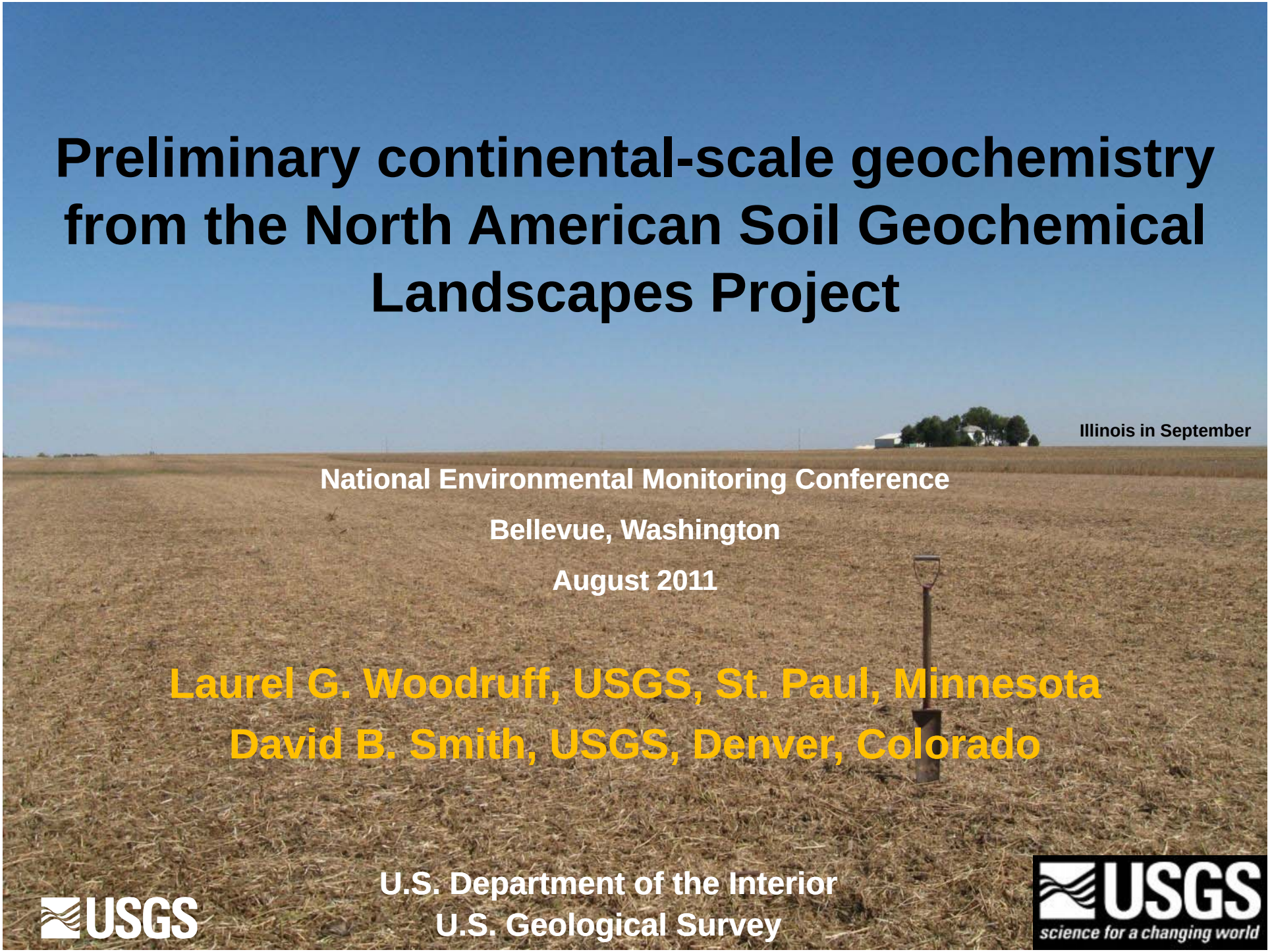
Preliminary continental-scale geochemistry from the North American Soil Geochemical Landscapes Project



