

LEAD — DANGEROUS POLLUTION

Clair Patterson, senior research fellow in geochemistry, has been studying trace occurrences of lead in the earth and the ocean. In the course of this work, he has found that there is a profound quantitative influence of industrial lead contamination in the oceans and atmosphere of the Northern Hemisphere. Moreover, Dr. Patterson challenges two commonly held beliefs: (1) that industrial and natural sources contribute more or less equal amounts of lead to the body burdens of the general population, and (2) that the current average ranges of lead concentrations in the blood are essentially "natural" levels, and, hence, safe. Actually, current lead blood levels suggest that the average American is being subjected to severe, chronic lead "insult."

A danger of lead poisoning is that it can attack the central nervous system. The classical symptoms are increased irritability and decreased ability of the brain to function properly. It is possible that similar impairments on a lesser, but still significant, scale might occur in persons subjected to severe, chronic lead insult. While much more must be learned about the metabolism of lead in the human body, it is known that absorbed lead accumulates in the body, and may be stored in the skeleton.

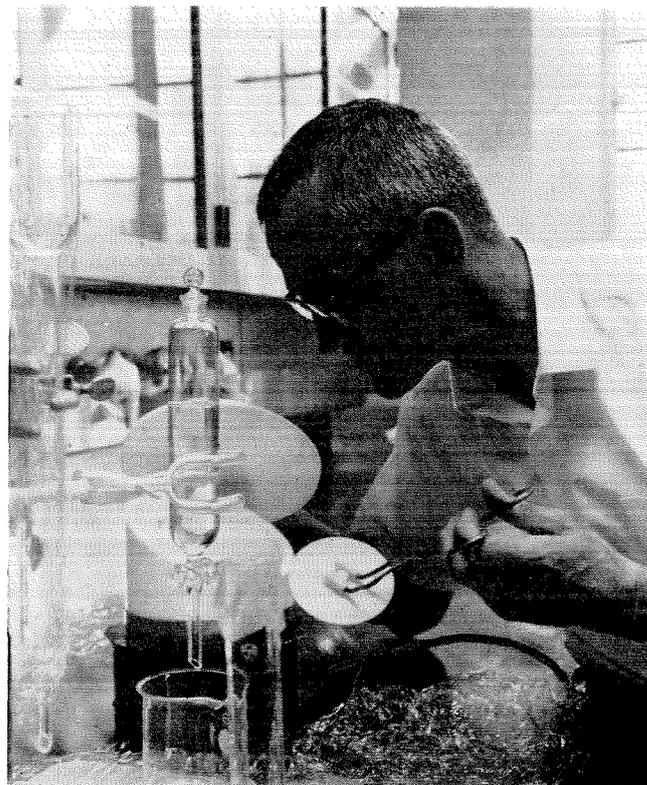
Dr. Patterson points out that it would be tragic if it were recognized many decades from now that large segments of our population had suffered needlessly because the early warning signs now being seen went unheeded. He emphasizes that current average lead concentration in the blood (0.25 ppm) is approaching the recognized threshold level (0.5 to 0.8 ppm) of lead poisoning, and may be 100 times the level that humans had at the time the physiological responses to lead were being developed.

Evidence that lead pollutants are not from natural sources is found in samples taken by Dr. Patterson and colleagues Dr. Tsaihua J. Chow at the University of California's Scripps Institute of Oceanography, and Dr. M. Tatsumoto of the U.S. Geological Survey in Denver. The samples show that the lead collected from three diverse sources (air in Los Angeles; gasoline in San Diego; and snow on a high, isolated slope of Mount Lassen) is identical isotopically, but different from samples

of lead deposited on the ocean floor near California in prehistoric times.

In work sponsored by the U.S. Public Health Service and the Atomic Energy Commission, Dr. Patterson and his colleagues have found that the industrial production of lead today is 100 times greater than the natural flow of dissolved lead salts into all the oceans of the earth, and that the atmosphere now contains thousands of times more lead than it did in pre-industrial periods. Evidence has been found recently in samples taken from various levels in the Greenland ice sheet, of a substantial increase in lead in the snow for the last several decades. Further samples taken at a more remote location in Greenland are currently being analyzed, and Dr. Patterson will take samples in the place most remote from civilization — Antarctica — in the near future.

