Deep Ultraviolet Raman Spectroscopy on Mars: Raman Bandwidth Calibration and Spectral Background Subtraction Provides Insights into the History of Jezero Crater

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The Scanning Habitable Environments with Raman & Luminescence for Organics & Chemicals (SHERLOC) instrument aboard the Perseverance Rover is a 248.6 nm deep ultraviolet Raman and fluorescence imaging spectrometer used for the identification and mapping of minerals and organics on the Martian surface. Careful calibration and processing of SHERLOC spectral data is needed to extract as much information as possible from the data. Bandwidth calibration is used to remove the instrumental component from the observed Raman spectral bandwidths, allowing for the extraction of information from Raman bandwidths and for the comparison of Raman bandwidths between SHERLOC and terrestrial analogue instruments. Using the bandwidth calibration, we show that Mg-Sulfates observed on Mars surface target Quartier have a symmetric stretching (v1) bandwidth consistent with well-crystalline $MgSO_4$ while the target Dourbes has a broadened v1 band, indicating either the $MgSO_4$ is amorphous or that two Sulfate minerals with different v1 frequencies contribute to the spectra.

A procedure was developed to remove the SHERLOC spectral background from Raman and fluorescence spectra. SHERLOC Raman and fluorescence spectra were collected with the SHEROC instrument arm in the Stowed configuration with the SHERLOC field of view directed at the dark nighttime Martian sky with no target at the instrument focus. These “stowed-arm” spectra provide the spectral background of the instrument that must be accounted for. A spectral subtraction procedure was developed to remove the contribution of the background from the spectrum. Background subtraction of SHERLOC Raman spectra enable the observation of a broad Raman feature at ~1050 cm^{-1} found ubiquitously in every scan of the Martian surface by SHERLOC. This Raman feature is interpreted as deriving from either an amorphous silicate or crystalline feldspar, both which have been widely observed by the Chemistry and Minerology (CheMin) x-ray diffraction instrument at Gale crater.