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FIELD ANALYSIS OF MERCURY IN WATER, SEDIMENT AND SOIL USING STATIC HEADSPACE ANALYSIS

A new field screening tool for the analysis of mercury (Hg) in water, sediment and soil has been developed at Oak Ridge National Laboratory for cost-effective application at Hg-contaminated sites. Samples are chemically pretreated in ordinary containers, followed by analysis of the sample headspace Hg vapor using a portable commercially-available analyzer. Mercury in water samples is reduced directly by the addition of stannous chloride, while solids are first digested with aqua regia or an iodine-based extractant to liberate the Hg from the solids. Aided by vigorous agitation after addition of the reductant, the elemental Hg partitions between the solution and headspace according to Henry's Law. The method requires about 2 and 20 minutes to complete for water and solids, respectively. Intercomparisons with laboratory-analyzed environmental samples have shown very good agreement. Over the tested range of concentrations in water (0.1 - 400 μg/L), precision and accuracy were quite acceptable for a field screening method. The method is sufficiently simple and easily implemented for field studies. High school students (DOE Honors Program) have been quickly and successfully trained to run the analysis. For Hg extraction from soil and sediment, aqua regia is effective for short interval (15-minute) ambient temperature extraction. The limit of detection using this technique depends largely on weight of soil extracted and the volume which is transferred for reduction, but is at least 2 μg/g. Linearity in instrument response can be maintained at even high soil concentrations (soils exceeding 1% by weight mercury have been analyzed) as long as the quantity of mercury transferred and reduced is kept below the air saturation value. The method was entered into a field method intercomparison project sponsored by the Gas Research Institute and DOE at the University of North Dakota. Preliminary information from the sponsors indicates excellent method performance against both approved laboratory protocols and the other three field method under evaluation. Practical applications for this field screening technique include defining the boundaries of shallow groundwater Hg plumes (e.g., using push screen sampling), tracking surface water sources of Hg in an industrial complex, preliminary site mapping of soil/sediment contamination, selecting soil/sediment samples for laboratory analysis, field monitoring of the progress of soil remedial action, and detecting initial breakthrough in sorbent column studies or full-scale water treatment systems. Using this method, the number of samples collected for laboratory analysis may be greatly reduced as a rapid field method exists to direct the collection and to rapidly verify achievement of remedial target concentration. If applied during the remediation of the floodplain of Lower East Fork Poplar Creek (Oak Ridge, Tennessee) to direct and confirm cleanup, costs are estimated to be reduced by several million dollars. Method development and validation costs to date have been approximately $50,000, which has already been recovered by cost avoidance by using the method to refine the estimate of the soil volume above the Remedial Goal Option (400 μg/g) for excavation.

This research was sponsored by the U. S. Department of Energy's Y-12 Plant, Environmental Restoration Division. Oak Ridge National Laboratory and the Y-12 Plant are managed for the U. S. Department of Energy under contract DE-AC05-84OR21400 with Lockheed Martin Energy Systems, Inc.

[Prepared by Ralph R. Turner, ESD/ORNL, 615/574-7856, E-mail RRT@ORNL.GOV]

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