CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

GEOLOGICAL SCIENCES

January 9, 1964

Dr. R. A. Kehoe
College of Medicine
University of Cincinnati
Cincinnati 19, Ohio

Dear Dr. Kehoe:

The subject of this letter concerns some geochemical studies of lead and their relation to public health. Nuclear geochemists utilize lead isotopes as tracers to help understand the geological history of the earth, and marine leads are important because small smaples can represent vast portions of the earth's surface and thus are of general significance.

Find enclosed reports of some geochemical investigations of common lead in the oceans and in the atmosphere. During the course of this first serious geochemical investigation of common lead in the oceans it became evident that the magnitude (for the entire earth in prehistoric times) of the yearly flow of natural lead from eroded rocks, to rivers, to oceans, to sediments was much smaller than the magnitude of the present yearly production of industrial lead products such as insecticides, paints, and tetraethyl lead. It seemed probable that man is perturbing the marine geochemical cycle. The first enclosed report (on pelagic sediments) contains the information which led to this conclusion and, for convenience in reading, those portions of this enclosed report which concern this matter are indexed on the outside cover.

Stimulated by these earlier findings, some direct investigations of the concentrations of common lead in sea water were later pushed to a successful conclusion, and these are outlined in the second and third enclosed reports (the NRC xerox and the chapter from Houterman's birthday volume). Because of extreme difficulties associated with direct measurements of lead in sea water, the earlier extensive isotopic studies were made only indirectly upon lead-enriched ocean-bottom deposits, and although this later study reports the reliable analyses of water samples taken during only two cruises, it represents the culmination of years of analytical effort and samplings from many other cruises as well. The effects of industrial lead contamination were clearly observed in the oceans, and this report outlines some of the factors which are involved in considering pervasive pollution of the oceans by lead tetraethyl decomposition aerosols.

The fourth enclosed report attempts to generalize the observations over a larger world scale and also extends the investigations to include measurements of lead in snow. As might be expected, complexities become apparent in this study, but the general validity of earlier conclusions are substantiated by the finding of increased concentrations of lead in surface ocean waters near southern Europe, and especially by the discovery of extremely large amounts of industrial lead in snow from a remote rural area.

Although it was intended that this research investigate certain geochemical problems of a specialized nature, some parts of the work are nevertheless related to matters of public health. For example, we are given a better understanding of the relative magnitudes, on a world-wide scale, of natural lead and industrial pollutant lead in the seas and in the air. We have come to recognize that pollutant lead levels on a world-wide scale are tens to thousands of times larger than natural lead levels, and that the route: ore lead, to tetraethyl lead, to atmosphere, to seas is of major importance. In addition, techniques have been developed and used for the determination of lead concentrations by isotope dilution which are more sensitive and accurate at extreme low limits of concentrations than the colorimetric and spectrographic methods now used in public health work.

The large increases in lead concentrations which are observed in extensive surface layers of the oceans may be no cause for concern because dilution has reduced the absolute amounts to exceedingly small values. Urban atmospheres are an entirely different matter, however, since we observe a marked and widely dispersed lead pollution which originated in the air at a small number of very intense point sources which coincide with the locations of large fractions of human populations. In the past decade, concentrations of industrial lead in urban air have increased, while recommended permissable limits in city air have decreased precipitously. In view of these facts and the fact that concentrations of lead in the air of many urban areas now exceed a limit that permits an ingestion of no more than 30 micrograms of lead per day, there is real cause for alarm and concern. The immediate prohibition of the use of leaded automotive fuels seems called for.

For more than a decade investigators in the field of nuclear plumbology have been acutely aware of industrial lead contamination in the air because such research involves the study of the isotopic composition of microgram quantities of lead obtained from mineral samples of geochemical significance. Since lead occurs only as a trace constituent in minerals, there is usually more industrial lead contamination in the air than in the samples, and much time has been expended in devising methods of preventing air contamination from interfering with the analyses. These investigators are not toxologists, however, and most are basic research scientists, reluctant to divert much of their time to public affairs. When the California Institute of Technology News Bureau recently asked if they might put out a release on the work contained in the reports enclosed in this letter, I agreed, recognizing an unavoidable responsibility. Following the news release, a few persons in industry and in positions of responsibility related to toxicology and air purity standards have requested scientific reports. This letter is written to assist those few who are conscientiously attempting to understand the somewhat obscure problems of lead geochemistry. This letter has also been sent, unsolicited, to about two dozen additional persons of similar scientific responsibility in the United States, Canada, Japan, and Europe.

Sincerely,

Clair Patterson

Clair C. Patterson

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Enclosures