Preliminary Report on U-Th-Pb Isotopic Systematics of NWA 7034: Implications for Geochemical Evolution of the Martian Crust

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The SNC meteorites have played an important role in elucidating geochemical evolution of Mars. However, spacecraft data suggest that the SNCs do not represent the Martian crust and cast doubt on their use in modeling a history of the planet [1]. NWA 7034, discovered in Morocco in 2011, is an only Martian meteorite that compositionally resembles an averaged Martian crust measured by orbiters and landers [2]. The discovery of this meteorite offers an opportunity to study a typical Martian crust for the first time. Uranium-thorium-lead isotopic systematics has been a traditional geochemical tracer used in studies of the terrestrial crust. Here, we present a preliminary report on the U-Th-Pb systematics of NWA 7034.

We conducted a five step acid leaching experiment [3] for ~40 mg bulk rock sample of NWA 7034. The trace element abundances (e.g., REEs, U, Th, and Pb) of the five leachates and the residue were measured with a quadrupole ICP-MS. In addition, the Pb isotopic compositions of the same samples were measured with a TIMS. Lead isotopic compositions of the five leachates produced a linear trend passing through an isotopic composition of common terrestrial Pb [4] in a $^{207}Pb/^{204}Pb$-$^{206}Pb/^{204}Pb$ diagram, which implies the effect of terrestrial alteration to the leachate fractions. In contrast, Pb isotopic composition of the acid residue does not participate in the linear trend, suggesting that the residue fraction has not seriously been affected by the terrestrial alteration. This surmise is supported by the REE pattern of the acid residue that is consistent with that of plagioclase in NWA 7034 [5]. To note, plagioclase is the strongest mineral to weathering in NWA 7034 [6].

Two U-Pb ages were reported for NWA 7533, a pair meteorite of NWA 7034; the older age of 4428 Ma recorded in zircons is interpreted to be the timing of crystallization [7], while the younger age of 1357 Ma obtained by the measurements of apatites probably represents the resetting age [8]. The Pb isotopic composition of the acid residue falls closely to those of plagioclase altered at 1357 Ma [8]. We determined the initial Pb isotopic composition of NWA 7034 at 1357 Ma using the Pb isotopic composition and $^{238}U/^{204}Pb$ ratio (= μ) of the acid residue. In addition, Bellucci *et al.* (2015) [8] has reported the initial Pb isotopic composition of NWA 7533 at 4428 Ma. Taken together, the initial $^{206}Pb/^{204}Pb$ ratios of the Martian crust were determined to be 9.89 ±0.07 and 16.27 ±0.01 at 4428 and 1357 Ma, respectively. A Pb growth curve with the present μ-value of 7.97 passes through the two Pb isotopic compositions. On the other hand, the Martian mantle has been constrained to have μ-values of 1.8-4.4 by U-Pb analyses of SNC meteorites [9]. This indicates that the Martian crust represented by NWA 7034 has a μ-value about two times higher than that of the Martian mantle.

References: [1] McSween, H. Y. *et al.* (2009) *Science*, **324**, 736-. [2] Agee, C. B. *et al.* (2013) *Science*, **339**, 780-. [3] Moriwaki, R. *et al.* (2017) *EPSL*, **474**, 180-. [4] Stacey, J. T. and Kramers, J. D. (1975) *EPSL*, **26**,

207-. [5] Santos, A. R. *et al.* (2015) *GCA*, **157**, 56-. [6] Hurowitz, J. A. *et al.* (2006). *JGR: Planets*, 111.E2. [7] Humayun, M. *et al.* (2013) *Nature*, **503**, 513-. [8] Bellucci, J. J. *et al.* (2015) *EPSL*, **410**, 34-. [9] Tobita *et al.* (2017) *Geochem. J.* **51**, 81-.

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