2019金属组学研讨会

# 金属组学在环境研究中的应用

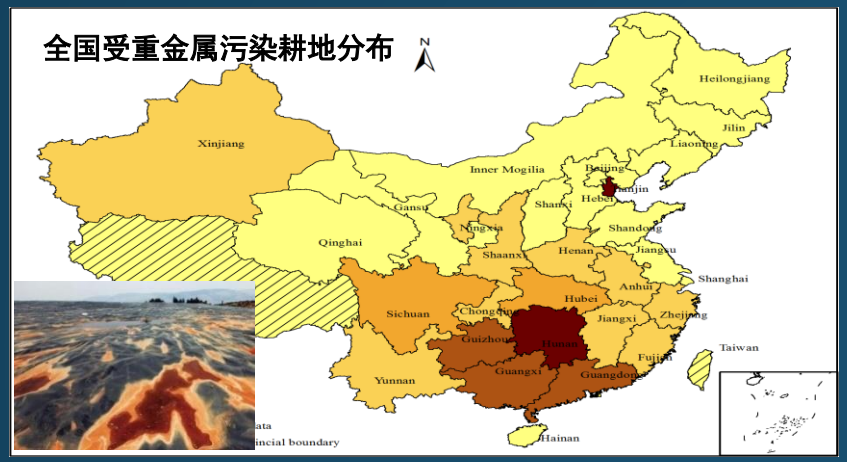
胡立刚

中国科学院生态环境研究中心

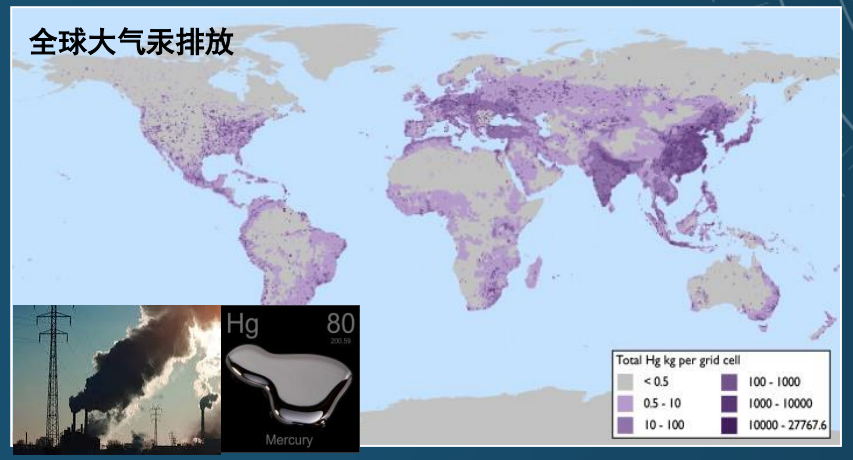
2019-01-11

# 我国金属环境污染呈加剧的趋势

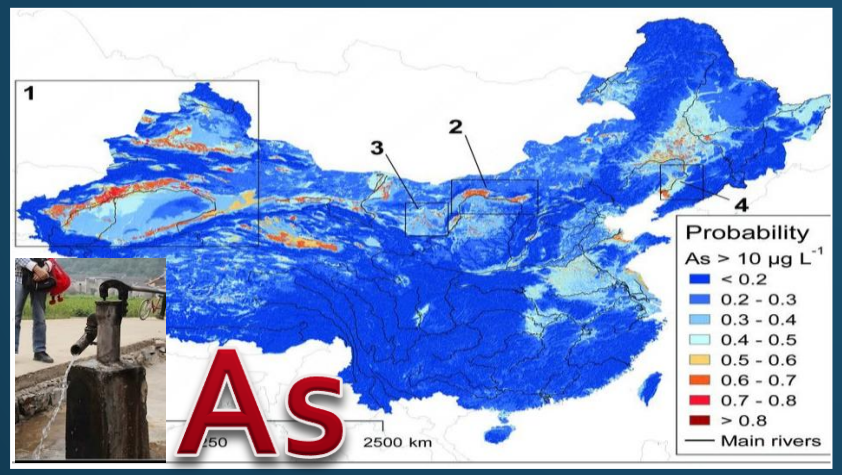
土壤



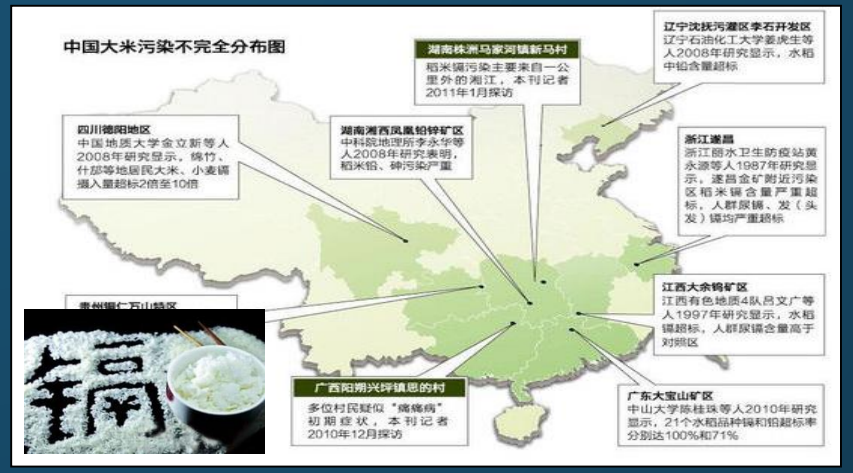

大气




水




食品



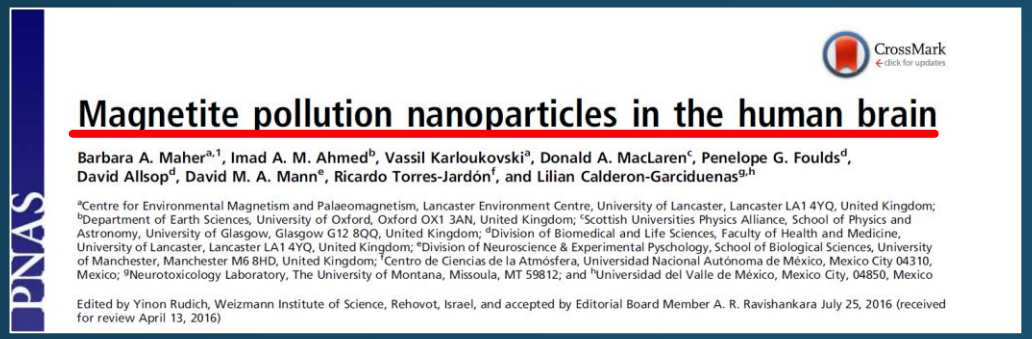
# 金属是导致公共重大健康问题的主要污染物


外源污染物暴露

世界卫生组织公布的引起重大公共健康问题的10种化学品中金属（含类金属）占了4项，包括：汞、铅、砷、镉。

http://www.who.int/ipcs/assessment/public_health/chemicals_phc/zh/

# 大气金属细颗粒物暴露与疾病潜在相关



PNAS

CrossMark click for updates

## Magnetite pollution nanoparticles in the human brain

Barbara A. Maher[a,1], Imad A. M. Ahmed[b], Vassil Karloukovski[a], Donald