Survey of the Mercury Content of Earthworms on the South River Virginia Floodplain

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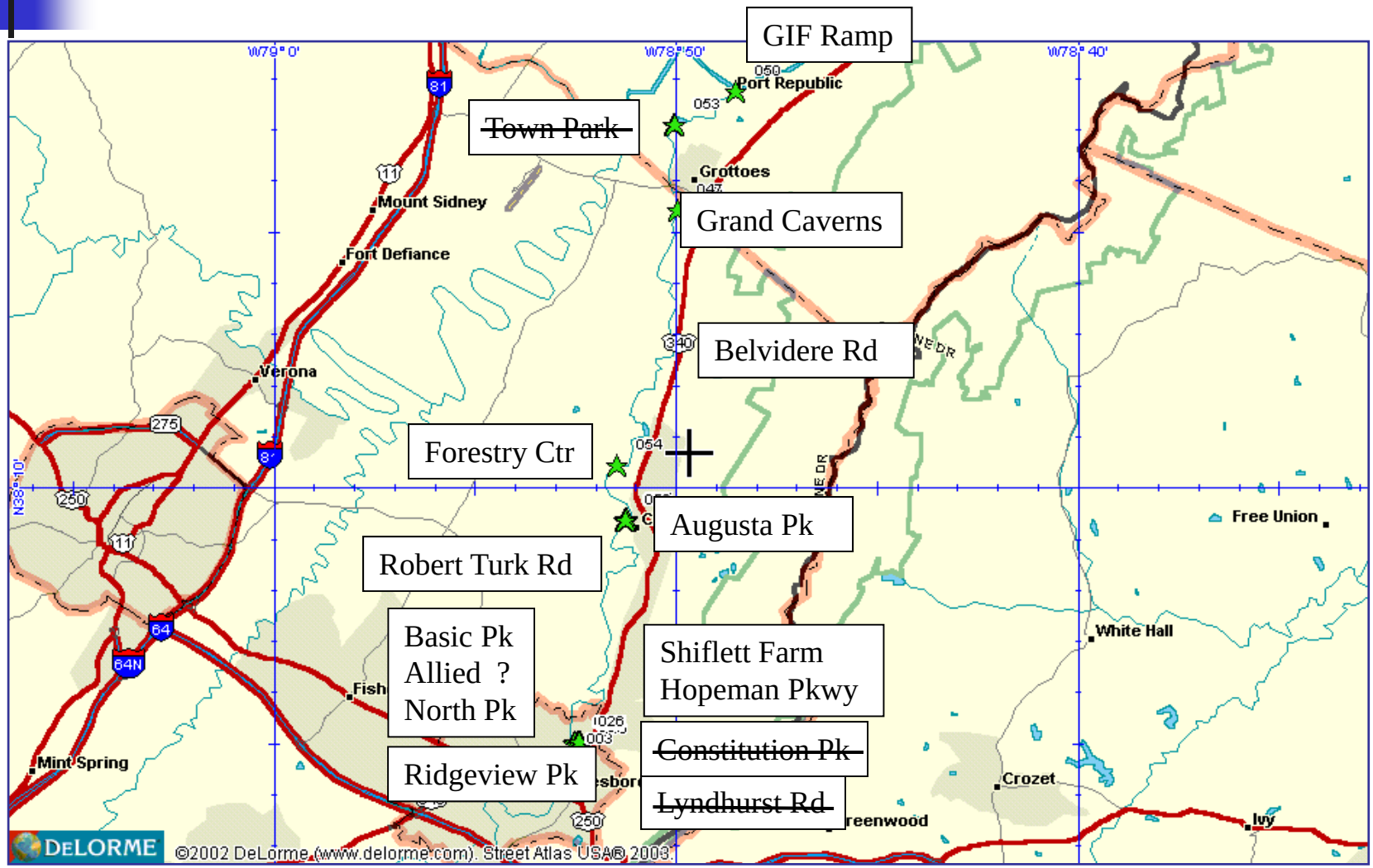
Objectives of Study

- Contribute to the development of an understanding of potential food web interactions using earthworms, which are an example of a lower tropic level organism in terrestrial ecosystems.
- Conduct a survey of Hg concentrations in earthworms to understand the extent to which mercury bioaccumulates in earthworms.
- Evaluate the relationship between total Hg and MeHg concentrations in earthworm and paired soil samples.

