NORTHWEST AFRICA 1911: A SECOND PALLASITE FROM THE ZINDER-IIIF IRON PARENT BODY. J. S. Boesenberg[1] and M. Humayun[2]. [1]Dept of Earth, Environmental and Planetary Sciences, Brown University, 324 Brook Street, Providence, RI 02920, USA (joseph_boesenberg@brown.edu). [2]National High Magnetic Field Laboratory and Dept. of Earth, Ocean & Atmospheric Science, Florida State University, Tallahassee, FL 32310, USA.

Introduction: Northwest Africa 1911 is a 53 gram pyroxene pallasite that was discovered in 2003. Based on the petrological and chemical analysis of its silicates, oxides and metal, we have determined that it is the second silicate-bearing sample from the Zinder-IIIF parent body [1,2]. We explore the chemical linkages of NWA 1911 to this group and the complexities of this parent body.

Analysis: A small, 4 mm x 12 mm thin section of NWA 1911 was borrowed from the collection of Ted Bunch. Microprobe analysis of silicates, oxides and metal and sample characterization was performed at Brown Univ., while trace element abundances in metal were measured by laser ablation ICP-MS at Florida State University.

Results: Modal mineralogical abundances for NWA 1911 have been reported by [3] as olivine 40.2%, opx 34.5%, metal 24.3%, and troilite and chromite 1%. Trace merrillite has also been identified in this study. The olivine [($Fa_{11.9}$, avg)($Fa_{10.8-12.3}$, range), Fe/Mn=35.6 (n=56, 6 grains)] in NWA 1911 is rounded to sub-angular and generally 2 to 4 mm diameter. Pyroxene occurs in a variety of settings and is present both as opx and cpx. The opx occurs as 1) rounded, up to 4mm diameter grains, 2) a 100 µm rounded inclusion in olivine, and 3) as small (<20 µm), irregular cpx and opx inclusions within multiple symplectites that also include troilite. The compositions of the large opx grains vary mildly from grain to grain, primarily in Ca content, ranging from 0.85 to 1.3 wt% CaO. The three large opx grains measured have core compositions that have a range of $Wo_{1.6-1.8}$ $En_{86.5-87.0}$ while rims are $Wo_{1.9-2.3}$ $En_{86.3-86.6}$. All three grains have approximately equal TiO_2 (~0.13 wt%), Al_2O_3 (~0.95 wt%), Cr_2O_3 (~0.85 wt%), and Fe/Mn ratios of 20-23. The 100 micron opx inclusion found in olivine contains similar TiO_2, Al_2O_3, and Fe/Mn ratios as the large grains, but lower Cr_2O_3 (~0.63 wt%). The cpx only occurs as 10 micron or smaller inclusions in the symplectites with a compositional range of $Wo_{41.2-46.8}En_{53.5-49.2}$ and Fe/Mn=18.3 (n=8, 8 grains) with low ~0.28 wt% Cr_2O_3 and ~0.15 wt% TiO_2. Chromite is present both as small (tens of microns in diameter) and large grains (100s of microns in diameter) often found between and adjacent to olivines and metal, and containing merrillite inclusions. Chromite is occasionally found in the fine-grained symplectites along with troilite, cpx, opx and olivine. The chromite compositions (100*Fe/(Fe+Mg) = 51.4 to 77.6, 100*Al/(Cr+Al) = 31.4 to 12.5) are similar to the most Al-rich chromites found in MG pallasites (Fig. 1) and overlap those in Zinder, though cover a larger Fe/(Fe+Mg) range. Merrillite is the only phosphate present. Troilite is uncommon. Multiple symplectite regions composed of troilite + opx + cpx +/- olivine +/- chromite can be found in NWA 1911. Olivine compositions that border symplectite regions are slightly more Mg-rich (Fa~11) than other regions.

