IMPACT MELT ROCKS AND PRISTINE CLASTS IN NORTHWEST AFRICA 7533. R.H. Hewins[1,2], B. Zanda[1,2], M. Humayun.[3], J.-P.Lorand[4], S. Pont[1]. [1]LMCM, MNHN, 75005 Paris, FR. [2]Rutgers University, Piscataway, NJ08854, USA. [3]Florida State University, Tallahassee, FL32310, USA; [4]LPG Université, 44322 Nantes, FR.

Introduction: NWA 7533 is a Martian breccia [1-3] paired with NWA 7034 and 7475 [4-6], and "fiendishly complex" [7]. Its impact origin was established from the textures and concentrations of siderophile elements [1-3]. Some medium grained igneous clasts, also of impact origin [2,3] contain zircons formed at 4,428±25 Myr [3]. Here we investigate further the compositions of lithic and pyroxene clasts to search for pristine material and use the Ni contents of pyroxenes to clarify their provenance.

Methods: For Ni analyses in silicates, we used an SXFive EMP at 20 kV and 300 nA, counting for 100 sec on three WDS simultaneously. Results were verified with San Carlos, Chassigny, Eagle Station and Tatahouine olivine or pyroxene internal standards. The detection limit, a probability function considering the risk of treating positive as zero, and vice-versa, at the 95% confidence level, is 24 ppm Ni in our pyroxene.

The Ni contents of olivine in San Carlos and Chassigny were easily duplicated. For low Ni concentrations we obtained much better precision using 20 rather than 15 kV (Fig. 1). Our error bars (s.d. of replicates) bracket literature values for Ni in olivine in Eagle Station and orthopyroxene in Tatahouine, which have the lowest concentrations (Fig. 1).

Petrography: Fine grained clast-laden melt rocks with high concentrations of siderophile elements are a major component in NWA 7533 [1-3]. Subophitic microbasalts, generally clast-free, have similar major and trace element compositions to the melt rocks [1-3]. The main occurrence of zircon, apart from crystal-clasts, is in noritic to monzonitic lithic clasts. Fig. 2 shows a noritic clast with a ferroan orthopyroxene grain ($En_{45.3}Fs_{52.1}Wo_{2.6}$) speckled with augite ($En_{36.3}Fs_{21.0}Wo_{42.7}$) and magnesian orthopyroxene ($En_{65.3}Fs_{32.2}Wo_{2.5}$), two small grains of plagioclase ($An_{39.5}Ab_{57.8}Or_{2.6}$), Cr-bearing magnetite and one large zircon. More zircon occurs in clasts of the more fractionated monzonitic material. Fig. 3 shows a monzonitic clast with augite ($En_{33.0}Fs_{20.0}Wo_{47.0}$), plagioclase ($An_{3.9}Ab_{90.9}Or_{5.2}$) and orthoclase ($An_{1.3}Ab_{10.4}Or_{88.3}$) and two large zircon grains.

Clasts may be too small for complete characterization but we distinguish noritic from monzonitic, i.e. orthopyroxene, plagioclase and Cr-magnetite bearing types from augite, two-feldspar and Ti-magnetite bearing types. Average compositions for each phase in clasts are shown in Fig. 4: the distinction between noritic with more calcic plagioclase associated with orthopyroxene (and augite) and monzonitic with alkali feldspars associated with augite only is clear. There are also crystal clasts of orthopyroxene (i.e. unattached to plagioclase) more magnesian (En_{77-73}) than in lithic clasts. Hence we infer the presence of orthopyroxenites in the target materials of the breccia.

Siderophile Elements: Clasts analyzed by [2,3] show high concentrations of siderophile elements, except for very feldspathic material and one pyroxene crystal clast 7533-3-pxn59. The medium grained igneous clasts are identified as impact melt on this basis, e.g. a clast of mugearitic composition has 378 ppm Ni. However, they contain no highly Ni-rich phases, except for secondary pyrite, and their magnetite contains only ~3000 ppm Ni [8]. Hence we have examined Ni contents of pyroxene, the main possible host phase.

