GEOLOGIC MAPPING IN DEATH VALLEY, CALIFORNIA/NEVADA USING NASA/JPL AIRBORNE SYSTEMS (AVIRIS, TIMS, AND AIRSAR)

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EXTENDED ABSTRACT

A multi-sensor aircraft campaign called the "Geologic Remote Sensing Field Experiment" (GRSFE) conducted during 1989 resulted in acquisition of high quality multispectral images in the visible, near infrared, shortwave infrared, thermal infrared, and microwave regions of the electromagnetic spectrum. The airborne data sets include the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) (0.4 - 2.5 μm, 224 bands), the Thermal Infrared Multispectral Scanner (TIMS) (8-12 μm, 6 bands) and the Airborne Synthetic Aperture Radar (AIRSAR) (P, L, and C band, quad polarization, multiple incidence angles). Ancillary data include Landsat Thematic Mapper (TM, 7 bands), laboratory and field spectral measurements, and traditional geologic mapping.

The GRSFE data for a site in the northern Death Valley (California and Nevada) region, USA were calibrated to physical units and geometrically registered to a map base. AVIRIS data were calibrated to reflectance using ground targets and the "empirical line" method. TIMS data were calibrated to radiance using the onboard blackbody measurements and converted to emissivity using the modelled emittance method (assuming an emissivity of 0.93 in band 6). AIRSAR phase, cross-talk, co-channel imbalance, and absolute radiometry were calibrated using data characteristics, theoretical models, and trihedral corner reflectors. The AVIRIS, TM, and TIMS were analyzed using both color images and digital spectral analysis. The AIRSAR data were analyzed using color images, and frequency and polarization signatures. The AVIRIS and TM visible and infrared multispectral remote sensing observations provided information about the surficial composition (mineralogy) of the rocks and soils. AVIRIS allowed identification and mapping of the minerals calcite, dolomite, sericite, hematite, and goethite based on their spectral signatures. Selected mineral mixtures were identified and mapped by utilizing discrete absorption bands in the visible portion of the spectrum for the iron oxides and bands in the shortwave infrared for the other minerals. TIMS spectral signatures in the thermal infrared region between 8 and 12 μm and emissivity ratio images provided compositional (lithological) information not contained in AVIRIS data (primarily silica

content information). Variation of the AIRSAR radar backscatter as a function of wavelength allowed mapping of varied surface morphology (relative surface roughness).

A variety of rock types, regional and localized lithological variation, and the effects of processes such as weathering, erosion, soil development, and faulting were detected and mapped using the optical remote sensing data. The Radar data were used to characterize both local and regional faulting and other geologic structures, particularly in unconsolidated alluvium. The integrated optical and microwave data sets provided complementary information that allowed identification and mapping of new structures, control of both lithology and alteration by structure, and associations of surface morphology and composition. This case study establishes that the use of combined optical and microwave image data for deriving physically based, quantitative measurements of the Earth's surface results in improved geologic mapping. The results to date are an improved understanding of the nature and distribution of structures, lithology, weathering, and alteration in the northern Death Valley Region. The research is presently being expanded to cover much of Death Valley from Artist's Drive northward. New geologic information derived from the quantitative remote sensing studies will be used to develop models that explain the interaction of complex depositional and erosional processes controlling the configuration of the modern land surface in this region.**

** This is a summary of results published during 1991 at two symposia. The complete references are listed below.

Kruse, F. A., and Dietz, J. B., 1991, Integration of optical and microwave images for geologic mapping and resource exploration: in Proceedings, International Symposium on Remote Sensing of Environment, Thematic Conference on Remote Sensing for Exploration Geology, 8th, 29 April - 2 May 1991, Denver, Colorado, Environmental Research Institute of Michigan, Ann Arbor, p. 535-548.

Kruse, F. A., and Dietz, J. B., 1991, Integration of diverse remote sensing data sets for geologic mapping and resource exploration: SPIE Symposium on Remote Sensing for Geology and Geophysics, 1-5 April 1991, Orlando, Florida, (in press).