GRAIN SIZE AS A PROXY OF DEPOSITIONAL ENVIRONMENT THROUGH ASSESSMENT OF SEDIMENT CORES FROM KISMET, FIRE ISLAND, NEW YORK

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Introduction:

An understanding and determination of grain size is one of the most essential measures in a sedimentologic study. Preliminary results from this study show there is clear differentiation between the grain sizes of the sands associated with the beach and dune barrier island facies collected from Fire Island. Continued analysis of the five sediment cores will refine these conclusions and lead to the possibly use of grain size as a proxy.

The record of grain size variability can be developed into a time-series data set, called a proxy. A proxy data set is utilized as a substitute for one or more climatic, environmental, or physical conditions that existed in the past but cannot be measured directly. For example, mean grain size from sediment cores was utilized by Simms et. al., 2006 as a proxy for changes in the sedimentary facies between dune, barrier flat, inlet, shoreface and marine, to study the Holocene evolution of the Mustang Island barrier island system. These grain size data contributed to the researchers' understanding of the environments and their changes over time. Traditional use of grain size data in river transport dynamics, state that resulting peak in annual discharge of a river should carry coarser sediments and thus, may be a potential proxy of paleoprecipitation (Boggs, 1995). Additionally, grain size variability within a time series data set may also record post- fire basinal erosion, shoreline transport proxies, ice core exposure records, eolian dust transport and anthropogenic environmental impacts such as metal contamination and organic enrichment.

Methodology:

Sediment cores were collected with the Hofstra University Vibracore system supervised by Bret Bennington in a shoreline normal transect near Kismet, Fire Island, NY. The locations of the cores are shown in Figure 1.

Figure 1

Figure 1 shows the location of the study area on Fire Island and a close up of the shoreline normal transect along which the sediment cores were taken.

Each sediment core is described at centimeter scale intervals and measured for grain size. Various techniques have been used to measure grain size, and recently, tools such as the laser diffractometer have advanced the resolution of grain size measurement as well as cut down on measurement time. Grain size measurements under 1.4mm are obtained on the Mastersizer 2000 with sample and analytical steps will follow procedure as outlined in Dias and Sperazza (2012 and 2013). Sediments over 1.4mm, the practical limit of the Mastersizer, are measured by sieve analysis. Refined methodology under the procedure in Dias and Sperazza (2012 and 2013) has calculated uncertainty of ~1.7% at 2 sigma. These methodological studies enhance the resolution of grain size as a sedimentologic proxy and improve our use of these newer analytical techniques.

Results:

Sediment core A (Figure 2) consisted of alternating layers between quartz and heavy mineral assemblages (Figure 3) with a discontinuous peat layer at the basal portion of the core (Figure 4). Sediment core B1 and B2 consisted of primarily quartz. Core B2 consisted of loose sediment for 30 centimeters and is not pictured in Figure 2. Core B1 has a thin, <1cm, heavy mineral band at 57 to 58 centimeters and a small peat deposit at 63 and 64 centimeters (Figure 5). Sediment cores C1 and C2 (Figure 2) are composed of quartz and feldspar sands with a transition to darker material below an iron oxidation band near the basal part of C2. This is thought to be due to organic matter since these sediment cores were taken from the back barrier.

