Impact of Different Pollutant Sources on Human Health Using Solid Aerosol's Elemental Analysis

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Abstract: Atomic absorption spectroscopy (AAS) was used in this study to find out the metal constituents and concentration for Seven (7) trace metals in the atmosphere of Faisalabad. The maximum elemental constituents and concentration for Zn, Cu, Cr, Ni, Pb, Mg and Cd in ppm were found to be Cadmium Cd(1) in amounts ranging between (2.596→1.95475) in Pool (5→3), Chromium Cr(2) in amounts ranging between (0.0145→0.01125) in Pool (2→3), Nickel Ni(3) in amounts ranging between (0.9925→0.35575) in Pool (5→3), Lead Pb(4) in amounts ranging between (1.33675→0.2632) in Pool (2→3), Zinc Zn(5) in amounts ranging between (2.515→1.38825) in Pool (4→5), Magnesium Mg(6) in amounts ranging between (1.22125→1.15875) in Pool (4→5), Calcium Ca(7) in amounts ranging between (11.46725→3.53875) in Pool (4→3) respectively. Following pool wise trend pattern of identified elements in solid aerosols is given in Table **1** & **2**. The comparison of results reported in literature with the obtained results showed some differences in concentrations which could be explained on the basis of climatological and meteorological set up of different pools under investigations. Furthermore, the health hazards due to identified trace metals were also investigated and were found that the metals were highly toxic and generating serious health hazards.

Keywords: Elemental atmospheric air pollution, co-relationship with health hazards, confirmed *via* Empirical relations and sociological survey need of protective measures.

1. INTRODUCTION

Environment, in its wider sense, includes everything, which is external to a human being. Environmental Pollution means the accumulation or concentration of wastes that cannot be disposed off by natural recycling process due to their excessive quantity or unique chemical composition [1]. Any substance which is present in nature beyond permissible limits as well as has detrimental effects not only on the environment but also on living organisms is called Pollutant e.g., Cd, Cr, Pb, Zn, Cu, Ni, Ca, and Mg. These chemicals are released into the atmosphere from different natural and anthropogenic sources. High temperature industrial process release coarse fractions of Mg, Ca, Ni, Mn, Cu and Zn. Automobile exhaust and fertilizer industries also release these metals, their compounds, or other salts [2-8]. The urban population is exposed to the aerosol toxic metals that often are well above natural background [9-13]. Many studies on atmospheric metal concentration and their related health hazards have been conducted in several parts of the world which showed diverse fluctuations and disparities among the trace element constituents [14-24]. All these metals produce different diseases like oxides of Zinc along with oxides of Iron produce gastric disorder and vomiting, irritation of skin and mucous membrane. Nickel, Chromium, Lead, Cadmium, Copper and Carcinogenic calcium causes slowing of heart rate, leukemia and different types of cancer [25-31]. Cobalt and Manganese cause chronic and acute poisoning which results in Anemia and Hypertension [32]. When these chemicals are released into the atmosphere, they enter into the human chain, as soon as they enter biological system cause deaths in some cases. Due to the lack of air quality management capabilities, the Pakistan is suffering from deterioration of air quality. Evidence from various governmental organizations and international agencies has indicated that air pollution is a significant risk to the environment, quality of life and human health. Besides health hazards, heavy metal pollution impair visibility, plays an important role in acidic rain, adversely affects the radiation budget and consequently disturbs a variety of environmental processes may change the cloud properties by nucleation, condensation and chemistry of environment by providing the media for various heterogeneous reactions and carriers for chemical species. Atmospheric aerosol particles are solid or liquid particles suspended in air. Processes that control formation, transformation and the removal of atmospheric aerosols is of great interest in atmospheric science. The reason is that these particles, which are often smaller than 1 micrometer in diameter, play an important part in Earth's radiation budget through the scattering of sunlight and through the interaction with clouds. Human activities, such as burning of fossil fuels and land use, change the properties of the aerosol and

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may therefore influence the climate. This can be either directly through an increase in aerosols or indirectly through the way the anthropogenic aerosols change the way clouds form. Also, heterogeneous reactions on the aerosol particle surfaces influence the gas phase composition and chemistry of the atmosphere. And these particles are responsible for adverse health effects through inhalation. To assess the role of aerosols in our environment and the influence by anthropogenic emissions requires an understanding of the life cycle and transport patterns of solid aerosol particles, their compositional evolution as well as a detailed knowledge of cloud formation and nucleation mechanisms depend on the properties of the pre-existing aerosols [33-36].

