, is being integrated with an electromechanical drill under development by Honeybee Robotics, shown in Figure 1d. The WATSON drill is based on Honeybee's AMNH Deep Drill, successfully tested in a Gypsum quarry outside Salton Sea, CA in 2015 [1].

WATSON will investigate the organic distribution within subsurface ice by drilling to a depth of 100 m and mapping the interior of the ice borehole with dual deep UV Raman and fluorescence spectrometers operating at an excitation wavelength of 248.6 nm. WATSON leverages high-TRL technologies developed for SHERLOC [2], the deep UV Raman and fluorescence instrument selected for Mars 2020. Analysis of ice shavings returned to the surface by the Honeybee drill will aid in understanding and interpreting the Raman and fluorescence data obtained in-situ. In addition to detecting and characterizing organic material in subsurface ice, WATSON is intended to help understand whether analyses of a single site can provide information regarding organic content and distribution over geological timescales.

Organic detection in sub-surface ice: Benefits of deep UV excitation include a pre-resonance or resonance Raman enhancement in some organics, and a Raman window below 270 nm, out of the fluorescence region [3]. UV laser-induced fluorescence occurs with a cross section that is typically several orders of magnitude stronger than Raman scattering, and can be used to rapidly detect bacteria or concentrations of organic material [4].

With the WATSON instrument, fluorescence maps across a sample will be obtained rapidly and can be used to identify regions of interest for subsequent Raman scans to detect and characterize any organic material present. Laboratory work in parallel to our instrument development is currently correlating fluorescence emission with organic deposits in ice, and work continues to understand the relationship between fluorescence emission and the likelihood of obtaining a strong Raman signal indicating the presence of C=C, C-H, or other chemical bonds.

An initial field test in Kangerlussuaq, Greenland in March 2017 will provide an opportunity to investigate ice conditions within the borehole. 2018 and 2019 deployments to Kangerlussuaq, Greenland and Summit, Greenland respectively will demonstrate full operation of WATSON to a planned depth of 100 m.

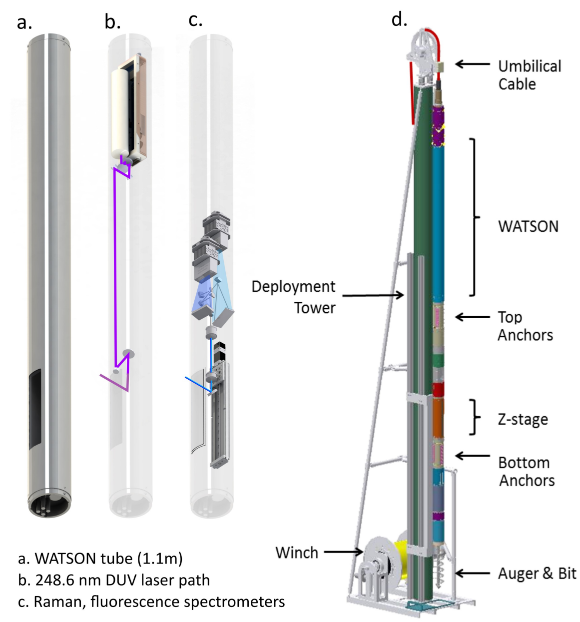

Figure 1. WATSON schematic showing (a) ~1 m housing, (b) 248.6 nm laser path to the ice surface, and (c) the light return into separate Raman and fluorescence spectrometers, and (d) the Honeybee drill and deployment system.

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