



Bioaccessibility studies using *in vitro* extraction methods on soils of North America

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The Challenge

Anthropogenic versus Geogenic

NationBriefs

CALIFORNIANS
FIND WILDFIRES
BURN LUNGS, TOO

LAS VEGAS
REVIEW-JOURNAL

Friday
Feb 18,

BLM study reveals high levels of
arsenic in dust at Nellis Dunes

8/20/08

Arsenic- diabetes link gets broader

A study indicates a tie-in
even with low levels of
arsenic. The jury's out
on what it all means.

By **Carla K. Johnson**
The Associated Press

Peru volcano ash sickens 1,000 people
Wed Apr 18, 2008 07:03 PM ET

 **USGS**

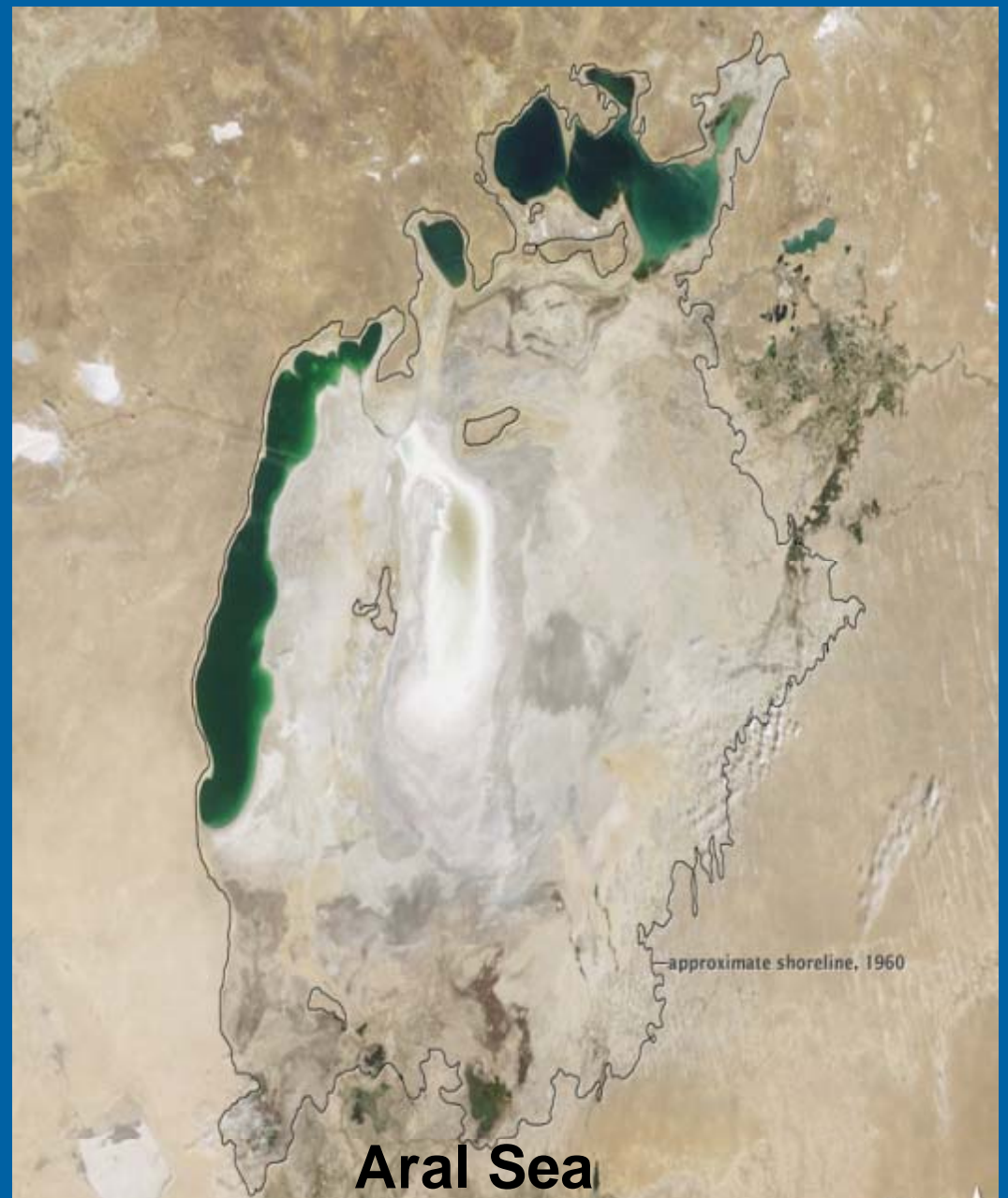
The Challenge

For Particulate Matter Research (PM)

Anthropogenic – Human impact on the environment (e.g., chemicals, pesticides, energy production, and mining)

Geogenic – produced from the Earth by natural processes (e.g., volcanic ash, windborne ash from wildfires, and mineral dusts)

Geoanthropogenic - produced from natural sources by processes that are modified or enhanced by human activities, e.g., dusts from lakebeds dried by human removal of water)



