AIR POLLUTION BY FLUORIDE COMPOUNDS

NEAR AN ALUMINUM FACTORY

by

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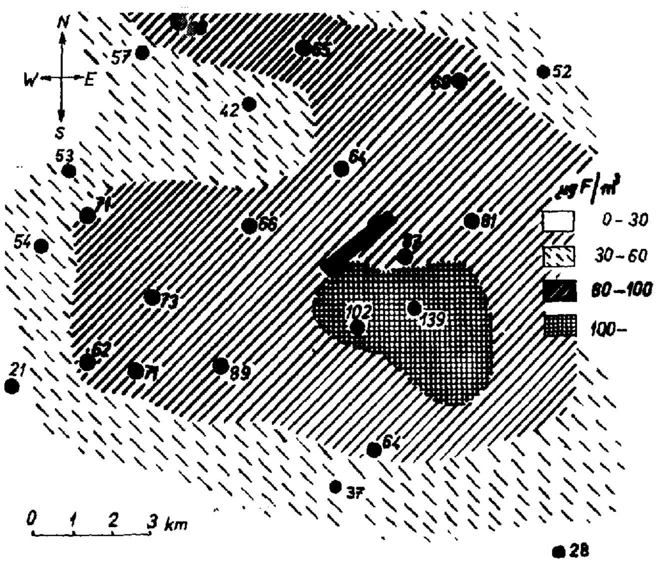
From the electrolytic pots of an aluminum factory near Bratislava between 3.6 and 4.2 tons of F compounds had been escaping daily either as fumes or aerosols. In addition such other noxious agents as SO_2, carbon, fly-ash, tar products, arsenic and those due to combustion of coal in the electrical power plant were emitted. From 1958 to 1965 the contamination near the factory averaged 0.14 mg F/m^3 with top values up to 1.13 mg F/m^3 (Fig. 1). This average of 0.14 represents a 5 fold increase above the maximum allowable concentration (MAC) of 0.03 mg F/m^3.

Fig. 1

Average F Values in Air Near the Plant 1958 to 1965.



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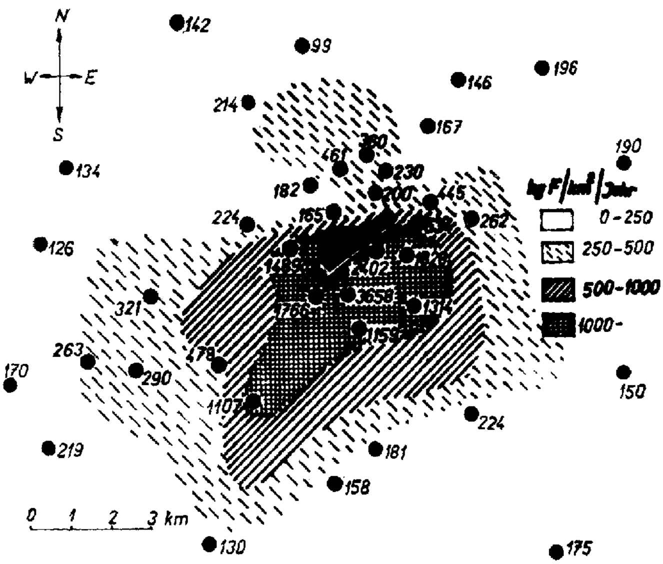
Gaseous fluorides, namely HF and SiF_4 constitute 39% of these values as compared to 61% solids, namely CaF_2, NaF and Alf_3. The proportion varies with the distance from the factory: At an area 8 to 9 km from the factory 15% solid and 85% gaseous F compounds were present in the atmosphere. It is apparent, therefore, that near the factory sedimentation of the solid F compounds takes place, which accounts for the relative increase of the gaseous compounds.

Fall-out: This observation is further borne out by analyses of the fly-ash near the factory which ranged from 27.5 to 1543 tons/km^2 a year. The fly-ash contained between 0.03 and 3.21% fluorides. In "uncontaminated" areas these values ranged from 0.05 to 0.32%. If these data are applied to the calculation of the yearly F fallout, the values near the factory were from 44 to 7337 kg F/km^2 (Fig. 2), and in the "uncontaminated" areas from 30.3 to 137.4 kg F/km^2 a year with an average of 82 kg F/km^2. This represents a 90 fold excess above the maximum levels near the factory.

Fig. 2

Average F Content in Fall-out at the Individual Sampling Stations 1956 to 1959

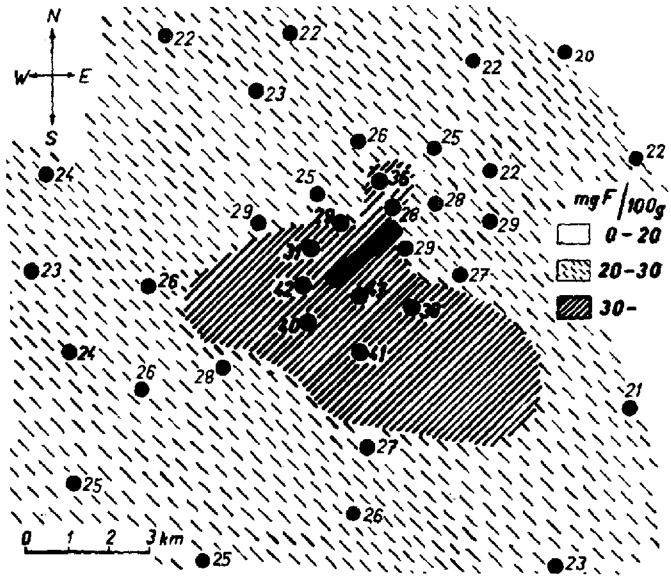


Soil: The constant daily emission of F accounts for a marked increase of fluoride in the surface layers of the soil. After a rainfall the F compounds, which are generally readily soluble, dissolve and seep into the deeper layers of the soil or run off into the surface waters.

