PB-PB CHRONOMETRY OF THE DARK MELT LITHOLOGY OF THE CHELYABINSK LL CHONDRITE. A. Bouvier, University of Minnesota, Department of Earth Sciences, Minneapolis, MN 55455, USA (abouvier@umn.edu).

Introduction: On February, 15th 2013, a meteor fireball was witnessed in the Ural region, exploding at an altitude of 25-30 km, and generating a shockwave that injured more than 1,500 people in the city of Chelyabinsk in Russia. On February 19th, scientists of the Vernadsky Institute started recovering meteorites nearby the towns of Deputatsky, Pervomaysky and Emanjelinka, about 40 km south-west of Chelyabinsk. Hundreds of meteorite fragments from <1g to 1.8kg (most of them <20g) were found, often in patches, in the snow. The Chelyabinsk meteorite is an LL5 ordinary chondrite, with shock stage S4 [1]. About a third of the stones consist of a dark, fine-grained impact melt containing mineral and chondrule fragments [1]. This abundant dark melt is of particular interest for understanding impact processes within the asteroid belt and, because of its rapid recovery, is particularly suitable for Pb-Pb chronometry.

Study: A fragment from an individual stone representative of the dark melt lithology (10-134, 3.9g out of 5.9g) was recovered from the patch #10 and donated by the Vernadsky Institute to conduct chemical and isotopic studies at UMN. A ~1g interior piece of the fine grained dark melt lithology (chondrules and clasts were not observed in 10-134) was crushed as a bulk-rock powder. Two fractions of this powder were subsequently acid washed during a 5 to 6 steps leaching protocol (using Aristar Ultra HBr, HCl and HF, and double distilled HNO_3 acids) to progressively dissolve the recrystallized dark melt. Pb extraction and isotopic analysis using Tl-doping method followed similar protocols as described in [2] except that the Pb isotopic analyses were carried out by Neptune Plus MC-ICPMS techniques hooked up to a 50µl/mn ESI nebulizer and Cetac Aridus dessolvator giving together a sensitivity of 1800V/ppm.

Results: The $^{206}Pb/^{204}Pb$ ratios corrected from chemistry blank contribution for the leachates (L) and residues (R) of the two bulk rock samples of the dark melt lithology range from 70 to 81 for L1 to L4, and 142, 420, and 275 (identical for the two whole-rock residues) for L5, L6, and R respectively. Taken together, the Pb isotopic compositions of L5, L6 and R give an isochron Pb-Pb age of 4538.3 ± 2.1 Ma, MSWD = 0.17 (Fig. 1), using the $^{238}U/^{235}U$ ratio of 137.79 which was suggested to be homogeneous among bulk chondrites [3].

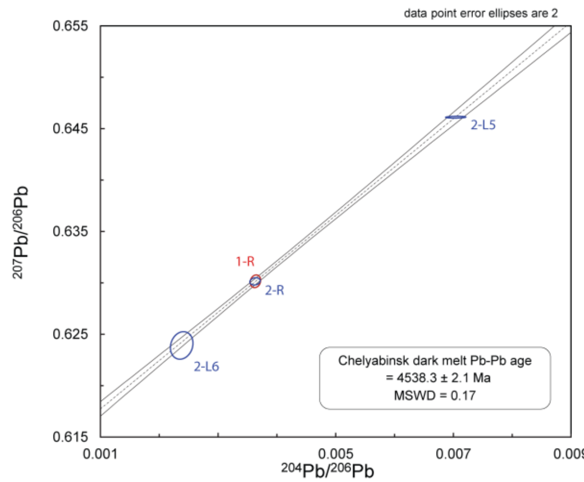

Figure 1: $^{207}Pb/^{206}Pb$ vs. $^{204}Pb/^{206}Pb$ of leachates and residues of the Chelyabinsk dark melt lithology.

Discussion: The Pb-Pb age of the dark melt of Chelyabinsk is ~30 My after the birth of the Solar System [2]. It is significantly older than Ar-Ar ages measured in other shocked LL chondrites (0.2-4.4 Ga) [4], but similar to Pb-Pb ages measured previously in relatively unshocked (S1-S2) type 5 L chondrites [5]. The Pb-Pb dates of L and LL chondrites were interpreted as cooling ages during thermal metamorphism on the respective parent bodies as well as secondary disturbances for L chondrites [5]. The ~4.54 Ga Pb-Pb age of the dark melt indicates that the LL parent body has been affected by at least one major impact event producing abundant shock melt following the main period of accretion of the parent body within the first 10 Ma of Solar System history [5]. The association of the light chondritic lithology with the dark melt brings new insight on the evolution of the LL chondrite parent body. Comparison of Pb-Pb dating with other radiometric methods in both lithologies will bring further constraints on the impact and thermal evolution of the LL parent asteroid [4].

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References: [1] Meteoritical Bulletin, MAPS 48, in prep. [2] Bouvier A. & Wadhwa M. 2010. Nature Geosc. 3:637-641 [3] Connelly J. N. et al. 2012. Science 338:651-655 [4] Swindle T. D. et al. 2013. Geological Society, London, v. 378, doi:10.1144/SP378.6 [5] Bouvier A. et al. 2007. GCA 71:1583-1604.