Floodplain Soil Sample Locations

Twelve sites remain as potential sampling locations.



Sample collection procedure

- Five earthworm and soil samples from a 10x10m grid at each site
  - Randomly select five 1 x 1m quadrats within grid for earthworms and soil samples.
  - Excavate each quadrat to collect minimum of 30 individual earthworms.
  - Soil sample excavated from each quadrat analyzed for Hg.
- Site composite soil sample for characterization.

Earthworm and Soil samples at each Site

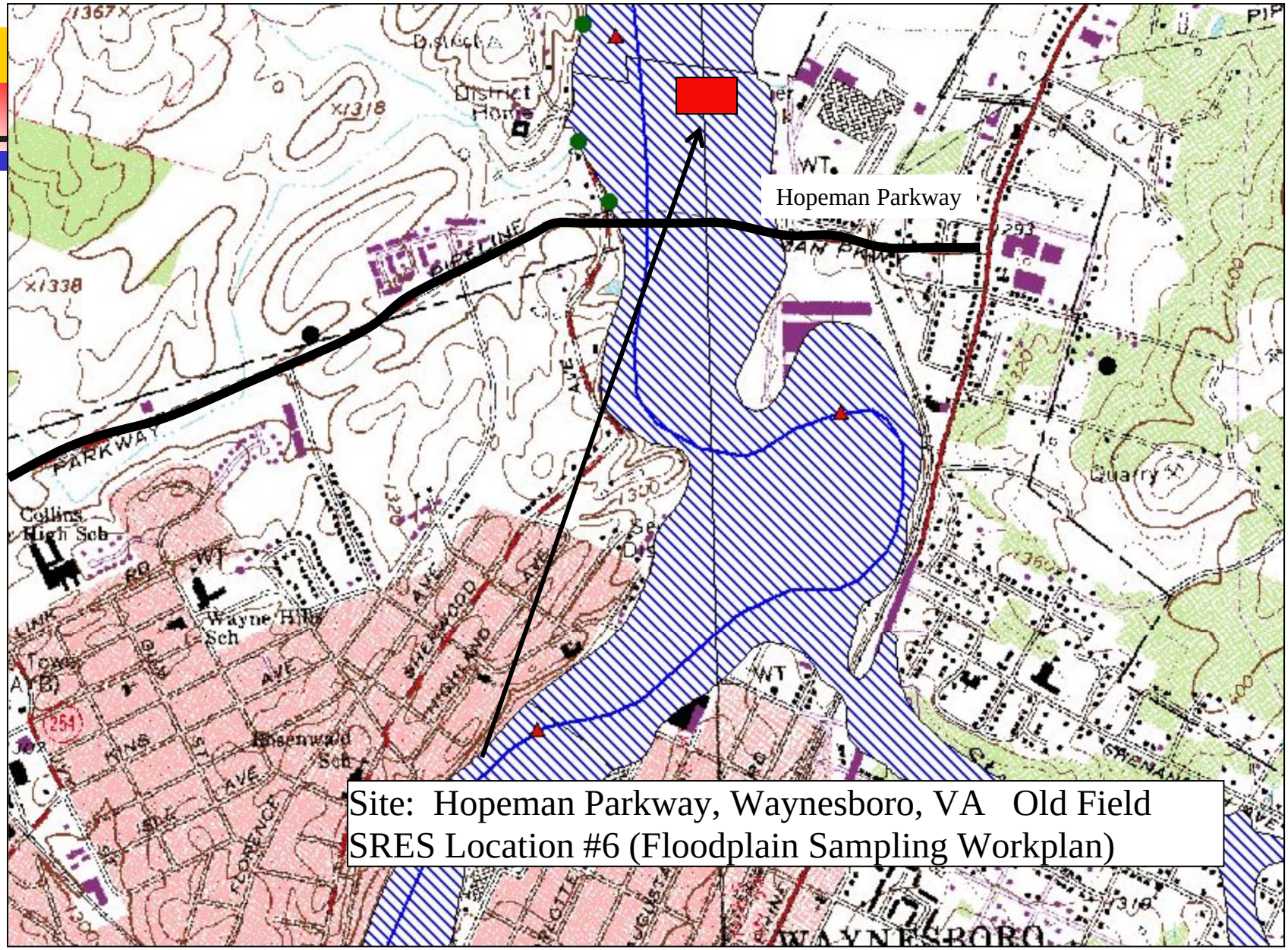
Quadrat No.	Earthworms				Soil			
	Total Hg		MeHg					
	Un-deparated†	De-parated	Un-deparated†	De-parated†	Total Hg	MeHg†	XAS‡	Soil test§
1	1	1	1	1	1	1		0.2
2		1			1			0.2
3	1	1	1	1	1	1		0.2
4		1			1			0.2
5	1	1	1	1	1	1		0.2
Total samples/location	3	5	3	3	5	3	?	1