The average compositions of orthopyroxene crystal clasts and three pigeonites are shown in Fig. 5. Excluding 2 high values, they have Ni concentrations (mean 21 ppm, s.d. 13) close to the detection limit and to ALH 84001 pyroxene composition. The pyroxenes in lithic clasts (plagioclase-bearing) have between 100 and 800 ppm Ni (mean 299, s.d. 184), excluding 2 clasts with low values, like those in melt rock groundmass. Error bars in Fig. 5 are the s.d. of replicates.

Discussion and Conclusion: The high Ni in the pyroxenes of the 4.4 Gyr noritic-monzonitic clasts of NWA 7533 is consistent with crystallization from impact melts suggested by [2,3]. Ni from projectiles is not fractionated out of the silicate, due to high fO_2 and low fS_2 in the melt, indicated by the presence of magnetite but no magmatic sulfides.

The orthopyroxene with low Ni contents resembles that in ALH 84001 in major elements. Pyroxene 7533-3-pxn59 [2,3] has similar Ir to ALH 84001, though higher concentrations of most siderophiles as the latter has "extraordinarily low concentrations of Au, Ni and, especially, Re" [9]. Ni-poor orthopyroxene in NWA 7533 represents pristine crustal orthopyroxenite.

References: [1] Hewins R. H. et al. (2013) *LPS* XLXV, Abstract #2385. [2] Humayun M. et al. (2013) *Lunar Planet Sci.* XLXV, Abstract #1429. [3] Humayun M. et al., (2013) *Nature* 503, 513-516. [4] Agee C. B. et al. (2013) *Science* 339, 780–785. [5] Korotev R. L. et al. (2013) *Meteorit. Planet. Sci.* 47 Abstract #5046. [6] Wittmann A. et al., (2013) *Meteorit. Planet. Sci.* 47 Abstract #5272. [7] McSween H. Y. (2013) *Nature* 503, 473-474. [8] Hewins R. H. et al. (2013) *Meteorit. Planet. Sci.* 47 Abstract #5252.

[9] Warren P. H. and Kallemeyn G. W. (1996) *Meteorit. Planet. Sci.* 31, 97-105.

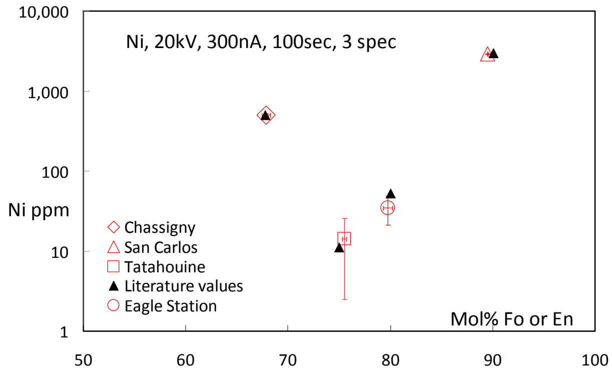

Fig. 1 *Comparison of our Ni analyses of reference samples with literature values.*

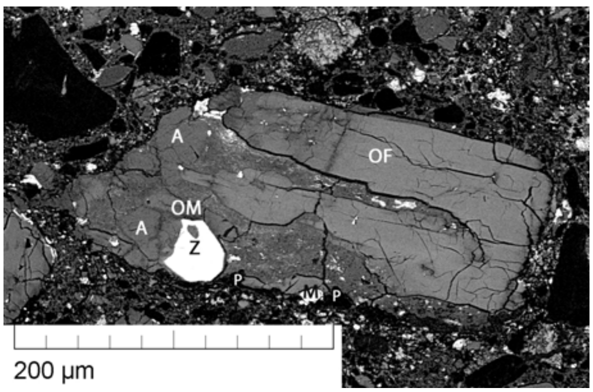

Fig. 2 *Noritic clast with ferroan (OF) and magnesian orthopyroxene (OM), augite (A), plagioclase (P), magnetite (M) and zircon (Z).*