A. MacLaren[c], Penelope G. Foulds[d], David Allsop[d], David M. A. Mann[e], Ricardo Torres-Jardón[f], and Lilian Calderon-Garciduenas[g,h]

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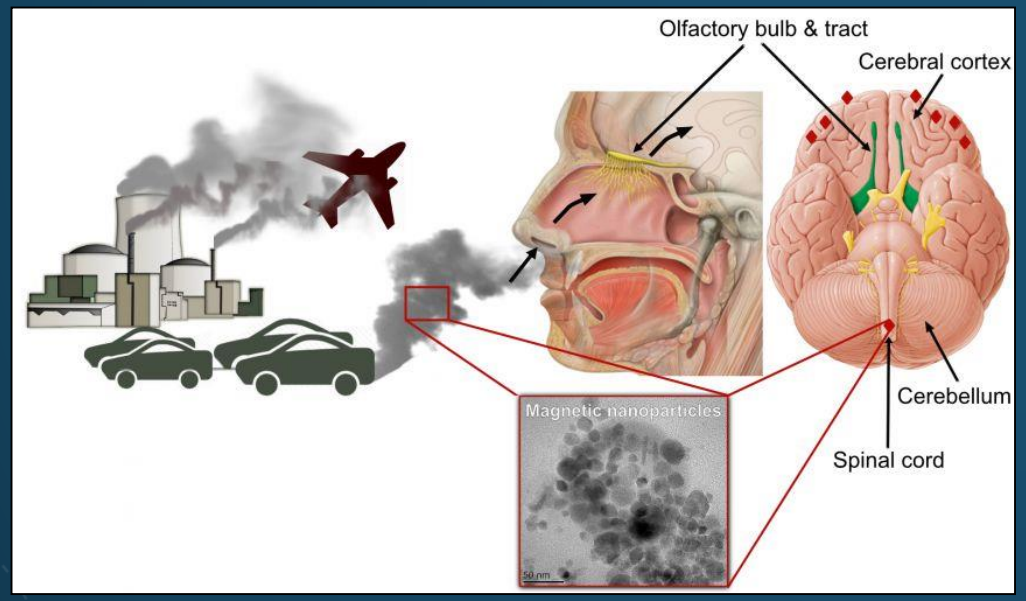
Edited by Yinon Rudich, Weizmann Institute of Science, Rehovot, Israel, and accepted by Editorial Board Member A. R. Ravishankara July 25, 2016 (received for review April 13, 2016)




Maher, B.A., et al., ***PNAS***, 2016, 113, 10797
Pankhurst, Q., et al., ***J. Alzheimers Dis.***, 2008, 13, 49
Plascencia-Villa, G., et al., ***Sci. Rep.***, 2016, 6, 24873
Underwood, E., ***Science***, 2017, 355, 342.

