Soil Contamination from PCB-Containing Buildings

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BACKGROUND: Polychlorinated biphenyls (PCBs) in construction materials, such as caulking used around windows and expansion joints, may constitute a source of PCB contamination in the building interiors and in surrounding soil. Several studies of soil contamination have been conducted around buildings where the caulking has been removed by grinding or scraping. The PCBs in soil may have been generated in the process of removing the caulking, but natural weathering and deterioration of the caulking may have also been a source.

OBJECTIVES: The objectives of this study were to measure PCB levels in soil surrounding buildings where PCB-containing caulk was still in place, and to evaluate the mobility of the PCBs from caulk using the Toxicity Characteristic Leaching Procedure (U.S. Environmental Protection Agency Method 1311).

DISCUSSION: We found soil PCB contamination ranging from 3.3 to 34 mg/kg around buildings with undisturbed caulking that contained 10,000–36,200 mg/kg PCBs. The results of the Toxicity Characteristic Leaching Procedure (leachate concentrations of 76–288 mg PCB/L) suggest that PCBs in caulking can be mobilized, apparently as complexes with dissolved organic matter that also leach off the caulking material.

CONCLUSIONS AND RECOMMENDATIONS: Although these new findings are based on a small sample size, they demonstrate the need for a national survey of PCBs in building materials and in soil surrounding these buildings. Because the buildings constructed during the time the PCB caulking was in use (1960s and 1970s) include schools, hospitals, and apartment buildings, the potential for exposure of children is a particular concern. It is necessary to reconsider the practice of disposing of old PCB caulking removed during building renovations in conventional landfills, given the apparent mobility of PCBs from the caulking material. Disposal of some caulking material in nonhazardous landfills might lead to high PCB levels in landfill leachate.


Methods

We identified three buildings (designated A, B, and C) where PCB-containing caulk appeared to be present. In the opinion of an experienced bricklayer (G.W.) who examined these buildings, the PCB-containing caulk had not been disturbed or removed from the walls we selected for sampling. These three buildings were typical of masonry buildings constructed in the 1960s and 1970s. One was a university family-housing unit, and the other two were schools. We sampled the caulking, and at each building we also sampled surface soil at a distance of approximately 30 cm from the building foundation. PCB content of both the caulking and soil samples was determined in accordance with U.S. EPA Method 8082 (U.S. EPA 2000).

In order to assess the mobility of PCBs from samples of caulking material, we used the Toxicity Characteristic Leaching Procedure [TCLP; U.S. EPA Method 1311 (U.S. EPA 1992)]. Of the three buildings where we had collected paired caulking and soil samples, we had only the recommended amount of caulking material (100 g) from building A to conduct the procedure, so we selected 2 other caulking samples from the original set of 24 that we tested in 2004 (Herrick et al. 2004). This test was designed to simulate leachate generation from a material if it were co-disposed with municipal solid waste in a nonhazardous waste landfill (U.S. EPA 1998). The extraction liquid simulates municipal solid waste leachate. Although these are not the conditions to which intact caulking would be subjected during natural weathering in a building, this test does determine the mobility of analytes in liquid, solid, and multiphasic waste; it is used to determine whether PCB bulk product waste can be disposed of in nonhazardous waste landfills. We postulated that the finding of PCBs in the caulking leachate would suggest a possible pathway between the caulking material and soil. Each of these three caulking samples had PCB content > 5,000 mg/kg in the bulk material.

Results

The analysis of the bulk caulking material from the three buildings yielded the following results: building A, 36,200 mg/kg; building B, 10,000 mg/kg; building C, 14,800 mg/kg. Soil analysis for PCB in the soil surrounding these buildings found 34 mg/kg at building A; 3.3 mg/kg at building B; and 3.4 mg/kg at building C.

Caulking samples from the three buildings subjected to the TCLP contained 36,200 mg/kg (building 1, which was the same as building A), 5,010 mg/kg (building 2), and 5,970 mg/kg (building 3). Analysis of the extract from the three samples analyzed by the TCLP found PCBs at 76 mg/L (building 1), 137 mg/L (building 2), and 288 mg/L (building 3). These levels exceed by a factor of at least 7,600 the 10-μg/L limit for the result of leachate tests that allows PCB bulk product waste to be disposed of in nonhazardous waste landfills (U.S. EPA 1998).

Discussion

In 2004, we found that 8 of 24 buildings sampled in the Greater Boston Area contained caulking material with > 50 ppm PCB, with the highest level of 36,200 ppm (Herrick et al. 2004). The findings from studies in Finland (Priha et al. 2005) and the investigation at the PCB-containing school in New York (Whitaker 2005) strongly suggest that this caulking material can be a source of soil contamination around the outside perimeter of these buildings. In these cases, however, the caulking had been removed from the buildings before testing for soil contamination. Because the process of removing the caulking includes scraping, grinding, and other steps that may aerosolize the PCB-containing material, the source of the soil contamination could not be established. Natural weathering and deterioration of the caulking over the almost 30 years it was in the building walls may have contributed, but soil contamination from the removal process could not be ruled out.

In the present study, we selected walls of buildings where the caulking had apparently never been disturbed. We found PCB soil contamination around these buildings, and the results of the TCLP demonstrate that PCBs appear to be readily mobilized from the caulking. The TCLP results should be interpreted with caution because the procedure is designed to simulate conditions in municipal solid waste landfills and not natural weathering. Because the PCB concentrations in the extracts from the TCLP far exceed the aqueous solubility of PCBs (generally around 0.1–10 μg/L, depending on the congener), we believe that the PCBs apparently exist as complexes with dissolved organic matter that also leached off the caulking material.

Although the concentration of PCBs in the bulk caulking samples appeared to be a reasonable predictor of the amount of PCBs found in the soil around the buildings containing the caulking, the amount of PCBs released by the TCLP extraction procedure was not related to the PCB content of the bulk material. This may be a result of the small number of samples we examined. Given that the caulking material is at least 30 years old, it may be degraded to the point that the PCBs, which were plasticizers in the original polysulfide polymer formulations, can be mobilized into solution. In some cases, the caulking has clearly lost its elasticity (Figure 1) and the extent of degradation in any caulking material sample may be a better predictor of the amount of PCBs that can be mobilized than the bulk PCB content of the caulking.

Conclusions

Our findings suggest that the most likely cause of soil contamination found around these PCB-containing buildings is natural weathering. PCBs appear to be mobilized from the caulking as part of a complex with dissolved organic material. The practice of disposing of old PCB caulking removed during building renovations in conventional landfills should be reconsidered, given the apparent mobility of PCBs from the caulking material. Disposal of this caulking material in nonhazardous waste landfills could lead to high PCB levels in landfill leachate. In 2004 we recommended a random probability-based survey of schools, hospitals, and other masonry buildings constructed or renovated during the time PCB-containing caulking was in use, to assess the extent to which this material is still in place (Herrick et al. 2004). Although our study is small, these new findings suggest that this survey should include measurement of PCBs in soil surrounding buildings where PCB caulking is present and an assessment of the risk that this material may pose, especially to children in schools and other buildings where soil contamination is found.

REFERENCES


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Figure 1. Deteriorated PCB caulking in a building expansion joint.
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