APOLLO IMPACT MELT BRECCIA 73275 AS AN IMBRIUM EJECTUM INTO THE APOLLO 17 SENRENITATIS LANDING SITE: IMPLICATIONS FROM SIMS U-PB DATING OF MICRO-BADDELEYITES. B. Zhang[1], P. H. Warren[1], K. D. McKeegan[1], & E. A. Bell[1] [1]Department of Earth, Planetary & Space Sciences, University of California, Los Angeles, CA 90095-1567, USA.

Introduction: One of the main findings made from the Apollo samples is that the Earth-Moon system might have experienced a spike of mass flux input at 3.75−3.95 Ga, the late heavy bombardment (LHB) [1]. The LHB has critical implications for mass flux over time, windows for habitability and emergence of life, and topographic features of inner planets [2]. However, increasing evidence has shown that all Apollo landing sites have been influenced by later-emplaced Imbrium ejecta [3, 4], and the clustered formation ages of Apollo impact melt breccias at 3.75−3.95 may instead represent the end of a prolonged bombardment period [5].

For the Apollo 17 Serenitatis highland landing site, a prior study has shown that poikilitic impact melt breccia (PIMB) 73155 is likely to be an Imbrium-originated ejectum, and the South Massif may have abundant Imbrium-ejecta components [6]. In the present study, we used an ion microprobe to analyze baddeleyite in Apollo 17 micro-poikilitic IMB 73275. We aim to (1) date baddeleyite crystallizing from impact melt, (2) add constraints to the origin of Apollo 17 PIMBs, (3) assess the influence of Imbrium ejecta at the Apollo 17 landing site, and (4) explore possible *in situ* dating strategies for future Artemis samples.

Methods and Sample Description: The U-Pb dating was carried out using ims-1290 ion microprobe at UCLA with Hyperion-II RF ion source [7]. A 3 nA O_3 primary beam was focused to a ca. 6 μm spot. Analyses were run at a mass resolving power ca. 5000, and the relative ionization between Pb and U was calibrated using the Phalaborwa baddeleyite standard.

Sample 73275 was acquired at Station 3 on the Light Mantle deposit, a landslide of South Massif. 73275 is a clast-poor micro-poikilitic IMB, whose composition is similar to those of other Apollo 17 PIMBs [8]. The impact melt is composed of plagioclase, orthopyroxene and minor olivine [9]. Our thin section 73275,66 has mineralogy and texture consistent with the whole rock and was found to have minor phases such as ilmenite, baddeleyite, and phosphate. Poikilitic ilmenite grains occur intergrown with pyroxene and plagioclase in the impact-melt matrix, and all found baddeleyite grains are exsolutions (<10 μm) from the ilmenite grains.

Results and Discussion: Thirteen SIMS U-Pb analyses show $^{207}Pb/^{206}Pb$ ages of 3882 Ma to 3993 Ma, with a weighted mean of 3922 ± 8 Ma (2σ, MSWD = 1.67). The U-Pb ages show an upper intercept at 3923 ± 13 Ma and a lower intercept at 7 ± 83 Ma (2σ, MSWD = 2) on the concordia diagram. Note that some spots show apparent reverse discordance, and the cause of the discordance is under investigation. The weighted mean $^{207}Pb/^{206}Pb$ age and upper intercept of U-Pb ages are identical and close to the $^{40}Ar/^{39}Ar$ age of 73275 whole rock at 3870 ± 50 Ma [10, 11] within errors. The lower intercept of U-Pb ages is consistent with the cosmic ray exposure age of 160 Ma by ^{38}Ar [10].

The fine and unfractured texture of baddeleyite exsolutions from the poikilitic ilmenites shows that the ilmenites crystallized at a later stage of the impact-melt crystallization, and the baddeleyites are the latest product of the crystallization. We hence interpret the $^{207}Pb/^{206}Pb$ ages of 73275,66 baddeleyites as the crystallization age of the breccia. The lower intercept of U-Pb ages most likely represents the excavation age of 73275, during which Pb in the baddeleyites was partially lost.

Our study reports the first Apollo breccia that has consistent $^{207}Pb/^{206}Pb$ ages for numerous baddeleyite grains, and these grains crystallized from impact melt. The $^{207}Pb/^{206}Pb$ age of 3922 ± 8 Ma for 73275 is identical to the counterpart for 73155 poikilitic zircons at 3921 ± 14 Ma [6]. These ages are interpreted as the Imbrium-basin-formation age [6, 12]. Highly-siderophile-element data suggest that Apollo 17 PIMBs in general formed in a single event [13], and had 73275 and 73155 formed from separate impacts, their further similarity in terms of texture and age would constitute a remarkable coincidence. Our results thus support the idea that the Apollo 17 PIMBs likely represent ejecta of Imbrium impact melt, and such Imbrium-originated components are abundant at the Apollo 17 landing site [6]. We also envision our high-spatial-resolution *in situ* U-Pb dating of micro-baddeleyites as an example for extracting meaningful chronologic information from micro Zr-rich minerals in current Apollo collections and future Artemis highland samples.

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