AN ANALYSIS OF GRAIN SIZE DISTRIBUTION OF MOBILIZED SAND AT THE GRAND FALLS DUNE SITE. A. M. Sunda[1], R.K. Hayward[1]and T. N. Titus[1], [1]U.S.G.S., Astrogeology Science Center, 2255 N. Gemini Dr., Flagstaff, AZ 86001.

Introduction: The Grand Falls dune study site is located 40 miles northeast of Flagstaff, Arizona on the Navajo Reservation, where the San Francisco Volcanic Field meets the Chinle Formation. Figure 1 shows ripples on dunes that are composed of fine-grain quartz sand and coarse-grain basalt sand. The Little Colorado River and San Francisco Volcanic Field are the most likely sources of the two types of sand found in the Grand Falls dune study site [1]. A long-term project observing the Grand Falls dune study site has been operating since 2013 [2].

Figure 1. Foreground shows ripples higlighted by basalt sand; San Francisco Peaks in the background

Methods: The dune site is monitored by four Big Spring Number Eight (BSNE) passive sediment samplers, a Sensit erosion sensor and three anemometers that log data at one-minute intervals [2].BSNE #1, #2, and #3 are at 20, 45, and 100 cm above ground level, respectively; the Mars BSNE is 55 cm above ground level. In the first year of the study, the BSNEs were emptied on a monthly basis and after strong wind events. In the second and third years of the study, the BSNEs were emptied every two to three months and after strong wind events. Samples retrieved from the BSNEs were processed through a stack of eight sieve screens ranging from 0-4 Phi, and an analysis was done on the resulting data. This sieve process did not directly separate basalt sand from quartz sand.

Results: A statistical analysis of the 88 samples generally shows a bimodal size distribution at the lowest height. The modal trend changes as height above ground increases. Figure 2 shows a comparison of samples with differing distribution from 6/30/2015 and 02/27/2016.

Grain	Collection Date	
Size	6/30/2015	2/27/2016
(mm)	BNSE #1 weight (g)	
0.355	0.76	19.29
0.25	2.43	2.1
0.178	6.55	42.98
0.125	40.76	1028.6
0.09	108.99	275.42
0.075	142.56	453.59
0.045	84.13	170.18
0.032	34.38	77.49
0.017	8.59	20.1
Total	429.15	2089.75
(mm)	BNSE #2 weight (g)	
0.355	0.26	10.59
0.25	0.5	10.89
0.178	0.7	16.52
0.125	2.93	55.56
0.09	8.02	94.96
0.075	20.03	210.07
0.045	27.49	157.09
0.032	17.93	71.28
0.017	6.41	20.76
Total	84.27	647.72
(mm)	BNSE #3 weight (g)	
0.355	0	0.92
0.25	0	1.06
0.178	0	1.02
0.125	0.5	2.6
0.09	0.39	5.39
0.075	2.79	24.4
0.045	6.28	51.22
0.032	7.72	34.35
0.017	3.83	11.33
Total	21.51	132.29
(mm)	Mars BNSE weight (g)	
0.355	0	3.7
0.25	0	5.23
0.178	0	7.81
0.125	0.98	29.55
0.09	1.41	67.92
0.075	10.99	216.72
0.045	19.32	170.51
0.032	16.26	74.82
0.017	5.92	21.81
Total	54.88	598.07

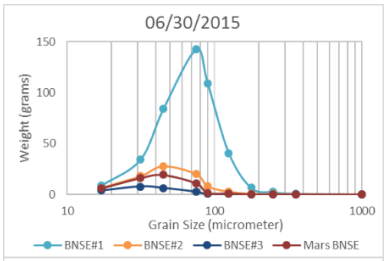
Figure 2. Comparison of two collection dates 06/30/2015 and 02/27/2016. According to the Wentworth Size classification, medium grain sand has a diameter between 0.5-0.25 millimeters.

For collection date 02/27/2016, BSNE #3 collected medium-grain sand at a height of one meter above ground level. Figure 3 shows a statistical analysis for collection date 02/27/2016; the distribution of grain size changes with height above the ground. Figure 4 illustrates the variability in grain size distribution between the two sample dates. Collection date 02/27/2016 shows a bimodal distribution for BSNE #1 and fine-grain peaks for BSNE #2 and Mars BSNE. Collection date 06/30/2016 shows a unimodal distribution for BSNE #1 with fine-grain peaks for BSNE #2 and Mars BSNE.

Date	Grain Size Distribution (mm)	
2/27/2016	median	mode
BNSE #1	0.13	0.125
BNSE #2	0.082	0.075
BNSE #3	0.045	0.045
Mars BNSE	0.079	0.075
Material Distribution %		
	%Sand	%Very fine
BNSE #1	52	48
BNSE #2	38	62
BNSE #3	21	79
Mars BNSE	32	68

Figure 3. Analysis of grain size distribution for sample collection date 2/27/2016.

a)



b)

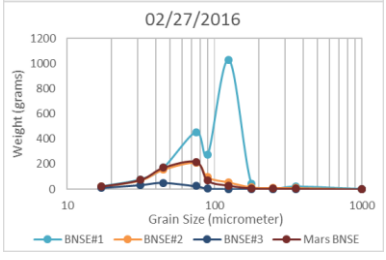


Figure 4. a) Grain size distribution plot for collection date 06/30/2015. b) Grain size distribution plot for collection date 02/27/2016.

Discussion: The basalt sand is angular, coarse- to medium-grain sand typical of cinder cone fallout. The quartz sand is well-rounded, medium- to fine- grain sand that is typical of eolian systems. Both sand types are represented in samples collected from the BSNEs and the distribution varies with season and elevation. Total accumulation is greater in collections from February - June than in collections from August - January and coarse-grain sand typically moves in April, May, and June.

Summary: The basalt and quartz sand are subject to the same environmental conditions but accumulate at different rates. A future analysis of sand type distribution will give us further insight into the variations in transport dynamics of the bimodal sand at the Grand Falls dune study site. The distribution of mobilized sand at the Grand Falls dune study site is variable.

References: [1] Bogel et al. (2015) *Geomorphology 228.* [2] Hayward et al. (2017) Fifth International Planetary Dunes Workshop, Abstract.

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