Raman spectroscopy for mineral identification and quantification for in situ planetary surface analysis: A point count method

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Abstract. Quantification of mineral proportions in rocks and soils by Raman spectroscopy on a planetary surface is best done by taking many narrow-beam spectra from different locations on the rock or soil, with each spectrum yielding peaks from only one or two minerals. The proportion of each mineral in the rock or soil can then be determined from the fraction of the spectra that contain its peaks, in analogy with the standard petrographic technique of point counting. The method can also be used for nondestructive laboratory characterization of rock samples. Although Raman peaks for different minerals seldom overlap each other, it is impractical to obtain proportions of constituent minerals by Raman spectroscopy through analysis of peak intensities in a spectrum obtained by broad-beam sensing of a representative area of the target material. That is because the Raman signal strength produced by a mineral in a rock or soil is not related in a simple way through the Raman scattering cross section of that mineral to its proportion in the rock, and the signal-to-noise ratio of a Raman spectrum is poor when a sample is stimulated by a low-power laser beam of broad diameter. Results obtained by the Raman point-count method are demonstrated for a lunar thin section (14161,7062) and a rock fragment (15273,7039). Major minerals (plagioclase and pyroxene), minor minerals (cristobalite and K-feldspar), and accessory minerals (whitlockite, apatite, and baddeleyite) were easily identified. Identification of the rock types, KREEP basalt or melt rock, from the 100-location spectra was straightforward.