THE ASTROBIOLOGY ANALYTICAL LABORATORY AT NASA GODDARD SPACE FLIGHT CENTER: ANALYSIS OF SOLUBLE ORGANIC COMPOUNDS IN EXTRATERRESTRIAL SAMPLES. J. E. Elsila1,*, J. C. Aponte1, D. P. Glavin1, H. V. Graham1, H. L. McLain1,2,3, A. Mojarro1,4, E. P. Parker1, F. Seguin1,2,5, D. N. Simkus1,2,3, G. M. Weiss1,2,5, and J. P. Dworkin1. 1NASA Goddard Space Flight Center, Greenbelt, MD 20771, 2Center for Research and Exploration in Space Science and Technology, NASA/GSFC, Greenbelt, MD 20771. 3Department of Physics, Catholic University of America, Washington, D.C. 20064, 4NASA Postdoctoral Program, Oak Ridge Associated Universities, Oak Ridge, TN, 37831, 5Center for Space Sciences and Technology, University of Maryland Baltimore County, Baltimore, MD 21250.

Introduction: The Astrobiology Analytical Laboratory at NASA Goddard Space Flight Center is an ~1800 ft² unique facility dedicated to analyzing organic compounds in terrestrial analogs and extraterrestrial materials (Figure 1). Our primary work focuses on identification and quantitation of soluble organic compounds, as well as measuring the enantiomeric ratios of chiral species and determining stable isotopic compositions. We welcome collaborations with researchers who have complementary techniques, intriguing samples, and/or relevant science questions.

Laboratory Instrumentation: Our fundamental analytical approach is a targeted search by compound class using chromatographic separation of sample extracts and mass spectrometry (MS). We are equipped with a wide variety of analytical instruments: liquid and gas chromatographs (including ultrahigh precision liquid chromatography and tandem gas chromatography) and a range of MS techniques including Orbitrap MS, quadrupole-time-of-flight MS, triple quadrupole MS, and isotope ratio MS (bulk and compound-specific analyses, with current work to optimize position-specific isotope analysis [1]), along with a variety of possible ionization sources. We typically derivatize liquid extracts for analyses targeted by compound class but we can also pyrolyze bulk solid or isolated samples prior to GC-MS analysis, pyrolyze in the presence of wet chemistry reagents for silylation or methylation of thermally unstable and less volatile analytes, introduce samples by direct analysis in real time (DART), introduce hypervolatiles in the gas phase, or survey unknowns without derivatization.

We routinely perform sample preparations including extractions (e.g., using hot water, organic solvents with or without heating, or room-temperature sonication), acid vapor hydrolysis, desalting, and derivatization techniques targeting specific compound classes [2]. We have a variety of sample preparation capabilities, including an ISO <8 white room with a fume hood and two ISO 5 HEPA filtered benches. Supporting equipment includes balances and microbalances, furnaces for pyrolyzing glass and substrates, freeze dryer, stereo microscope, a torch, rotary evaporator, vacuum concentrators, ultrahigh purity water, glassware, a gas manifold, oxygen/propane torch for sealing glassware, chemical fume hoods, a cryoball mill, a nitrogen glovebox, meteorite safes, backup power, and a dedicated data server with daily backups to a different building.

Research and Collaboration:
Our lab focuses on science questions related to the origin, distribution, and evolution of organic compounds throughout the Solar System. We analyze terrestrial and extraterrestrial samples including meteorites [3-7], lunar regolith [8], and returned cometary [9, 10] and asteroidal [11, 12] samples. We also analyze laboratory analogs created to support in situ Mars missions and the impact of ionizing radiation on organics [13, 14] and to simulate potential astrochemical processes or environments [15]. We compare our results to modeled or predicted astrochemical processes [16, 17]. In addition, we study questions related to curation and contamination of precious extraterrestrial samples [18, 19]. We aim to quantify compounds present in low abundances in highly complex mixtures while controlling or understanding terrestrial contamination. We routinely study compounds such as amino acids, amines, carboxylic ac-
ids, aldehydes, ketones, cyanide species, alcohols, peptides, polycyclic aromatic hydrocarbons, and hypervolatiles, and we continue to expand our list of targeted compound classes.

Although we are not equipped to serve as a “facility instrument” or to provide analyses for hire, we are open to collaborations. We have hosted visiting scientists and students through a variety of programs and have been part of many cross-institutional proposals to various NASA programs. Interested researchers are encouraged to reach out to discuss potential collaborations. We welcome conversations about both short-term projects (e.g., analyses of a single sample of interest) and longer-term (e.g., investigations of processes through laboratory simulations). Please visit our website for additional information:

https://science.gsfc.nasa.gov/691/analytical/

References: