THE ATMOSPHERIC TRANSPORT AND DEPOSITION OF ARSENIC AND OTHER METALS IN SOUTHEASTERN UNITED STATES.

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It has been recently recognized that the required nutrients are introduced into the remote ecosystems bordering the western Atlantic Ocean are derived from Africa. Identification of North African sources is confirmed by mass distribution and a characteristic Al/Ca ratio of greater than 3.8 (Perry and others, 1997, Fig 1), ratio of ^{7}Be and ^{210}Pb (Holmes and Others 2000), and satellite tracking. Prospero (1999) has determined that the flux of Saharan dust in Southern Florida ranges between 10 μg/m^{3} to 100 μg/m^{3} daily. Swap and others (1992) demonstrated that the bromeliads in the Amazon rain forest benefit from the introduction of such material. Shinn and others (2000) have suggested that African dust may be the substrate that conveys spores and other deleterious organic matter throughout the Caribbean and southeastern United States.

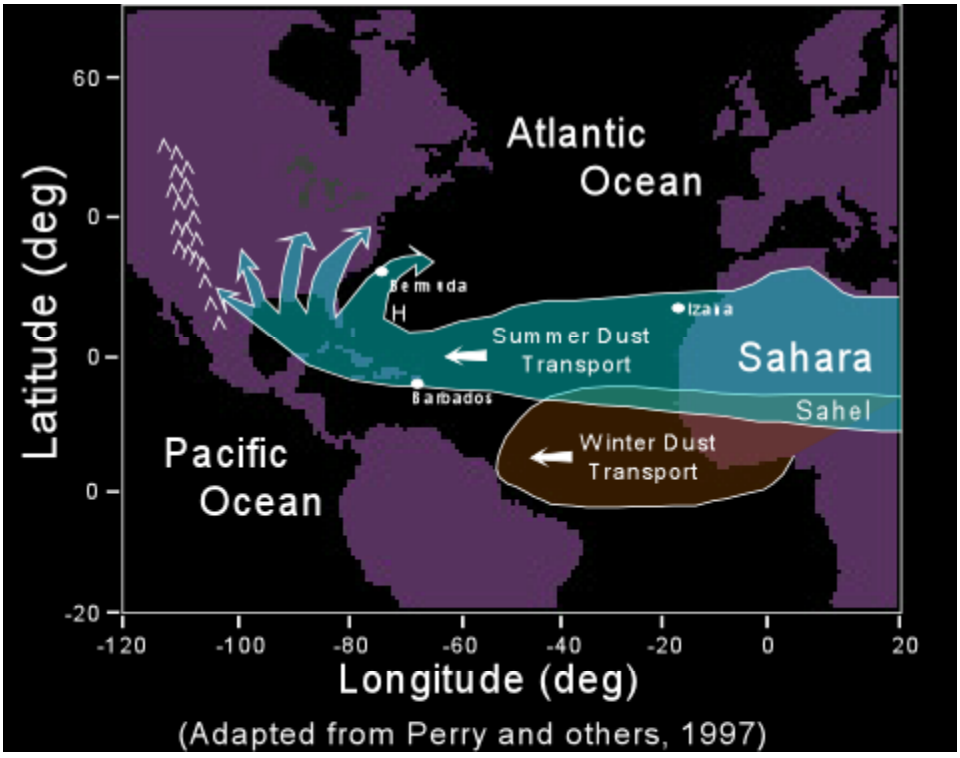

Figure 1 -- The seasonal paths of African mineral dust transported across the Central Atlantic.

The composition of material collected in Africa, from "dust-events" that crossed the Azores, and collection sites, such as cisterns in the Caribbean and the Eastern United Stated reveal that arsenic and other metals are transported within the dust. The arsenic content of dust material collected in Mali, North Central Africa, was approximately 17 μg/g. Arsenic in cistern material collected on

eastern-most end of St. John, U.S. Virgin Islands was about 38 μg/g. For comparison, the arsenic values measure in sediment in a Nassau cistern was 10 μg/g.