<http://earthobservatory.nasa.gov/IOTD/view.php?id=39944>

The Challenge

Geogenic or naturally occurring earth materials such as soils, dusts and ash may contain known or potential toxicants. Exposure levels needed to trigger disease and causal links to disease are lacking for many materials



The Challenge

Occupational exposures

- Single element or mixture
- Concentration
- Route of Exposure
- Duration of Exposure

Environmental exposures

- Element mixture (metals)
- Concentration
- Route of Exposure
- Duration of Exposure
- Matrix composition and effects

The Challenge

Particle Characteristics of Toxicological Interest

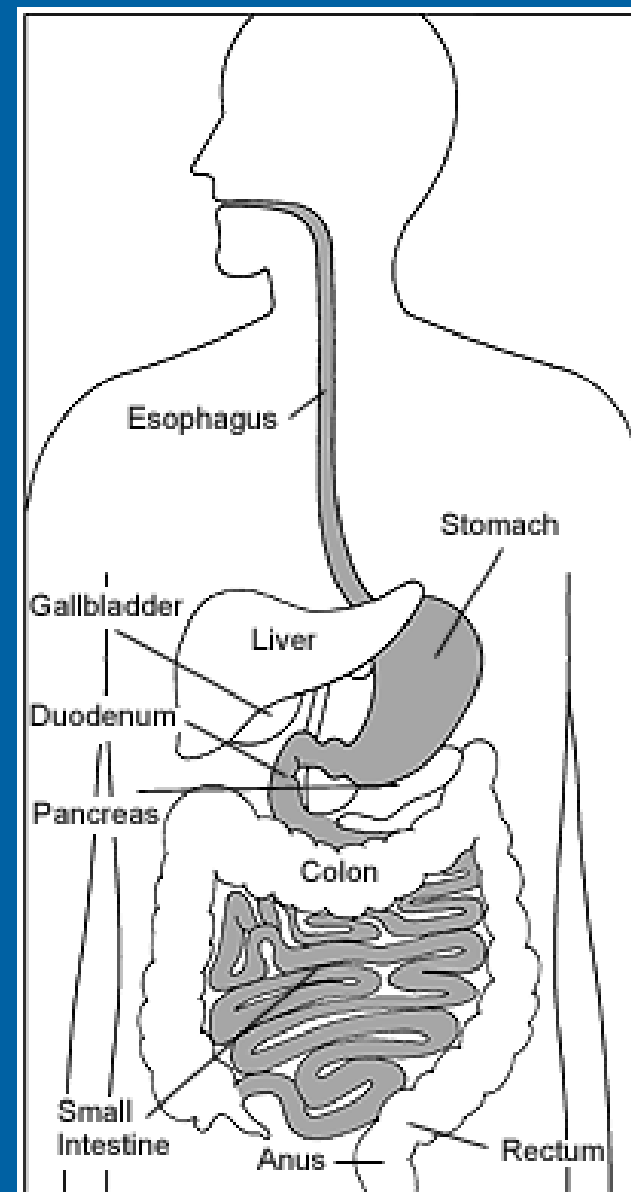
- Particle mineralogy
- Particle size distribution
- Particle morphology
- Chemical composition (bulk, and of different phases)
- Particle biosolubility, bioreactivity, bioaccessibility along inhalation, ingestion exposure pathways

In Vitro Bioaccessibility Tests (IVBA)

Bioaccessibility – The amount of a toxicant that is soluble in simulated body fluid and available for uptake. IVBA's measure bioaccessibility in simulated body fluids


(% Bioaccess. = (conc. leachate/total conc.)* 100)

- Fast & Inexpensive
- Gastric (pH 1.5)
- Gastric to Intestinal
- Lung (pH 7.4)
- Phagolysosomal (pH 4.5)
- Linked to detailed mineralogical, physical characterization of test materials



IVBA

Hamilton, Alice, 1869-1970

U. S. DEPARTMENT OF LABOR BUREAU OF LABOR STATISTICS ROYAL MEEKER, Commissioner		HD 8051 A62 NO. 141
BULLETIN OF THE UNITED STATES BUREAU OF LABOR STATISTICS	{ WHOLE NUMBER 141	
INDUSTRIAL ACCIDENTS AND HYGIENE SERIES: No. 4		
LEAD POISONING IN THE SMELTING AND REFINING OF LEAD		
		
FEBRUARY 17, 1914		
WASHINGTON GOVERNMENT PRINTING OFFICE 1914		

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APPENDIX I.—THE SOLUBILITY OF LEAD SULPHIDE ORES AND OF LEAD SULPHIDE IN HUMAN GASTRIC JUICE.

By A. WOELFEL and A. J. CARLSON, Department of Physiology, University of Chicago.

The following tests of the solubility of lead sulphide ore dust in human gastric juice were made at the request of Dr. Alice Hamilton, special investigator of occupational lead poisoning for the United States Bureau of Labor Statistics, who reported to us that she had found some 25 cases of lead poisoning among men employed in mines and concentrating mills in southeastern Missouri. The mines in this region are supposed to yield practically pure galena.

