METEORITES FROM THE FRANCONIA, ARIZONA AREA: OBSERVATIONS AND SUMMARY OF PETROGRAPHIC CHARACTERISTICS.

L. V. Bleacher[1], G. R. Huss[1], L. A. Leshin[1], M. Miller, R. Garcia, S. Clary, J. Gwilliam, and L. Sloan. [1]Center for Meteorite Studies, Arizona State University, Tempe, AZ 85287.

Introduction: The Franconia meteorite was discovered in a dry wash in Mojave County, Arizona, USA, by John P. Wolfe on October 31, 2002. The original find, located without use of a metal detector, consisted of one specimen weighing approximately 4.75 kg. The specimen was classified by Alan Rubin at UCLA as an H ordinary chondrite (H5, S3, W2) [1]. Approximately one year after the original Franconia find, additional hunters began finding meteorites within a ~10 km radius of the first find, many not knowing that a meteorite had already been found in the area. To date, it is estimated that well over 100 specimens, comprising a total known weight of > 100 kg, have been found in the Franconia, AZ area. In early 2003, Mike Miller and Ruben Garcia contacted the ASU Center for Meteorite Studies (CMS) for help in sorting out a large group of meteorites, including a variety of stones and several small iron masses, from the same general area. Subsequently, additional stony specimens were brought in for classification by Sonny Clary and John Gwilliam. The relationship between the small irons and the stony majority is still under study and will not be discussed here. This abstract summarizes the similarities and differences among the 19 stony finds from the Franconia, AZ area that have been examined and classified by the CMS to date.

Methods: Due to the large number of specimens brought to the CMS for classification, the meteorites were first separated into groups with similar properties based on visual observations in hand specimens of exterior appearance, matrix color, chondrule abundance and size, metal abundance and grain size, and presence of metal veining or lack thereof. A representative member of each of the resulting groups was thin sectioned, its silicate minerals analyzed for olivine and pyroxene end-member compositions, and its petrologic type, shock stage, and weathering grade determined. Each section was then compared to the section used in the UCLA classification of Franconia, a different thin section of Franconia made by the CMS from a part slice, and a third thin section from a meteorite found in the Franconia, AZ area by Larry Sloan and classified by PSU as H3-5, S2-5, W1 (this meteorite does not yet have an approved name).

Silicate mineral chemistry. Each thin section was thoroughly documented with a JEOL JSM IC845 scanning electron microscope at ASU. Olivine and pyroxene compositions were determined using a JEOL JXA 8600 electron microprobe at ASU. Chondrule grains were the primary target. Operating conditions included a 15 kV accelerating potential, 10 nA probe current, and focused beam ($\lesssim 1$ μm). Data were corrected with a ZAF program and were used in olivine and pyroxene end-member calculations for fayalite (Fa) and wollastonite (Wo), enstatite (En), and ferrosilite (Fs), respectively.

Petrography. Petrologic type was determined according to the guidelines of [2], particularly chondrule delineation from matrix, extent of matrix and glass recrystallization, abundance of primary clinopyroxene, abundance and grain size of secondary plagioclase feldspar, and extent of olivine equilibration. The extent of shock experienced by each sectioned meteorite was determined based on the guidelines of [3] for olivine extinction and fracture characteristics and presence of shock veins or shock-blackened clasts. Weathering grades for each were determined by evaluation of the extent of oxidation experienced by metal, troilite, and silicates [4].

Results: *Hand specimen appearance.* In hand specimen, meteorite exteriors vary in color from dark black to red-brown, with fusion crust completely absent on portions of some specimens. Two meteorites appear much "older' than the others due to their extremely weathered, rusty exteriors devoid of most fusion crust and/or cementation of terrestrial sand-sized clasts in cracks. Interiors vary in color from mottled blue-gray to red-brown and dark brown. Chondrules and metal grains are easily visible in all specimens, but appear more obvious and/or abundant in some than others.

Composition. All but one of the meteorites examined by the CMS have H-chondrite compositions [2]. Because the exception resembles an L-group ordinary chondrite and is clearly unrelated to the rest of the meteorites found in the Franconia, AZ area and examined by the CMS, it will not be discussed in further detail here. The mean olivine composition ($Fa_{18.0\pm0.4}$) of all H chondrites examined in this study is similar to Franconia ($Fa_{17.6}$). However, the chondrites can be separated into two main groups based on their spread in Fa. Group A (includes eleven of the examined meteorites) is similar to Franconia in that they exhibit negligible spreads in Fa. Group B (seven meteorites) differs from Franconia and Group A by exhibiting larger spreads in olivine composition to both higher and lower Fa values. The largest spread between outliers for a member of Group B is 22.3 mol% Fa.

Petrographic characteristics. The majority of the Franconia, AZ area finds examined by the CMS are of petrologic type 5. Two chondrites in Group B resemble

H4-5 genomict breccias, while another two chondrites in Group B are composed of solely petrologic type 4 chondrite material. The significance of these similarities and differences in petrologic type will be discussed in more detail below.

