Bioaccessibility and Extractability of Treated Lead Based Paint

Prepared for

ECOBOND LBP, LLC

Prepared by

Nicholas Basta
Professor of Soil and Environmental Chemistry

Shane Whitacre
Research Associate

Soil, Water, and Environmental Laboratory
School of Environment and Natural Resources

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Scope of Work

Paint samples (32) were received from Ecobond LBP, LLC (Ecobond). Sample preparation and treatment was conducted by Ecobond and samples split for designated analysis prior to delivery to the Soil Environmental chemistry Laboratory (Table 1).

Table 1. Sample receipt by the Ohio State University Soil Environmental Chemistry Laboratory and assignment of Lab IDs

Label	Analysis	#	Project ID	Treated/ Untreated	Lab ID
Treated Pb paint	Inhalation 1	1	MT2	T	MT2_1-T
Treated Pb paint	Inhalation 2	2	MT2	T	MT2_2-T
Treated Pb paint	Inhalation 3	3	MT2	T	MT2_3-T
Treated Pb paint	IVBA 1	4	MT2	T	MT2_4-T
Treated Pb paint	IVBA 2	5	MT2	T	MT2_5-T
Treated Pb paint	IVBA 3	6	MT2	T	MT2_6-T
Treated Pb paint	SPLP 1	7	MT2	T	MT2_7-T
Treated Pb paint	SPLP 2	8	MT2	T	MT2_8-T
Treated Pb paint	SPLP 3	9	MT2	T	MT2_9-T
Treated Pb paint	TCLP 1	10	MT2	T	MT2_10-T
Treated Pb paint	TCLP 2	11	MT2	T	MT2_11-T
Treated Pb paint	TCLP 3	12	MT2	T	MT2_12-T
Treated Pb paint	WEXT 1	13	MT2	T	MT2_13-T
Treated Pb paint	WEXT 2	14	MT2	T	MT2_14-T
Treated Pb paint	WEXT 3	15	MT2	T	MT2_15-T
Untreated Pb paint	Inhalation 1	1	MT2	U	MT2_1-U
Untreated Pb paint	Inhalation 2	2	MT2	U	MT2_2-U
Untreated Pb paint	Inhalation 3	3	MT2	U	MT2_3-U
Untreated Pb paint	IVBA 1	4	MT2	U	MT2_4-U
Untreated Pb paint	IVBA 2	5	MT2	U	MT2_5-U
Untreated Pb paint	IVBA 3	6	MT2	U	MT2_6-U
Untreated Pb paint	SPLP 1	7	MT2	U	MT2_7-U
Untreated Pb paint	SPLP 2	8	MT2	U	MT2_8-U
Untreated Pb paint	SPLP 3	9	MT2	U	MT2_9-U
Untreated Pb paint	TCLP 1	10	MT2	U	MT2_10-U
Untreated Pb paint	TCLP 2	11	MT2	U	MT2_11-U
Untreated Pb paint	TCLP 3	12	MT2	U	MT2_12-U
Untreated Pb paint	WEXT 1	13	MT2	U	MT2_13-U
Untreated Pb paint	WEXT 2	14	MT2	U	MT2_14-U
Untreated Pb paint	WEXT 3	15	MT2	U	MT2_15-U
Treated Pb paint	extra material	17	MT2	T	MT2_17-T
Untreated Pb paint	extra material	17	MT2	U	MT2_17-U

Methods

Characterization and Leachability

Soils were processed to <250µm to obtain the size fraction most likely to adhere to the fingers of children. Total Pb by US EPA method 6200 (USEPA 2007a) was determined on all materials designated for a test method (Table 1). Additionally EPA SW-846 Test Method 1311 Toxicity Characteristic Leaching Procedure (TCLP, USEPA 2007b), EPA SW-846 Test Method 1312 Synthetic Precipitation Leaching Procedure (SPLP, USEPA 2007c), a de-ionized water extraction test (WEXT) using method 1312 with water in place of the SPLP extractant.

Bioaccessibility

Two types of Pb bioaccessibility were determined: (i) oral bioaccessibility associated with incidental soil ingestion and (ii) lung bioaccessibility associated with inhalation.

Oral / incidental ingestion bioaccessibility associated with incidental soil ingestion was determined by using EPA Method 1340, 9200.2-86 In Vitro Bioaccessibility (IVBA) with a modified pH of 2.5 (US EPA, 2008). Briefly, EPA 9200 procedure is a single-step in vitro extraction in which 100 milliliters (mL) of gastric solution (0.40 molar [M] glycine, preheated to 37 degrees Celsius (ºC) and 1.0 g soil (<250 µm) was added to a 175 mL high density polyethylene (HDPE) bottle and placed into a rotator shaker located in a 37ºC incubator. Soil samples were rotated at 40 ± 2 revolutions per minute (rpm) for 1 hour. After 1 hour, an aliquot of suspension was collected with a syringe and filtered (0.45 µm filter).

