Fixation and remediation of trace elements associated with coal fly ash

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Introduction

Fly ash is the dominant component of solid waste produced by coal combustion. Only 38% of the total fly ash generated in 2010 was used for beneficial purposes, primarily due to concerns about potential leaching of trace elements to the environment [1]. In this study, bench-scale batch and column experiments were performed to test treatment methods aimed at reducing the mobility of trace elements associated with coal fly ash.

Results and Conclusions

Chemical fixation of fly ash using a ferrous sulfate (FS) treatment was tested at various solid:liquid ratios for a range of fly ash compositions. The best results were obtained for the 1:30 FS treatment, which successfully reduced the mobility of oxyanion trace elements in all of the fly ash samples studied. Sequential chemical extractions of treated and untreated coal fly ash showed that much of the As, Cr, Mo, Se and V associated with the acidic (Class F) fly ash samples was transferred from mobile to more stable, reducible fractions. Although reduction in trace element mobility was similar for alkaline (Class C) fly ash, FS treatment was less effective in reducing the mobility of As and Se. These elements showed significant reductions in mobility during long-term leaching, suggesting that this treatment method could increase the beneficial use of fly ash.

Older, unlined disposal facilities may serve as sources of trace elements to the environment if meteoric water interacts with the fly ash, creating leachate. Surfactant-modified zeolite (SMZ) has the potential to adsorb both cationic and anionic trace elements from aqueous solutions, but has not previously been tested for remediation of trace elements in fly ash leachate. Bench-scale batch and column experiments were performed to test the ability of SMZ to remediate trace elements in fly ash leachate. Batch experiments showed SMZ affected modest decreases in the concentrations of all oxyanion trace elements in leachate generated from both Class F and Class C fly ash, but was more effective for removal of Cr. Column experiments designed to simulate the use of SMZ as a permeable reactive barrier (PRB) at a CCP disposal facility showed large reductions in leachate trace element concentrations, but indicate that the effective lifetime of a SMZ PRB in the ash disposal environment would be relatively short.

[1] Adams, Thomas H. (2011) *ACAA Press Release*, **Dec. 13, 2011,** 4 pp.

An isotopic record of mercury in San Francisco Bay

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San Francisco (SF) Bay is an urban estuary that has been subjected to extensive pollutant inputs over the past 150 years. Potentially important sources of mercury (Hg) to SF Bay include Hg mining, placer gold mining, agriculture and industrial activity[1]. A previous study of Hg stable isotopes from intertidal surface sediment showed a geographic gradient in δ^{202}Hg from south (higher δ^{202}Hg) to north (lower δ^{202}Hg)[2]. To constrain background Hg isotopic composition and understand possible changes in Hg sources to SF Bay through time, we analyzed samples from eight dated sediment cores from SF Bay for total Hg concentration (HgT) and Hg isotopic composition. Sediment cores were collected at six open water sites (water depth: 2.3 to 7.8 m) and two wetland locations. At least three sediment intervals (pre-anthropogenic, ~1960, surface) were analyzed from each core. Sediment was also collected downstream of placer gold mines in the Yuba River, CA. HgT was measured by CV-AAS and Hg isotopic composition was determined by CV-MC-ICP-MS.

In all cores analyzed, HgT in pre-anthropogenic sediment is between 39 and 73 ng/g, which is within the range of expected background HgT[3]. In 1960-dated sediment, HgT varies from 239 to 532 ng/g in SF Bay open water cores and is significantly higher in wetland cores (3657 and 4777 ng/g). Surface sediment HgT in the eight cores range from 200 to 640 ng/g. HgT in the sediment derived from gold mine tailings is between 3180 and 6821 ng/g.

In all of the SF Bay cores, the pre-anthropogenic isotopic composition of Hg is similar: δ^{202}Hg = -1.00‰ (2SD = 0.14, n=6), Δ^{201}Hg = 0.09‰ (2SD = 0.08, n = 6) and Δ^{199}Hg = 0.18‰ (2SD = 0.07, n = 6). The 1960-dated sediment in the open water cores show a geographic trend similar to that reported by [2] for intertidal surface sediments: the southernmost location has the highest δ^{202}Hg (-0.32‰), the south-central locations have lower δ^{202}Hg (-0.40‰) while further north in San Pablo Bay δ^{202}Hg is lowest (-0.62‰). In surface sediment, δ^{202}Hg shows little geographic variation [δ^{202}Hg = -0.52‰ (2SD = 0.07, n = 6)]. In the sediment derived from gold mine tailings δ^{202}Hg = -0.57‰ (2SD = 0.21, n=2).

The results demonstrate that the isotopic composition of pre-anthropogenic Hg in SF Bay is different than Hg input from anthropogenic sources. A geographic trend in δ^{202}Hg is observed in sediment from ~1960, but δ^{202}Hg of SF Bay open water surface sediment does not vary geographically. It appears that intertidal surface sediments retain an isotopic memory of distinct Hg sources to SF Bay, whereas open water surface sediments have been homogenized, obscuring distinct signals of Hg source.

[1] Conaway *et al.* (2008) *Rev. of Environmental Contamination and Toxicology* **194,** 29-54. [2] Gehrke *et al.* (2011) *Geochimica Et Cosmochimica Acta* **75,** 691-705. [3] Conaway *et al.* (2004) *Marine Chemistry* **90,** 175-184.