Uranium isotopic composition of volcanic angrites Northwest Africa 12320, Northwest Africa 12004, and Northwest Africa 12774 and ungrouped achondrite Erg Chech 002.

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Introduction: Variability of $^{238}U/^{235}U$ in terrestrial and extraterrestrial rocks and minerals reflects conditions of their formation, and affects the accuracy of U-Pb and Pb-Pb isotopic dates [1-4]. Accurate Pb-Pb chronology of meteorites and their components requires precise determination of U isotopic composition. Here we present the $^{238}U/^{235}U$ ratios of an ungrouped achondrite Erg Chech 002 and three recently discovered volcanic angrites: Northwest Africa (NWA) 12774, NWA 12004, and NWA 12320.

Samples and methods: Crushed and sieved whole rock fractions were pre-cleaned by ultrasonic agitation in ethanol, MQ water and distilled acetone. Each fraction was separated into two parts: (1) 30-40% for direct dissolution after cleaning, and (2) 60-70% for leaching in 0.5M HNO_3 for dissolving possible phosphates, and dissolution of a residue in a mixture of concentrated HF and HNO_3 acids.

All aliquots were spiked with IRMM-3636 $^{233-236}U$ double spike [5] before chemical separation with anion exchange AG®1-X8 and Uteva® resins. Samples were analysed on the Neptune Plus MC-ICPMS at the Research School of Earth Sciences, Australian National University, in static multicollector mode. Samples were introduced to the plasma using Aridus desolvating nebulizer. Faraday cups used for measuring ^{238}U and monitoring Th were connected to the amplifiers with 10^{11} Ω resistors, while the cups used for measuring ^{233}U, ^{235}U and ^{236}U were connected to the amplifiers with 10^{12} Ω resistors. Measurement quality was monitored by bracketing with the IRMM 184 uranium isotopic standard. The data for secondary standards (NIST SRM 960 and basalts BCR-2 and BHVO-2) and meteorites were adjusted for consistency with the accepted $^{238}U/^{235}U$=137.683±0.020 in IRMM 184 [6]. Secondary standards were analysed at various intensities (^{238}U between 1 and 20 V) and various sample to spike ratios to confirm data quality.

Results and discussion: The $^{238}U/^{235}U$ ratios measured in this study are presented in Fig. 1, uncertainty bars are 2σ. The weighted average $^{238}U/^{235}U$ ratio of terrestrial basalt is 137.7951 ± 0.0037 (n = 6). Uranium isotopic composition of NWA 12320 ($^{238}U/^{235}U$ = 137.8019 ± 0.0071, n = 6) and NWA 12004 ($^{238}U/^{235}U$ = 137.8073 ± 0.0083, n = 4) angrites are in agreement with published values for volcanic angrites D'Orbigny and Sahara 99555 [2, 7, 8], and close to the values in terrestrial igneous rocks and perceived average value of the Solar System [9, 10]. There is no detectable difference between $^{238}U/^{235}U$ in leachates and residues in these meteorites. The U isotopic composition of NWA 12774 is more complex. The $^{238}U/^{235}U$ values of bulk rock and wash are consistent with each other and yield the weighted average value of 137.8137 ± 0.0093, while the residue has $^{238}U/^{235}U$ ratio of 137.7794 ± 0.0144, lower than angrites in this study. It indicates that the U isotopic composition of rapidly cooled angrites may have internal heterogeneity that was previously seen in plutonic angrites but not in volcanic angrites [7].

The ungrouped achondrite Erg Chech 002 has a weighted average $^{238}U/^{235}U$ ratio of 137.8268 ± 0.0029 (n = 9), with no detectable difference between leachate and residue. This value is higher than, and well resolved from, the values in most meteorites and terrestrial igneous rocks studied so far. The reasons for such variations in differentiated planetary bodies are uncertain, but it is clear that the variability of $^{238}U/^{235}U$ ratio among achondrites is real and need to be explored.

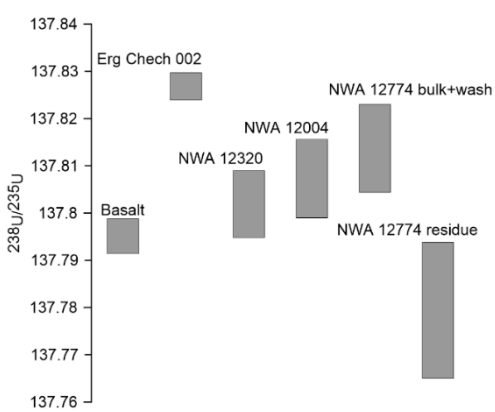

Fig. 1. $^{238}U/^{235}U$ ratios in terrestrial basalt, Erg Chech 002 and angrites

References: [1] Brennecka, G., et al., (2010). Science, 327(5964): p. 449-451. [2] Brennecka, G.A. and M. Wadhwa, (2012). Proceedings of the National Academy of Sciences, 109(24): p. 9299-9303. [3] Hiess, J., et al., (2012). Science, 335(6076): p. 1610-1614. [4] Tissot, F.L.H., N. Dauphas, and L. Grossman, (2016). Science Advances, 2(3). [5] Verbruggen, A., et al., (2008). JRC Scientific and Technical Reports. [6] Richter, S., et al., (2010). International Journal of Mass Spectrometry, 295(1): p. 94-97. [7] Huyskens, M., Y. Amelin, and Q.-Z. Yin, (2020). LPS, Abstract #2326. [8] Tissot, F.L.H., N. Dauphas, and T.L. Grove, (2017). Geochimica et Cosmochimica Acta, 213: p. 593-617. [9] Connelly, J.N., et al., (2012). Science, 338(6107): p. 651-655. [10] Goldmann, A., et al., (2015). Geochimica et Cosmochimica Acta, 148: p. 145-158.