DISTINCT CHLORINE ISOTOPE RESERVOIRS ON MARS. ORIGINS AND INTERACTIONS.

C.K.Shearer[1,2], S. Messenger[3], Z.D. Sharp[2], P.V. Burger[1], N. Nguyen[3,4], and F.M. McCubbin[3]
[1]Institute of Meteoritics, University of New Mexico, Albuquerque, New Mexico 87131 (cshearer@unm.edu), [2] Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131, [3] NASA Johnson Space Center, Mailcode XI, 2101 NASA Parkway, Houston, Texas 77058, [4]Jacobs, NASA Johnson Space Center, Houston, Texas 77058

Introduction: The style, magnitude, timing, and mixing components involved in the interaction between mantle derived martian magmas and martian crust have long been a point of debate [1-7]. Understanding this process is fundamental to deciphering the composition of the martian crust and its interaction with the atmosphere, the compositional diversity and oxygen fugacity variations in the martian mantle, the bulk composition of Mars and the materials from which it accreted, and the noble gas composition of Mars and the Sun. We examined the Cl isotopic composition of multiple generations and textures of apatite in Chassigny to extricate the crustal and mantle components and to reveal the style and timing of the addition of crustal components to mantle-derived magmas. Chlorine isotopic measurents were carried out by isotopic imaging using the JSC NanoSIMS 50L ion microprobe [8].

Results: The δ^{37}Cl in the apatite in Chassigny exhibits considerable variation which is correlated to textural type. The measured δ^{37}Cl for the intercumulus apatite ranges from ~0 to +3.6‰. Conversely, the apatite in the melt inclusions has a δ^{37}Cl that ranges from -3.6 to -5.5‰. The δ^{37}Cl for large intercumulus type 2 apatite ranges from -2.4 to -6.7‰. However, analyzing the individual pixels for the rastered data for these large apatites indicates that their rims are more enriched in heavy Cl than their cores. Differences between textural types exceed both the precision of the analysis (< 1‰) and matrix effects attributed to Cl concentrations (< 0.5‰ for the range of Cl observed in the Chassigny apatite).

Discussion: The measurement of the δ^{37}Cl in apatite in martian meteorite Chassigny confirms that two Cl isotopic reservoirs exist on Mars: (1) an isotopically light-Cl mantle reservoir (δ^{37}Cl=-4 to -6‰) which exhibits limited variability and is the same for depleted and enriched mantle sources and (2) an isotopically heavy-Cl crustal reservoir (δ^{37}Cl>0) which exhibits significant variability [9-11]. The mantle component is preserved in melt inclusions that also hosts the solar noble gas composition documented in Chassigny. The preservation of these two distinct components in a single meteorite provides petrogenetic insights into the interaction between these two reservoirs and constrains the relationship between two major martian crustal lithologies (chassignites, nakhlites). The existence of these two reservoirs has profound implication for the evolution of the martian atmosphere, the nature of material that accreted to form Mars, and volatiles in the solar nebula. The enrichment of the crust in heavy Cl resulted from protracted loss of ^{35}Cl to space and started early in the history of Mars. The light Cl signature of accreting materials that formed Mars (and is represented by the martian mantle) is different from the Earth, Moon, and many primitive meteorites. These differences represent distinct Cl and volatile reservoirs in the solar nebula. The low δ^{37}Cl reservoir represents the primordial Solar System composition from which Mars accreted. The higher δ^{37}Cl values observed for the Earth, Moon, and many chondrites are not primordial, rather they represent the later incorporation of ^{37}Cl-enriched HCl-hydrates into accreting material [10,12].

Swindle [13] used the noble gas isotopic composition of Chassigny as the starting point for modeling the mass fractionation of the Martian atmosphere. Examining the potential of crustal and mantle Cl isotope components in Chassigny and the other chassignites allows us to better unravel the origins of the noble gas components. Finally, the SAM instrument on the Mars Science Lab has reported Cl isotopic composition of material from Gale Crater [11], characterized by a wide variation in δ^{37}Cl that is not reproduced in the martian meteorites. Further analyses of δ^{37}Cl components in martian meteorites may provide a deeper understanding of these new results from the martian surface.

References: [1] Jones, J.H. (1989) *Proc. Lunar Planet. Sci. Conf. 19th.* Lunar and Planetary Institute, Houston, 465-474. [2] Norman, M. D. (1999) *Meteoritics and Planetary Science **34***, 439-449. [3] Wadhwa, M.M. (2001) *Science* **291**, 1527-1530. [4] Herd, C.D.K. et al. (2002) *Geochimica et Cosmochimica Acta* **66**, 2025-2036. [5] Symes, S.J.K. et al. (2008) *Geochimica et Cosmochimica Acta* **72,** 1696-1710. [6] Debaille, V. et al. (2008) *Earth and Planetary Science Letters* **269**, 186-199. [7] Shearer, C.K. et al. (2008) *Meteoritics and Planetary Science* **43**, 1241-1258. [8] Shearer C.K. et al. (2017) *Geochimica et Cosmochimica Acta* in review. [9] Shearer C. K. et al. (2014) *45th Lunar and Planetary Science Conference XLV*. Lunar and Planetary Institute, Houston #1502. [10] Sharp, Z.D. et al. (2016) *Meteoritics and Planetary Science*, **51**, 1-16. [11] Farley, K.A. et al. (2016) *Earth and Planetary Science Letters* **438**, 14-24. [12] Gargano, A.M. et al. (2017) abstract this volume. [13]Swindle, T.D. (2002) *MSA Reviews in Mineralogy and Geochemistry* **47**, 171-190.