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**United States Department of the Interior**  
ROGERS C. B. MORTON, *Secretary*



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## ABSTRACT

Mercury determinations for 912 samples of soils and other regoliths from sites approximately 50 miles apart throughout the United States are represented on a map by symbols showing five ranges of concentration. A histogram of mercury concentrations in the samples is also given. The geometric mean concentration of mercury is 71 parts per billion for all samples, 96 ppb for samples from the Eastern United States, and 55 ppb for samples from Western United States. Twelve samples contained at least 1,000 ppb mercury; the greatest concentration found was 4,600 ppb.

## INTRODUCTION

The concentrations of 34 elements (excluding mercury) in samples of soils and other regoliths from sites about 50 miles apart on routes of travel throughout the conterminous United States were reported by Shacklette, Hamilton, Boerngen, and Bowles (1971). Only after that report had been prepared were analytical methods made available for detecting mercury and some other elements in surficial materials collected for this study. Because of the current widespread interest in the mercury concentration in natural materials, the samples from the earlier study, as well as some additional samples, have been analyzed for mercury. The samples were collected and prepared for analysis in the same manner as reported earlier (Shacklette and others, 1971) and were analyzed in randomized sequence. Mercury concentrations in the samples were determined by using the method described by Vaughn and McCarthy (1964). The lower detection limit of this method

for these materials is 10 ppb (parts per billion,  $1 \times 10^{-9}$  gram per gram).

Mercury analyses of soils and other surficial materials that were reported in the literature commonly were performed for use in mineral exploration or for detecting areas of suspected mercury contamination. A summary of the reports of mercury in natural materials was given by Fleischer (1970). References to reports of mercury in rocks, soils, and stream sediments were presented by Pierce, Botbol, and Learned (1970), who stated, "Statistics for only four sets of soil samples are available, and these suggest a background value of 500 ppb mercury for soils in Western United States." Shacklette (1965, p. C10) reported that soils overlying cinnabar deposits may contain as much as 40,000 ppb mercury in their A<sub>2</sub> and B horizons. In a study of roadside contamination in Missouri, mercury concentrations in samples of soils were found to range from 40 to 650 ppb (Shacklette, 1970). Worldwide "average" (presumably, arithmetic mean) concentration of mercury in soils was reported by Vinogradov (1959, p. 184) to be 10 ppb and by Hawkes and Webb (1962, p. 369) to range from 30 to 300 ppb.

Although most samples of this study were collected along roads, the specific sampling sites were selected to represent surficial materials that were, insofar as possible, but little altered from their natural condition. Some samples, of necessity, were collected in cultivated fields; the degree of contamination of these samples, and

of some from roadsides, cannot be evaluated from the data at hand. Surficial materials analyzed in this study were ordinarily sampled at a depth of 8 inches. We believe that soils and other regoliths from this depth commonly show little or no effects of surficial contamination that may have occurred.

Many geologists and others of the U.S. Geological Survey assisted this study by collecting samples along routes of travel to areas of other kinds of field studies; this assistance, and that of computer specialists, was acknowledged in the earlier report of this sampling program (Shacklette and others, 1971). Additional samples for this study of mercury in surficial materials were collected by R. N. Eicher, R. F. Gantner, J. A. Erdman and J. R. Keith, and J. J. Connor and H. T. Shacklette. The mercury analyses were performed by R. L. Turner.

### RESULTS OF ANALYSES

The mercury values were transformed to a logarithmic form because the frequency distribution is more nearly symmetrical on a logarithmic scale than on an arithmetic scale. The best measure of central tendency in a lognormal distribution is given by the geometric mean, which is the antilogarithm of the mean logarithm. An estimate of the arithmetic mean was derived from the data by the use of Sichel's (1952) technique. These methods of statistical evaluation are the same as those used for evaluating other elements in the samples (Shacklette and others, 1971).

We measured the precision of the analytical method for mercury by analyzing 47 randomly selected samples in duplicate. The 47 duplicates were randomly interspersed among the other 912 samples and were unknown to the analyst. The logarithmic variance of the analytical method is 0.0689. This means that the analyses are reproducible within a factor of 1.83 at the 68-percent level of confidence, or within a factor of 3.35 at the 95-percent level.

Statistics for the mercury concentration of all samples, as well as of samples from both east and west of the 97th meridian, are given in table 1. Shown in figure 1 are the distribution of the sampling sites throughout the conterminous United States and the mercury concentra-

tions of the samples expressed in terms of five geometric ranges of concentration.

