The Mystery of Unexpected Seasonal Rise in Oxygen on Mars

*Sushil K Atreya[1], Melissa G Trainer[2], Paul R Mahaffy[2], Michael H Wong[1]

1. University of Michigan Ann Arbor, 2. NASA-GSFC

Measurements over three Mars years have repeatedly confirmed that the relative abundance of oxygen gas in the atmosphere of Mars increases beginning in the spring and continuing through the summer [1]. This startling discovery was unexpected, considering all photochemical models had predicted that oxygen is a long-lived species in the Martian atmosphere [2,3]. The quadrupole mass spectrometer of the Sample Analysis at Mars (SAM) instrument suite on Curiosity Rover at Gale Crater made the measurements. Previous observations could monitor the gas for no more than a few sols. We suggest that the spring-summer excess in oxygen results from a complex interplay of mechanisms between the subsurface and the atmosphere of Mars. Three potential reservoirs of oxygen in the subsurface are perchlorates [4,5], hydrogen peroxide [6,7,8], and brines [9]. Subsurface ice or water is important for their production and loss [10,11]. Seasonal increase in spring-summer is detected also for methane [12], suggesting a common mechanism for the release of oxygen and methane. Both oxygen and methane are potential biomarkers; hence their behavior is key to understanding the habitability of Mars. We stress biological explanations for the observed seasonal pattern in these gases can only be supported after all abiotic processes are ruled out. References: [1]M.G. Trainer et al. (2019) JGR, doi:10.1029/2019JE006175. [2]S.K. Atreya, Z.G. Gu (1994) JGR, 99(E6), 13133. [3]V. Krasnopolsky (2010) Icarus 207, 638. [4]D. Ming et al. (2014) Science doi:10.1126/science.1245267. [5]D. Glavin et al. (2015) JGR 120, doi:10.1002/2014JE004737. [6]Atreya et al. (2006) Astrobiology 6 (no. 3), 439. [7]Encrenaz et al. (2019) AA 627, doi:10.1051/0004-6361/201935300. [8]S.K. Atreya et al. (2019) 9th International Conference on Mars, Abstract #6067. [9]V. Stamenkovic et al. (2018) NGS, doi.org/10.1038/s41561-018-0243-0. [10]Y.S. Kim et al. (2013) J. Am. Chem. Soc. 135, 4910. [11]E.H. Wilson et al. JGR 121, 1472. [12]C.R. Webster et al. Science 360, 1093.

Keywords: Mars, Earth, Aqua, Oxygen, Methane, Habitability