## 人脑组织样本中发现大量外源铁氧化物细颗粒

# THE POLLUTED BRAIN

The microscopic particles sifting from freeways and power plants don't just harm your heart and lungs. They may also attack your brain

By **Emily Underwood**, *in Los Angeles, California*

In a barbed wire–enclosed parking lot 100 meters downwind of the Route 110 freeway, an aluminum hose sticks out of a white trailer, its nozzle aimed at an overpass. Every minute, the hose sucks up hundreds of liters of air mixed with exhaust from the roughly 300,000 cars and diesel-burning freight trucks that rumble by each day.

Crouched inside the trailer, a young chemical engineer named Arian Saffari lifts the lid off a sooty cylinder attached to the hose, part of a sophisticated filtration system that captures and sorts pollutants by size. Inside is a scientific payload: particles of sulfate, nitrate, ammonium, black carbon, and heavy metal at least 200 times smaller than the width of a human hair.

The particles are too fine for many air pollution sensors to accurately measure, says Saffari, who works in a lab led by Constantinos Sioutas at the University of Southern California (USC) here. Typically smaller than 0.2 μm in diameter, these "ultrafine" particles fall within a broader class of air pollutants commonly referred to as PM2.5 because of their size, 2.5 μm or less. When it comes to toxicity, size matters: The smaller the particles that cells are exposed to, Saffari says, the higher their levels of oxidative stress, marked by the production of chemically reactive molecules such as peroxides, which can damage DNA and other cellular structures.

Some of the health risks of inhaling fine and ultrafine particles are well-established, such as asthma, lung cancer, and, most recently, heart disease. But a growing body of evidence suggests that exposure can also harm the brain, accelerating cognitive aging and may even increase risk of Alzheimer's disease and other forms of dementia.

The link between air pollution and dementia remains controversial—even its proponents warn that more research is needed to confirm a causal connection and work out just how the particles might enter the brain and make mischief there. But a growing number of epidemiological studies from around the world, new findings from animal models and human brain imaging studies, and increasingly sophisticated techniques for modeling PM2.5 exposures have raised alarms. Indeed, in an 11-year epidemiological study to be published next week in *Translational Psychiatry*, USC researchers will report that living in places with PM2.5 exposures higher than the Environmental Protection Agency's [illegible]