By definition trace elements are chemical components that naturally occur in soil, plant and wild life in minute concentrations, also known as Trace minerals. They are necessary for the optimal development and metabolic festraining of all living things. For human beings proper cell metabolism effective immune feqrition and healthy reproduction are dependent on a total of 72 of these elements. Since they provide nutritional value, they are sometime effected to as micronutrients. The health giving properties of trace metals vary greatly and some are not even understood yet for instance CV is inversed in the regulation of metabolism of glucose and lipid fats and is also thought to be an aid to weight loss since it promotes the processing of fat for energy rather than its several trace elements are essential storage for the protection, how more regulation and neutrons emission in brain .But when the amount of trace metals becomes greater than permissible limit. They become toxic and generate health hazards.

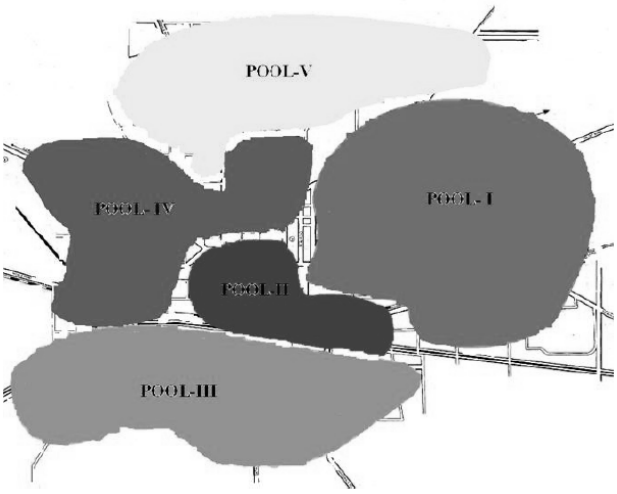

Figure 1: Site selection for Faisalabad City.

Perturbations in signaling is one of the principal modes of action resulting in toxicity which is common to most trace elements. Oxidative processes enhancement resulting in the increase of super oxide anion radical (O^{2-}), H_2O_2 and hydrogen peroxide radical (OH) is the base for other connections with signaling response. Oxidative stress affects numerous cellular components such as DNA, lipids and proteins through oxidation reactions.

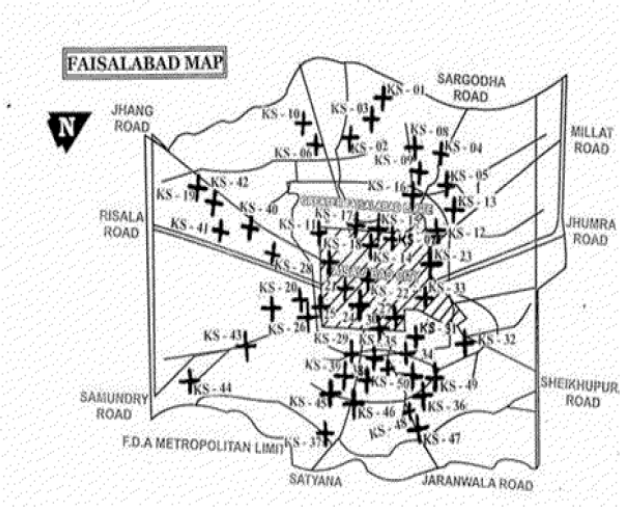

Figure 2: Pool classification for Faisalabad City.

