Summary of NASA Postdoctoral Program Activities

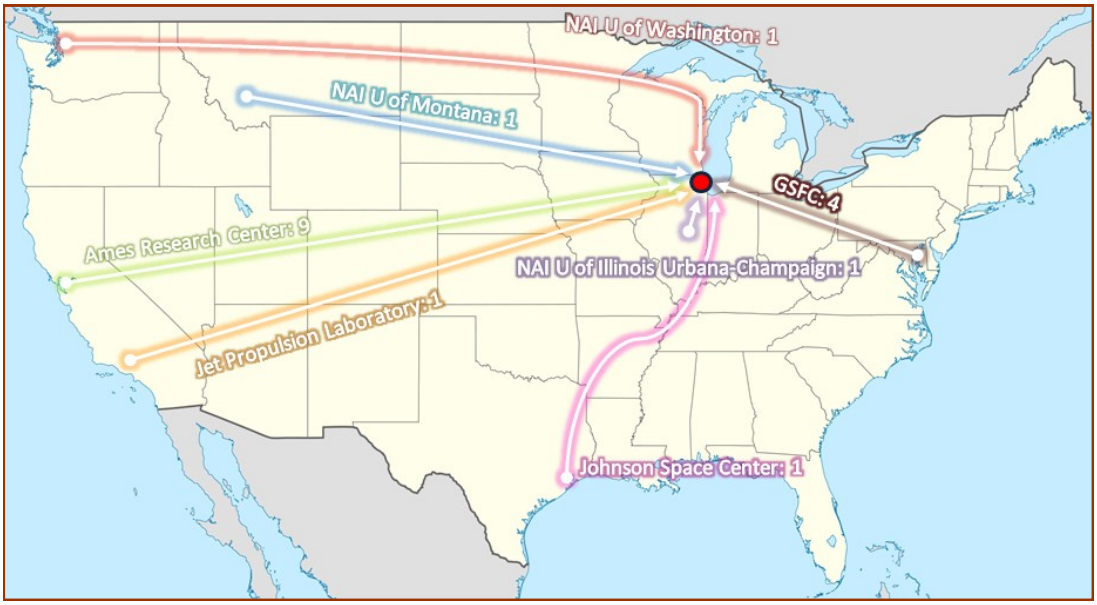
Astrobiology Science Conference (AbSciCon) 2015

Chicago, Illinois

15-19 June 2015

AbSciCon2015 convened at the Hilton Chicago in downtown Chicago from June 15th to 19th, 2015. The conference was one in a series of meetings organized by the multidisciplinary astrobiology community; it united researchers from all over the world and provided a chance for scientists to report on research findings; share data with their fellow astrobiologists; foster collaboration; and educate early career and new researchers in the field. The conference theme was “Habitability, Habitable Worlds, and Life.”

Bob Gibson and Maegen Rochner of ORAU attended AbSciCon2015 to meet with NPP Fellows and Alumni; attend presentations, poster sessions, and the FameLab USA Regional Heat; and to present the NPP All-Hands Briefing. Attendance at AbSciCon served as this year’s NAI Center Visit. The conference attracted NPP Fellows and Alumni from other NASA centers outside of NAI, but all are included in this report.



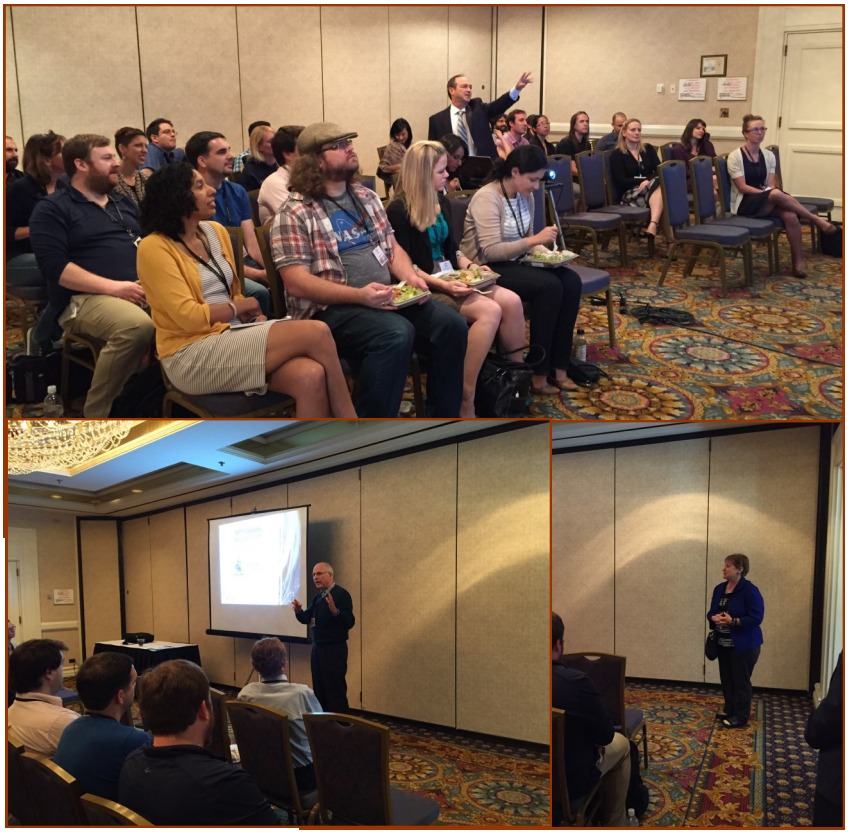
Map of current NPP Fellows travelling to AbSciCon2015 in Chicago: 18 total: 3 from NAI, 9 from ARC, 1 from JSC, 1 from JPL, and 4 from GSFC. (Courtesy Greyson Dickey)

