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Potential connection between agricultural sulfur use and mercury methylation in vineyards

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Soil health for agriculture has traditionally focused on crop needs and environmental consequences of nitrogen (N) and phosphorus (P). Yet crops also require sulfur (S) as a nutrient, pesticide/fungicide, and pH regulator. High levels of S under reducing conditions can stimulate the conversion of inorganic mercury (Hg) into methyl Hg (MeHg) – the toxic and bioavailable form of Hg – by sulfate reducing bacteria. The use of S in California, U.S.A. vineyards provides an interesting case study for the environmental consequences of S inputs and the interaction with Hg. Vineyards ubiquitously and regularly apply elemental S as a fungicide during the growing season. Since S is the major chemical addition, these areas are ideal for investigating the transport and fate of S in agricultural soils. California soils also have elevated concentrations of Hg due to historic mining when Hg was used to extract gold, elevated atmospheric Hg deposition, and naturally occurring cinnabar.

We examine the extent to which S inputs to vineyards stimulate Hg methylation in California vineyards, and ask: How does Hg methylation in vineyards (high S) compare to non-agricultural (low S) soils? We collected soils from four vineyard and four non-agricultural sites at two depths (0-10 cm, 10-20 cm) at the end of the dry growing season and in the middle of the rainy dormant season. Samples were analyzed for total Hg, MeHg, and sulfate concentrations. We then performed an incubation experiment in which these soils were spiked with inorganic $Hg(II)^{200}$ and $MeHg^{199}$ and incubated for 24 and 48 hours to determine the potential for Hg methylation. We found that while during the dry season, vineyard sites had ~1.5 times the amount of sulfate (360 mg S/kg) compared to non-agricultural (woodland and grassland) sites (230 mg S/kg), total Hg and MeHg concentrations, as well as the percent of Hg present as MeHg and Hg methylation rates were greatest in the woodland sites (100 mg THg/g vs. 30 mg THg/g; 0.8 ng MeHg/g vs. 0.4 ng MeHg/g; 1% MeHg vs. 0.6% MeHg). We will discuss the implications of our findings for vineyard and agricultural use of S.