The literature on industrial plumbism usually takes for granted the nonpoisonousness of lead sulphide in the animal body, though the experimental data on which this belief is founded are both meager and conflicting. Blum,¹ who is the most widely quoted authority on the subject, found that he could feed animals large quantities of lead sulphide without apparently producing any injurious effects. Leymann² says that the sulphide is the compound found in most of the ore smelted in Germany, and experience shows that it does not give rise to lead poisoning in workmen—experience which is confirmed by tests on animals. If there is any danger at all in the handling of these ores it is so slight as to be practically negligible.

The North American Soil Geochemical Landscapes Project.

Examine size fraction (<2mm or <250 μ m) and variations/controls in/on bioaccessibility

- N-S transect
- Randomly selected
- 0 – 5 cm soil
- Split, half sieved to <2mm and half to <250 μ m
- Simulated gastric leach (pH 1.5, temperature 37° for 1 hour)

(Morman et al. 2009. Applied Geochemistry, v. 24 8)



Results - Total Chemistry (mg/kg)

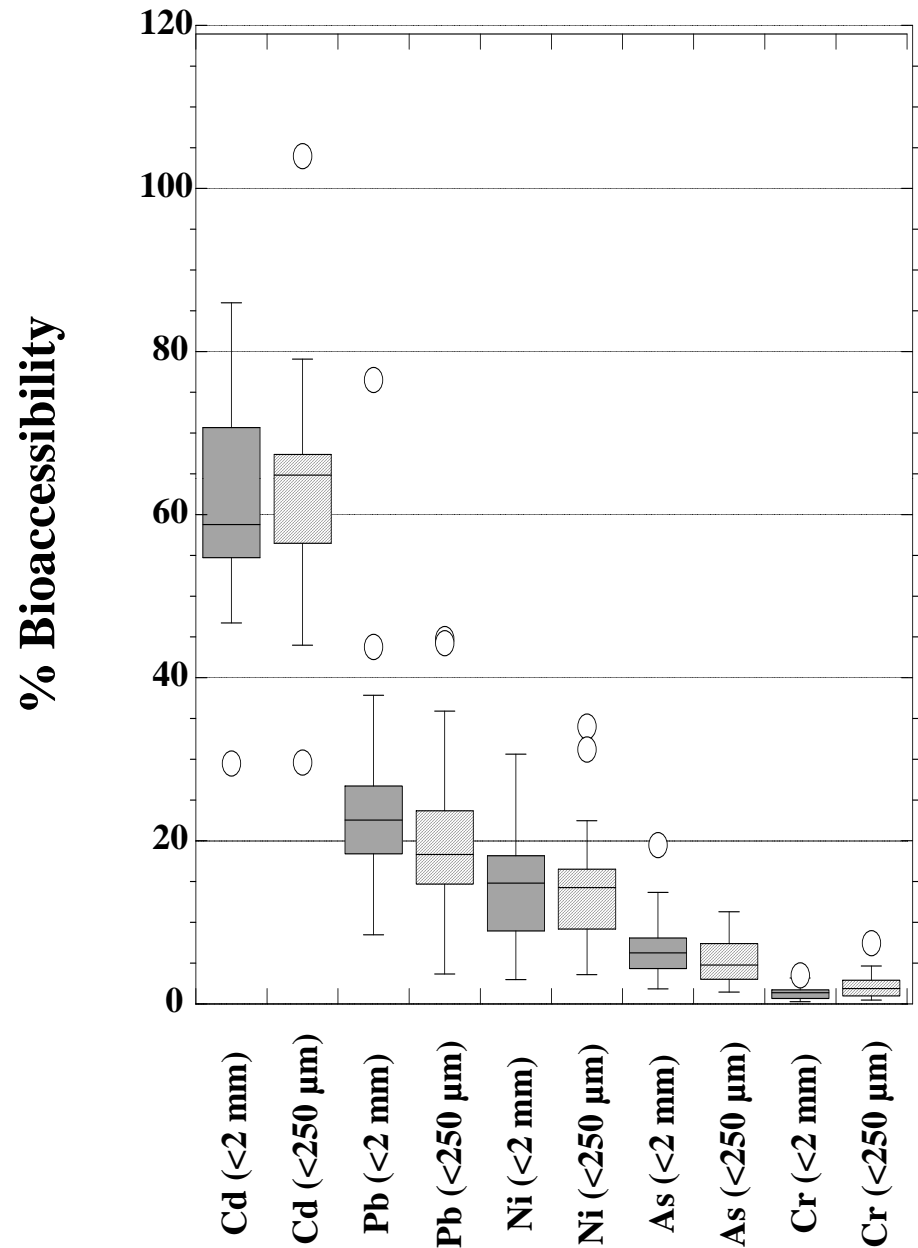
	As	Cd	Cr	Ni	Pb
Both Transects					
Max	20	8.2	6030	2820	318
Min	<1	<0.1	2	2	3
Median	4.5	0.2	29	14	19
N-S Transect					
Max	11	0.8	79	63	93
Min	<1	<0.1	4	4	7
Median	3	0.3	31	16	17
Selected Samples					
Max	11	0.7	50	30	93
Min	1	<0.1	9	5	9
Median	4	0.3	34	14	17

