Characterization of Metal Concentrations in Rural and Urban $PM_{2.5}$ and $PM_{10-2.5}$ in Colorado

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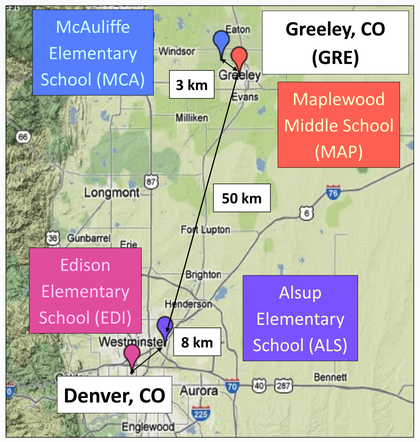
BACKGROUND

- Particulate matter (PM) associated with aggravated asthma, difficulty breathing and premature death.
- Colorado Coarse Urban Rural Sources Health (CCRUSH) Study
  - Characterize $PM_{10-2.5}$ composition and sources
  - Collect samples for one year at four monitoring sites – two in Denver (urban), two in Greeley (rural)
  - Evaluate possible $PM_{10-2.5}$ associations with health outcomes

MONITORING SITES



MEASUREMENTS

Dichotomous Filter Samplers

- Collected 1 year $PM_{10-2.5}$ and $PM_{2.5}$ samples every 6th day for 24 hours
- Chemical analysis by Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)

COMPARISON OF METAL CONCENTRATIONS AT EDI

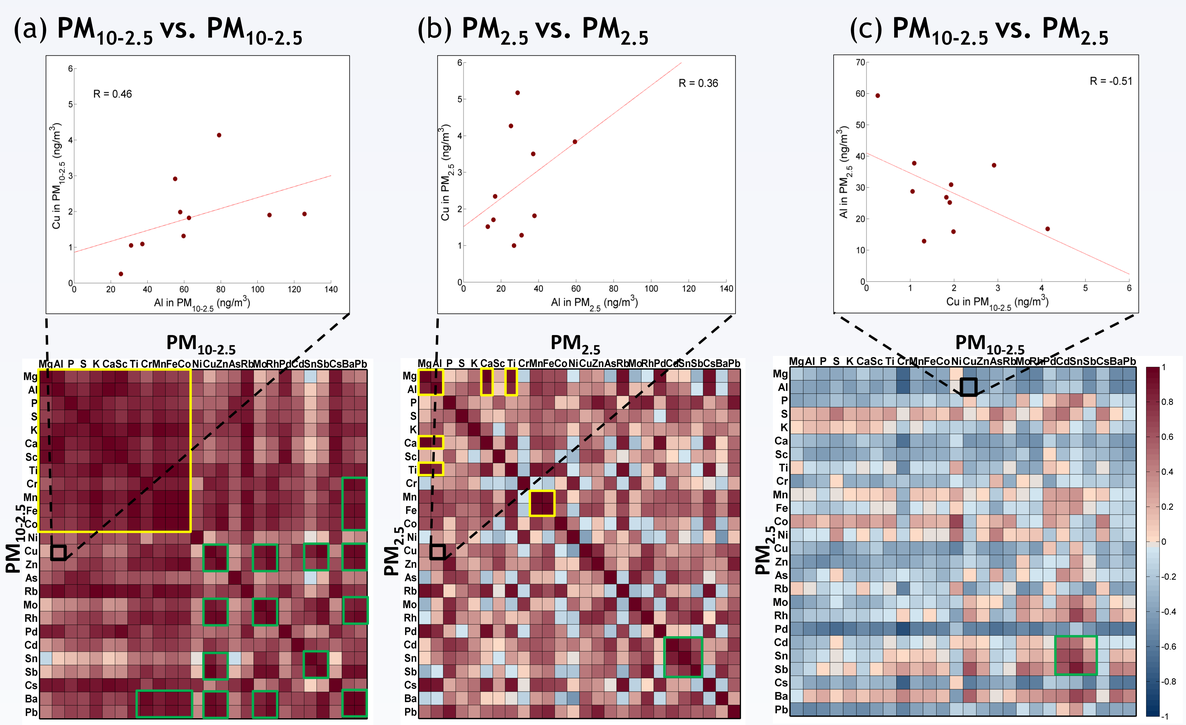


Figure 1. Correlations between elements at Edison within the same and across PM sizes. Correlations boxed in yellow highlight elements that likely originate from crustal material while green boxes highlight elements that may originate from non-crustal sources.

