SAND TRANSPORT PATHWAYS OF DARK DUNES IN THE SPERRGEBIET: SAND COMPOSITION AND DUNE MIGRATION RATES FROM ASTER DATA. S. P. Scheidt[1], [1]CEPS/NASM MRC 315, Smithsonian Institution, Washington D.C. 20013-7012 (sscheidt77@gmail.com).

Introduction: The Coregistration of Optically Sensed Images and Correlation (COSI-Corr) software [1] has shown to be a useful tool for measuring the migration of dunes on Earth [2,3] and detecting the movement of aeolian bedforms on the surface of Mars [4,5]. Linear spectral unmixing of thermal infrared (TIR) has been used as an effect tool for extracting the mineralogical composition of both Mars and Earth surface materials as well [6,7]. Using these techniques together, a great deal of information can be exploited about an aeolian system, regardless of the planet.

Geologic Background: The Namib Sand Sea is an ancient and modern sand accumulation area [8, and others]. It is a large group of south-north-trending complex linear dunes at its core, located along the Atlantic coast of Namibia between 23º and 26.5º S (Figure 1). Other complex and spatially varied dune patterns exist, including transverse ridges and barchan forms at the southern margin (8,9). Studies of sands have shown that the Namib Sand Sea has probably persisted for the past one million years [10], and the primary source of sand, past and modern, has been the Orange River at the southernmost edge of the Sperrgebeit, a large deflation basin and source area of sand [10,11]. North-migrating convoys of dark-colored barchan dunes make up well-defined sand transport corridors in the Sperrgebiet deflation basin [8, 12, and others] which are sourced from south-facing reentrant coastal embayments along the Atlantic shoreline [12].

Methods: The migration rates of dunes at the southern margin of the Namib Sand Sea were recently measured using COSI-Corr from Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) sensor data [13]. These results were recently improved and the study area was expanded using ASTER L1A data products as the data source. COSI-Corr is a change detection method, described here in simple terms. The ASTER satellite images from multiple dates were orthorectified and co-registered in a common geographic coordinate system. Areas of correlation (no change) and decorrelation (lateral land surface movement) were determined between the "before" and "after" image data from years 2001, 2002, 2006, 2007, 2008 and 2009. New image data was produced containing the relative N/S and E/W displacement fields at each pixel location for each image pair processed. Where these pixels are associated with dunes, the pixel values represent the migration rate of that dune or part thereof. All the COSI-Corr results were thoroughly evaluated at the dune scale for

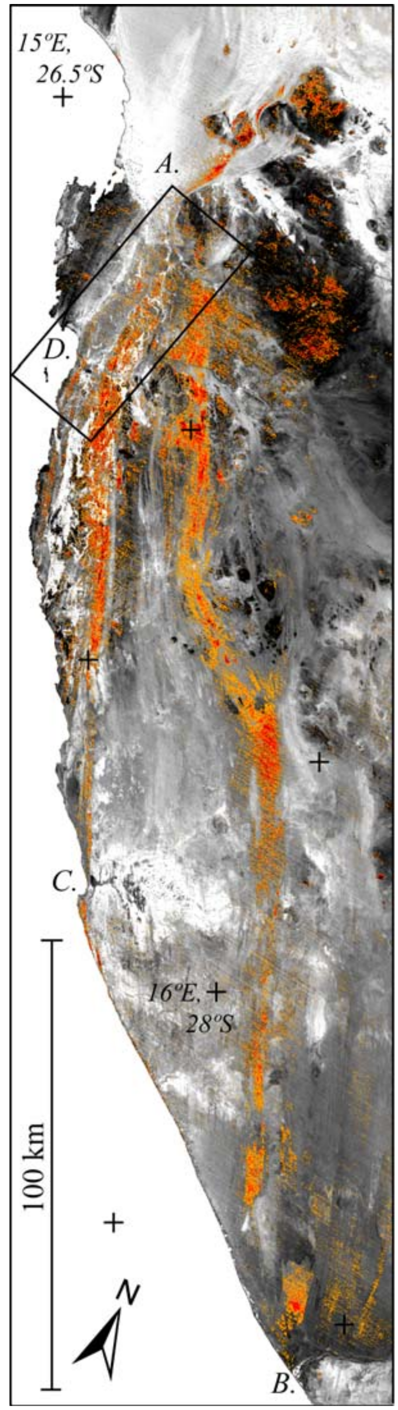

Figure 1. Dark sand transport pathways in the Sperrgebiet (orange and red color scale). Quartz abundance from ASTER shown by underlain image (white = quartz rich). A. Namib Sand Sea. B. Mouth of the Orange River. C. Chamais Bay. D. COSI-Corr study area (box) and Elizabeth Bay.

accuracy and filtered to contain only valid dune migration rates. These data were compiled to generate statistics of the dune field's migration rate, direction and frequency distribution of dune velocity by area.