Results

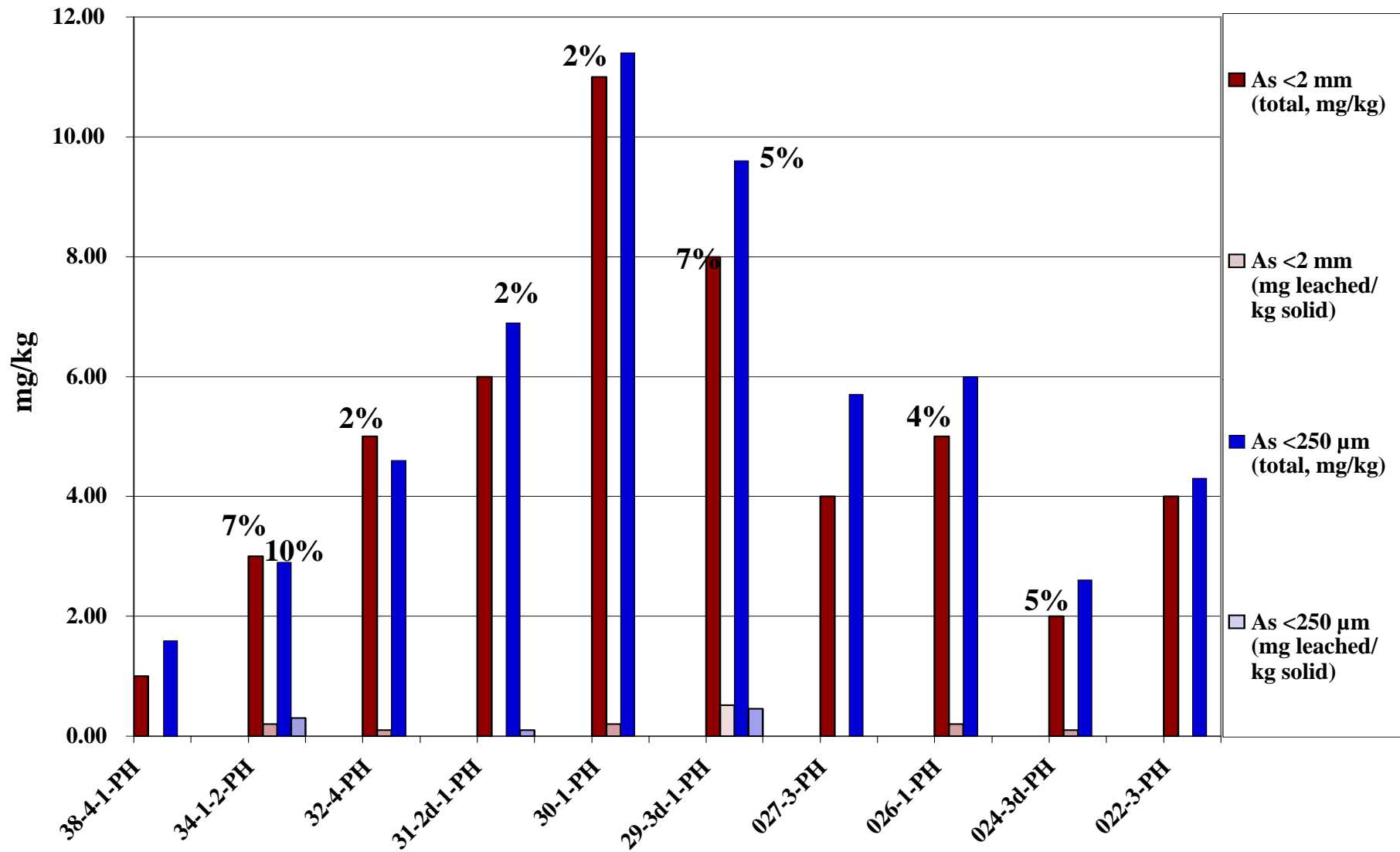
No significant difference in median concentration values between size fractions for total chemistry or % bioaccessibility.

