Abstract
This project involved the creation of three different types of asteroid simulants C-Type, M-Type and S-Type. The purpose of creating these asteroid simulants was to realistically test asteroid mining tools. Three containment units, called test bays, held the asteroid simulants composed of their respective mineral composition. The structure was designed to withstand any stresses the core drill might impose while in NASA’s neutral buoyancy lab with a safety factor of three.

Objective
Asteroids may comprise an abundance of raw materials that could be advantageous to Earth projects and space exploration. Asteroid materials found in S- and C-type asteroids can be used for propellant of space vehicles. M-type asteroids have valuable minerals such as platinum and rhodium. The team’s objective for creating asteroid simulants is to successfully help NASA test their prototype core drill. By providing NASA with a realistic asteroid simulant, they can ultimately discover problems with real asteroid mining.

Project Outline
For the experimental testing stage, three types of asteroids of varying age characteristics were placed within a structural frame comprised of three bays as shown in the figure below. These sample asteroids were composed mainly of silicates such as feldspar and quartz. Using these asteroid regenerations, NASA fully tested their asteroid mining tools in a myriad of environments; thus, determining whether the tools would operate optimally and beneficially on a realistic reduced gravitational setting.

Testing
The structure in its entirety consisted of three individual 14 x 42 x 5.25 inch target bays that were bound to one another by three metallic, extension springs in consideration for acoustic disturbances. In an effort to reduce the overall weight of the structure without greatly reducing its structural integrity, the siding of each bay was comprised of 1 inch thick Douglas Fir while 6061-T651 Aluminum Plate (0.25-0.5 inch thick) was used for each base plate of the bays.

Future Implication
A better understanding of asteroid various structures and composites will be achieved allowing the furthering of microgravity research involving core drilling. The data gathered will provide a conclusion on the drill efficiency to collect asteroid material as well as dangers presented by having loose debris close to the drill operator. After collecting data on the exit patterns of the debris in a microgravity environment an appropriate capturing device can be designed to ensure maximum collection. Developing a device that collects excess debris will also decrease the potential for damage to the drilling device while it is being in use. Asteroid drilling will become very popular for gathering rare minerals and space exploration in the coming decades.

<table>
<thead>
<tr>
<th>Spectral Type</th>
<th>Similar Meteorite</th>
<th>Resources</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type C</td>
<td>Carbonaceous Chondrite</td>
<td>Waste, Metal, Organic Compounds</td>
<td>Rocket propulsion and other consumables for spacecraft mission; metal for 3D printing or hardware to use in space exploration; rubble or plastic or mixture for rocket fuel or CO2 production.</td>
</tr>
<tr>
<td>Type S</td>
<td>D.L. chondrite</td>
<td>Metallic Group Metals</td>
<td>For use in earth applications</td>
</tr>
<tr>
<td>Type M</td>
<td>Iron Meteorite</td>
<td>Metals including platinum group metals</td>
<td>Manufacturing large hardware less in space for colonization or larger colonies and/or for use on Earth</td>
</tr>
</tbody>
</table>

Starting Differential Equation

\[
\begin{align*}
\frac{dt}{d\omega} + b &= 0 \\
\theta(0) &= \theta_0 \\
\frac{d\theta}{d\omega} &= \theta_f
\end{align*}
\]

Boundary Conditions

Asteroid drilling, designed by Bryan Versteeg.