

Mercury stable isotope variability in ore, mine-waste calcine, and leachates of mine-waste calcine within a historical mercury mining district

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The isotopic composition of mercury (Hg) was measured for cinnabar ore, mine-waste calcine produced during ore retorting, and leachates obtained from water leaching experiments of mine-waste calcine from a large Hg mining district in the USA. We have found significant ranges of mass-dependent Hg isotopic ratios between cinnabar ore and resultant mine-waste calcine. For the Terlingua district, Texas, $\delta^{202}\text{Hg} = -1.66\text{‰}$ for cinnabar, $\delta^{202}\text{Hg} = -2.70$ to 1.39‰ for other Hg minerals, $\delta^{202}\text{Hg} = -1.34$ to 1.52‰ for calcines, and $\delta^{202}\text{Hg} = -0.17$ to 2.09‰ for water leachates of calcines (relative to NIST 3133, $2\text{sd} = 0.24\text{‰}$). $\delta^{202}\text{Hg}$ values of the mine-waste calcine are as much as 3‰ heavier than those of cinnabar ore prior to retorting, likely due to fractionation during the retort process. In addition, $\delta^{202}\text{Hg}$ measurements for leachates of the calcines are isotopically similar to, or as much as 1.17‰ greater than, the calcines, most likely due to Hg isotopic fractionation during formation of soluble by-product Hg compounds in the calcines during ore retorting. As a result of the wide range of $\delta^{202}\text{Hg}$ composition between the cinnabar ore, mine-waste calcine, and water leachates, it is unreliable to trace Hg sources from Hg mined areas using only the $\delta^{202}\text{Hg}$ determined for cinnabar ore. These results suggest that more detailed examination of the Hg isotopic compositions of cinnabar ore, mine-waste calcine, and leachates of the calcines are important when using Hg as an environmental tracer in areas mined for Hg. In addition, Hg isotopic composition of other possible sources of Hg to the area and that of the sediment and water should be considered [1]. Tracing of mining-related Hg in the environment is further complicated by possible microbial and photochemical isotopic Hg fractionations in water and sediment, and such fractionation processes have not been well characterized in ecosystems downstream from areas mined for Hg.

[1] Foucher, *et al.* (2009) *Environ. Sci. Technol.* **43**, 33-39.

Why are (precipitation mediated) aerosol effects on clouds so difficult to establish?

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The idea that the atmospheric aerosol can regulate cloud properties dates back more than fifty years. Theoretical arguments suggest that the initial stages of precipitation formation scale with the inverse square of the cloud drop number, which in turn is proportional to the concentration of the hygroscopic aerosol. Nonetheless the evidence that the aerosol robustly alters the properties of clouds and precipitation tends to remain anecdotal and controversial. Why? We, use a hierarchy of models to argue that numerous processes occurring on the cloud- and micro-scale buffer the immediate effects of the aerosol on cloud properties, thus making such effects delicate at best, and therefore difficult to establish observationally. Global modeling studies have not incorporated such effects and should show a stronger effect of the aerosol on clouds; however, because they so poorly represent the cloud types and cloud processes that the aerosol is thought to affect, their aerosol effects more likely represent the deficiency of their cloud representation than they do the behavior of Earth's atmosphere.