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Air Pollution of Aswan City by Some Rare Earth Metals and Transition Metals

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The mean uptakes of the trace metals (TM) during respiration were estimated in five sites at Aswan city and its environs including rural, desert, urban, suburban development and industrial population centres. Medium values of TM concentration (ng/m^3) in these centres indicates no hazards in view of the proposed model for global air categories.

INTRODUCTION

The scandium and vanadium families as well as the cerium metals of the lanthanides are known as trace metals.[1] Excessive levels of the trace metals (TM) may occur either naturally as a result of weathering of rocks or by human activities. Hence, living organisms which have evolved against a low background of TM may be harmed by the new level, and cultivated land damaged. The effect of toxic substances occurring in natural environment has been established in many comprehensive papers[2]. Purves[3] evaluated the global biological consequences of trace elements originally mined from localized limited deposits.

EXPERIMENTAL

A network monitoring programme was established[4], with the intention of studying the natural dustfall particles in Aswan town during the year 1982. A very simple method[5] of dry collection bucket was adapted for seasonal sampling of dustfallout. Anderson sampler and standard high volume sampler were also used. In each of the five experimental sites of the dustfall (Fig. 1) sampling has been carried out regularly every three months by the use of six collecting buckets, each of 5 litres size and with basal area of 139.56 cm^2.

The clay fraction of each sample was separated using a settling rate method[2]. The clay suspensions were siphoned and evaporated in an oven until nearly dry. Drying of each sample was completed in a desiccator. The dry samples were ground in an agate mortar and discs for XRF analyses were prepared. A representative dustfall sample from Aswan area for the year 1982 was prepared, part of which was analysed for the TM composition by means of atomic absorption and the remainder of the sample has been used as a standard for XRF analyses. Size fractionated aerosol samples were collected at the five sites of Aswan

(Fig. 1) by use of a model 65-000 high volume (0.57 m^3/min) Anderson sampler. The filter and its holder faced downwards to prevent gravitation

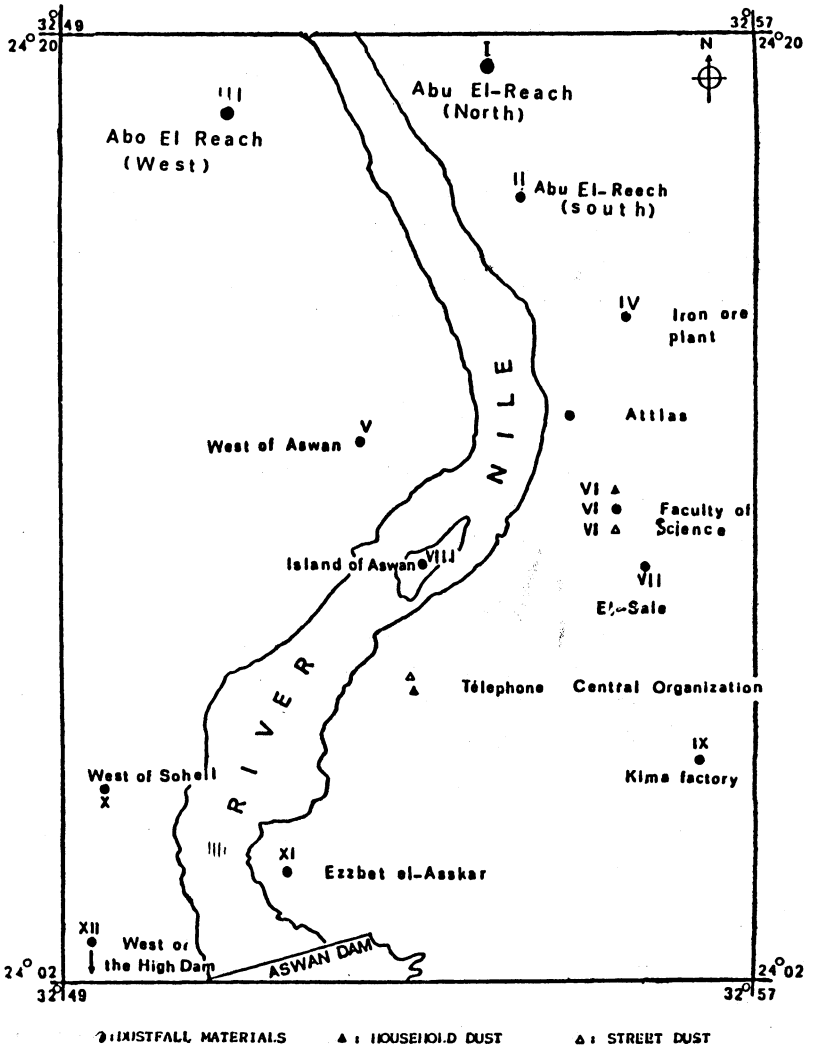

Fig. 1 Location of the experimental sites of the monitoring network dust materials in Aswan, Egypt (see F. S. M. Hassan, *Asian J. Chem.*, 2(3), 275 (1990).

of particles outside the range of interest, i.e. mainly the respirable size fraction. Aerosols were fractionated into size classes > 7.0, 7–3.3, 3.3–2.0, 2.0–1.1, < 1.1 μm. equivalent aerodynamic diameter. All samples were submitted for atomic absorption spectroscopy (AAS), neutron activation analyses (NAA) and incipient coupling plasma (ICP). Meteorological data

including wind measurements were obtained from the Aswan Meteorological Centre. Sample filters (Whatman 41) were changed twice per calendar month. Standard high-volume samples (1.5 m^3/min) were also used to collect samples on Whatman-41 filters for the determination of total concentration of dust in the air.

