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Mapping Hydrothermal Alteration Products On Mt Tongariro Using Multispectral Satellite Data, XRD Analysis and Reflectance Spectroscopy

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For Dumbo and Poppa

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"You must unlearn what you have learned." - Yoda

Abstract

The threat of a major collapse/landslide from a volcanic cone is a primary hazard of concern in the Tongariro National Park. The geologic record at Ruapehu and Tongariro volcanoes shows that past debris flows (lahars) have often contained a high proportion of alteration products. The present flanks of volcanoes in the Tongariro National Park have several hydrothermally altered zones that could be sources of future collapses. The purpose of this study was to assess the overall extent of alteration products and map altered zones on Mount Tongariro using field spectroscopy, X-Ray Diffraction analysis and analysis of satellite data.

Hyperspectral data from the Hyperion sensor on the EO1 satellite and multi-spectral data from the Aster sensor on the EOS (Terra) satellite platform were acquired for the study area. The low signal to noise ratio of the Hyperion dataset meant the data was not suitable for analysis. The Aster data was chosen as it contains bands above 1500nm, the wavelength range where diagnostic abosorptions for minerals appear. There were analysis issues with the Aster scene but once the questionable bands were removed, areas of hydrothermal alteration were successfully identified and located.

Mineral samples were collected from a variety of visually unique areas and reflectance spectra recorded using a portable spectroradiometer, along with the GPS locations. These samples were identified in the laboratory using the Spectral Analyst tool in ENVI and comparing them to the USGS, JPL and JHU mineral spectral libraries.

The identification results from the field spectra and traditional X-Ray Diffraction (XRD) analysis of the samples were used to ground truth the satellite data. XRD was used to identify the alteration products and confirm the findings of the field spectra analysis. This enabled the selection of accurate end-members that were used to perform a classification of the imagery of the study area. The XRD and field spectroscopy data correlated well, and only the problem of several mixed minerals hindered a direct corelation.

The alteration products form some of the least stable zones on the volcano. Smectite was identified in many of the samples which is a swelling/shrinking clay associated with volcanic faluire. Identifying these zones provides crucial information in the production of a new lahar hazard map for the Tongariro National Park. The northern flank of the Te Maari craters was found to contain hydrothermal alteration products and this areas has generated many colapses in the past.

Identifying large areas or mapping out larger zones of hydrothermal alteration products was not possible due to the small surface expression of some of the hydrothermal fields and also the atmospheric/signal to noise interference with the main satellite sensors. The mixed method approach used in this study remains useful and ongoing attempts at working with new hyperspectral data as it comes available should be investigated.

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