FRAGMENTS OF ASTEROIDS IN LUNAR ROCKS. Y. Liu[1], A. Zhang[1,2], L.A. Taylor[1]. [1]Planetary Geosciences Institute, Department of Earth & Planetary Sciences, Univ. of Tennessee, Knoxville, TN 37996, USA, Email: yangl@utk.edu. [2]Purple Mountain Observatory, Nanjing 21008, China.

Introduction: Asteroidal fragments in lunar breccias and soils are critical to an understanding of the nature of the major impactors of the Moon. Observing FeNi metal is typically the simplest way for identifying asteroidal fragments. Schreibersite [$(Fe,Ni)_3P$] in FeNi metal is a clear indicator of asteroidal contamination, although this was validated only after the realization that schreibersite-bearing Apollo 14 "basalts" (14310, [1]) are actually impact-melt rocks. Among hundreds of rocks examined, Hunter and Taylor (1981) [2] identified schreibersite, sometimes with cohenite [$(Fe,Ni)_3C$], in 88 Apollo 16 breccias. On the other hand, fragments of chondrites are rarely observed in lunar rocks, and only four possible chondritic fragments have been reported: a carbonaceous chondrite in Apollo 12 soil by McSween [3] and Zolensky [4], an enstatite chondrite in Apollo 15 by Haggerty [5] and Rubin [6], a chondritic fragment (carbonaceous or ordinary) in lunar meteorite regolith breccia PCA 02007 by Taylor et al. [7] and Day et al. [8]; and an olivine-rich sphere with barred-olivine texture in lunar meteorite breccia Dhofar 1428 by Zhang et al. [9]. To determine whether these fragments indeed are chondritic, and to verify the source for them, we have studied these fragments in Dhofar 1428 and PCA 02007, and compare them with two similar olivine-rich spheres in Apollo impact-melt rock 62295.

Results: The olivine-rich sphere (~200 μm) in Dhofar 1428 consists of olivine and plagioclase. Part of the sphere contains a barred-olivine texture, typically found in chondrules. The periphery of the sphere is outlined by fine-grained FeNi metals/sulfides. Chemically, olivine (Fo_{77-83}) in the Dhofar 1428 chondrule has $(Fe/Mn)_a$ of 61–75 and plagioclase ranges from $An_{87–90}$ [9]. Apollo 16 impact-melt rock 62295 contains spheres of a similar texture [10]. From center to rim of the spheres in 62295, olivine becomes Mg-enriched (from Fo_{84} to Fo_{95}) with $(Fe/Mn)_a$ of 57–72 [10]. Plagioclase in the 62295 spheres is unusually An rich ($An_{95–100}$). The Mg-rich olivine in these fragments cannot be easily explained by enrichment of Mg through Fe reduction or vaporization of Fe or other lunar sources [11].

The chondritic fragment in PCA 02007 is perhaps most intriguing. This fragment contains olivine, plagioclase, and pockets of sulfides, FeNi metal, and schreibersite setting in a glass matrix [7, 8]. Olivine cores (Fo_{99}) contain $(Fe/Mn)_a$ of 11 ± 8 with high Cr_2O_3 (0.29 ±0.12 wt%) and olivine rims are more Fe-rich (Fo_{82-44}). Plagioclase is An_{80} with FeO and MgO of 1.2 wt% and 0.27 wt%.

Oxygen isotope analyses of these probable chondritic fragments will provide further insights on the formation of these asterodial fragments.

References: [1] El Goresy. et al. (1972) PLSC 3, 333-349. [2] Hunter & Taylor (1981) PLSC 12th, 253–359. [3] McSween (1976) EPSL 31, 193–199. [4] Zolensky (1997) MaPS, 32, 15–18. [5] Haggerty (1972) The Apollo 15 Lunar Samples, 85-91. [6] Rubin (1997) MaPS, 32, 135-141. [7] Taylor et al. (2004) 67th Meteor.l Soc. Mtg., #5183. [8] Day et al. (2006) GCA 70, 5957–5989. [9] Zhang et al. (2009) this vol. [10] Roedder & Weiblen (1977) Proc. Lunar Sci. Conf. 8th, 2641–2654. [11] Ruzicka et al. (2000) MaPS, 35, 173–192.