Illinois in September

National Environmental Monitoring Conference

Bellevue, Washington

August 2011

Laurel G. Woodruff, USGS, St. Paul, Minnesota

David B. Smith, USGS, Denver, Colorado

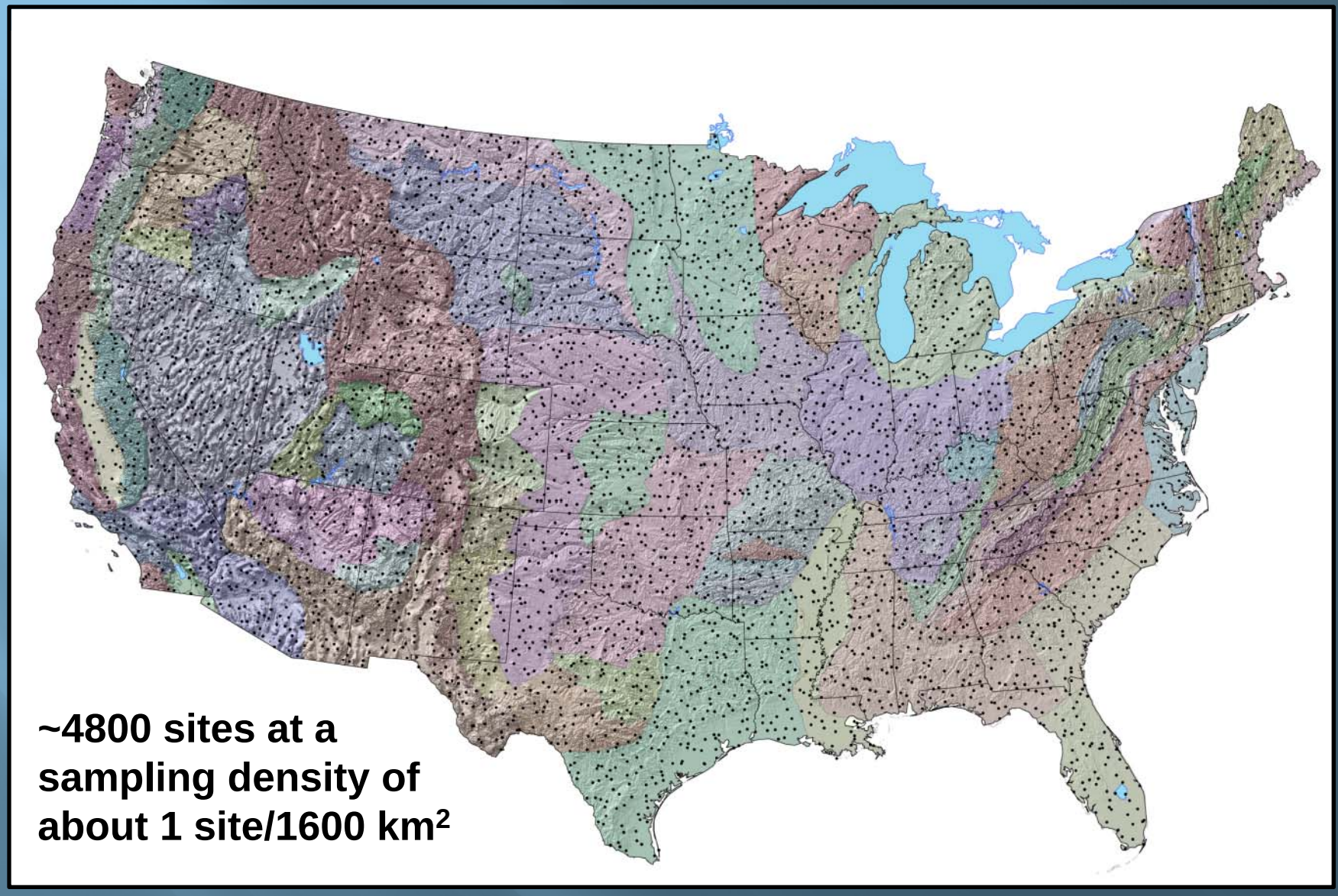
U.S. Department of the Interior

U.S. Geological Survey

USGS

USGS science for a changing world

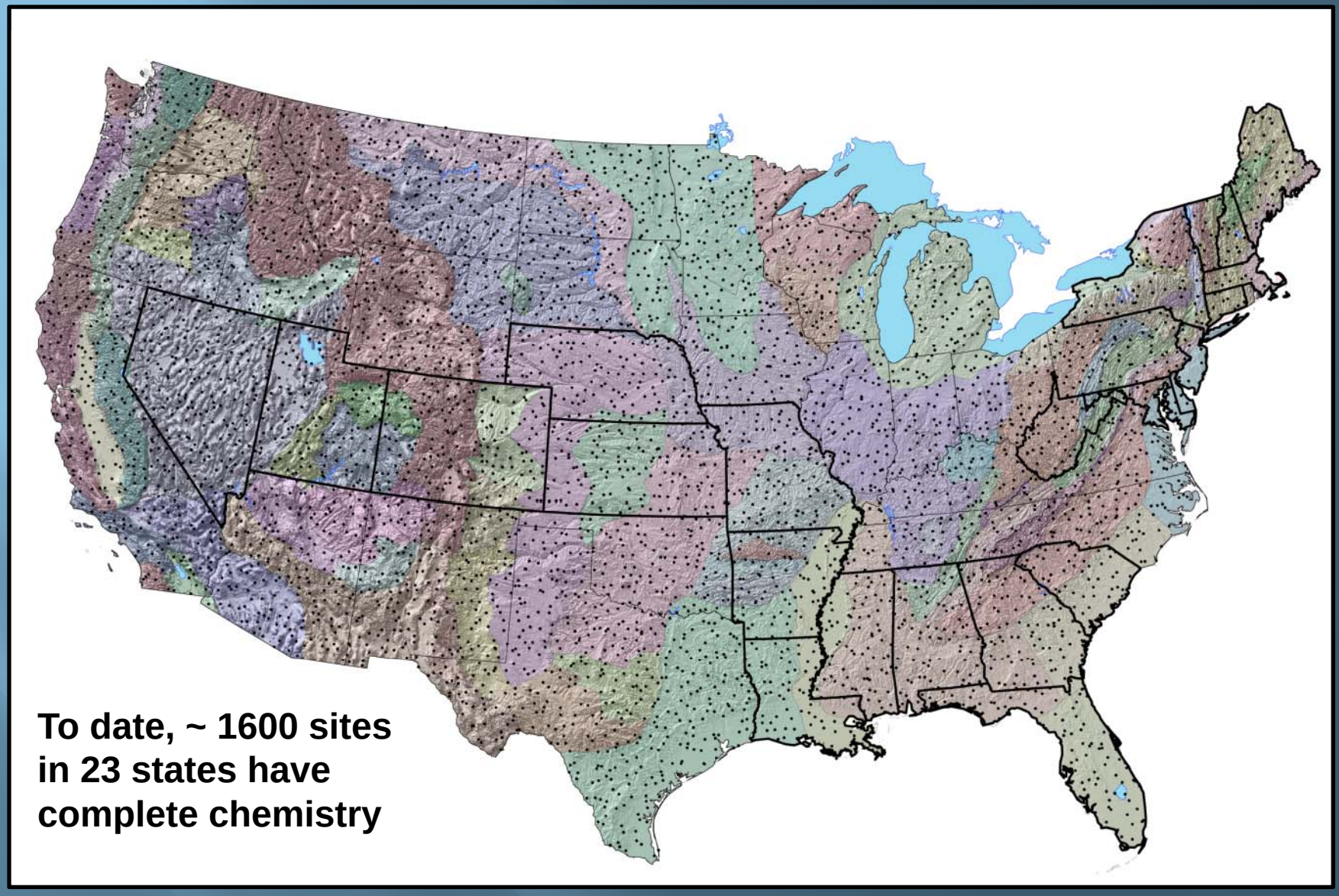
US Spatial Sample Sites



~4800 sites at a sampling density of about 1 site/1600 km^2

USGS

US Spatial Sample Sites



To date, ~ 1600 sites in 23 states have complete chemistry

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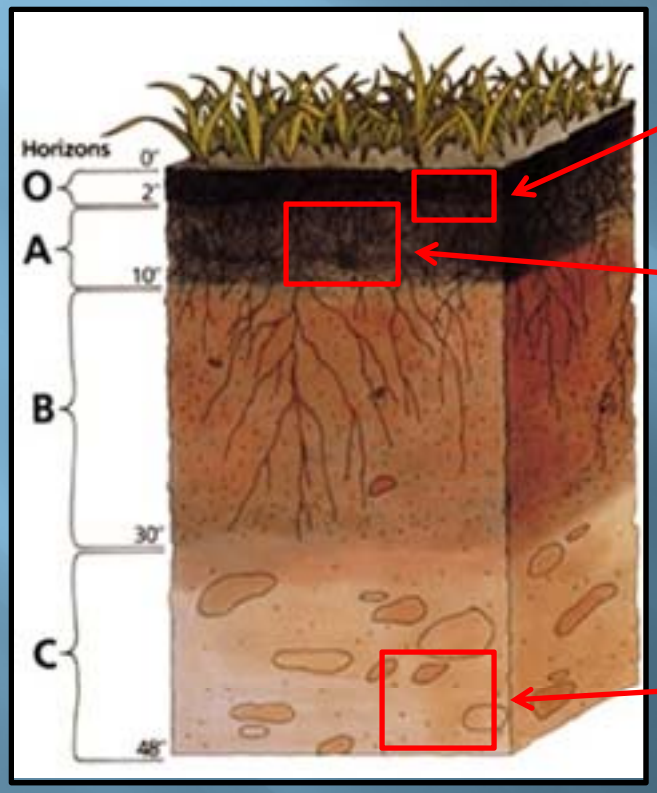
Three samples collected at each site



1. 0 to 5 cm depth, regardless of horizon
   1614 samples

2. Composite of A horizon
   1613 samples

3. Deeper subsoil ~ 1 m depth, B or C horizon
   1606 samples

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Sample analyses on < 2 mm fraction

- Near-total extraction for 42 major and trace elements (combined ICP-MS/ICP-AES)
- Mercury, Selenium and Arsenic by single element methods
- Total and Inorganic carbon (A and C horizons)
- Quantitative XRD mineralogy (A and C horizons)

Total of ~1600 sites x 3 samples x 46 elements = ~221,000 elements in geochemical data array, to date.

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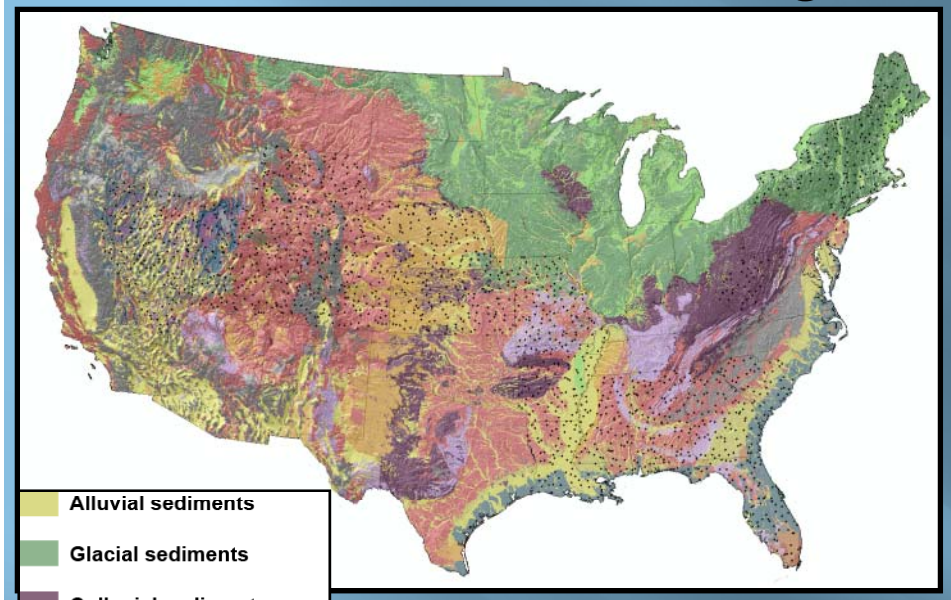
Major soil chemistry influences

- Parent material
  - Weathered bedrock of many types
  - Transported and sorted materials
    - Alluvium
    - Colluvium
    - Glacial deposits
    - Windblown deposits
- Time
  - Soils developed over millions to thousands of years
- Climate
  - Strong gradients of both temperature and precipitation
- Anthropogenic influences
  - Agriculture
  - Industrialization/Mining/Mineral Processing
  - Historic land use

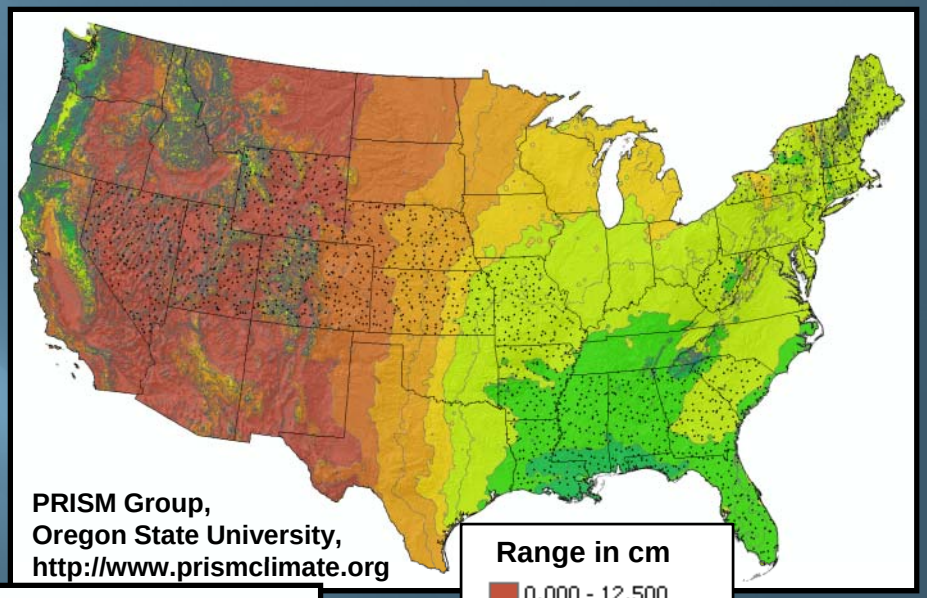
USGS

Parent Materials – Soil Age



- Alluvial sediments
- Glacial sediments
- Colluvial sediments
- Eolian sediments
- Residual materials developed in bedrock
- Residual materials in carbonate-rich bedrock
- Volcanic rocks

Climate – annual precipitation

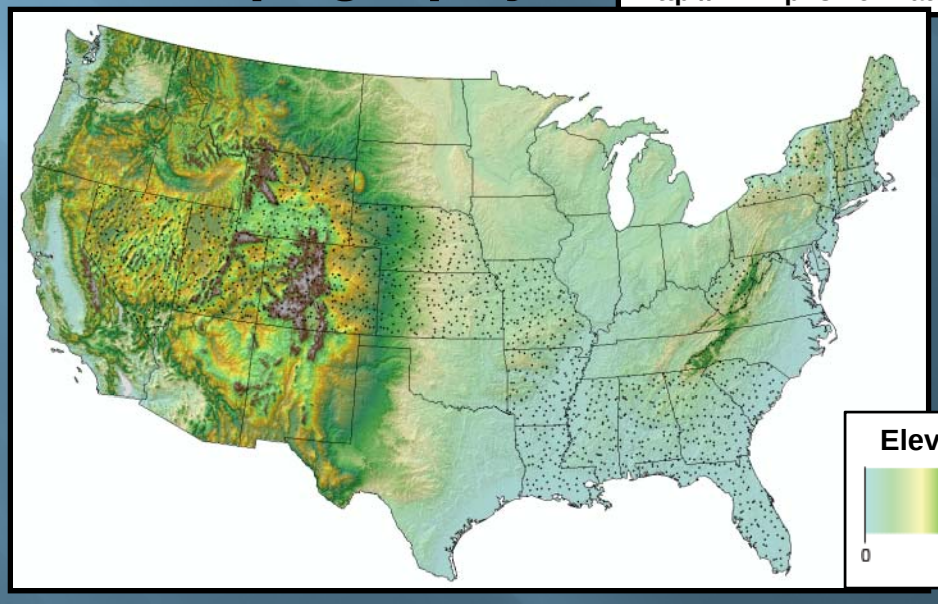


PRISM Group,
Oregon State University,
http://www.prismclimate.org

Range in cm

- 0.000 - 12.500
- 12.501 - 20.000
- 20.001 - 27.500
- 27.501 - 35.000
- 35.001 - 45.000
- 45.001 - 60.000
- 60.001 - 80.000
- 80.001 115.000
- 115.001 - 160.000
- 160.001 - 200.000

