(Abstract)

Mercury: Its Occurrence and Effects in the Ecosystem

David B. Peakall and Raymond J. Lovett

Mercury was known to ancient civilizations and is a modern problem. It has been mined at Almaden, in Spain, for 27 centuries and its toxic properties were known to Hippocrates 400 years before the birth of Christ. In recent years mercury has become an environmental problem with many deaths in Japan (Minamata disease), banning of fishing in parts of Sweden, Canada, and the United States, and the closing of the game bird season in the prairie provinces of Canada.

The total world production of mercury during the period 1963-67 was 8 to 9 million kilograms (18 to 20 million pounds) per year. The U.S. usage of mercury during this period has been 2.2 to 2.7 million kilograms (5 to 6 million pounds) per year. King (1957) has estimated that 80 industries use mercury in more than 3000 different ways. The two biggest users of mercury in the United States are in electrical apparatus (13.1 to 19.9%) and in the electrolytic preparation of chlorine and caustic soda (10.2 to 20.6%). The usage of mercury as a fungicide over this period has varied from 81 to 127 thousand kilograms (180,000 lb. to 280,000 lb) (2.9-5.6% of total usage) in the United States (U.S. Bureau of Mines, 1967). Approximately half of the mercury used was recycled in 1967; there are reports that the situation has improved since then.

Unlike many global contaminators that are causing concern today mercury is naturally occurring. Beside the direct use of mercury by man, other human activities such as the burning of fossil fuel and land clearance leading to greater erosion increase the cycling rate of mercury. The overall cycling of mercury is given in Figure 1. The earliest definitive measurements are those of Stock and Cucuel (1934). At this time the world production of mercury was about a quarter of current levels. Stock and Cucuel gave a value of 0.03 ng/g for seawater (off Helgoland). In the Pacific Ocean, Hosohara (1961) found values of 0.15-0.27 ng/g at a depth of 3000 m. A look at Figure 1 suggests that man's activities are unlikely to affect the concentration in the oceans since the amount in the oceans is four orders of magnitude greater than man's annual usage. Stock and Cucuel (1934) gave a value of 1 ng/g for the River Rhine, which is high compared to values recently determined in Sweden where Johnels et al. (1967) give a value of 0.13 ng/g for an uncontaminated river and 0.25 ng/g for the Stockholm archipelago. Aidin'yan (1962, 1963) gives values of 0.4-3.0 ng/g for rivers in European Russia and states that the levels are much higher than those in other European rivers. Wershaw (1970), examining samples from 73 rivers in the United States, found 34 with less than 0.1 ng/g, 27 between 0.1 and 1.0 ng/g, and only two over 5 ng/g.

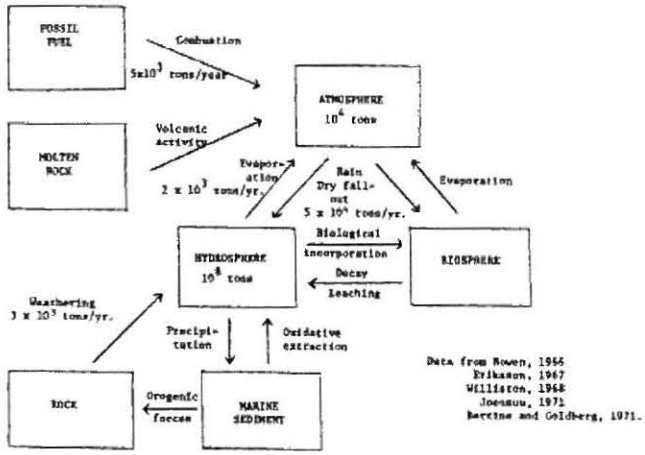
Determinations of concentrations of mercury in the air in the San Francisco Bay area have been made by Williston (1968). He found that levels ranged from 0.5-25 ng/m^3 in the winter and from 1-50 ng/m^3 in summer. Ocean winds lead to low readings, winds from industrial areas, to high but erratic readings. Smog was always associated with high readings. Twenty miles offshore values were 0.6-0.7 ng/m^3, indicating that most atmospheric mercury originates from the land.

Chemistry and Biological Transformation of Mercury

Mercury is unique in its power to form stable compounds with organic radicals. The number of compounds which can be formed is so large that mercury can be said to have an organic chemistry of its own.

There are many dozens of mercurials that have been used, to a greater or lesser extent, in agriculture. Broadly, they may be divided into three groups – alkyl, alkoxyalkyl, or aryl. Typical examples would be methylmercuric hydroxide, methoxyethylemercuric hydroxide, and phenylmercuric acetate.

The transformation of mercury compounds varies a great deal in terrestrial and aquatic environments. In aquatic environments mercury may be precipitated or methylated. The mercury in the sediment is often in the form of the



Notes: (1) Input and output into the atmosphere do not balance as no figures appear to be available for evaporation from the biosphere or for volcanic activity.

(2) Man's annual usage is 10^4 tons of which approximately half is re-cycled.

Fig. 1. Overall global cycling of mercury.

The authors are in the Section of Ecology and Systematics, Cornell University, Ithaca, New York 14850.

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