Trace-Metal Pollution– Sources, Routes, and Fates

On a clear day—
You may not be able to see forever on a clear winter day in Pasadena, but—looking across the Keck parking lot—you can see Altadena at the foot of the sharply delineated San Gabriel Mountains. The palm tree in the lower right-hand corner is almost the only identifiable feature in the photograph on the opposite page, taken on a smoggy summer day. The cause of the reduction in visibility is the high concentration of atmospheric particulate matter.

It's no secret—especially to southern Californians—that industry and automobiles discharge large amounts of pollution into the atmosphere. Of course, what happens next is not so clear, but now a group of Caltech researchers is trying to find out by studying the sources, routes, and fates of trace metals emitted into the air in the Los Angeles Basin.

Earlier research showed that 18 metric tons of lead are exhausted into the basin each day—12 tons deposited within the basin, and 6 blown out of it. Fallout measurements within a radius of about 150 kilometers (93 miles)—in the Mojave Desert, the Coachella Valley, the San Gabriel Mountains, and the coastal islands—account for less than 3 of those 6 tons. The other 3 are evidently transported more than 150 km before being removed from the atmosphere.

More lead is blown out of the Los Angeles Basin every day than is exhausted into the atmosphere in all of Riverside and San Bernardino counties and the Southeast Desert Air Basin. During daytime hours, polluted air generally moves east and north from Los Angeles, which means that Riverside and San Bernardino counties, which are downwind, cannot effectively control the amount of lead in their atmosphere by simply controlling local emissions. They must depend on the reduction of lead emissions in Los Angeles and Orange counties.

The analysis of pollutants that reach the coastal waters through rainout-washout, rainy weather runoff, dry weather runoff (from the watering of lawns, for example), treated sewage, and atmospheric fallout reveals that approximately 500 metric tons of lead enter the ocean annually. This breaks down into 30 tons from rainout-washout, 10 from dry weather runoff, 230 from treated sewage, and 70 from atmospheric fallout.

Obviously, since they play such an important role in transporting lead to the coastal waters, the atmospheric routes must be controlled as much as wastewater sources. Also entering the ocean each year—with sewage as the primary source—are 1,600 metric tons of zinc, 300 tons of nickel, and 30 of cadmium.

The flow of atmospheric zinc through the environment has also been studied in detail, and mass flow rates along the environmental pathways have been determined. The primary sources of atmospheric zinc are metallurgical operations, tire dust, and automotive exhaust. Most of the tire dust zinc is in large particles and deposits near roadways. Atmospheric nickel results primarily from combustion of fuel oil in power plants and other industrial operations.

These detailed studies of the flows of zinc, lead, nickel, and cadmium within the basin increase understanding of how trace metals move; and they also may make it possible to predict the behavior of other substances that might be introduced into the environment. The Caltech group hopes their research can eventually lead to effective regulation of toxic substances. It is increasingly clear to them that the environment must be considered as a unit when the effects of pollution are being assessed.

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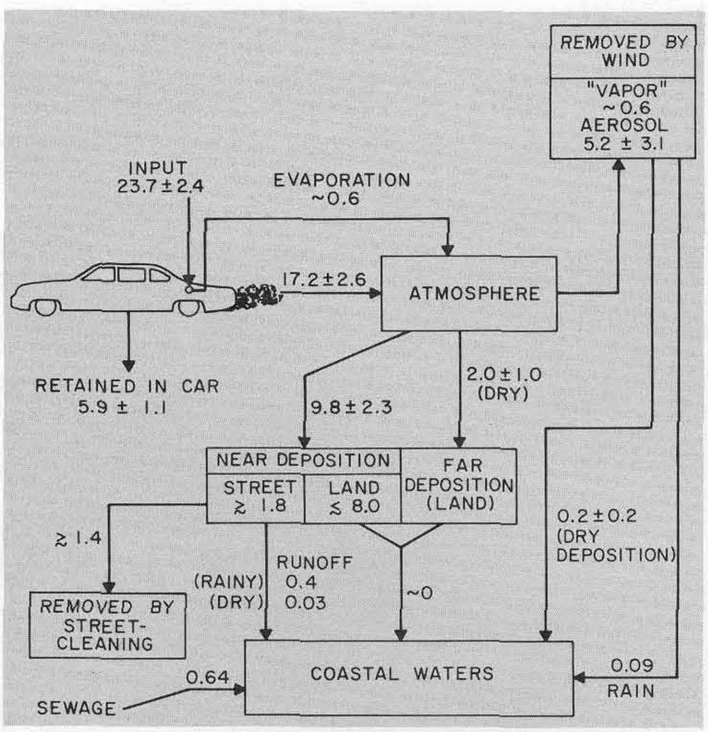

A flow diagram for lead emitted from automobiles in the Los Angeles area. Discharged into the atmosphere, primarily in particulate form, the lead is then either deposited on the land and streets, or it is blown out of the basin—depending on the size of the particles. The flows are indicated in metric tons per day.

—and on a smoggy one
Most of the reduction in visibility shown in this picture is the result of the conversion of pollutant gases to particles. A smaller fraction comes from direct particulate emissions—of lead, for example—from automobiles and industries.