Topography



Elevation in meters

0 1000 2000 3000 4000

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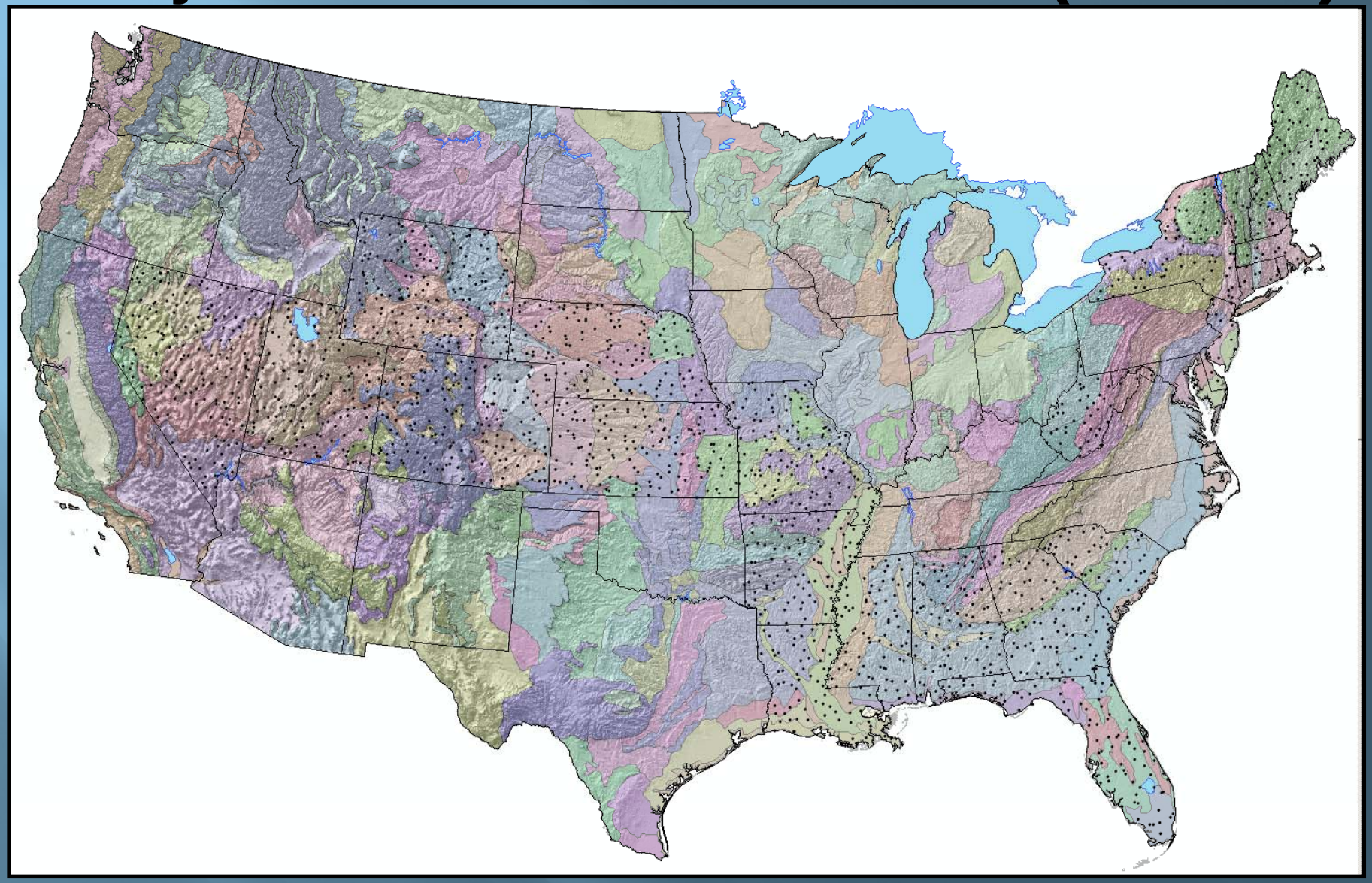
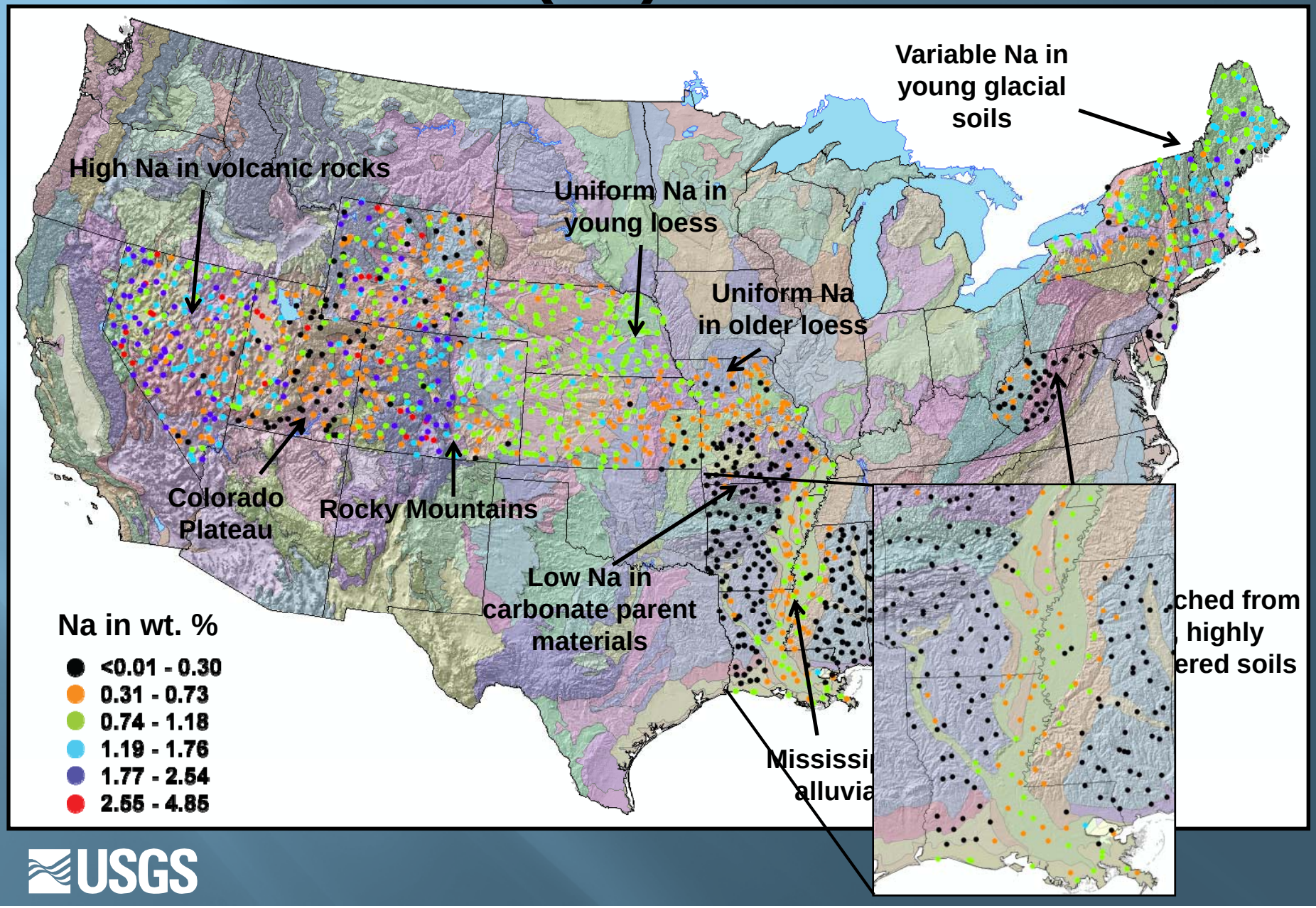
Major Land Resource Areas (MLRAs)



USGS

USDA, 2006, Handbook 296, Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin.

