

# 用 Moss Bag 富集研究汞矿附近元素汞的沉降\*

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**摘 要** 应用 Moss Bag 监测元素汞的干湿沉降. 结果表明: 矿区大气汞浓度  $200\text{--}1135\text{ng} \cdot \text{m}^{-3}$  时汞的湿沉降为  $1700\mu\text{g} \cdot \text{m}^{-2} \cdot \text{a}^{-1}$ ; 干沉降  $987\mu\text{g} \cdot \text{m}^{-2} \cdot \text{a}^{-1}$ . 而当距矿区 67km, 大气汞浓度  $3.4\text{--}4.0\text{ng} \cdot \text{m}^{-3}$  时, 其干沉降  $21\mu\text{g} \cdot \text{m}^{-2} \cdot \text{a}^{-1}$ , 湿沉降  $33\mu\text{g} \cdot \text{m}^{-2} \cdot \text{a}^{-1}$ , 湿沉降占总沉降 61%—63%, 干沉降占 37%—39%, 元素汞的干湿沉降与距汞源的距离明显相关.

**关键词** 汞, Moss Bag 富集, 干湿沉降, 汞矿区.

汞散布到大气中, 再按干湿沉降在大气中移动到距汞源一定距离的区域.

由于苔藓 (moss) 具有较大的阳离子交换量 ( $0.9\text{--}1.5\text{meq} \cdot \text{g}^{-1}$  干重)<sup>[1]</sup>, 自 90 年代以来, 用 Moss Bag 技术监测评价大气中重金属污染工作在芬兰<sup>[2]</sup> 和瑞典<sup>[3,4]</sup> 均有报道.

本研究选择贵州某汞矿区以及汞矿附近相对纯净的梵净山自然保护区, 用 Moss Bag 技术监测汞的干湿沉降 (dry deposition and wet deposition), 探讨了汞源附近汞的大气污染.

## 1 材料与方法

### 1.1 Moss Bag 的制作

从相对清洁区采集苔藓 (moss), 大灰藓 (*Hypnum plumaeforme* wils) 摘取大于 6cm 以上植株, 用  $0.5\text{mol} \cdot \text{L}^{-1}$  HCl 浸泡 24h, 然后用蒸馏水洗净, 置于清洁处自然风干, 备用.

称取风干后的 moss 3.0g, 装入尼龙网袋<sup>[1]</sup> 几何尺寸如图 1. 其大小为  $15.5\text{cm} \times 6.5\text{cm}$ , 网眼为  $1.5\text{mm} \times 2.0\text{mm}$ , 展开时面积约等于  $100\text{cm}^2$ .

### 1.2 干湿沉降的监测方法

将 Moss Bag 悬挂于所选择的 2 个点, 1 个 Moss Bag 用塑料罩覆盖上面, 另一个完全暴露于大气中, 并保证距离地面 3m 以上, 如图 2 所示. 时间周期为 60d, 1996-04-26—1996-06-26. 监测当年气候正常. 每月取下 Moss Bag 所损失的重量不允许大于 5%, 3 次重复.

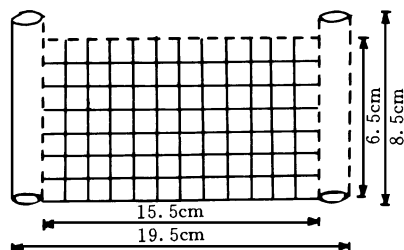


图 1 Moss Bag 几何尺寸

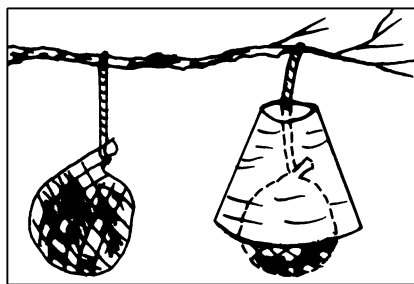


图 2 覆盖与完全暴露的 Moss Bag

### 1.3 样品的采集

在贵州某汞矿及离矿区 67km 相对清洁的梵净山自然保护区采集苔藓植物同时测定大气汞浓度.