Composition mapping using ASTER thermal infrared image data. The spatial pattern of dune migration shown by COSI-Corr data revealed the distinct pattern of sand transport corridors described by past researchers[8,12, and others]. These image data were overlain in Google Earth, and the COSI-Corr data corresponded to other dark streaks and convoys of dark-colored barchan dunes. These could be traced to other coastal sand source areas, including the mouth of the Orange River, 260 km south of the Namib Sand Sea.

These observations prompted the mapping of the sand transport pathways of the dark dunes using the sand's unique spectral character and sand composition. A seamless, multispectral, radiometrically balanced mosaic of ASTER TIR data [14] was constructed to cover the Sperrgebiet region between the southern Namib margin and the Orange River. The ASTER instrument has multispectral capabilities (5 bands) in the TIR wavelength region (8.125 - 11.65 μm), and accurate and quantitative compositional mapping was achieved using these data and linear spectral unmixing [6,7,15,16]. Image spectral endmembers were selected from four locations: quartz-rich sand, a coastal source of dark sand, alluvial fan and bedrock.

Results: The underlain black and white image in Figure 1 shows the areal distribution of quartz-rich sand, where bright areas represent high abundance and dark areas are quartz poor. Quartz-rich sand was mapped as the most abundant spectral endmember in the Namib Sand Sea, especially as a transport corridor emanating from Elizabeth Bay (location D). Several quartz-rich corridors in the north-south orientation are visible in the Sperrgebiet basin as well. Dark-colored sand (at visible wavelengths) was also mapped, shown here on a color scale ranging from orange to red, corresponding to an areal abundance of 30% and 100% (Figure 1). This pattern shows two primary sand transport corridors extending across the Sperrgebiet to the Namib Sand Sea from location B (Figure 1) and the other from the Chamais Bay (location C, Figure 1). The dark sand endmember mapped from ASTER TIR corresponded to both dark-colored streaks in Google Earth and the dark-colored migrating barchan dunes in the COSI-Corr study (subset box D, Figure 1).

In the COSI-Corr study area (850 km^2), 12% of the area was consistently identified as active dunes within sand transport pathways. COSI-Corr data from subset box D, Figure 1 were used to show the distribution of direction and magnitude of dunes migrating within the sand transport corridors as a sand rose (Figure 2). Below the sand rose, the percentage of the active dune field moving at different migration rates is also shown (Figure 2). Using COSI-Corr data of dunes in the the Chamais Bay sand transport corridor, sand flux of the dark-colored dunes averaged 520 m^3 m^{-1} yr^{-1}, ranging from 170 to 1260 m^3 m^{-1} yr^{-1}, between 2001 and 2009. This source of dark colored sand was not mapped further north into the Namib Sand Sea other than a small concentration at the southern margin of 8 km^2 (location A, Figure 1).

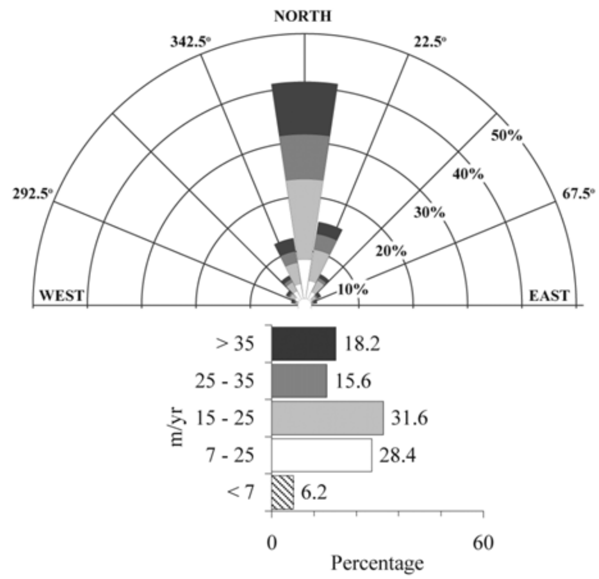

Figure 2. Sand rose showing dune migration direction and magnitude distribution from COSI-Corr data.

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