

土壤有效态微量元素含量与不同地貌单元关系的研究

——以河南省新乡地区卫辉市和辉县市为例

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摘要 选择上自太行山下至黄河故道的一个具有不同地貌类型的典型区域, 研究了土壤中 6 种对植物生长发育必需的微量元素有效态含量与地貌变化的关系。水溶态硼随地形下降而含量增加; 易还原态锰含量与地形高低呈一致变化; 钼含量以山地及低地最低; 锌含量多偏低; 铜在不同地貌土壤中的含量均在中等以上。

关键词 有效态, 地貌, 微量元素, 土壤。

锌、硼、锰、钼、铁、铜是植物生长发育必需的微量元素。近 20 余年来广泛应用于农田、菜地及果园, 但多在平原地区推广, 而在广大的山区则应用较少, 导致这些地区缺乏微量元素的土壤生长的农作物产量进一步提高受到限制。

该项工作选择了太行山地一典型区域, 即河南省新乡地区的卫辉市与辉县市近 3000km² 范围内进行不同地貌的土壤中上述元素丰缺程度的研究。

1 地貌类型

该两市相邻, 卫辉市位于太行山东麓, 古黄河北岸, 最高海拔 1069m, 山区面积占 29.1%,

其余为平原及背河洼地。辉县市位于太行山中部, 全区多为低山和中低山, 最高海拔 1732m, 500m 左右的低山占总面积 50%, 丘陵占 21%, 平原为 29%。两市的地形为西北高东南低。随海拔高度及地貌因素而分布不同类型土壤, 由高至低的土壤为: 太行山地淋溶褐土及褐土性土 (I)、山前丘陵岗地的典型褐土 (II)、山前倾斜平原的潮褐土 (III)、山前交接洼地及平原分布的黄潮土 (IV)、洼地盐化潮土 (V)、古黄河滩地的褐土化潮土 (VI) 及黄河故道的冲积风沙土 (VII) (图 1)。

2 样品采集

用 1/5 万土壤分布图为底图, 在图上以 8cm² 方格为单位确定采样地点, 采集农田耕层 0—25cm 的土样, 采样地点均选择距村庄 100—200m; 土壤肥力可代表大面积农田, 方法是在麦行间挖取 3—4 处的土壤, 各取相近数量再混合为一个样品。但较高山地因高岭起伏, 沟壑广布而无农田, 故仅在坡耕地及梯田内采样, 总计在 2 市范围内共采集 84 个地点的样品。

3 分析方法

锌、铜、铁用 DTPA 溶液提取, 锰用鲜土以 1mol/L 浓度的中性醋酸铵加 0.2% 对苯二酚提

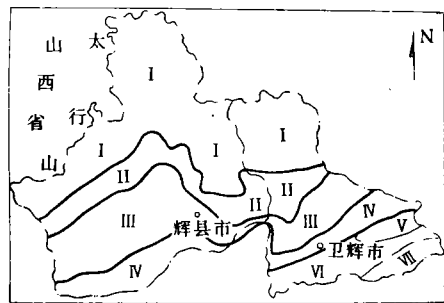


图 1 辉县市与卫辉市的地貌类型

I. 太行山地, 淋溶褐土和褐土性土 II. 山前丘陵岗地, 典型褐土 III. 山前倾斜平原, 潮褐土 IV. 山前交接洼地, 黄潮土 V. 洼地, 盐化潮土 VI. 古黄河滩地, 褐土化潮土 VII. 黄河故道, 冲积风沙土

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取易还原态锰,提取液均用原子吸收分光光度法测定。硼是用沸水在回流条件下提取 5min 后以姜黄素比色法测定。钼用草酸-草酸铵溶液浸提(pH3.3)后以催化极谱法测定。

4 元素丰缺评价标准

对各元素测定的数据均用国内外通用的评价标准进行丰缺程度判断^[1],该标准见表 1。

表 1 土壤有效态微量元素的丰缺评价标准

元素	分级含量(10^{-6})			缺乏临界值
	低	中	高	
硼	<0.50	$0.51-2.00$	>2.00	0.50
锌	<1.0	$1.1-2.0$	>2.1	1.0
锰	<100	$100-200$	>200	100
钼	<0.15	$0.16-2.0$	>2.0	0.15
铁	<7.0	$7.1-10.0$	>10.0	7.0
铜	<0.2	$0.21-1.0$	>1.0	0.2

5 结果与讨论

各类土壤的有效态元素含量与地貌变化的关系:

5.1 硼

研究区域的土壤有效硼含量为 0.20×10^{-6} — 1.85×10^{-6} ,平均值为 0.54×10^{-6} ,低于缺硼临界值($<0.50 \times 10^{-6}$)的土壤占 75%。从山地的淋溶褐土至山前倾斜平原的潮褐土有 95% 的土样含硼低于临界值。交接洼地的黄潮土和黄河滩地的褐土化潮土多为中等含量,但平原上的盐化潮土又达到高含量,这与相邻高地淋洗出的硼汇集于盐碱洼地以及盐土下层的硼易随盐分上升而富集于农田耕层均有关^[2,3]。总的看来,土壤硼从山地至平原而逐渐增加(图 2),显示出该元素的淋溶性强,这也与早有研究指出的、发育于石灰性母质的以及质地粗的易淋溶土壤一般缺硼相一致^[4]。例外的是分布于该区域最低处的黄河故道风沙土,水溶硼含量极低(0.28×10^{-6}),这是由于沙土质地粗、粘粒组分少(18.8%)。有机质含量低(0.5%以下),故硼更易淋溶而迁移。

5.2 锌

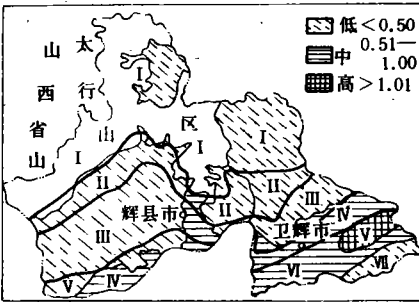


图 2 不同地貌区域土壤有效 B 的含量

有效锌为 0.12×10^{-6} — 4.32×10^{-6} ,平均值 0.57×10^{-6} ,接近临界值(0.50×10^{-6}),其中有 86% 的土壤有效锌含量低于临界值,表明该区域的土壤锌低或极低。冲积风沙土,褐土化潮土和盐化潮土的缺乏率为 100%,黄潮土为 90%,潮褐土、淋溶褐土和褐土性土为 75%—83%。锌含量高低与地貌关系是:北部山区较高而南部平原则下降,但是极少数工矿附近或城郊污染区的土壤有效锌达到高值(图 3)。早有研究证明,当土壤 pH 值由 5 增到 7 时,植物吸收锌的量减少 1/2^[6],因石灰性土壤的锌易与钙结合为难溶的锌酸钙。该区域为石灰性土壤,有机质含量偏低,故研究的 6 种元素中以锌的缺乏率最高。

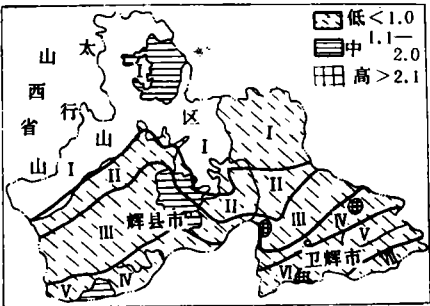


图 3 不同地貌区域土壤有效 Zn 的含量

5.3 锰

土壤中有有效的易还原态锰含量为 28.9×10^{-6} — 255.5×10^{-6} ,平均值为 134×10^{-6} ,其中仅 23% 的土壤为低水平。随地形由高向低而锰含量亦下降。如山地淋溶褐土及褐土性土的含量

几乎均在中等和高水平(图 4),但在古黄河滩地的低处却均降至低含量。因此山地明显高于平原。这与成土母质的矿物组成及土壤有机质含量均有关。尤以有机质是影响锰有效性的的重要因素^[7],山地淋溶褐土的有机质含量均高于 1.4%,黄河故道风沙土仅为 0.5% 以下。据 Shuman 报道^[8],对土壤增施有机肥可提高有效锰量。锰在有机质含量高的土壤中可形成稳定的抗沉降的复合物,这也是保持其有效性的机制之一。

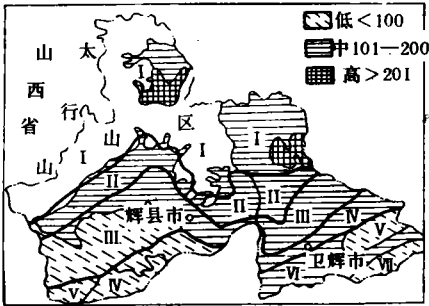


图 4 不同地貌区域的土壤有效 Mn 的含量

5.4 钼

有效钼含量为 0.06×10^{-6} — 0.41×10^{-6} ,平均值为 0.16×10^{-6} ,其中有 28% 的土壤为高含量,58% 的土壤含量低于临界值。联系不同地貌进行比较,山地淋溶褐土最低。Smith 等亦曾提出,凡地势高的土壤,有效钼亦低^[9]。但是该项研究中位于低地的盐化潮土及水稻土含钼量亦低。这可能与游离的含铁氧化物对钼的固定有关。因此,土壤有效钼含量高低与地貌无规律性联系。总的看来是多数土壤缺钼,在所研究的 6 元素中为第 3 位缺乏的微量元素(图 5)。

