VOLATILES AND ISOTOPES, AND THE EXPLORATION OF ANCIENT AND MODERN MARTIAN HABITABILITY WITH THE CURIOSITY ROVER. P. R. Mahaffy[1], [1]NASA Goddard Space Fllight Center, Greenbelt, MD 20771 (Paul.R.Mahaffy@NASA.gov).

Introduction: The Mars Science Laboratory Mission was designed to pave the way for the study of life beyond Earth through a search for a habitable environment in a carefully selected landing site on Mars. Its ongoing exploration of Gale Crater with the Curiosity Rover has provided a rich data set that revealed such an environment in an ancient lakebed [1]. Volatile and isotope measurements of both the atmosphere and solids contribute to our growing understanding of both modern and ancient environments.

Organics and Tracers of Near Surface Exposure to Damaging Cosmic Radiation: The simplest organic compound methane has now been confirmed in the atmosphere [2] and chlorinated organic compounds [3] thermally released from a powdered rock sampled from Yellowknife Bay mudstone. The mystery of methane is likely to continue for some time, as a discrimination between a biotic and abiotic source can not be realized with the information available from the SAM instrument [4] on the Curiosity rover. The detection of chlorinated organic compounds is a step forward in understanding that near surface environments may preserve such compunds and motivates the continued search as the MSL mission proceeds into its extended mission for even more complex molecules perhaps aided by the onboard wet chemistry capabilities of SAM.

The combined ^{3}He, ^{21}Ne, and ^{36}Ar measurements of SAM enabled a determination [5] of the exposure of this material to cosmic radiation that can transform organic compounds [6]. Future sample return missions should use this proven capability to determine the extent of radiaton processing of candidate samples to cherry pick those that may have the greatest probability of containing clear biosignatures.

Thermally Evolved H2O, CO2, O2, HCl, and NO: Solid samples analyzed by SAM by evolved gas analysis (EGA) show O_2, HCl, and NO releases that are consistent with the breakdown of perchlorates or oxychlorine compounds and nitrates [7,8]. The relationship between the abundance of these compounds is presently being explored with the aid of extensive laboratory tests and is beginning to provide a context for understanding martian nitrogen and chlorine cycles. Of course, these chemistries must also be better understood as the plans for future human exploration on the surface of Mars become more concrete.

Likewise, the signature of evolved water for some of the drilled samples supports the XRD [9] detection of clays that are viewed as candidate hosts for ancient organic compounds. Some of the evolved CO_2 is likely the product of combusted organic compounds [10].

Isotope Measurements that Inform Regarding Atmospheric Loss and the Loss of Water Over Geological Time: C, O, and H isotopes in atmospheric gases point toward significant atmospheric loss over time [11]. An additional clear signature of atmospheric loss is the ^{36}Ar/^{38}Ar ratio [12] since this is a volatile inert gas that will either remain in the atmosphere or escape to space. The measurement of D/H in ancient Yellowknife Bay mudstone [13] provides a 3+ billion year reference point for the D/H of the water that formed these clays and can help constrain the models of water loss over time.

Continued Exploration of Mt. Sharp: This snapshot of volatile and isotopic results complements a wide range of geological, geochemical, and environmental studies enabled by the payload of the Curiosity Rover. A detailed stratagraphic exploration of the Pahrump Hills region has just now been completed. Future targets for this exploration include sites showing signatures of phyllosilicates, hematite, and sulfates that had provided much of the original motivation for this landing site through orbital imaging and spectroscopy.

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