Bull. Environm. Contam. Toxicol. 22,426-429 (1979)

Distribution of Cadmium, Lead and Zinc in Soil Around Two Phosphate Processing Plants in Pocatello, Idaho

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Four states, Idaho, Montana, Utah and Wyoming compose the western phosphate field. Eighty percent of this field lies in southeast Idaho which accounts for almost 35 percent of the U.S. phosphate reserves. In 1975, about 6 million short tons of phosphate ore were produced by the five mines in southeast Idaho, accounting for 11 percent of the U.S. production (U.S. GEOLOGICAL SURVEY 1976). There are five processing plants located outside Pocatello and Soda Springs, Idaho manufacturing most of this ore into elemental phosphorus, phosphate fertilizers and animal feed supplements.

The phosphate shale ores mined from Idaho contain high concentrations of certain trace elements. According to the data compiled by the U.S. Geological Survey (1976), cadmium concentrations in the phosphate ores from this area are significantly high. For example, average cadmium concentration in Meade Peak phosphatic shale ore is 90 ppm with a maximum value up to 800 ppm. In the Bloomington Canyon vanadiferous zone phosphate rock, average cadmium concentration reaches 470 ppm. Phosphate fertilizers produced in this area have also been shown to contain high amounts of cadmium (RUESS et al. 1976).

A recent report by the U.S. Geological Survey (1976) indicates that the concentrations of 14 selected elements in soil increase as the phosphate processing plants at Pocatello are approached. Concentrations of these elements within 1 mile northeast of the plants are generally about twice their concentrations 40 miles away. However, no data for cadmium was given. Since cadmium is a highly toxic trace element, knowledge of its distribution around the phosphate processing plants is essential for environmental considerations.

In the summer of 1977, we investigated the distribution of cadmium, lead, and zinc in soil around the two phosphate processing plants outside Pocatello with respect to distance, depth, and wind direction. The two processing plants (an elemental phosphorus plant and a phosphate fertilizer plant) are located 4 miles northwest of Pocatello and are separated from each other by less than 1000 yards. Soil samples were collected at different depths along various lines radiating from the mid-point between the two

0007-4861/79/0022-0426 $01.00
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phosphate plants. The boundary of the Fort Hall Indian Reservation runs from north to south in the vicinity west of the plants. This area west of the plants was not sampled because it is located on the Indian Reservation which was not accessible to this study. The soil samples were dried in an oven, ground with a mortar and pestle, and then sifted through a U.S. No. 80 standard testing sieve. Cadmium, lead, and zinc in soil (less than 80 mesh size fraction) were analyzed by a Perkin-Elmer model 360 atomic absorption spectrophotometer. Procedures of atomic absorption analysis are described elsewhere (HUTCHISON 1978).

Direction of the wind at Pocatello Airport, which lies 3 miles west of the processing plants is known. Well over 50 percent of the wind movement is from the southwest quadrant and about 20 percent from the southeast quadrant (U.S. GEOLOGICAL SURVEY, 1976). Our results indicate that cadmium content in soil around the processing plants correlates to the direction of wind movement of the area. Figure 1 shows average soil cadmium content obtained from three radii in the direction of north to northeast (N-NE) as a function of distance from the processing plants. The left side of Figure 1 shows corresponding soil cadmium content in the direction of south to southeast (S-SE) of the processing plants. The areas covered by these sampling lines are shown in the inset of the figure. It is clear that the area lying between the north to northeast radii has a much higher soil cadmium content compared with the area between the south to southeast radii from the processing plants. Average cadmium content in surface soil (0-2") in the N-NE direction at 1/2 mile from the plants reaches 40±8 ppm and decreases near exponentially to 2±1 ppm at 4 miles away. In the S-SE direction, average cadmium content in surface soil is less than 5 ppm within one mile of the processing plants and decreases to 2±1 ppm at 4 miles away. It should be pointed out that one site at 1/2 mile on the NNE radius is located on a large borrow pit formed by previous excavation. This site was not included in our average. Figure 1 also shows average cadmium content in soils at 2"-4" and at 4"-6" levels as a function of distance from the processing plants. The distribution patterns at these depths resemble that of the surface soil (0-2") but the average cadmium content in soil drops drastically at these lower levels. Indeed, soil cadmium content at 4"-6" level is only 4±1 ppm in the N-NE direction even at 1/2 mile away from the processing plants.

Distribution of lead and zinc in surface soil (0-2") in the N-NE direction and in the S-SE direction as a function of distance from the processing plants is shown in Figure 2. The distribution pattern of zinc is similar to that of cadmium. In the N-NE direction, average zinc concentrations in surface soil at 1/2 mile from the processing plants is about 236±49 ppm and it decreases by about a factor of 5 to 43±1 ppm at 4 miles away. In the S-SE direction, zinc content in surface soil is less than 55 ppm within one mile of the processing plants and decreases to 43±6 ppm at 4 miles away. Zinc content in soil also shows a sharp decrease as a

function of depth. It is lowered to 66±23 ppm at 2"-4" level at 1/2 mile in the N-NE direction and 48±16 ppm at 4"-6" level. Zinc is another trace element whose concentration is significantly high in the phosphate ores produced in southeast Idaho (U.S. GEOLOGICAL SURVEY, 1976). Lead shows much less pronounced enrichment in soil close to the processing plants. The surface soil in the N-NE direction contains 27±5 ppm at 1/2 mile away from the processing plants and the concentration decreases to 13±1 ppm at 4 miles away. The difference is about a factor of 2. Our lead values are in the same range as those reported by the U.S. Geological Survey (1976).