Lung / inhalation Pb bioaccessibility was determined using a simulated lung fluid test (Drysdale, 2008; Julien et al., 2011). The inhalation bioaccessibility test consisted of 1 g and 150 mL of lung fluid (gamble solution) placed into an incubator of 37 ± 2℃ and agitated at 40 rpm. The solution pH is monitored and adjusted to 7.4 ± 0.2 for 1 hour. After 1 hour, 10 mL of extraction solution was removed and 0.45 µm syringe filtered for analysis. All solution extracts for characterization and leachability as well as bioaccessbility were analyzed by ICP-OES (US EPA, 2007d).

Results

Results of individual sample replicates for each analysis are presented in Table 2. One sample (Treated Pb paint TCLP 1) was identified as an outlier and not used to determine the effect of treatment. Results were reproducible and within 30% coefficient of determination.

Table 2. Individual sample Pb results for total, inhalation bioaccessibility (IBA), gastric in vitro bioaccessible (IVBA), synthetic leaching procedure (SPLP), toxicity characteristic leaching procedure (TCLP) and water extraction test (WEXT).

		Pb				
		---------- mg/kg ----------				
Sample Description	Total	IBA	IVBA	SPLP	TCLP	WEXT
Treated Pb paint IBA 1	120,060	97.1				
Treated Pb paint IBA 2	151,560	86.5				
Treated Pb paint IBA 3	126,340	120				
Treated Pb paint IVBA 1	130,370		9851			
Treated Pb paint IVBA 2	127,550		12496			
Treated Pb paint IVBA 3	128,090		16871			
Treated Pb paint SPLP 1	163,010			<1		
Treated Pb paint SPLP 2	160,210			<1		
Treated Pb paint SPLP 3	149,620			<1		
Treated Pb paint TCLP 1	140,740				<1000[a]	
Treated Pb paint TCLP 2	166,040				23569	
Treated Pb paint TCLP 3	147,790				20121	
Treated Pb paint WEXT 1	170,590					<1
Treated Pb paint WEXT 2	167,480					<1
Treated Pb paint WEXT 3	135,280					<1
Treated Pb paint extra	139,450					
Untreated Pb paint IBA 1	208,130	46.1				
Untreated Pb paint IBA 2	207,420	178				
Untreated Pb paint IBA 3	206,610	65.8				
Untreated Pb paint IVBA 1	209,200		156690			
Untreated Pb paint IVBA 2	209,460		135723			
Untreated Pb paint IVBA 3	209,030		168127			
Untreated Pb paint SPLP 1	205,780			3779		
Untreated Pb paint SPLP 2	205,510			3457		
Untreated Pb paint SPLP 3	206,020			4264		
Untreated Pb paint TCLP 1	202,020				59119	
Untreated Pb paint TCLP 2	206,530				56700	
Untreated Pb paint TCLP 3	207,360				53069	
Untreated Pb paint WEXT 1	205,180					4005
Untreated Pb paint WEXT 2	205,630					3979
Untreated Pb paint WEXT 3	206,440					4428
Untreated Pb paint extra	206,970					

[a] result determined to be an outlier and not used in calculated results

In order to evaluate the effect of the treatment to reduce Pb availability, results were converted to percent of total (equation 1) and percent reductions calculated (equation 2). For sample results below the reporting limit, a value of ½ the reporting limit was used in equation 1.

Pb %= 100*[extracted Pb (mg/kg)/Total Pb (mg/kg)] Eq. 1

Pb % Reduction = 100*[(Pb% untreated - Pb% treated)/Pb% untreated] Eq. 2

Treatment results, with statistically significant (*P<0.01*) treatment effects indicated, are presented in Table 3. The Ecobond treatment significantly reduced IVBA, SPLP, TCLP and WEXT. Although lung bioacccessibility (LIV) was not reduced by Ecobond, bioaccessibility was insignificant in the untreated paint, 0.047%, and likely not a significant exposure concern.

Table 3. Treatment results for Pb by test method for treated (T) and untreated (U) samples as percent of total and percent reduction (in parentheses).

Pb % of Total (%Reduction)[a]									
LIV		IVBA		SPLP		TCLP		WEXT	
T	U	T	U	T	U	T	U	T	U
0.078		10.2		0.00032		13.9		0.00034	
(0)	0.047	(86)[b]	73.4	(99)[b]	1.86	(49)[b]	27.4	(99)[b]	2.00

[a]LIV = lung bioaccessibility; IVBA = oral bioaccessibility; SPLP is U.S. EPA Method 1312; TCLP is U.S. EPA Method 1311; WEXT is water extractable Pb.

[b]Treatment resulted in statistically significant (P<0.01) reduction in Pb availability

References

Drysdale, M. E. B. (2008). Application of simulated lung fluid analysis to characterize the influence of smelter activity on the respiratory bioaccessibility of nickel-bearing soils in Kalgoorlie, Western Australia.

Julien, C., Esperanza, P., Bruno, M., & Alleman, L. Y. (2011). Development of an in vitro method to estimate lung bioaccessibility of metals from atmospheric particles. Journal of Environmental Monitoring, 13(3), 621-630.

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