Thus the surface of the soil undergoes a constant purification process. Whereas the F content of the soil is usually indicative of the degree of contamination, it is largely dependent on the duration and intensity of the dry season. Therefore we often find relatively little F on the surface of the soil near the factory (Fig. 3). The highest F values in soil

Fig. 3

Average F Values of Soil at the Individual Sampling Stations 1958 to 1965

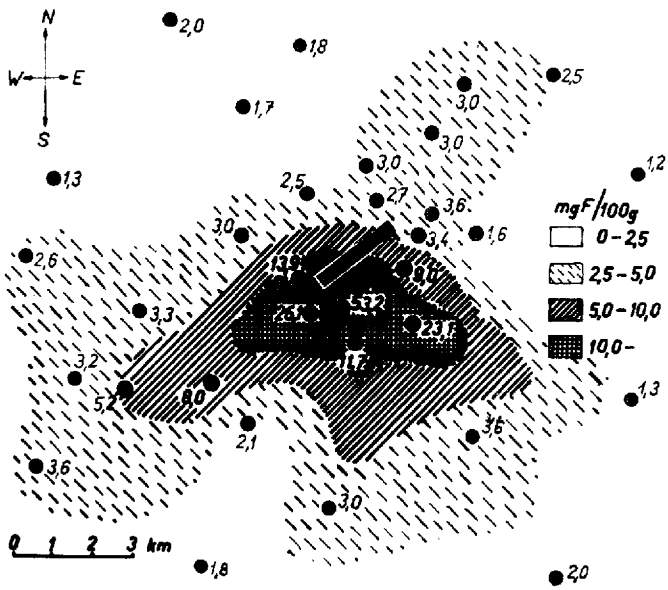


were 135 mg/100 g (1350 ppm). This is 4 to 7 times higher than the usual F content of soil which range from 20 to 30 mg/100 g (200 to 300 ppm) according to the literature. In our control area which was not affected by F emission we observed an average of 12.6 mg F/100 g (126 ppm) of soi

Vegetation: From the soil F enters the vegetation and agricultural products through which it reaches the human organism. Grass near the factory contained F values up to 133 mg/100 g dry substance (1330 ppm) as compared with averages of the order of magnitude of 1 to 3 mg/100 g (10 to 30 ppm). This represents a substantial increase (Fig 4). In addition, small quantities of F adhere as dust to the surface of grass. We found up to 10.4 mg/100 g of F in fresh grass. In assessing fluorosis in cattle, the F content of grass as well as that present on its surface must be taken into account.

Fig. 4

Average F Values of Grass at the Individual Sampling Stations 1960 to 1965



Water: Fluoride Emission had only a minor effect upon ground waters. After the factory had been in production for more than 10 years, the F content of water from the nearest water source was only 0.6 mg F/liter as compared with 0.2 mg F/l in factory-distant waters. Only rarely was there an excess of 1 ppm. Standing waters i.e. ponds, swamps and puddles are more contaminated by F emissions than running waters. Whereas running surface waters near the factory showed only slightly increased F levels with values of the order of 0.11 to 0.85 mg/liter, the standing surface waters near the factory contained as much as 10.9 mg/l.

Animal Life: The F emissions have a direct and indirect effect upon living organisms and populations. Bones of sparrows caught near the factory contained 101.3 to 352.7 mg F/100 g ash, whereas in "normal" control samples only 8.4 to 56.5 mg F/100 g ash were found. Aquatic life reflected the high F content of water. Bones of three kinds of frogs caught near the factory showed F levels of the order of 85.2 to 788.0 mg/100 g ash compared with control values of 39.2 to 106.7. Additional studies are in progress.

It appears, therefore, that the best means of assessing the long-term effect of F emissions is the determination of F fall-out and of

F content in plants and biological material. Meteorological influences appear to be less significant in the evaluation of F damage. The composition of soil, the presence of F dust on the surface of plants, the F content of flowing and ground waters are of little use in determining F damage to human, animal and plant life.

Although the above observations are incomplete and present only a small portion of the problem, they serve as a basis for planning protective measures such as the following:

1. Regulations concerning the distribution of produce grown near the factory area.

2. Restriction of buildings in the vicinity of the factory.

3. Translocation of populations residing in highly polluted localities.

4. Population surveys.

5. Overall building regulations in districts adjoining the factory.

These measures are undoubtedly more costly than the establishment of technical devices to absorb and eliminate the toxic pollutants.