The difference between *natural* and *typical* levels of lead concentrations and absorptions is the difference between pre- and post-industrial production of lead in large quantities. Typical levels of



Clair Patterson, senior research fellow in geochemistry

*Comparison of Lead Absorption in Humans
in Natural and Typical Environments*

Source	Uncontaminated Man (micrograms/day)	Contaminated Man (micrograms/day)
Food	1	20
Water	0.05	1
Air	0.004	10 (urban) 1 (rural)
Tobacco (1½ packs/day)	---	10

lead in man and his environment may, therefore, be greatly different from natural levels. While actual measurements of natural levels may be available in the future from such things as frozen mammoth tissues, dated mammalian teeth and bones preserved in arid cairns, and tree rings, they can only be estimated reliably by geochemical means now.

As shown above, man today absorbs 20 times as much lead in food and water as he did in an inferred natural environment, and he absorbs over 2000 times as much lead from the air he breathes if he lives in an urban area. As shown below, discussions of absorption are more significant than those of ingestion because the system disposes of lead taken into the body with different efficiencies. Thus, lead in food is more easily passed out of the body than is lead in air, which has to pass into the bloodstream before elimination.

*Ingestion and Absorption of Lead
for a Typical Human*

Substance	Lead Ingested (micrograms/day)	Fraction Absorbed	Lead Absorbed (micrograms/day)
Food	400	0.05	20
Water	10	0.1	1
Urban air	26	0.4	10
Rural air	1	0.4	0.4
Tobacco smoke (1½ packs/day)	24	0.4	10

Dr. Patterson has used gradational relations of chemical properties and observed abundances among the metals mercury, thallium, bismuth, germanium, tin, calcium, strontium, and barium in man and his environment to infer natural levels of lead.

Some striking differences between inferred natural and existing conditions of lead contamination are that:

- (1) Existing average body burdens of lead are about 100 times larger than natural burdens.
- (2) Existing rates of average lead absorption are about 30 times higher than natural rates.
- (3) Existing atmospheric sources of lead make highly significant contributions to absorbed lead, while such sources make insignificant contributions under natural conditions.

Sources of Contamination

Air. The principal sources of lead in the atmosphere are lead alkyls (the result of burning leaded gasolines in automobiles), coal flyash, and lead paint dust. Of these, lead alkyls contribute about 100 times as much absorbable lead as the other two.

Although not actually an atmospheric constituent, lead in tobaccos (present from insect-spraying with lead arsenate) is also ingested through the respiratory system. The amount of lead absorbed into the body by smoke inhalation (for 1½ packs of cigarettes a day) is equivalent to the absorption of lead from all other sources in the urban air.

Food. Although most food is grown in rural areas, it doesn't escape considerable fallout of decomposed lead alkyls. In fact, the amount of fallout is over 1000 times the amount of lead actually ingested in food, so that contamination by only 0.1% of the fallout on crop lands may be significant. Studies made of strontium-90 retention in plants indicate, by analogy, that lead may be retained against rainfall runoff to the extent of about 10% on foliage, about 1% on fruits and pruned leafy vegetables, and 0.1% on edible parts of grains. This may yield about 1 ppm for foliage, 0.04 ppm for fruits and vegetables, and 0.01 ppm for grains.

Additional lead comes from solder used in canned food, and it appears quite possible that the amount of lead dissolved in the food in a medium-sized can could be as much as an entire day's intake from other sources.

Contamination from lead arsenate insecticides is not as significant as it was a few years ago because of the increasing use of organic insecticides. However, wherever it is used, concentrations of lead on the order of several ppm can be expected.

Additional contamination may come from lead used in ceramics and the production of tableware, glass, china glazes, and porcelain enamels for food processing equipment and kitchenware.

Water. It appears that concentrations of about 10 micrograms per liter in water result from a multitude of sources, including lead derived from atmospheric washout of lead alkyls and from lead service pipes in water systems.

Conclusions

With the exception of tobacco smoke, a large part of the lead ingested today can be traced to leaded gasolines used in automobiles. The remainder commonly originates from such sources as solder, lead arsenate, lead piping, and leaded glazes.