Effectiveness of best management practices to slow down Pb weathering in a shooting range in Florida

Lena Q. Ma

Soil and Water Science Department, University of Florida

INTRODUCTION

Lead contamination in the environment has received much attention due to its toxicity to both humans and animals. Much Pb has been used in industry and recreation activities, with 74,500 tons being used as Pb bullets in the USA in 2008 [1,2]. As a result, large amounts of Pb have been deposited in shooting ranges.

Weathering of Pb bullets in a shooting range include both chemical and physical reactions, i.e., transformation of metallic Pb to ionic Pb species as well as transfer of metallic Pb from bullets into soil fraction (<2 mm). The high humidity, temperature and rainfall in Florida enhance the weathering of Pb–bullets, and dissolution and leaching of weathered Pb-bullets in shooting range soils [3,4]. The weathered bullets are mostly composed of cerussite [$Pb(CO_3)_2$], hydrocerussite [$Pb(CO_3)_2(OH)_2$], and small amounts of anglesite[5-7], which may increase Pb availability in the environment and pose a risk to ecological systems[8,9]. Therefore, slowing down the weathering of Pb–bullets in shooting range soil is important to minimize Pb exposure in the environment.

In a previous study, we investigated the effectiveness of three best management practices (BMP) in slowing down Pb–bullet weathering in a shooting range [10]. Specifically, we examined the effects of

1) Using sand berm to slow down Pb transformation from metallic to ionic form;
2) Liming on Pb immobilization from soluble to insoluble form;
3) Removing of Pb bullets via sieving on Pb weathering from large to small particles.

While we demonstrated BMPs 1 and 3 were effective in slowing Pb–bullet weathering, the results from BMP 2 were inconclusive. In addition, there were unanswered questions regarding BMPs 1 and 3.

OBJECTIVE

Our overall objective of this proposal is to examine the issues associated with the three BMPs we tested in the previous study [10]. Specifically, we would like to answer the following three questions:

1) Though we demonstrated reduced weathering of Pb-bullets in sand berm compared to soil berm, there was a question on whether the weathered Pb was leached out from the berm as the sand berm has lower holding capacity than the soil berm, therefore causing less Pb accumulated in the sand berm;
2) Liming increases soil pH, thereby should reduce Pb–bullet weathering and Pb solubility. However, our results were inclusive, partially because the increased soil pH also enhanced 1) hydrolysis of Pb in solution, and 2) complexation of Pb with dissolved organic C. Both possibly contributed to the total soluble Pb concentrations in the berm. Therefore, it is important to determine the optimum pH for minimal Pb solubility in soils.
3) We have demonstrated that sieving significantly increased total Pb concentrations in the soil fraction; however, our data were from one location. More data are needed to confirm our observation.