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Advancing Canada's Martian In Situ Spectrometer: Sub-cm Chemistry for the Ongoing Assessment of Past Habitability on Mars

Thursday, 16 June 2016 10:00 (15 minutes)

Canada's Martian spectrometer, the Alpha Particle X-ray Spectrometer (APXS), is a physics-based third-generation chemical analysis instrument carried by NASA's newest rover on Mars. Mounted at the end of the arm of the Mars Science Laboratory rover *Curiosity*, the fourth and most-recent APXS conducts high-precision in situ measurements of Martian rocks and soils, playing a significant role in understanding the surface composition and geochemical processes of Mars. Sample excitation is provided by 1.1 GBq Curium-244 sources utilizing both PIXE and XRF excitation. This results in a higher sensitivity that varies only slowly across the range of geochemically important elements (Z>10) than would be the case with either excitation method alone. Use of radionuclides confers the additional benefits of low weight, low power, and high durability, all critical for space exploration missions. Trace elements can be quantified in as little as 10-20 minutes to the 10s of ppm level thanks to a Peltier-cooled silicon drift detector providing a resolution (FWHM) of 140 eV at 5.9 keV. This enables multiple laterally offset measurements of a single target during the cool Martian mornings or evenings, important for quantifying sub-cm scale chemistry.

Unlike in a laboratory setting on Earth, targets on Mars are not always flat, can be dust covered, are shrouded by 10 mbar CO_2, and can be laterally heterogeneous on the scale of the field of view (FOV) of the APXS. Additionally, uncertainty in the placement of arm-mounted instruments, like the APXS, can lead to misinterpretation of spectra acquired in these heterogeneous regions. The fingerprints of a warmer, wetter Mars are hidden in the chemistry, often at a scale that does not fill the dime-sized APXS FOV. Oversampling targets with multiple APXS measurements in close proximity and combining these spectra with images from the rover-arm-mounted Mars Hand Lens Imager allows us to localize the APXS FOVs, mitigating placement uncertainty, compensate for the effects of cm-scale surface relief, and arrive at sub-cm-scale chemistry. Quantitative chemistry at these small scales, including elements important to life such as P and S, is critical for elucidating the formation mechanisms of ancient Mars and further contributes to *Curiosity*'s quest for finding and understanding past habitable environments on Mars.

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