Published by AAAS

Science

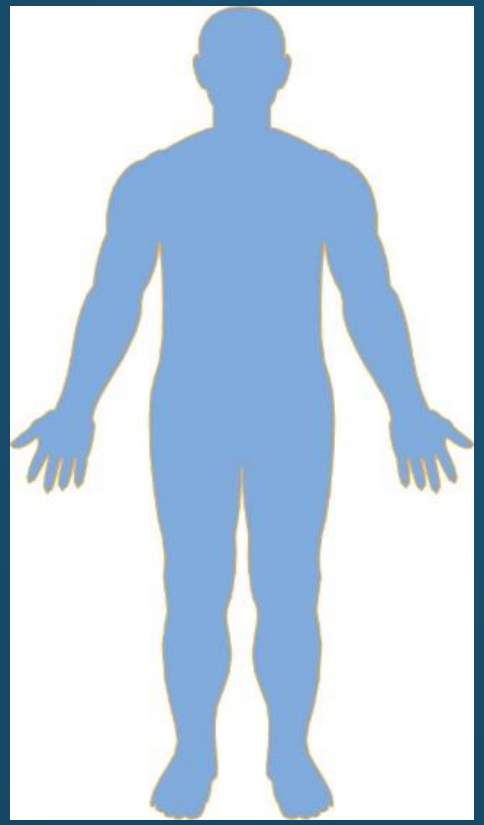
# 重金属健康危害分子机制尚不清晰

水

大气

食品

土壤



铅、汞

铅、汞、砷、镉

镉、砷

砷

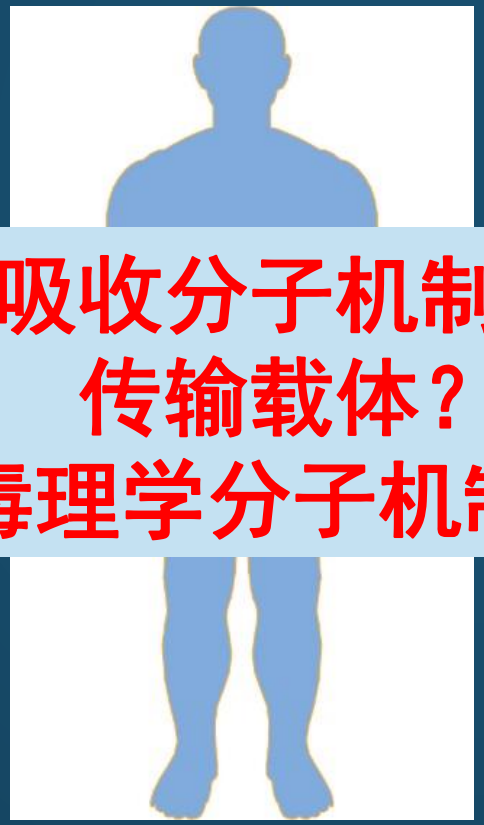
# 重金属健康危害分子机制尚不清晰

水

大气

食品

土壤



吸收分子机制？
传输载体？
毒理学分子机制？

铅、汞

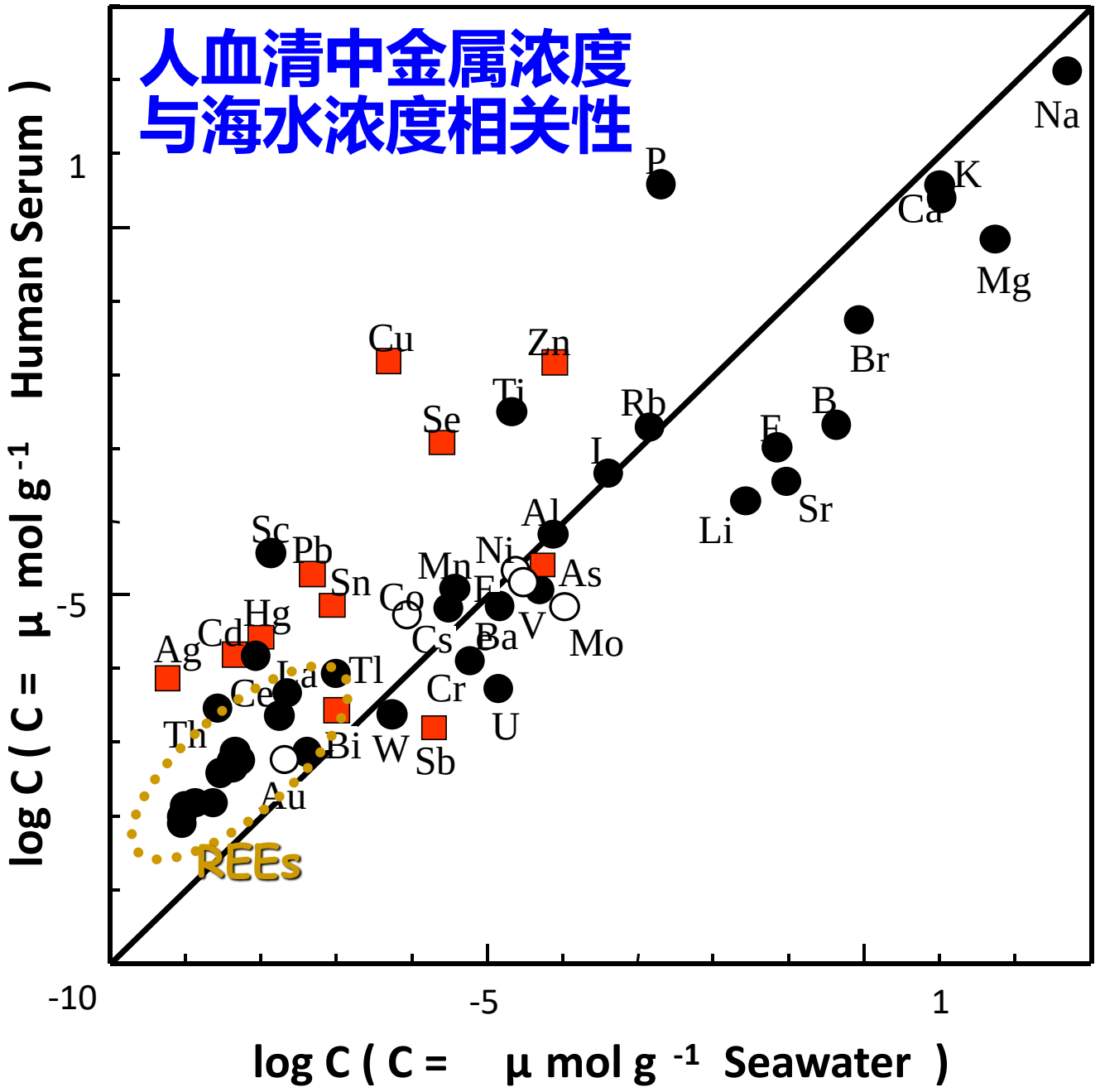
铅、汞、砷、镉

镉、砷

砷

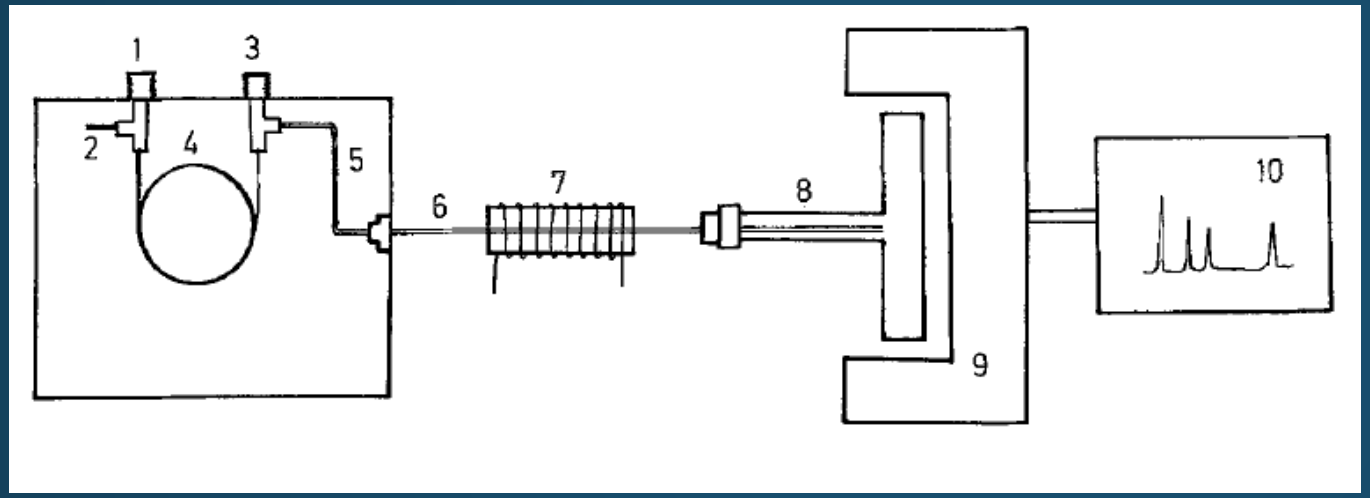
# 金属总量分析

## 环境与生物体内金属浓度的相关性

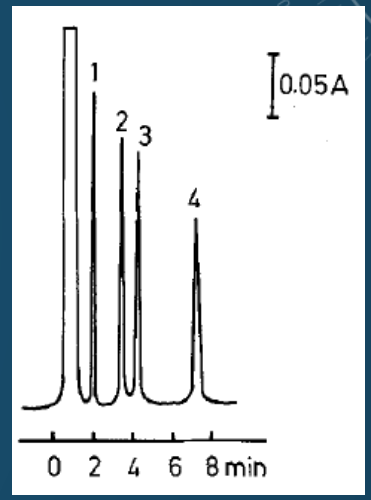



Hiroki Haraguchi

# 金属形态分析




Schematic diagram of the CGC-AAS system