All-Hands Briefing

NPP Fellows and Alumni at the All-Hands Briefing

L to R: Sanjoy Som, Kathryn Bywaters, Arsev Aydinoglu, Trinity Hamilton, Queenie Chan, Matthew Herron, Jessica Creamer (front), Betul Kacar, Margie Kinnersley, James Morris, Rika Anderson (front), Heather Graham, Eva Stueeken (front), Bradley Burcar (back), Aaron Englehart, Thomas Gautier, prospective NPP Fellow (front), Michel Nuevo, Andro Rios (front), Laura Barge, Jeremy Tregloan-Reed, Milena Popovic, Jose Aponte

On Tuesday, June 16, from 12:30-1:45pm, Dr. Bob Gibson presented the all-hands briefing to current NPP Fellows and Alumni. The presentation included introductory information about NPP, alumni employment and research, statistics, current Fellows, Fellows per center, changes to the program, statistics on past AbSciCon attendance, and topics for discussion. Before the presentation, Dr. Mary Voytek, Senior Scientist for Astrobiology in the Science Mission Directorate at NASA HQ; Dr. Carl Pilcher, NAI Interim Director; and Dr. Ed Goolish, Deputy Director of NAI, gave introductory remarks to the audience of NPP Fellows and Alumni. Dr. Melissa Kirven-Brooks of NAI organized the meeting and served as its host.



All-Hands Briefing

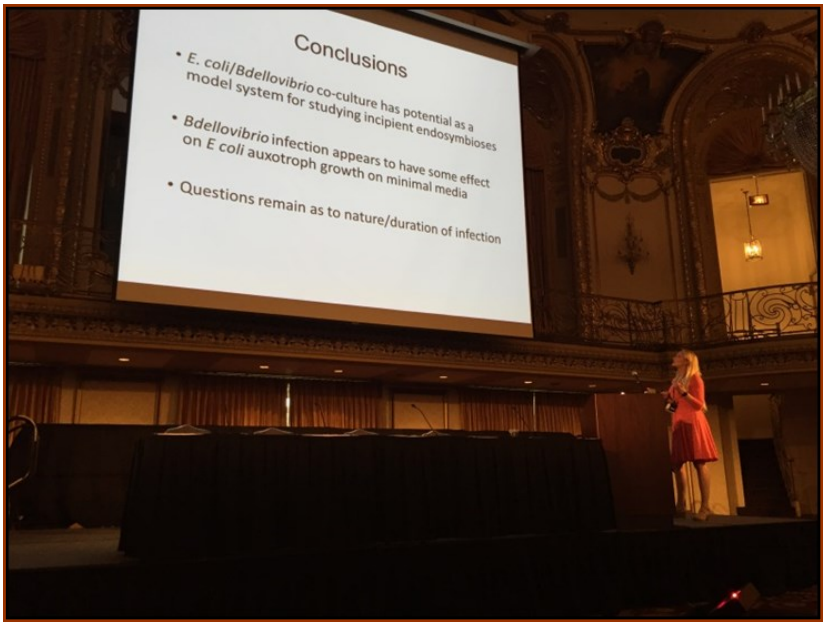
FameLab

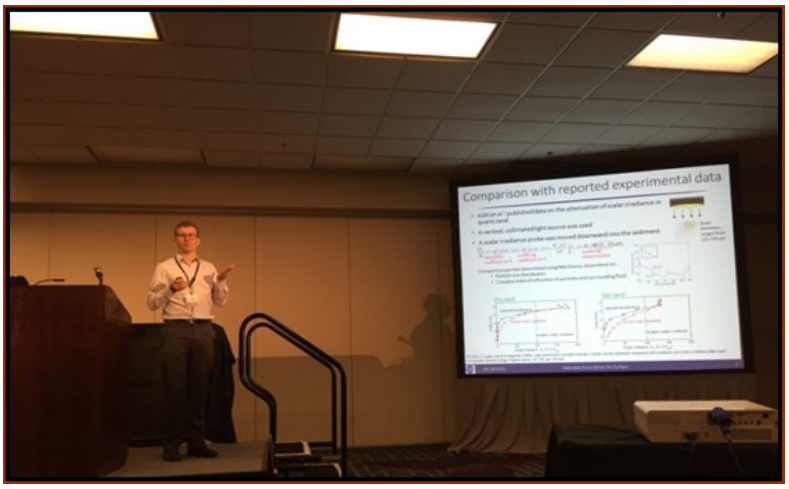
On Monday evening, June 15, we also attended the FameLab USA Regional Heat. FameLab is a science communications event where early career scientists enhance their science communication skills through practice, training, and eventually competition. Ten competitors at the AbSciCon Regional Heat gave three-minute presentations on a science topic without PowerPoint slides, with the goal being to explain their science to non-scientists. Each presenter was judged on three criteria: content, clarity, and charisma. The presentations were judged by three experts in NASA science and science communications, including current NPP Fellow Dr. Heather Graham. The event was MC'd by NPP Alumnus Shawn Domagal-Goldman, a NASA civil servant at GSFC, who helped initiate NASA's version of the competition during his time in the NPMP at NASA HQ.

