An Analysis of Asteroids
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Intro

Do rare earth elements exist in significant quantities on asteroids near earth? By acquiring data in the public domain, a meaningful data package can be assembled to answer this question. By defining a null and alternative hypothesis to frame this question along with additional supporting data, it should be possible to make a strong argument to answer this question.

The alternative hypothesis (H_a) can be defined as:

> **If and asteroid with rare earth elements are close to earth, then a measurable amount of rare earth elements more or less will be detected.**

By contrast the null hypothesis (H_o) can be defined as:

> **If an asteroid with rare earth elements are close to earth, then a measurable amount of rare earth elements will not be detected more or less observed.**

By collecting data supporting the alternative hypothesis a convincing argument should be made to determine if asteroids near earth may have significant quantities of rare earth elements.

Background

The data for this report was acquired form Asterank Database (**Link**). Asterank is a scientific and economic database of over 600,000 asteroids. This database collects information from a variety of sources including NASA API and the London Metal Exchange API. The database is a collection of data consisting of asteroid mass, spectral data, orbits, and other critical data points. Asteroid mass and spectral data are employed to estimate a financial value of an asteroid based on current metal prices. (examples: Os, Ir, Ru, Pt, Rh, Co, Au, Pd, Ni, and Cr). These net values of an identified asteroid are reported on the Asterank website in a dollar amount to estimate the value of an asteroid. No supporting information was available regarding the methodology in the estimates provided.

Assumptions

For the purpose of this exercise, the financial value of each asteroid will serve as a metric to quantify the presence of precious metals and or rare earth elements. An asteroid estimated to be valued at 1 trillion dollars and above will be considered to have a significant amount of precious and rare earth metals. Categories were assigned to further assess the quantity of rare earth elements as follows: less than one billion, Less than a trillion, 1 trillion to 99 trillion, greater than 100 trillion, and no observed metal. A Dataset was constructed based on the proximity of an asteroid to earth. A range of 0.8 to 1.2 Astronomical Units (AU) will be used for this exercise.

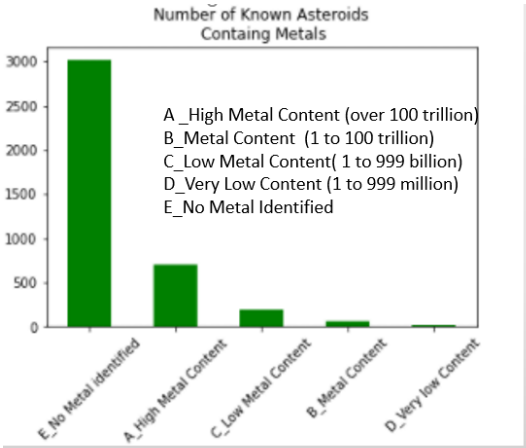
Resources

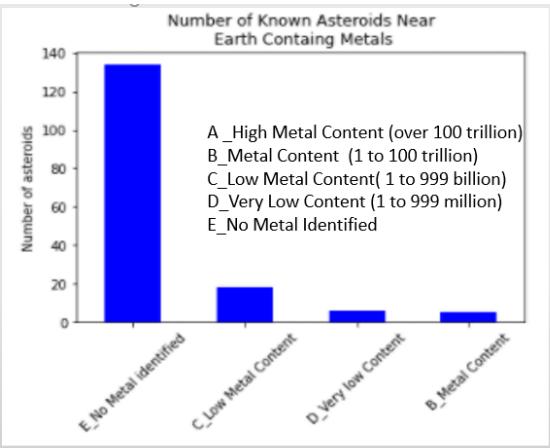
- Asterank Database
- Juniper notebook

Data

A dataset related to 4,000 asteroids was acquired from Asterank Database. This dataset was manipulated employing Juniper notebook for data analysis. Asteroids with an orbit of 0.8 to 1.2 AU were selected for further evaluation. Figure 1 is a break down of both data sets.