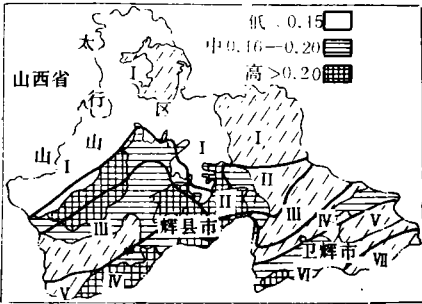


图 5 不同地貌区域土壤有效 Mo 的含量

5.5 铁

土壤有效铁含量为 4.12×10^{-6} — $44.9 \times$

10^{-6} ,平均值为 11.5×10^{-6} ,其中有 85% 的土壤所含有效铁高于临界值,缺铁土壤为 15%。以不同地貌进行比较,较高的山地土壤缺铁面积小,山前倾斜平原至洼地的盐化潮土则多为缺铁,古黄河滩地又多为较高含量,在黄河故道风沙土区的长期淹水的稻田又达到高含量,故有效铁含量高低与不同地貌无规律性关系。对影响土壤有效铁含量的主要因素,尚存在不同看法,较多学者认为,石灰性土壤及长期淹水的土壤,有效铁含量均较低,碱性土壤的铁易氧化为不溶的 Fe^{3+} 。但另有研究认为,排水不良的土壤中 Fe^{3+} 易还原为 Fe^{2+} ,使其有效性增加^[10]。本研究区域的土壤均为碱性,但各类土壤的有效铁含量不同(图 6),值得进一步研究。

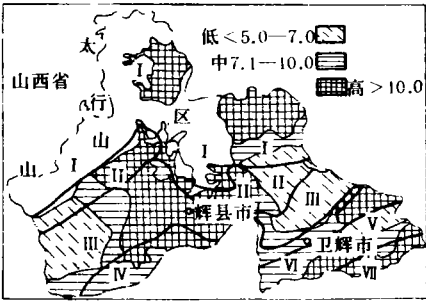


图 6 不同地貌区域土壤有效 Fe 的含量

5.6 铜

有效铜的含量为 0.41×10^{-6} — 4.18×10^{-6} ,平均为 1.36×10^{-6} ,该区域各类土壤有效铜下限均在临界值以上,表明铜不低,此外,与地形地貌无规律性联系(图 7)。

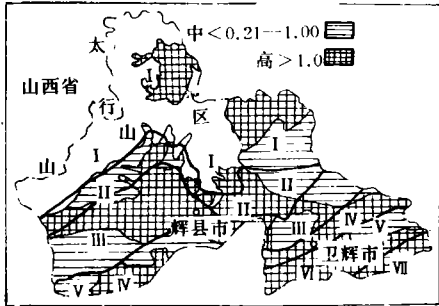


图 7 不同地貌区域土壤有效 Cu 的含量

综上所述,如将研究区域各类土壤的 6 种元素有效态含量低于缺乏率的土壤分布面积进行

比较,其高低顺序为:锌(86%)>硼(60.7%)>钼(58.3%)>锰(23.0%)>铁(15.0%)>铜(0%)。这表明施用微肥在该区域具有较大的增产潜力。

6 结语

本项研究结果表明,在上自太行山,下至黄河故道的一典型区域、即河南卫辉市与辉县市所辖范围内,土壤水溶态硼含量随地势往下而含量增加。易还原态锰含量与地形高低呈一致的变化,钼的含量以山地最低,而低地亦低。锌的含量除北部山区为中等水平外,大多数地区的含量均低,山前洼地和平原地的多数土壤几乎全为低含量。铜则相反,不同地貌的各类土壤的含量均在中等水平以上。土壤有效铁含量高低与不同地貌无规律性联系。

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Abstracts

Chinese Journal of Environmental Science

Performance of Modified Polyacrylonitrile- based Activated Carbon Fibers for SO₂ Adsorption. Liu Zhongzheng, Cuan Yaquan et al. (Dept. of Environ. Sci., Chengdu University of Science and Technology, Chengdu 610065); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 1—5

Polyacrylonitrile-based activated carbon fiber (ACF-PAN) made by the authors in laboratory was modified by adding different active components in order to improve its performance for adsorbing SO₂. Then ACF-PAN and the differently modified ACF-PANs were studied on their performances for SO₂ adsorption. It was found that the modified ACF-PANs had an equilibrium adsorption capacity which was more than 2 times that of ACF-PAN and about 10 times that of activated carbon (ACF-PAN, 62.9mg/g ACF; ACF-PAN (Ⅱ)₁₋₄, 113.6—143.7mg/g ACF; AC, 14.9mg/g AC), and an adsorption rate which was more than that of ACF-PAN, so that such a modification made the capacity of adsorbing SO₂ to be largely increased.

