EBSD INVESTIGATION OF CHASSIGNITE NWA 8694. B. J. Tkalcec and F. E. Brenker, Goethe University, Institute of Geoscience, Altenhöferallee 1, 60438 Frankfurt am Main, Germany. tkalcec@em.uni-frankfurt.de.

Introduction: With the recent discovery of clear evidence for solid-state plastic deformation in the olivine grains not only of several olivine-rich diogenites [1-3] but also dunitic ureilites [4], the question is raised as to whether such solid-state plastic deformation can be attributed to shock deformation from exposure to impact events that undoubtedly occurred on parent bodies. For this purpose, a comparison of the structural data of both shocked and unshocked samples allows us to contemplate the plausibility of impact shock as origin for the solid-state plastic deformation recorded in ultramafic achondrites. Chassignites are particularly interesting for this purpose since not only does their rare Martian dunitic composition provide abundant olivine grains for quantitative structural analysis but their diagnostically unambiguous evidence for shock exposure allows a direct comparison of their structural results with those of non-shocked olivine-rich achondrites. Here we present structural results of the shocked chassignite NWA 8694 and compare them with previous structural results of shocked and unshocked olivine-rich diogenites [1-3] as well as unshocked dunitic ureilites [4].

Chassignite NWA 8694: Only three samples of Martian dunite are known so far: Chassigny with ~92 vol% olvine, NWA 2737 with ~85 vol% [5] and the recently found NWA 8694 with ~85 vol% [6]. Like the first two chassignites, NWA 8694 is a cumulate dunite with mm-size cumulate olivine grains (Fo_{53}) and interstitial low and high calcium pyroxenes as well as chromite, feldspar and glass [6, 7]. All three chassignites display clear evidence for extensive and intense shock exposure to pressures of ~35 GPa (Chassigny and NWA 8694) [7, 8] and even ~55 GPa (NWA 2737) [5]. NWA 8694 is thought to have crystallised under oxidising conditions in a thick Martian lava flow or shallow intrusion where it was subject to and endured impact events to which the interstitial feldspar reacted with extensive shock isotropisation and the olivine grains with intense fracturing and undulatory extinction [7].

Method: Structural analysis using electron backscattered diffraction (EBSD) was performed on the olivine grains of chassignite NWA 8694 in order to determine the presence or absence of any lattice-preferred orientation (LPO) as indicator for any occurrence of solid-state plastic deformation.

Results: The EBSD results for NWA 8694, comprising 542 different data points, are sufficient in number to qualify these results as statistically robust. Plotted both as contoured and scattered data pole figures of the recorded data points, the EBSD results for NWA 8694 reveal an unambiguously random, non-orientated distribution of all three olivine axes. A subsequent quantification of the fabric strength according to the M-index [9] verifies numerically with M = 0.03 (Table 1) the lack of any LPO of the olivine grains and attests a random fabric. These EBSD results thus confirm the non-occurrence of any solid-state plastic deformation in the clearly shocked chassignite NWA 8694.

Table 1: Comparison of Fabric Strengths

	Olivine vol%	**Fabric Strength M-index**	**Shock State**
Chassignite			
NWA 8694	~85	0.03	shocked (S3-4)
Diogenites [1-3]			
NWA 5784	~91	0.22	shocked
NWA 5480*	>90[A] ~45[B]	0.19 [A] 0.09 [B]	unshocked
MIL 07001	~13	0.09	unshocked
Ureilites [4]			
NWA 5996	>90	0.23	unshocked
NWA 7630	>90	0.16	unshocked

*Two distinct zones were determined in NWA 5480 and were analysed separately: [A]Zone A (dunitic); [B]Zone B (olivine with pyroxene schlieren).

Discussion: The lack of LPO in the olivine grains of the shocked chassignite NWA 8694 is in direct contrast to the EBSD results (Table 1) of shocked and unshocked olivine-rich diogenite samples and unshocked dunitic ureilites, all of which record medium to strong LPOs with fabrics quantified to M-indexes ranging from M=0.09 to M=0.23 which, unlike the random fabric of NWA 8694, indicate the occurrence of solid-state plastic deformation. The random fabric recorded for the shocked NWA 8694 negates not only any occurrence of plastic deformation but also any other mineral orientation process.

The results reveal an indiscriminate presence or absence of LPO with regard to the shocked or unshocked state of the sampled achondrites. Of the two shocked samples, NWA 8694 displays a random fabric whereas NWA 5784 displays a strongly preferred

fabric. The latter, displaying both cataclastic as well as plastic deformation [2], further demonstrates that exposure to impact shock neither causes nor eradicates ductile plastic deformation. Interestingly, solid-state plastic deformation is recorded in all four unshocked achondrites (NWA 5480, MIL 07001, NWA 5996 and NWA 7630), indicating a non-impact origin for their fabrics.

Conclusion: The results of this EBSD comparison of shocked and unshocked achondrites lend further support to the case advocated by Tkalcec & Brenker [2, 3] that exposure to an impact shock event is neither the cause of the solid-state plastic deformation recorded in olivine-rich diogenites and dunitic ureilites, nor does it eradicate any preceding LPO.

References: [1] Tkalcec B. J. et al. (2013) *Nature Geosci. 6,* 93-97. [2] Tkalcec B. J. and Brenker F. E. (2014) *Meteoritics & Planet. Sci., 49(7),* 1202-1213. [3] Tkalcec B. J. and Brenker F. E. (2015) *Journ. Sruct. Geol 77,* 138-150. [4] Tkalcec B. J. and Brenker F. E. (2016) *MetSoc LXXIX* Abstract 6282. [5] Treiman A. R. et al. (2007) *JGR, 112,* E04002 [6] Hewins R. H. et al. (2015) *LPSC XLVI,* Abstract 2249. [7] Mikouchi T. et al. (2016) *LPSC XLVII* Abstract 3983. [8] Langenhorst F. and Greshake A. (1999) *Meteoritics & Planet. Sci. 34,* 43-48. [9] Skemer P. et al. (2005) *Tectonophysics 411*,157–167.