AN APPROACH FOR COLLECTION, CONCENTRATION, AND ISOLATION OF DNA FROM TERRESTRIAL AND EXO-PLANETARY SOILS USING SCODAPHORESIS. C. Bradburne[1], C. Neish[1], C. Robinson[2], S. Kinahan[1], J. Proescher[1], J. Maydan[3], A. Marziali[3], and J. DiRuggiero[2].[1] The Johns Hopkins University Applied Physics Laboratory, Laurel, MD [2] The Johns Hopkins University, Department of Biology, Baltimore, MD. [3] Boreal Genomics, Los Altos, CA.

Introduction: Isolation of DNA from the genomes of soil-dwelling microbes is a difficult problem that requires extensive hands-on laboratory manipulation, as well as chemical and physical extraction techniques. SCODAphoresis is a new, enabling technology developed by Boreal Genomics (Vancouver, CA) which shows promise in this field, has few to no moving parts, and is amenable to automation. We are implementing this technique to isolate DNA from soils of astrobiological significance [1], with eventual development targeted for an automated, *in-situ*, and pressurized instrument on a Mars rover. In this presentation, we will show a comparative analysis of SCODAphoresis to other DNA extraction techniques for Mars-analogue, low-biomass soils.

Synchronous Coefficient of Drag Analysis (SCODA). SCODA is a novel technique for the concentration and purification of nucleic acids, developed by Boreal Genomics (Vancouver, CA). The movement of nucleic acids through an electrophoretic gel is non-linear in the presence of increasing charge, allowing a separation parameter. Using rotating electric fields, molecules can be driven in periodic motion that allows them to be focused, and DNA molecules are ultimately driven slightly toward the center relative to their starting location after each field rotation cycle. Contaminants, which exhibit linear motion in an electrophoretic gel, are driven in circular orbits, and so do not co-purify with nucleic acids. The resulting DNA is concentrated and free from normal soil inhibitors such as humic acid, which typically co-purify with DNA [2].

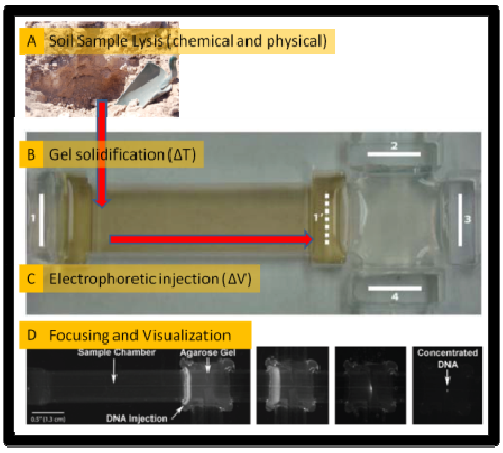

Figure 1: A schematic showing the sample preparation process for DNA focusing.

The sample preparation process. In Figure 1, soil samples (A) are extracted and placed into an un-solidified gel matrix containing components for chemical and physical lysis. A flow through Centricon or similar filter is used to reduce salinity of the lysed sample, and to provide a rough first removal of contaminants. Sample/gel matrix (B) is solidified by manipulating temperature. Sample in solid gel matrix is then injected into the focusing chamber (C) by applying an electric field in one direction. Following injection, DNA in the sample is focused (D) by application of rotating electric fields and collected in the center. Here, DNA bound to a fluorescent indicator present within the gel is visualized migrating through the gel to the central collection point (red arrow). For detailed physical equations describing the concept of SCODA phoresis, please see [2].

Comparative analysis of extraction techniques. DNA extractions, yields, and qualitative metrics are compared for material from the Bea Hill (BEA), Kevin Garden (KEV), and Andrew Garden (AND) locations in the hyper arid core of the Atacama desert in Chile, and from the University Valley (UV) and Pearse Valleys in Antarctica. These soils are all extremely challenging for genomic DNA extraction, due to oxidizing conditions, high salinity, and extremely low microbial load. We demonstrate a 10-fold or more increase of DNA recovery from these samples, and describe the communities herein.

The application of the SCODAphoresis technology to this problem is a first step in developing a future DNA collection, concentration, and detection capability on a future lander/rover. The instrument and process should be very amenable to development of an automated, *in situ* instrument that can serve as a DNA collection, concentration, and detection capability on Mars. In the context of Mars sample return, a SCODA-based instrument may prove ideal for characterization of the landing site, and final selection of the sampling area.

References:

[1] Navarro-Gonzalez, R., et al., (2003) *Science*. 302 (5647): p. 1018-1021. [2] Pel, J., et al., (2009) *Proceedings of the National Academy of Sciences*, 106 (35): p. 14796-14801.