PRELIMINARY GEOCHEMICAL AND MINERALOGICAL ASSESSMENT OF THE BEACH SAND, VIEQUES, PUERTO RICO

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INTRODUCTION

Representative beach sand samples were collected from Vieques (18.095901948142554, -65.49229758368986; Puerto Rico) and chemically analyzed for provenance interpretation (Figure 1). Puerto Rico is the eastern-most island of the Greater Antilles, which is a group of islands in the Caribbean Sea that includes the countries of Cuba, Hispaniola (Haiti and the Dominican Republic), Jamaica, and the U.S. territory – the Commonwealth of Puerto Rico. Puerto Rico (and its outlying islands of Culebra and Vieques), along with the U.S and British Virgin Islands are the subaerial form of a microplate that exists at a seismically active plate boundary between the North American plate and the northeast margin of the Caribbean plate (Kaye 1959; United States Geological Survey Bulletin #1042-1, 1957).

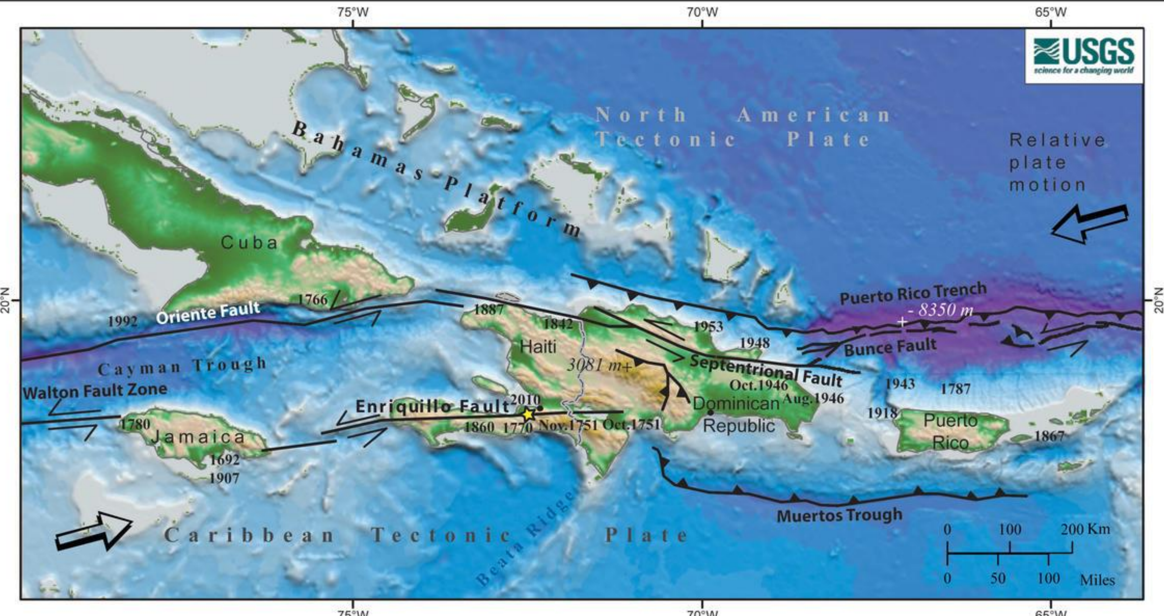


Figure 1: Map of the North American – Caribbean tectonic plate boundary. Colors denote depth below sea level and elevation on land. Bold numbers are the years of moderately large (larger than about M7) historical earthquakes written next to their approximate location. From http://woodshole.er.usgs.gov/project-pages/caribbean/

BACKGROUND

The Black Sand Beach is a short drive from the town of La Esperanza and it's about a quarter of a mile long. Samples were collected from low-and high tide dominated areas. The most abundant heavy mineral in the beach sands of Puerto Rico is magnetite. It occurs on all shores of the island. Ilmenite is present, associated with the magnetite. The beach sands also contain minor amounts of chromite. The west and southwest shores, from Punta Guanajiba to Ponce, are composed of weathered rocks, mangrove swamps, and beaches composed of shell fragments.