In a very simplistic model of signaling system sleading toward toxicity or tolerance, the following would be the train of events. Trace elements entry in the system is facilitated by transport protein or diffusion. At the topical level there is increased production of H_2O_2 by direct action on NADPH oxidize; at the systemic level there is disruption of phospholipids bilayer due to lipid per oxidation, leading top reduction of ROS inducing synergistic action of SOD, CAT, and APx and increasing H_2O_2 levels especially by SOD. In due time course, excess metals enter cellular organelles like mitochondria and chloroplasts (plants), act as a sink in the electron flow or mist direct the electron flow (depending on the redox status of the metal), which causes production of free radicals. Free radicals, in turn, initiate the antioxidant systems (Halliwel Asada Pathway) to quench H_2O_2. Unquenched H_2O_2 in addition to other free radicals gives rise to singlet oxygen. In addition, receptor metal complex in the plasma membrane causes excess calcium ion concentration which initiates the cal-modulin-Ca^{2+} system activating various kinases. These reactive molecules and kinases act as signals on the transcription factors present in the nuclear as well as the organelle DNA, leading to the production of stress protein sand secondary metabolites that can act as

either damage causing agents or stress counting agents.

The present study was conducted in order to assess the concentration of heavy metals in the atmosphere of Faisalabad and their effect on environment. For the confirmation of interactive relationship between solid aerosols and environment co relationship was also established. These results were also compared with other similar studies quoted in national and international journals having impact factors.

2. MATERIALS AND METHODS

In this study attempt has been made to estimate the trace elements like Cd, Cr, Ni, Zn, Cu, Mg and Pb in the atmosphere comprising of various pools of Faisalabad city. 50 sites were randomly selected for analysis covering industrial, transportational, commercial and residential nature of the Faisalabad environment. Air samples containing solid aerosols were collected using Kimoto high volume air sampler from selected areas of Faisalabad. Samples were collected for a period of 12 hrs with an average flow rate of 0.8m^3/min. Solid aerosols were trapped on glass fiber filters with the collection efficiency of 90%. The filters were weighed before and after sampling [37]. Then analyzed by atomic absorption spectrophotometer (Model No. Varian AA-1475).

It is compulsory to know the constituents of solid aerosols and their sizes as these parameters not only determine the scattering and absorption properties but also provide us information to interact with gaseous pollutants in the environment and react to form new solid aerosol particles or to modify existing ones by homogeneous, homo molecular nucleation or homogeneous, heterogeneous molecular nucleation and their ability to get into the human respiratory system and generate health hazards.

Atomic absorption spectrometry (AAS) used in this study to work on the principle that the amount of energy absorbed in flame is proportional to the concentration of the element present in the sample. Since each element has its own characteristic absorption wavelength, when the sample is in solution form it is found that the measured extinction coefficient σ is proportional to the concentration of the absorbing substance and hence may be written as

$$\mu = K \sigma$$

Where μ is the linear extinction coefficient and K is the extinction coefficient per unit concentration.

The results obtained in this study slightly disagreed from similar previous and current studies conducted by other workers. This disagreement is explained not only in terms of climatological, geological, geographical set ups and latitude, longitude location with respect to solid aerosol sources but also expansion in industrial and transportational set up [36-40].

3. RESULTS AND DISCUSSION

3.1. Elemental Analysis of Solid Aerosols By Atomic Absorption Spectrophotometery (AAS)

In order to determine trace elements through solid aerosols in the Faisalabad. 15 samples were collected from various sites in Faisalabad by dividing it into five pools. After this, all the given samples were subjected to trace elemental analysis by the Atomic Absorption Spectrophotometery (AAS) technique for determination of Ca, Cd, Cr, Ni, Mg, Zn and Pb. The average

Table 1: Average Concentration of Identified Elements in Selected Pools of Faisalabad Environment

