

Lead in Urban Soils: Analytical Method Considerations

LEE Leda, WAI Win, GRINSHTEIN Michael, DAYAN Sara, and CHENG Zhongqi

Brooklyn College of The City University of New York, Environmental Sciences Analytical Center

Abstract:

Urban soils often contain dangerous levels of lead resulting from historical deposition of leaded gasoline and paint, as well as fine particulates from incineration most prevalent from this last century. The renewed interest in redevelopment and urban agriculture resulted in a need for fast, affordable analytical methods for soil screening and remediation. This paper compares five different techniques that are reportedly being used; the purpose is to establish a baseline to compare lead values reported by different laboratories.

Eight air dried garden soil samples, varying in lead content, were treated separately for four hours with (1) 10% HCl leach; (2) 1-M Na-Acetate, pH=4.8; and (3) 1-M Ammonium Acetate. The results were compared to those by a total digestion method (EPA methods 3050B and 3051A). The leachate and digested solutions were then analyzed by a Perkin Elmer DRCE ICP-MS (EPA method 6020A). Compared to the values obtained with the total digestion method, 10% HCl leached out 60-94% of lead, 1-M ammonium-acetate leached out 10-29% of lead, while very little Pb was extracted by pH-adjusted Na-acetate (1-7%).

The results from an X-ray Fluorescence based method (EPA method 6200), widely used in industrial applications and commercial laboratories, was also compared. We used a portable XRF Environmental Analyzer (Innov-X, alpha-4000), with a detection limit of 10-100 ppm. Samples were tested in plastic sandwich bags as they were received from customers, without drying or sieving. Counts for empty plastic bags are negligible. At an exposure time of 1 minute, instrument statistics gave about 1-2% uncertainty. The variability of replicate runs is also similar (n=3). Heterogeneity was apparent, however, as values for different spots in the same bag varied by up to 40%, although the majority of cases were below 10%.

The potential effect of grain size on XRF measurements was also studied. The same sample with ~2500 ppm Pb was divided into two portions, one air dried and the other dried at 105°C in an oven. Each was then sieved to seven different size fractions (<125 µm, 125-180 µm, 180-250 µm, 250-500 µm, 0.5-1 µm, 1-2 µm, and >2 µm). Lead content generally decreases as grain size increases, with the variability among replicate runs also significantly increases (2% for the <125 µm fraction, and 100% for the >2 mm fraction, n=3). There is no systematic difference in values measured for air dried or oven dried samples, suggesting that moisture content is not likely an important factor considering the heterogeneous nature of urban soils. The XRF measured values can deviate from those by the total digestion method, but the magnitude of deviation is more for the larger size fractions (e.g., 50-100% for the 1-2 mm fraction, compared to 10% for the <125 µm fraction).

Overall, results by the XRF Analyzer correlate well with those from the above mentioned total digestion method ($r=0.86$, $n=112$). For a total of 59 soil samples whose total digestion values exceed the 400 ppm threshold, only four (or 3%) reported XRF values lower than 400 ppm.

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Information of corresponding author

Full Name: Zhongqi Cheng, PhD

Organization: Environmental Sciences Analytical Center, Brooklyn College of The City
University of New York

Mailing address: 2900 Bedford Avenue, Brooklyn, NY 11210

Tel: (718) 951-5000 ext. 2647

E-mail: zcheng@brooklyn.cuny.edu