Air quality assessment in Middletown, Ohio - Lichen biomonitoring of steel production

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Steel production results in direct and indirect formation of various airborne emissions. According to recent epidemiological studies, metal bearing atmospheric particulate matter (PM) is linked to adverse health effects including pulmonary and cardiovascular diseases, central nervous system diseases, and strokes. AK steel, a leading steel plant in the US, is located in Middletown, southwest Ohio, and surrounded by residential areas that could be impacted by emissions from AK Steel.

We employed lichen biomonitoring to assess the quality of air in Middletown. Major and trace element abundances were measured by ICP-OES. Particulate matter (PM) from each source was acquired by a Sigma-2 passive sampler, which accumulates dry deposition (dust) during the collection period. Particle morphology, size distribution, and chemical compositions were determined by SEM/EDX.

Cobalt, Mn, Ni, Cr, V, and Zn concentrations decrease with increasing distance from the Steel plant. Iron, Pb, Mo, and V show minor to moderate enrichments compared to the background, while Cr, Mn, Ni, and Zn display a wide range of enrichment factors (EFs) and show moderately severe to severe enrichment in some areas. Microscopic investigations of dust samples confirm an abundance of Fe and Mn-rich particles, consistent with steel production emissions.

Preliminary Pb isotopic data indicate that Pb isotopes can be used to distinguish between various potential sources atmospheric pollution in this area.