Figure 1



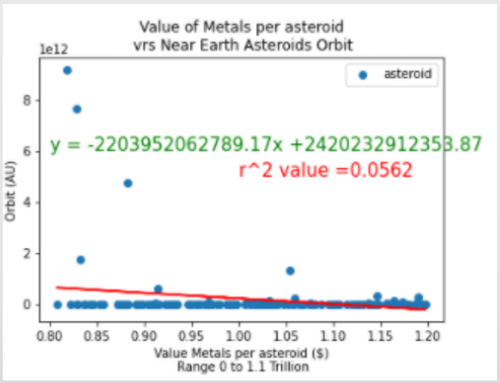


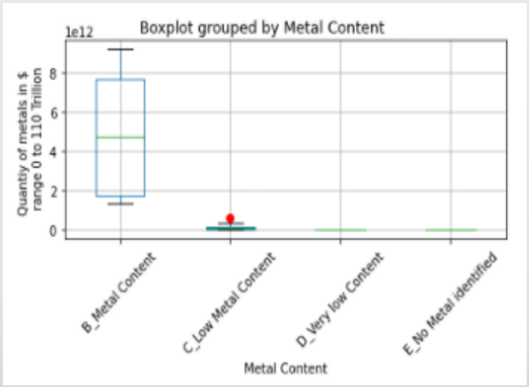
4000 asteroids were considered
Max orbit 365 AU: Min orbit 0.642 AU
75% asteroids have no observed metals.
18% asteroids have over 110 trillion of identified metals
2% asteroids have between 1 to 110 trillion
5% asteroids have between 1 to 999 billion
1% asteroids have between 1 to 999 million

- **163 Asteroids met orbit criteria**
- **Max orbit AU 1.2: Min orbit 0.8 AU**
- 82% asteroids have no observed metals.
- 5% asteroids have between 1 to 110 trillion
- 11% asteroids have between 1 to 999 billion
- 4% asteroids have between 1 to 999 million

Figure 1 would suggest that around 75% of the known asteroids do not contain metals. 20% of these asteroids do contain a significant amount of precious metal. By examining asteroids with orbits similar to earth (orbits of 0.8 AU to 1.2 AU) it would seem that about 15% of the 163 asteroids examined contain a significant amount a rare earth metal.

Figure 2





Scatter plot

- Plot represents 163 asteroids ranging from 0$ to 100$ trillion (Orbit of asteroids 0.8 to 1.2 AU).
- X axis range is 0 (Low metal density) to 1.1 trillion (High metal density).
- r^2 value suggests there is no correlation between orbit distance and quantity of metal on an asteroid

Boxplot

- Plot represents 163 asteroids ranging from 0$ to 100 trillion$. Orbit of asteroids 0.8 to 1.2 AU.
- No asteroids over 110 trillion were observed in orbital restricted data set.
- B_Metal content mean falls within the data distribution.
- C_Low metal Content did have outliers. For this exercise not significant

Figure 2 would represent correlation between asteroids possessing an orbit of 0.8 to 1.2 AU and observed quantities of metal. The r^2 value would suggest there is no correlation between orbit and composition of an asteroid. This should have no impact on determining if there are a significant number of asteroids near earth that have rare earth metals. The boxplot in Figure 2 allows a look at the distribution of asteroids that have metal content (defined as ranging from1 trillion dollars to 100 trillion dollars). The distribution does not contain any outliers and makes up 5% of the samples size. This will be used as a sample set for a one sample t-test.

A one sample t-test was employed to acquire a p value to assess the null hypothesis. The samples were taken from asteroids ranging in orbit from 0.8 AU to 1.2 AU. The samples were defined as follows:

- Sample 1 consisted of asteroids with no observed metals
- Sample 2 consisted of asteroids believed to have Metal (1 to 100 trillion)

Results:

p-Value = = 0.03398119
t-statistic = -31666205

Conclusion

The Null hypothesis can be rejected bassed on the p-value result. This would support the alternative hypothesis:

> **If an asteroid with rare earth elements are close to earth, then a measurable amount of rare earth elements more or less will be detected.**

The data collected supports the hypotheses that asteroids in proximity to the earth do contain rare earth elements. The p-value complimented with the data presented would suggest that rare earth elements exist in statistical meaningful quantities on asteroids near earth orbit.