Sodium (Na) in C horizon



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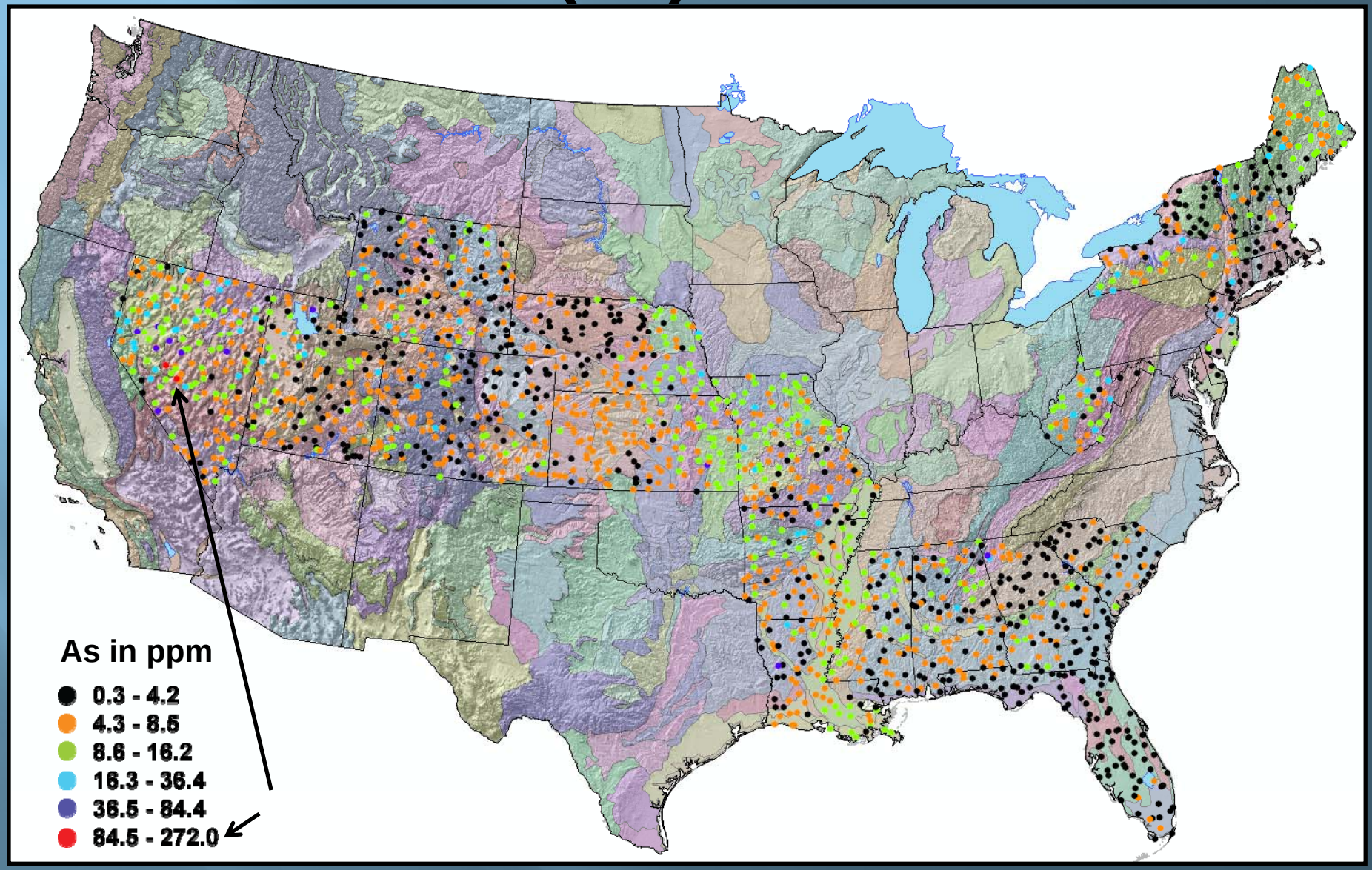
Arsenic (As) in C horizon



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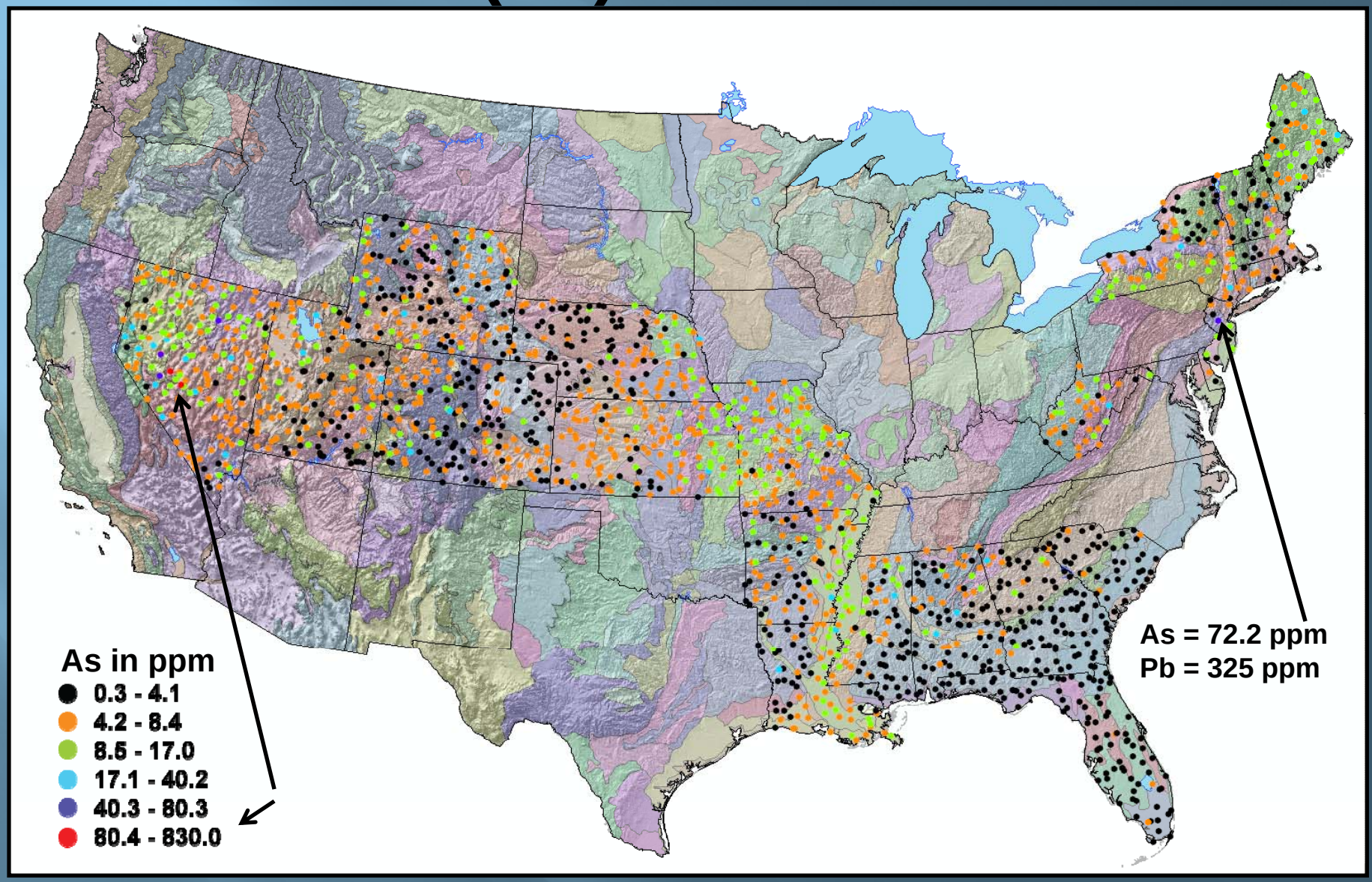
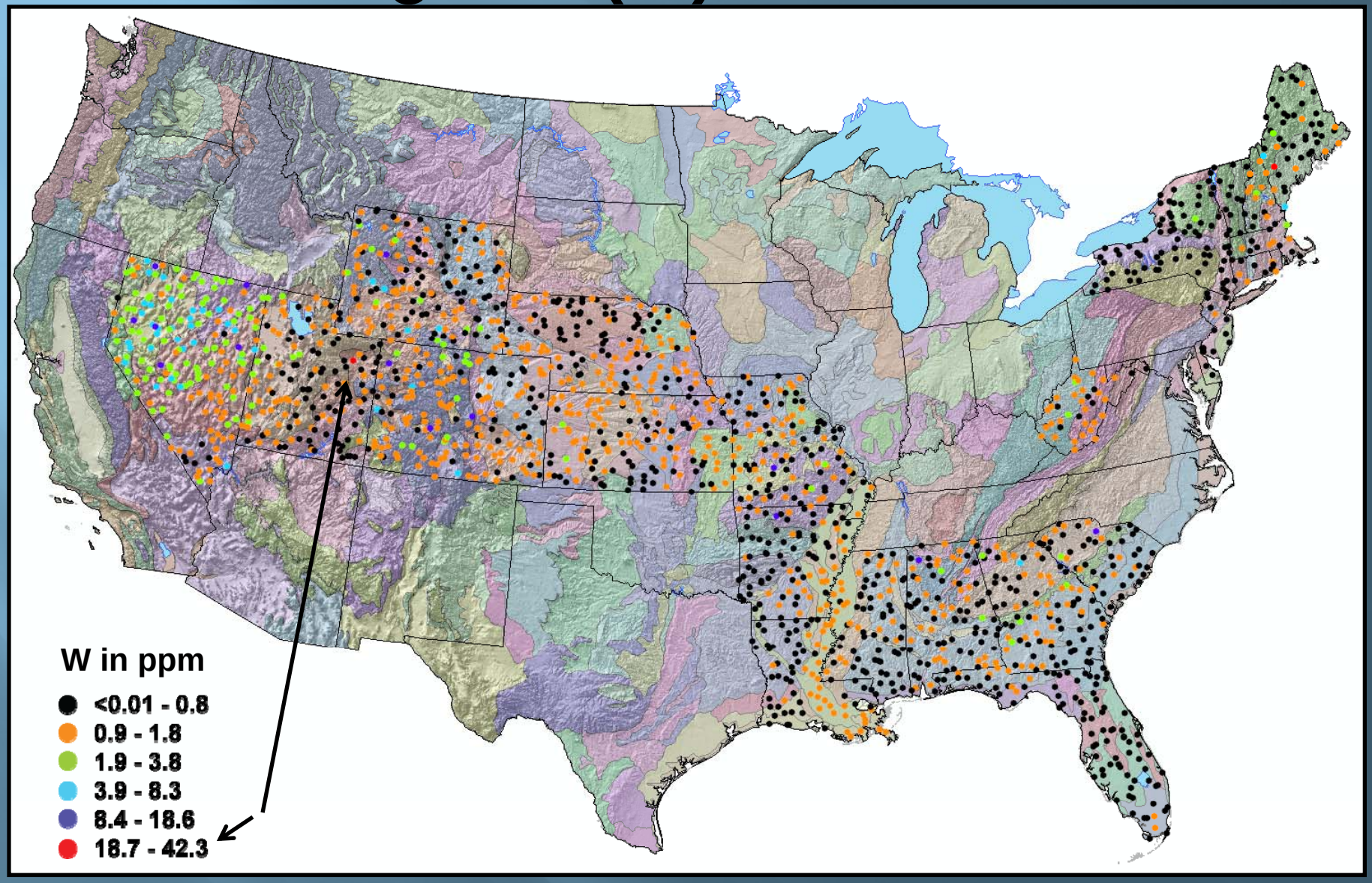
Arsenic (As) in 0 to 5 cm soils