Figure 2

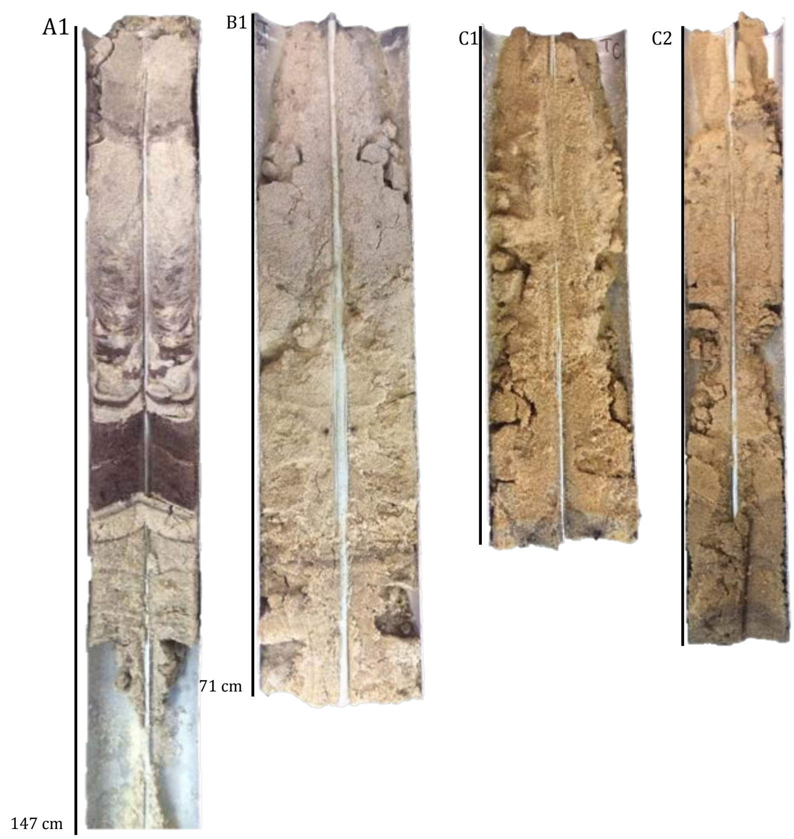

Figure 2 shows the sediment cores A1, B1, C1 and C2. Core B2 is not pictured since it did not have stratigraphy and was about 30 centimeters of unconsolidated modern dune sediment.

Figure 3

Figure 4

Figure 5

Figure 3 (top left) shows the 25 to 50 centimeter section of sediment core A1. This section consists of herringbone cross stratification of heavy mineral deposits and quartz sand.

Figure 4 (top right) shows the 120 to 147 centimeter section of sediment core A1. This section is the basal part of the core and has a sharp break between the lighter sands and darker sand deposits containing small peat nodules.

Figure 5 (left) shows the basal part of sediment core B1. This section consists of a thin, heavy mineral band at the 57-centimeter depth and a small peat nodule at 63 centimeters.

Grain size analysis completed at centimeter intervals for the sediment cores ranged from 191.456 to 600.35 micrometers for sediment cores Al, B1 and B2. Sediment core A1 consists of median grain sizes generally in the 400-500 micrometers with areas of lower grain size, 305.294-340.729 micrometers, associated with the heavy mineral deposits. The coarsest particle sizes, 531.525-600.35 micrometers, in this core seem to be associated with areas that show a mixing of quartz and heavy minerals, twigs, some pebble size grains and larger shell fragments. Sediment cores B1 and B2 consisted of the finest median grain sizes in the entirety of B2 and the upper 20 centimeters of B1 before increasing for about 10 centimeters to median grain size of upper to middle 200-micrometer sizes. Sediment core B1 then dropped back to median grain size of 190 to 210 micrometers before gradually increasing in grain size to 416.365 micrometers at the 51-centimeter mark, the last 20 centimeters of the core have yet to be analyzed. Grain sizes for the cores A1 and B1 are shown in Figures 6 and 7.