TABLE 1.—Concentrations of mercury, in parts per billion, in samples of soils and other surficial materials from the conterminous United States

[Number of samples is given in parentheses after area]				
Area	Range	Geometric mean	Geometric deviation	Arithmetic mean
Entire conterminous United States (912)	<10-4,600	71	2.60	112
Western United States, west of the 97th meridian (492)	<10-4,600	55	2.46	83
Eastern United States, east of the 97th meridian (420)	10-3,400	96	2.53	147

### DISCUSSION OF RESULTS

The arithmetic mean concentration of mercury in the samples analyzed for this report (112 ppb) falls within the range of values reported for Missouri soils by Shacklette (1970, p. 35) and for soils used in geochemical prospecting as reported by Hawkes and Webb (1962, p. 369). This concentration, however, is much greater than the average (10 ppb) reported for worldwide soils by Vinogradov (1959, p. 184).

The difference in geometric mean concentrations of mercury in samples from the Eastern and Western United States (table 1) is statistically significant at the 99.9-percent confidence level. The mean concentration of mercury in surficial materials from the Western United States is much less than the background value (500 ppb) suggested by Pierce, Botbol, and Learned (1970, p. 14) for soils from the same region.

The greatest mercury concentration found in surficial materials was in a sample from Summit County, Utah, that contained 4,600 ppb. This sample contained no visible organic materials. The greatest concentration found in surficial materials from the Eastern United States was in a sample from Walton County, Fla., that contained 3,400 ppb mercury. This sample, which consisted of organic-stained sand, was from an area of humate deposits that were described by Swanson and Palacas (1965). An additional sample, collected at the same locality, contained 2,000 ppb mercury.

Other high mercury concentrations were found in samples from Cameron Parish, La. (2,500

ppb); Monterey County, Calif. (1,500 ppb); Eagle County, Colo. (1,300 ppb); Presque Isle County, Mich. (1,200 ppb); Menominee County, Mich. (1,200 ppb); Pacific County, Wash. (1,200 ppb); Chelan County, Wash. (1,200 ppb); Charlton County, Ga. (1,000 ppb); Aitkin County, Minn. (1,000 ppb); and Santa Clara County, Calif. (1,000 ppb). These samples from Michigan, Minnesota, Louisiana, and Georgia were of mucks, bog soils, or dark organic-stained sands, and their mercury contents suggest that this metal was enriched in the organic materials that were present. The samples from California, Colorado, and Washington were not noted to have a high organic content; their high mercury concentrations may be due to a high mercury content of underlying geologic materials or to pollution.

