

North American Soil Geochemical Landscapes Project



Goals

- ▶ Establish baseline geochemistry & microbiology for North America
- ▶ Interpret data in light of natural and human factors
 - Geology & climate
 - Industrialization, urbanization & agriculture
- ▶ Data for use by environmental agencies and others – baseline risk assessment
- ▶ Establish archive of soil samples for future studies
- ▶ Identify areas for additional sampling

Timeline

- ▶ Initiated by US, Canadian and Mexican, Geological Surveys – 2001
- ▶ Additional planning with EPA, other government agencies, universities
- ▶ Pilot Studies 2004
- ▶ Sampling started 2007
- ▶ 10+ years for completion

Previous Studies

- ▶ Highways
- ▶ Shallow depth (20 cm)
- ▶ Native vegetation

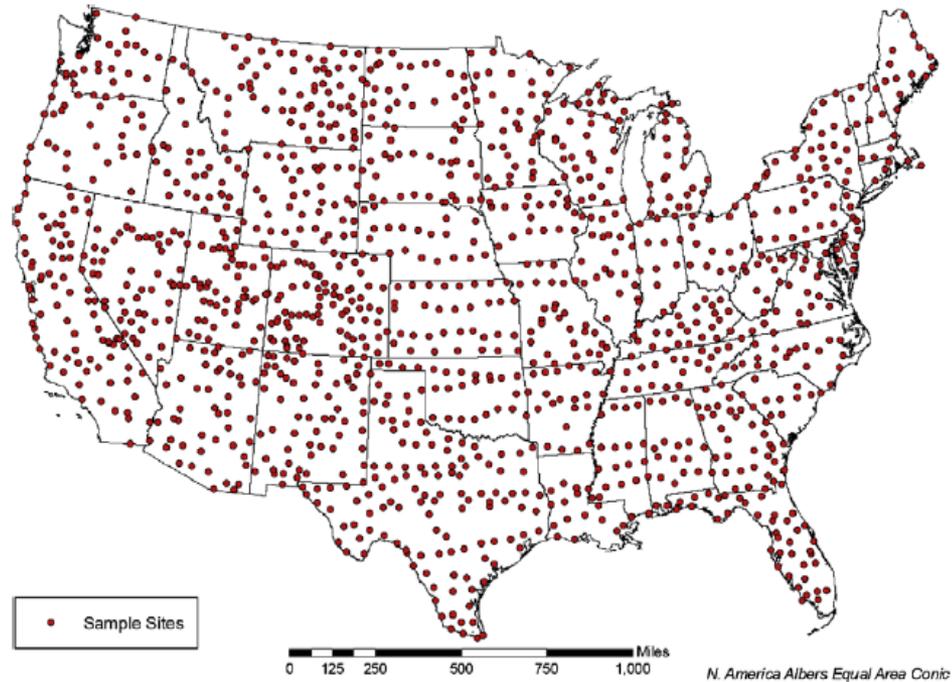
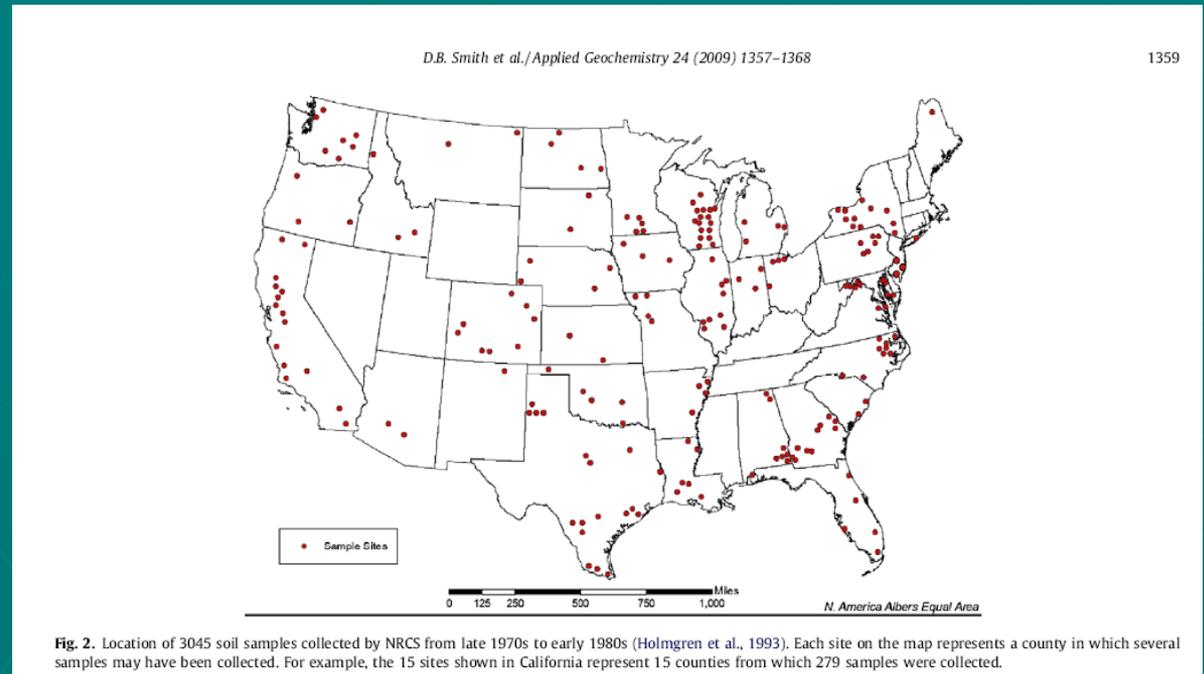


Fig. 1. Location of 1323 soil samples collected by USGS from mid 1960s to late 1970s (Shacklette and Boerngen, 1984).

