The Concentration of Contaminant Alkali Salts in Ground Level Air[1]

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A KNOWLEDGE of the concentration of alkali salts in ground level air[2] is of great interest to chemists and physicists in connection with problems of atmospheric corrosion (*1–3*) and in connection with background effects in spectroscopic work (*4*). Studies of salt concentrations in air appear to have been made principally by meteorologists interested in nucleation phenomena and by the various investigators concerned with the causes and the effects of atmospheric pollution (*5*). Since many of these papers appear in publications not usually consulted by, or readily available to most chemists and physicists, we have thought it worth while to summarize here for ready reference the results of our literature survey of this topic. No claim is made for complete coverage; it is believed, however, that our results and data form a representative cross section of present knowledge.

The possible origin of nuclei of all types in ground level air has been discussed in detail by Landsberg (*6*)

TABLE 1

CONCENTRATION OF ALKALI HALIDES IN GROUND LEVEL AIR
Coastal Sites*

Location	Number of determinations	Period of observation	Average of reported concentrations	Na/cm^3 × 10^{-11}	Reference
Roche Douvres, France	1	3 days	0.00462 g Cl/341 l	2200	25
North Sea, Germany	?	?	0.9 mg NaCl/100 l	900	19
Mogadiscio, It. Somaliland	3	3 days	54.3 mg Cl/l H_2O†	170	1
Eupatoria, USSR	*ca.* 250	2 mos	823 μg NaCl/m^3	84	13–14
Pompano, Fla.	4	1 day	600 μμg NaCl/cm^3	62	28
La Jolla, Calif.	23	2 mos	0.228 mg Cl/m^3	39	15–17
Venice, Italy	13	13 days	0.125 mg Cl/m^3	21	24
Bermuda	7‡	1 day	20.1 g Cl/cm^3 × 10^{12}	3.4	26
Woods Hole, Mass.	7§	6 days	13.8 g Cl/cm^3 × 10^{12}	2.5	26
	3	1 day	8.9 g Cl/cm^3 × 10^{12}	1.6	29
Beaufort Harbor, N. C.	12	8 days	72.201 mg salt/dm^2‖	1.7	22
Brunswick Co., N. C.	?	?	2.3 mg salt/dm^2#	0.5	23

* Arranged in order of decreasing concentration.
† Air at 82% relative humidity and 25° C.
‡ This data was obtained at altitudes from 15–1200 m.
§ Values for altitudes up to 4 m.
‖ Wind velocity, 13.4 mi/hr.
Wind velocity, 5 km/hr.

TABLE 2

CONCENTRATION OF ALKALI HALIDES IN GROUND LEVEL AIR
Inland Sites*

Location	Distance inland, km	Number of determinations	Period of observation	Average of reported concentration	Na/cm^3 × 10^{-11}	Reference
Tokyo, Japan	10	†	12 mos	4.4 μg Cl/m^3	0.7	9
Tokyo, Japan	10	†	12 mos	7.6 μg Cl/m^3	1.3	10
Los Angeles, Calif.	24	†	†	0.01 ppm NaCl	1	5
Chion-ji, Japan	30	14	13 days	7.3 μg Cl/m^3	1.2	20
Pt. Grey, B. C.	30	30	3 mos	3.75 mg NaCl/1000 m^3	0.4	2
Pavia, Italy	95	10	?	0.016 mg Cl/m^3	2.7	11
Pavia, Italy	95	21	14 mos	0.0194 mg Cl/m^3	3.2	12

* Arranged in order of increasing distance from the sea.
† An unspecified number of determinations were carried out over a period of at least a year.

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[2] The term "ground level air" as used in this paper refers to the part of the troposphere that extends from sea level to about 2000 meters.