† Specific quadrat samples for analysis will be randomly selected.
‡ X-ray Absorption Spectroscopy on selected soils.
§ A composite sample with soil from the quadrats.

Test of Earthworm Collection and Depuration Procedure

Date of collection: April 24, 2006

Field Collector: Andy Carnahan


Hopeman Parkway
Site: Hopeman Parkway, Waynesboro, VA Old Field
SRES Location #6 (Floodplain Sampling Workplan)

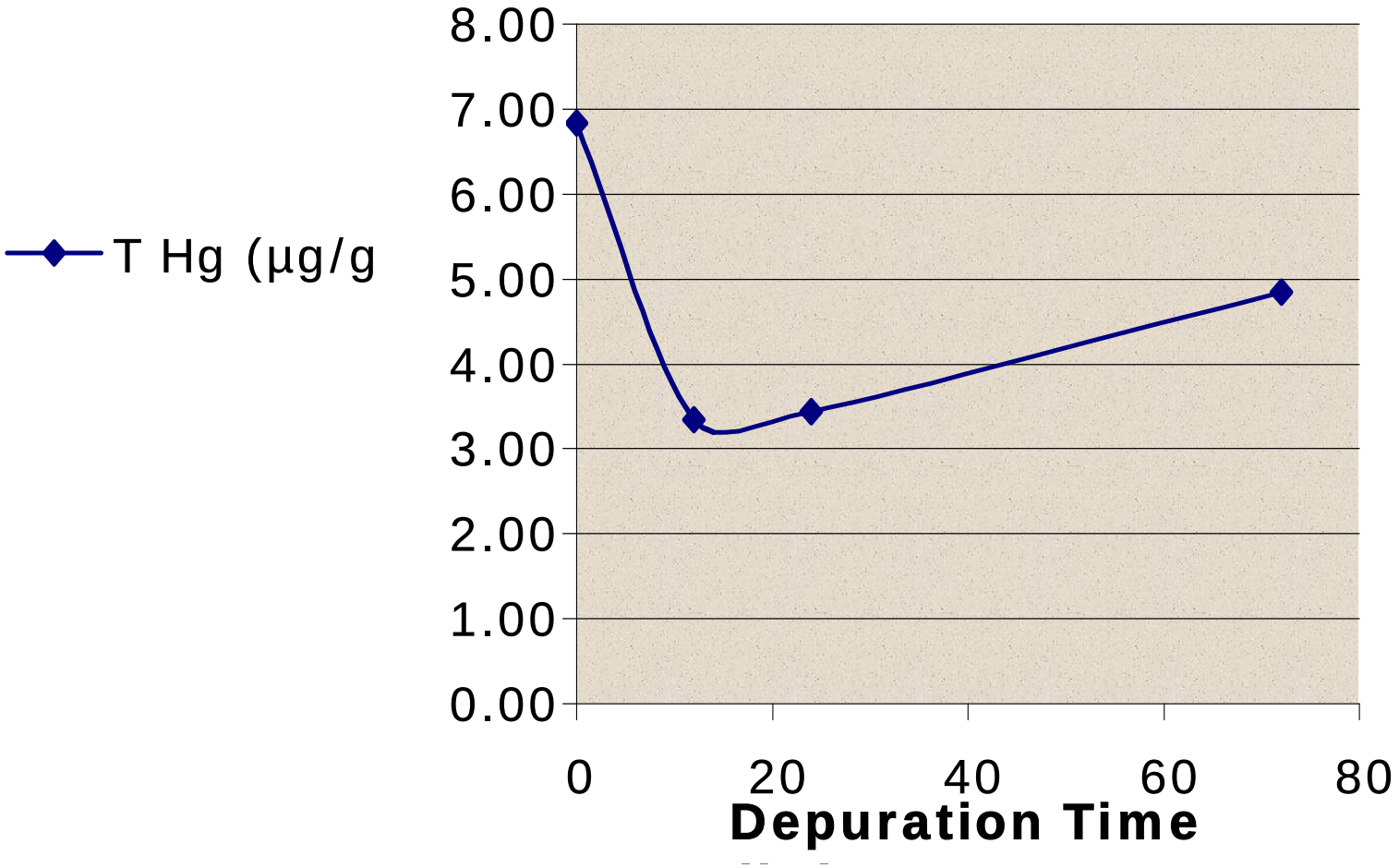
Earthworms collected from five random 1 x 1 m quadrats.

