

河西走廊1994-04-08浮尘暴·黄沙的气象特征和大气气溶胶测定

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摘要 报道 1994-04-07—1994-04-08 河西走廊形成浮尘暴·黄沙天气过程、气象观测和大气总悬浮微粒(TSP)测定结果,说明我国西北地区发生的浮尘暴·黄沙天气的气象及大气气溶胶特点。嘉峪关和酒泉一带是这次黄沙的中心;酒泉等地的 TSP 浓度高达 $38.00\text{mg}/\text{m}^3$,室内 TSP 浓度高达 $8.63\text{mg}/\text{m}^3$,自然降尘浓度达 $296.22\text{t}/(\text{km}^2 \cdot \text{月})$;黄沙云高约 2000—3000m;主要组成元素 Si、Al、Ca、Fe、Mg、Mn 和 Ti 等含量上升;黄沙沿嘉峪关、酒泉、金昌、兰州和北京渐次减少;1994-04-11 的 2:00 在甘肃省大部分地区出现了哈布(Haboob)现象。建议今后对尘暴·黄沙的研究还应测定黄沙气溶胶浓度、粒度分布和不同粒度微粒的化学组成,测定雨土、降水、降尘和气温的变化。

关键词 浮尘暴,黄沙,TSP,哈布现象,河西走廊。

1994-04-07—1994-04-08,甘肃省河西走廊出现了严重的浮尘暴·黄沙天气(以下简称黄沙天气),天空黄沙遮天,能见度骤然下降,汽车白天开灯行驶,交通严重受阻,行人步履艰难,中州机场被迫关闭,而且风沙还摧毁了大量农田和灌区。由于这次浮尘持续时间长,空气中黄沙气溶胶浓度异常高,人们普遍感到胸闷憋气,呼吸困难,甚至造成心理恐慌。

近 10 多年来,关于黄沙发生源地和移动路线等问题有不少报道^[1],但类似这次黄沙天气的气象和大气气溶胶鲜见报导。本文着重叙述了 1994-04-08 黄沙天气的气象特征和大气气溶胶浓度测定结果,并用以探讨黄沙天气形成过程中的若干特点。

1 形成黄沙现象的天气过程

根据地面风的移动轨迹和气象部门观测的天气过程分析,04-06—04-07 由蒙古高原南下的一股强冷空气到了乌兰布和沙漠附近之后,风向由往南转向往西,经银川一带侵入巴丹吉林沙漠引起扬沙和尘暴,继续向西进入河西走廊。与此同时,由塔克拉玛干沙漠刮起的一股西风,卷起沙尘经库穆塔格沙漠进入敦煌、安西一带并继续向东,最后在嘉峪关、酒泉一带与来自巴丹吉林

沙漠的东风相遇。由于两股风向相反,携带大量沙尘的强风相遇,便出现了两股风相互对峙,风力大减,将大量的沙尘滞留在空中,使大气中黄沙浓度异常高,能见度骤然下降。且空气相对稳定,黄沙天气持续时间长达 72h 以上(见图 1)。

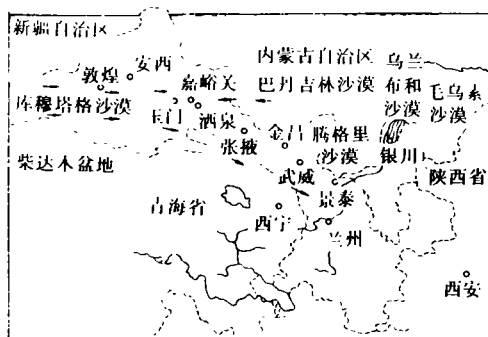


图 1 1994-04-06—1994-04-07 西北地区大风移动路线图

从地面天气图(图 2)分析,这次黄沙天气的形成,是由蒙古高原南下并在途中转向西的强东风与来自新疆塔里木盆地的强西风在河西走廊相遇并形成风向切变线而造成的。从 04-04 起,在新疆南部的塔里木盆地形成了一个热低压,在其北部的蒙古高原形成一个冷高压中心,而且在冷高压与热低压之间形成了很强的气压梯度,其

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每年春天都发生沙尘暴或黄沙天气,当地已形成了对沙尘暴自然灾害天气进行监测的**黄沙监测系统**,而且对这次黄沙也及时进行了测定。表 3 为甘肃省部分地区环境监测站等单位测定 1994-04-08 黄沙气溶胶的结果。这次捕捉到的**总悬浮微粒(TSP)**与平常 TSP 不同,量大色黄。