The winners are announced at the FameLab Regional Heat on Monday night: Dr. Mary Voytek (left) shaking hands with the winner, Dan Scolnic. Current NPP Fellow Heather Graham (third from right) was a judge.

Focus on the Fellows

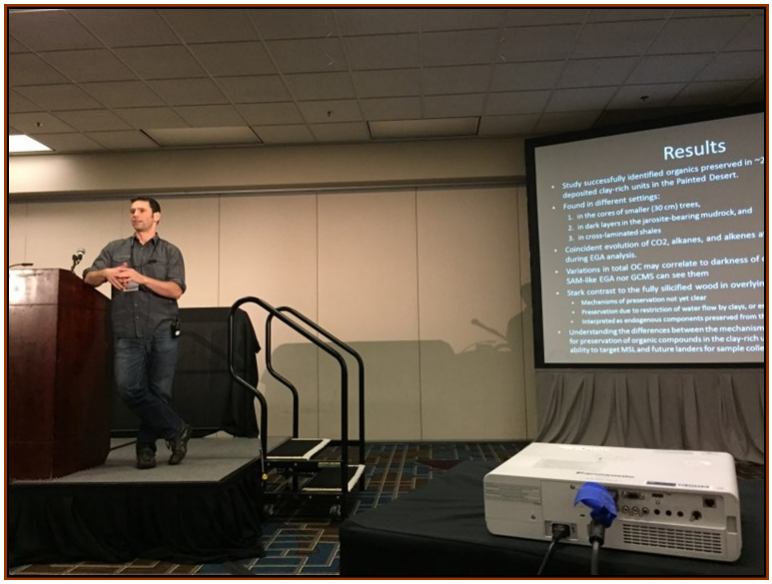
Margie Kinnersley (NAI) presented her research on mitochondriogenesis and the prokaryote-eukaryote transition. This major transition in the history of life on Earth helped increase cellular diversity, and because mitochondriogenesis coincides with eukaryogensis, it has been hypothesized that the acquisition of mitochondria fueled the transition. Kinnersley hopes to model mitochondriogenesis under the guidance of the "parasitism" hypothesis, which states that mutualism evolved from parasitism, or that a parasite can become part of its host. Mitochondria may have originated as parasites that co-evolved with their host. Kinnersley studies E.coli and its parasite Bdellovibrio bacteriovorus as experimental models for eukaryogenesis.





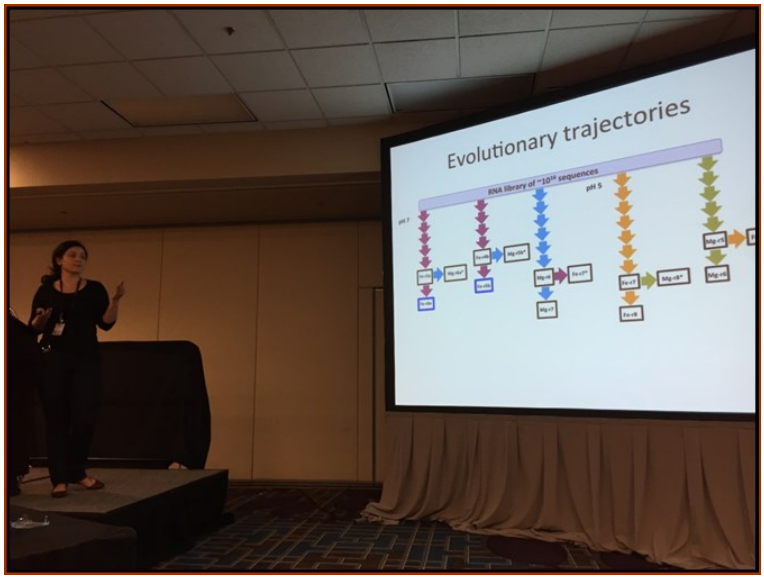
Thomas Murphy (ARC) presented his research on the use of radiative transfer models to identify zones within sediments that absorb or reflect UV radiation. Subsurface environments under certain sediment beds, such as sand, soil, clay, microbial mats, and regolith, may provide habitable environments by shielding life from hostile radiation. Murphy hopes to use this model for Earth-like planets to predict and test different terrestrial environments for habitability.

