Introduction: The recent discovery of jarosite at the Meridiani Planum region of Mars suggests that aqueous solutions were once present on Mars. Absolute age dating of Martian jarosite would give further insight into Martian fluvial processes as well as aid in establishing future Martian landing sites for possible sample return missions. Absolute age dating of Martian surface processes will enhance our understanding of Martian geologic time scales as well as allow the calibration of relative dating techniques such as crater dating. Because sample return missions are unlikely in the near future, we propose an in-situ dating technique of jarosite using the JPL developed laser ablation electron impact ionization mass spectrometer (LA-ESI-MMS). We suggest that the Rb-Sr isotope system may be the most amenable geochronometer that can be used for Martian rocks because other widely used systems such as Sm-Nd, Lu-Hf, U-Pb, or K-Ar systems will be exceedingly low in concentrations, require very high precision isotope ratio analysis, or significant sample manipulation to perform the analysis. In contrast, Sr concentrations in many rock forming minerals are high (>100 ppm) and because of the wide range in Rb/Sr ratios and the relatively short decay of

\[ ^{87}\text{Rb} \]
and

\[ ^{147}\text{Sm} \]
there are wide ranges in

\[ ^{87}\text{Sr} / ^{86}\text{Sr} \]
ratios which can produce meaningful isochrons or model ages if an

\[ ^{87}\text{Sr} / ^{86}\text{Sr} \]
isotope ratio precision greater than ~0.02% can be produced [1].

MMS Capabilities: The miniature mass spectrometer (Figure 1) developed at the Jet Propulsion Laborato-
Figure 4: Plot of $^{87}\text{Sr}/^{86}\text{Sr}$ versus time of sulfates with different $^{87}\text{Rb}/^{86}\text{Sr}$ ratios. The intersection of these lines with possible Martian reservoirs defines the time that the minerals precipitated from aqueous solutions.

SO$_4^{2-}$ and Sr$^{2+}$ for K$^+$ may control the Sr concentration in jarosite (Figure 3) [4]. The very high Rb/Sr ratio measured in P poor jarosite implies that it will be possible make robust model age determinations as shown in Figure 4. For example, if we consider the possible Rb-Sr reservoirs on Mars, as inferred from SNC meteorites that have either very high or low Rb/Sr ratios; if the K-rich sulfate has a Rb/Sr ratio of ~2 the model ages will have a high precision (Figure 4). We note that in the case of old minerals the precision of the model age will be higher because the uncertainty of the $^{87}\text{Sr}/^{86}\text{Sr}$ of the reservoir will be smaller (Figure 4). Alternatively, it may be possible to constrain the initial $^{87}\text{Sr}/^{86}\text{Sr}$ of the reservoir by analysis of Ca or Mg sulfates which will have low Rb/Sr ratios. If the initial $^{87}\text{Sr}/^{86}\text{Sr}$ can be inferred the uncertainty in the possible source curves can be eliminated, which improves the precision of the model age.

Future Work: Our future work will include analyzing Sr isotopes in Sr rich minerals (celestite; SrSO$_4$ and strontianite; SrCO$_3$) and feldspars by laser ablation and standardizing these results relative to Rb-Sr analysis of these minerals via TIMS. An additional effort will be to fine tune the ability of the MMS to measure the major- and minor-element composition of minerals by using the 2-250amu mass range afforded by the modified CCD detector array. This capability will allow us to correlate spot Sr isotope analyses with bulk- or mineral chemical compositions. Additional work will include a continuation of the survey of Rb-Sr analysis on additional jarosite samples.