VIEQUES, PUERTO RICO – The Black Sand Beach

HEAVY MINERALS

Heavy minerals are a major constituent of the beach sand in many places on the south coast and magnetite often constitutes more than 15 percent of the sand. The east coast, from the Rio Grande de Patillas to Naguabo, consists of outcropping volcanic and intrusive rocks of Cretaceous and early Tertiary age and sandy beaches. Rich concentrations of heavy minerals occur locally (Picture 1-3).

BULK OXIDES & TRACE ELEMENTS

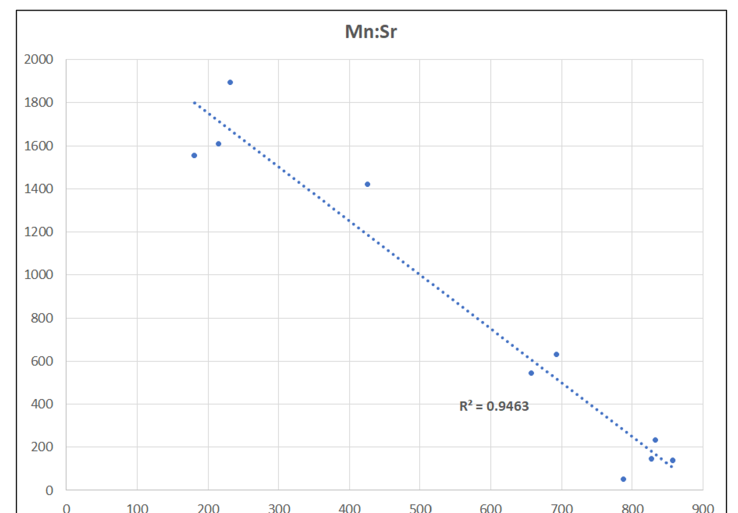
Both trace elements (V, Mn, Ti, Zr, Y, Cr, Sr, Rb, Ce, La, etc.) (Table 1A) and bulk oxide (silica, alumina, soda, potash, magnesia, ferrous and ferric oxide, calcium oxide, etc.) (Table 1B). Analyses were performed on collected sands by using X-ray Fluorescence (XRF) and Inductively coupled plasma mass spectrometry (ICP-MS). (Table 1A and 1B, and Graph 1-4.)

	Trace Elements		
Low Tide	Mn	Sr	V
K1L	181	1555	62
K2L	231	1895	193
K3L	215	1610	191
K4L	827	147	1755
K5L	657	543	1180
High Tide	Mn	Sr	V
K1H	425	1420	587
K2H	857	140.5	1735
K3H	693	630	1270
K4H	833	232	1695
K5H	787	51.4	1790
	Mn:Sr	Mn:V	Sr:V
R value	-0.97	0.99	-0.98
R^2 value	95%	99%	97%

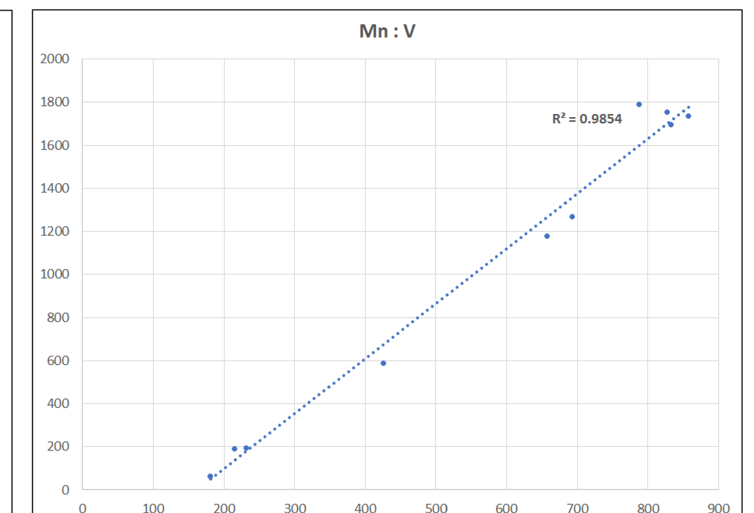
	Bulk Oxides		
Low Tide	SiO2	Fe2O3	CaO
K1L	46.2	4.2	19.8
K2L	37.1	9.3	22.2
K3L	41.2	9.3	19.6
K4L	4.0	91.7	2.8
K5L	19.9	59.2	8.3
Low Tide	SiO2	Fe2O3	CaO
K1H	28.7	28.5	18.4
K2H	3.8	91.5	2.9
K3H	13.0	65.7	9.6
K4H	5.5	87.4	3.9
K5H	2.1	97.3	1.2
	Si:Fe	Si:Ca	Fe:Ca
R value	-0.99	0.96	-0.99
R^2 value	98%	92%	98%

Table 1A (left): Beach sand composition: Representative Trace elements.