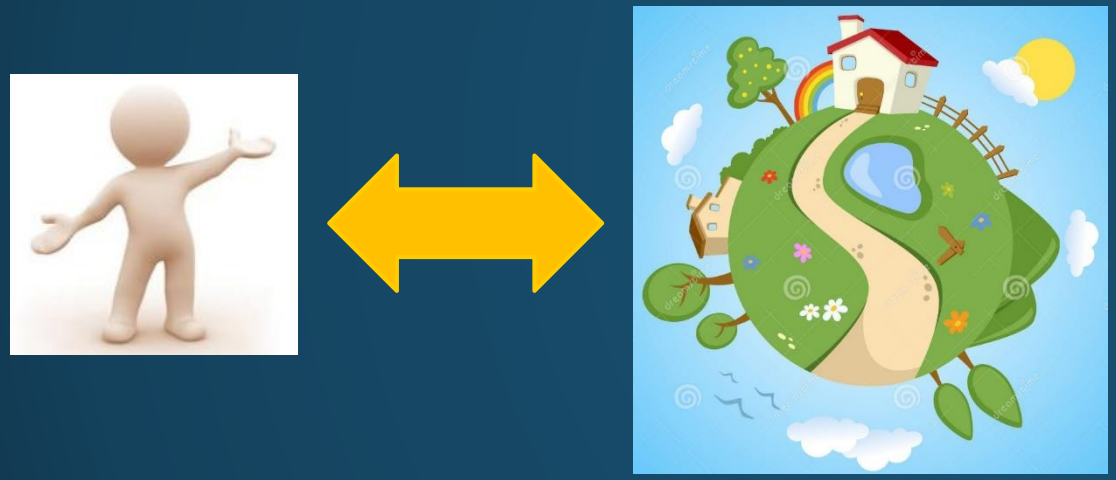



Typical chromatogram of organomercuric species

**Capillary Gas Chromatography – Atomic Absorption Spectrometry**

Jiang GB, et al, Fresenius Z. Anal. Chem., 1989, 334, 27

# 环境金属组学(ENVIRONMETALLOMICS)

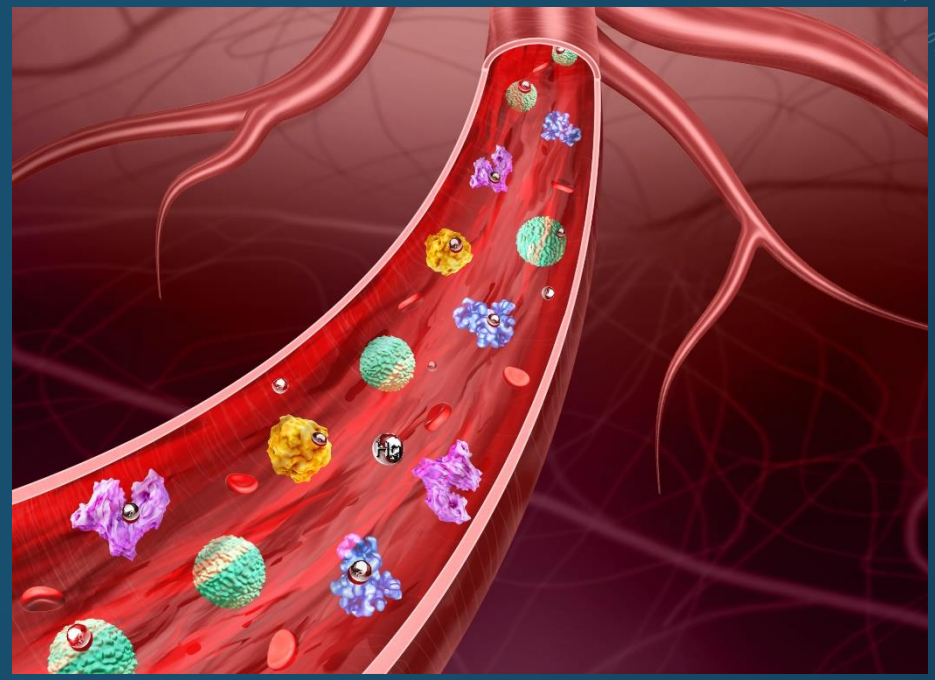


**Biosphere-Geosphere interaction**

- The entirety of metal and metalloid species that can induce toxic effects on the living beings in the concentration range generally presented in the environment