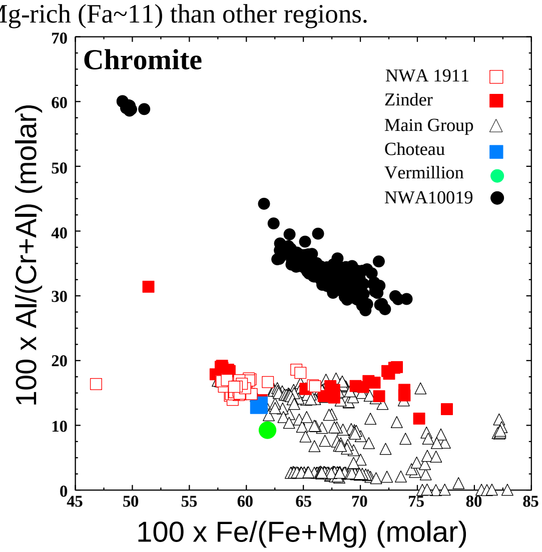

Figure 1: Fe/(Fe+Mg) vs Al/(Al+Cr) plot showing chromite from NWA 1911, Zinder, other pyx pallasites and Main Group pallasites.

The composition of the metal from NWA 1911 is extremely similar to that of Zinder and the IIIF irons [4, 5, 6], which consist of 8 meteorites. The composition of the NWA 1911 metal is Fe 90.7 wt%, Ni 7.70 wt%, Co 4119 ppm, Cu 132 ppm, Ga 6.05 ppm, Ge 1.11 ppm, As 5.29 ppm, Mo 6.1 ppm, Ru 9.8 ppm, Rh 1.6 ppm, Pd 3.7 ppm, Sn 0.77 ppm, Sb 0.06 ppm, W 1.43 ppm, Re 0.69 ppm, Os 8.58 ppm, Ir 7.48 ppm, Pt 12.9 ppm and Au 0.90 ppm (Fig. 2). It shares the characteristically low-Ga and Ge concentrations of Zinder and the IIIFs along with relatively low Ni.

Discussion: A brief chemical and petrological comparison of NWA 1911 to Zinder shows that these two meteorites are nearly identical, based on their major, minor and trace element mineral compositions. All mineral compositions overlap each other including olivine, opx, cpx, chromite, merrillite and metal. Some phases, such as chromite, have a larger range in one meteorite or the other, but can be explained as sampling bias, since only one section of each meteorite has been studied by the authors. Zinder and NWA 1911 have essentially the same $\delta^{18}O$ oxygen isotopic composition [3], but slightly different $\delta^{17}O$ compositions with Zinder lying just above the TF line and NWA 1911 falling below the TF line near the heavy end of MG pallasites. Though we know the samples were carefully acid washed and measured by [3], we suspect that one or both of these meteorites has been extensively terrestrially contaminated enough to affect its oxygen isotopic composition. NWA 1911 appears more weathered than Zinder. Assuming the oxygen isotopic difference is resolved by subsequent measurements, a difficulty with pairing these two meteorites is their find localities (Morocco and Niger), which are separated by ~1000 miles. Tektite strewn fields are known to be this wide [7], but not meteorite strewn fields.

With the inclusion of NWA 1911 to the Zinder-IIIF iron group, a definitive parent body composed of mantle and core components now exists. A potential problem with this IIIF-Zinder-NWA 1911 association however is that the IIIF irons plot along the carbonaceous chondrite line in Mo isotopic space [8], but the oxygen isotopes of NWA 1911 and Zinder plot with the non-carbonaceous achondrites, including angrites, HEDs and SNCs near the TF line, suggesting that IIIFs may not derive from the same parent body as Zinder or NWA 1911. Mo, Cr and Pd isotopes on Zinder and NWA 1911 are planned for the near future to investigate this dilemma.

References: [1] Boesenberg J. S. et al. (2017) LPS XLVIII, 2319 (abstr). [2] Humayun M. et al. (2018) LPS XLIX, 1461 (abstr). [3] Bunch T. E. et al. (2005) *Meteoritics & Planet. Sci., 40*, A26. [4] Scott E. R. D. and Wasson J. T. (1976) *GCA*, *40*, 103-115. [5] Scott E. R. D. (1978) *GCA*, *42*, 143-1251. [6] Pernicka E. and Wasson J. T. (1987) *GCA*, *51*, 1717-1726. [7] Glass B. P. (1990) *Tectonophysics* 171, 393-404. [8] Kruijer T. S. et al., (2017) LPS XLVIII, 1386 (abstr).

Figure 2: Trace element concentrations from NWA 1911 metal compared to metal from Zinder, the IIIF irons, the other pyroxene pallasites, MG pallasites and the IIIAB irons. All concentrations are in ppm. NWA 1911 and Zinder overlap in the two Au plots.