Tyler Robinson (ARC) presented his research on the use of ocean "glint" identification to find habitable exoplanets with surface water. Observations of the "glint" effect, or the mirror-like reflection of sunlight off a planetary ocean, may be a large part of future missions to detect habitability from reflected light observations. Robinson used three observations of Earth by the LCROSS mission to validate a VPL 3D spectral Earth model to test the use of glint as a possible future technique to detect exoplanet habitability.



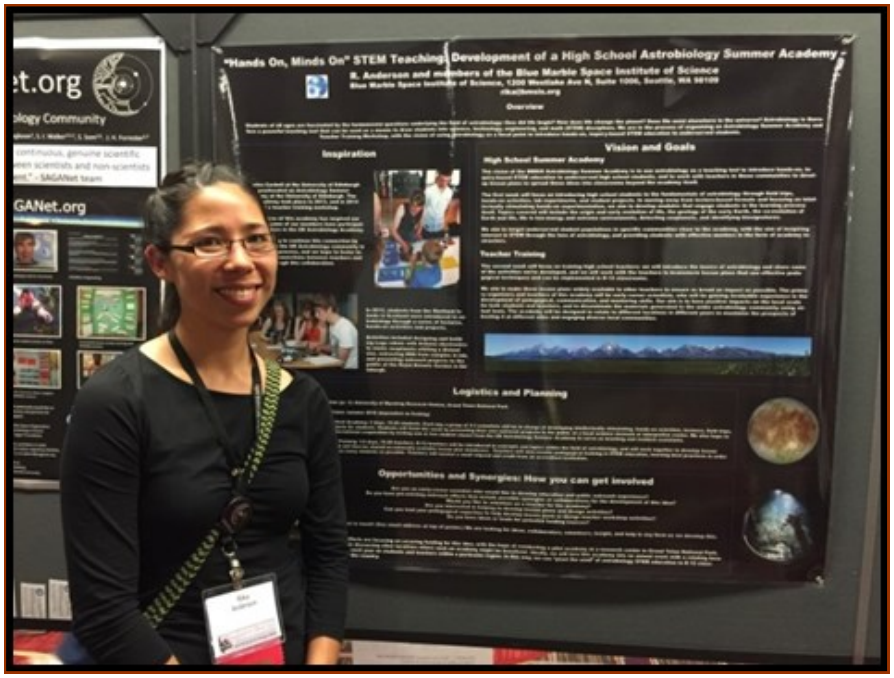
Eldar Noe Dobrea (ARC) presented his research on the use of Mars analog environments in the Painted Desert of Arizona to identify clay layers and associated organic content, which may aid in landing site selection for missions seeking organic content on Mars. Organic compounds are often found with clay minerals because interlayer binding allows the sorption of organics onto the surfaces of layered silicates. The identification of clay layers can aid in the discovery of organics, but also of importance is the preservation of these organics. Noe Dobrea researches the preservation potential of organics in clay layers in Petrified Forest as analog to environments in Western Arabia Terra on Mars. Of note has been the discovery of high concentrations of organics in carbonate nodules found in jarosite rinds. Jarosite often suggests a very acidic environment, not normally optimal for organic preservation. However, in this case, jarosite may represent prime sites for high organic content. The identification of jarosite on Mars could direct landers to areas of high organic content to sample.

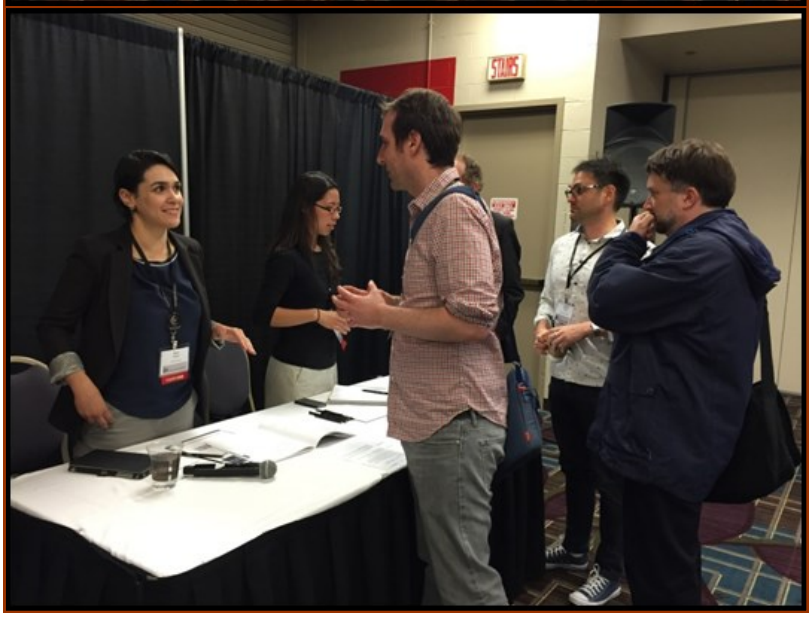
Milena Popovic (ARC) presented her research on the role that RNA may have played in the origins of life on early Earth. Many experiments have evaluated the role of RNA in **in vitro** experiments, but have not taken into account the now known chemical environments of early Earth. Popovic evolved self-cleaving ribozymes with Fe or Mg in anoxic atmospheres and various pH levels to simulate differing environments of early Earth and to test the influence of soluble Fe, abundant on early Earth, and pH, existing in a wide range on early Earth, on the evolution of differing RNA sequences. She found that differing conditions led to differences in RNA sequences and secondary structures, which highlights the impact of pH and other environmental conditions on the evolution of RNA catalysis.