CRUSTAL ENRICHMENT FACTORS (CEFs)

- Assess the relative contributions of human and natural sources of elements
- Compare select element concentrations found in samples with corresponding element concentrations in earth's crust.

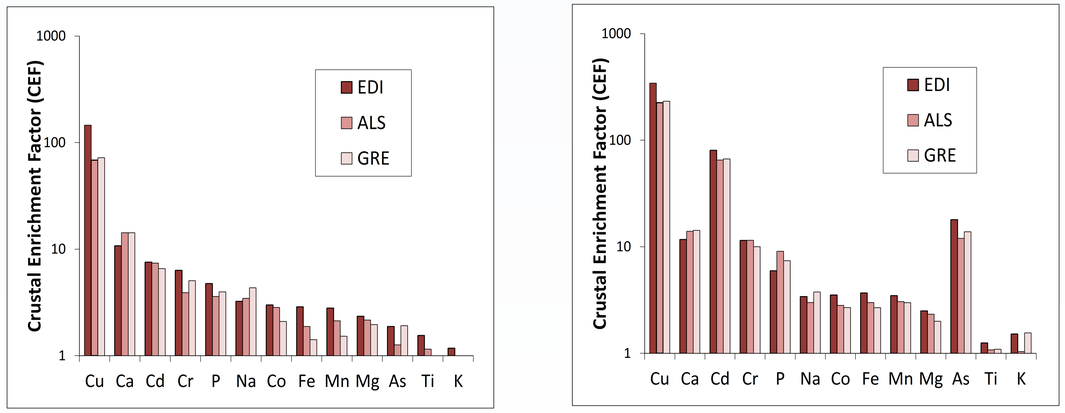


Figure 2. CEFs of 13 elements in (a) $PM_{10-2.5}$ and (b) $PM_{2.5}$ at Edison, Alsup and Greeley. Used local soil data obtained from the National Cooperative Soil Characterization Database (National Cooperative Soil Survey). Sources different from crustal material are indicated by CEFs greater than 10. The reference element was Al.

SUMMARY

- Correlations between Al, S, K, Ca and Fe in the coarse mode suggest crustal material source for $PM_{10-2.5}$
- Correlations between Ba, Sb, Sn, Fe, Cu, Mo, and Zn are consistent with brake linings (Lough et al. 2005; Hjortenkrans et al. 2007).
- CEF finding consistent with a study in Los Angeles that showed high CEF for Cu (Cheung et al. 2011). Other metals with high CEF in the study included Sb, Sn, Mo, S, Pb, Zn and Ba.
- These clues combined suggest crustal material and brake wear may be sources of these transition metals.

FUTURE WORK

- Principal Component Analysis
- Identify more local and regional sources
- Evaluate associations with arrhythmic events, respiratory emergency department (ED) visits, cardiovascular ED visits, preterm births and intrauterine growth retardation

REFERENCES

Cheung, K., N. Daher, W. Kam, M. M. Shafer, Z. Ning, J. J. Schauer, and C. Sioutas, 2011: Spatial and temporal variation of chemical composition and mass closure of ambient coarse particulate matter (PM 10e2 . 5) in the Los Angeles area. *Atmospheric Environment*, **45**, 2651-2662.

Hjortenkrans, D. S. T., B. G. Bergbäck, and A. V. Häggerud, 2007: Metal Emissions from Brake Linings and Tires: Case Studies of Stockholm, Sweden 1995/1998 and 2005. *Environmental Science & Technology*, **41**, 5224-5230.

Lough, G. C., J. J. Schauer, J.-S. Park, M. M. Shafer, J. T. Deminter, and J. P. Weinstein, 2005: Emissions of metals associated with motor vehicle roadways. *Environmental science & technology*, **39**, 826-836.

National Cooperative Soil Survey National Cooperative Soil Characterization Database Available online at http://ncsslabdatamart.sc.egov.usda.gov. Accessed July 10, 2012.

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