Shock stage and weathering grade were found to vary from chondrite to chondrite (S1 to S3; W1 to W3). However, they were not given much weight in the determination of any possible pairings. Extent of shock has been shown to vary within some chondrites [3], thus variation in shock stage among paired meteorites is not surprising. Variation in weathering grade among paired meteorites is also not uncommon and may be a result of where each specimen landed (i.e. in a wash, on top of a mesa, etc.).

Discussion: Although most of the Franconia, AZ area finds examined by the CMS are classified as H ordinary chondrites and were found within an area of size not atypical for chondrite strewn fields, it is unclear how may falls are represented. Due to similarities in both olivine and pyroxene composition and texture, most members of Group A most likely pair with each other and Franconia. Their mean pyroxene composition ($Wo_{1.3\pm0.1}En_{82.6\pm0.4}Fs_{15.9\pm0.4}$) is similar to Franconia ($Wo_{1.1\pm0.1}En_{83.4\pm0.4}Fs_{15.7\pm0.3}$), they exhibit negligible spreads in Fa and Fs, and they are texturally similar in that they have characteristics of petrologic type 5 chondrites. In thin section, chondrules are visible but their outlines are not clearly delineated in most cases. Most chondrules are porphyritic. Matrix is extensively recrystallized in most specimens. Neither clinopyroxene nor plagioclase is a major component of this group of meteorites. One meteorite in Group A differs from the other group members in that its chondrules are significantly larger, perhaps an indication that it may not pair with Franconia, even though it is similar to Franconia in terms of overall texture, mean olivine and pyroxene compositions and compositional homogeneity.

Determining the pairings, if any, between and among the members of Group B and Franconia is more difficult, not only due to the larger spreads in Fa exhibited by this group, but because they exhibit a range of textures as well. Three members of Group B resemble petrologic type 5 chondrites and are thus similar to Franconia in extent of intergrowth between chondrules and matrix, extent of matrix recrystallization, minor clinopyroxene, and little to no plagioclase. The spread in olivine composition exhibited by the aforementionedd three members could be the result of brecciation, not lack of equilibration, as evidenced by their textures.

Lack of equilibration, however, may be the reason for the spread in Fa observed for the two members of Group B classified as H 4-5 genomict breccias. These chondrites exhibit considerably less intergrowth between chondrules and matrix in some thin section regions than Franconia. Clinopyroxene is a relatively major component of these specimens, while well-developed and coarse plagioclase is not observed. In addition, these two meteorites contain shock-produced clasts, which are observed in the chondrite classified by PSU but not in the other chondrites examined in this study. Taken together, these observations indicate that although these two members of Group B appear to pair with each other, and possibly the chondrite examined by PSU, in that they resemble H4-5 genomict breccias, they may not pair with Franconia.

The two members of Group B that are composed of solely petrologic type 4 material, due to the presence of more well-defined chondrules and less recrystallized matrix than the other chondrites, appear altogether different from Franconia and the rest of the examined H chondrites. Their mean pyroxene compositions differ significantly from Franconia in Fs and Wo contents $Wo_{0.4\pm0.0}En_{90.4\pm1.0}Fs_{9.0\pm1.0}$ and $Wo_{1.1\pm0.1}En_{83.4\pm0.4}$ $Fs_{15.7\pm0.3}$, respectively. These observations indicate that these two meteorites pair with each other but not with Franconia or the other H chondrite finds.

Summary: This investigation has shown that many of the meteorites found in the area around Franconia, AZ, are pieces of the Franconia fall. The less equilibrated textures, variable Fa and Fs, and shock-produced clasts observed in several of the examined H chondrites may reflect a heterogeneous Franconia parent body or they may be sufficiently distinct to assign some chondrites to separate falls. The latter possibility is supported by the discovery of an L chondrite within the same general area, suggesting that the Franconia, AZ area may be similar to others that have yielded recoveries from multiple meteorite falls, such as the Roosevelt County, NM [5] and Gold Basin, AZ [6] regions, and may provide mounting evidence to suggest that several meteorites from different fall events may be found in a localized area outside of the extreme dry and cold deserts of Africa and Antarctica, respectively, if conditions are suitable for their preservation and discovery.

References: [1] Russell S. S. et al. (2004) *MAPS, 39*, A215-A272. [2] Van Schmus W. R. and Wood J. A. (1967) *GCA, 31*, 747–765. [3] Stöffler D. et al. (1991) *GCA., 55*, 3845-3867. [4] Wlotzka F. (1993) *Meteoritics, 28*, 460. [5] Zolensky M. E. et al. (1990) *Meteoritics, 25*, 11-17. [6] Kring D. A. et al. (2001) *MAPS 36*, 1057-1066.