IRON, SODIUM AND POTASSIUM CONTENTS TO AID ESTIMATION OF THE RELATIVE CONTRIBUTIONS OF VARIOUS SOURCES TO THE ATMOSPHERIC AEROSOLS—A PROPOSITION

Input of tropospheric aerosols—which amount to about $10^{15}$ tons day$^{-1}$, can broadly be classified as natural and man-made. In an exhaustive review Hidy and Brock,1 have discussed various sources and their global contributions to the tropospheric aerosols. An initial attempt was made at this laboratory2 to estimate the relative contributions of natural and man-made sources to atmospheric aerosol formation by taking account of their Fe and K contents only, which is perhaps not valid where sea spray also plays a vital part. In the present note Na is also taken into account in addition to Fe and K to take care of the oceanic contribution.

If one restricts interest to industrial urban areas only, it may perhaps be justified to assume that only the following shall be the principal sources of atmospheric aerosols: (1) sea spray—more so in coastal regions, (2) dust rise by winds, construction and building operations, (3) combustion of fuels—mainly coal—and other industrial operations and (4) oxidation of H$_2$S and SO$_2$ to sulphates and probably other sulphur containing organic compounds which produce aerosols free from Fe, Na, and K. It may as well be noted that aerosols arising from sources (1), (2), and (3) will contain Fe, Na and K in widely different proportions. In non-industrial areas the contribution from (3) will be relatively much less.

We now make the following reasonable assumptions: (a) That the major portion by weight of the terrestrial dust is of local origin—say within a few tens of Kms., and (b) That the source of coal supply to given region remains the same over reasonable periods of time and thus their relative contents of Fe, Na and K remain more or less constant.

From literature we find that for the terrestrial dust and sea spray the global Fe/K ratios are 1.92 and 0.00 respectively and the Na/K ratios for the same are 1.1 and 30 respectively. For bituminous coal and lignite also as some measurements indicate the above two ratios are very much different. It is, therefore, surmised that the widely different ratios Fe/K and Na/K in the three major contributors to the tropospheric aerosols will give rise to unique ratios of Fe/K and Na/K in a composite sample of atmospheric dust depending upon the relative contributions from these sources.

We now mathematically show how the estimation of Fe/K and Na/K in suspended dust samples can lead to the evaluation of the contributions from the above three major sources.

We know that the Fe/K and Na/K ratios in sea spray are 0.0 and 30.0 respectively. Let the measured ratios of Fe/K in the local soil and fly-ash samples be A and B respectively and the ratios of Na/K in the same be C and D respectively. If the fractions of K contributed by the soil, the fly-ash and the sea-spray are a, b and c respectively then:

$$a + b + c = 1$$

(1) The observed ratio Fe/K for the suspended dust load will be given by

$$X = \frac{a \cdot A + b \cdot B + C \cdot 0}{a + b + c} \text{ (Fe/K for sea-spray = 0)}$$

from (1) this reduces to

$$X = a \cdot A + b \cdot B$$

(2) In the same way the ratio Na/K in the suspended dust sample is given by

$$Y = a \cdot C + b \cdot D + c \cdot 30 \text{ (Na/K for sea-spray = 30)}$$

(3) combining equations (1), (2) and (3) we get

$$a = \frac{B \cdot (30 - Y) - X \cdot (30 - D)}{B \cdot (30 - C) - X \cdot (30 - D)}$$

(4)$$b = \frac{X - a \cdot A}{B}$$

(5)$$c = 1 - (a + b)$$

(6) Since for a given region A, B, C and D are assumed to be constants and predetermined, a direct measurement of x and y will enable us to evaluate a, b and c and thus total material contributed from the three major sources mentioned earlier with the help of their known contents, of K. The sum of the materials contributed by these sources when subtracted from the total mass of the suspended dust sample gives the contribution from the fourth category of sources mentioned earlier which are free from Fe, Na and K.

It is expected that in most cases, the present method will give a fairly good estimate of the man-made and natural contributions to the atmospheric dust load, although in certain cases account shall have to be taken for specific sources such as the cement dust, etc.

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