

# Accepted Manuscript

Trace Elements in Atmospheric Wet Precipitation in Detroit Metropolitan Area:  
Levels and Possible Sources

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PII: S0045-6535(18)31367-5

DOI: 10.1016/j.chemosphere.2018.07.103

Reference: CHEM 21818

To appear in: *Chemosphere*

Received Date: 03 May 2018

Accepted Date: 18 July 2018

Please cite this article as: Edward Cable, Yiwei Deng, Trace Elements in Atmospheric Wet Precipitation in Detroit Metropolitan Area: Levels and Possible Sources, *Chemosphere* (2018), doi: 10.1016/j.chemosphere.2018.07.103

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### Abstract

Rain and snow samples were collected in the Detroit metropolitan area and analyzed by inductively coupled plasma–mass spectrometry (ICP-MS). Twenty-two elements were detected in a concentration range from  $\sim 0.03$  to  $\sim 1.8 \times 10^3$   $\mu\text{g}/\text{kg}$ . An enrichment factor ( $EF$ ), defined as,

$$EF = \frac{(X/Al)_{sample}}{(X/Al)_{crust}},$$
 was estimated for each element ( $X$ ) detected, and used to determine the

possible origins of the element. Based on the hypothesis that crustal material is the only source of aluminum (Al) found in the environment, an  $EF$  value near unity for an element suggests that crustal material is a major source of this element. If  $EF > 10$ , an element is enriched in the atmosphere relative to its concentration in the earth's crust, implying a source other than the crust. Alkali, alkaline earth and lanthanide elements exhibit low  $EF$  values, indicating mainly a crustal source. Six elements (Cu, P, As, Zn, Cd and Pb) were significantly enriched in the atmospheric wet deposition as their  $EF$  values were greater than 10, thus originated likely from anthropogenic emissions. The relative order of the moderately and highly enriched elements is estimated as follows:

$$\text{Cd} > \text{Pb} > \text{Zn} > \text{As} > \text{Cu} > \text{P}$$

A high enrichment ( $EF \sim 100$ ) for phosphorus was caused plausibly by extensive usage of phosphorus-containing fertilizers and pesticides.

**Key Words:** Trace elements, Enrichment factor, Rain and snow, Wet deposition, Atmospheric pollution, Acid rain

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