表 2 河西走廊张掖地区 04-07—04-09 气象观测结果

日期	时间	天气现象	能见度(m)	风向	风速(m/s)	平均风速(m/s)
04-07	02:00	浮尘天气	12	SSE	2	2.5
	08:00	浮尘天气	几乎接近于零	NNE	3	
	14:00	浮尘天气	几乎接近于零	WNW	5	
	20:00	浮尘天气	几乎接近于零	C ¹⁾	0	
04-08	02:00	浮尘天气	几乎接近于零	NW	3	3.3
	08:00	浮尘天气	几乎接近于零	NW	5	
	14:00	浮尘天气	几乎接近于零	WNW	4	
	20:00	浮尘天气	几乎接近于零	ESE	1	
04-09	02:00	浮尘天气	几乎接近于零	C	0	1.8
	08:00	浮尘天气	几乎接近于零	WNW	3	
	14:00	浮尘天气	几乎接近于零	NW	2	
	20:00	浮尘天气	几乎接近于零	WNW	2	

1) 指静风状态

表 3 河西走廊出现浮尘天气时 TSP 的测定结果¹⁾

编号	测定地点	测定高度(m)	测定日期	TSP 日平均浓度(mg/m ³)
1	嘉峪关	8	04-08	22.88
				最高值为 38.00
2	酒泉	7	04-08	11.09
				最高值为 13.34
3	张掖		04-08	办公室内:8.63
				起居室内:5.49
4	金昌	7	04-08	9.81
5	兰州	63	04-08	5.527
6	银川	18	04-07	3.966
7	北京	13	04-12	0.757

1) ①1—6 均使用由青岛崂山电子实验所制造的 KB-120 大容量大气采样器,北京则使用了日本纪本电子株式会社制造的大容量大气采样器;②自然降尘浓度为:酒泉:296.22t/(km²·月),张掖:151.60t/(km²·月);③TSP 测定均在当地环境监测站屋顶上进行的;④这次采集到的 TSP 均呈淡黄色或黄色。

这就证明,黄沙主要来自乌兰布和、巴丹吉林和塔克拉玛干沙漠的沙漠表层土。

表 4 为 1992-04-17 在北京地区出现黄沙时测定 TSP 及其主要化学成分的结果。TSP 是采用 KB-120 大容量大气采样器采集,化学成分分析则利用 ICP(Perkin-Elmer 2321、Spectrometer)进行的。其主要目的是要确定黄沙气溶胶的主要化学组成成分。虽然 1992-04-17 出现的北京的黄沙规模并不大,但仍明显地表现出黄沙天气的若

干特点。表 4 中只列出 4 个采样点,即,农展馆(NZ)、石景山(SJ)、灯市口(DS)和前门(QM)。

3 结果与讨论

3.1 黄沙源地

根据天气图分析和地面观测以及 04-06—04-07 在敦煌、安西以及银川出现风沙的情况,说明 1994-04-08 黄沙来自我国两大黄沙发源地的两股风在河西走廊会合造成的。嘉峪关和酒泉一带是这次黄沙现象的中心。酒泉等地的总悬浮微粒浓度高达 38.00mg/m³,甚至室内总悬浮微粒浓度高达 8.63mg/m³,自然降尘浓度达 296.22t/(km²·月),是河西走廊大气相对稳定,空中滞留着来自巴丹吉林、塔克拉玛干沙漠的沙尘所致。

3.2 黄沙天气的特征

黄沙天气的主要特征,是空中悬浮着高浓度的黄沙气溶胶,形成一大片黄沙云,其高度约 2000—3000m,遮住太阳;地面风力很小或处于静风状态,能见度很低。黄沙天气过程中如遇到降雨,则含有大量黄沙的雨水落地而出现“雨土”,即黄泥雨(Mud rain)。这次在兰州收集到雨土。同样的现象在 1993-05-05 金昌市出现沙尘暴时,在西安(05-06)也出现了雨土。

表 4 黄沙气溶胶的化学组成元素分析结果(μg/m³)