Karen Smith (GSFC) presented her research on the formation of complex organic compounds from pyridine in low-temperature, ice environments such as those found in interstellar ices and on comets. She studies the stability of pyridine ices under radiation and the synthesis of organic compounds from pyridine under energetic processing. Ices in interstellar clouds, eventually incorporated into comets and meteorites, may have contained organic compounds formed by this process, which could have later seeded early Earth with life.

Rika Anderson (NAI) presented her research on the extent to which "genetic drift," or changes in genes or alleles by random chance (in contrast to natural selection), drives genomic variation and evolution through analysis of 47 genomes of the thermophile crenarchaeon Sulfolobus acidocaldarius. Through her research, Anderson has found that geographically separated populations have experienced differences in genetic variation, creating "genomic islands," mainly with variations in membrane proteins. She hypothesizes that these variations might be driven by viral infections, which can drive some variations in surface proteins. For example, some surface proteins disguise themselves as sugars to protect from viruses.

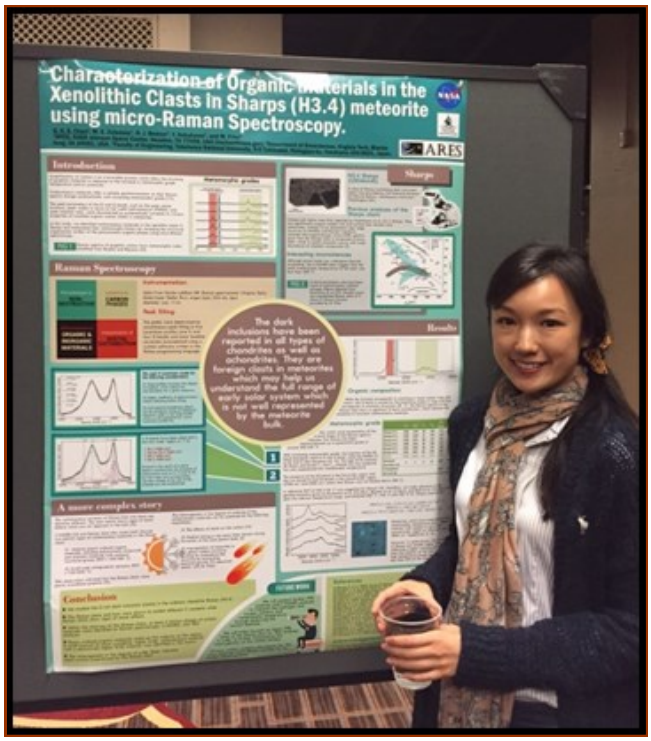




Anderson also presented a poster on her efforts in education and outreach, more specifically, the development of a high school summer academy. She, along with other members of the Blue Marble Space Institute of Science, seek to create an Astrobiology Summer Academy and Teacher Training Workshop that will use astrobiology as the focus of hands-on STEM education for underserved high school populations. The two-week academy will consist of one week of hands-on activities, field trips and experiments with students; the second week will consist of teacher training in astrobiology and lesson planning in STEM fields. Anderson and her colleagues are currently seeking funding for this project.

Rika Anderson was co-chair with former NPP Fellow Betul Kacar of the session in which she presented, titled: "Chance and Necessity: From Molecules and Viruses to Cells and Population II," which drew a large crowd and kept the two busy with questions well into the post session coffee break.

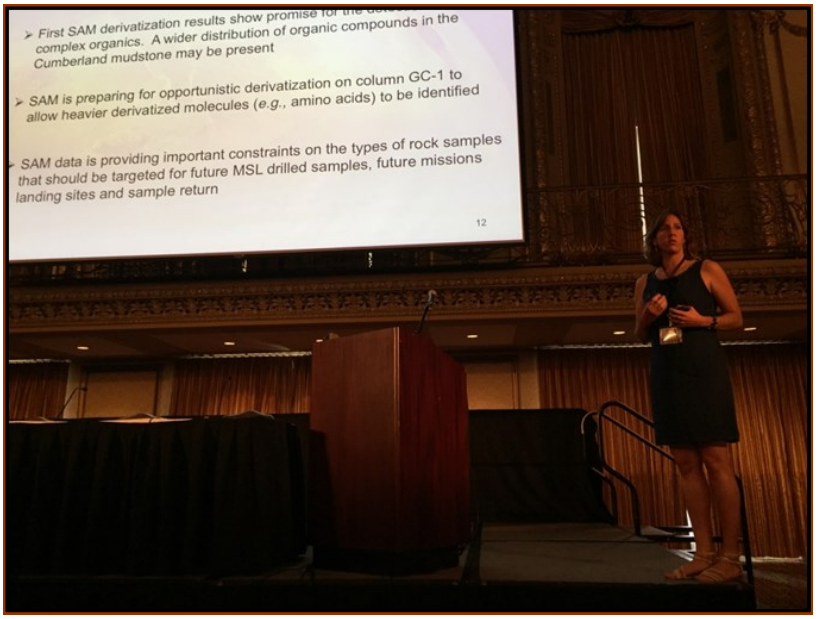
Betul Kacar (left) and Rika Anderson, session chairs, were swamped with questions well into the coffee break.

