SULFUR AND OXYGEN ISOTOPIC ANALYSIS OF A COSMIC SYMPLECTITE FROM A COMET WILD 2 STARDUST TERMINAL PARTICLE.

A. N. Nguyen[1,2], E. L. Berger[2,3], K. Nakamura-Messenger[2], and S. Messenger[2]. [1]JETS, NASA JSC, Houston TX. [2]Robert M. Walker Laboratory for Space Science, ARES, NASA JSC, Houston TX. [3]GeoControl Systems, JETS, NASA JSC, Houston TX. lan-anh.n.nguyen@nasa.gov.

Introduction: Analyses of comet 81P/Wild 2 samples returned from the Stardust mission have uncovered surprising similarities to meteoritic material, including the identification of inner solar system grains [1-3]. The TEM characterization of terminal particle (TP) 4 from Stardust track #147 revealed an assemblage consisting of symplectically intergrown pentlandite and nanocrystalline maghemite coexisting with high-Ca pyroxene [4]. Mineralogically similar cosmic symplectites (COS) containing pentlandite and magnetite in the primitive Acfer 094 meteorite are highly depleted in ^{16}O (δ^{17}O, δ^{18}O ~ 180 ‰) [5-7]. This isotopic signature is proposed to record alteration with primordial solar nebula water. Conversely, the normal O isotopic composition of the Stardust COS indicates alteration by a different aqueous reservoir, perhaps on the comet [8]. In this study, we analyzed the Wild 2 COS for S isotopes to further constrain its origin.

Experimental: Thin sections of TP4 (12 μm) were produced and their mineralogy was thoroughly characterized by TEM. Two of the sections were analyzed for O isotopes by isotopic imaging in the JSC NanoSIMS 50L. The sample in one of the slices was completely consumed. The remaining material in the adjacent slice was analyzed simultaneously for ^{16}O, ^{32}S, ^{33}S, ^{34}S, and ^{56}Fe^{16}O in electron multipliers using a Cs^{+} primary ion beam. Quasi-simultaneous arrival (QSA) can have a significant effect on S isotopic ratios when using electron multipliers, resulting in undercounting of ^{32}S [9]. Canyon Diablo troilite (CDT) was measured numerous times to deduce a correction factor for QSA and ensure measurement reproducibility. Isotopic ratios are reported relative to CDT.

Results and Discussion: The Wild 2 COS is enriched in the heavy S isotopes relative to CDT (δ^{33}S = 6.5 ± 1.6 ‰; δ^{34}S = 5.1 ± 0.7 ‰; 1σ). The degree of ^{33}S enrichment indicates mass-independent fractionation (MIF) with Δ^{33}S = 3.9 ± 1.7 ‰. MIF of S has been observed in some chondrules (Δ^{33}S up to 0.11‰) [10], but this effect has not been identified in sulfides from carbonaceous chondrites [11] or IDPs [12]. S isotopic analysis of Stardust impact craters also did not reveal MIF or anomalies, save for one potential ^{32}S-rich presolar sulfide [13]. Measurement errors on these impact craters were much larger than those in this study, however. MIF of S has been proposed to result from heterogeneities in the solar nebula from nucleosynthetic components [14] or photochemical irradiation of solar nebula gas [10]. Presolar SiC grains are observed to have ^{32}S enrichments [15, 16] contrary to the S isotopic composition of the cometary COS. The S isotopic composition more likely reflects irradiation of nebular gas.

References: [1] Brownlee D. et al. (2006) *Science, 314,* 1711. [2] Nakamura-Messenger K. et al. (2011) *MPS, 46,* 1033. [3] Joswiak D.J. et al. (2014) *GCA, 144,* 277. [4] Nakamura-Messenger K. et al. (2012) *LPS, 43,* #2551. [5] Sakamoto N. et al. (2007) *Science, 317,* 231. [6] Seto Y. et al. (2008) *GCA, 72,* 2723. [7] Nittler L.R. et al. (2015) *LPS, 46,* #2097. [8] Nguyen A.N. et al. (2014) *MPS, 49,* A5388. [9] Slodzian G. et al. (2004) *App. Surf. Sci., 231-232,* 874. [10] Rai V.K. and Thiemens M.H. (2007) *GCA, 71,* 1341. [11] Bullock E.S. et al. (2010) *MPS, 45,* 885. [12] Mukhopadhyay S. et al. (2003) *MPS, 38,* A5289. [13] Heck P.R. et al. (2012) *MPS, 47,* 649. [14] Farquhar J. et al. (2000) *GCA, 64,* 1819. [15] Hoppe P. et al. (2012) *ApJL, 745,* L26. [16] Gyngard F. et al. (2012) *MPS, 47,* A5255.