Sr. No.	Identification of elements in Solid Aerosols	Pool Selections				
		Pool (1) Average Conc.(ppm)	Pool (2) Average Conc.(ppm)	Pool (3) Average Conc.(ppm)	Pool (4) Average Conc.(ppm)	Pool (5) Average Conc.(ppm)
1	Cadmium (Cd)	2.0942	2.24825	1.95475	2.259	2.596
2	Chromium (Cr)	0.0158	0.0145	0.01125	0.012	0.014
3	Nickel (Ni)	0.4822	0.599	0.35575	0.64275	0.9925
4	Lead (Pb)	1.0324	1.33675	0.2632	0.80575	0.4475
5	Zinc (Zn)	2.1108	2.4635	2.27	2.515	1.38825
6	Magnesium (Mg)	1.1736	1.217	1.206	1.22125	1.15875
7	Calcium (Ca)	8.307	8.30525	3.53875	11.46725	6.7755

Table 2: Pool Wise Trend Pattern of Identified Elements in Faisalabad Environment

Sr. No.	Identification of elements in Solid Aerosols	Pool wise Identification of elements in solid aerosols trend				
		Pool (1) Average Conc.(ppm)	Pool (2) Average Conc.(ppm)	Pool (3) Average Conc.(ppm)	Pool (4) Average Conc.(ppm)	Pool (5) Average Conc.(ppm)
1	Cadmium (Cd)	P5>P4>P2>P1>P3				
2	Chromium (Cr)	P1>P2>P5>P4>P3				
3	Nickel (Ni)	P5>P4>P2>P1>P3				
4	Lead (Pb)	P2>P1>P4>P5>P3				
5	Zinc (Zn)	P4>P2>P3>P1>P5				
6	Magnesium (Mg)	P4>P2>P3>P1>P5				
7	Calcium (Ca)	P4>P1>P2>P5>P3				

concentration of these trace elements is given in Table **1**. The average concentrations of all the elements according to their pools are plotted against sample codes (Cd), (Cr), (Ni), (Cu), (Mg), (Zn) and (Pb). In order to know which region had lighter trace element concentration in solid aerosols loadings than the others. The average pool wise concentration of identified elements were given in Cadmium Cd(1) in amounts ranging between (2.596→1.95475) in Pool (5→3), Chromium Cr(2) in amounts ranging between (0.0145→0.01125) in Pool (2→3), Nikel Ni(3) in amounts ranging between (0.9925→0.35575) in Pool (5→3), Lead Pb(4) in amounts ranging between (1.33675→0.2632) in Pool (2→3), Zinc Zn(5) in amounts ranging between (2.515→1.38825) in Pool (4→5), Magnesium Mg(6) in amounts ranging between (1.22125→1.15875) in Pool (4→5), Calcium Ca(7) in amounts ranging between (11.46725→3.53875) in Pool (4→3) respectively. Following Pool wise Trend pattern of as Identified elements in solid aerosols is given in Table **2**.

To check the authenticity of the data and trace metals statistical analysis was carried out which showed the wide variations in SD [41-50] and CV pointing out the instability of the environment which is not only disturbing the ecology but also the human health (Table **3**).

3.2. Health Hazards of Solid Aerosol Samples

Health hazards of heavy metals such as Cd, Cr, Ni, Cu, Mg, Zn and Pb contained in solid aerosols samples selected from different pools were also investigated in this study. These metals were found to be highly toxic and generating serious health hazards like blood pressure, heart attacks, kidney diseases, fibrosis of lungs, constipation and loss of appetite, abdominal pain and paralysis of muscles Gastrointestinal, irritation and vomiting.

The following strategy was adopted in this study.

- Filling of the questionnaires from 500 (250 from Pool1, 100 from Pool 2 and 150 from Pool 3) residents about their health status.
- Interviews of the doctors and effectees of different hospitals and clinics of concerned pools were conducted.

Table 3: Statistical Analysis of Major Identified Elements by AAS

Identified Elements	Max	Min	Mean	S.D	CV
Cd	2.596	1.95475	2.275	0.641	28.176
Cr	0.0158	0.011	0.0134	.0001815	1.355
Ni	0.9925	0.35575	0.674	0.241	35.757
Pb	1.33675	0.2632	0.801	0.406	50.687
Zn	2.515	1.38825	1.952	0.426	21.824
Mg	1.22125	1.15875	1.19	0.0236	1.983
Ca	11.46725	3.53875	7.503	2.996	39.93

- Empirical relations from this data were developed with respect to trace metals.
- Using the empirical relations was found the percentages of the effectees.