Key words: modification, activated carbon fiber, sulfur dioxide, adsorption, polyacrylonitrile.

Effects of Mercury on Sewage Purification and Physiological Characteristics of Immobilized *Chlorella*. Yan Guo'an, Li Yijian (Dept. of Environ. Sci., Wuhan University 430072); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 6—9

Chlorella vulgaris entrapped in an alginate gel was used to remove NH₄⁺-N and PO₄³⁻-P from wastewaters containing different levels of mercury (Hg²⁺) in laboratory, and the effects of mercury on the removals of nutrient salts and on the physiological features such as chlorophyll- a, photosynthetic intensity, growth and peroxidase activity of the immobilized algae were examined and compared with those of free algae (control). It was found that the immobilized algae had an increased resistance to the toxicity of mercury so that a concentration of 0.2×10^{-6} Hg²⁺ or less did not significantly affect its efficiency in removing the nutrients while allowing the free algae to have a significantly reduced efficiency in removing the nutrients. As the Hg²⁺ concentration increased, the immobilized algae had a gradually decreasing removal of nutrients which was still higher than that of free algae in a wastewater without Hg²⁺. Similarly, the growth, chlorophyll-a content, photosynthetic intensity and peroxidase activity of the immobilized algae decreased with increasing the Hg²⁺ concentration but were still higher than those of free algae.

Key words: mercury, immobilized *Chlorella*, sewage purification, physiological characteristics.

Study on the Optimized Conditions for Entrapping

Anaerobic Activated Sludge in PVA. Min Hang et al. (Dept. of Environ. Sci., Zhejiang University of Agriculture, Hangzhou 310029); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 10—14

The optimized conditions under which anaerobic activated sludge was immobilized with a mixed carrier process using polyvinyl alcohol (PVA) as major entrapping material were studied. The mixed carrier consisted of PVA, 0.15% sodium alginate, 2% Fe (iron powder), 0.3% CaCO₃, and 4% silica gel. It was found that the optimum conditions were the concentration of 8% PVA and the initial concentration of 20% sludge. The pH value of boric acid solution had an effect on the immobilization and the use of sodium carbonate as pH adjusting agent allowed the boric acid in gel solution to have a pH of 6.7 which increased the strength of immobile phase and its activity of producing methane. This mixed carrier process effectively solved the problems that the immobilized cell technology applied in wastewater treatment faced, such as difficulty in forming spherical particles, ease of the particles to be broken, loss of the activity in producing methane, and floatation of the particles upon producing methane.

Key words: PVA, anaerobic aludge, wastewater treatment, conditions for immobilization.

Study on the Transportation and Transformation of Phenol in Saturated Silt Loam. Zhu Wanpeng et al. (Dept. of Environ. Eng., Tsinghua University, Beijing 100084); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 15—18

The transportation and transformation of phenol in saturated silt loam were studied by means of batch adsorption, batch biodegradation and dynamic soil column experiments. Longitudinal dispersion coefficient (*D*), adsorption coefficient (*K_a*) and biodegradation coefficient (*K*) were obtained through curve fitting and parameter estimation; *K_a* = 0.112cm³/g, *K* = 0.55d⁻¹. The results indicate that phenol was hard to be adsorbed by the silt loam, readily biodegraded in the soil under an aerobic condition, but less biodegraded under an anaerobic condition. The presences of N and P speeded up biodegradation of phenol. Batch tests usually overestimate the *K_a* values because of the "Solids Effect".

Key words: phenol, silt loam, transportation and transformation.

Relationship of the Contents of Available Trace Elements in Soil to Topographical Units; A Case Study in the Weihui City and Huixian City of the Xinxiang Prefecture, Henan Province. Liu Xiudi and Li Jiyun (Research Center for Eco-Environ. Sci.,

Chinese Academy of Sciences, Beijing 100085); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 19—22

A typical region with various types of topography extended from the Taihang Mountains to the ancient course of the Yellow River was selected to study the relationship between the contents of the available species of six trace elements in soil, which were essential for plants to grow, and the topographical changes. The results show that the level of water soluble boron species in soil was increasing with the topography dropping; the level of easily reducible manganese species changed in consistence with the topography; the level of molybdenum species was the lowest in mountainous areas and lowlands; the level of zinc was generally lower in most areas; and the level of copper was middle or higher in all the soils of various topographies. The results obtained provide a scientific basis for the application of trace elements fertilizers to soil and the studies to find the causes for abundance or deficiency of various elements in different topographies.

