THE ASK (ASTROBIOLOGY SEARCH KIT) INSTRUMENT H. D. Smith[1], A.G. Duncan[2], C.R. Lloyd[2]. L.D. Merrill[2], P.L. Neary[2] and E. Quigley[3] 1. KIPR/ NASA Ames Research Center, Moffett Field, Ca 94035. Heather.D.Smith@NASA.Gov 2. Retego Labs, Centerville, UT 84014 3. NASA Ames Research Center, Moffett Field. CA 94035.

Introduction:. Astrobiology Search Kit (ASK) instrument is a field portable spectrometer that: 1) Searches for evidence of biomarkers common to life on Earth; and 2) Assesses the habitability of the surface material (liquid, ice, soil) by measuring chemical constituents and mineralogy.

The scientific basis of the instrument is wet chemistry combined with spectroscopy. Specifically, transmission, reflectance and organic (biological and geochemical) native fluorescence. Reagents for the wet chemistry assays are freeze dried providing a three year shelf life stability. For the geochemical assessment, we use wet-chemistry protocols that are well-established and proven assays.

ASK uses both contact ad non-contact methods. The contact method is similar to current techniques in environmental assays and medical diagnostics. These methods are indicative of specific lipids and proteins, common to most organisms on Earth. The non-contact method is spectroscopy- fluorescence, transmission, and reflectance. We search for extant life, biosignatures, and the chemistry surrounding those biomolecules. Employing multiple techniques allows for redundancy within the same sample- essential to life detection verification.

The ASK instrument is relevant to several potential near-term missions. We compare the ASK instrument capability to the mission goals/objectives of the Europa Lander directed mission. We have chosen this mission as the example since the mission goals and preliminary requirements are described in the Europa Lander Science Definition report. With that said all biology has the same biochemistry, the fundamental core biomolecules and geochemical methods are applicable to other planetary bodies.

The size for ASK instrument is in the 1U range and could be a payload on a mission ranging from an interplanetary cubesat size to a New Frontiers Icy moons mission.

Science Objective	ASK Instrument measurement	Mission Science Objective Relevance
1. Search for Life	Biomolecules- detection via native fluorescence ATP, NADH, Chlorophyll a. Tryptophan, tyrosine, phenylalanine amino acids. Nucleic acid and lipid- detection through "wet chemistry array"	Terrestrial bodies: Mars Surface mission-discovery class. Europa or Enceladeus surface mission. - New Frontiers or Directed mission.
2. Habitability / Geochemical surface processes	Wet Chemistry array- elemental chemistry, pH, N CHNOPS elements, Calcium carbonate.	Terrestrial bodies: Lunar CubeSat to measure regolith chemistry for organics and trace minerals. Water chemistry of melted ice- Europa, Mars.

Science Goal: *1. Search for evidence of biomarkers and /or life, especially extant life.*

On Earth, all organisms that we know of have similar biochemistry- they use the same 20 amino acids, have nucleic acids (DNA or RNA), use the TCA Krebs cycle for energy and rely on Carbon, Hydrogen, Nitrogen, Oxygen, Phosphate, and Sulfur elements (CHNOPS). Due to these commonalities of life on Earth, our life detection instrument suite aims to detect aspects of each of these. The ASK instrument utilizes complementary biomolecule (life detection) methods using spectroscopy (including fluorescence) and biochemical assays based on enzymatic reactions in the Krebs cycle to gain an understanding of the biological mileau of the sample.

The biomarker assay employs dry chemistries, and transmission and fluorescence and spectroscopy. The core detection technology utilizes the Patent Pending (US 2017/0038357-A1) Retego Labs advanced spec-

trometer. We have a complement of wet chemistry and fluorescence assays to detect universal compounds (DNA, RNA, NADH, and ATP for instance) and unique compounds to a specific extant life process such as (F420) in methanogens. The biomarker assays provide an insight into the diversity and evolution of microbial life providing a glance into the microbiome of the planetary body.

Science Goal 2: *Asses the habitability (particularly through quantitative compositional measurements of Europa via in situ techniques uniquely available to a landed mission.* Our search for extant life on Ocean Worlds begins with assessing the habitability by determining the basic chemistry of the sub-surface brine through a combination of in-situ chemistry assays and spectroscopy with a flight modified version of the COTS Retego Labs TTR-1 Advanced Spectrometer- the basis for the ASK instrument.

The Retego Labs Advanced Spectrometer is designed for chemistry assays in brine produced water from the oil and gas industry. The brine water from these fields ranges from low to near saturation. Retego Labs designed a method using *dry* chemical assays combined with fluorescence to measure the desired constituents within the brine (listed in the table below). These assays are specifically designed for brine environments, have more than a four year shelf-life and require no additional liquid reagents.

Water Chemistry Assay	**Detection Range**	**Time for assay**
Total Hardness	3 to 570 mg/L	60 seconds
Total Dissolved Solids (TDS)	10 to 250,000 mg/L	60 seconds
Sulfide	0.05 to 33 mg/L	60 seconds
Sulfate	2.5 to 1600 mg/L	60 seconds
pH	2 to 10 pH units	60 seconds
Nitrite	50 to 4000 ppb (0.5 to 40 mg/L)	60 seconds
Ferrous Iron	0.06 to 18 mg/L	60 seconds
Ferric Iron	1 to 115 mg/L	60 seconds
Copper	0.2 to 20 mg/L	60 seconds
Chromium (Hexavalent)	0.01 to 3 mg/L	60 seconds
Chloride	10 to 15,000 mg/L	60 seconds
Calcium (as $CaCO_3$)	2 to 500 mg/L	90 seconds
Boron	1 to 150 mg/L	90 seconds
Alkalinity	12 to 1500 mg/L	90 seconds

In this presentation we describe the ASK instrument and present preliminary results on the instrument biomarker capability.

References:

[1] National Aeronautics and Space Administration. (2016). Europa Lander Study 2016 Report. JPL D-97667. Task Order NNN16D011T.