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13. Supported by NSF grant GA-15226. Contribution No. 1555 from the Rosenstiel School of Marine and Atmospheric Science, University of Miami.

21 July 1972

Lead Aerosol Baseline: Concentration at White Mountain and Laguna Mountain, California

Abstract. *The lead aerosol concentration at White Mountain, California, may be regarded as the present baseline concentration for atmospheric lead for the continental United States. The seasonal trend of lead aerosols at White Mountain and Laguna Mountain shows a summer maximum and a winter minimum. This is because both mountain sampling sites are well above the thermal (radiation) inversion, which normally occurs in the winter, trapping pollutants below the inversion boundary.*

For evaluating the extent of lead aerosol contamination, it is desirable to know the continental lead aerosol baseline concentration. The natural lead concentration of the pristine atmosphere has been estimated from geochemical data (*1*) to be 0.0006 μg per cubic meter of air. Measurements of lead aerosols in the marine and arctic atmospheres show the following concentrations: north central Pacific Ocean, 0.0010 (*2*); windward Oahu, 0.0017 (*3*); south Indian Ocean, 0.0010 (*4*); north Indian Ocean, 0.0040 (*4*); Novaya Zemlya, 0.0002 (*4*); and Greenland, 0.0005 μg/m^3 (*5*).

Most lead aerosol concentrations over land areas were monitored in populous regions where the atmospheric lead concentration is usually in the range of several micrograms per cubic meter (*6*). The lowest lead aerosol concentration thus far reported on the continental United States was 0.022 μg/m^3 (*7*). We have determined the seasonal trend of lead aerosol concentrations at two mountainous locations which are virtually uninhabited and far above the thermal (radiation) inversion; their lead aerosol content may approach the continental baseline concentration.

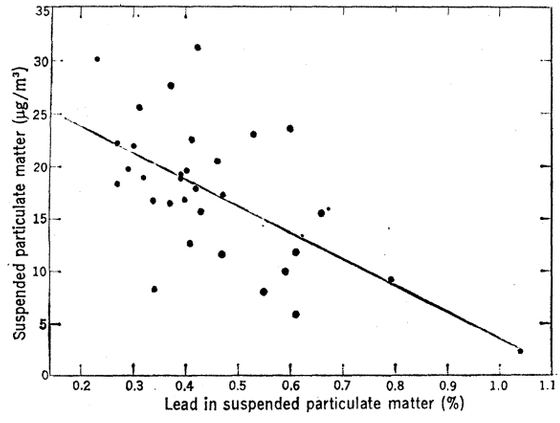

Fig. 1. Negative regression correlation between the percentage of lead aerosols and the concentration of suspended particulate matter at Laguna Mountain, California.

Barcroft Laboratory, a research station of the University of California, is located at 37°35′N, 118°15′W in the White Mountains, at an elevation of 3800 m; it is approximately 35 km north-northeast of and some 2530 m above Bishop, California. The laboratory is situated at the end of a seldom-used private road, with a locked gate about 3 km from the sampling site. The primary method of transportation to the laboratory is by helicopter from the university's Owens Valley Laboratory near Bishop.

Because of its high altitude and unusual geographic location, Barcroft Laboratory experiences extremes in meteorological conditions. The lowest temperature recorded at the laboratory was −37°C. Temperatures below freezing occur during any month of the year. The Sierra Nevada Mountains are between the White Mountains and the Pacific Ocean. The average annual precipitation at the laboratory is 48 cm, most of which falls as snow, which occurs even during the summer months. Snow usually covers the ground except during the three summer months. The average maximum wind from 1953 to 1969 (the mean of daily maximum 1-hour wind velocities) was about 43 km/hour, and the maximum wind (the highest 1-hour wind velocity) was 152 km/hour. About 60 percent of the wind is from the west or southwest. The average barometric pressure is 640 mb.

The Laguna Mountain sampling site is at the astronomical observatory of San Diego State University on the crest of the Peninsular Ranges; it is located at 32°51′N, 116°25′W, at an elevation of 1850 m. The San Diego metropolitan area is approximately 72 km west of this location. Automotive traffic is probably less than a dozen cars per week within 1 km of this location. Two kilometers west of the site is a mountain road with a daily traffic of 200 to 300 cars. The average barometric pressure is 815 mb.

The sampling, chemical, and mass spectrometric procedures have already been described (*8*). The samples consist of Millipore filters (type AAWP, 0.8-μm mean pore size) through which air is drawn by vacuum pumps. Each sample generally represents continuous filtration of air for 1 month. The two air samplers at the White Mountain research station have daily pumping rates of 17 and 25 m^3 of air, and the sampler at the Laguna Mountain site has a rate of 25 m^3/day. The lead contents were

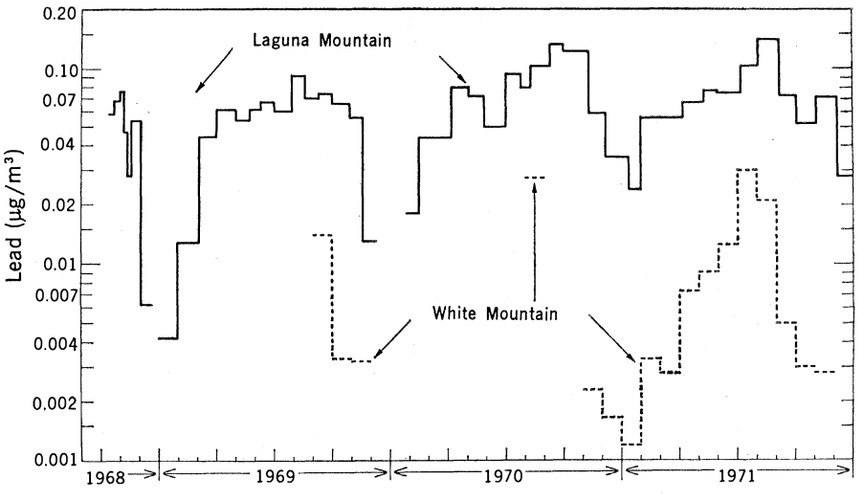

Fig. 2. Seasonal trend of lead aerosol concentrations at White Mountain and Laguna Mountain, California.

determined by the isotope dilution method.

Figure 1 represents the correlation between the percentage of lead present in the suspended particulate matter and the amount of total particulate in the samples taken at Laguna Mountain during a 3-year period. These two parameters show a negative regression relationship, which indicates that the two components originate from different sources. The suspended particulate matter is mainly composed of siliceous dusts and fine flakes of muscovite from the windblown soil. Analyses of soil samples from Laguna Mountain and White Mountain showed lead contents of 6 and 8 parts per million, respectively. The lead aerosols, which constitute 0.22 to 1.1 percent of the suspended particulate matter in the atmosphere at Laguna Mountain, could not possibly be derived from airborne local soil. The lead aerosols more likely originate from the combustion exhaust of automotive fuels in distant cities and are eventually diffused to these locations.

Figure 2 represents the seasonal trend of monthly average lead aerosol concentrations at the White Mountain and Laguna Mountain stations. The White Mountain site is the highest-altitude station for continuous year-round air sampling in existence. A severe winter resulting in loss of electrical power at the White Mountain laboratory curtailed sampling during part of 1969 and 1970. For 1971 the lead aerosol concentration at White Mountain ranged from 0.0012 to 0.029 $\mu g/m^3$, and the annual average was 0.0080 $\mu g/m^3$. The lead aerosol concentrations at Laguna Mountain ranged from 0.0040 to 0.141 $\mu g/m^3$ for 1969, 1970, and 1971, and the annual averages were 0.048, 0.070, and 0.069 $\mu g/m^3$, respectively. The lead aerosol concentration at White Mountain was lower than that at Laguna Mountain because the former location is at a higher altitude and farther away from sources of pollution than the latter. However, both mountain sites showed the seasonal trend, with a minimum lead concentration in the winter months, a gradual increase in the spring, and a maximum during the summer and early autumn. This trend of summer maximum and winter minimum is the reverse of what we have observed at San Diego (*8*); this is because our San Diego stations are located near the seashore, with summer sea breezes dispersing the lead aerosols, and the thermal (radiation) inversions, which commonly occur in the winter, trapping the lead pollutants in the atmosphere. The sampling sites at Laguna Mountain and White Mountain are well above the thermal inversion boundary, which reaches an altitude of 200 to 1000 m. However, summer traffic on the mountain roads and near the sampling sites may also contribute to the summer maximum.

The annual average lead aerosol concentration at the White Mountain station, which is 0.0080 $\mu g/m^3$, may be considered as the present baseline concentration for atmospheric lead for the continental United States.

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Siliceous Algal and Bacterial Stromatolites in Hot Spring and Geyser Effluents of Yellowstone National Park

Abstract. *Growing algal and bacterial stromatolites composed of nearly amorphous silica occur around hot springs and geysers in Yellowstone National Park, Wyoming. Some Precambrian stromatolites may be bacterial rather than algal, which has important implications in atmospheric evolution, since bacterial photosynthesis does not release oxygen.* Conophyton *stromatolites were thought to have become extinct at the end of the Precambrian, but are still growing in hot spring effluents.*

Growing algal and bacterial stromatolites (*1*) composed of nearly amorphous silica occur in the alkaline effluents of hot springs and geysers in Yellowstone National Park, Wyoming (see Fig. 1). They are the subjects of a continuing study, but because of their significance for current research programs we are reporting our first results here. These are: (i) The stromatolites are primarily siliceous. (ii) Photosynthetic flexibacteria are very abundant in the stromato-