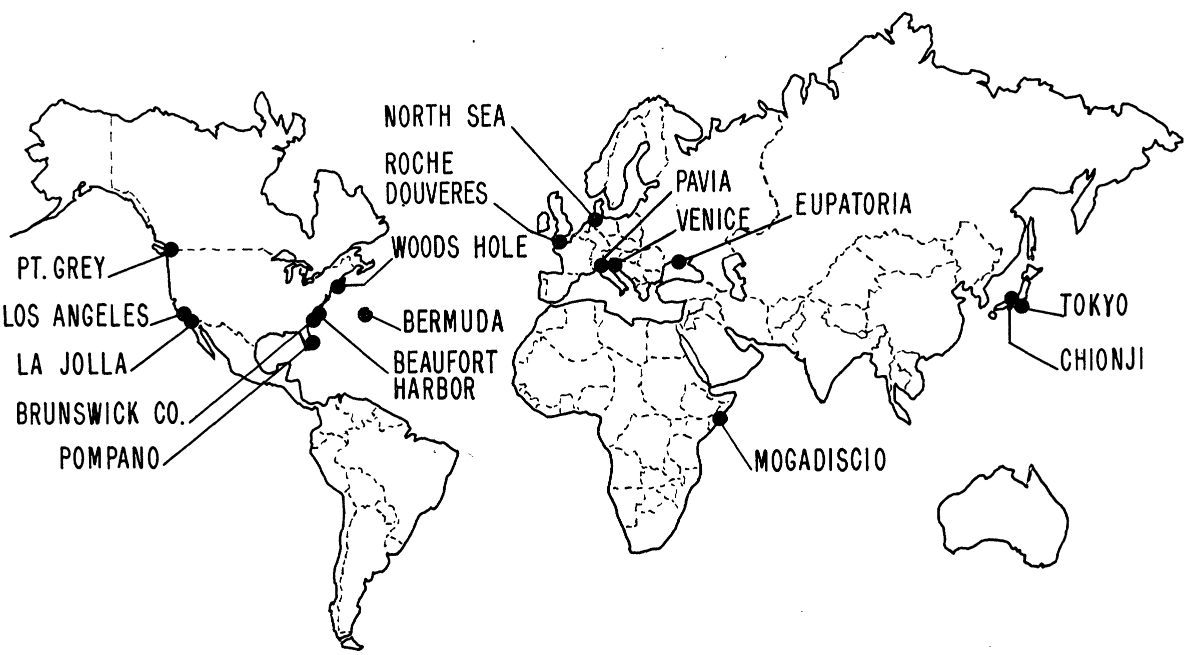

FIG. 1. A map showing the approximate location of the test sites listed in Tables 1 and 2.

and Neuberger (*7, 8*). The more abundant nuclei in the air are of terrestrial origin[3] and are believed to arise primarily from volcanic activity, radioactive emanations, forest fires, domestic and industrial combustion effluents including motor vehicle exhaust gases, and the action of the wind in sweeping up and carrying along such particulate matter as soil, dust, bacteria, and pollens. The more specific origin of the alkali salts in air is to be found principally in oceanic salts carried inland by the action of the wind and in the manifold combustion products issuing into the air.

A wide variation in the concentration of nuclei in air has been shown to exist. It is perhaps obvious that the location of the test site, the previous history of an ambient air mass, and transient local phenomena will contribute to this variation. The data presented below (Tables 1 and 2) show, for instance, that the concentration of sodium chloride in ground level air is generally higher at coastal sites than at inland test stations. The detailed effects of meteorological conditions on the concentration of nuclei have not been established as yet with certainty. There is, however, some evidence that the chloride concentration increases with increasing wind velocity (*9*) and decreases with increasing humidity (*10*).

To determine the concentration of alkali halides in air, a measured volume of air is usually bubbled through chloride-free water (*9–24*) or passed through a suitable filter from which the suspended matter can be leached with chloride-free water (*2, 25*). The chloride content of the water is then determined by titration with silver nitrate. A less common "isopiestic" method has been employed by Woodcock (*3, 26–29*). Droplets and particulate matter from air were collected on glass plates which were then placed in a controlled humidity chamber where the change in drop diameter with change in humidity could be observed with the aid of a microscope. The chloride ion concentration on the plates was then estimated by means of graphs constructed from data on concentrated sea water with known chloride concentration.

