

NPS/USGS Cooperative Biochemistry Studies

By Larry Jackson

In 1983 the USGS and the NPS signed an interagency agreement which facilitates joint investigations of the influences of human-induced (anthropogenic) atmospheric emissions of trace metals and sulfur on vegetation and soils in and near selected NP lands. Studies are in progress or have been completed at Theodore Roosevelt, Big Thicket, Redwood, Great Smoky Mountains, Everglades/Biscayne, Wrangell-St. Elias, and Denali NPs and the Santa Monica Mountains NRA. Studies have focused on developing baselines for various chemical elements to be used in assessing environmental degradation, in examining spatial trends of plant and soil chemistry with respect to contamination sources, and in investigating biogeochemical processes that influence our ability to discriminate between elements of natural and anthropogenic origin.

While study designs and specific objectives differ from one park region to another, establishing baseline geochemical and biogeochemical levels has been an important starting point for each project. Elemental content of soils and vascular plants, lichens, and mosses have been used to establish modern-day baseline ranges and to examine the spatial and temporal variability of specific element concentrations. Regardless of the source of contamination, it is difficult to assess the extent of contamination without an understanding of a background value. It is virtually impossible, however, to obtain a true "background" value. The historical data simply do not exist. Attempts have been made at estimating background values by analyzing certain plant specimens, by making comparisons with the most pristine locations from around

the world, and by a variety of other techniques.

An alternative to estimating a true background element concentration (before any human impact) is to determine a contemporary baseline range against which future changes may be measured. For the areas in which we have had research projects, there are almost no chemical data that indicate the magnitude of element concentrations or the spatial or temporal variability against which comparisons may be made. Although the elemental content of a particular plant species may have been measured at a different location, differences between regions and even between micro-habitats may significantly affect the elemental content of plants or soils. Hence, we have worked to establish a reference point for a particular region at a specific time. In our work, this has been defined usually as the 95 percent expected concentration range for an element in a specific plant species, plant part, or soil horizon at a specific time.

Seasonal cycling of elements or other episodic changes in element content may produce a significantly different baseline range; thus, it is important to understand the processes controlling element mobility in an environment in order to use ranges that are measured for one particular point in time. In addition to establishing elemental baseline ranges, these studies have helped to understand the impact from point pollution sources (such as from a chemical spill) and non-point pollution sources (such as from the widespread application of insecticides) and to define future research needs for biomonitoring programs.

The establishment of element baseline ranges is typified by our work in Theodore Roosevelt.

Redwood, and Denali NPs where lichens and mosses are being used as air quality monitors. Scales of spatial variability in element concentrations in *Parmelia sulcata* and *Parmelia chlorochroa* in Theodore Roosevelt NP, *Hypogymnia enteromorpha* and *Usnea* spp. in Redwood NP, and *Peltigera aphthosa* and *Hylocomium splendens* in Denali NP were examined using analysis of variance sampling designs. Baseline element concentration ranges were determined for those elements which did not exhibit large geographical concentration trends and for which analytical measurement error was not a large proportion of the total element variability.

Similar studies have been done in Everglades NP and Santa Monica Mountains NRA to establish baseline element concentration ranges for vascular plants. In the Santa Monica Mountains *Ceanothus megacarpus* and *Rhus laurina* were sampled and analyzed. Large seasonal differences in some nutrient and nonessential element concentrations were observed in the two chaparral species. In addition, some spatial trends were noted which may be due to their proximity to anthropogenic emissions or differences in the geochemistry of the soils throughout the region. These seasonal and spatial trends make the establishment of baseline ranges difficult. These trends also point to the importance of understanding the processes controlling biogeochemical cycling in an individual environment in order to have an effective biomonitoring program.

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Selected References

- Crock, J.G., Beck, Katy, Fey, D.L., Hageman, P.L., Papp, C.S., and Peacock, T.R., 1992. Element concentrations and baselines for moss, lichens, spruce, and surface soils, in and near Wrangell-Saint Elias NP and Preserve, Alaska: USGS Open-File Report 92- (in press).
- Crock, J.G., Gough, L.P., Magis, D.R., Curry, K.L., Fey, D.L., Hageman, P.L. and Welsch, E.P., 1992. Element concentrations and trends for moss, lichen, and surface soils in and near Denali NP and Preserve, Alaska: USGS Open-File Report 92-323, 149 p.
- Gough, L.P., Jackson, L.L., Bennett, J.P., Severson, R.C., Engleman, E.E., and Briggs, P.H., 1986, The regional influence of an oil-fired power plant on the concentration of elements in native materials in and near south Florida national parks: USGS Open-File Report 86-395, 63 p.
- Gough, L.P., Severson, R.C., and Jackson, L.L., 1988. Determining baseline element composition of lichens. I. *Parmelia sulcata* at Theodore Roosevelt NP, North Dakota: Water, Air, and Soil Pollution, v. 38, pp. 157-167.
- Gough, L.P., Jackson, L.L., and Sacklin, J.A., 1988. Determining baseline element composition of lichens. II. *Hypogymnia enteromorpha* and *Usnea* spp. at Redwood NP, California: Water, Air, and Soil pollution, v. 38, pp. 169-180.
- Jackson, L.L., and Gough, L.P., 1988. The use of stable sulfur isotope ratios in air pollution studies: an ecosystem approach in South Florida in Rundel, P.W., Ehleringer, J.R., and Nagy, K.A., eds., Stable Isotopes in Ecological Research: New York, Springer Verlag Publications, pp. 471-490.
- Jackson, L.L., and Gough, L.P., 1991. Seasonal and spatial biogeochemistry trends for chaparral vegetation and soil geochemistry in the Santa Monica Mountains National Recreation Area, CA: USGS Open-File Report 91-0005, 113 p.