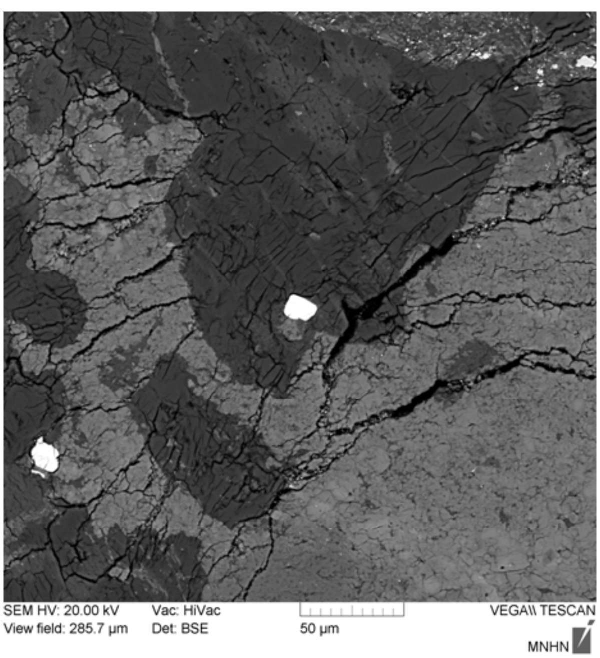

Fig. 3 *Monzonitic clast with augite, albite, orthoclase and two zircon grains.*

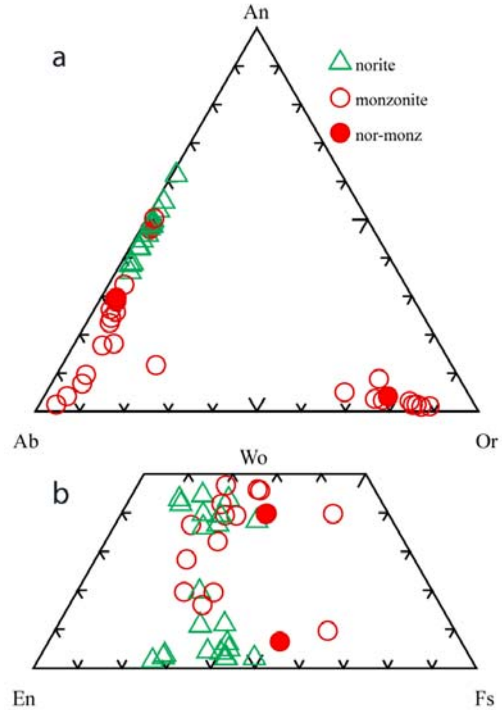

Fig. 4 *Average compositions for (a) feldspars and (b) pyroxenes in noritic and monzonitic clasts. Using also magnetite, there are few ambiguities in classification.*

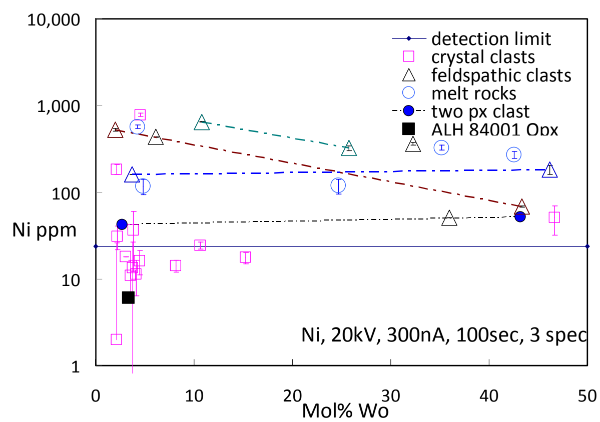

Fig. 5 *Ni concentrations in (mainly) orthopyroxene clasts and in pyroxenes in lithic clasts and melt rock groundmass.*

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