Key words: topography, trace elements, soil.

Study on the Methane Emission from Spring Rice Fields in Beijing. Zhang Jianbo et al. (Center for Environ. Sciences, Dept. of Technical Physics, Peking University, Beijing 100871); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 23—26

The emission of methane (CH_4) from spring rice fields under different field managements was measured in Beijing in 1991. Under the traditional practice of local agricultural management, the CH_4 emission flux was found to have a mean value of $8.7\text{mg}/(\text{m}^2 \cdot \text{h})$. The seasonal variation in CH_4 emission was observed with the peak values occurred in the tillering and flowering phases. The redox potential in soil was found to be correlated with CH_4 emission. The organic manures applied in field resulted in an increased CH_4 emission. Intermittent irrigation on a scientific basis to have an alternating dry and flooded paddy may be an effective way to increase rice yield and to reduce CH_4 emission. Direct dry-sowing technology may largely cut down CH_4 emission but may reduce rice yield that needs to be further studied.

Key words: methane emission, rice field, emission flux, field management.

Study on the Photolysis of Dimethyl Sulfide and the Rate Constant of Forming Dimethyl Disulfide. Zhong Jinxian, Yang Wenxiang et al. (Research Center for Eco- Environmental Sciences, Chinese Academy of Sciences, Beijing 100085); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 27—30

Dimethyl sulfide (DMS) was irradiated with a low pressure mercury lamp and then the photolytic products were detected with a Fourier transform infrared spectroscope in a long path cell of 20m at different times. The results show that dimethyl sulfide was photolyzed to form dimethyl disulfide and ethane by following a first order reaction, with a

rate constant of $8.70 \times 10^{-5}\text{s}^{-1}$ for the formation of dimethyl disulfide. A system of $\text{DMS} + \text{H}_2\text{O}_2$ and a system of $\text{DMS} + \text{NO}$ were also studied by using the same method. It was found that in the presence of sufficient H_2O_2 , DMS was photolyzed to form CH_2O and $\text{CH}_3\text{SO}_3\text{H}$. In the case of $\text{DMS} + \text{NO}$, the photolytic products were CH_3SSCH_3 , C_2H_6 and CH_3SNO .

Key words: dimethyl sulfide, photolysis, rate constant of reaction.

Pilot Study on the Industrialized Production of chrome Pig Iron Smelted from a Sintered Chrome Slag Ore. Liu Dayin and Zhou Caixin et al. (Dept. of Environ. Eng., Huangshi College 435000); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 31—34

A pilot study on the industrialized production of chrome pig iron was carried out in a small-sized blast furnace of 30m^3 by using a sintered ore of chrome slag as flux. $\text{Cr}(\text{VI})$ in chrome slag was reduced at a rate of near 100% and more than 94% of total chromium were reduced metallizationally. The consumption of slag per tonne of product iron was 2.298t on average with the maximum of 2.785t. For smelting a chrome pig iron containing more than 10% Cr, it was necessary to simultaneously add chromite in order to increase the level of chromium. By keeping the furnace temperature at over 1480K, controlling the alkalinity at a lower level and adding the subsidiary burden to reduce the melting point of furnace slag, the mobility of furnace slag was significantly improved that resulted in the successful separation of iron from slag. The secondary pollution during the pilot study was monitored and it was found that it was necessary to control the dispersion of blast furnace gas in order to reduce the deposition of dust from the production process.

Key words: chrome slag, use of waste as a resource, blast furnace, iron smelting, chrome pig iron.

Study on the Application of Activated Coal Ashes in Rubber Products. Lu Yaojiao, Zhang Jishuang et al. (Dept. of Environ. Eng., Hunan University, Changsha 410082); *Chin. J. Environ. Sci.*, **15**(5), 1994, pp. 35—39

A study was carried out on the application of many kinds of activated pulverized coal ashes to replace activated calcium carbonate, light calcium carbonate or medium- super carbon black as fillers or reinforcers in rubber products. The results show that better activating agents are one of key factors to obtain the activated pulverized coal ashes of high quality, and the particle sizes and surface properties of the coal ashes are the major factors affecting the mechanical performances of composite materials. The use of both better activators and dry grinding activation processes can incorporate the above factors to obtain more preferable activated coal ashes, allowing them to be well compatible with organic components, which are coupled with its