Previous Studies

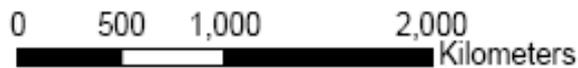
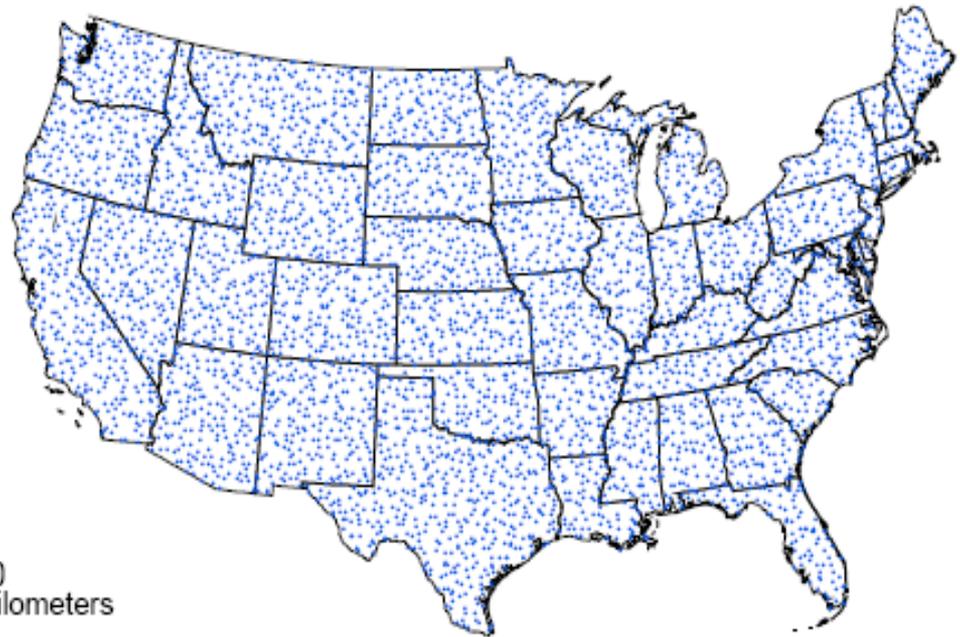
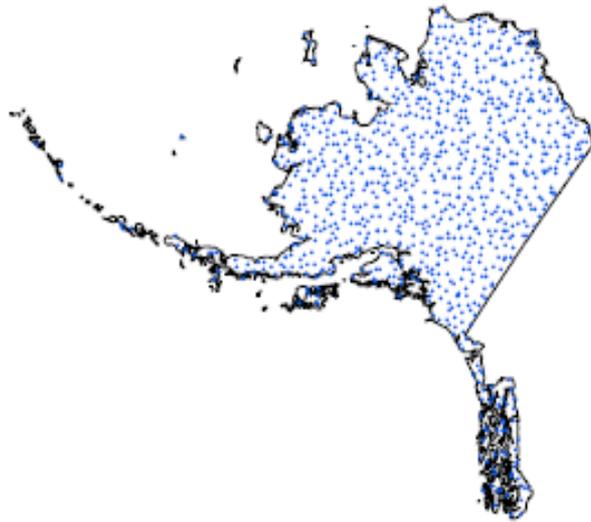
- ▶ Natural Resources Conservation Service (1993) – metals in agricultural soils
- ▶ State surveys – different methods



GRTS

- ▶ General Randomized Tessellation Stratified sampling design
- ▶ Ensures spatial uniformity and randomness unlike previous studies
- ▶ 13,596 sites for North America
 - US=5,813 Canada=6,183 Mexico=1,600
- ▶ Over 4 times as many sites as Shacklette studies

