U-Pb AGE OF THE UNGROUPED ACHONDRITE NWA 8486

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Introduction: NWA 8486 is an ungrouped achondrite (single stone, ~44 g) that was acquired in 2014 by the Center for Meteorite Studies, ASU. This meteorite is thought to be paired with the ungrouped achondrite NWA 7325, which has been the subject of much study in recent years due to its unusual plutonic texture and gabbroic composition, consisting of ~55% calcic plagioclase, ~30% diopside, ~15% forsterite and minor accessory phases [1-3]. Most notably, the unique major element composition of NWA 7325 led [1] to draw comparison with the MESSENGER X-ray and γ-ray spectrometer data for Mercury's surface [4], suggesting that this achondrite may be the first sample of mercurian origin. While its possible connection to Mercury is uncertain [1,3], NWA 7325 remains an intriguing specimen from a previously unsampled achondritic parent body. Prior chronological studies of NWA 7325 yielded Al-Mg ages of 4562.8 ± 0.3 Ma [5] and 4563.09 ± 0.26 Ma [3] and an absolute U-Pb age of 4563.4 ± 2.6 Ma [3]. The relatively large uncertainty for the U-Pb age is due to the extremely low concentrations of U (and, therefore, radiogenic Pb) in this sample (1.1 - 6.4 ppb [3]) – up to two orders of magnitude lower than in other achondrites (e.g. [6]). Here, we report U-Pb data for the paired NWA 8486 achondrite to: 1) Confirm the pairing between these samples; 2) Improve on the U-Pb age by using larger sample aliquots; and 3) Compare the ages obtained using different mass spectrometry techniques (i.e., MC-ICPMS and TIMS).

Methodology: Four pyroxene (PYX) fractions (each ~20-35 mg) and one pyroxene-enriched whole-rock (WR) fraction (~33 mg) were obtained by hand-picking after gentle crushing and sieving of ~2 g of bulk NWA 8486. The aliquots, which are ~3 times larger than those for NWA 7325 [3], were washed, acid leached, and taken through column chemistry using techniques similar to [3]. All residues and washes were spiked with a mixed U-Pb spike. Following dissolution and column chemistry procedures, Pb isotopes were measured using a Triton Plus TIMS at ANU. The U isotope compositions will be measured using a Neptune MC-ICPMS at ASU in the near future.

Results: As seen for NWA 7325, the NWA 8486 aliquot residues have low Pb concentrations of 1.4-2.7 ppb, and show evidence for radiogenic Pb with elevated $^{206}Pb/^{204}Pb$ ratios of 37-81. The $^{206}Pb/^{204}Pb$ ratios for the washes are 17-19, indicating successful removal of non-radiogenic Pb from the residues by acid leaching, where these values represent a mixture of terrestrial Pb (~18.7 [7]) and primordial Pb (~9.3 [8]). An isochron age of 4562 ± 40 Ma (MSWD = 79, $^{238}U/^{235}U$ = 137.79) is obtained using Pb isotopic data for all five residues. The large uncertainty on this age may relate to residual common Pb within the aliquots – especially in the WR. Excluding the WR and one PYX with $^{206}Pb/^{204}Pb$ <50, we obtain an isochron age of 4565.5 ± 5.8 Ma (MSWD = 0.56). Furthermore, by combining these data with those PYX used for the NWA 7325 isochron [3], we obtain an improved isochron age of 4563.9 ± 1.7 Ma (MSWD = 1.10). The weighted average model $^{207}Pb^*/^{206}Pb^*$ age for the three NWA 8486 PYX with $^{206}Pb/^{204}Pb$ >50 is 4558.9 ± 4.5 Ma (MSWD = 2.7). When combined with the NWA 7325 PYX with $^{206}Pb/^{204}Pb$ >50 [3], this yields a combined weighted average model $^{207}Pb^*/^{206}Pb^*$ age of 4558.5 ± 1.6 Ma (MSWD = 1.6). The slight discrepancy between the isochron ages and the calculated model ages is further indication that some common Pb may still reside in these residues.

Discussion: Our preferred NWA 8486 Pb-Pb isochron age of 4563.9 ± 1.7 Ma, combined with previously reported Al-Mg and Pb-Pb ages of ~4563 Ma for NWA 7325 [3, 5] supports a crystallization age of ~4 Ma after CAI formation [9-10]. This age is similar to those reported previously for ungrouped achondrites NWA 2976, NWA 6704, SaU 493, NWA 4470 and quenched angrites [11-13], although these achondrites originated on distinct parent bodies [14-16]. This suggests that magmatic activity within ~4 Ma of CAI formation was commonplace on planetesimals in the early Solar System.

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