RESULTS AND DISCUSSION

The XRF results of the clay fraction of samples collected into buckets are listed in Table 1 together with the mean annual percent frequency of the clay in dust fallout at five sites. In these sites, five high-volume

TABLE 1

TRACE-METAL CONCENTRATIONS (ppm) IN THE CLAY FRACTION OF DUST FALLOUT AT FIVE SITES IN ASWAN AND MEAN ANNUAL CONCENTRATION OF THE CLAY IN AIR "C" (ng/m^3/min)

Element	Site No.						
	I Abu-El Reesh			V W. Aswan	VII El-Sale	VIII Aswan Island	IX Kima
	Ia	Ib	Ic				
Sc	16	19	ULD	16	19	15	21
Y	25	14	28	13	12	10	13
La	21	22	ULD	16	1	11	14
V	92	117	ULD	112	68	117	95
Nb	15	7	22	7	1	ULD	6
Ce	63	70	ULD	28	33	32	46
% Clay		27.05		27.92	22.43	18.61	15.65
"C"		35478		7011	22699	38870	14101

ULD = under the limit of detection.

samplers were used (Tables 2 and 3) during the year 1982 for the determination of total concentration of dust in the air. Considering the percentage of the clay fraction of the buckets dry collection, concentrations of the clay in Aswan air in the five sites were calculated in nanogram/m^3. Calculations obtatned by this method indicated that TM concentrations measured with the buckets were generally within $\pm 25\%$ of the Anderson samplers. However, comparison between the TM values for the clay fraction (Table 1) and those for the bulk samples[15] indicated higher concentrations of scandium, lanthanum, and vanadium in the former. Size grade less than 8 microns is known to be capable of pene-

TABLE 2

TRACE-METALS CONCENTRATION IN THE AIR IN DIFFERENT POPULATION CENTRES IN ASWAN (T.M.C.), AND THE MEAN UPTAKE OF TM (UP-W) DURING INHALATION FOR A NORMAL 42 HOUR WEEK IN AN OPEN SPACE, TOGETHER WITH TLV-TWA VALUES*, ALL VALUES IN NANOGRAM/m³

Population	Rural	Desert	Rural Peri-Urban Developing	Urban	Industrial	TMC, 1982		TLV-TWA
Site	Abu El-Reesh	West of Aswan	Aswan Island	El-Sale	Kima			
No. / TM	Ib TMC. (UP-W)	V TMC. (UP-W)	VIII TMC. (UP-W)	VII TMC. (UP-W)	IX TMC. (UP-W)	Median	(Range)	
Sc	0.67(12.9)	0.11(2.15)	0.58(11.2)	0.43(8.3)	0.3(5.7)	0.43	(0.11–0.67)	—
Y	0.5(9.5)	0.09(1.7)	0.39(7.5)	0.27(5.2)	0.18(3.5)	0.27	(0.09–0.5)	1
La	0.78(14.99)	0.11(2.154)	0.43(8.21)	0.023(0.44)	0.197(3.79)	0.197	(0.023–0.78)	—
V	4.15(79.7)	0.79(15.1)	4.05(87.32)	1.54(29.64)	1.34(25.7)	1.54	(0.79–4.55)	0.5
Nb	0.25(4.8)	0.049(0.94)	Zero (Zero)	0.023(0.44)	0.085(1.62)	0.049	(0–0.25)	—
Ce	2.483(47.7)	0.196(3.769)	1.24(23.88)	0.75(14.4)	0.65(12.45)	0.75	(0.196–2.483)	—

*TLA–TWA=Threshold limit value-Time weighted Average (the time-weighted average concentration for a normal 40 hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect (Anonymous, 1978).