Sample Locations



Canada



Mexico

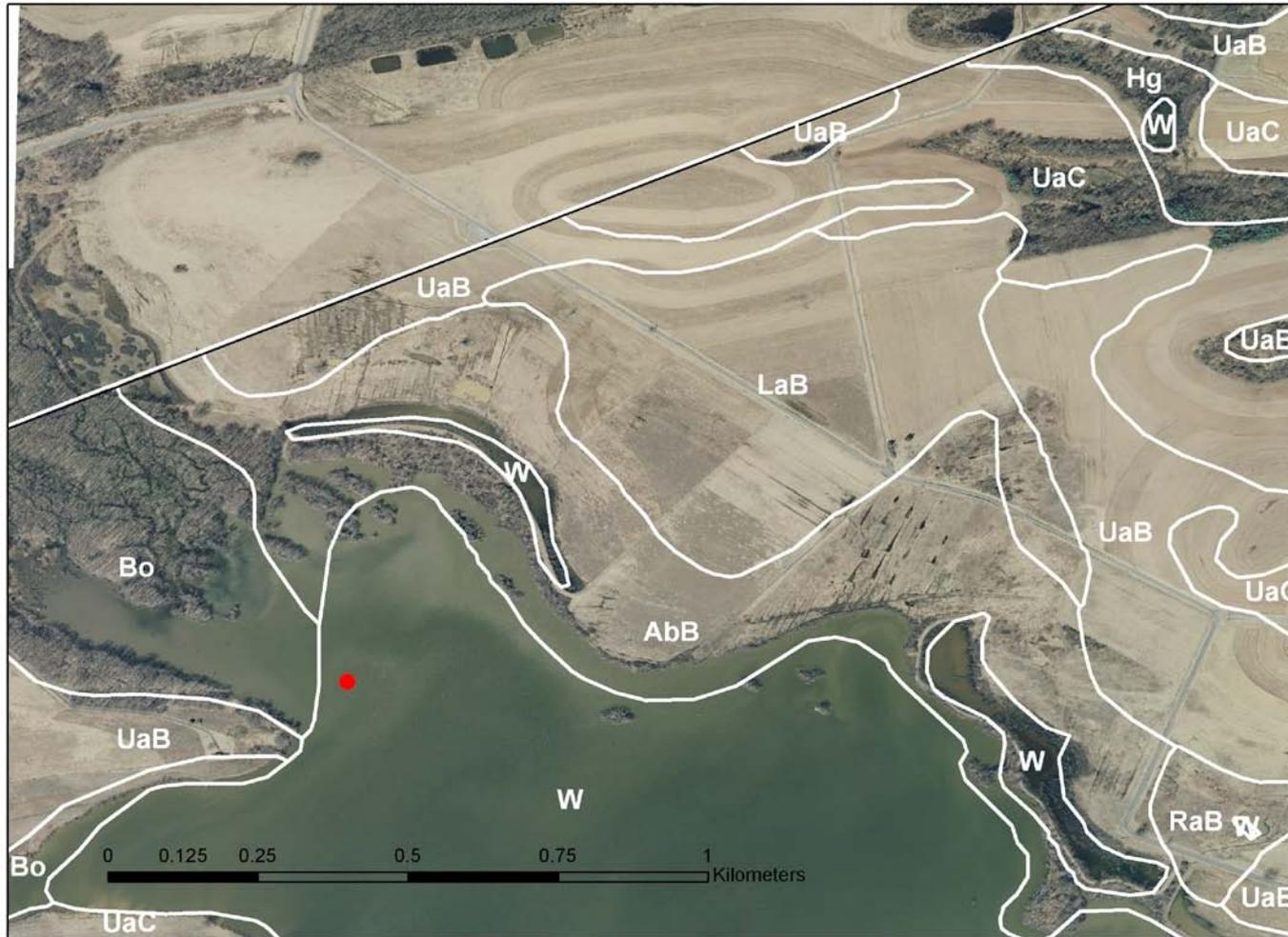


0 250 500 1,000 Kilometers

Site Selection

- ▶ 1 km² area centered on GRTS coordinate
- ▶ Select site "most representative" of soil and landscape characteristics
- ▶ Avoid sites
 - <200m from major highways
 - <50m from rural roads
 - <100 m from buildings
 - End rows of agricultural fields
 - Major industrial emitters – power plants, smelters