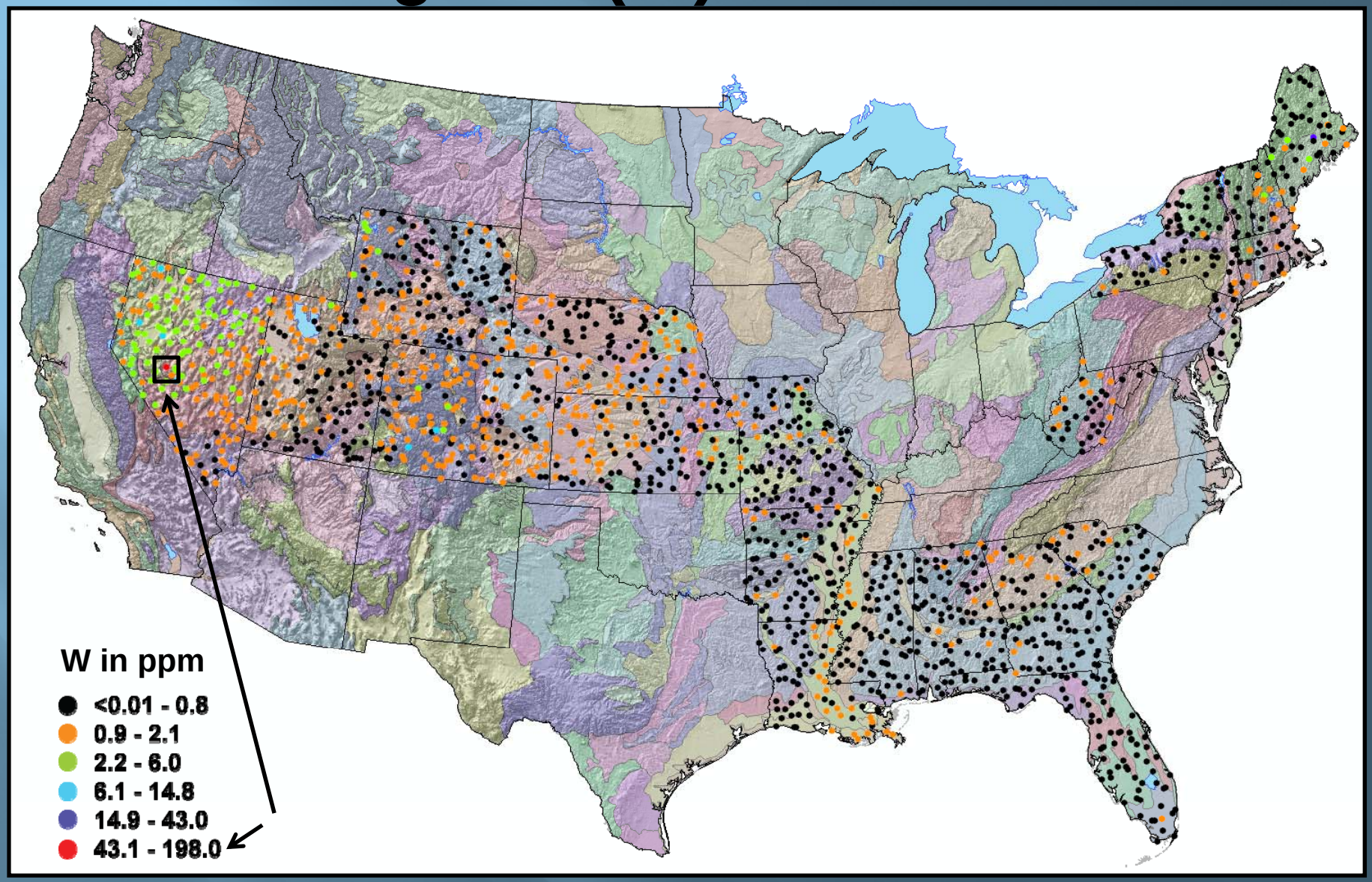
USGS

Tungsten (W) in C horizon



USGS

Tungsten (W) in A horizon



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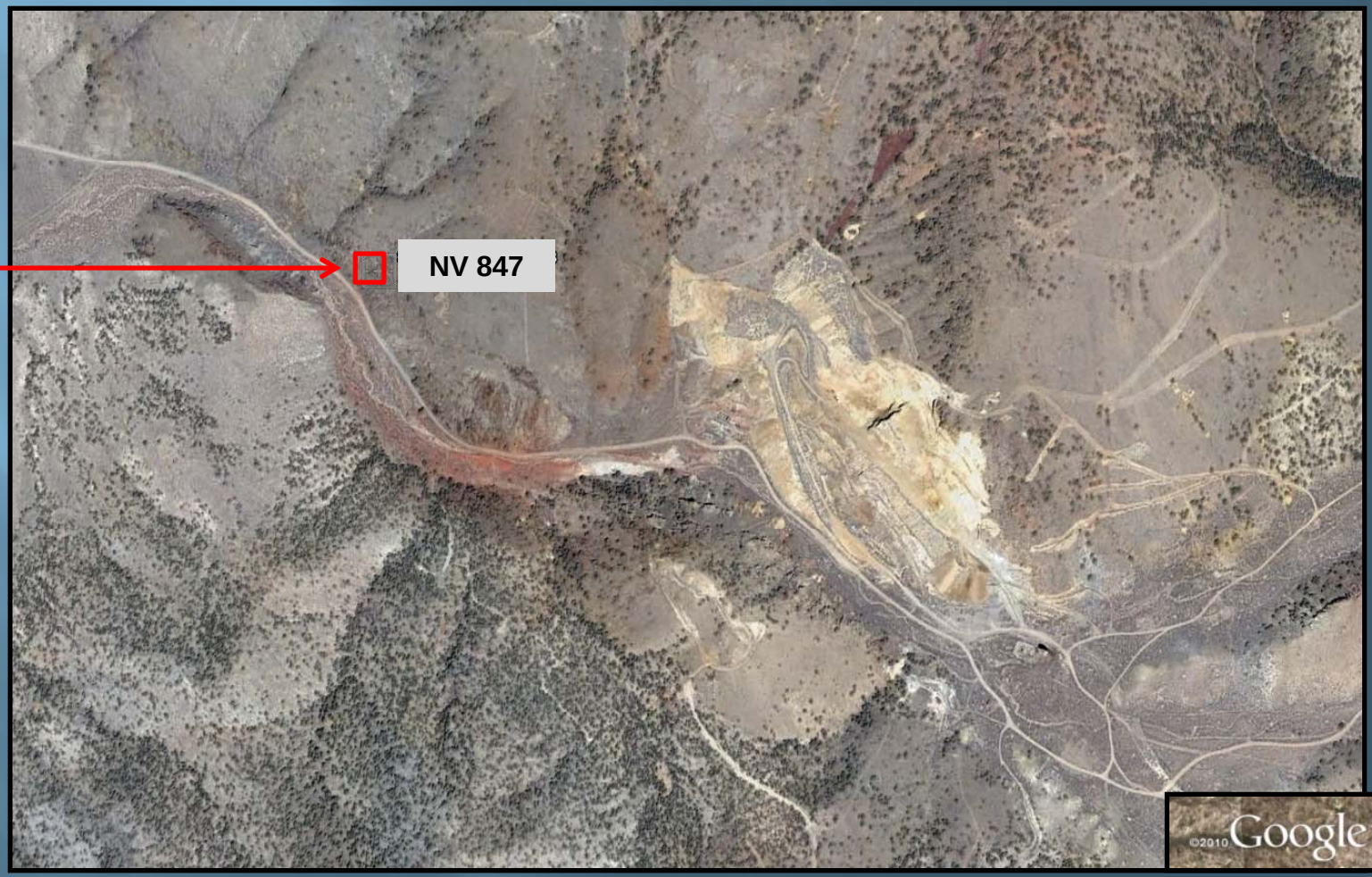
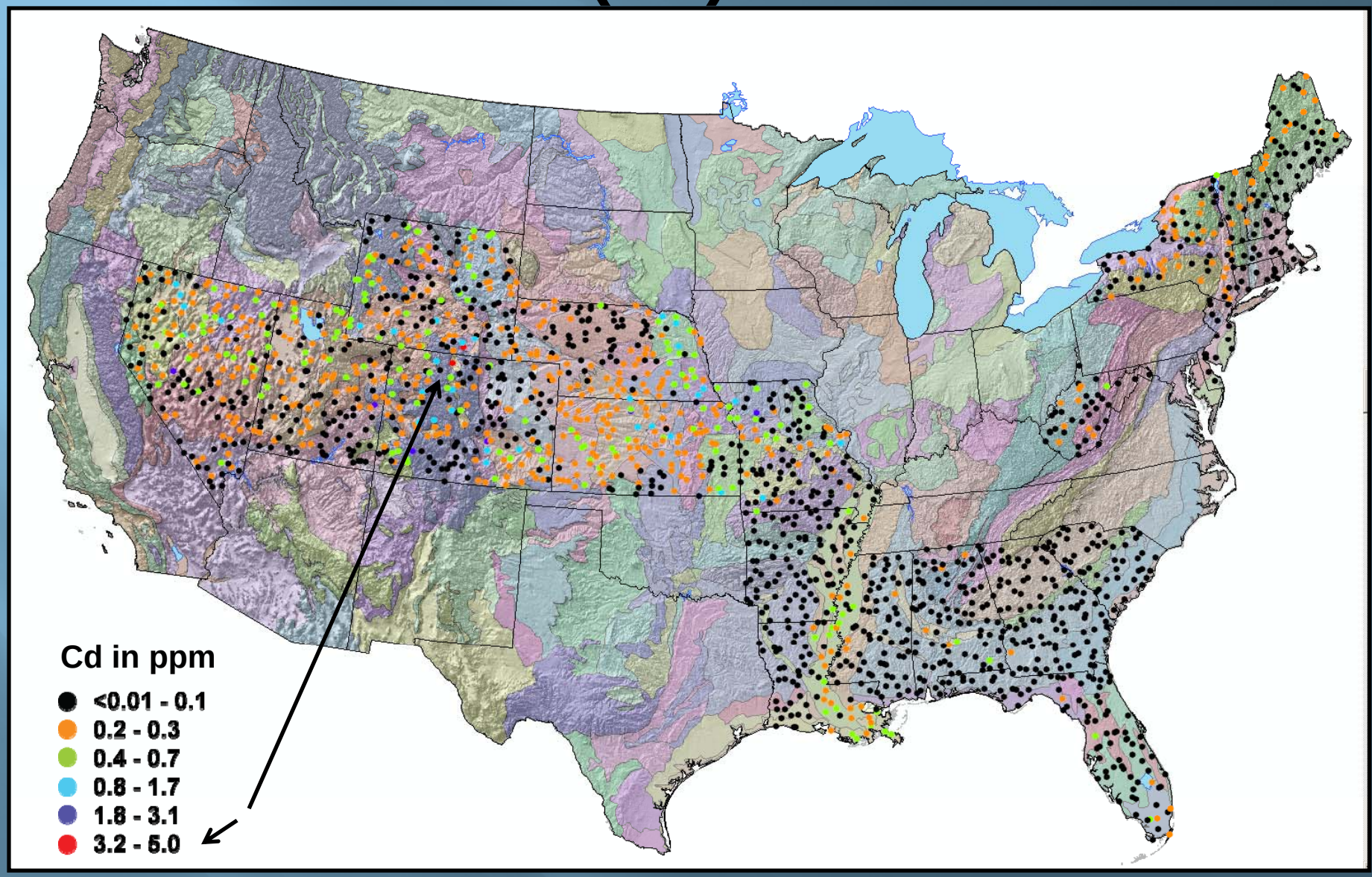
	As	Ag	Bi	Cu	Pb	Sb	Te	W	Zn
O-5 cm	417	>10	694	616	>10,000	73	50.5	1150	>10,000
A	195	>10	129	88	2200	33	10.0	198	2130
C	193	<1	5	35	80	28	<0.1	12	145