The data collected from questionnaires filled by 500 residents indicate that 6.15% had developed cancer, 10.09% ENT diseases, 0.34% respiratory diseases, 2.74% skin gastrointestinal, 33.29% giddiness, 40.47% headache and 6.87% heart attack. Empirical relations were developed employing the statistical method given by Aban Asrar (1996). In these regression equations the values of R^2 (the coefficient of co-relation) are 87.8 for the heart patients, 68.3 for headache, 66.6 for giddiness, 79.7 for E.N.T., 73.3 for fatigue, 77.10 for gastrointestinal, 96.5 for respiratory diseases, 69.3 for urinary diseases, 88.7 for blood pressure, 71.5 for anemia, 86.0 for skin diseases and 81.3 for cancer confirmed through personal interviews using these empirical relations the percentage of effectees were found out and their trend was also checked and presented pool wise in Table **4** or from the doctors of some selected clinics existing in the selected areas [51-60].

It is speculated from this study that average health has close linknkage with path ways of solid aerosol population. The elders, infants and persons with chronic, cardiopulmonary diseases, influenza or

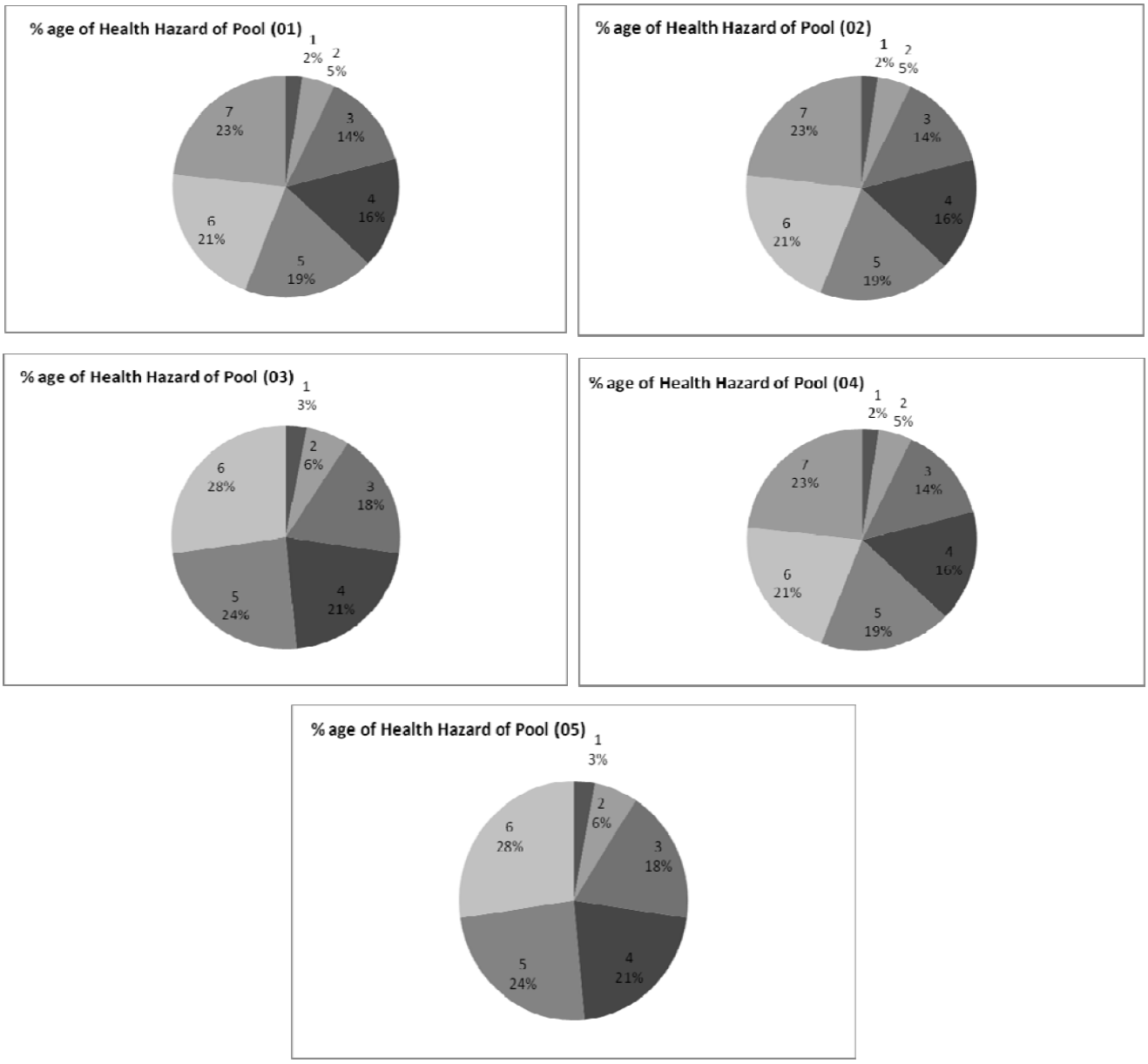

Figure 3: Pool Wise Percentage Health Hazards Related To Faisalabad Environment.

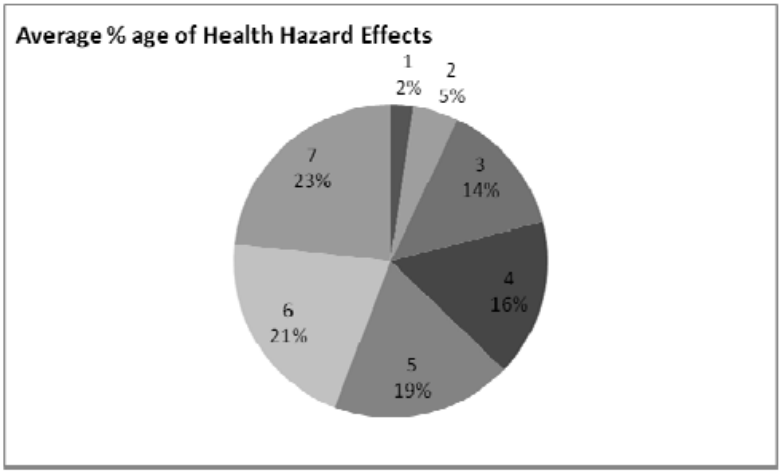

Figure 4: Pi- Graph showing the overall over all average % age of health hazard effects related to total environment of Faisalabad.

Table 4: Health Hazard's Trend in the Atmosphere of Faisalabad