Site Selection



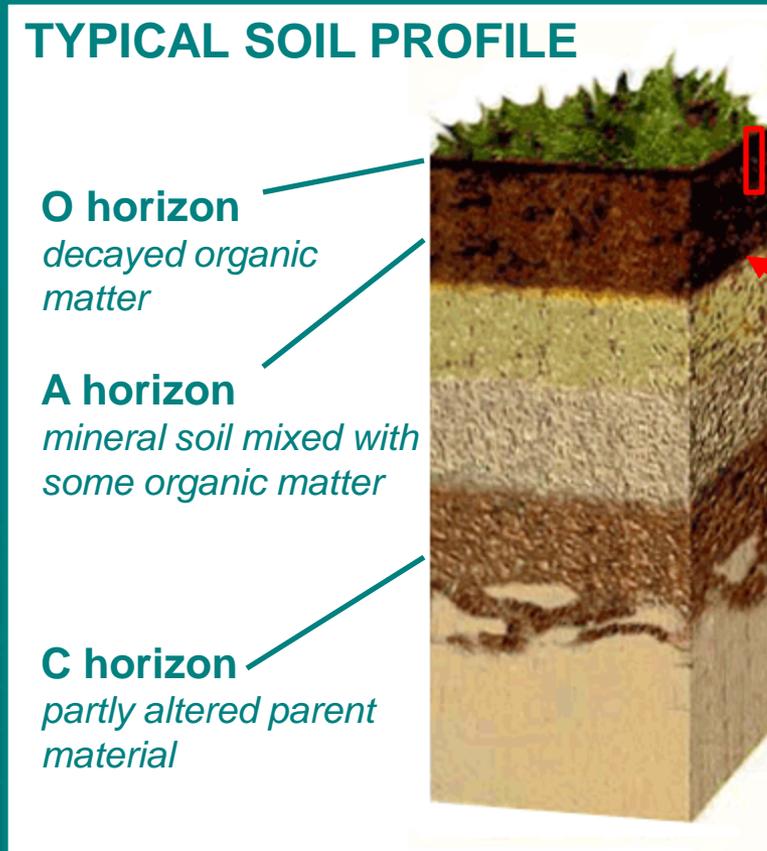
Sample Analysis

- Near-total extraction for ~44 major and trace elements (ICP-MS/ICP-AES/AA)
 - Pb, As, Hg, Se
- Total carbon, carbonate carbon (organic carbon by difference)
- *Bacillus anthracis* (anthrax) and other soil pathogens (EPA funding)
- Quantitative mineralogy by X-ray diffraction
- Phospholipid fatty acid (PLFA) analysis on 10% of samples

Microbiology

- ▶ Phospholipid fatty acids (PLFA)
 - Can be used to identify microbial/bacterial communities
 - indicator of environmental impact & stress – pollution, metals, temperature
- ▶ Soil Pathogens (Anthrax)
 - Determine areas of elevated risk to humans, livestock and wildlife

Samples collected from each site



1: 0 to 5 cm depth – regardless of horizon (1 – 2 kg + 1 fifty ml tube for soil pathogens)

2: A horizon (2 kg)

3: C horizon or closest approximation (1 – 2 kg)

Additional samples from every tenth site

TYPICAL SOIL PROFILE

O horizon

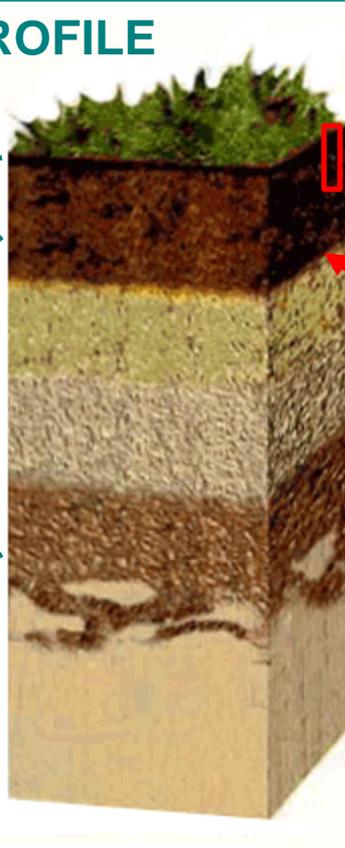
decayed organic matter

A horizon

mineral soil mixed with some organic matter

C horizon

partly altered parent material



- 1:** 0 to 5 cm depth – (1 centrifuge tube for PLFA analysis)
 - 2:** A horizon (1 centrifuge tube for PLFA analysis)
 - 3:** C horizon or closest approximation (1 centrifuge tube for PLFA analysis)
- *Must be kept cold from time of collection.**
- 4:** Soil density from A & C horizons

