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Geochemical modelling of Terrestrial Igneous Rock Compositions using Laboratory Thermal Emission Spectroscopy with an overview on its applications to Indian Mars Mission.

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Abstract

We attempt geochemical modelling of igneous rock samples with a range of compositions using laboratory-generated thermal emission spectra. Igneous rock samples, plutonic and volcanic variants of alkaline and sub-alkaline composition were used for the analysis. The collected rock samples were analysed for mineralogical composition, mineral chemistry, and bulk rock chemistry using various techniques. Laboratory thermal emission spectrometer was developed by attaching an in-house fabricated emissivity apparatus to FTIR spectrometer thus, modifying the optical path of FT-IR spectrometer. Rock samples, chipped for the fresh surface, of fist size, were used to generate emissivity spectra. The emissivity spectrum of each rock sample so generated was deconvolved into its constituent minerals with the help of a spectral library of end-member minerals and using simple linear retrieval algorithm. The deconvolution was achieved by reducing RMS error while matching the measured spectrum to the modelled spectrum. Mineral chemistry and bulk rock chemistry was derived from the modelled spectrum with the help of the spectral library of end-member minerals developed by ASU, USA. We applied the existing IUGS classification scheme for all the analysed rock samples based on bulk rock chemistry derived using thermal emission spectroscopy and compared with measured bulk chemistry from XRF. The method is found to be useful in the classification of both plutonic and volcanic rock types within an error limit of 1σ. The classification is effective in differentiating alkaline rock types from sub-alkaline varieties. Measured and modelled silica percentage is found to be closely matching whereas total alkali shows over and under estimation. The emissivity spectra of collected rock samples were resampled to 12 bands corresponding to the spectral bands of Thermal Infrared Imaging Spectrometer (TIS) onboard Indian Mars Orbiter Mission. The analysis shows that TIS will be able to differentiate major Martian surface compositions. Consequently, we believe that the instrument will help us to improve our understanding on Martian surface in particular and its evolution and crustal differentiation in general.

Keywords: Emissivity, thermal infrared, rock spectra, linear deconvolution, Mars