- At least 15 worms were rinsed in DI water and allocated to each of the following treatments
  - Depurated for 72 hr.
  - Depurated for 24 hr.
  - Depurated for 12 hr.
  - Not depurated, processed within 15 min of establishing depuration conditions in a culture container.
- A composite soil sample was also collected.

Soil Hg in composite of 5 quadrates at Hopeman Parkway

- Total Hg
  - 25.5 µg / g dry wt soil
- MeHg
  - 0.0028 µg / g dry wt soil

Earthworm Hg in composite of five quadrats at Hopeman Parkway



Drought hits

- We were ready to collect data in June, July and August
- The second most severe drought on record set in and the earthworms died or disappeared to depths below excavation criteria.
- Then a minor flooding event occurred which drowned some of the worms.
- During September conditions improved and we have now successfully collected earthworms from three sites.

Expansion of objectives

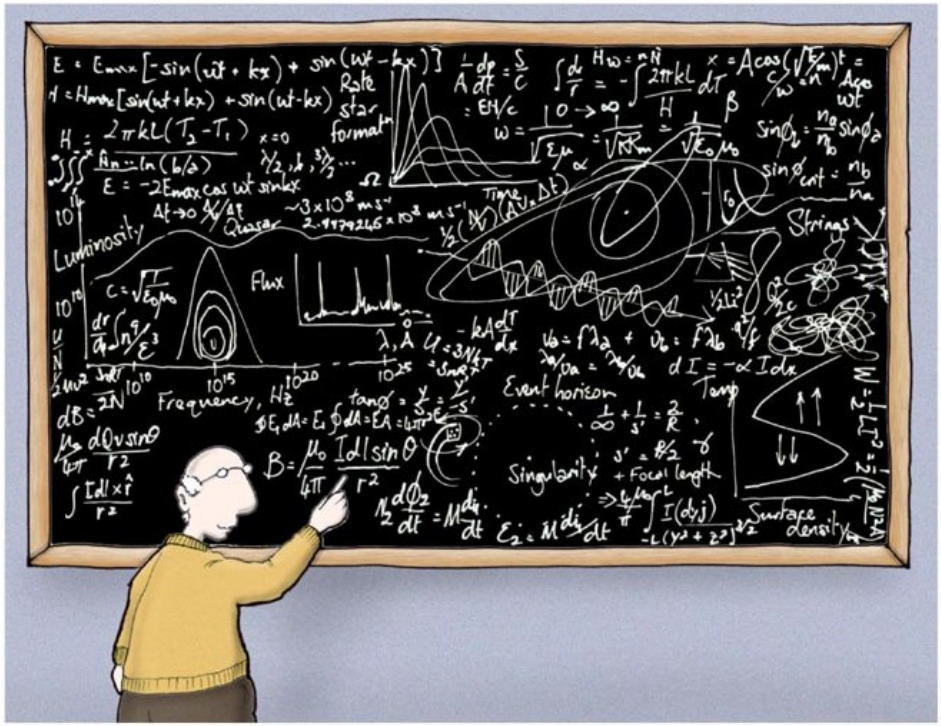
- Survey the molecular species of Hg in the soil utilizing synchrotron radiation to determine the in-situ speciation of Hg in selected soils.
  - Goal is to examine the relationship of Hg speciation in soil to its bioavailability.