Regression analysis showed no correlation with several 'controls' on mobility (soil pH, clay content, organic C,)

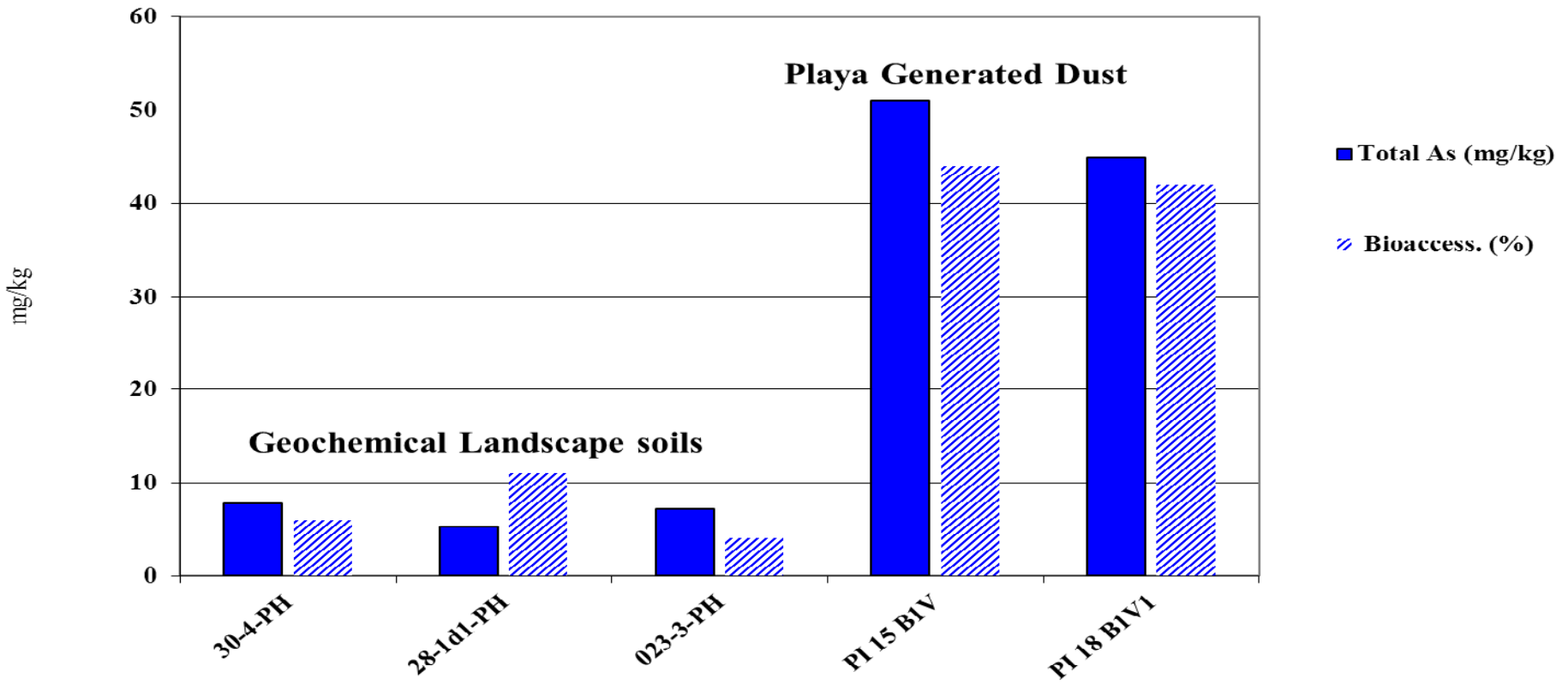
Cd, Ni and Pb demonstrated weak correlation to total concentration