According to this study, all three elements exhibit the same type of distribution pattern in soil around the processing plants with cadmium more pronounced relative to lead and zinc. Significant contamination of cadmium was found in surface soil within 2 miles in the direction of N-NE (off the wind) from the processing plants. Effects of such contaminated soil on biological systems are not known. Further study along this direction is highly desireable.

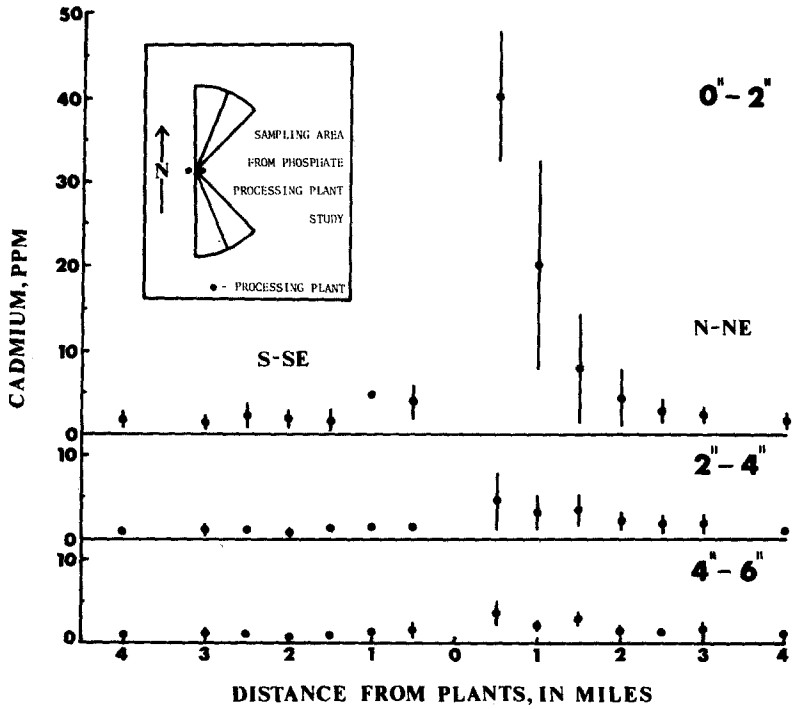

Figure 1. Distribution of cadmium in soil around two phosphate processing plants outside Pocatello, Idaho.

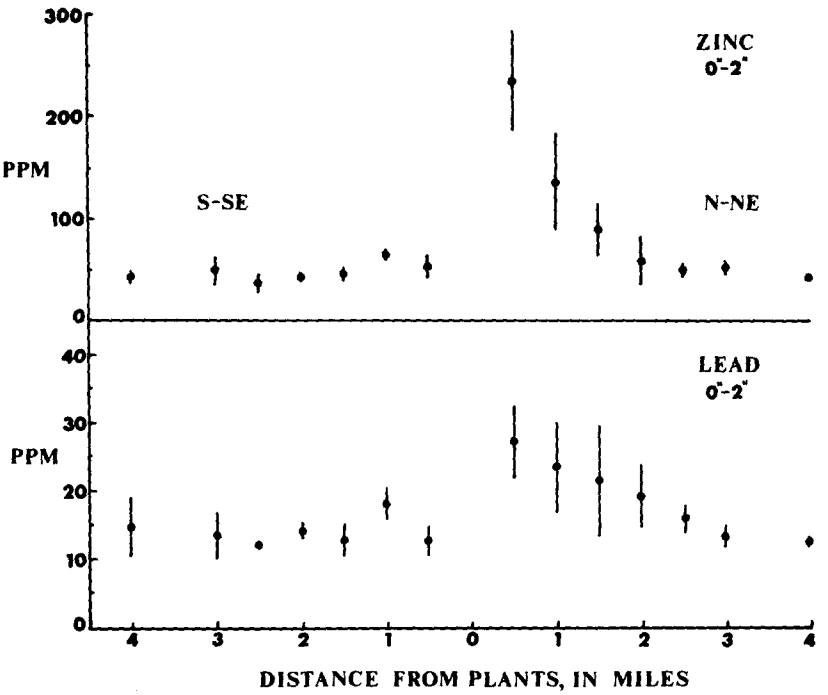

Figure 2. Distribution of zinc and lead in soil around two phosphate processing plants outside Pocatello, Idaho.

Acknowledgement. This study was supported by a grant from the National Science Foundation, Student-Originated-Studies Program.

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