TABLE 3

MEDIUM VALUES OF ELEMENTAL CONTENTS OF DUSTFALL IN DIFFERENT PARTS OF THE GLOBE (in log ng/m³)
[Clean and contaminated categories are according to Bowen's classification (1979) (Ref. 8)]

X	CLEAN AIR										CONTAMINATED AIR				
	ASWAN						N. Norway 1974 (Ref. 9)	Shetland 1976 (Ref. 10)	N. W. Canada 1977 (Ref. 11)	South Pole 1977 (Ref. 7)	Toronto industr. (Ref. 12)	Europe (Ref. 6)	N. America (Ref. 13)	South Africa (Ref. 14)	
	Median	Ib	V	VIII	VII	IX								Rural	Urban
Sc	−0.37	−0.17	−0.95	−0.23	−0.37	−0.52	−2.3	−1.82	−1.36	−3.92	−0.57	−0.82	0.11	0.62	0.78
Y	−0.57	−0.3	−1.05	− .41	−0.57	−0.74	—	—	—	—	—	−0.66	—	—	—
La	−0.71	−0.1	−0.95	−0.37	−1.64	−0.70	−1.52	−0.69	−1.05	−3.3	0.38	0.18	0.39	—	—
V	0.19	0.62	−1.1	0.66	0.19	0.13	0.28	0.48	0.69	−2.82	1.15	1.48	2.6	0.52	0.86
Nb	−1.31	−0.6	−1.3	—	−1.64	−1.07	—	—	—	—	—	−0.92	—	—	—
Ce	−0.13	0.39	−0.70	0.09	−0.12	1.19	−1.22	−1	− .62	−2.62	—	−0.05	0.77	—	—

trating the lung tissues[16]. Mean trace metal concentrations (T.M.C.) of size classes 7–3.3, 3.3–2.0, 2.0–1.1, and < 1.1 microns are listed in Table 2.

A Model for Global Air Categories

In order to specify the Aswan air to one of the two end-member categories of the natural air (clean or contaminated), and for lack of suitable background to determine element enrichments in the arid zone, the data provided in Table 2 have been compared with other available data of TM concentration in the natural air from several localities in the globe (Table 3). Of special interest are the Europe sites[5] and the South Pole

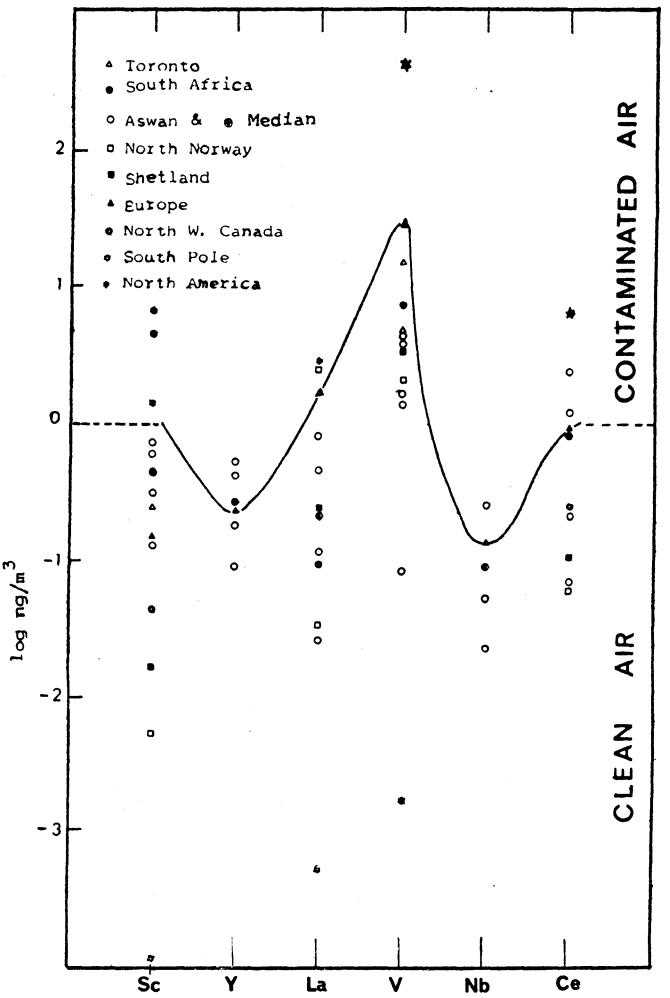

Fig. 2

sites[7] which are characterized by a different atmospheric regime. Following Bowen's classification[8], logarithms of the median values of TM contents, as well as Aswan individual sites (Tables 2 and 3) have been used to erect a model of relative quality of the natural air of the globe (Fig. 2). Hence, it is obvious that Aswan air belongs to the clean air category. Exceptions to this are Abu-El Reesh area, which is contaminated with Y, Nb, and Ce, and El-Sale area which is polluted with yttrium, and finally Kima site which is contaminated with cerium[15].

CONCLUSION

Two methods have been applied for determining the concentration of TM in the clay sized fraction of dust-fallout in Aswan. Calculations obtained by bucket dry collection method indicated that TM concentrations were generally within $\pm 25\%$ of the Anderson samplers method. The human uptake of the trace metals in different population centres (ng/m^3) has been estimated and listed in Table 2. Despite the low values of TM concentration in clay sized dustfall locally, high values of yttrium and cerium are noticed in Abu-El Reesh, and El-sale sectors and Kima area respectively. The effect of these two trace metals may increase chronically with long term exposuring to the pollution.

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