### 1.4 元素分析

大气汞用携带式 GARDIS-1A 测定, 检出限  $0.2\text{pq} \cdot \text{m}^{-3}$ , moss 风干, 磨细过 100 目筛,

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于石英管酸炸弹用  $\text{HNO}_3$  在 160℃ 消化, AAS 测汞, 检出限 10ml 溶液 ( $\text{Hg}$ )  $0.1\text{ng} \cdot \text{mL}^{-1}$  相应样品含汞  $0.001\text{mg} \cdot \text{kg}^{-1}$ , 重现性误差为 10%。

## 2 结果与讨论

### 2.1 大气汞浓度测定

对 9 个点采样, 24h 连续测定, 其采样点见图 3, 结果见图 4。由图 4 可知, 在汞矿区大气汞的浓度是  $200\text{—}1135\text{ng} \cdot \text{m}^{-3}$ , 说明在矿区, 大气汞的浓度较高, 随温度、湿度、风向的改变, 产生散布-沉降-再散布的循环。图 4 表明大气汞的浓度随距汞源的距离增加而减少, 产生汞浓度梯度, 在梵净山大气汞的浓度仅有  $3\text{—}5\text{ng} \cdot \text{m}^{-3}$ 。当然汞的辐射与沉降与距离以及汞浓度, 汞的形态、湿度、风速、湍流、降雨量和人为活动等诸因素的影响有关。

### 2.2 moss 测定结果

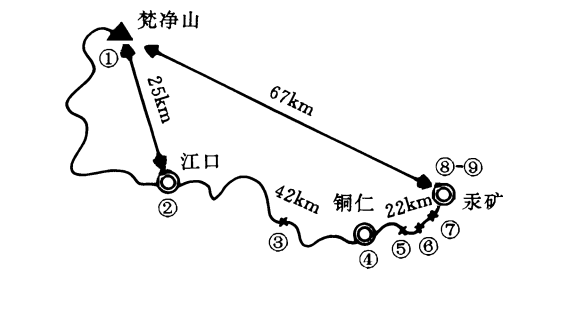


图 3 采样点的示意图

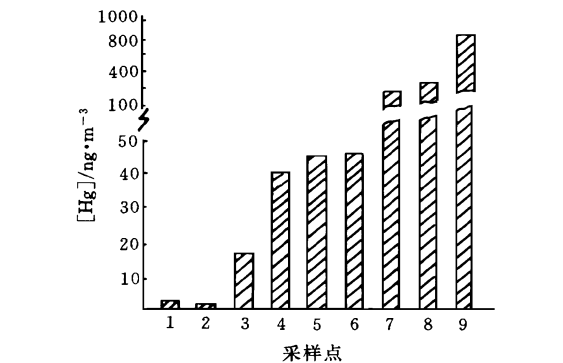


图 4 大气汞测定结果

苔藓样品的采集点见图 3。其分析结果如

表 1 所示。苔藓的汞含量随距汞源距离的增加而降低, 在 30km 以内符合数学方程式  $c = 23.17e^{-0.115r}$  ( $r = 0.99$ ), 苔藓中汞含量变化与大气汞的移动趋势相一致。从目前人们所接受的解释, 大部分  $\text{Hg}^{2+}$  和  $\text{Hg}^0$  的沉降在 100km 的范围, 其它 50% 汞将散射在 1000—2000km 范围, 而 5% 将分布到全球。当然这种解释是相对的。

表 1 苔藓汞含量的测定结果

距离/km	3	10	15	20	30
汞含量/ $\text{mg} \cdot \text{kg}^{-1}$	16.6	7.69	4.43	2.55	0.85

### 2.3 Moss Bag 测定结果

覆盖的 Moss Bag 所接收的是干沉降累积, 而暴露在空气中的 Moss Bag 所接受的是总沉降累积, 测定结果如表 2 所示。在汞矿区, 汞的沉降速率是  $2694\mu\text{g} \cdot \text{m}^{-2} \cdot \text{a}^{-1}$ , 湿沉降占 63%, 而在梵净山, 汞的沉降速率是  $54\mu\text{g} \cdot \text{m}^{-2} \cdot \text{a}^{-1}$ , 湿沉降占 61%, 由于所选择点在同一地区, 降雨量基本相同, 所以, 湿沉降表现所占比例一致。2 个总沉降速率的差异明显与距汞源的距离相关, 它们的变化趋势也同大气汞含量浓度、苔藓汞含量变化趋势一致。

表 2 汞沉降测定结果/ $\mu\text{g} \cdot \text{m}^2 \cdot \text{a}^{-1}$

测 点	总沉降		湿沉降		干沉降	
	速率	速度	占总沉降 W%	速度	占总沉降 W%	
汞 矿	2694	1700	63	987	37	
梵净山自然保护区	54	33	61	21	39	