Advanced Photon Source

(Argonne National Laboratory, Argonne, IL)

Introduction into X-ray Absorption Spectroscopy (XAS)

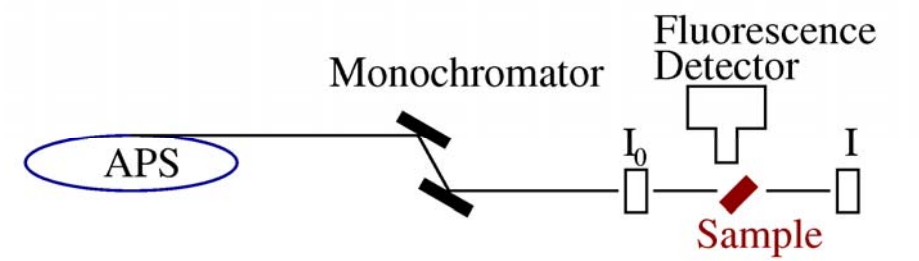
- Used to determine speciation
  - Bond Distance
  - Number of neighboring atoms (Coordination Number)
  - Information on identity of neighboring atoms

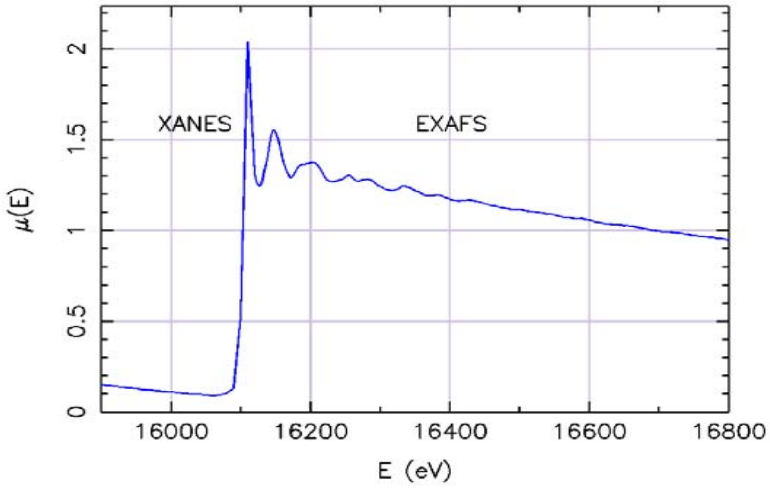


- In-situ method, eliminates artifacts from sequential extraction methods that may alter the chemistry of the system

X-ray Absorption Spectroscopy

X-ray Absorption Spectroscopy: Measure energy-dependence of the x-ray absorption coefficient μ(E) [either log(I_0 /I) or (I_f / I_0)] of a core-level of a selected element





XANES = X-ray Absorption Near-Edge Spectroscopy

EXAFS = Extended X-ray Absorption Fine-Structure

Element Specific: Elements with Z>20 can be examined.

Valence Probe: XANES gives chemical state and formal valence of selected element.

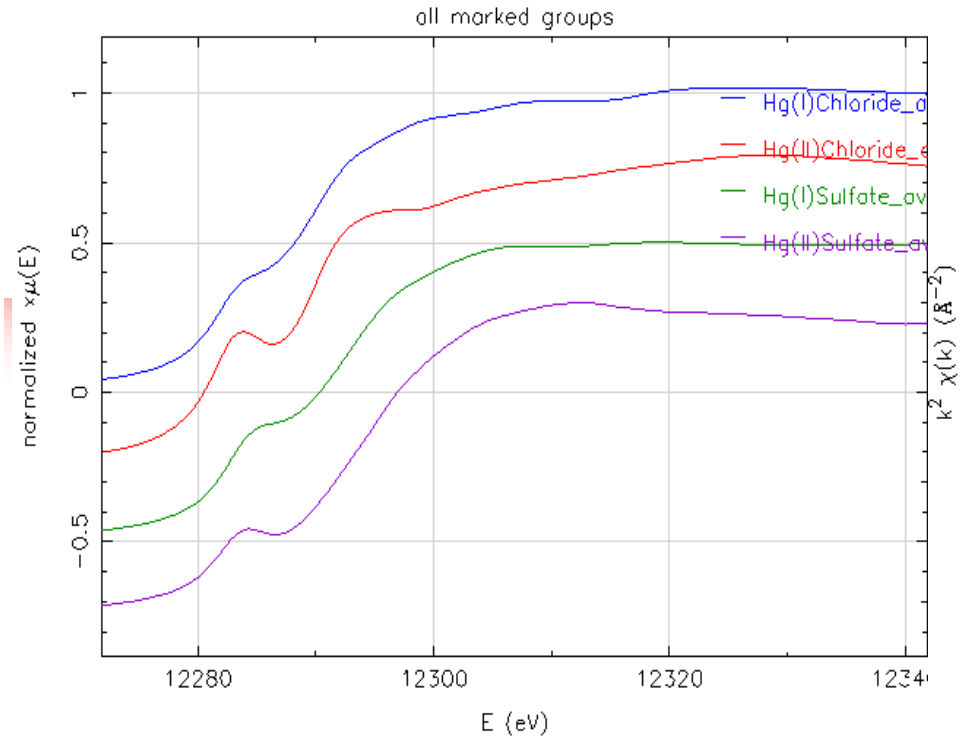
Local Structure Probe: EXAFS gives atomic species, distance, and number of near-neighbor atoms around a selected element..

