〈特別講演2〉

"Sources, Transport and Deposition of Trace Metals to Coastal Waters of the North Atlantic"

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Many atmospheric trace elements are co-emitted with sulfer and nitrogen during high temperature combustion. This results in the potential for significant atmospheric mobilization and deposition of other trace elements in acid precipitation which may have equally important ecological implication.

The trace elements, Al ,As, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Sb, Se and Zn have been successfully measured in atmospheric precipitation events at Lewes, DE on mid-Atlantic coast since 1982. This constitutes probably the longest and most comprehensive trace element precipitation record in the United States.

The concentrations exhibit large event and seasonal variation according to remote sources and local meteorology. For instance there can be variations of over an order of magnitude of crustal elements from just seasonal agricultural trilling. The yearly volume weighted mean concentrations of copper shows a uniform level, while lead shows a gradual long term decline coincident with the phasing out of leaded gasoline in the U.S. This necessitates long and continual records for accurate trend and flux analysis.

The precipitation enrichment factors at Lewes are nearly identical to those found in local aerosol, and even more remote marine areas. This globally pervasive sequence in aerosols and precipitation bears witness to the common volatility, transport, and deposition via precipitation of most atmospheric trace elements.

The sources of trace elements in coastal precipitation can be deduced as follows. A good correlation of many trace elements to acid species in Lewes, DE precipitation which points to the common sources of some metals with acid species. Some of the best correlations are between metalloids such as As and Se which points to common sources from coal combustion. In addition the redox conditions of those reactions coincident with cloud scavenging. One can also utilize air mass trajectory analysis using either isobaric or isentropic models. Sectoring the air mass sources for the precipitation at Lewes suggests long range continental emission sources to the south and midwest.

The atmospheric flux of trace elements by coastal precipitaion can be put in perspective with other fluxes to coastal water bodies. The dry deposition component slightly dominates the west component for the crustal elements (Al, Cr, Fe, Mn and Ni) which is consistent with their sub-micron accumulation modes as emission derived elements.

The atmospheric fluxes of most trace elements, while minor direct input terms for estuaries, can dominate on the basis of the entire watershed. However if one compares the direct wet deposition flux to open waters of Delware Bay eastuary itself, the wet atmospheric component is minor to that entering from fluvial and tidal sources. This may be unrealistic when one considers that the fresh and tidal sources themselves may be directly derieved from atmospheric deposition to their watersheds, or indirectly from chemical reactions of diagenesis within their soils. Finally, the direct total atmospheric deposition to coastal waters of the Middle Atlantic Bight has been compared to that estimated to be entering from the net tidal flux of the large estuarine river systems (Chesapeake, Delware and Hudson). The percentage atmospheric input to the Middle Atlantic Bight while minor for some elements such as Cu and Mn, can be dominate for other elements such as Pb and Zn. As for nutrients, atmospheric delivery of trace elements to coastal waters can be important. Clearly, the atmospheric fluxes of many emission trace elements dominates the exported estuarines fluxes to coastal waters of the middle Atlantic region. The same conclusion has been reached for many other coastal water around the world.