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AERIAL FALLOUT OF METALS DURING A BRUSHFIRE

There has been concern that major forest or brush fires may create significant pulse inputs of trace contaminants to the coastal ecosystem by remobilizing metals previously deposited on land and foliage through aerial fallout. To examine this possibility, we conducted limited sampling programs during and after one of the largest fires of the decade in southern California.

In late November 1975, 65,000 acres were burned in two separate regions of the Angeles National Forest above the Los Angeles/Orange County Basin. These fires created a dramatic smoke plume roughly 100 km in width, which deposited a layer of ash throughout the Basin; in addition, hot desert winds carried the plume far out over the ocean (Figure 1).

PROCEDURES

During the two days of heaviest ash fallout, acid-washed Pyrex baking dishes (0.075 sq m) were exposed at eight of our standard survey stations along more than 200 km of coast—from north to south: Station 1, Carpenteria; Station 2, Port Hueneme; Station 3, Zuma Beach; Station 4, Santa Monica; Station 5, Long Beach; Station 6, Newport Beach; Station 7, San Clemente Beach; and Station 8, Encinitas. Three sites around the resort village of Avalon on Santa Catalina Island (Stations 9 through 11) were also sampled. This sampling was repeated under similar desert wind conditions 1 week after the fires had been extinguished.

At the end of' the exposure period, each collection dish was washed several times with a dilute nitric acid stream, which was transferred to a cleaned polyethylene bottle in the field. The samples were subsequently digested and concentrated prior to analysis by atomic absorption spectrometry. Several unexposed clean dishes were "sampled" in the same manner to obtain representative process blanks.

RESULTS

Most of the lowest signals obtained in the analysis were from the post-fire samples from Santa Catalina Island. In Table 1, we compare the net values for each of the nine metals analyzed in these three samples with the corresponding process blank values. These results indicate that the blanks obtained constituted only second-order corrections in this survey.

The results of two earlier surveys on Catalina Island by Caltech scientists support those from our study. Using different collection techniques, Patterson and Settle (1974) measured a deposition flux for lead of 14 yg/sq m/day, while Huntzicker et al. (1975) measured a corresponding rate of 33 pg/sq m/day. In comparison, the net

values we obtained at our three Catalina Island sites were 19, 21, and 23 pg/sq m/day. As is illustrated in Figure 2, considerably higher deposition rates were observed during the fire in the region between Zuma Beach (Station 3) and Newport Beach (Station 6) where the smoke plume intersected the coast.

During the fire, higher rates were also observed at Santa Catalina Island. The fact that all of the metals studied exhibited the same general pattern, with fallout rate distinctly increasing toward the center of the plume, indicates that such fires can indeed mobilize metals and create pulse inputs of these contaminants to the coastal ecosystem. In contrast, no significant differences were observed for total DDT, or for 1254 PCB (shown on Figure 2).

To evaluate the importance of fire mobilization of metals, we have estimated aerial inputs of these metals during both the fire and post-fire periods sampled. For a given metal, we first calculated the median net deposition rate for the four stations along approximately 100 km of coast between Zuma Beach and Newport Beach that lay beneath the smoke plume. This median was then averaged with the median value obtained for Santa Catalina Island (approximately 50 km offshore;, and the resulting value was applied to a 10,000 sq km zone (100 by 100 km) lying off the Los Angeles/Orange County Basin. Our results for the 2-day survey (conducted under desert wind conditions) were then extrapolated to a full year. Because the winds usually
blow in the opposite direction, from the ocean onto the land, this method of calculation should over-estimate the actual inputs from aerial fallout; the annual values for both fire and non-fire conditions are given in Table 2.

For comparative purposes. Table 2 shows the sum of the 1975 annual mass emissions from the Los Angeles City, Los Angeles County (JWPCP), and Orange County municipal wastewater treatment plants, which are the dominant sources of municipal wastewater discharged from the Basin to this sector of the Bight.

The data indicate that aerial fallout probably is a relatively minor source of most metals to the coastal waters off highly populated sections of southern California. With the exception of lead, which is used in antiknock additives in gasoline and primarily enters the atmosphere via auto mobile emissions, aerial inputs of the toxic metals* are one to two orders of magnitude below those from municipal wastewater. The importance of the aerial fallout of these contaminants would not be much altered even if major forest fires burned under desert wind conditions the year around. Thus, fires do not appear to be significant sources of trace metals or chlorinated hydrocarbons to the coastal marine ecosystem.

REFERENCES

Huntzicker, J.J., S.K. Friedlander, and C.I. Davidson. 1975. Marine balance for automobile-emitted lead in Los Angeles Basin. Environ. Sci. Technol. 9:488-57.

Patterson, C., and D. Settle. 1974. Contribution of lead via aerosol deposition to the Southern California Bight. In J. Rech. Atmos., special publ.: International Symposium on Chemistry of Sea/Air Particulate Exchange Processes.

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* Excluding iron and manganese, which are relatively nontoxic.

Table 1. Comparison of trace metal values (ug) measured over a 7-day interval in three post-fire aerial fallout samples from Santa Catalina Island and four process blanks.

