

# Chapter 11: Identifying Asteroids for Mining

## Student Worksheet

### Objective:

Gain an understanding of the science of mining asteroids, a new and potentially very important industry.

### Engage:

What do you think the image in Figure 1 might represent? What is the significance of the largest circles? How many different symbols do you see?

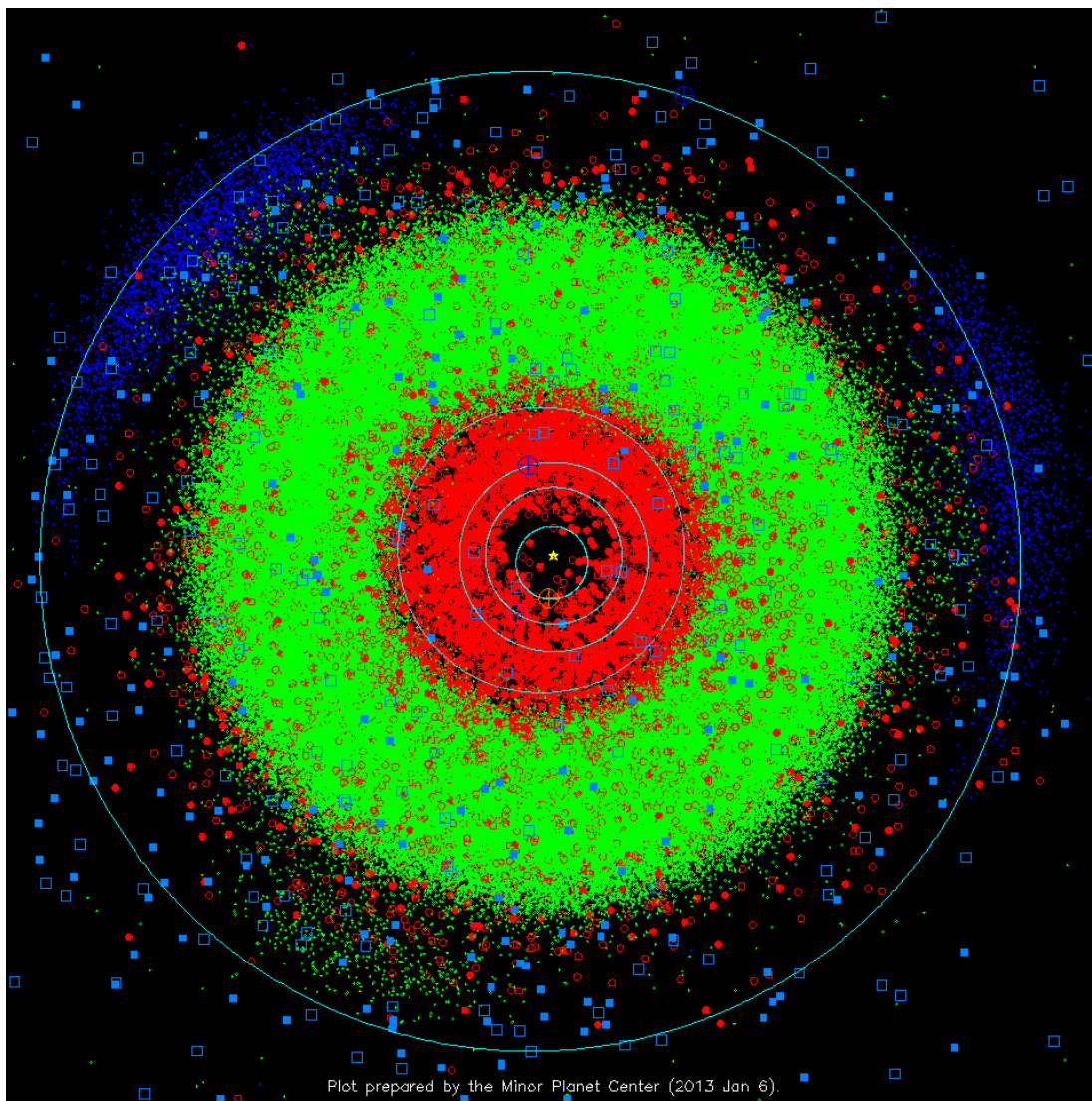


Figure 1

Gareth Williams/Minor Planet Center

## Introduction:

Figure 1 represents a plot of known asteroids reaching out to just past Jupiter's orbit. The orbits of the major planets, Mercury through Jupiter, are shown as the largest circles. The green dots represent known asteroids in the main asteroid belt. The red circles, considered near-Earth asteroids, represent asteroids that come within 1.3 AU at their perihelion. The blue squares are comets. The blue dots in two clouds along Jupiter's orbit are called Jupiter Trojans. Trojans are considered any moon or minor body that shares an orbit with a major planet. These asteroids may one day solve a problem associated with space travel.

Most of the bulk of sending a spacecraft into space is the fuel to launch it from Earth. Anything going into Earth's orbit must reach orbital velocity. Anything leaving Earth's orbit must reach escape velocity. Isaac Newton uncovered these formulae. For Earth these values are listed below, where  $M$  is for the *mass* of a planet and  $r$  is for the *radius* of a planet.

$$v_{orbital} = \sqrt{\frac{GM}{r}} \quad v_{escape} = \sqrt{\frac{2GM}{r}}$$
$$v_{orbital} = 7.89km/s \quad v_{escape} = 11.2km/s$$

As you can see, these velocities depend on the mass and radius of the body from which one wishes to escape or orbit.

The Apollo Missions to the Moon needed to be able to return to Earth. It was fortunate that the Moon is much less massive than the Earth; thus, the fuel needed to escape the Moon was not as significant as the fuel needed to leave the Earth. So, coming home was much easier. The prospect for Earthlings to travel roundtrip between planets with an Earth like mass seems impossible due to reasons of fueling.

In this investigation you will discover how asteroid mining proposes a solution to the roundtrip problem, as well as the ability to use metals found in asteroids. This is an exciting new endeavor. Maybe you will one day work in this field. Maybe the implications of asteroid mining will one day affect the lives of everyone on (or off) Earth.

**Your Task:**

Look into operations at Planetary Resources, an American company dedicated to using the resources available on asteroids to enable more human space exploration and improve life on Earth.

**Procedure:**

1. Investigate the basics of Asteroids in your textbook.
2. Use the Planetary Resources website to learn more about the plans and opportunities involved in asteroid mining.
3. Draw conclusions and answer questions to deepen your understanding.

**Conclusion:**

1. What is considered a near-Earth Asteroid? How many are known?
2. What are the typical sizes of near-Earth asteroids?
3. How will asteroid targets be identified?
4. Water and rare metals are the main targets in asteroid mining. Why water? Give a brief, overview answer. Specifics will be asked for in later questions.
5. Why rare metals?



Magazine called, “So You’re Going to Mine Asteroids? Oh, Really.” This article highlights some great ideas in asteroid repositioning. It can be found in the media section of their website, or can easily be found in an Internet search.

11. Compare the adjectives used in the introduction to the interview with those used on the Planetary Resources web page. What does this discrepancy suggest?
  
12. What are your thoughts on this potential new industry? What do you like about it? What do you not like? Why?

**Extend:**

- Planetary Resources did not come up with the idea to mine asteroids. How early are the records of the ideas about mining asteroids? Describe some of the early plans.
  
- Impact sites on Earth from large meteorites and small asteroids are potentially rich with precious metals. Has evidence of this been found? Why or why not.