采样点	TSP	Al	Ca	Fe	K	Mg	Mn	Si	Ti
NZ(a)	1077	73.1	56.3	36.3	19.1	17.1	0.864	220	4.40
(b)	166	8.26	10.5	4.75	1.81	2.03	0.106	24.1	0.525
SJ(a)	2044	96.2	86.9	72.3	35.6	28.3	1.620	315	7.29
(b)	227	15.3	12.7	11.0	4.00	3.77	0.347	38.9	0.829
DS(a)	1584	91.1	61.1	53.0	27.7	20.2	0.855	309	5.18
(b)	274	11.7	15.3	7.55	4.64	3.42	0.150	37.4	0.785
QM(a)	1948	98.1	104	61.0	30.6	25.7	1.210	359	6.69
(b)	289	11.8	22.5	8.78	4.22	4.05	0.217	42.0	0.787

(a) 表示 1992-04-17 出现黄沙时的样品;(b) 表示 1992-04-14 非黄沙日的样品

3.3 黄沙气溶胶的分布

嘉峪关和酒泉是这次形成黄沙的中心,其 TSP 浓度远远超过平时的几十倍,自然降尘量也在历年来监测数据中是从未有过的。从表 2 可知,随着蒙古高压缓慢东移和南压,黄沙天气逐渐向东扩展,波及到兰州以及北京等地,因而兰州在 04-09—04-10,北京在 04-12 都出现了黄沙,而且 TSP 浓度也按嘉峪关、酒泉、金昌、兰州、北京的顺序依次减少。这从另一个侧面说明了黄沙气溶胶东移的轨迹。从日本方面得知,04-14—04-16 在日本出现黄沙。由于 04-04—04-07 兰州地区最高气温上升到 25—29℃,日平均气温比往年同期偏高 5—8℃,所以在冷空气侵入河西走廊,暖空气东移时,有可能把黄沙送入高空,经北京一带后出海,漂到日本上空。但日本出现的黄沙与这次 94-04-08 黄沙是否有关,有待于进一步研究。

3.4 黄沙气溶胶的化学组成成分

北京出现的黄沙来自西北干旱半干旱地区。从表 4 可知,在北京出现黄沙时,TSP 浓度急剧上升,高达平时的 5—8 倍,而且其颜色由平时的黑灰色变成淡黄色,主要组成元素 Si、Al、Ca、Fe、Mg、Mn 和 Ti 等的含量也急剧上升。分析结果表明,黄沙的主要化学成分来自组成沙漠表层土的矿物^[3],如石英[SiO₂]、长石[KAlSi₃O₈]、高岭土[Al₂Si₂O₅(OH)₄]、方解石[CaCO₃]、绿泥石[(Mg • Fe • Al)₂(Si • Al)₈O₂₀(OH)₁₆]、云母[K(Mg • Fe)₃(Al • Si₃O₁₀)(OH)₂]等。

3.5 哈布现象

随着新疆南部的低压热空气东移之后接踵

而来的冷空气与东南暖湿气流相遇,加之黄沙的阳伞效应的作用,1994-04-11 2:00 在甘肃省大部分地区出现了降水和降温。这就是撒哈拉沙漠的苏丹等地经常出现的哈布(Haboob)现象,即沙尘暴过后出现降水和降温。1993-05-05 在金昌市发生沙尘暴时也同样出现了哈布现象^[4]。应当指出,目前关于在沙尘暴或黄沙天气之后出现哈布现象的机理尚不清楚,但对它的研究,尤其是对防止哈布现象给农业造成的危害方面是大有好处的。

4 结束语

1994-04-08 黄沙出现时曾收集了大范围的气象资料和地面观测数据,而且对黄沙气溶胶进行了多点测定,获得了有益的数据。但从研究沙尘暴和黄沙的角度来看,今后还应测定黄沙气溶胶浓度、粒度分布以及不同粒度微粒的化学组分;还要测定雨土(降水携带的黄沙)、降水、降尘和气温的变化等。这不仅有助于推算出黄沙的发生量、传输通量、沉降量,而且探讨黄沙对环境的影响以及由黄沙现象引发的其他现象是不可缺少的。

致谢 在本次研究中曾得到甘肃省部分环境监测站、宁夏回族自治区环保所李振声、王建,北京市环境监测中心木成义、韩玉朴等同志的通力支持,在此一并表示感谢。

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of 146.8—351.4 ml/(L · d), a hydrogen content of above 60% in the gas, and a COD removal of 62.3%—78.2%. When the concentrations of wastewater ranged from 1260 to 5040 mgCOD/L, the IPSB could maintain stable hydrogen production for 93 hours, with an average gas production rate of 120.7—140.0 ml/(L · d), a hydrogen content of above 75% in the gas, and a COD removal of 41%—61.3%.

Key words: hydrogen production, photosynthetic bacteria, soybean wastewater.

