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Mapping Chestnut Oak Forest Associated With Silicified Hydrothermally Altered Rocks in the Carolina Slate Belt Using Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) Data

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ABSTRACT

The Carolina slate belt is a 10- to 50- kilometer-wide zone of 350- to 600- million-year-old volcanic and sedimentary rocks extending from Georgia to Virginia. An older group of heterogeneous volcanic rocks is unconformably overlain by an extensive unit of rhyodacitic to dacitic rocks. These units were intruded by granitic to dioritic complexes which resulted in hornfels and hydrothermally altered rocks ranging from quartz-sericite to nearly pure quartz. Gold and silver deposits and pyrophyllite deposits are associated with the hydrothermally altered rocks, particularly along northeast-trending shear zones.

Mineral resource studies in the slate belt are complicated by the complex geology, deep weathering of bedrock, and dense vegetation cover over much of the area. To augment conventional geologic mapping and mineral resource studies in the area the U. S. Geological Survey has been evaluating the use of Landsat images and, more recently, Airborne Visible-Infrared Imaging Spectrometer (AVIRIS) data for mapping spectral reflectance variations in the forest canopy that might be related to altered, potentially mineralized rocks. Previous analysis of a December 1, 1981, Landsat Multispectral Scanner (MSS) image showed good spatial correspondence between known areas of hydrothermally altered, commonly mineralized rocks and pixels derived by thresholding a principal component image. Field studies showed that most of these areas are topographically high and have a forest community of principally Quercus prinus (chestnut oak) and subordinate Pinus virginiana (Virginia pine) and Acer rubrum (red maple).

The understory is typically open with patches of Vaccinium sp. (blueberry). Analyses of Landsat Thematic Mapper images recorded on November 9, 1982, and also 1988, which is near the peak of autumn colors, essentially duplicated the earlier MSS results. However, in both of these studies, numerous areas underlain by unaltered silicic volcanics also showed as anomalies, reducing the

effectiveness of the Landsat-image maps for mineral resource studies.

Initial analysis of AVIRIS images recorded on June 26, 1996, indicates that chestnut oak growing on highly siliceous altered rocks can be distinguished from the chestnut-oak canopy on unaltered silicic volcanic rocks, as well as from the background canopy on other unaltered lithologic units. Calibration of 10 scenes of AVIRIS data was accomplished by using a modified version of the Atmosphere Removal Program (ATREM), and a laboratory spectrum representing a spectrally uniform plowed field. A matched-filter algorithm was used to map anomalous and background canopies in the 0.49 to 1.3 micrometer region. The resulting anomalous-class image was thresholded to retain only the highest digital numbers and, hence, the best matches to the AVIRIS canopy reference spectrum. The main difference between anomalous and background

canopy spectra is weaker intensity of the 0.96 and 1.19 micrometer water absorption features in the anomalous canopy spectra. AVIRIS spectra of chestnut-oak canopy growing on unaltered silicic volcanic rocks are similar to those that characterize other background forest types. Soil analyses indicate that nutrients are anomalously low in residual samples representing the silicified altered areas. The spatial agreement with known hydrothermally silicified bedrock situated along the 10-scene strip of AVIRIS data is very high with no known omissions, except where forests have been cut or replanted. Two areas of silicified rocks were identified in this study that had not been previously documented. A few areas that were initially erroneously identified as being underlain by silicified rocks were eliminated subsequently by reprocessing these scenes using additional AVIRIS reference spectra.