Spatial and Temporal Variation of Elemental Deposition in Maricopa County

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INTRODUCTION

Lichens have been used extensively as bioindicators of air pollution. They are differentially sensitive to various gases or pollutants, such as SO2. In addition, they accumulate and transpire high levels of elements from atmospheric deposition. Spatial and temporal deposition patterns over several years can be gleaned from elemental levels accumulated by lichens. Advantages to using lichens as surrogate atmospheric deposition receptors include:

• their ability to accumulate elements to concentrations that vastly exceed their physiological requirements through particulate entrapment and ion uptake mechanisms.

• their lack of roots and minimal interaction with the soil (many are epiphytes and/or occur on rocks), resulting in a almost total dependence on an atmospheric source of nutrients.

• their wide-spread distributions that allows investigation of one species at many different locations.

• their perennial nature (often living decades to hundreds of years) and slow growth rate, resulting in their morphology remaining relatively unchanged with time.

• their widespread distribution that allows investigation of one species at many different locations.

• their lack of stomates and waxy cuticle that allows elemental uptake across their entire surface.

METHODS

Samples of lichens (Xanthoparmelia spp., see picture below) were collected between February and April, 1998 from 32 sites throughout Maricopa County (map in figure 1). Twenty-five of the sites had been previously collected for lichens by Nash (1975) and seven additional sites were added to increase spatial resolution. Several different procedures for wet digesting lichens were tested for recovery of known standards for several elements. After cleaning and wet digesting, samples were analyzed for Sr, Cr, Ni, Co, Cu, Zn, Ag, Cd, Sn, Sb, Ce, Pr, Nd, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Au and Pb via inductively coupled plasma mass spectrometry (ICP-MS). Patterns were identified by using cluster and principal component analysis, means could be compared relative to the new 1998 data.

SPATIAL PATTERNS 1998

CONCLUSIONS

Copper:
Spatial:
Concentrated in copper mining regions and north of old smelter.
Temporal trends:
Levels remain fairly constant for most parts of the county. A sharp decline in the south is related to closure of Ajo smelter in 1986.

Lead:
Spatial:
Concentrated in the Phoenix metropolitan area.
Temporal trends:
Lead levels dropped substantially (except in station #02), which is probably due to the shift from leaded to unleaded gasoline in the 1970’s and 1980’s.

Zinc:
Spatial:
Concentrated in metropolitan areas and adjacent agricultural areas.
Temporal trends:
Zinc levels have increased by 116 – 246 %, due to new industrial (coatings), traffic and agricultural inputs.

Principal Component Analysis

Three major factors help explain observed spatial patterns. Rare earth element component representing widespread dust derived from geological materials. Cu, Cr, Ni and Se component derived from a restricted geological deposit.

Overall:
A traditional gradient approach is unsatisfactory to explain complex atmospheric fallout patterns in Maricopa County. Most elemental concentrations found in this study are within the range of values reported for unpolluted to slightly polluted areas.

Major air pollution sources in Maricopa County are: (1) traffic, (2) agriculture, (3) mining, and (4) industry.

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