Antimony (Sb) Environmental Interactions and Sequestration Associated with Amendments at Small Arms Firing Ranges

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Agronomy

Ecological Sciences and Engineering

There are over 12,000 private and military operated small arms firing ranges (SAFRs) located in the United States. The metalloid antimony (Sb) is used at 1 to 3 wt% as a hardening agent in lead (Pb)-Sb alloyed bullets; historically up to 600 tons have been used per year in the manufacture of such bullet. As bullets fragment and corrode in SAFR soils they can release Pb and Sb as leachate and runoff into the environment. The corrosion products often react differently in the environment where Pb typically sorbs to soil particles and the migration potential of Sb is not well understood.

Best management practices (BMPs) to reduce the migration of Pb from SAFRs have been researched and developed by many, such as the U.S. Army Environmental Command (USAEC), the U.S. Environmental Protection Agency, and the Interstate Technology & Regulatory Council (ITRC). Their approach often avoided other components used in bullets such as Sb, copper, and zinc which were assumed to react similarly to Pb.

Rapid and significant Sb migration from SAFRs was observed relative to Pb, Cu, and Zn, under dynamic loading conditions. Even with a Sb:Pb bullet weight percent ratio of 1:99 the observed soluble Sb concentration in the leachate from the SAFRs was significantly larger than the soluble Pb concentration in the leachate. The addition of a commercially available amendment significantly reduced the Sb migration from the SAFR while providing reasonable Freundlich ($r^2 \geq 0.99$) and linear ($r^2 \geq 0.96$) isotherm model fits for both Sb(III) and Sb(V).

Andy Martin

Andy grew up in the suburbs of Chicago, Illinois and relocated to Ponca City, Oklahoma where he graduated High School. Andy attended Purdue University where he graduated with a Bachelor of Science in Chemical Engineering in 1995 and was commissioned a Second Lieutenant in the U.S. Army. After almost eight years as an Engineer Officer Andy attended the University of Illinois at Urbana-Champaign and received a Master of Science in Environmental Engineering in 2003. Andy moved to Vicksburg, MS to work for the U.S. Army Engineer Research and Development Center (ERDC) as a Research Environmental Engineer. In 2009, Andy was selected to participate in the ERDC's long term training program and he entered the Ecological Sciences and Engineering (ESE) graduate program at Purdue. While in the ESE program, he has studied the environmental interactions of the metalloid antimony (Sb) and is developing its mitigation strategies at small arms firing ranges.