Sr. No.	Diseases	Average % Age of Health Hazards Effects	Health Hazards Trend in Faisalabad Environment
1	ENT	10.09002	Headache> Giddiness>ENT> Heart Attack> Cancer> Skin Diseases> Respiratory Diseases
2	Giddiness	33.28468	
3	Fatigue	ND	
4	Gastrointestinal	ND	
5	Urinary	ND	
6	Cancer	6.14492	
7	Heart Attack	6.8685	
8	Headache	40.4711	
9	Skin Diseases	2.73798	
10	Respiratory Diseases	0.3381	

asthma most susceptible to mortality and serious morbidity effects while others are susceptible to less serious health effects such as transient increase in respiratory symptom, decreased lung function or physio logic changes. These findings were also confirmed through idea of co founding factors and index of agreement, the latest trend used for health implications. Addition knowledge is needed about the specific pollutant from specific area of interest or mixed pollutants from total environment for the adverse health effects and the biologic mechanism involved.

4. CONCLUSIONS

The biotic effects of heavy metals when unduly exposed to them could becomes potentially life threatening hence cannot be neglected, while these metals are in many ways indispensible, good precaution and adequate occupational hygiene should be taken in handling them as per recommendations of the concerned area doctors. Although the heavy metals poising could be clinically diagnosed and medically treated the best option is to prevent heavy metals pollution and the subsequent human poisoning.

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