EAGLE: A SYNTHETIC APERTURE RADAR MAPPER FOR THE MARS SCOUT PROGRAM. Bruce A. Campbell[1] and the Eagle Science Team, [1]Smithsonian Institution, MRC 315, Washington, DC 20013-7012 (campbellb@si.edu).

Introduction: Many aspects of the geologic and climate history of Mars are hidden beneath surficial sediments. A radar imaging system can penetrate these sediments to reveal buried fluvial, volcanic, impact, and perhaps glacial features. Eagle is an orbiting radar mapper for the Mars Scout program.

Background: The Mars Express and Mars Reconnaissance Orbiter spacecraft both carry radar sounder systems (MARSIS and SHARAD). These instruments transmit a radar signal with wavelength of meters to tens of meters, and penetrate to depths of several km in typical dry crustal rocks. Sounders, however, provide relatively coarse horizontal resolution (1-10 km), and cannot reveal detail of the near-surface (upper 10 m) geologic environment.

Synthetic aperture radar (SAR) systems operate at higher frequencies (shorter wavelengths), and use a side-looking geometry to achieve high spatial resolution. At wavelengths of a few tens of cm ("L" or "P" band in radar terminology), the radar signal can penetrate to significant depths (meters to tens of meters), depending upon the rock abundance and bulk chemistry of the target region, and be scattered back to the sensor by subsurface rocks, voids, or interfaces. These reflections can be used to map geologic features beneath surface mantling deposits.

For example, in lunar highlands material, which has a low abundance of radar-absorbing minerals, 70-cm radar signals propagate up to 50 m to reveal buried mixed zones of feldspathic and basaltic debris [1]. In much less "dry" conditions, such as those found in terrestrial deserts, penetration of 1-2 m has been used to reveal ancient drainage patterns [2]. Both cases show that it is not always necessary for the radar to encounter a discrete "bedrock" interface – often there are significant geologic unit boundaries delineated by changes in the bulk scattering properties (rock abundance or loss tangent) of deep deposits.

The surface of Mars is covered, to varying degrees, by surficial sediments deposited and modified by aeolian, volcanic, fluvial, impact, or other processes. These surficial sediments obscure the underlying geologic setting and context, leaving very limited outcrops of bedrock in some areas (Fig. 1). Near-infrared and thermal infrared sensors can reveal the properties of the upper few cm, at best. A SAR can map the subsurface geology, and the properties of the overlying sediments, across much of the planet.

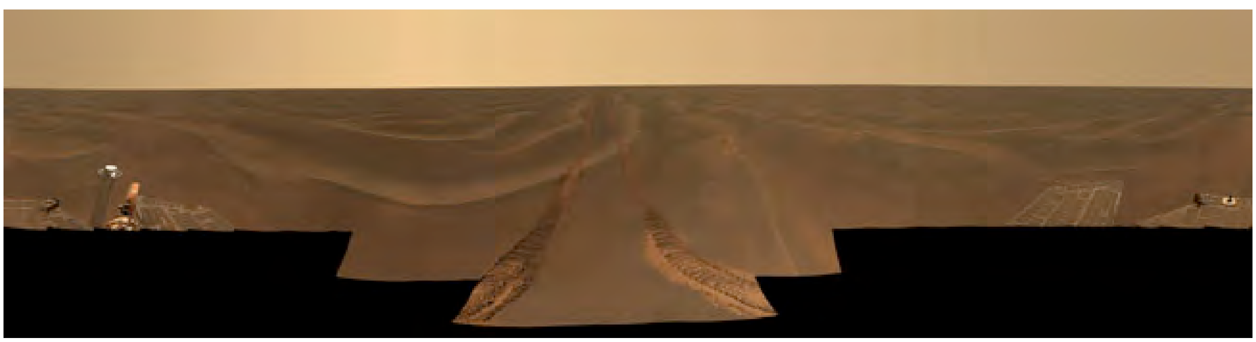

Figure 1. View from Opportunity Rover of "Rub al Khali" region.

The Eagle Mission: We propose an orbiter for the Mars Scout program that carries a single major instrument: a synthetic aperture radar mapper. The principal operating mode will be at a wavelength between 30 and 70 cm, with a horizontal spatial resolution of 20 m in "high-resolution" mode. Synoptic, near-global maps of Mars will be produced at 60-80 m spatial resolution. Full coverage of the planet can be achieved in less than one Earth year.

The primary measurements will use VV polarization to maximize penetration [3] of mantling deposits. Given the likely range of loss tangents across Mars, we expect (conservatively) penetration depths of 3-5 m. Low-loss areas, such as clean ice at the poles, would allow much deeper (tens of meters) probing.

Augmentations to this basic approach may include measurements in multiple polarizations and wavelengths to better discriminate surface and subsurface features. We will also collect repeat-pass interferometry data for selected areas. This type of measurement can be used to study seasonal surface changes on vertical scales of cm, and to estimate the thickness of deep scattering layers.

Expected Results: Radar mapping from orbit will open up a "new" Mars. We will study fluvial features down to small horizontal scales, extending the mapping of drainage networks beneath the mantling sediments. Radar probing will reveal the extent of basin ejecta across the highlands, and the degree of subsequent erosion that may expose ancient terrain. Studies of the MER and other landing sites will offer a local to regional context for the outcrops visited by the rovers. Finally, we will conduct detailed seasonal monitoring of high-latitude deposits to measure the degree of change associated with the global volatile cycle.

The Education and Public Outreach programs associated with Eagle will be led by the National Air and Space Museum, which is visited by up to 10 million people each year. We will use this direct connection with the public, as well as our extensive web-related programs, to bring the scientific results and the excitement of "uncovering Mars" to a broad audience.

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