It has been tacitly assumed by some workers in this field that the concentration of sodium ions is equal to that of the experimentally determined chloride ions and they have therefore reported their results directly in terms of sodium chloride concentrations. The accuracy of this procedure, however, is open to some question in view of the recent work of Sugawara *et al.* (*30–32*) and Mijake (*33*). These workers found from an analysis of the rain water in a light rain falling near a large body of salt water that the ratio of sodium to chloride ions was approximately equal to that found in sea water ($[Na^+]/[Cl^-] = 0.85$). They furthermore found that this ratio varied from 0.48 to 2.43 when other types of condensation such as mountain fog, sea fog, rime, inland rain, or heavy rainstorms were being considered. It is evident from these examples that the concentrations of sodium ions reported on the basis of a 1:1 equivalence with the experimentally determined chloride ions (as has been done for most of the data in Tables 1 and 2) are subject to some error. The values obtained in this manner are, however, probably accurate to within an order of magnitude.[4]

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[3] Nuclei of extraterrestrial origin are believed to contribute only a very small fraction to the total number observed.

[4] Some direct determinations of sodium in the air have been carried out recently. In the smog studies in Los Angeles (*5*), the precipitate collected in a Westinghouse Precipitron was analyzed for sodium salts by flame photometry. Photoelectric counting techniques for sodium in airborne nuclei have also been described recently by Soudain (*34*) and by Vonnegut and Neubauer (*35*).

As far as the authors are aware, data on the concentration of alkali salts in ground level air are available from 16 different sites. The 15 investigators engaged in these studies have made a total of some 500 individual determinations. The data obtained in these studies are presented in Tables 1 and 2, which refer to coastal and inland sites, respectively. For convenience in the application of these results to background effects in flame spectroscopy (*4*), the data have been converted to common units of sodium atoms/cm^3 (Na/cm^3) under the assumption that $[\mathrm{Na}^+]/[\mathrm{Cl}^-] = 1$. The overall average of Na/cm^3 found for the various inland sites, is 1.5×10^{11} sodium atoms/cm^3.

The locations of the sites mentioned in Tables 1 and 2 are shown in the accompanying map (Fig. 1). It may be noted that these sites form a representative sample of test locations in the northern temperate zone.

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Some Carbohydrate Components of Reticular Fibers[1]

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OVER HALF A CENTURY AGO, Mall (*1*) showed that connective tissue contains translucent netlike "reticular fibers," as distinct from the white bundles of collagenous fibers; and Siegfried (*2*) isolated from reticular fibers a material which he called "reticulin." A few years later, histologists showed that in sections of various tissues treated by the silver method of Bielschowsky, reticular fibers stain black,[2] while collagenous fibers stain light brown (*3–7*). This has remained the only universally accepted criterion for the distinction between these fibers. There were either no or negligible differences when the two types of fibers were compared by the usual staining techniques (*8*), by chemical methods of analysis (*9*), or by the techniques of electron microscopy (*10–12*) and x-ray diffraction (*13–15*).

There is a widespread opinion that even the result obtained with the silver method does not reflect true chemical differences between the two types of fibers. Instead, it is attributed to a physical effect related to fiber diameter, with the smaller reticular fibers presenting a greater surface for the precipitation of silver than the larger collagenous fibers, and thus appearing black instead of light brown (*8, 16*).

However, the fact that the periodic acid-Schiff technique stains reticular fibers intensely (*17, 18*) and collagenous fibers only faintly (*18*) suggested the existence of some chemical differences. The evidence accumulated by the work of several investigators (*19–21*) indicates that in routine histological sections, the periodic acid-Schiff technique detects 1,2-glycol and α-amino alcohol groups (which are oxidized by periodic acid to yield aldehyde groups which

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[2] For convenience, the term "reticular fibers" is used in the present work to include fibers as well as the membranous structures stained by the silver method: basement membrane, membrana propria, reticulum. Rühle (*34*) and many others feel that these membranes are composed of reticular fibers.