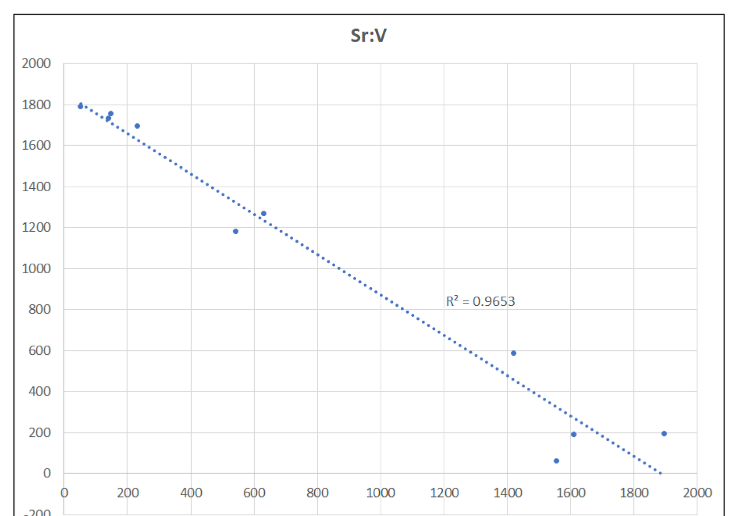
Table 1B (right): Beach sand composition: Bulk Oxides



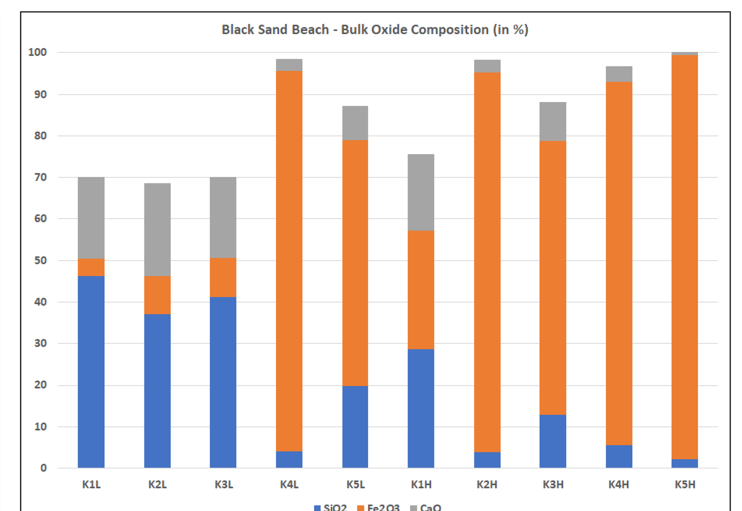
Graph 1 : Mn to Sr ratio showing a nearly perfect negative correlation with R^2 95% (values are in parts per million, ppm)



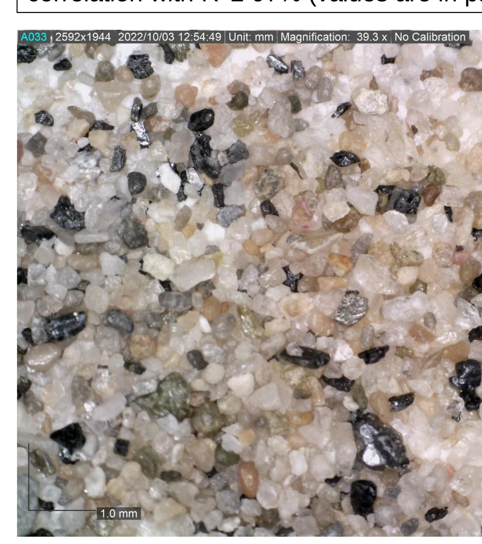
Graph 2: Mn to V ratio showing a nearly perfect positive correlation with R^2 99% (values are in parts per million, ppm)