- All contaminants (e.g., organic contaminants) and biologically-originated materials (e.g., proteins and extracellular polymeric substances) that are able to regulate the homeostasis of toxic and essential elements

# TRANSPORTATION OF METALS IN BLOOD

- How heavy metals are delivered to target organs?
- What are the main carriers for heavy metals in blood?

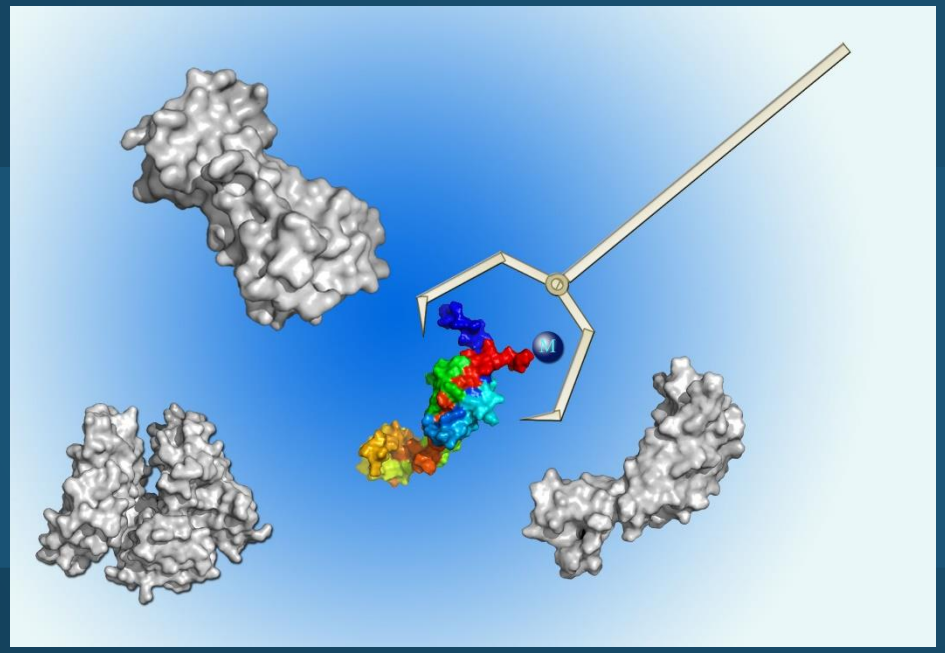


"