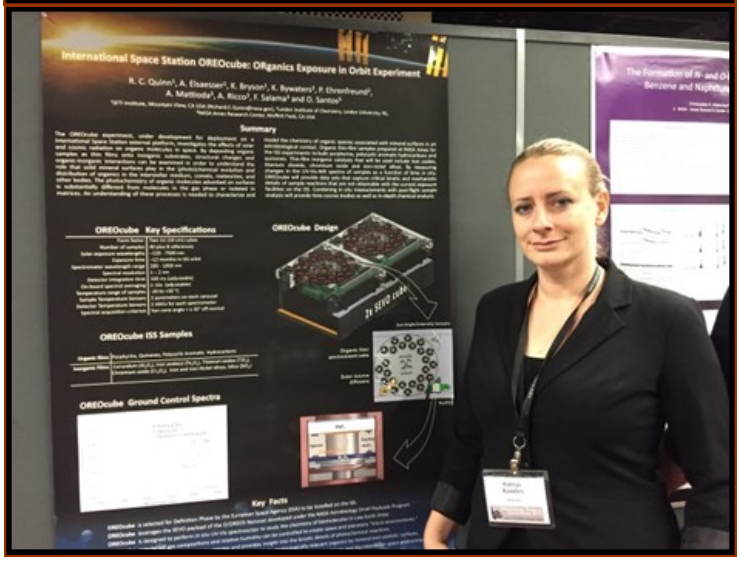


Queenie Chan (JSC) presented her research on magnetite plaquettes, or barrel-shaped stacks of disks that resemble a spiral, found in carbonaceous chrondrites (CC's), non-metallic meteorites that have not been modified by melting or differentiation. Magnetite is known to be a catalyst in the formation of amino acids. Asymmetric catalysts like magnetite may be an abiotic component of the formation of chiral asymmetry in amino acids. Chiral asymmetry, or chirality, describes two things that have identical composition but are arranged in a non-superposable mirror image. [Hands are a great example as they are mirror images of each other, but the major components of the hand cannot coincide.] Chan seeks to better understand the internal morphology of magnetite plaquettes to further understand if it influences organic chirality.

Chan also presented a poster on the use of microraman spectroscopy to determine the metamorphic grade of carbonaceous material in xenolithic clasts of the meteorite Sharps (H3.4).

Caroline Freissinet (GSFC) presented her research on a very unique opportunity to study residual vapor reaction products with organic compounds and other molecules in the Cumberland mudstone on Mars. Wet chemistry experiments on the Sample Analysis at Mars (SAM) instrument were designed to extract organic compounds from the Cumberland mudstone using gas chromatography-mass spectrometry (GCMS) using the derivatization agent MTBSTFA, contained in "puncturable" cups. Even through the cups have not been punctured, it was discovered that some MTBSTFA vapor has been leaking into the SAM Sample Manipulation System (SMS), thus providing the opportunity to study how this residual vapor reacts with solid samples of the Cumberland mudstone. Several reaction products were generated at elevated temperatures, and this study represents the first successful MTBSTFA derivatization experiment on Mars. The ultimate goal of Freissinet's research is to further understand the chemical nature of organic matter in the Cumberland mudstone.