Graph 3 : Sr to V ratio showing a nearly perfect negative correlation with R^2 97% (values are in parts per million, ppm)

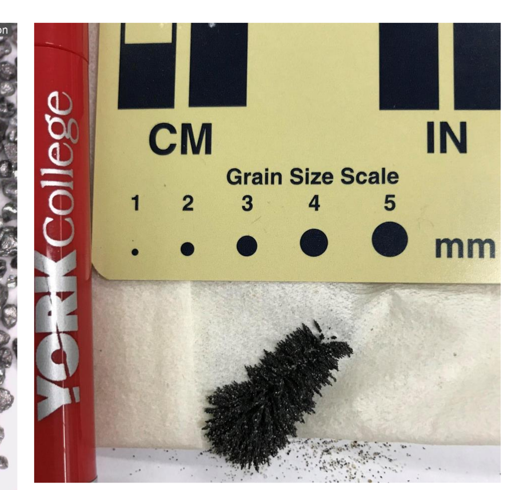


Graph 4 : Bulk Oxide composition (values are in percentage)



Picture 1: Primarily light-colored beach sand with quartz from the Black Sand Beach.

Picture 2: Primarily dark colored beach sand from the Black Sand Beach.



Picture 3: Magnetic beach sand shown with scale.

MAGNETIC SEPARATION

In general, high tide samples contained a higher percentage of magnetic material. Magnetic material made up 72% on average, with a maximum of 93%.(Table 2A and Graph 5).

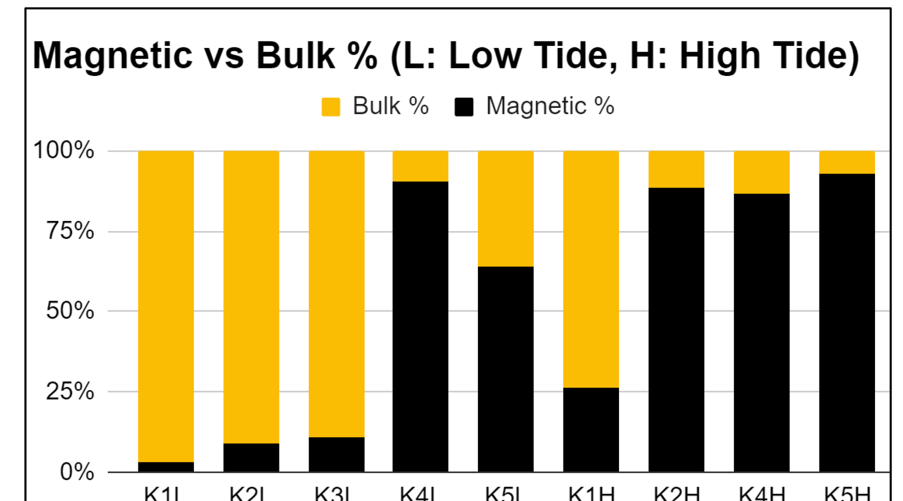
Most of the low tide samples were almost entirely non-magnetic (Table 2B and Graph 5).

High Tide	Magnetic %	Bulk %
K1H	26%	74%
K2H	89%	11%
K3H	66%	34%
K4H	87%	13%
K5H	93%	7%

Table 2A : Magnetic separation data for high tide samples showing higher magnetic versus non-magnetic composition.

Low Tide	Magnetic %	Bulk %
K1L	3%	97%
K2L	9%	91%
K3L	11%	89%
K4L	90%	10%
K5L	64%	36%

Table 2B : Magnetic separation data for low tide samples showing typically lower magnetic versus non-magnetic composition.



Graph 5 : Magnetic separation comparing high and low tide samples

CONCLUSIONS

Based on geochemical discriminating factor, there seemed to be an affinity of most of the black sands with volcanic-sourced derivation. Ceaseless shoreline processes ultimately fractionated heavy mineral concentrations in black sands due to hydraulic sorting.

CITED LITERATURE

Kaye, Clifford, A. 1959. Coastal Geology of Puerto Rico, Geological Survey Professional Paper 317. Accessed online: https://pubs.usgs.gov/pp/0317a/report.pdf

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ABSTRACT

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