*Sharp tools make good work*

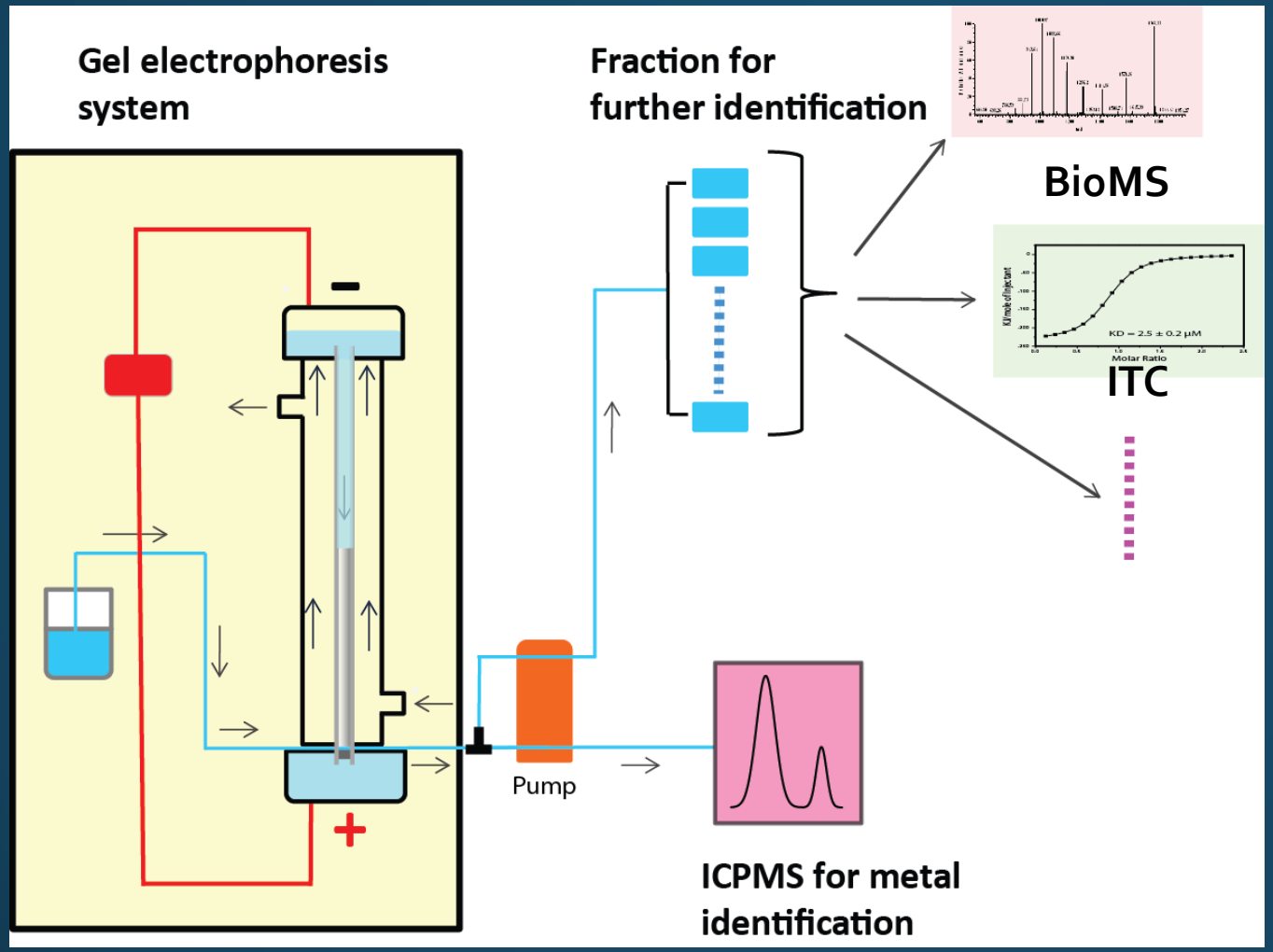
***工欲善其事，必先利其器***

"