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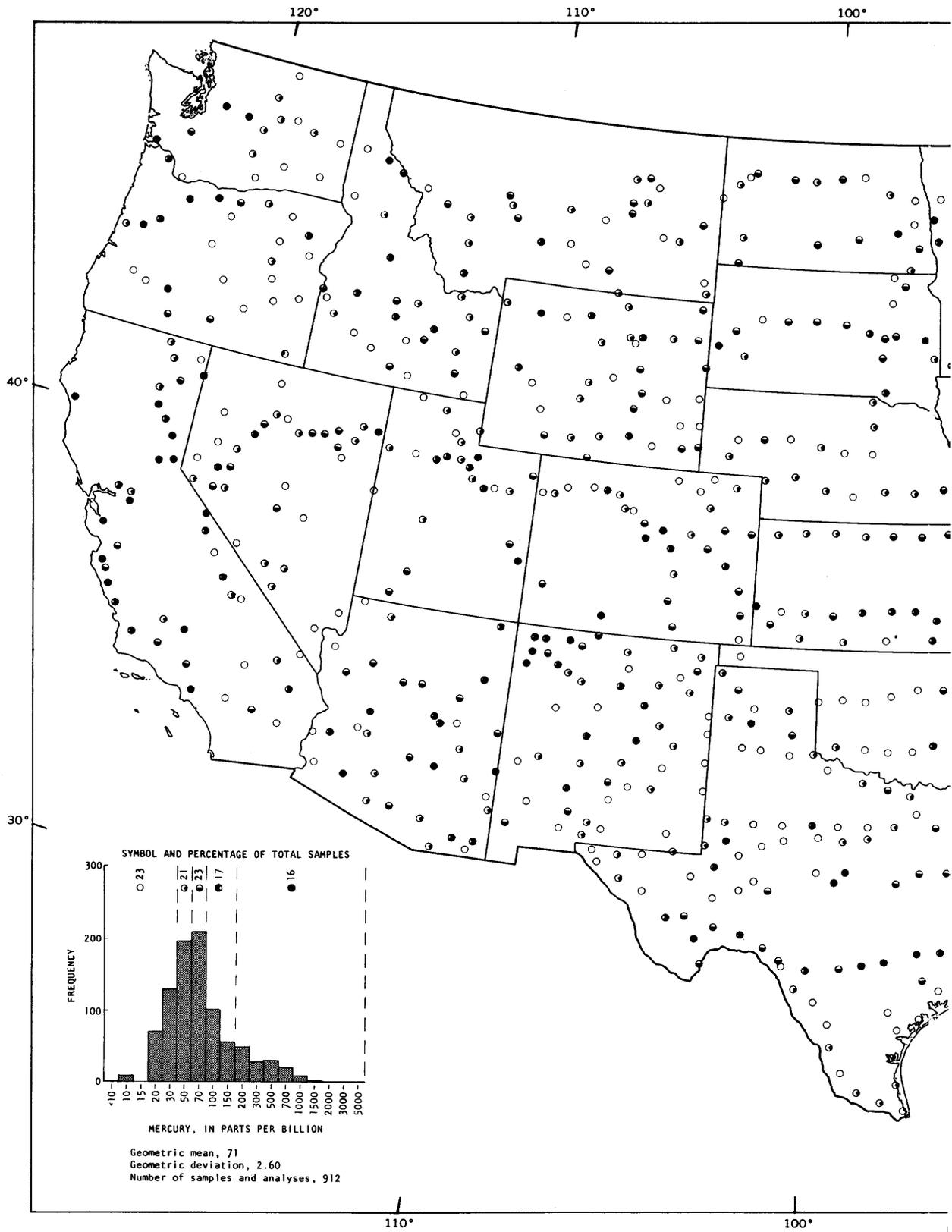
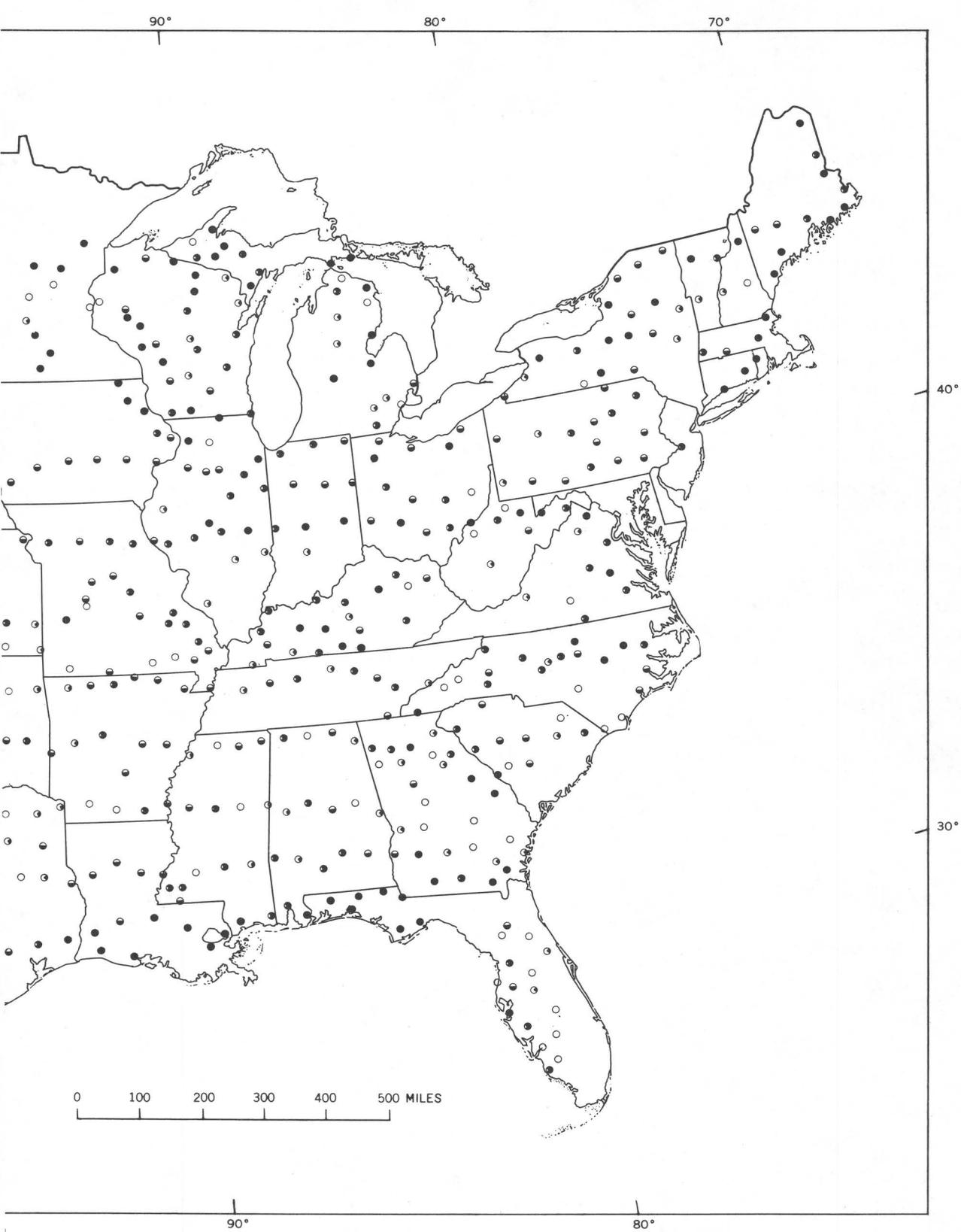


FIGURE 1.—Mercury concentrations in surficial



materials from the conterminous United States.