Arsenic

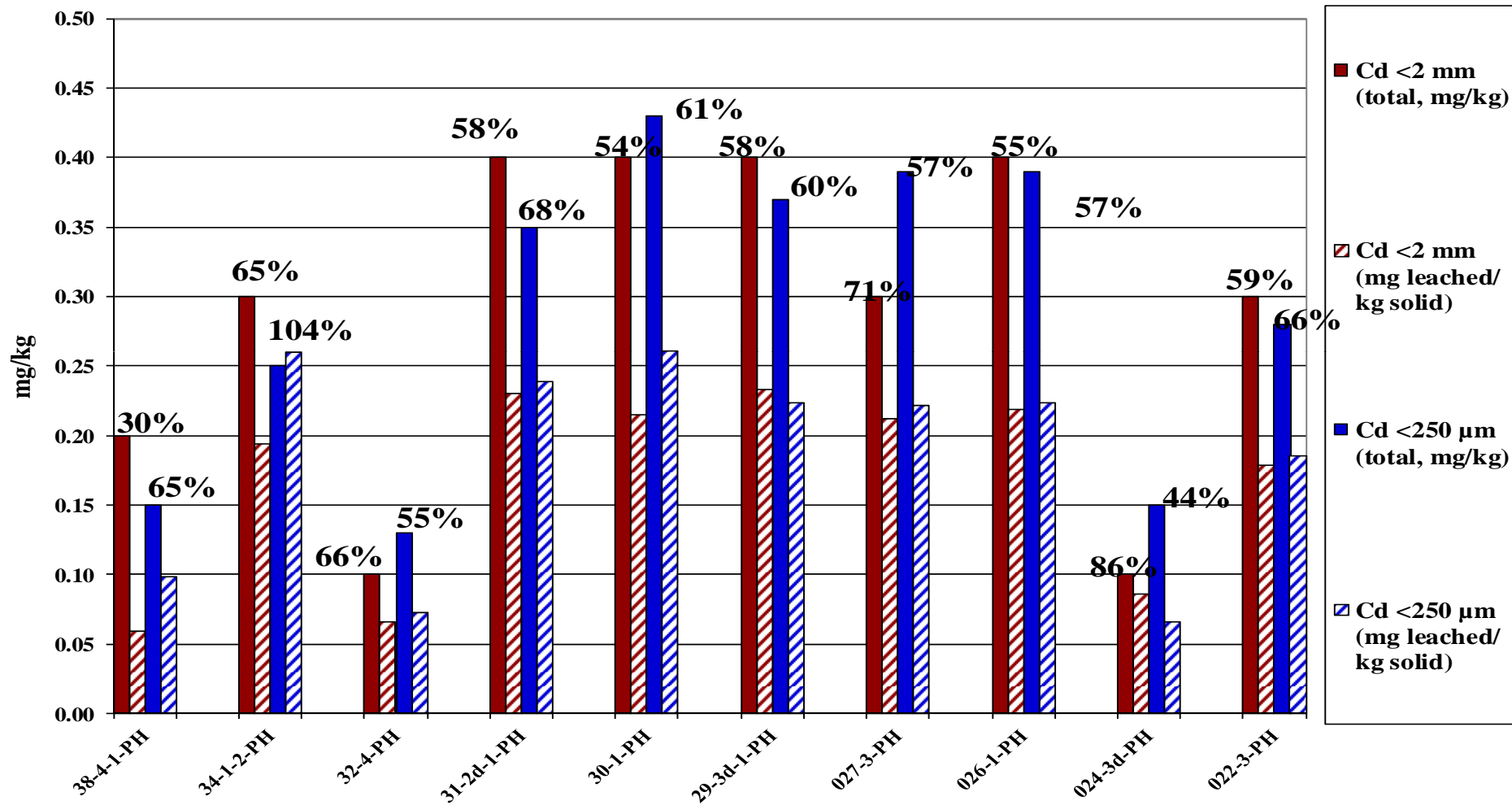


Arsenic

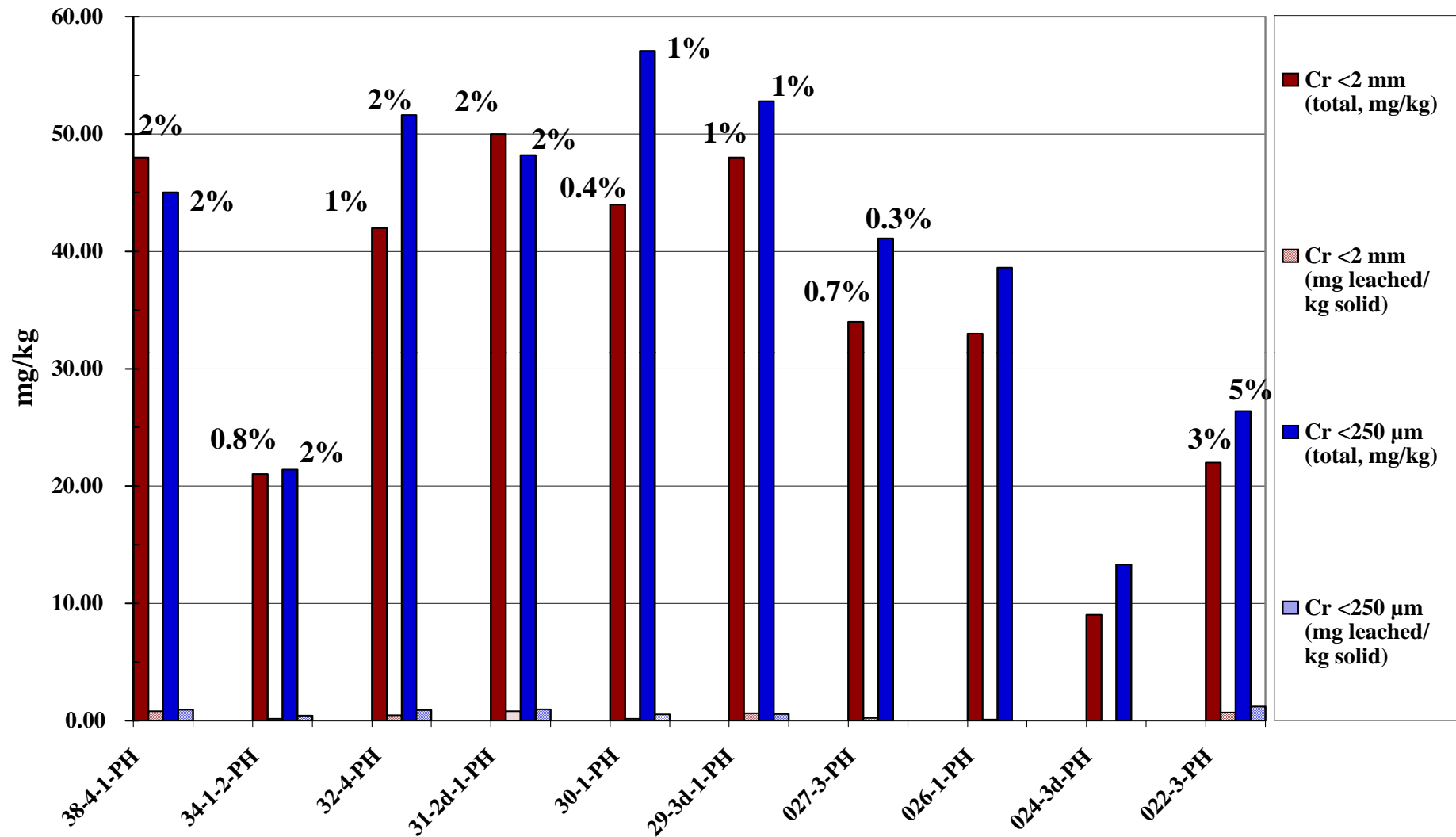


Morman, S., et al, 2008, Geological Society of America Meeting abstracts with Program, Vol. 40, No. 6, p78