The largest data set available with arsenic analyzes is provided by the IMPROVE (Interagency Monitoring of Protected Visual Environments) program. The IMPROVE data, collected throughout the United States, including a site on St. Johns the Virgin Islands, provides a unique look into the distribution of various metals and organic substances in aerosols. The IMPROVE program has as its objectives (1) to establish current visibility and aerosol conditions in federal lands, (2) to identify chemical species and emission sources responsible for existing man-made visibility impairments, and (3) to document long-term trends. At each site, four simultaneous samples are collected: one PM_{10} sample (particles less than 10μm in diameter) on a Teflon filter and three PM_{25} (particles < 25μm in diameter) samples on Teflon, nylon and quartz filters. These samplers are programs to locket two 24-hour samples per week. The PM_{10} filter is used to determine total gravimetric PM_{10} mass concentration, while the PM_{25} Teflon filter is analyzed to determine gravimetric mass concentration and concentrations of selected elements using particle-induced x-ray emission (PIXE), x-ray fluorescence (XRF) and Proton Elastic Scattering Analysis (PESA). The nylon filter is analyzed to determine nitrate and sulfate aerosol concentrations using Ion Chromatography (IC). The quartz filters are analyzed for organic and elemental carbon using the Thermal Optical Reflectance (TOR) method. In addition to a Virgin Islands site, the IMPROVE program established three sites in Florida, one in Everglades National Park in south Florida, one a Chassahowitzka National Wildlife Refuge along the Gulf Coast in Central Florida and one in the Okefenokee Wildlife Refuge on the Florida/Georgia border.

Historical aerosol data for the central Atlantic established that the highest dust concentrations are associated with high aluminum concentrations (Arimoto and others, 1995) and that aluminum concentrations could be used as a proxy for dust. Casual inspection of the IMPROVE data revealed an apparent relationship between aluminum and arsenic at the Virgin Island location. Closer inspection confirmed this relationship and out of the 679 samples collected at the Virgin Islands site since 1990, 289 (35%) had detectable arsenic. Arsenic, in the 289 samples, ranged from 0.5 to 44 μg/g, with a mean of 17 μg/g. At the Everglades National Park (Fig. 2), arsenic was present in 61% of the 913 samples. A plot of aluminum versus arsenic suggest approximately 50% of the arsenic is associated with other than soil material. At Chassahowitzka, 83% of the 662 samples contained measurable arsenic and only ~25% were linked with the aluminum concentrations. At the Okefenokee, 71% of the 779 samples contained measurable arsenic and ~ 2.5% had an association with aluminum. Of all the sites, Chassahowitzka samples appeared to have the highest arsenic concentrations ranging from 0.5 to 198 μg/g with a mean value of 33 μg/g.

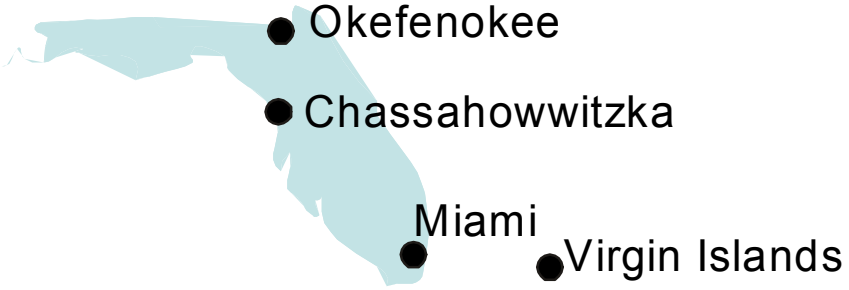

Fig 2 - Location of sampling sites

These data suggest that the flux of African dust does influence the input of arsenic to the southeastern United States, but its contribution is minor compared to other sources. Elemental statistical analysis of the data, suggest a weak correlation with SO_4, but this correlation is very weak. There is a hint that the elevated arsenic concentration in central Florida and the Everglades maybe due to fire, releasing deposited arsenic from the organic sediment that is present throughout central and south Florida. As the "dust" programs continues, this possibility will be further examined along with establishing the historical record by analysis of the organic sediments with central and south Florida.

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