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AN LDRIMS INSTRUMENT FOR PORTABLE Rb-Sr DATING WITH ACCURACY OF BETTER THAN ±150 MA FOR THE MARS-2020 ROVER

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Using a laser desorption resonance ionization mass spectrometer (LDRIMS), we can now demonstrate repeatable dates with portable hardware that could be carried on MER- or MSL-sized rovers. This is important because NASA is developing science requirements for a Mars 2020 rover mission based on MSL hardware, and for Mars, the National Research Council Decadal Survey (NRC DS) specifically supports: "...long-term development of instruments ... focusing on the most important future in situ measurements... [including] ... in situ geochronology experiments". The LDRIMS instrument can produce these science measurements today, and in so doing, triage samples for Mars Sample Return.

The LDRIMS technique can be miniaturized and avoids the mass interference issues requiring unwieldy chemical separation for traditional geochronology techniques. With LDRIMS sample is placed in a time-of-flight (TOF) mass spectrometer and surface atoms, molecules, and ions are desorbed with a 213 nm laser. Ions are suppressed by an electric field and the plume of expanding particles is present for many μs, during which it is first illuminated with laser light tuned to ionize only Sr, and then 1-3 μs later, for Rb. This eliminates isobars for Rb and Sr, insures that the measured atoms come from the same ablation event, and hence target materials, and reduces the total number of measurements required. The LDRIMS system has demonstrated a sensitivity of 300 parts-per-trillion, and isotope ratio precisions of ±0.3 to ±0.1% in 3000-5000 ablations of one spot on a sample in 3-5 minutes.

The bench top prototype has been tested on the Boulder Creek Granite (BCG) from Elephant Butte, Colorado, comprised primarily of a gneissic quartz monzonite and granodiorite. Whole rock Rb-Sr TIMS measurements of the BCG, and our own preliminary micro-drill TIMS measurements of individual minerals, are consistent with an age of 1700±40 Ma. To obtain a LDRIMS date using the BCG sample, we measured hundreds of spots with a ∼300 μm spacing, producing microscopic pits ∼75 μm wide by ∼0.5 μm deep. We also acquire interleaved measurements of a glass calibration standard, MPI-DING-T1-G.

Four repeat measurement runs were carried out over 6 months; the results have an average of 1.766 Ma±0.147 Ga for an MSWD=1, and for an MSWD=2, the average precision improves to ±0.105 Ga; both measurements have a precision and accuracy better than that called for by NASA (< ±200 Ma).

A second-generation portable version of the instrument has been built, with an approximate volume of 0.25 m̂3. We are now working on developing a "flight like" instrument, with a volume of approximately 0.03 m̂3.