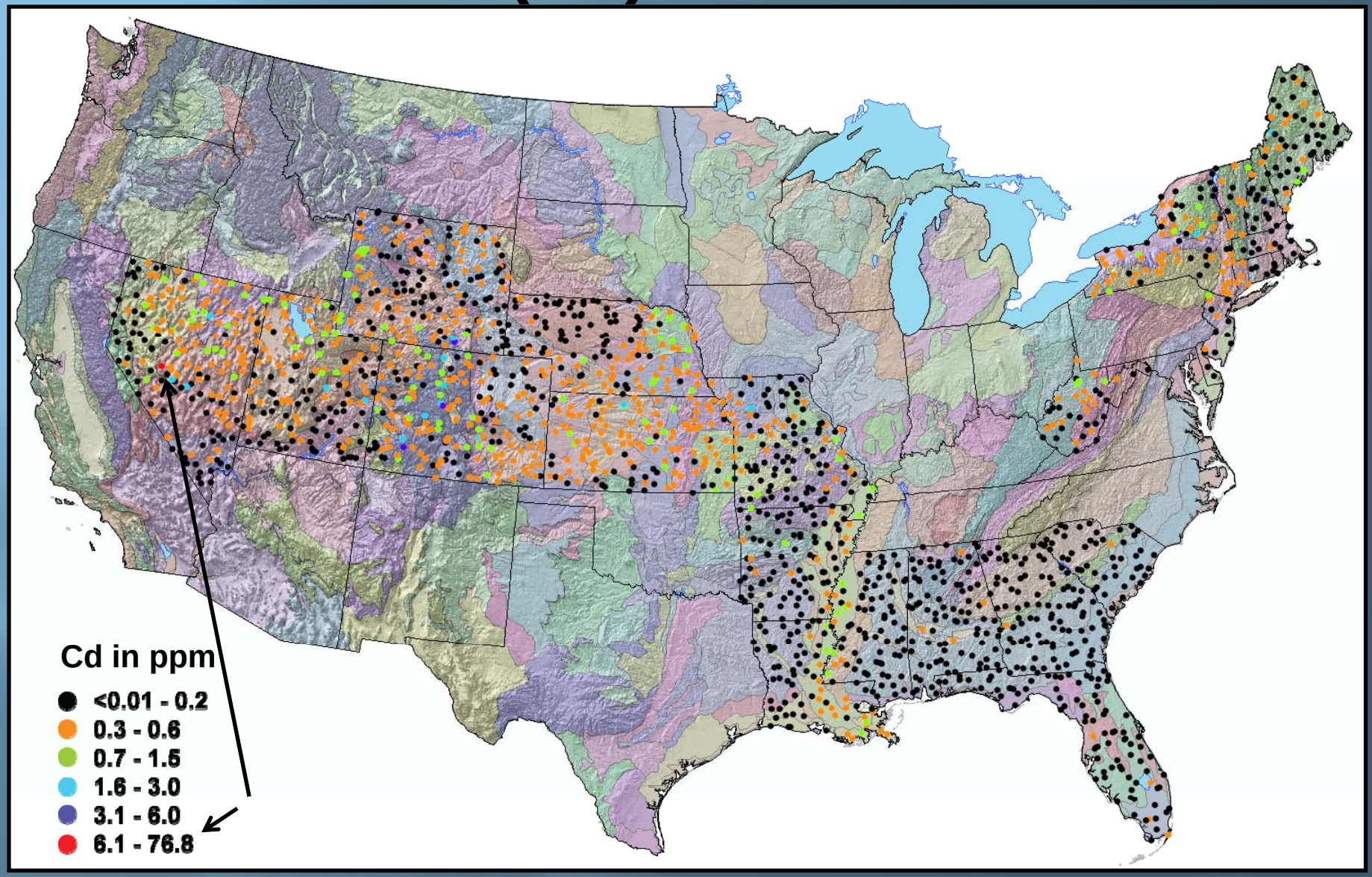
USGS

Cadmium (Cd) in C horizon



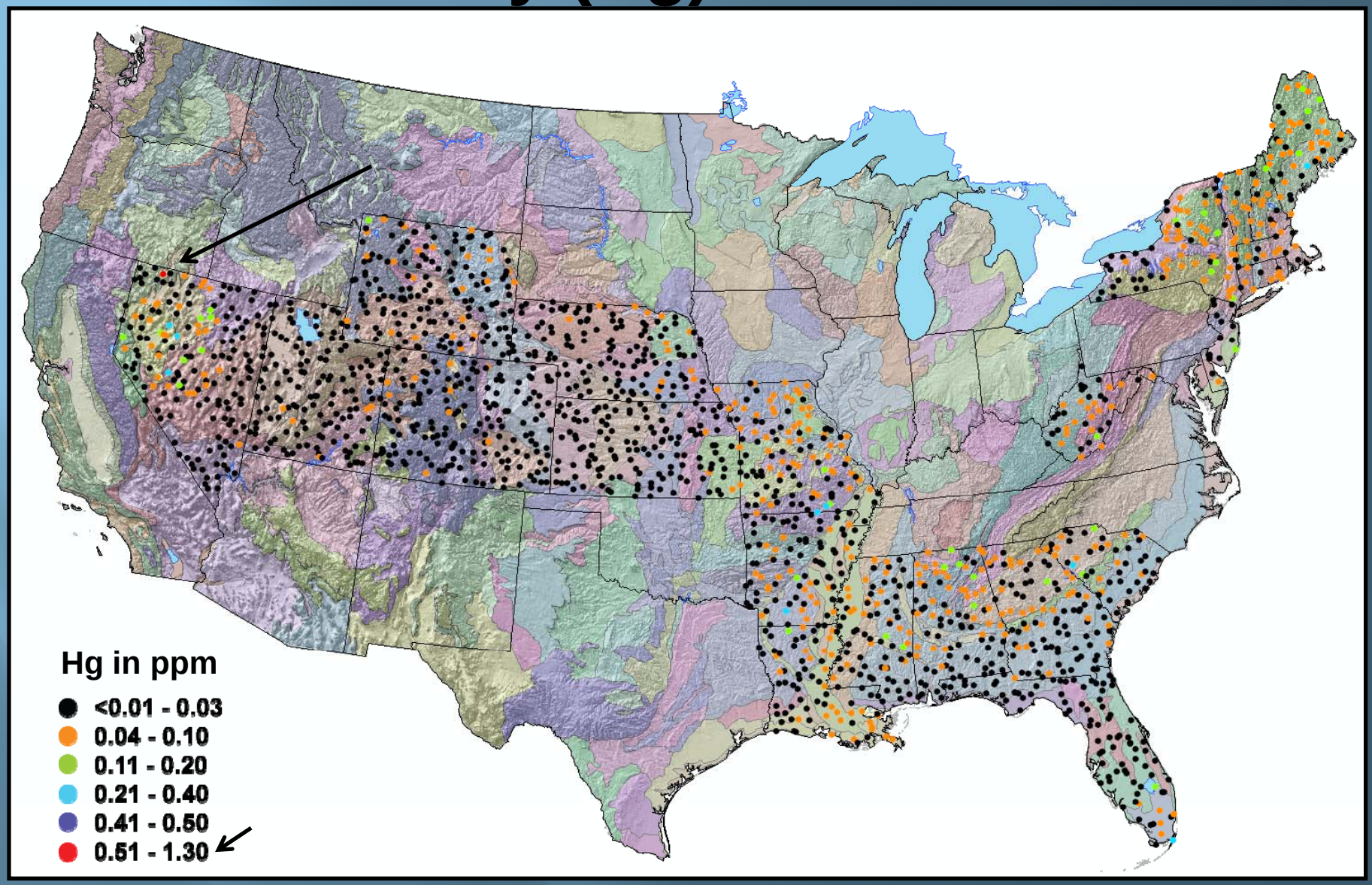
USGS

Cadmium (Cd) in 0 to 5 cm soils



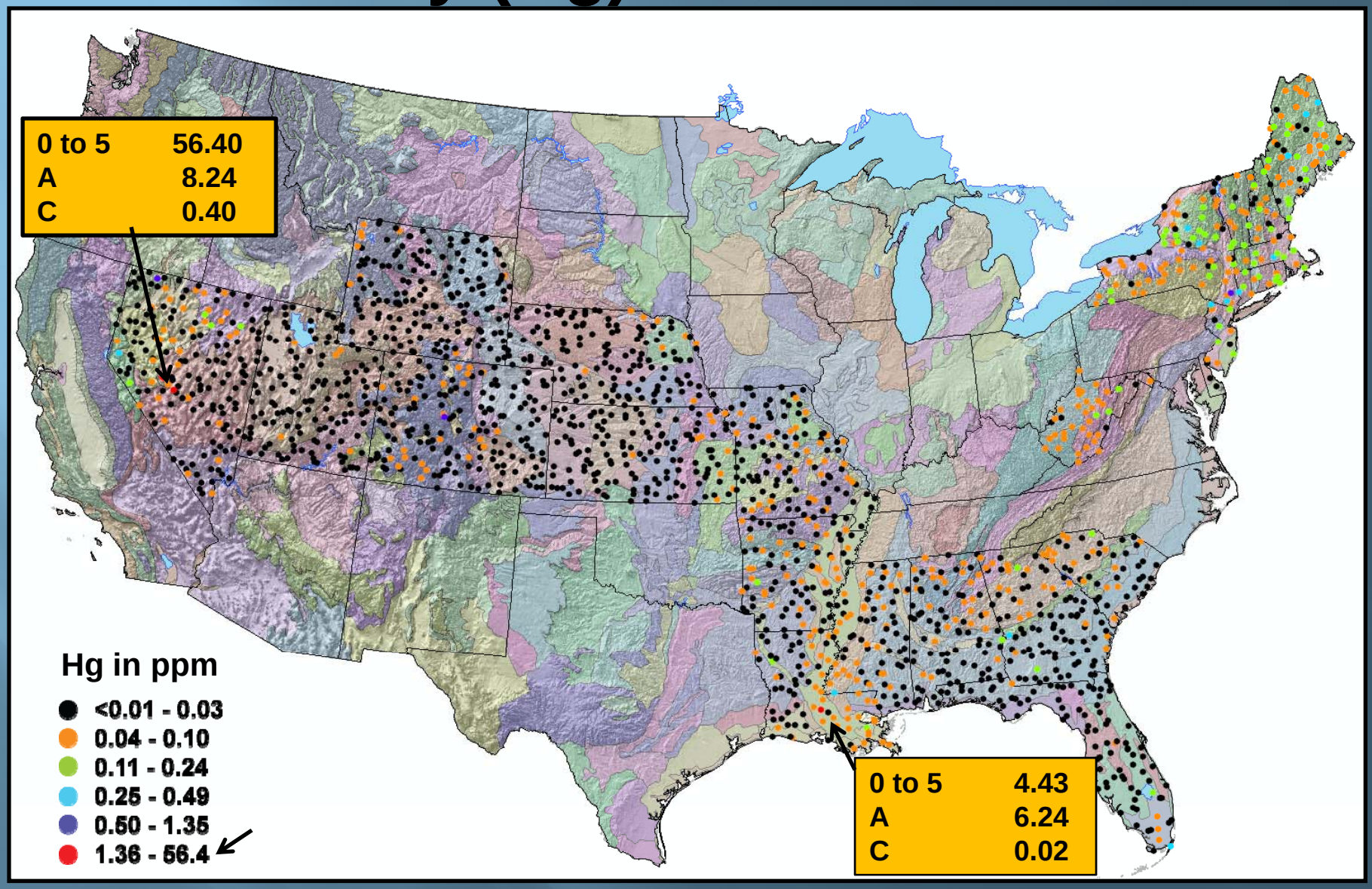
USGS

Mercury (Hg) in C horizon



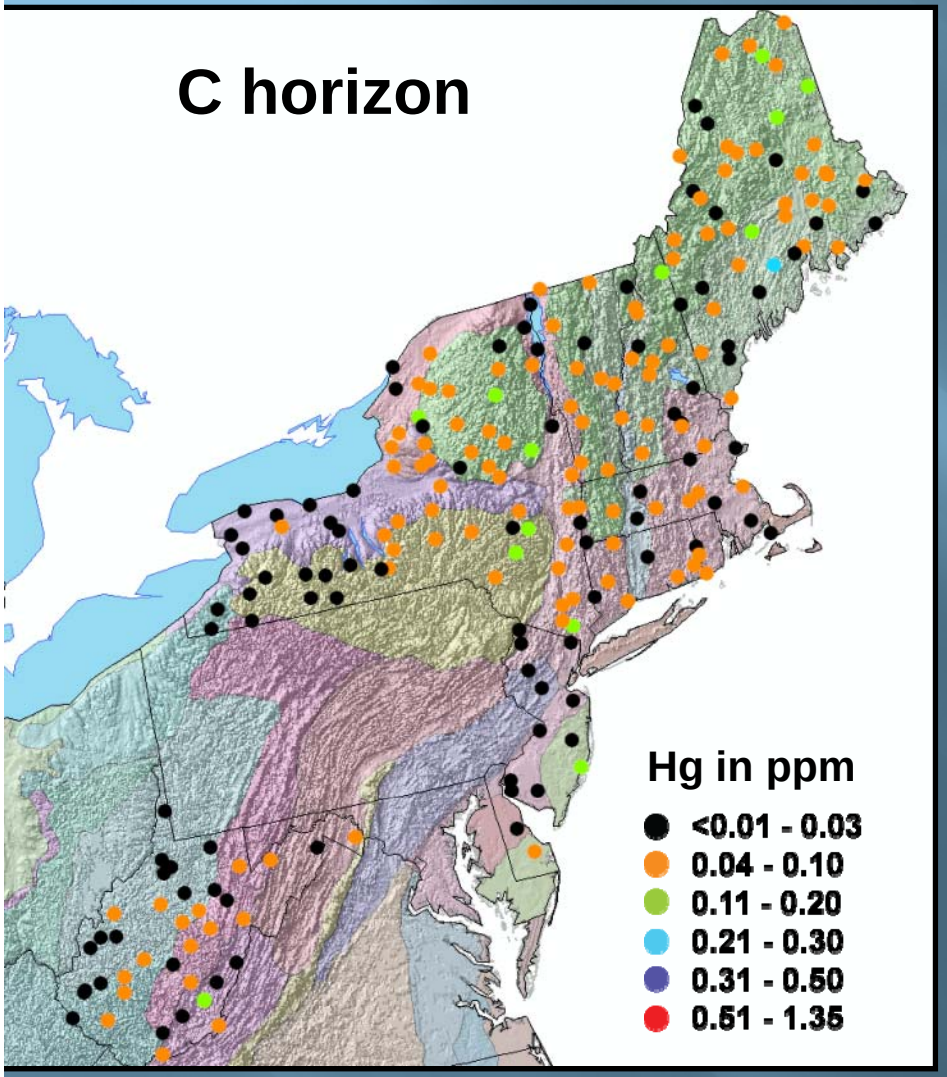
USGS

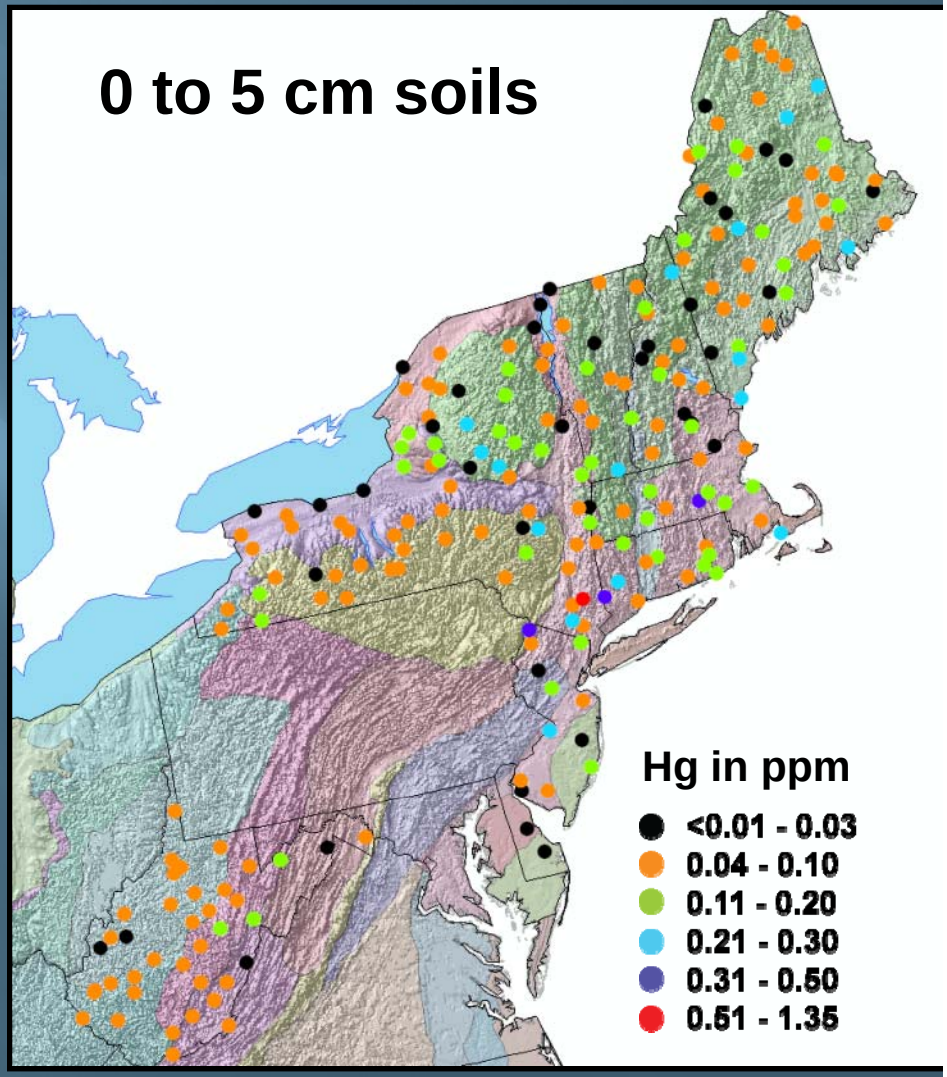
Mercury (Hg) in 0 to 5 cm soils



USGS

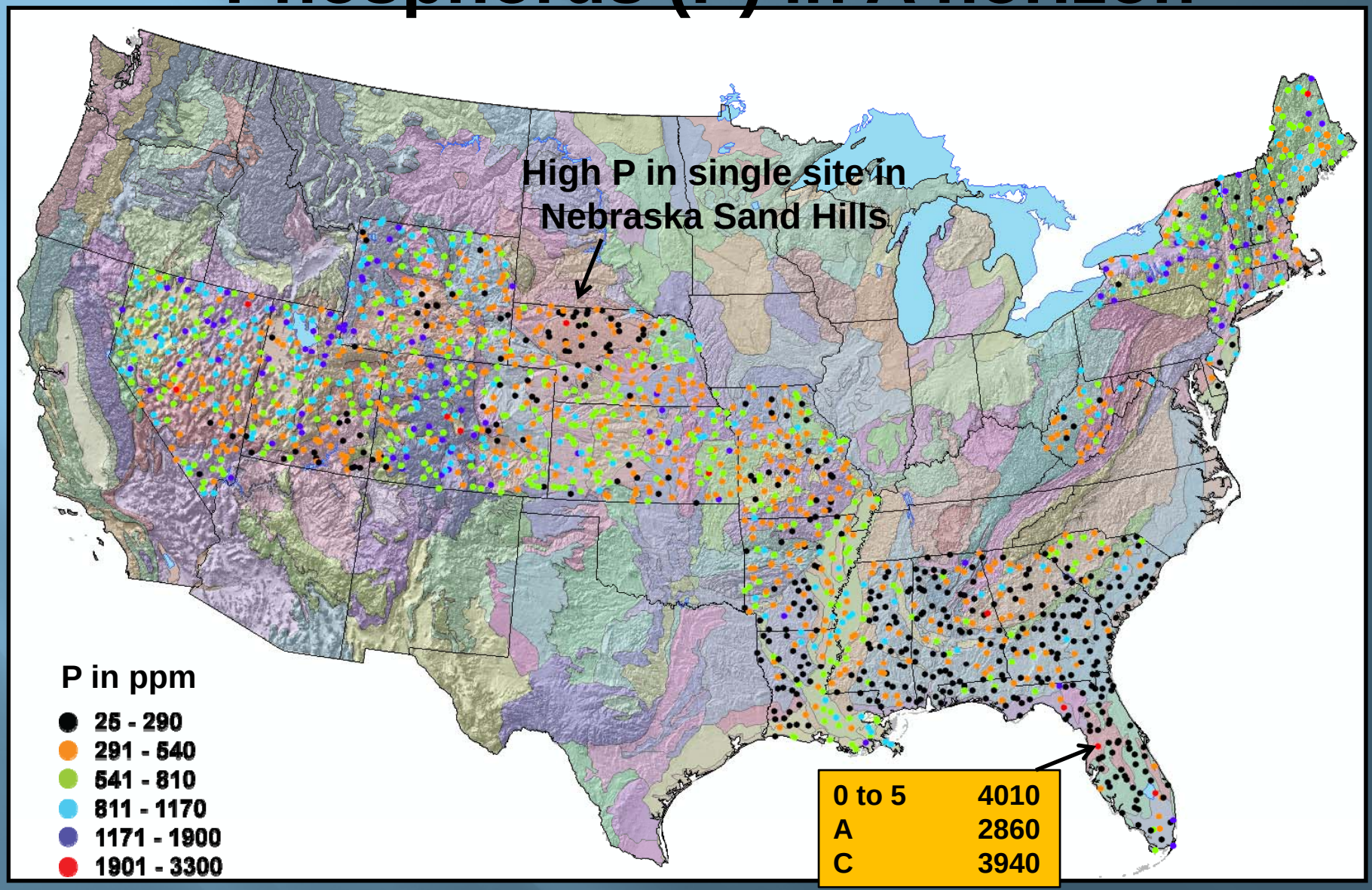
Mercury in NE topsoils and subsoils





USGS

Phosphorus (P) in A horizon