Pilot Study on the Capacity of Coarse Sediments to Purify Wastewater. Zhang Mingquan et al. (Research Division of Water Resource & the Environ., Lanzhou Univ., Lanzhou 210024); *Chin. J. Environ. Sci.*, **16**(1), 1995, pp. 45—47

The capacity of coarse sediments to purify waste water was determined in laboratory by both continuous and intermittent infiltration tests. It was found that more than 50 percent of bacteria, synthetic detergent and total chromium can be removed from the municipal waste water after its infiltrating through a 1.5m thick gravel soil. The removal of Mn(II) may be up to 76.2% in the intermittent infiltration test, but only 24.7% in the continuous infiltration test. There is an aeration condition in coarse sediments when waste water is infiltrating through it, that is advantageous for nitrification.

Key words: purifying of waste water, coarse sediments, continuous infiltration, intermittent infiltration.

A New Method for Assessing Environment Quality: Twice-slope classification. Ding Jinbao (Zhuzhou Research Institute of Environmental Science, Zhuzhou 412000); *Chin. J. Environ. Sci.*, **16**(1), 1995, pp. 48—51

Based on the principles of the white function construction in the grey system theory and the grey classification, and the weight thought from fuzzy comprehensive assessment, a new method for assessing environment quality, i. e., the twice-slope classification, was suggested. A successful example of using the new method to assess air environment quality was given in this paper. A function based on the twice-slope method was established, and the value range of pollutants in the function was expanded with a full use of information. Compared with other methods, the new method made the use of information much fuller and gave the conclusion more reasonable and credible. It could also overcome the defects of both fuzzy comprehensive assessment

and grey classification and have more practical use in environment quality assessment.

Key words: twice-slope classification, fuzzy comprehensive assessment, grey classification, environment quality assessment.

Study on Large Pore Size Ultrafiltration Membrane of Polyvinylidene fluoride (PVDF). Wang Jingrong (Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085); *Chin. J. Environ. Sci.*, **16**(1), 1995, pp. 52—53

A study on the preparation of large pore size ultrafiltration membrane of PVDF was reported in this paper. The effect of main parameters, such as solvents, additives and temperature, on the membrane properties was discussed. The membranes with a weight cut-off of 240000 and 150000 were prepared. The flux of 30—70 ml/(cm² · h) and the rejection rate above 90% can be achieved.

Key words: polyvinylidene fluoride, large pore size, ultrafiltration membrane.

Meteorological Characteristics of the Surface Dust Storm Bearing Yellow Sands Occurred on 8 April 1994 in the Hexi (Gansu) corridor and the Determination of Atmospheric Aerosol. Quan Hao et al. (Sino-Japanese Friendship Center of Environmental Protection, Beijing 100029); *Chin. J. Environ. Sci.*, **16**(1), 1995, pp. 54—57

The process of forming the weather characterized by the surface dust storm bearing yellow sands occurred on 7—8 April 1994 in the Hexi Corridor of Gansu Province, and the results from both the meteorological observation and the determination of atmospheric total suspended particulates (TSP) were reported, along with describing the meteorology and the characteristics of a atmospheric aerosol while a weather of surface dust storm bearing yellow sands being occurred in northwest China. This surface dust storm was centred on the area of Jiayuguan and Jiuquan, where it was found to have a TSP concentration of up to 38.00mg/m³, an indoor TSP level of 8.63 mg/m³, a natural dust deposition intensity of 296.22 t/(km² · month), a cloud of yellow sands raising up to an altitude of about 2000 to 3000 m, and an increase in the levels of main constituting elements such as Si, Al, Ca, Fe, Mg, Mn and Ti. The atmospheric contents of yellow sands were being progressively decreased along the line from Jiayuguan, Jiuquan, Jincang, Lanzhou to Beijing as the distance increased. Then, at 2 AM on 11 April, the Haboob phenomenon occurred in most parts of the Gansu Province. It was suggested that in a future study on the dust storm bearing yellow

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sands, measurements should be made also on the concentration of yellow sand aerosol, the distribution of its particle sizes, the chemical compositions in the particles of different sizes, and the changes in rain-borne soils, rainfall, dust deposition, and air temperature.

Key words: surface dust storm, yellow sand, TSP, Haboob phenomenon, The Hexi (Gansu) Corridor.

