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Canadian Space Agency ASTRO Undergraduate Research Award:
Summer 2013 Research Summary

The proposed area of research for my summer research project was the study of ammonia-bearing minerals using spectroscopic techniques. The goal of this project was to investigate whether characteristic spectral signatures exist for ammonia. It will also be important to assess whether anionic groups shift these features so that the relationship between composition, structure, and spectroscopy can be identified. The suggested presence of ammonium-bearing minerals on Ceres, some Kuiper belt objects, and comets, along with the suggested presence of nitrogen on Mars highlight the relevance and importance of being able to identify ammonium-bearing minerals in the solar system. Additionally, since ammonium contains nitrogen, it is biologically relevant, and since ammonium is stable under high heat stress, it can be considered as a biomarker.

Due to unforeseen circumstances, the project is being extended over the next few months, therefore the data collection is currently in progress. Within the next few weeks, the samples will be analyzed with reflectance spectroscopy, and X-ray diffraction. The samples to be analyzed include a variety of ammonium-bearing minerals: ammonium sulfates, ammonium chlorides, ammonium nitrates, ammonium phosphate, ammonium carbonate, and ammonium feldspar.

In addition to the aforementioned project, I also have been working in collaboration with Jen Ronholm from McGill University on a project involving bioprecipitated carbonates. The goal of the project is to investigate whether there are differences in composition, morphology, structure, and spectral features between biogenic and abiogenic carbonates. The relevance to this project for planetary exploration is the need for detecting differences between inorganic and organic minerals. The biomineralized carbonates were produced by extremophiles from Axel Heiberg Island, and were grown either on calcium acetate or calcium citrate media.

The biomineralized carbonate samples were analyzed along with various carbonates that were used as standard sources for comparison. The samples have been analyzed using Raman spectroscopy (532 nm), reflectance spectroscopy, X-ray diffraction, and fluorescence spectroscopy (365 nm). The data will be interpreted within the next few weeks to come. This week, the samples will be placed in a chamber that simulates Mars conditions in order to evaluate how these harsh conditions may alter these compounds. The samples will be kept in the chamber for around one month, and will be removed and analyzed with the same suite of spectral techniques. If no differences exist, the samples may be subject to further incubation in the chamber.