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Analysis of volcanic fields near Popocatepetl, Mexico, from AVIRIS data

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We investigate the compositional distribution of tephras over a volcanic field approximately 50 km south of Popocate'petl. The surface mineralogy is expected to reveal some of the eruptive history of the field. AVIRIS was flown over this area on November 23, 1994. The resulting 224-band image has been provided for us by Dr. Harold Lang of JPL.

Popocate'petl (5452 m) is a stratovolcano located 60 km SE of Mexico City in the eastern portion of the WNW trending 1,000 km long Trans-Mexican Volcanic Belt (TMVB). The presence of three successive debris-avalanche deposits fanning southward documents the previous existence of other large volcanic edifices destroyed by gravitational collapse. The present cone consists of inter-layered lavas and pyroclastic deposits of intermediate to silicic composition. Such volcanoes usally result in violent phreato-magmatic eruptions (e.g., Mt. Saint Helens), due to the viscous nature of the magmas, which also tends to restrict lava flows to within a few kilometers of the vent. Ash-flow and/or air-fall deposits, on the other hand, can spread very far. Small cinder cones of more basic composition were also found east and west of Popocate'petl. During the last 20,000 years, at least seven Plinian eruptions occured near Popocatepetl, producing pumice-fall and ash-flow deposits as far away as Mexico City (Siebe et al. 1995). The volcanic field in our AVIRIS image has presumably preserved a lot of the dynamic geologic history related to Popocatepetl and other volcanoes active in the past in the TMVB.

VIS-NIR reflectance spectrometry is very sensitive to different extents of alteration in basaltic tephras (Farrand, 1991). AVIRIS images can potentially differentiate between many stages of alteration between highly palagonitized tephras and unaltered ones because of the high spectral resolution. This is partly due to the fact that many volcanic products (e.g., basaltic tuffs) have not one characteristic mineral with an associated absorption feature that can be used to map their distribution. The overall shapes of the reflectance spectra have proven more diagnostic, which hyperspectral images provide in great detail. Using the power of AVIRIS-class imagery it is possible, for example, to look for multiple hydroclastic and/or dry vents and try to reconstruct the eruptive/hydrologic history of the volcanic field. Relatively few works have dealt so far with the detection of either active or inactive volcanic features from AVIRIS data. Hot spots and gas emanations were investigated by, e.g., Oppenheimer et al. (1993), DeJong et al. (1996). Thorough analysis of compositional distribution of tephras has been done for the Lunar Crater Volcanic Field in a number of works by Farrand and co-workers (Farrand 1991, Farrand and Harsa'nyi 1994, 1995) and Mere'nyi et al. (1996a,b). We will present a detailed spectral classification of the volcanic field near Popocatepetl and attempt mineralogic interpretation based on eariler works and laboratory spectra. In a subsequent phase, field work is also planned, which will help interpretation. It will also further refine our knowledge of reflectance spectra of pyroclastic and hydroclastic volcanic products and their recognition from AVIRIS images.

The relevance of this investigation is emphasized by its spatial and genetic relationships to Popocate'petl, which has been showing activities in the past two years. The fact that the largest eruption in 50 years occurred on July 1, 1997 makes this work extremely timely.

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