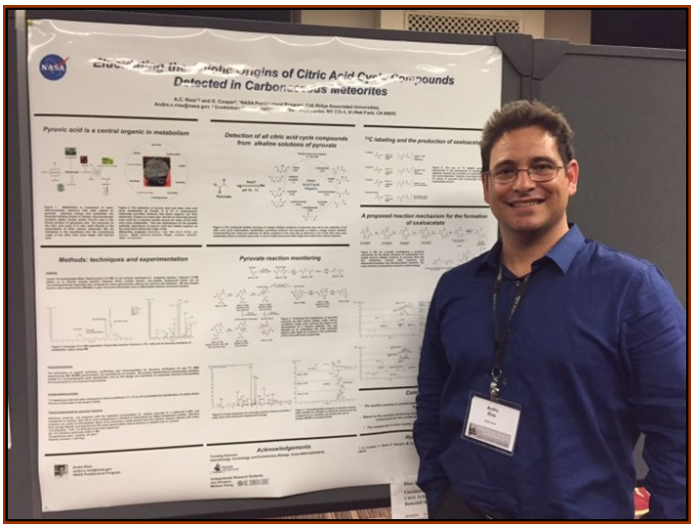


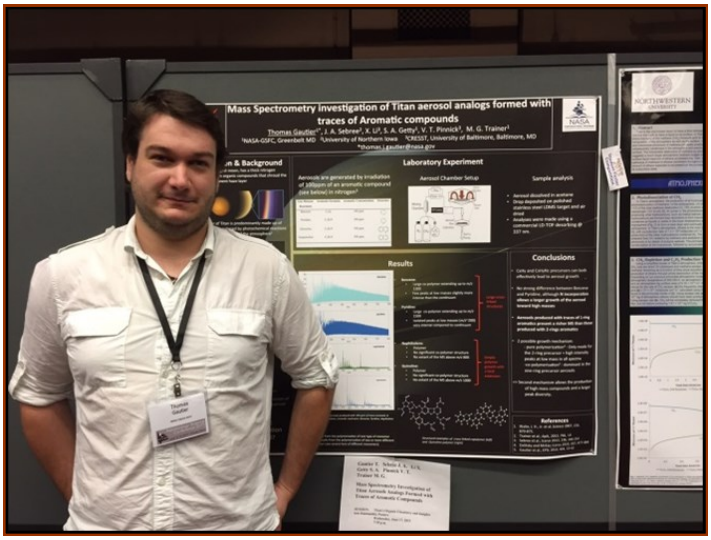
Kathryn Bywaters (ARC) presented her research on the release of oxygen from Martian soils. The Viking mission was the first to indicate reactive oxidizing species in the surface material of Mars, denoted by an oxygen product. Later, another mission, Phoenix, discovered perchlorate in samples from the northern polar regions of Mars. Perchlorate salts can be strong oxidants at high temperatures but are usually stable. However, perchlorate radiolysis products and trapped-air species may be the key to the oxygen releases seen on Mars. To determine if the decomposition of perchlorates leads to oxygen release on Mars, Bywaters irradiated and humidified magnesium and calcium perchlorate samples in a simulated Mars atmosphere. She found that irradiated calcium perchlorate decomposed at a much lower temperature and released oxygen during the fusion/melting process. The addition of water also led to oxygen release. These findings have implications for the distribution of oxidants on Mars, the history of water on the planet, and the preservation of biomarkers, as their preservation is impacted by oxidizing species.

Jeremy Tregloan-Reed (ARC) presented research that casts doubt on the presumed association of oxygen (O_2 and O_3) and life on exoplanets. Currently, some of the efforts to identify habitable exoplanets have focused on detecting oxygen as a sign of a habitable biosphere because O_2 is produced by photosynthesis. However, there are abiotic processes that can produce oxygen in an exoplanet's atmosphere. For one, the conversion of O_2 to O_3 can occur through photolysis, or the conversion of O_2 to O_3 through UV radiation from a star, but this does not discount the original production of oxygen through photosynthesis. Tregloan-Reed and his colleagues however, have discovered that oxygen may also be produced through the abiotic process of weathering. When peroxy defects in igneous rocks hydrolyse, a reaction product H_2O_2 is formed, which further decomposes into H_2O and O. This oxygen will first oxidize iron and turn S to sulfate but will eventually be released into the atmosphere as free oxygen O_2. This means that oxygen may not always equal life on other planets.

Tregloan-Reed also presented a poster on how complex organics could have formed abiogenically (from non-living matter) through the weathering of C, H, O, N, and S bearing rocks.

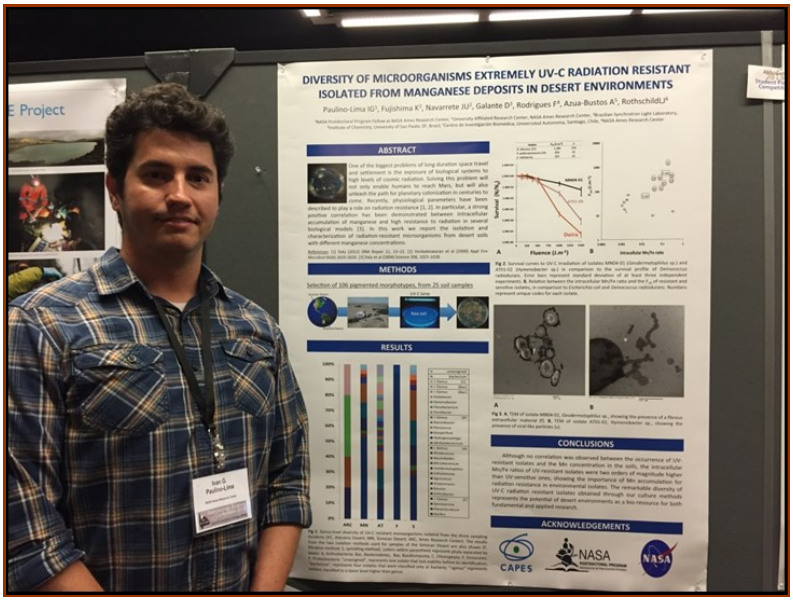
Andro Rios (ARC) presented a poster on the abiotic origins of citric acid cycle compounds in carbonaceous meteorites. Recently, citric acid compounds, like oxaloacetate, and pyruvate were detected in carbonaceous meteorites. Pyruvate is a central molecule in metabolic processes, a product of glycolysis or the breakdown of glucose, which feeds the citric acid cycle. Pyruvate could have played a role in the formation of metabolism, or proto-metabolism (chemical reactions that have the characteristics of metabolism but occur in a pre-biotic environment). Rios is studying the molecular pathway for the reactions that form citric acid compounds to better understand if they all come from one precursor, like pyruvate, or from many. This will help researchers understand the natural selection of some citric acid compounds in prebiotic environments.