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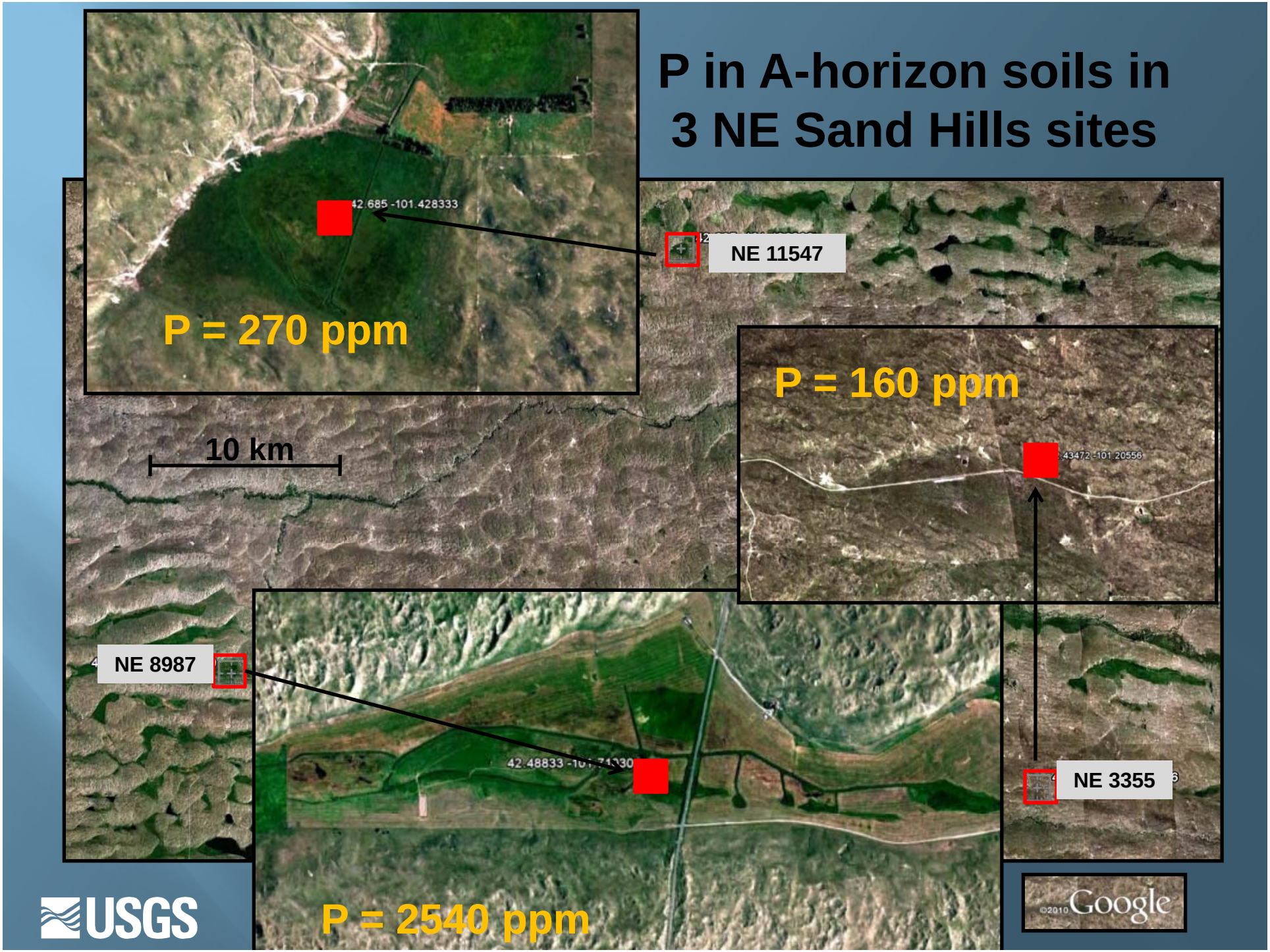
P in A-horizon soils in 3 NE Sand Hills sites
42.685 -101.428333
P = 270 ppm
NE 11547
P = 160 ppm
43472 -101.20556
10 km
NE 8987
42.48833 -101.71330
NE 3355
P = 2540 ppm
USGS
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Conclusions from Preliminary Spatial Sampling

- The geochemical data generated by the NASLGP are creating a robust database of soil geochemistry for the United States
- Low density (1 sample/~1600 km^2) sampling provides soil geochemical and mineralogical data that display coherent continental- and subcontinental-scale element patterns
- These patterns reflect profound differences in soil parent materials and hemisphere-wide climate effects, at times overprinted by human activity
- Spatial sampling at this scale and collecting multiple samples at varying soil depths at individual sites provide detailed information about the natural variability of elements in the environment and possible human impacts

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