Figure 6

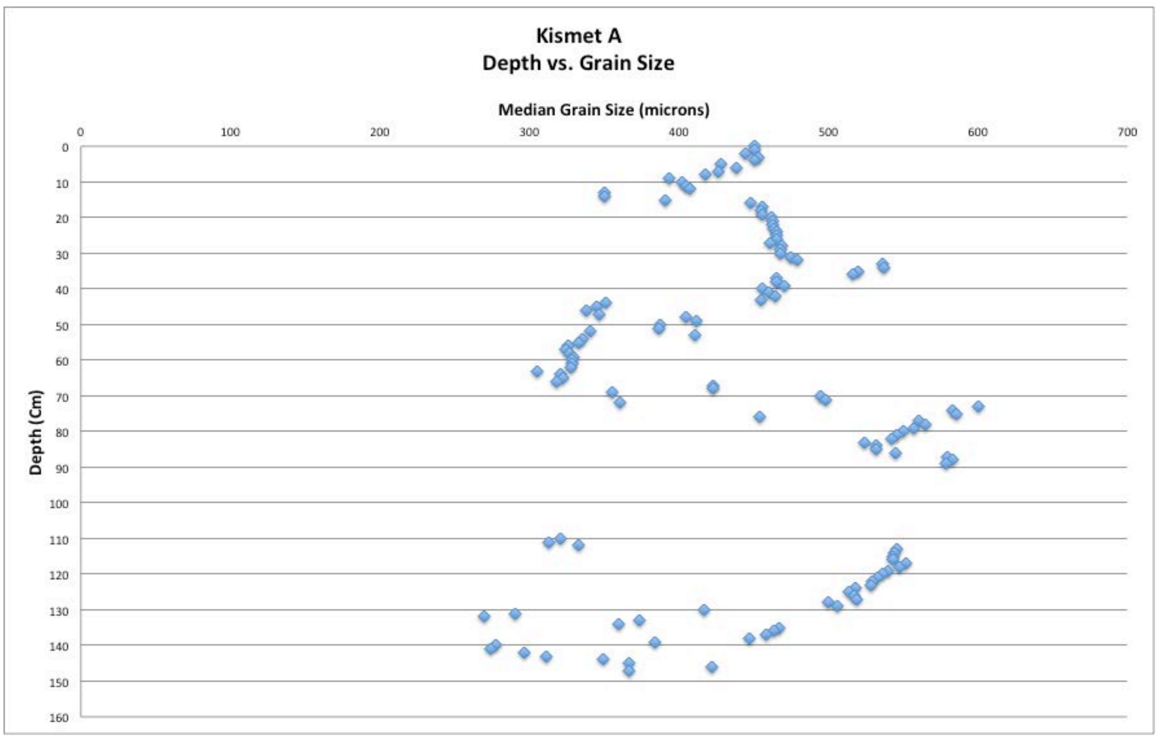

Figure 6 shows the grain size distribution of the centimeter sampling intervals for sediment core A1. This plot shows variation with depth and some clustering which could be related to facies, the possible clustering will be further investigated.

