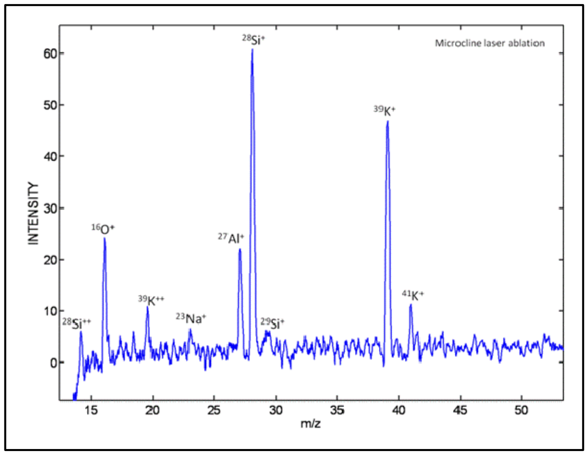
IN-SITU K-Ar GEOCHRONOLOGY: AGE DATING FOR SOLAR SYSTEM SAMPLE RETURN SELECTION. J. Hurowitz[1], O. Aharonson[2], M. Channon[2], S. Chemtob[2], M. Coleman[1], J. Eiler[2], K. Farley[2], J. Grotzinger[2], M. Hecht[1], J. Kirschvink[2], D. McLeese[1], E. Neidholdt[1], G. Rossman, M. Sinha[1], W. Sturhahn[1], K. Waltenberg[2,3], P. Vasconcelos[3], W. Zimmerman[1], B. Beard[4], C. Johnson[4]. [1]Jet Propulsion Laboratory, California Institute of Technology, [2]Div. of Geological and Planetary Sciences, California Institute of Technology, [3]School of Earth Sciences, The University of Queensland, [4]Dept. of Geoscience, University of Wisconsin-Madison.

Introduction: The development of an in-situ geochronology capability for Mars and other planetary surfaces has the potential to fundamentally change our understanding of the evolution of terrestrial bodies in the Solar System. For Mars specifically, many of our most basic scientific questions about the geologic history of the planet require accurate knowledge of the absolute time at which an event or process took place. For instance, what was the age and rate of early Martian climate change faithfully recorded in the mineralogy and morphology of surface lithologies (e.g., [1])?

Currently, our only means of assessing the absolute age of a surface on a planetary body is through the use of crater counting statistics. This technique is fraught with uncertainty for planets with active geologic surfaces, on the order of billions of years in some cases (e.g., [2]). Accordingly, there is much room for improvement in our understanding of the absolute chronology of the surfaces of rocky planetary bodies.

Age Characterization Prior to Sample Return: While returned samples will receive in-depth analytical treatment in terrestrial geochronology laboratories, the ability to characterize the ages of samples in-situ would provide an invaluable dataset, ensuring that the samples selected for Earth return would capture those periods in the geological evolution of a planet that are of greatest interest to the scientific community. In October 2009, the Keck Institute for Space Studies and JPL made a major award to a group of Caltech scientists, and JPL scientists and engineers, respectively, to investigate a broad range of concepts for in-situ age dating, with an emphasis on Mars. Below, we briefly describe one of the more promising in-situ techniques we are developing using miniaturized flight hardware.

Methodology & Instrument Development: In the methodology we are currently developing, a powdered or fragmental rock sample would be positioned in a crucible that has been loaded (prior to flight) with a Li-based fluxing agent and a solid double-spike containing ^{41}K and ^{39}Ar. Under vacuum, the sample-flux-spike mixture would be fused at low-T (≤ 1000°C) via resistance heating and the $^{40}Ar_{Sample}/^{39}Ar_{Spike}$ ratio measured using a focal plane miniature mass spectrometer (MMS), detailed in [3]. The sample would then be cooled to a glass, and sampled with a 1064 nm pulsed Nd-YAG laser. The ablated K-neutrals are ionized by electron impact and the $^{39}K_{Sample}/^{41}K_{Spike}$ ratio analyzed on the MMS. Whole rock ages can then be calculated from measured sample/spike ratios. To date, we have built testbed instrument systems that have made measurements demonstrating: (1) low-T Ar-release, (2) sample-spike equilibration, (3) quench glass formation, and (4) K-isotope measurement by laser ablation at ~1 wt% levels. Example results are shown on **Figs. 1A, B**.



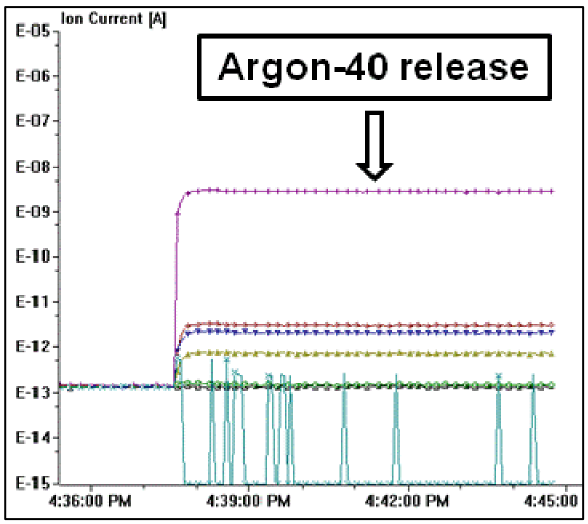


Fig. 1A (top): Intensity (arbitrary units) vs. m/z during laser ablation sampling of K-feldspar and analysis on the MMS. **1B** (bottom): Ion current on a quadrupole MS vs. time during melting of K-feldspar in Li-tetraborate flux at 1000°C.

References: [1] Bibring, J.P., et al. (2006) *Science 312,* 400-404. [2] Hartmann, W.K. and Neukum, G. (2001) *Space Sci. Rev. 96,* 165-194. [3] Sinha, M.P. and Wadsworth, M. (2005) *Rev. Sci. Instrum. 76,* 8.