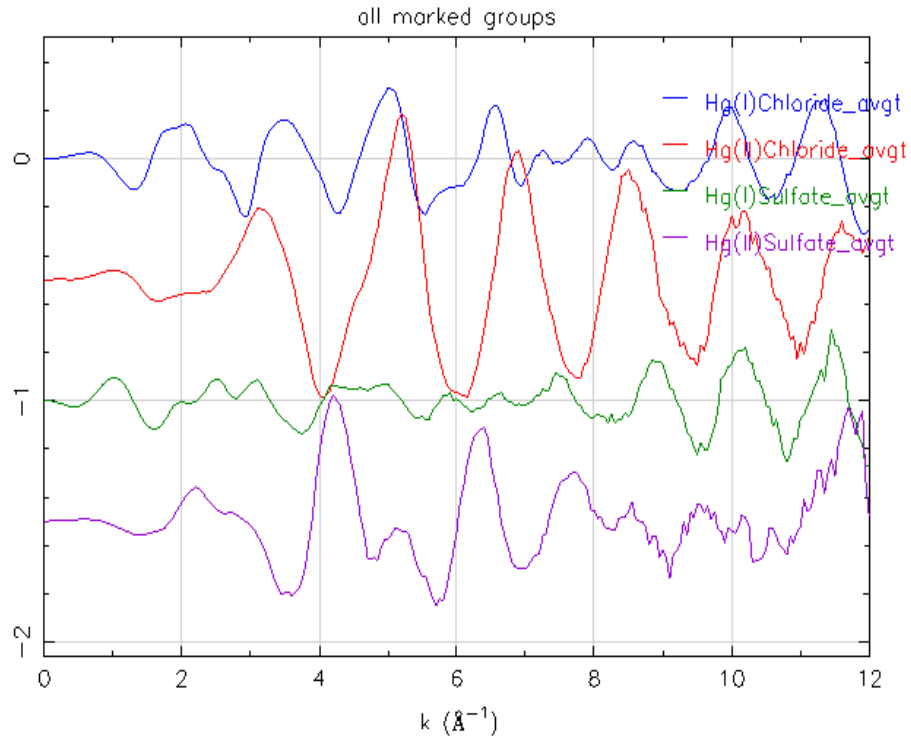
Low Concentration: concentrations down to 10 ppm for XANES, 100 ppm for EXAFS.

Natural Samples (in-situ): samples can be in solution, liquids, amorphous solids, soils, aggregates, plant roots, surfaces, etc.

Small Spot Size: XANES and EXAFS measurements can be made on samples down to ~5 microns in size.

Hg X-ray Absorption Spectroscopy





Current status and plans

- Field survey work ongoing
  - In process of collecting earthworm and soil samples
  - Plan to complete by November
- Evaluate soil and earthworm data and prepare appropriate reports – Dec 2006 to Feb 2007
  - Compare results to literature.
  - Develop path forward for summer 2007.
- Gather soil Hg speciation data using the synchrotron at the Advanced Photon Source