Figure 7

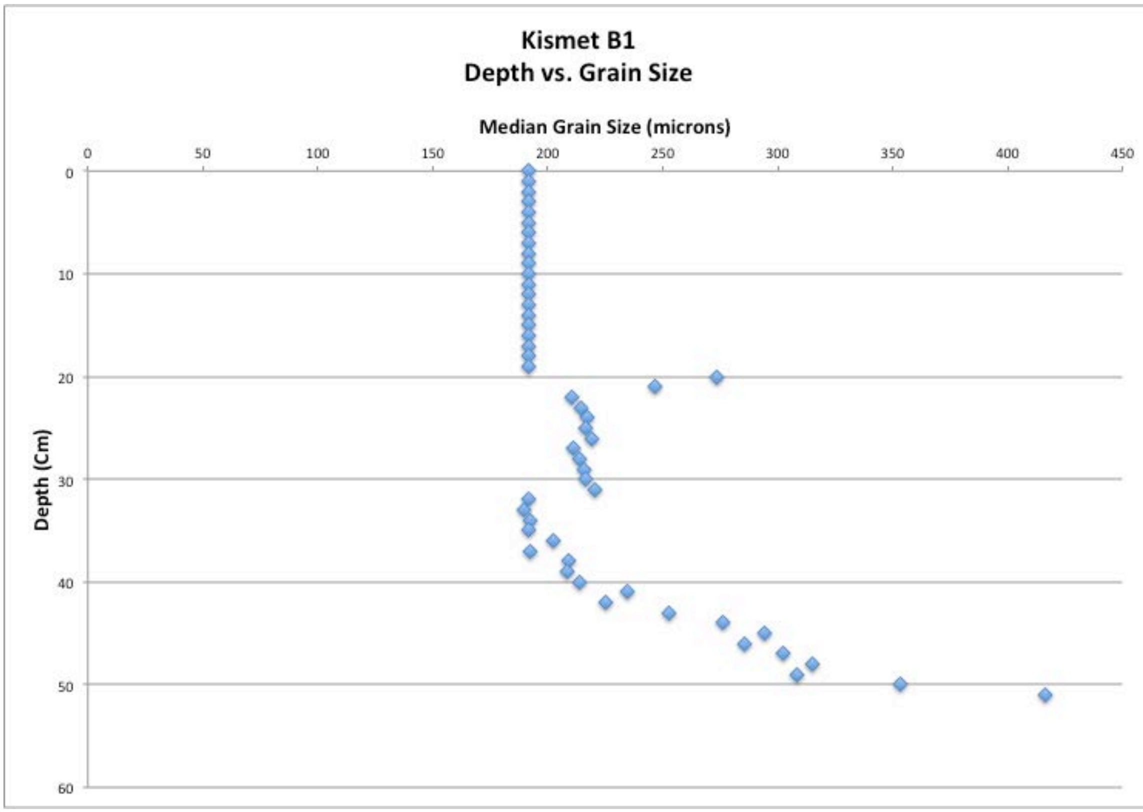

Figure 7 shows the grain size distribution of the centimeter sampling intervals for sediment core B1. From 20 to 30 centimeters, there is a slight increase in grain size, then the grain size drops back to below 200 microns before showing a gradual coarsening downward pattern. This plot will be continued the length of the sediment core, 71 centimeters to observe the grain size with depth trend.

Discussion and Conclusions:

It has been suggested that barrier islands are composed of four major environments and associated facies: beaches, dunes, barrier flats, and inlets (Shepard, 1960). The beach facies (backshore and foreshore) consist of well-sorted sands, predominately quartz in composition, with few heavy minerals, including magnetite and often shell fragments (Simms, 2006). The dune facies consists of clean, well-sorted fine to very fine sand, with few heavy minerals, including magnetite (Shepard, 1955). It was found by Simms, 2006 that occasionally root casts were found within cores interpreted to represent the dune facies. Barrier flat facies can have many subfacies and are dominated by storm washover and eolian transport (Shepard, 1960). Inlet facies are recognized by the presence of a muddy or sandy shell hash or a sand and mud laminated portion (Simms, 2006).

Based on first order, current interpretations, the cores A1, B1 and B2 contain the beach and dune facies. The top of core A1 is representative of the modern beach; the sediment core was taken on the beachfront in the backshore area, in front of the Fire Island dunes. It is suggested that this sediment core is showing two subfacies of the main beach facies. The subfacies seen would be the backshore and the upper foreshore surf and swash zones. The backshore consists of the quartz dominated, well-sorted coarser sands, with median grains size 428.43 to 450.852 micrometers. The cross bedded middle of the sediment core can be interpreted as the upper foreshore surf and swash zones, with the swash zones having a herringbone cross stratification and the surf zone a longshore trough cross bedded structure. It is possible that there are storm-associated deposits in this core where twigs, coarser grains and some pebbles are found with the mixing of quartz and heavy mineral sands. The basal portion of the core consists of a sharp contact between clean sands and darker sands, plant debris and small peat nodules.

Core B1 contains the dune facies and possibly the barrier flat facies. The top of the sediment core is representative of the dune facies due to the clean, well-sorted fine sands, median grain size around 190 micrometers. Also, the top portion of the core, until around 50 centimeters, consists of dune plant fragments. The barrier flat facies can contain washover deposits and the heavy mineral band at 57 centimeters can be evidence of a washover event. Sediment core B2 is entirely unconsolidated, clean, well sorted sand and has abundant dune plant material throughout.

Further analysis of the sediment core B1 and backbarrier cores, C1 and C2 will add to the facies interpretation of this area. Upon completion of the grain size analysis, K-means clustering algorithm will be applied to the data to further investigate the possible clustering of data points to support preliminary visual facies analysis. Grain size clustering within the sediment cores and between associated facies can give insight to the environmental interpretation of the barrier island and lead to the further use of grain size as a proxy of depositional environment.

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