Cadmium



Chromium

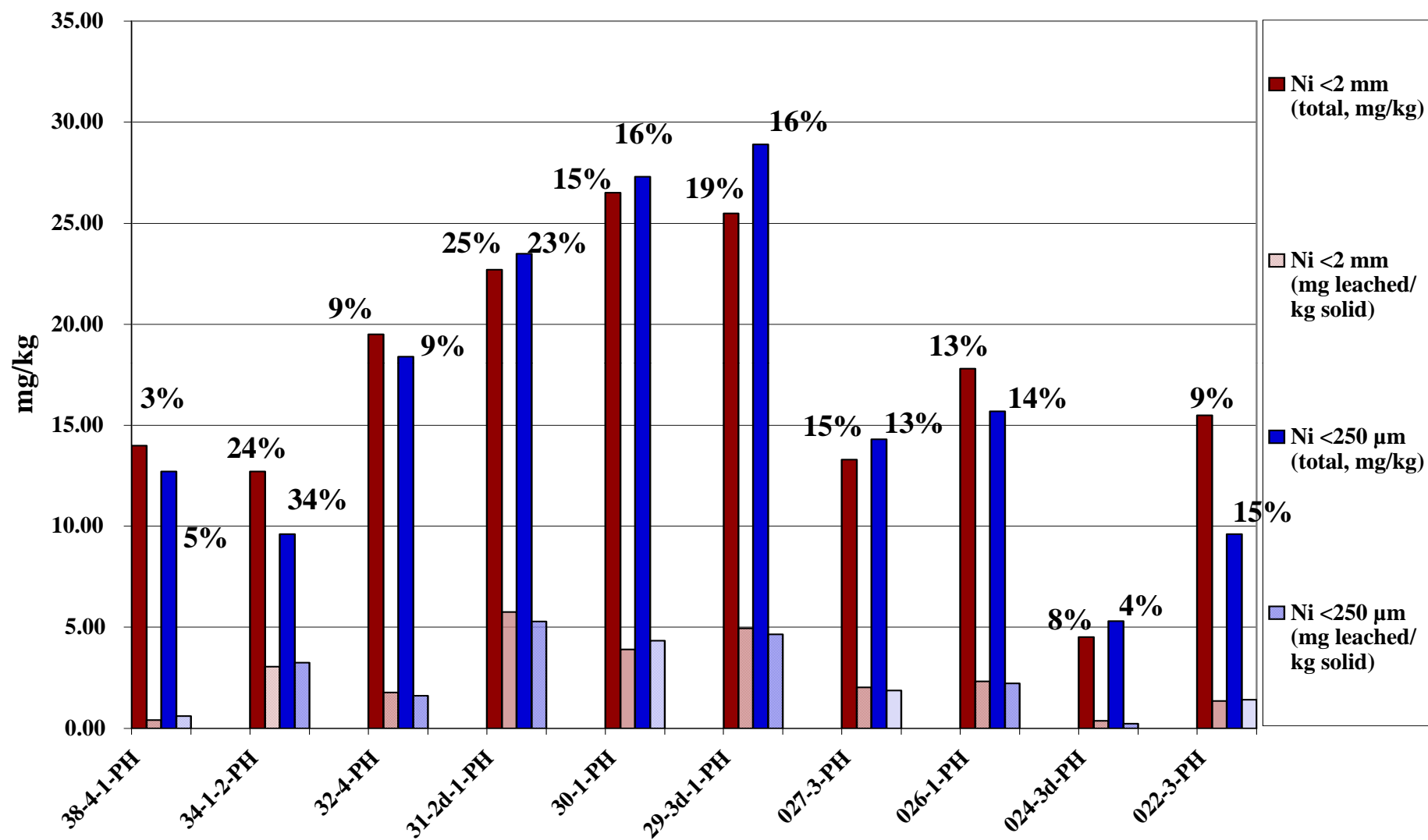


Interferences on Cr Values

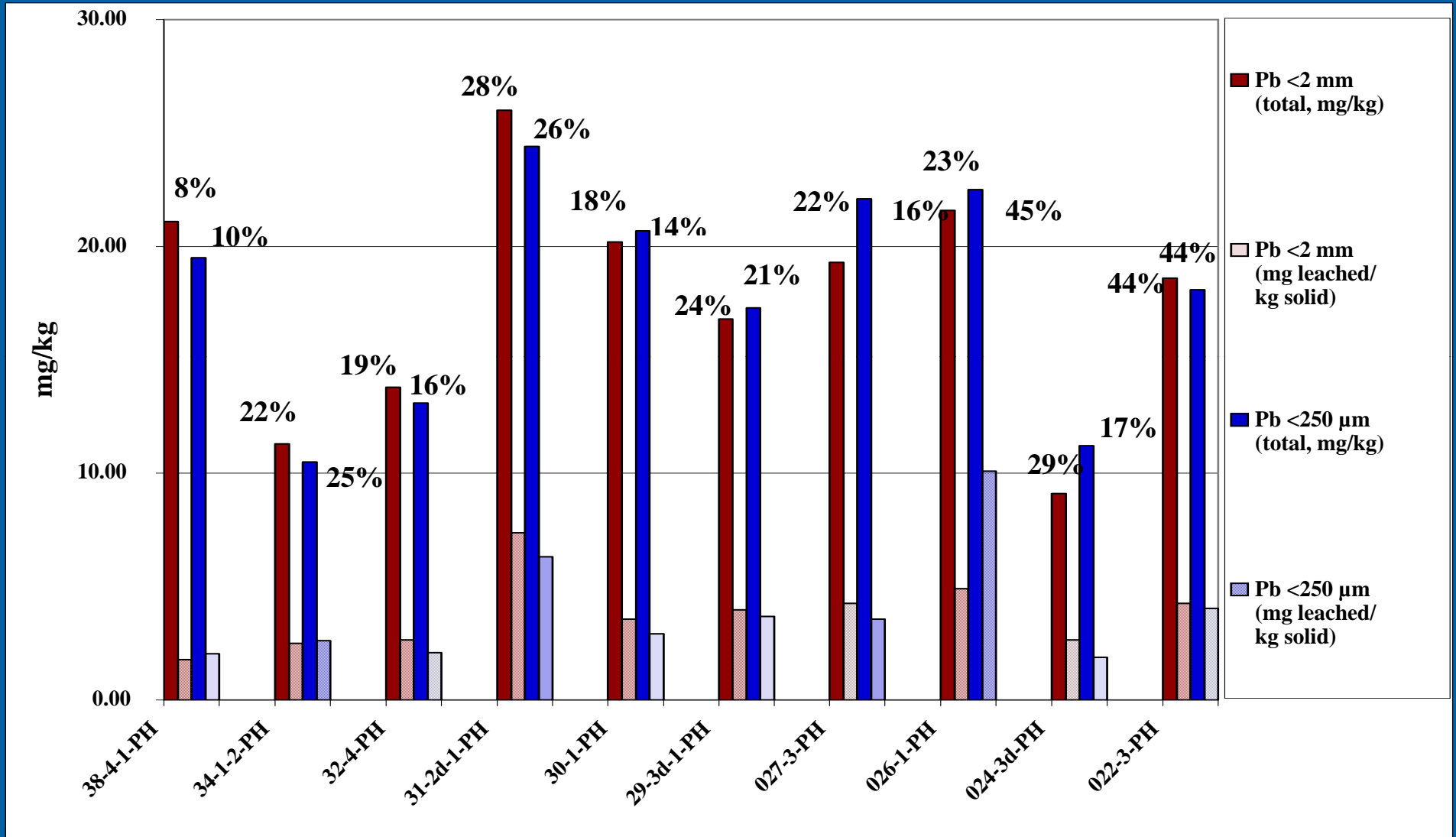
- Cr measured at ^{52}Cr or ^{53}Cr
- Using normal quadrupole ICP-MS false positives can result due to interferences at these masses from $^{40}\text{Ar}^{12}\text{C}$ and $^{37}\text{Cl}^{16}\text{O}$ which are formed in the plasma
- Use of Dynamic Reaction Cell (DRC) ICP-MS with NH_3 as the reaction gas can eliminate these interferences giving an accurate concentration for Cr background levels in the fluids
 - NH_3 at 0.9 and RPq at 0.65
 - Both solutions were run in both modes during the same analysis

Cr Concentration	Normal Q-ICP-MS	DRC-ICP-MS
Lung Fluid Blank	110 ppb	0.9 ppb
Gastric Fluid Blank	92 ppb	1.5 ppb

Nickel



Lead



Conclusions

- No significant difference between soil size fractions for metals examined
- No strong correlations with usual controls on element mobility in soils
- IVBA's are a useful tool within context - particle characteristics, source apportionment etc.

Thanks

**Geoff Plumlee, Paul Lamothe, Ruth Wolf
and Monique Adams**