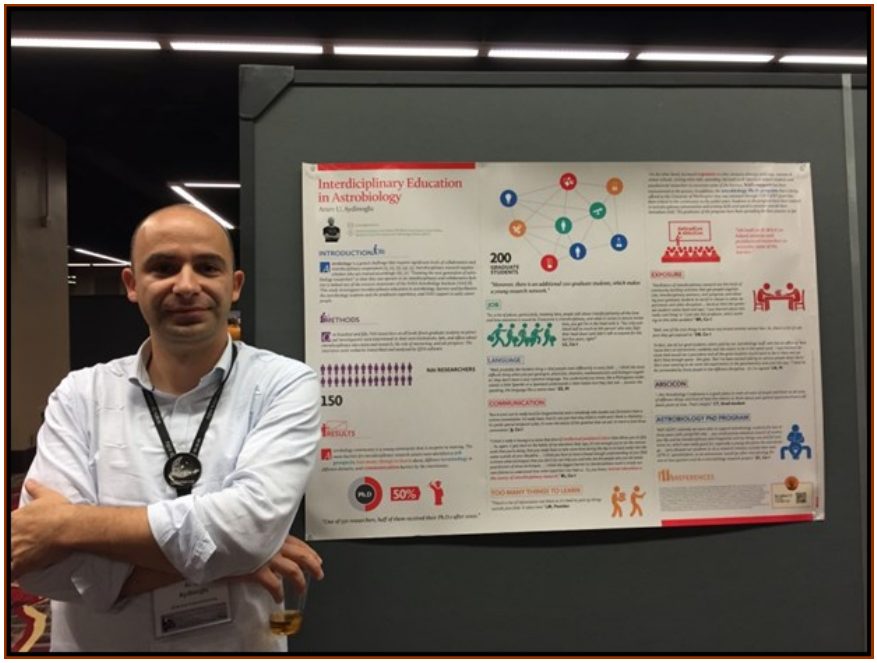


Thomas Gautier (GSFC) presented a poster on analogs for the atmosphere of Saturn's moon Titan. Titan may represent one of the best places to search for extraterrestrial life as it is the only satellite (moon, dwarf planet or planet that orbits another body) known to have a dense atmosphere similar Many scientists even believe that Titan has a water cycle similar to that of Earth, but it is much colder. The atmosphere is mostly nitrogen, which when reacted with solar radiation, produces a layer of hydrocarbon haze or smog. Gautier studies ways to duplicate the formation of Titan's aerosols in the lab, and therefore better understand the composition of the moon's atmosphere.

Ivan Paulino-Lima (ARC) presented two posters on the search for UV resistant microorganisms. Daytime UV radiation on the surface of Mars is strong enough to damage or kill most living things unless protected or buried deep in the soil. The identification of species resistant to large doses of simulated Mars radiation would therefore be important in the search for possible life on Mars. Paulino-Lima and his colleagues collected strains of Geodermatophilus and other microorganisms from manganese deposits in the Sonoran desert to test for Martian UV resistance. They found a diversity of microorganisms more resistant to UV-C radiation than D. radiodurans, a bacterium considered to be the most UV-C resistant organism, including Geodermatophilus. Based on this finding, desert environments with high-Mn availability will be a great resource for future studies of Martian UV resistant life.



NPP Alumni



Arsev Aydinoglu (NPP NAI Alumnus) presented two posters: one on interdisciplinary education in astrobiology and another that presented results from a survey of NAI researchers (from graduate students to principle investigators) and their interactions with virtual events organized and supported by NAI. Aydinoglu is currently a visiting scholar at the Research Center for Science and Technology Policies, METU (ODTU-TEKPOL).

(Right) Bob Gibson and **Aaron Burton** (NPP GSFC Alumnus), who presented his research on amino acids in meteorites and implications for the origins of life. He is now at Johnson Space Center, representing a successful post-appointment center-to-center hiring.

Shawn Domagal-Goldman (NPP HQ Alumnus) was author or co-author on 13 different presentations, in addition to his duties as MC of the FameLab competition at AbSciCon. He presented on astrobiology-focused strategies for the planned Large UV-Optical-Infrared (LUVOIR) space-based observatory, which will center on the search for life beyond our solar system. Domagal-Goldman is currently a Research Space Scientist at GSFC.

Matthew Herron (NPP NAI Alumnus) presented his research on the origins of multicellularity in green algae. The transition to multicellular life was a turning point in the evolution of complex life and Herron hopes to better understand how, why, and where this transition occurred. Herron is currently a Research Assistant Professor in the Division of Biological Sciences at the University of Montana.