Editor's Note

Christopher J. Schmitt¹

Received: 25 November 2016 / Accepted: 7 December 2016 / Published online: 28 December 2016
© Springer 2016

Heavy metal contamination at shooting ranges is well documented (e.g., Heier et al. 2009; Islam et al. 2016). Primarily lead, but also copper, zinc, and antimony often occur at high concentrations in shooting range soils; cadmium, nickel, silver, and arsenic may also be present (Cao et al. 2003; Islam et al. 2016). These metals represent a potential threat to human health and wildlife. Although much of the lead and other metals remains in the soil (Clausen et al. 2011), some metals can also contaminate groundwater and surface water and thereby threaten aquatic life (Heier et al. 2009). Results of a study published in the current issue of the *Bulletin of Environmental Contamination and Toxicology* (Stauffer et al. 2017) indicate that mercury contamination may also be an issue at shooting ranges, which has not been previously reported.

Stauffer et al. (2017) collected and analyzed soil samples for mercury and other metals at ranges of differing ages in Switzerland and found that mercury concentrations were elevated ($>500 \mu\text{g/kg}$) at older ranges. Concentrations were greatest near the shooting positions and tended to decrease with distance downrange, which led Stauffer et al. (2017) to conclude that the mercury resulted from the historical use of ammunition ignited by mercury-based primers. Mercury(II) fulminate was the ignition source in percussion caps and metallic cartridge primers from the 1830s until the mid-1900s (Beck et al. 2007). Modern primers do not contain mercury, but older ammunition continued to be expended into the 1960s.

Mercury in soil can be transformed by sulfate- and iron-reducing bacteria to more mobile and highly toxic methylated forms that can bioaccumulate and biomagnify (e.g., Rieder et al. 2011; Kwon et al. 2015). The findings of Stauffer et al. (2017) indicate that mercury represents a previously unrecognized environmental hazard to consider when remediating and monitoring older ranges.

References

- Beck W, Evers J, Göbel M, Oehlinger G, Klapötke TM (2007) The crystal and molecular structure of mercury fulminate (knallquecksilber). *Z Anorg Allg Chem* 633:1417–1422
- Cao X, Ma LQ, Chen M, Hardison DW Jr, Harris WG (2003) Lead transformation and distribution in the soils of shooting ranges in Florida, USA. *Sci Total Environ* 307:179–189
- Clausen JL, Bostick B, Korte N (2011) Migration of lead in surface water, pore water, and groundwater with a focus on firing ranges. *Crit Rev Environ Sci Technol* 41:1397–1448
- Heier LS, Lien IB, Strømseng AE, Ljønes M, Rosseland BO (2009) Speciation of lead, copper, zinc and antimony in water draining a shooting range—Time dependant metal accumulation and biomarker responses in brown trout (*Salmo trutta* L.). *Sci Total Environ* 407:4047–4055
- Islam MN, Nguyen XP, Jung H-Y, Park J-H (2016) Chemical speciation and quantitative evaluation of heavy metal pollution hazards in two army shooting range backstop soils. *Bull Environ Contam Toxicol* 96:179–185
- Kwon SY, Blum JD, Nadelhoffer KJ, Dvonch JT, Tsui MT-K (2015) Isotopic study of mercury sources and transfer between a freshwater lake and adjacent forest food web. *Sci Total Environ* 532:220–229
- Rieder SR, Brunner I, Horvat M, Jacobs A, Frey B (2011) Accumulation of mercury and methylmercury by mushrooms and earthworms from forest soils. *Environ Pollut* 159:2861–2869
- Stauffer M, Pignolet A, Alvarado JAC (2017) Persistent mercury contamination in shooting range soils: legacy from former primers. *Bull Environ Contam Toxicol*. doi:10.1007/s00128-016-1976-3

✉ Christopher J. Schmitt
cjschmitt@usgs.gov

¹ US Geological Survey, Columbia Environmental Research Center, 4200 New Haven Road, Columbia, MO 65203, USA