Pilot Studies

D.B. Smith et al./Applied Geochemistry 24 (2009) 1357–1368

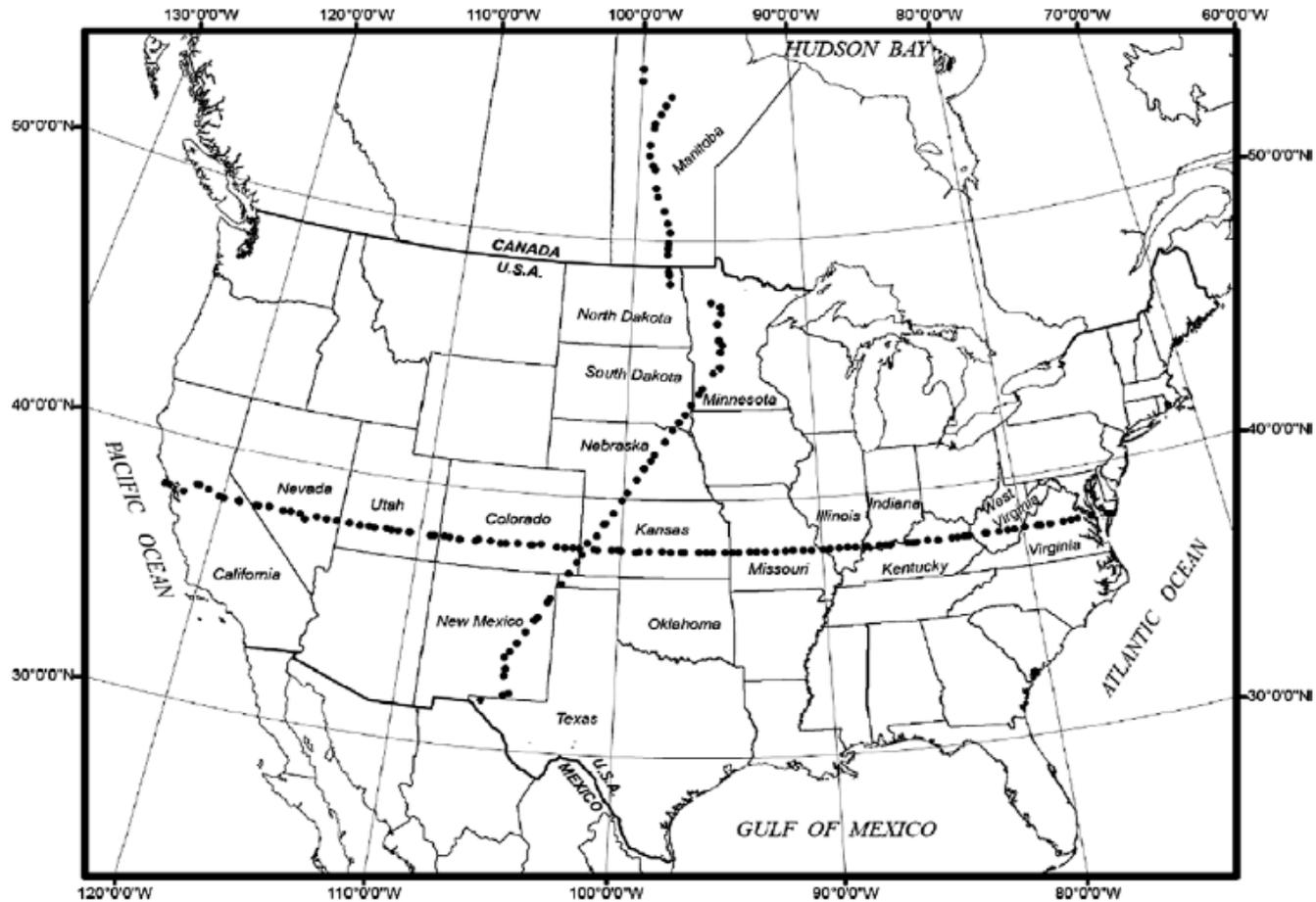
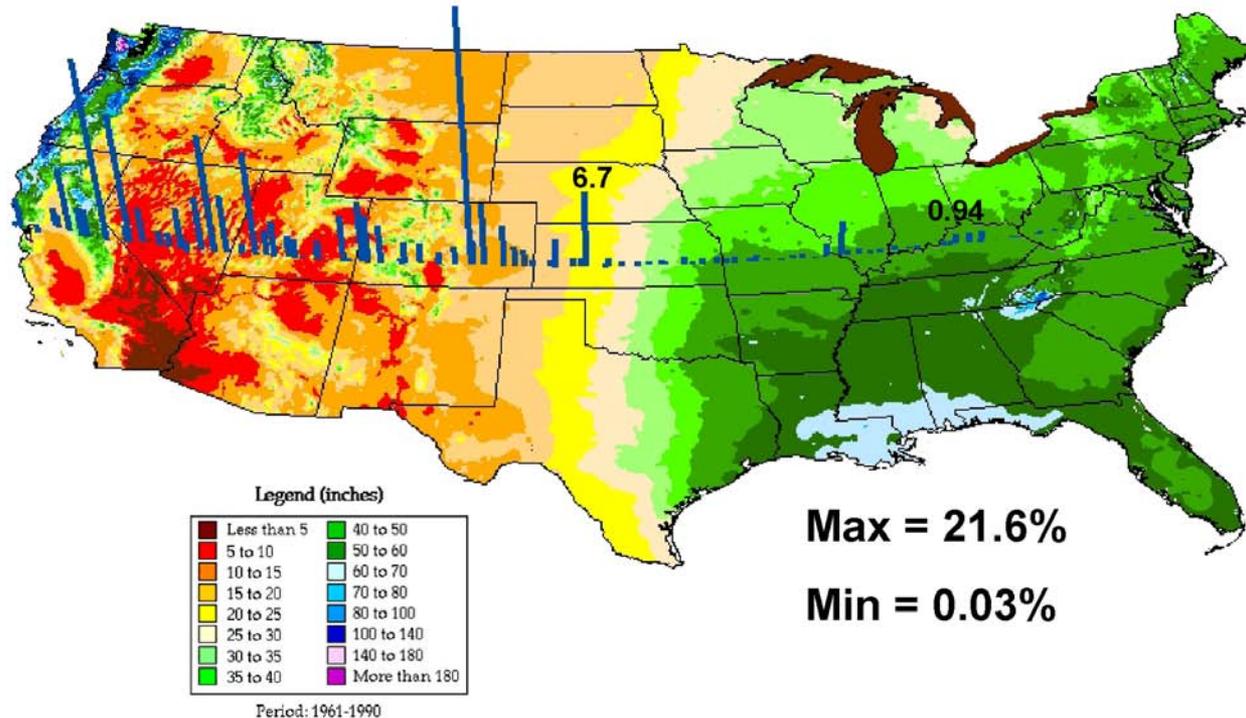


