BADDELEYITE OCCURRENCES IN MARTIAN METEORITES AND THE POTENTIAL FOR *IN SITU* GEOCHRONOLOGY OF ZAGAMI

C. D. K. Herd[1] and T. J. McCoy[2]. [1]Department of Earth and Atmospheric Sciences, 1-26 Earth Sciences Building, University of Alberta, Edmonton, AB, Canada, T6G 2E3. E-mail: herd@ualberta.ca. [1,2]Department of Mineral Sciences, Smithsonian National Museum of Natural History, 10th & Constitution NW, Washington, DC, 20560-0119.

Introduction: Baddeleyite (ZrO_2) is of interest for its potential use in U-Pb geochronology of martian meteorites [1]. Although it is more common in martian meteorites than previously recognized, small grain sizes require *in situ* approaches for analysis, i.e., ion probe mass spectrometry. The primary step, therefore, is locating and documenting baddeleyite grains in thin section. Here we report on the results of this process applied to Zagami, especially the Dark, Mottled Lithology (DML) [2]. Our observations have implications for the occurrence of baddeleyite in martian meteorites, and the potential for application of *in situ* U-Pb geochronology methods to this meteorite.

Methods: Thin sections reflecting the range of Zagami lithologies were examined, including normal Zagami and DML (USNM 6545-2), DML (UH 218) and a late-stage melt pocket (LSMP; UH 233). The Particle Search method, which maps Zr hotspots by WDS (Cameca SX-100 electron microprobe; University of Alberta) is the most efficient method for locating baddeleyite grains. Grain locations were then verified, documented and measured using the FEI Nova NanoSEM (Smithsonian).

Results: A total of 481 grains were located in the three thin sections; 320 in DML (specimens UH 218 and USNM 6545-2), 95 in Normal Zagami (USNM 6545-2) and 66 in the LSMP (UH 233). These occurrences correspond to frequencies of 1 grain approximately every 1.3 mm^2 in DML, 1 every 0.6 mm^2 in Normal Zagami, and 1 every 0.5 mm^2 in the LSMP. In each case, baddeleyite was found in association with late-stage crystallization products. Most commonly it is found within fine-grained, silica-rich mesostasis pockets, within coarse mesostasis (specific to LSMP) or enclosed within titanomagnetite.

Implications: The primary factor influencing baddeleyite occurrence is buildup of Zr in late-stage melt [3]. Baddeleyite may be expected to occur in any martian basalt that started with sufficient Zr content in the parental melt, and within which Zr remained incompatible in all other igneous minerals through the course of crystallization. Accordingly, baddeleyite is common in DML, an evolved, incompatible element-enriched lithology within an already Zr-rich rock [3]. That baddeleyite is relatively common in normal Zagami was unexpected, but its occurrence in association with late-stage crystallization phases is consistent with buildup of Zr as crystallization proceeds.

There is no lack of baddeleyite grains in Zagami. Based on our observations, the best places to find grains of sufficient size and abundances for *in situ* U-Pb geochronology are a) within coarse mesostasis in LSMP (average grain size 3.6 ± 2.4 µm, n = 26); and b) enclosed within titanomagnetite (4.5 ± 3.2 µm, n = 51). The largest grain found in LSMP coarse mesostasis is 14 x 9 µm. The largest grains found enclosed in titanomagnetite are 10 x 8 µm and 22 x 6 µm (where 6 µm is the maximum width).

References: [1] Herd C.D.K. et al. 2007. Abstract #1664. 38th LPSC. [2] McCoy T.J. et al. (1999) *Geochimica et Cosmochimica Acta,* 63:1249-1262. [3] Herd C.D.K. and T.J. McCoy (2011) Abstract #1801. 42nd LPSC.