

Sediment Sources and Transport within the White Sands Dune Field

Overview

Because of its unique gypsum composition, the White Sands offers the potential to study the transportation of sand within dune fields in a new way. Two different factors allow this: First, sand becomes finer grained when it is transported downwind, mostly because the coarser grains move more slowly. Second, when buried in moist sand, gypsum crystals can grow through precipitation from gypsum in groundwater or soil moisture. In most dune fields, sand across the dune field is very similar in size. This makes it difficult to determine how sand is being moved across dunes, or from dune to dune. In the White Sands, the coarser, re-grown crystals allow us to locate the sources of sand within and between dunes.

Methods

The study was conducted within a swath 3 km by 500 m elongate in the east-northeast sand transport direction. The study area (Figure 1) shows the 83 dune forms, consisting of 17 barchanoid ridge forms and 66 barchan forms. Ten dunes were selected and sampled with a grid spaced at 10 to 20 m. Two linear transects along the entire SW/NE length of the study area were sampled at 20 m spacing. Additional samples were collected within each distinct patch containing different surface features, such as erosion surfaces, granule ripples, and vegetation. Samples were located using a GPS, resulting in 5-25 cm vertical and sub-decimeter horizontal precisions. Each sample was paired with a GPS point, providing paired grain size and morphology measurements. Samples were collected October 2010-May 2011, November 2011, and January-February 2012. Samples were analyzed for grain size using a Malvern Mastersizer 2000 laser diffract meter.

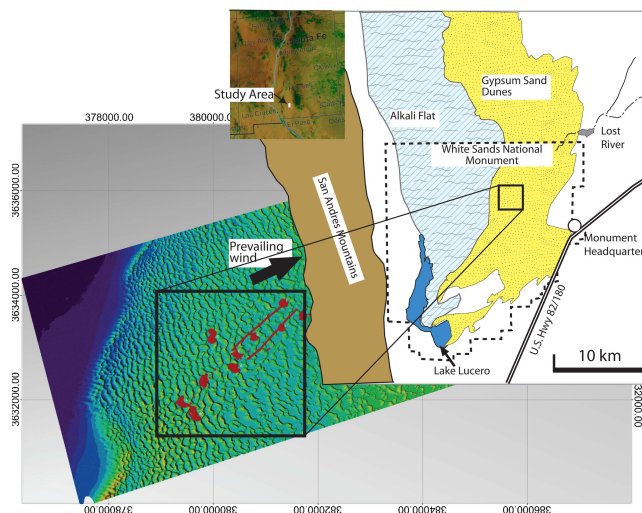


Figure 1. Location of the study area and the sampled dunes shown on a LiDAR map of the dunes (provided by Gary Kocurek).

Results

There was no relationship between height on the dunes and grain size. Grain size varied randomly on the dunes, with some parts of the dune finer than others; there were no consistent trends.

Each of the dunes had significantly different average grain sizes, with the dunes in the northwest being coarsest. No trends were discernible along or across the transect. Adjacent dunes were very different in grain size. The differences in grain size seem to correlate with the percentage of different types of interdunes upwind.

Objectives

The objectives of this project are to determine the local sources and transport paths of sand on, and between, dunes.

Objective 1 - To determine the actual patterns of grain size on dunes at White Sands. This has actually never been addressed thoroughly in any dune field in the world. Different studies have concluded that dunes become finer and coarser grained toward the top.

Objective 2 - To determine how sediment moves on dunes. Where is sediment eroded, and where is it transported?

Objective 3 - To determine the larger-scale transport paths within the White Sands. How much sediment is blown from one dune to another?

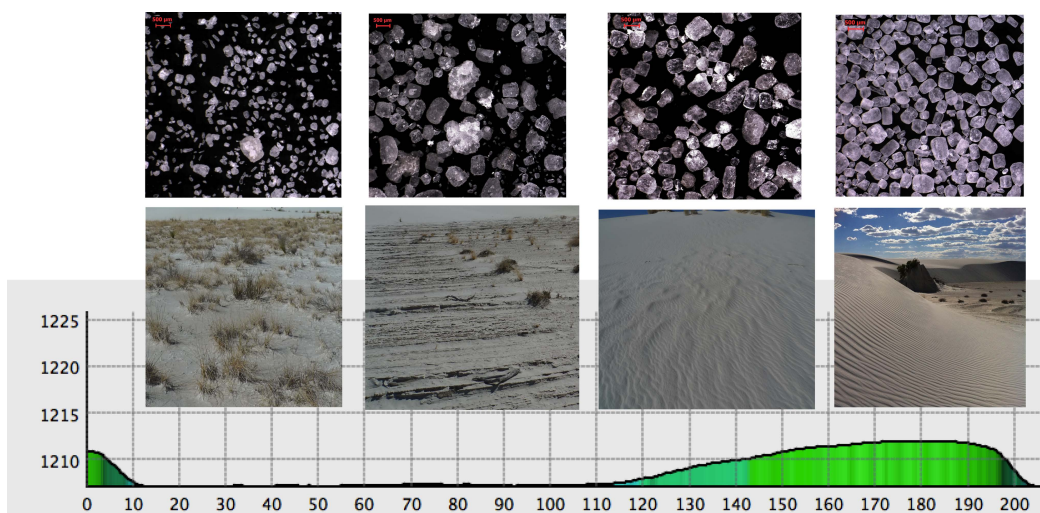


Figure 2. There are distinct types of surfaces on both dunes and interdunes. Each surface has a distinct and different population of sand grains. The photos (left) show the appearances of the different eolian surfaces. Photomicrographs show the grains sizes. Each photo is 6 mm across.

There were four distinct types of surfaces, each with its own population of grain sizes. Interdunes contained areas that can be classified as erosional, evaporitic, and vegetated (Figure 2). Dunes contained finer-grained dune sands, and coarser-grained ripple patches. Each of these sand types had sand grains with different size distributions and different shapes that can be observed under the microscope.

The grain sizes on sand dunes within the White Sands is largely controlled by the percentages of these different dune types and only partly controlled by the transport of sand through the dune field.

Discussion

Because the different interdune areas and local areas on dunes generate their own sand sizes, we should now be able to track the movement of sand on dunes. Further study will allow us to determine the effects of dune size and migration rate on sand transport across dunes and between dunes. This fundamental research should allow us to better understand what controls the patterns and movement of dune fields around the world and even on planets such as Mars.

White Sands Science Symposium

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