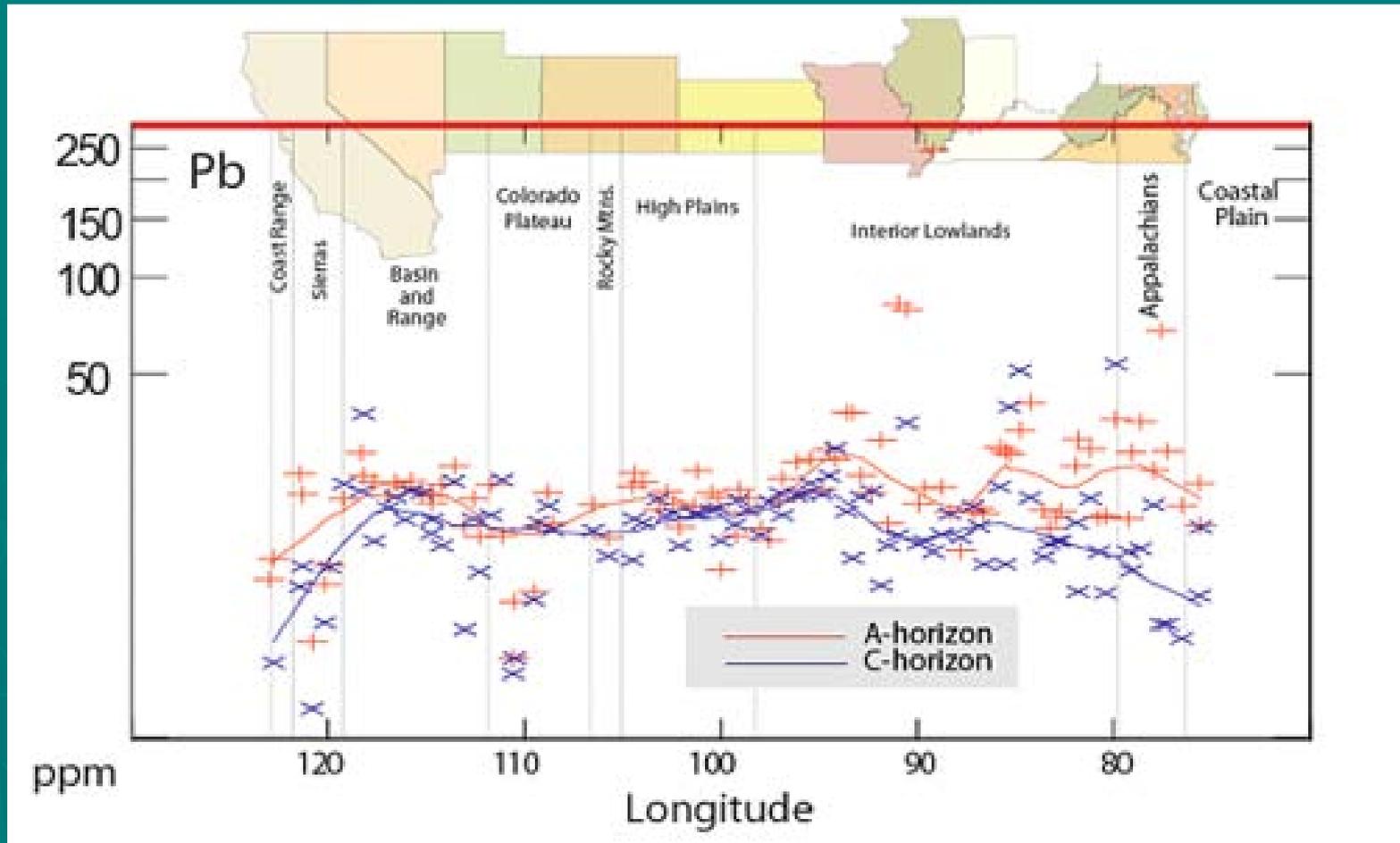
Fig. 3. Location of soil sampling sites along the two transects across Canada and the US.

