OSIRIS-REx, an asteroid sample return mission, is the third project of NASA's *New Frontiers* program. The OSIRIS-REx spacecraft is currently on its outbound cruise to asteroid 101955 Bennu and is scheduled to rendezvous in November of 2018. Bennu is a member of the rare B-class asteroids and is a potentially hazardous object (meaning that it has a non-zero probability of impacting Earth in the future). B-type asteroids are composed of carbon-rich compounds, potentially including organics and volatiles. B-types are theorized to be pristine, unaffected since the early days of the solar system. Obtaining a sample from Bennu would thus provide clues to the early composition of the Earth, and insights on how life began on Earth. The OSIRIS-REx science team will have about 1 Earth year to explore Bennu before selecting a sampling site. Of highest scientific interest is an organic-rich sample, and hence finding organics on the surface of Bennu is top priority. However, because Bennu is carbon-rich, it is very dark such that all 3 compositional spectrometers on the spacecraft have relatively large fields-of-view, and this will result in low spatial-resolution spectral maps. In fact, the highest spatial resolution will only be about 19 meters in diameter per observation. It is therefore of primary importance to understand if and how spectrometer observations can be combined, using spectral super-resolution, to enhance the spatial resolution of the observations, thus improving our chances of detecting the subtle spectral signatures of organic compounds on Bennu.

In this study, we conduct original research to explore some of the many different methods of creating spectral maps and determine which method provides spectral maps with the highest fidelity and highest spatial resolution. Our goal is to give the OSIRIS-REx science team a mapping protocol to follow during the Detailed Survey phase of the mission that will maximize the chances of detecting organics. Spectral maps are maps that identify the surface mineralogy at every location on Bennu. We begin by designing a "Truth" map of known mineralogy – in effect a simulated Bennu world – with strategically located "outcrops" of organics set in a carbon-rich non-organic background material. We simulate visible-to-near-infrared data sets using this Truth map, and pass these data through our mapping routines. Simulated data were created with an IDL routine "generate_test_data.pro" written by Jonathan Joseph at Cornell, and overlapping observations are combined on a per-facet basis with a MatLab program "makeMaps.m" written by Luke Hawley at the University of Arizona.

We then analyze the maps using software I developed at Ithaca College, with three new original metrics: Contrast, Smear, and Obliteration – to quantify the spatial resolvability of a spectral map. Because our mapping routines are based on round spectrometer fields-of-view, and our map projections use tessellated shape models of the asteroid with triangular facets, we are vulnerable to a number of projection effects. We investigated maps with different shape model facet sizes, maps created with different methods of assigning spectral data to facets, and maps that combine data from several global surveys. In this study, we investigated seven different methods of combining overlapping spectrum observations to assign spectral values to the facets of a shape model, we utilized three different shape model resolutions, and we explored three different global survey observation plans. Our results indicate that maps created by assigning data from the nearest spectrometer observation to a facet replicates our Truth map with highest fidelity. Maps created using finer shape model resolutions are of the highest fidelity, compared to maps using coarser shape model resolutions. We tested our hypothesis that combining the data from three different global surveys of the asteroid could be used to demonstrate spectral super-resolution, however the results were inconclusive due primarily to problems with the observation plans themselves. These findings will be of utmost importance to the OSIRIS-REx science team when creating spectral maps of Bennu, starting in April 2019.