Study on Acrylic Wastewater Treatment Using an Internal Circulating Bio-Fluidised Bed. Zhou Ping and Qian Yi (Dept. of Environ. Eng., Tsinghua Univ., Beijing 100084); *Chin. J. Environ. Sci.*, **16**(1), 1995, pp. 58—61

A pilot study on acrylic wastewater treatment by using an internal circulating three phase bio-fluidised bed was conducted. There were N_v of 4.0 and 6.8 kgCOD/(m³ · d) and N_s of 1.6 and 2.8 kgCOD/(kgVSS · d) when the influent had COD of 710 to 992 mg/L and 1277 to 2276 mg/L, respectively. Oxygen utilization rate was about 17%. Post-treatment experiment of the effluent from fluidised bed was also carried out and an acrylic wastewater treatment process was suggested.

Key words: acrylic wastewater, internal circulating three phase bio-fluidised bed, wastewater treatment.

Determination of Iron (I) and (II) in water by Ion Chromatography Combined with Atomic Absorption Spectrometry. Wang Xiaoqin et al. (Dept. of Chemistry, Tsinghua Univ., Beijing 100084); *Chin. J. Environ. Sci.*, **16**(1), 1995, pp. 62—64

A method for determination of Fe(I) and Fe(II), which combines ion chromatography and atomic absorption spectroscopy, is described. Fe(I) and Fe(II) were first separated on a Shima Pack column packed cation-exchange resin, and then determined by a graphite furnace atomic absorption spectrometry. The detection limits of Fe(II) and Fe(I) were at the 7.7 ng · ml⁻¹ and 3.8 mg · ml⁻¹, respectively. The method has been successfully used in iron species of tap water and river water.

Key words: ion chromatography, atomic absorption spectrometry, iron, species analysis.

Analysis of Atmospheric Particulates and Organic Pollutants in Datong. Liu Ruilian et al. (Datong Municipal Institute of Environmental Protection, Datong 037006), Zhao Zhenhua (Beijing Municipal Research Academy of Environmental protection, Beijing 100037); *Chin. J. Environ. Sci.*, **16**(1), 1995, pp. 65—67

This paper reports the determination of atmospheric

particulates from different functional districts in Datong. The inhalatable particulates (< 10μm) concentration accounts for about 50% of the total suspended particulates (TSP). The extracts in methylene chloride representing the total polluted organic materials account for about 20% of TSP. The compounds in the total polluted organic materials identified with GC, GC/MS and HPLC included 38 compounds of benene series and other aromatic hydrocarbons, 31 compounds of paraffins, and 14 compounds of phenols, ketones, nitrogen-containing organic and phthalates.

Key words: air pollution, particulate, organic pollutants.

Sequential Determination of Trace Chromium(VI), Nickel and Zinc in Electroplating Waste Waters by Flow-injection Spectrophotometry. Wang Peng et al. (Dept. of Applied Chemistry Harbin Institute of Technology, Harbin 150006); *Chin. J. Environ. Sci.*, **16**(1), 1995, pp. 68—70

An automated flow-injection system is described for the sequential spectrophotometric determination of trace Cr(VI), Zn and Ni in waste waters. The sample analysis frequency is 60h⁻¹ and the detection limit is 0.1 mg/L(Cr), 0.2mg/L(Zn), and 0.3mg/L(Ni), respectively. The relative standard deviation is around 1%. Results obtained with the proposed method are in a good agreement with the standard manual spectrophotometric methods.

Key words: environmental monitoring, flow-injection analysis, chromium(VI), nickel, zinc, wastewater.

Studies on the Determination of Nitrite with a Stopped Flow-Catalytic Spectrophotometric Procedure. Wang Jianhua and He Ronghuan (Chemistry Dept. of Yantai Teachers College, Yantai 264025); *Chin. J. Environ. Sci.*, **16**(1), 1995, pp. 71—73

A stopped flow-catalytic spectrophotometric procedure for the determination of nitrite was established based on its catalytic effect on the bromate-rhodamine B oxidation decolouring reaction. The optimal conditions for the determination were established as: [KBrO₃] = 5.0 × 10⁻² mol · L⁻¹, [rhodamine B] = 4.8 × 10⁻⁵ mol · L⁻¹, [H₂SO₄] = 0.75 mol · L⁻¹, and 50°C. The calibration graph was linear for 0—0.6 μg · L⁻¹ NO₂⁻, and the detection limit was 2 ng · L⁻¹. The reproducibility of the method was good, and the selectivity was improved significantly, with respect to conventional procedures. Nitrite contents in soil, vegetable, rain water and wastewater had been determined, and the results were satisfactory, the