



## Rock Formation and Cosmic Radiation Exposure Ages in Gale Crater Mudstones from the Mars Science Laboratory

Paul Mahaffy (1), Ken Farley (2), Charles Malespin (1), Ralph Gellert (3), and John Grotzinger (2)

(1) NASA Goddard, Laboratory for Atmospheres, Greenbelt, MD, United States (paul.r.mahaffy@nasa.gov), (2) California Institute of Technology, Pasadena, CA, United states, (3) Department of Physics, University of Guelph, Guelph, ON, Canada

The quadrupole mass spectrometer (QMS) in the Sample Analysis at Mars (SAM) suite of the Mars Science Laboratory (MSL) has been utilized to secure abundances of  $^3\text{He}$ ,  $^{21}\text{Ne}$ ,  $^{36}\text{Ar}$ , and  $^{40}\text{Ar}$  thermally evolved from the mudstone in the stratified Yellowknife Bay formation in Gale Crater. As reported by Farley et al. [1] these measurements of cosmogenic and radiogenic noble gases together with Cl and K abundances measured by MSL's alpha particle X-ray spectrometer enable a K-Ar rock formation age of  $4.21 \pm 0.35$  Ga to be established as well as a surface exposure age to cosmic radiation of  $78 \pm 30$  Ma. Understanding surface exposures to cosmic radiation is relevant to the MSL search for organic compounds since even the limited set of studies carried out, to date, indicate that even 10's to 100's of millions of years of near surface (1-3 meter) exposure may transform a significant fraction of the organic compounds exposed to this radiation [2,3,4]. Transformation of potential biosignatures and even loss of molecular structural information in compounds that could point to exogenous or endogenous sources suggests a new paradigm in the search for near surface organics that incorporates a search for the most recently exposed outcrops through erosional processes.

The K-Ar rock formation age determination shows promise for more precise in situ measurements that may help calibrate the martian cratering record that currently relies on extrapolation from the lunar record with its ground truth chronology with returned samples.

We will discuss the protocol for the in situ noble gas measurements secured with SAM and ongoing studies to optimize these measurements using the SAM testbed.

**References:** [1] Farley, K.A.M Science Magazine, 342, (2013). [2] G. Kminek et al., Earth Planet Sc Lett 245, 1 (2006). [3] Dartnell, L.R., Biogeosciences 4, 545 (2007). [4] Pavlov, A. A., et al. Geophys Res Lett 39, 13202 (2012).