**Northwest Columbia Plateau PM$_{10}$ Project**

**Objective 1:** Baseline Data for the Columbia Plateau

**Objective 7:** Determine the Relative Impact of Human Activity on Suspended Dust and PM$_{10}$ Emission Rates in the Columbia Plateau by Determining Erosion Rates for Non-anthropogenic and Anthropogenic Areas on a Regional Basis plus Estimating Pre-human Erosion Rates for Soils During High Wind Events

**Personnel:**

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**Co-investigators:** David Gaylord, WSU; Mark Sweeney, WSU; Shawn Blaesing-Thompson, WSU.

**Objectives of the Research**

1. (Objective 1): Analyze major soil types under cultivation as well as native vegetation for a series of properties related to wind erodibility and emissions of PM$_{10}$.

2. (Objective 1): Develop predictive maps of PM$_{10}$ and PM-2.5 potential emissibility, total potential erodibility (horizontal mass flux) and total suspendable component for the soils of the Columbia Plateau.

3. (Objective 7): Determine the effect of human activity on dust emission rates in the Columbia Plateau by estimating pre- and post-farming dust deposition rates.

4. (Objective 7): Improve scientific knowledge of the basic characteristics and geologic origin of the eolian sediments and soils on the Columbia Plateau, specifically the dynamic processes by which the saltation-dominated (dune) and suspension-dominated (loess) sediments were originated, entrained, and deposited since the Last Glacial Maximum.

**Major Findings (numbered to objectives above)**

- 1. (Objective 1) Organic carbon, particle size, volcanic glass content, cation exchange capacity, and exchangeable sodium percentage were measured on almost 600 surface soil samples and subjected to traditional statistical analysis, then geostatistical analysis to determine spatial patterns of these properties across the Columbia Plateau PM$_{10}$ area. These results appeared in the M.S. Thesis of Heidi Marks and in PM$_{10}$ project publications such as Farming With the Wind. A journal article was published detailing the spatial pattern of volcanic glass in soils of the Columbia Plateau and relationship to wind erosion (Busacca et al., 2001).

- 2. (Objective 1) The major objective of this phase of this project was to develop predictive maps of PM$_{10}$ and PM-2.5 potential emissions and total potential erodibility (horizontal mass flux) for the soils of the Columbia Plateau. Wind tunnel experimentation is an expensive and time-consuming way to measure total erosion. Our goal was to establish statistical
relationships between measured erosion, dry-aggregate size distribution, and available PM$_{10}$ (particulate matter <10mm) so that we could predict erosion and PM$_{10}$ emissions at more sites than we could measure using the wind tunnel. The predicted erosion and PM$_{10}$ emissions were then interpolated across the Columbia Plateau using geostatistical procedures and presented in map form. The research supported the M.S. Thesis of Shawn Blaesing-Thompson (Blaesing-Thompson, 2000). We published one paper that detailed development of new techniques to measure fine dust emissions potential (Chandler et al., 2002) and a second paper containing hazard prediction maps of PM$_{10}$ emissions potential (Chandler et al., 2004).

3. (Objective 7) In order to determine the effect of human activity on dust emission rates in the Columbia Plateau, we analyzed bottom sediments in Fourth of July Lake in eastern Washington to show at least a four-fold increase in dust fallout into the lake coincides with the introduction of modern agriculture on the Columbia Plateau. Natural dustfall is characterized by a relatively coarse mean particle diameter, with high temporal variability in mean particle size resulting from localized dust entrainment from dune blowouts or during dust storms superimposed upon a steady fallout of finer dust. In contrast, post-farming dust is characterized by a steady and abundant supply of fines from farm fields stripped of their natural perennial grass cover. An article in a conference proceeding (Busacca et al., 1998) summarized this work.

(Objectives 1 & 7) In October of 1998, the PI convened an international field tour and conference titled “Dust Aerosols, Loess Soils, and Global Change”. The tour was held in the eastern Washington PM$_{10}$ study area and the results of the PM$_{10}$ project were prominently shown on the tour. More than 40 scientists from 14 countries attended the tour. The conference was held in Seattle, Washington and was attended by almost 100 scientists from 17 countries. The PI edited a conference proceeding (Busacca, 1998a) and a field guide (Busacca, 1998b).

4. (Objective 7) These major findings were supported in the main by a grant of over $300,000 for three years from the National Science Foundation to Busacca and Gaylord, who are PI and cooperator on this PM$_{10}$ project. The PM$_{10}$ project provided critical support funding for fieldwork and age dating. Controls on the thickness and distribution of loess on the Columbia Plateau since the late Pleistocene include: 1) topography, 2) bioclimate, 3) dust source-sediment character, and 4) large-scale atmospheric circulation patterns. Funding from NSF, the PM$_{10}$ project supported the doctoral dissertation research of Mark Sweeney (2004).

Topographic features such as incised stream and river canyons have segregated saltation-transported eolian sand from suspension-transported silt. At Juniper Canyon, OR, sand dunes were trapped by the canyon, limiting saltation of sand, resulting in the accumulation of nearly 8 m of post last-glacial-maximum (<18,000 yr BP) L1 loess downwind of the canyon. Bioclimatic factors, including precipitation and vegetation density, also have controlled where loess and eolian sand accumulate, for example, on Eureka Flat, which has been a major ‘engine’ of dust production to form the Palouse (Sweeney et al., 2004b).
The prevailing southwesterly dust transporting winds may have been occurring for as long as 2 million years, but changes in atmospheric circulation patterns during the last glacial maximum related to the presence of the large continental ice sheets shut down dust production. Once the ice sheets receded, normal atmospheric flow resumed, and the engine for the Pacific Northwest eolian system was started again. We published a journal article reporting these findings in 2004 (Sweeney et al., 2004a).

- 5. (Objectives 1 & 7) Our research with the PM$_{10}$ project and allied research on loess soils led to the opportunity to publish a chapter in the Encyclopedia of Soil Science on wind erosion and climate change (Busacca and Chandler, 2002) and a chapter in the Encyclopedia of Soils in the Environment on loess (Busacca and Sweeney, 2004). The PI is senior author of a chapter on eolian sediments in a major new reference work on the Quaternary Period (Ice Ages) in the United States (Busacca et al., 2003).