## 参 考 文 献

- 1 Temple P J et al. Moss bag as monitors of atmospheric deposition. Journal of the Air Pollution Control Association, 1981, 31(6): 668—670
- 2 Lodenius M. Dry and wet deposition of elemental mercury measured by moss bags near a chloralkali plant. Proceeding of 10th World Clean Air Congress, Finland: 1995: 3, 412
- 3 Iverfeldt Å. Mercury in forest canopy throughfall water and its relation to atmospheric deposition. Water Air Soil Pollut., 1991, 56: 553—564
- 4 Dirscoll C T et al. Trace metals speciation and cycling. In: Moldan B and Cerny J (eds). Biogeochemistry of small catchments: A tool for environmental research, John Wiley & sons Ltd, 1994: 299—322

in lab..  $0.01\text{m}^3/\text{m}^3$   $\text{SO}_2$  is absorbed in a glass absorber with liquor of manganese waste slag. Under the condition of solid-liquid ratio  $\text{SO}_2:1:5$ , pH 1.8—2.2 and  $\text{SO}_2$  absorption efficiency

90%,  $\text{MnSO}_4 \cdot \text{H}_2\text{O}$  has been produced by primary crystallization of the absorption mother liquor. The products analysed have a purity of 94%  $\text{MnSO}_4 \cdot \text{H}_2\text{O}$ .

**Keywords:** sulfur dioxide, manganese waste slag, wet desulphurization.

### Research of Large Gangue Content Cement.

Xu Bin et al. (Dept. of Material Science, Southwest Institute of Technology, Mianyang 621002): *Chin. J. Environ. Sci.*, **18**(6), 1997, pp. 61—62

By means of activator, a kind of large gangue content cement was obtained, which gangue content is 60% and  $R_{28}$  is up to 49.6 MPa. The physical property such as normal consistency water demand, setting time and soundness of cement can meet the standard. The hardened cement has lower porosity of  $0.0413\text{cm}^3/\text{g}$  and lower hydrate heat which is  $253\text{kJ/kg}$ .

**Keywords:** large gangue content cement, activator, physical and mechanics property, porosity, hydrate heat.

### Study on a Dye Adsorption Made from Waste Asbestos Friction Materials.

Zhao Yuming et al. (State Key Lab of Pollution Control and Resource Reuse, Dept. of Environ. Sci. and Eng., Nanjing Univ., Nanjing, 210093): *Chin. J. Environ. Sci.*, **18**(6), 1997, pp. 63—65

A kind of new adsorbent was made from waste asbestos friction materials. The static adsorption capacity for cation yellow X-5GL is  $159.68\text{mg/g}$  in its aqueous solution which chromaticity is 50000, and the adsorption capacity for cation blue RL is  $79.68\text{mg/g}$  in its solution which chromaticity is 5000. The treating amount for waste water generated in the dyeing process from woolen textile factory can be as high as  $280\text{ml/g}$ . This adsorbent can also effectively adsorb reactive dye, and can be easily regenerated through aftertreatment when saturated adsorption is reached.

**Keywords:** asbestos friction materials, adsorption, cation dye, reactive dye.

**Study on the Treatment of Skin Wastewater by Sequencing Batch Reactor.** Zhu Shuqin et al. (Qiqihar Environ. Protection Sci. Research Institute, and Qiqihar Environ. Supervision Station, Qiqihar 161005): *Chin. J. Environ. Sci.*, **18**(6), 1997, pp. 66—67

Laboratory studies indicated that experimental conditions: simulating waste water temperature  $20^\circ\text{C}$ , DO  $2\text{mg/L}$ ,  $\text{COD}_\text{Cr}$   $1500\text{mg/L}$ ,  $\text{BOD}_5$   $900\text{mg/L}$ , MLSS  $2100\text{mg/L}$ . After 4 hours period aeration, the  $\text{COD}_\text{Cr}$  dropped toward about  $100\text{mg/L}$ ,  $\text{BOD}_5$  toward about  $40\text{mg/L}$ , the concentration of sludge increased from  $2100\text{mg/L}$  to about  $2600\text{mg/L}$ . Experimental results showed that sequencing batch reactor system to be operated in a limit aeration schedule can not cause sludge increase rapidly.

**Keywords:** sequencing batch reactor,  $\text{COD}_\text{Cr}$ ,  $\text{BOD}_5$ , MLSS, limit aeration, sludge expansion.

