Background Concentrations of Trace Metals in Florida Surface Soils

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EXECUTIVE SUMMARY
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PROJECT TITLE: Background Concentrations of Trace Metals in Florida Surface Soils
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OBJECTIVES

- To obtain an approved Research Quality Assurance Plan (RQAP) by Florida State Department of Environmental Protection (FDEP).
- To select 428, geographically and pedogenically representative, Florida surface soil samples from a pool of over 8,000 archived samples.
- To validate the sampling protocol used by the Florida Cooperative Soil Survey Program (FCSSP) to collect the archived soil samples, by collecting soil samples using both protocols [FCSSP and Environmental Protect Agency (EPA)].
- To compare two acid digestion methods (EPA-Methods 3051 and 3052) by determining 18 elemental concentrations in 40 major Florida surface soils and two standard reference materials (SRMs).

METHODOLOGY

A RQAP was prepared based on the FDEP quality assurance manual and revised according to RQAP review checklists (FDER, 1992). Four hundred twenty eight soil samples were selected based on soil survey information and the availability of the University of Florida Soil Characterization Laboratory (UFSCL) archive samples. Forty soil samples were digested using EPA Methods 3051 and 3052 in a microwave digester and analyzed using inductively coupled
plasma optical emission spectrometry (ICP-OES) and mass spectrometry (ICP-MS). Validation of method precision and accuracy were performed by using SRMs from the National Institute of Standards and Technology (NIST).

**RATIONALE**

Information on site-specific background concentrations of trace metals in Florida surface soils is critical for evaluating land application of non-hazardous waste materials and monitoring the mobility of trace metals from contaminated sites to adjacent areas. In this project, total concentrations of trace metals (Ag, Al, As, B, Ba, Be, Cd, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sb, Se, and Zn) in selected representative Florida soil samples were determined. These metals, except for Fe and Al, are of environmental concern and are regulated by federal and state laws as toxic elements (Kimbrough et al., 1989). Determination of Fe and Al is for reference purpose (Schropp, 1990).

**RESULTS**

- An 88-page long RQAP (#960 117) was prepared and approved by the FDEP.
- 428 surface soil samples were selected from a pool of over 8000 UFSC archives based on their taxonomic acreage and geographic distribution in Florida. Those samples include 120 Spodosols, 94 Entisols, 81 Ultisols, 60 Alfisols, 43 Histosols, 17 Mollisols and 13 Inceptisols.
- The FCSSP soil sampling protocol was compared to the EPA’s by collecting 10 pairs of Florida surface soil samples using the two protocols (FCSSP and EPA). These samples were digested using EPA Method 3051 and sent to FDEP for analysis in November, 1996.
- Physical, chemical, and mineralogical information of the 428 soil samples were downloaded from the UFSC computerized database. Site location for georeferencing those data was compiled for further study.
- 40 Florida soils and two NIST standard reference materials (SRM 2704 and SRM 2709) were digested using EPA Methods 3051 and 3052. Concentrations of 18 elements (Ag, As, B, Ba, Ca, Cd, Cr, Cu, K, Mg, Mn, Mo, Ni, P, Pb, Sb, Se, and Zn) were determined using inductively coupled plasma optical emission spectrometry (ICP-OES) and mass spectrometry (ICP-MS).
- Precision for elements Ag, As, Ba, Be, Ca, Cu, Mg, Mn, Ni, P, and Ni were <10\% relative standard deviation (RSD) using Method 3051, which is much better than that of Method 3050. The percent recoveries for As, Ca, Cd, Cu, Mg, Mn, Ni, P, Pb, and Zn from both SRMs were >60\% whereas those of Ba, K, Mo, Sb, and Se were far below 40\% and those of Cr were around 50\%. There were no significant differences in recoveries for most metals
between Methods 305 1 and 3050, but variations in recovery for a given element were less for EPA Method 305 1.

- Trace metal concentrations determined by EPA Method 3052 and 3051 were compared. Recoveries of trace metals in 40 Florida soils leached by nitric acid (EPA Method 305 1) were generally low except for Ba, Mn, and Pb, which were around 80%-120%. Some trace metals (As, Be, Cd, Cr, Mo, Ni, and Se) were too low to be detected. However, among the 3 major soil orders in Florida, Ultisols generally had the highest whereas Spodosols had the lowest concentrations for most trace metals. As to Entisols, the greater the soil surface coating, the greater the trace metal concentrations.

- Eleven monthly progress reports were submitted to the Florida Center for Solid and Hazardous Waste Management (FCSHWM). A manuscript entitled “Background Concentrations of Trace Metals in Florida Surface Soils” was prepared and presented at the Fourth FCSHWM Annual Research Symposium (1996 at Tampa, FL)

**CONCLUSIONS**

- Satisfactory matrix spike recoveries and excellent precision were achieved for most metals analyzed using an FDEP-approved RQAP. Precise digestion was also achieved for most trace metals by using EPA Method 305 1, except for Sb and Se, which were out of the target precision range. However, this is an alternative leaching method for EPA Method 3050 which produced much better overall precision.

- EPA Method 305 1 is suitable for leaching environmental samples, but it does not recover all the metals in a sample. Its recovery is element and sample dependent.

- Florida soils are especially prone to leaching due to their sandy textures, high hydraulic conductivities and low reactivities. Trace metal concentrations in those soils were relatively low. Using leaching procedure like EPA Method 305 1, we could only obtain satisfactory recoveries for limited numbers of trace metals such as Ba, Mn, and Pb. For most trace metals, such as As, Be, Cd, Cr, Mo, Ni, and Se, it is difficult to obtain reliable results. A more vigorous digestion method, like the triple-acid (EPA Method 3052), should be employed to obtain satisfactory recovery.