	Sample		Blank	
Metal	Median	Mean ± SE*	Median	Mean ± SE
Silver	0.004	0.005 ± 0.001	< 0.002	< 0.002
Cadmium	0.098	0.098 ± 0.003	0.011	0.011 ± 0.002
Chromium	0.40	0.40 ± 0.08	0.073	0.102 ± 0.033
Copper	3.8	4.0 ± 1.3	0.17	0.21 ± 0.06
Iron	320	300 ± 75	1.9	6.1 ± 4.2
Manganese	5.7	5.8 ± 0.5	0.022	0.026 ± 0.006
Nickel	0.86	0.78 ± 0.11	0.066	0.061 ± 0.011
Lead	10	12 ± 2.4	0.25	0.29 ± 0.06
Zinc	18	18 ± 3.1	0.78	0.80 ± 0.08

*Standard error.

Table 2. Upper-limit estimates for aerial fallout inputs (metric tons/yr) of trace metals to a 10,000-sk-km region off the Los Angeles/Orange County Basin and 1975 mass emission rates via three major municipal wastewater outfall systems.*

	Aerial Fallout		
Metal	Brush Fire	Non-Brush Fire	Municipal Wastewater
Silver	0.22	0.08	24
Cadmium	1.5	1.0	44
Chromium	51	8.1	560
Copper	91	32	500
Iron	23,000	3,600	5,700**
Manganese	560	66	93**
Nickel	40	17	260
Lead	820	420	180
Zinc	450	190	1,100

*Los Angeles City, Los Angeles County (JWPCP), and Orange County.
**1973 values.

Figure 1. This satellite photo of California and Mexico, taken during the great forest fire of November 1975, clearly shows the huge plume of smoke that extended 400 km out to sea.

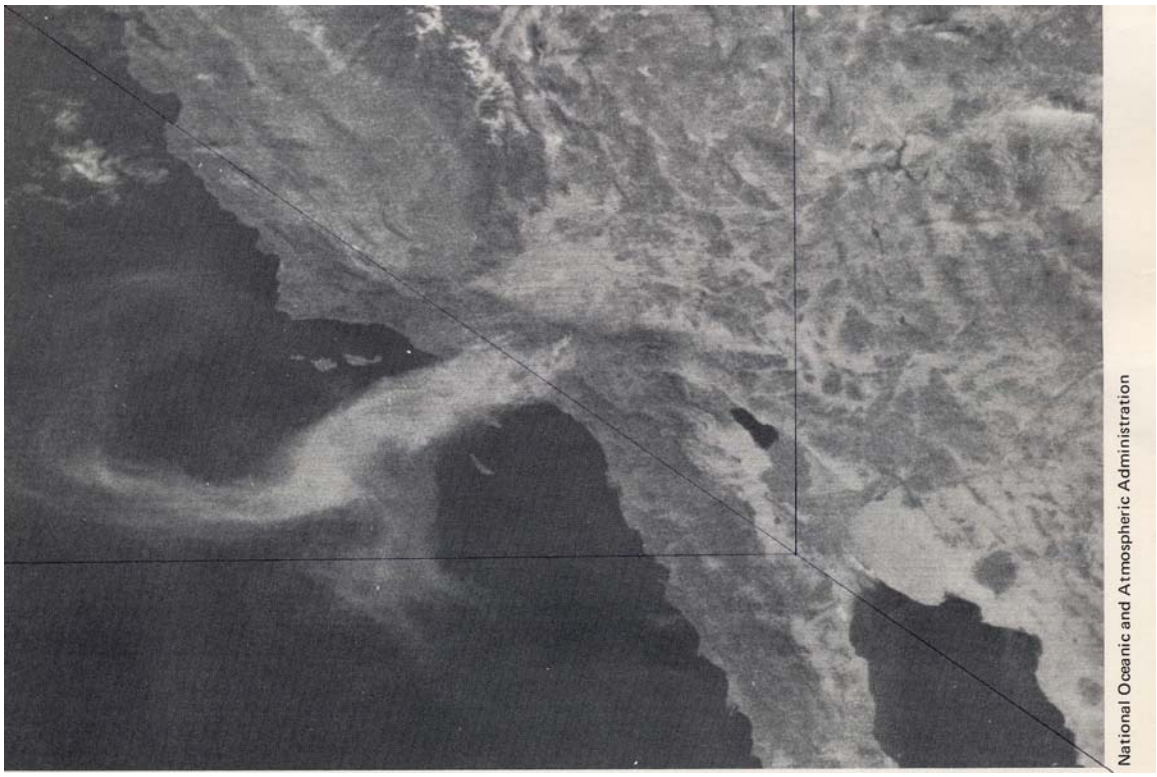

Figure 2. Aerial fallout of trace contaminants during (solid line) and after (dotted line) a major Southern California brushfire in November 1975. Stations range from Carpenteria in the north (Station 1) to Encinitas near San Diego (Station 8). Stations 9 through 11 are on Santa Catalina Island. The smoke plume covered Stations 3 through 6 and 9 through 11.