### GC Analytical Method for Acidic Phosphate Ester.

Deng Nansheng et al. (Dept. of Environ. Sci., Wuhan Univ., 430072): *Chin. J. Environ. Sci.*, **18**(6), 1997, pp. 68—70

Derivation methods of quaternary ammonium salt thermolysis, silanization, methyl iodide-esterification and diazomethane-esterification for acidic phosphate ester were compared in this paper. Results indicated that methyl iodide-esterification is the best derived method. GC quantitative analysis of this method was systematically studied and a simple, quick, precise and high-sensitivity GC analytical method was developed. Percent recovery of P507 is 97.0%—111% and its detection limit is  $0.92\text{ng}$  through this method. Percent recovery of P204 is 94.8%—97.8% and its detection limit is  $1.33\text{ng}$ . With the establishing of this method, the studies on the behavior of organophosphorus extracting agents especially the acidic phosphates in water-environment reach a new level.

**Keywords:** organophosphorus extracting agent, acidic phosphate ester, GC, derivation.

### Dry and Wet Deposition of Elemental Mercury Measured by Moss Bag near a Mercury Mine.

Tan Hong et al. (Guizhou Research Centre of

Physical Testing and Chemical Analysis, Guiyang 550002): *Chin. J. Environ. Sci.*, **18** (6), 1997, pp. 71—72

Dry and wet deposition of element mercury was measured by moss bag in this study. The results showed that when concentration of atmospheric mercury is  $200\text{--}1135\text{ng}\cdot\text{m}^{-3}$ , wet and dry deposition of mercury are  $1700\text{ }\mu\text{g}\cdot\text{m}^{-2}\cdot\text{a}^{-1}$ ,  $987\text{ }\mu\text{g}\cdot\text{m}^{-2}\cdot\text{a}^{-1}$  at the mercury mine area respectively. The concentration of gaseous mercury is  $3.4\text{--}4.0\text{ng}\cdot\text{m}^{-3}$ , wet and dry deposition of mercury are  $33\text{ }\mu\text{g}\cdot\text{m}^{-2}\cdot\text{a}^{-1}$ ,  $21\text{ }\mu\text{g}\cdot\text{m}^{-2}\cdot\text{a}^{-1}$  respectively at the area which is 67 km from mercury source. Wet deposition is 61%—63% and dry deposition is 37%—39%. Dry and Wet deposition of element mercury are correlation with distance from mercury source.

**Keywords:** mercury, moss bag, dry and wet deposition, mercury mine, atmospheric determination.

**The Design of the Chinese Provincial Environmental Information Systems.** Gao Lang, Cheng Shengtong et al. (Dept. of Environ. Eng., Tsinghua Univ., Beijing 100084): *Chin. J. Environ. Sci.*, **18**(6), 1997, pp. 73—75

This paper introduces the overall design, basic structure, main contents, developing process, and characteristics of the Provincial Environmental Information Systems (PEIS) that cover 27 provinces in China. Under the guidance of research on Environmental Information Resources Management Planning and Environmental Information Normalization, several basic databases, environmental management modules, and decision-making support modules were developed through the way of combining the structural life cycle idea with the fast prototype developing methodology. On the whole, the technique of the established systems is advanced, their functions are practical, their design is normalized, their management is convenient, and the establishment of them is the base for further development of the environmental information networks in our

country.

**Keywords:** information system, environmental management, environmental information system.

**A Study on the Impact Analysis of LCA.** Xi Deli et al. (Dept. of Environ. Eng., Tsinghua Univ., Beijing 100084): *Chin. J. Environ. Sci.*, **18**(6), 1997, pp. 76—80

The impact analysis is a key part in LCA. It is also the most difficult one in LCA. There are some disadvantages for both the existing qualitative and quantitative approaches. On the basis of the LCA index system proposed by authors earlier, the method of environmental quality assessment has been introduced to the impact analysis in this study, which makes the impact analysis much easier than before. Moreover, the obtained results are rather objective and comparable. This paper illustrates the estimation approaches for evaluation indexes and explains how to form the essential index system. It has been pointed out that the use of 5 essential indexes should be enough for defining the environmental properties of a product comprehensively.

**Keywords:** LCA, environmental quality assessment, impact analysis.

**Development, Application and Industrialization of Environmental Useful Microorganism.** Shi Jialiang et al. (Dept. of Environ. Sci., East China Normal University, Shanghai 200062): *Chin. J. Environ. Sci.*, **18**(6), 1997, pp. 81—83

Microorganisms play an important role in a lot of fields, such as the degradation and transformation of pollutants, recycling of resources, producing and development of green products, protection of ecological environment. It is discussed in this paper that the direction of development and industrialization of the useful microorganisms.

**Keywords:** environmental useful microorganism, industrialization, development, application.