Detection and Identification of Archaeological Sites and Features Using Synthetic Aperture Radar (SAR) Data Collected from an Airborne Platform

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This SERDP funded project is developing requirements and protocols for the use of high resolution aerial radar for more efficient inventory and evaluation of archaeological sites. Our test area is San Clemente Island, controlled by the United States Navy, offshore southern California. The JPL/NASA AIRSAR synthetic aperture radar instrument is unique in its multiwavelength and multipolarization capabilities, making it ideal for protocol development and requirements definition. In the course of this work we have developed new image processing procedures for AIRSAR data. Data include P, L, and C bands in both POLSAR (full polarization for all bands) and TOPSAR (DEM production) modes. The highly accurate TOPSAR DEM has allowed precise registration of the radar images to other ayers in the GIS data base. Algorithms are being developed that will co-register P-band imagery to L- and C- band imagery more precisely than previously. Also, mosaicked radar images have been produced from multiple flight lines. Mosaicked images display reduced speckle noise and minimize slope effects on backscatter. Finally, we have developed procedures to orthorectify all the radar images, which has necessitated the development of algorithms for using the TOPSAR DEM. Improved processing, orthorectification, and analysis protocols have allowed us for the first time to completely utilize the multiband, full polarization capability of AIRSAR for archaeological applications. Radar reflectivity recorded by AIRSAR is influenced by the following surface properties in descending order of effect: 1) topography, 2) structure, 3) surface roughness, and 4) dielectric property. These effects vary with wavelength, allowing surface characterization. Topographic information and hydrology, slope, and aspect, have been used in modeling the distribution of archaeological sites. Because slope modulated returns can mask other returns indicative of archaeological sites, we are developing ways to suppress this effect and increase backscatter variations related to occupation. We have determined that archaeological sites are characterized by vegetation anomalies and human placed rock clusters. Vegetative structure is being analyzed and characterized by radar response. This correlation is confirmed by field

investigation, and radar signatures are being developed and refined for detection of vegetation and soil zone anomalies from human occupation. Finally, we are determining the value of various polarizations and bands in detecting characteristics of human occupation sites to develop operational requirements for future work.