Pilot Studies

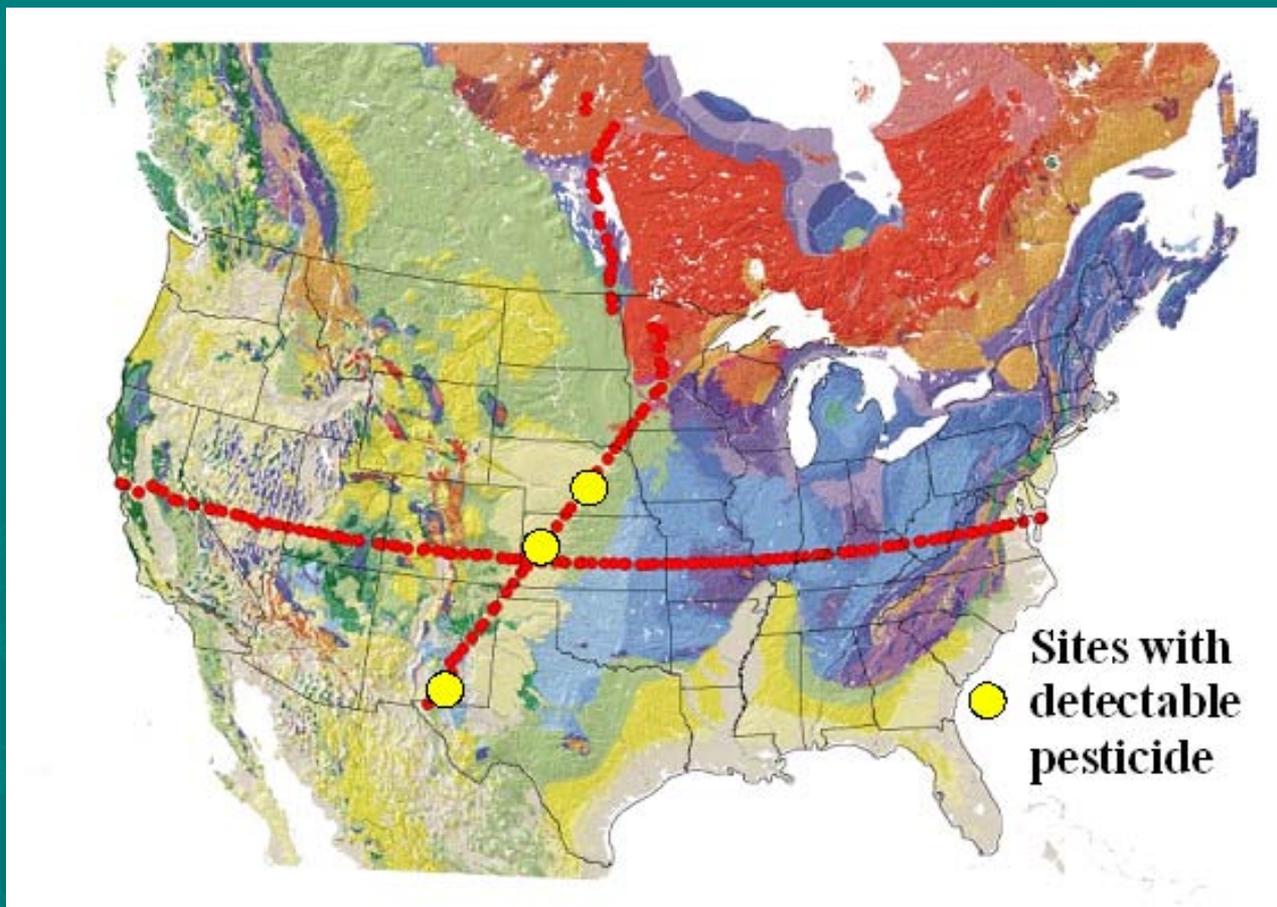
Calcium in A-horizon soils



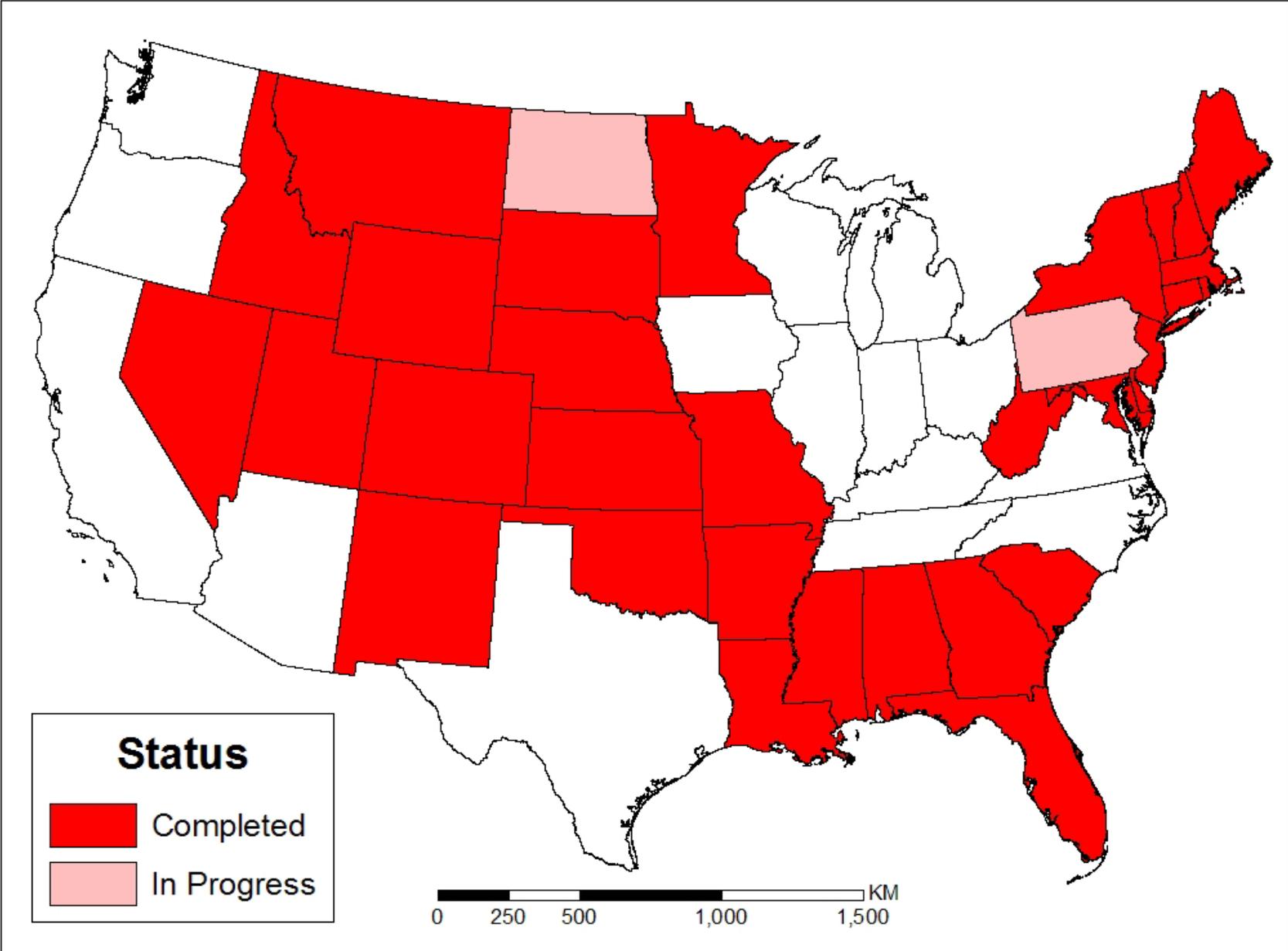
Pilot Studies



Pilot Studies



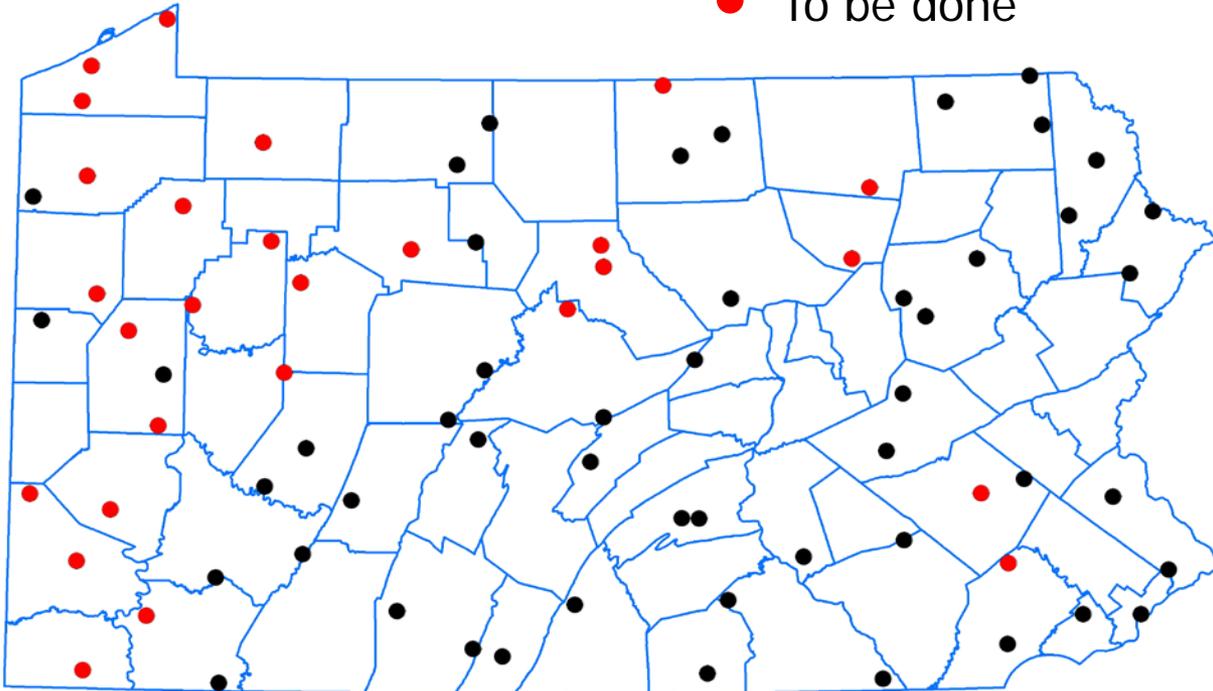
Organochlorine pesticides



Pennsylvania

● Completed

● To be done



References

- ▶ http://minerals.cr.usgs.gov/projects/geochemical_landscapes/index.html
- ▶ Applied Geochemistry 24 (2009)