PAIRING RELATIONSHIPS AMONG NORTHWEST AFRICAN BASALTIC LUNAR METEORITES BASED ON COMPOSITIONAL AND PETROGRAPHIC CHARACTERISTICS.

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Introduction:

In recent years, several "new" basaltic lunar meteorite stones have been collected in the deserts of Northwest Africa (NWA): NWA 2700, NWA 2727, NWA 2977, and NWA 3160. These stones consist of several different lithologies: a fragmental breccia of very low-Ti (VLT) basaltic material, a cumulate olivine gabbro, a porphyritic olivine basalt, and a coarse-grained ferrogabbro. Petrographic and preliminary geochemical results have been reported for these meteorites [1-2]. Here we discuss the chemical composition of the different lithologies within these aforementioned meteorite stones in more detail. We also examine the pairing relationships among these "new" stones, and compare them with previously studied basaltic lunar meteorites, particularly NWA 773 [3-4].

Methods:

We have obtained chemical compositions for numerous small subsamples (20-40 mg) of the various lithologies present in the different NWA basaltic meteorite stones by instrumental neutron activation analysis [for more detail see 5].

Petrography:

The four prominent lithologies in the "new" NWA meteorites are: (1) fragmental breccia of VLT basaltic material (present in NWA 2700, 2727, and 3160), (2) cumulate olivine gabbro (NWA 2700, 2727, and 2977), (3) porphyritic olivine basalt (NWA 2727 and 3160), and (4) ferrogabbro (NWA 2727). The breccia contains lithic clasts of the other lithologies, as well as abundant olivine and pyroxene clasts, lesser amounts of plagioclase clasts, and trace amounts of Fe,Ti,Cr oxides, silica, and glass clasts. Modally, the cumulate olivine gabbro consists of ~50% olivine, ~30-40% pyroxene, and 10-20% plagioclase. The ferrogabbro has a similar mineral assemblage and compositions as the cumulate, but a coarser grain size. The porphyritic basalt has phenocrysts of olivine and chromite, with a mesostasis of glass and skeletal olivine and pyroxene. The petrography of these meteorites is described in greater detail in [1,2].

Bulk Composition:

Due to the large clast size (relative to the size of our subsamples) of the various lithic components that make up these basaltic meteorites, we made no attempt to determine the bulk composition of each meteorite. Instead, we determined the composition of the individual lithologies that make up each meteorite (the ferrogabbro has not yet been analyzed; Fig. 1). The two igneous lithologies that have been analyzed, the cumulate and the basalt, have compositions typical of previously analyzed lunar basalts/gabbros. The paucity of Ti-bearing oxides indicates that the basalt (and all of the other lithologies as well) have low-Ti, and likely VLT composition. The fragmental breccia of VLT basaltic material has a bulk composition very close to that of the porphyritic olivine basalt, and is composed almost entirely of olivine and pyroxene clasts. A few subsamples of the breccia in NWA 3160 have abnormally high ITE concentrations. The cause of this is unclear at this time, but it is not the result of a heterogeneously mixed KREEP component. The composition that these points trend towards is much more Fe-rich than any known version of KREEP (Fig. 1). The "new" NWA basaltic meteorites are compositionally distinct from most previously studied lunar basalts, in having an enrichment in LREEs, depletion in Na_2O and Eu, and high Th/REE ratios.

Discussion:

Subsamples of all of the lithologies vary in composition, more so in the breccia and cumulate lithologies than in the basalt. The compositional variability among subsamples of a given lithology within a single stone is typically greater than the difference in the average composition of a given lithology between two different stones. The compositional variability we observe among subsamples of a given lithology is due to unrepresentative sampling of the constituent mineral phases, both for major and trace elements. This unrepresentative sampling is intentional and allows us approximate the composition and proportion of a lithology's constituent mineral or lithic components.

On the basis of the compositional similarities of lithologies shared among them, we conclude that the "new" lunar basaltic meteorite stones NWA 2700, 2727, 2977, and 3160 are paired with each other and with NWA 773. (A recently recovered and yet to be officially named NWA stone appears to be another pairing; it contains all four lithologies.)

All of the NWA basaltic meteorite stones in this study share several geochemical characteristics, very low Eu and Na_2O concentrations, LREE enrichment, high Th/REE ratio, that are uncommon in previously analyzed lunar basalts, and this may suggest a common source region for these meteorites, or even a petrogenetic relationship among them.

