GEOL 415 Assignment 3

1. Although oxygen isotope measurements have been used before and even during this research study, there is a clear limitation to that method that the authors outline. In respect to the three groups of stony-iron meteorites tested (howardite-eucrite-diogenites or HEDs, mesosiderites and pallasites), the oxygen isotope variation is very small. This little variance in results creates difficulty in distinguishing the origins of the three groups. The authors note that because of this, pallasites, mesoriderites and HEDs all plot within the same area on an oxygen isotope diagram.

   As such, this study is different because a more elaborate differentiation technique is used called laser-assisted fluorination. This assisted technique complements the oxygen isotope variation method further to enhance and gives more precise measurements. Therefore, this study is different in which a highly analytic precision method was employed to measure fractionation lines between +/- 0.02% which enabled the researchers to distinguish the overlaps present in plotting the area on the diagram previously.

2. The authors use laser assisted oxygen isotope analysis to examine three stony-iron meteorites: HEDs, mesosiderites and pallasites. The results from oxygen isotope analysis demonstrate that mesosiderites and HEDs are isotopically identical and so may be derived from the asteroid 4 Vesta however pallasites differ in composition. These results are also aligned with preliminary mineralogical and textural evidence that suggest that HEDs/mesosiderites have distinct settings compared to pallasites. Going back to oxygen isotope variations more specifically, laser assisted results show $\Delta^{17}O$ value for mesosiderites and HEDs are indistinguishable along $\delta^{18}O$ values yet are out similar range for the pallasites. This gives strong support to the idea that they may not derive from the same origin. As a matter of fact, $\Delta^{17}O$ for pallasites was found to be quite unique and does not correspond to any known group of basaltic meteorites.

3. The paper puts forth opposing views on HEDs and mesosiderites not being derived from 4 Vesta. The opposing researchers arguments include: lack of remote sensing evidence, lack of metal-rich clasts in howardites, scarce

amounts of olivine in the HEDs and silicate clast populations not being identical in the two groups.

Greenwood tries to refute them by stating that remote sensing evidence is not prevalent simply because metallic iron does not have spectral features in visible and near infrared spectrums. In other words, it is hard to look for remote sensing evidence that can not be detected. The opposing second argument is considered outdated because howardites containing metal-rich clasts have now been found. Thirdly, paucity of olivine in HEDs is not a strong argument to begin with because olivine is an accessory phase in HEDs. Also in addition, olivine-rich diogenites have been recently identified as well so the scarce amounts of olivine in HEDs argument by opposing researchers is somewhat old as well. With regards to silicate class populations not being identical, Greenwood explains that one should not compare altered mesosiderite clasts with unaltered HED material. This is because local-scale silicate mixing processes on a single parent body could also equally explain these differences anyway. As such, with all of this taken into account, a strong case is made that HEDs and mesosiderites may in fact be derived from the asteroid 4 Vesta.

4. Vestoids are asteroids with Vesta-like spectra and are derived from Vesta itself by impact processes in the early age of the solar system. They occupy locations on the asteroid belt that are near Vesta and solve a problem of how Vesta fragments can be close by or even near entering Earth-crossing orbit.

5. Mesosiderites have a controversial origin in terms of formation. The more accepted model proposes that since they are isotopically identical to HEDs, they are derived from the asteroid 4 Vesta. As for their actual formation, a molten asteroid core impacted with a second asteroid's surface layers.

6. The authors suggest that from the results of that study, the main group pallasites are derived from an asteroidal source that is distinct from both the mesosiderites and HEDs. Their origins lie from a disrupted/differentiated asteroid that has no known equivalents amount the basaltic meteorites. With respect to their formation, they seem to be the product of a major impact event which was followed by rapid solidification of the metal melt. Their lithology is composed of intermixed core and mantle material.

Reference material: