

A COMPARISON OF MINOR TRACE CONTAMINANTS IN ATMOSPHERIC  
PRECIPITATION AND IN WATER SUPPLIES

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In recent years there has been increasing concern over the allowable concentrations of minor trace contaminants in drinking water. One source of these elements is the atmosphere, from which aerosols may be deposited in surface waters either by dry fallout or by entrapment in atmospheric precipitation. A survey of the concentrations of some minor contaminants in precipitation should indicate the possible importance of this second mechanism.

The National Precipitation Sampling Network is maintained by the National Center for Atmospheric Research, in cooperation with several other agencies. The network consists of approximately thirty stations fairly evenly distributed throughout the mainland United States, plus one station at Mauna Loa Observatory, Hawaii. At each station an automatic precipitation collector remains open during periods of precipitation only, thereby excluding dry fallout from the sample. The collected precipitation is mailed from each station to NCAR, where pooled monthly samples are analyzed.

Chemical analyses for the trace elements discussed are performed by atomic absorption preceded by an extractive concentration procedure (4).

Figures 1 through 4 show nationwide distributions of the elements from September 1966 to January 1967. The symbol representing a station indicates the grams of contaminant, as the metal ion, deposited on one hectare by one centimeter of precipitation. This figure, having the dimensions of concentration, is relatively independent of the total amount of precipitation and is representative of the contaminant concentration in the air. It is, however, not completely independent of the amount of rainfall since frequent showers keep the air cleaner and since contaminant concentration decreases with duration of a rainfall. The numeral under the symbol represents grams of contaminant deposited per hectare per month averaged over the five month sampling period. This figure is directly proportional to both concentration and quantity of rainfall.

Certain generalizations are evidently applicable to those metals. The northwest portion of the U. S. is conspicuously low in contamination. The northeast is relatively quite high. The southeast and southwest vary from low to moderate in contamination, depending upon the particular metal. The maps suggest that the concentration patterns of these minor trace contaminants could be engendered primarily by human activity. Concentrations tend to increase in areas of mining and manufacturing.

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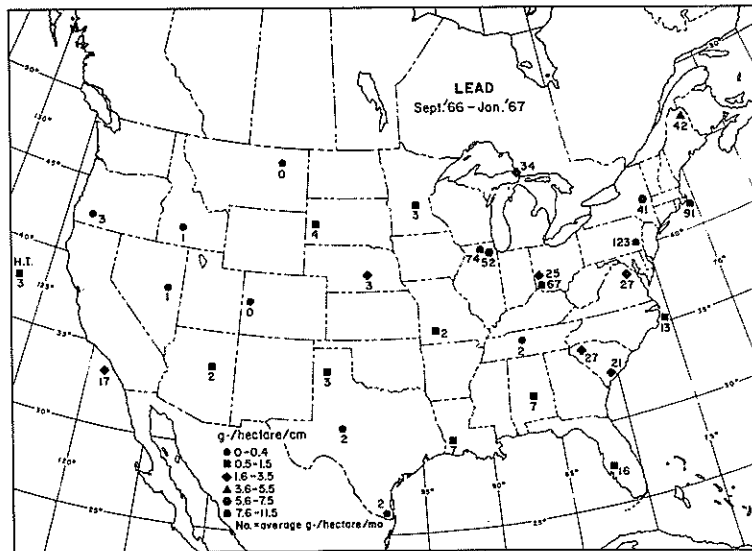


Fig. 1

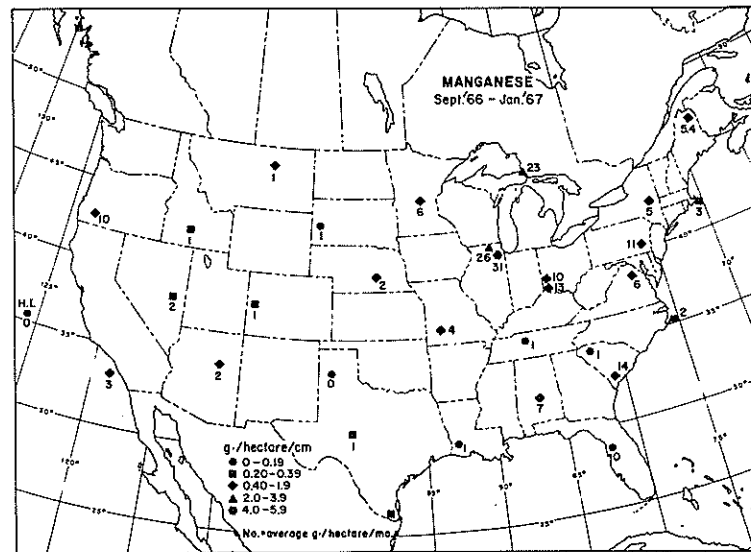


Fig. 2

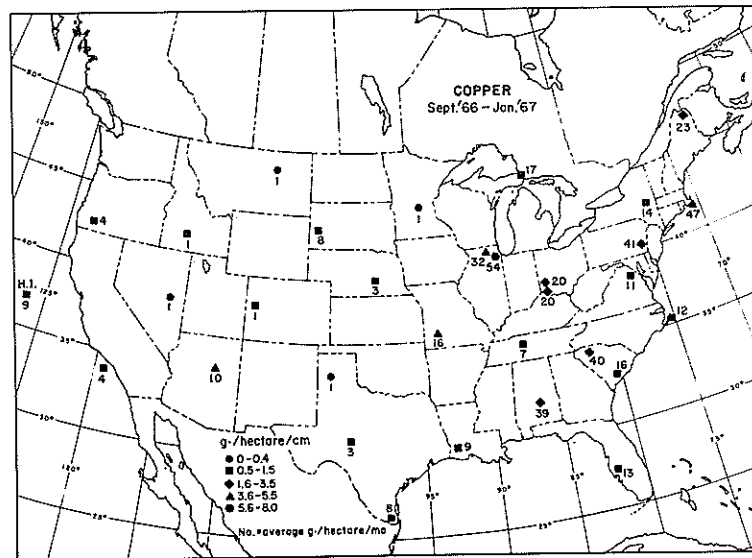


Fig. 3

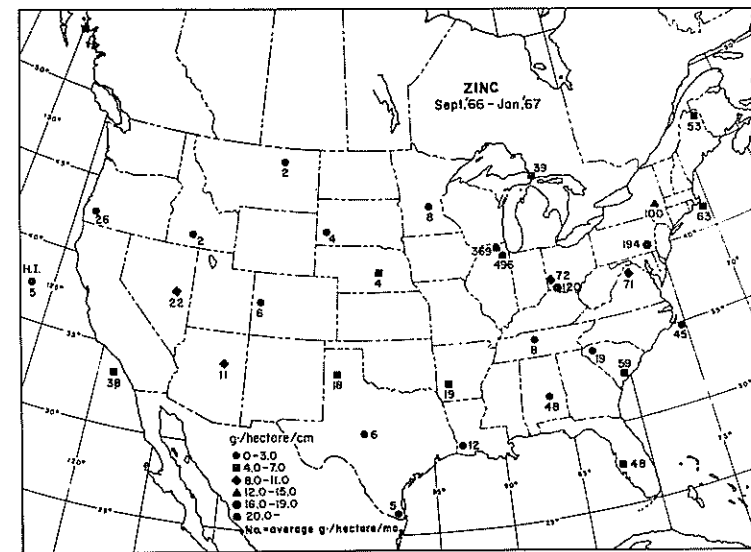


Fig. 4

Table 1 compares the average concentrations found in precipitation with those in surface water supplies before treatment (1). There is, on the average, twice as much lead in atmospheric precipitation as in the water supplies. This ratio implies the existence of a process whereby lead is depleted after precipitation reaches the surface. In the case of copper, the quantity found in precipitation could account for the average value found in surface water. Nickel and manganese, however, must have other sources in addition to atmospheric precipitation.

Only the lead average in precipitation comprises a significant percentage of the limits established by the U. S. Public Health Drinking Water Standards of 1962 (5). A plot of average lead values for the five month period against the quantity of leaded gasoline consumed in the county in which the sampling station is located, though showing considerable scatter, indicates a definite correlation, as might be expected, samples from areas where much gasoline is consumed tend to exert a large influence on the total lead average in precipitation. If median values, rather than averages, are compared the result is somewhat less startling. Both precipitation and the untreated water supplies have median lead concentrations of approximately 0.01 ppm.

Table 1

Trace contaminants in precipitation and in untreated water supplies

Element	A	B	C	$\frac{A}{C} \times 100$ %
	Average conc. in precipitation ppm	Average conc. in untreated water supplies ppm	U.S.P.H. conc. limits (1962) ppm	
Pb	0.034	0.017	0.05	68
Cd	0.0011	---	0.01	11
Mn	0.012	0.070	0.05	24
Cu	0.021	0.021	1.0	2
Zn	0.107	---	5.0	2
Ni	0.0043	0.0065		

A - Average of samples collected from Sept. 1966 through Jan. 1967

B - Average computed from data presented (1)

The appreciable lead contamination in precipitation is plausible in view of earlier investigations. Environmental lead contamination is widespread. Tatsumoto and Patterson (7) found lead concentrations in snow  $10^4$  greater than the amount attributable to naturally formed dust, in a remote area

500 miles east of the Los Angeles complex, at an altitude of 7,000 ft. The same authors estimate that the concentration of lead in the surface layer of the Pacific Ocean off the coast of southern California has increased tenfold during the past three or four decades. Their calculations indicate that the input of lead into the atmosphere by combustion of leaded gasoline could account for this observation (6).

Ettinger has previously discussed likely sources of lead contamination in water supplies (3). Large industrial complexes, with associated high consumptions of coal and leaded gasoline, do not necessarily cause appreciable dissolved lead enrichment of nearby water supplies. Samples showing high lead concentration had been exposed to contamination by metal-working and chemical industries. Apparently, natural processes control the concentration of dissolved lead in surface water. Ettinger concluded that only a fraction of lead in surface water remains dissolved, and that low turbidity of drinking water reduces the likelihood of the consumer's exposure to lead.

The median value for lead in drinking water, according to Durfor, is only 3.7 ppb (2). Our observations indicate that lead content of rainfall in urban areas may exceed the limit for drinking water by several hundred percent.

#### REFERENCES

1. Durfor, C. and E. Becker, Geological Water Supply Paper, No. 1812, 1964.
2. Durfor, C. and E. Becker, J. Am. Water Works Assoc., 56, 237 (1964).
3. Ettinger, M. B., Symposium on Environmental Lead Contamination, Public Health Service Pub. No. 1440. 1966.
4. Lazrus, A. L., E. Lorange, and J. P. Lodge, Jr., in preparation.
5. Public Health Service Drinking Water Standards, 1962, Public Health Service Pub. No. 956, 1962.
6. Tatsumoto, M. and C. Patterson, Nat'l. Acad. Sci. - Nat'l. Res. Council Pub. No. 1075, Report No. 38, 167 (1963).
7. Tatsumoto, M. and C. Patterson, Nature, 199, 350 (1963).

## C A R E E R O P P O R T U N I T I E S

A joint panel on Research Needs and Career Opportunities in the Water Resources Area was conducted to call the attention of students to these fields.

The following men presented papers in this panel discussion:

### Career Opportunities in the Water Resources Field:

Lloyd Calhoun

New Mexico Electric Service, Hobbs

Frank O. Elliott

New Mexico Oil and Gas Association, Roswell

Francis C. Koopman

Water Resources Division, U. S. Geological Survey, Albuquerque

Conrad G. Keyes

Civil Engineering, NMSU

### Career Opportunities in the Water Research Field:

E. D. Eaton

Office of Water Resources Research, Department of Interior,  
Washington, D. C.

P. J. Leyendecker

Director, Agricultural Experiment Station, NMSU

C. E. Jacob

Coordinator of Research, NMIMT, Socorro

Frank B. Titus

Graduate Student, University of New Mexico