References:

[1] Zeigler R. A.. et al. (2006) *LPS XXXVII*, Abstract #1804. [2] Bunch T. E. et al. (2006) *LPS*

XXXVII, Abstract #1375. [3] Fagan T. J. et al. (2003) *MAPS* **38**: 529-554. [4] Jolliff B. L. et al. (2003) *GCA* **67**: 4857-4879. [5] Zeigler R. A.. et al. (2006) *MAPS* **40**: 1073-1102.

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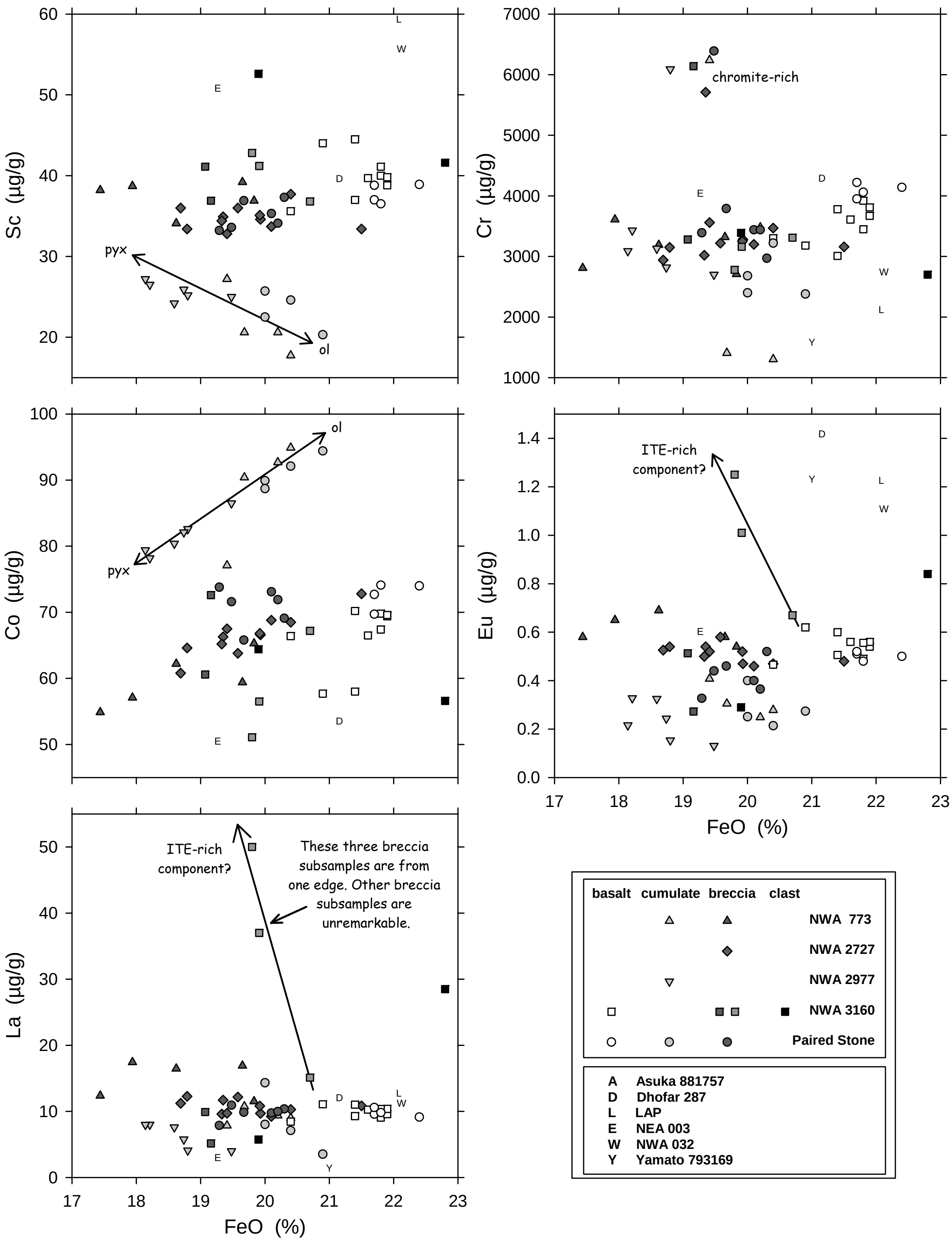

Figure 1: Two-element discrimination plots of Sc, Co, La, Cr, and Eu vs. FeO for many small subsamples of the "new" NWA basaltic meteorites in this work and NWA 773 [3-4]. Symbols are specific to both the NWA meteorite stone and the lithology. Also plotted are the average compositions of other basaltic lunar meteorites (data are unpublished analyses from this lab).