**Global analysis of metalloproteins in biological samples is challenging.**

# COLUMN 'TYPE' GEL ELECTROPHORESIS SYSTEM FOR IDENTIFICATION OF METALLOPROTEINS

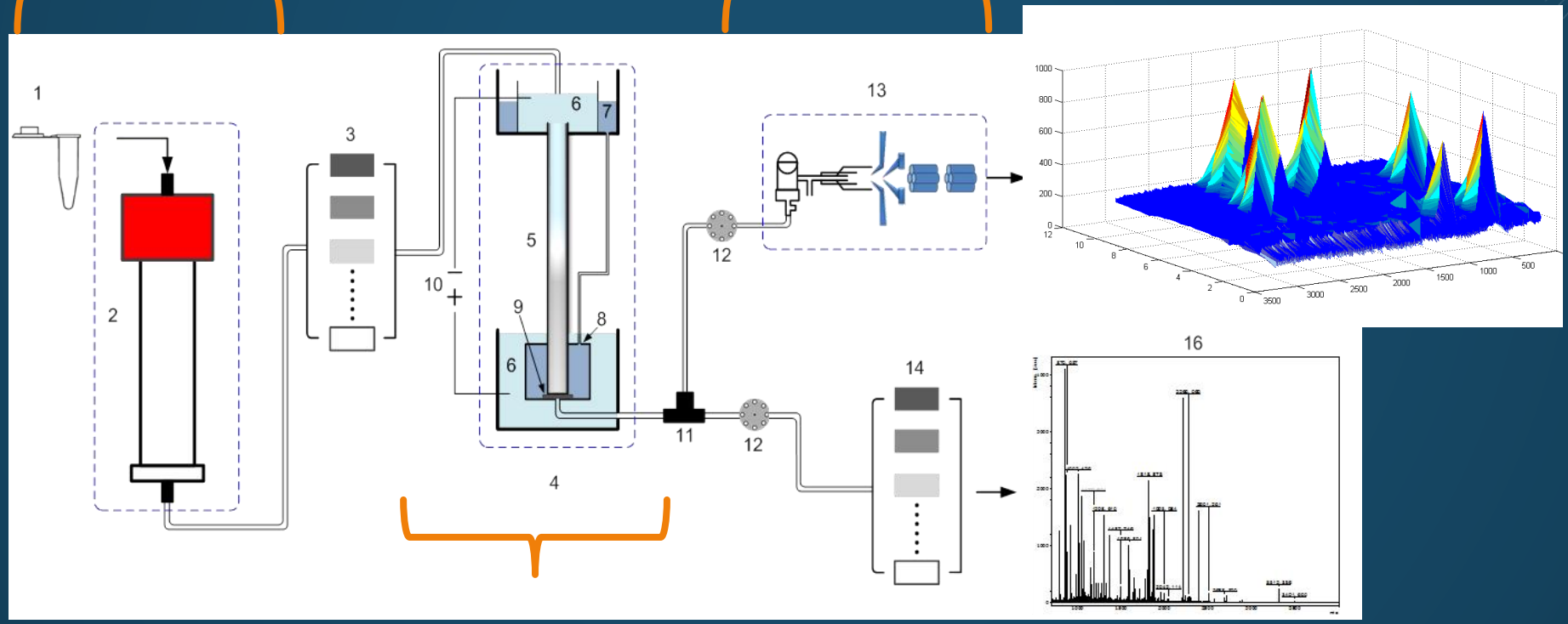



Hu L., et al. *Angew*, 2013, 52, 4916

# OFFLINE 2D( IEX-GE)-ICP MS FOR CHARACTERIZATION OF METALLOPROTEINS

1st dimension

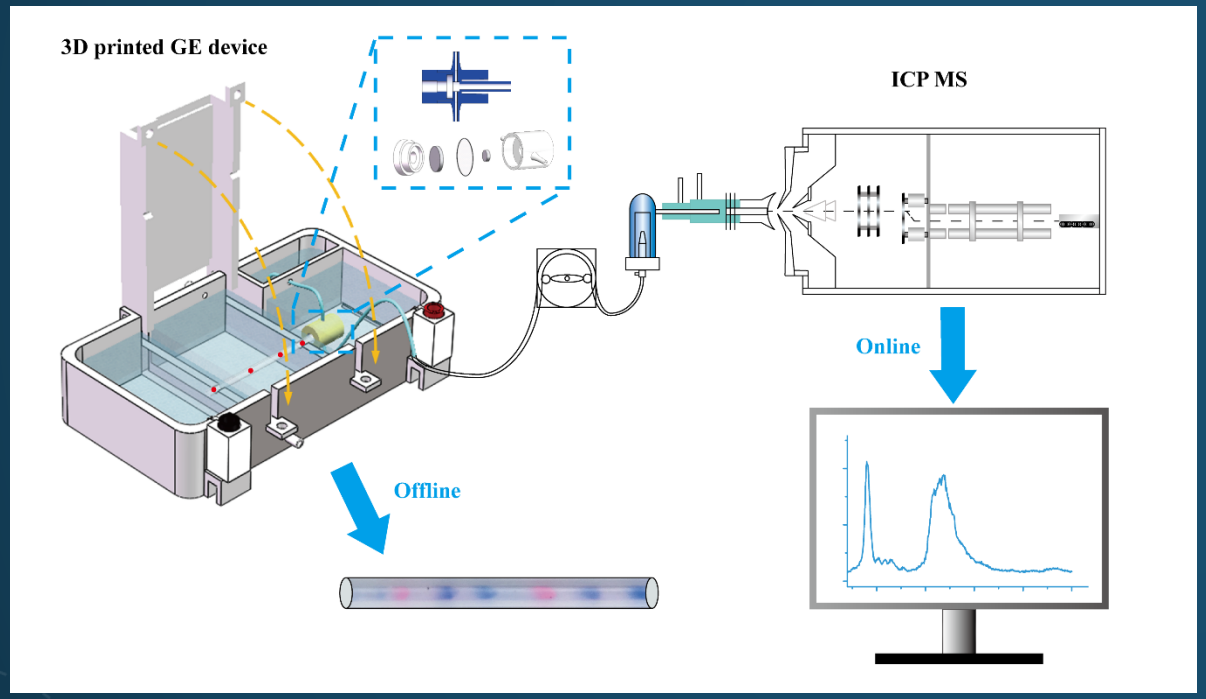
ICP MS

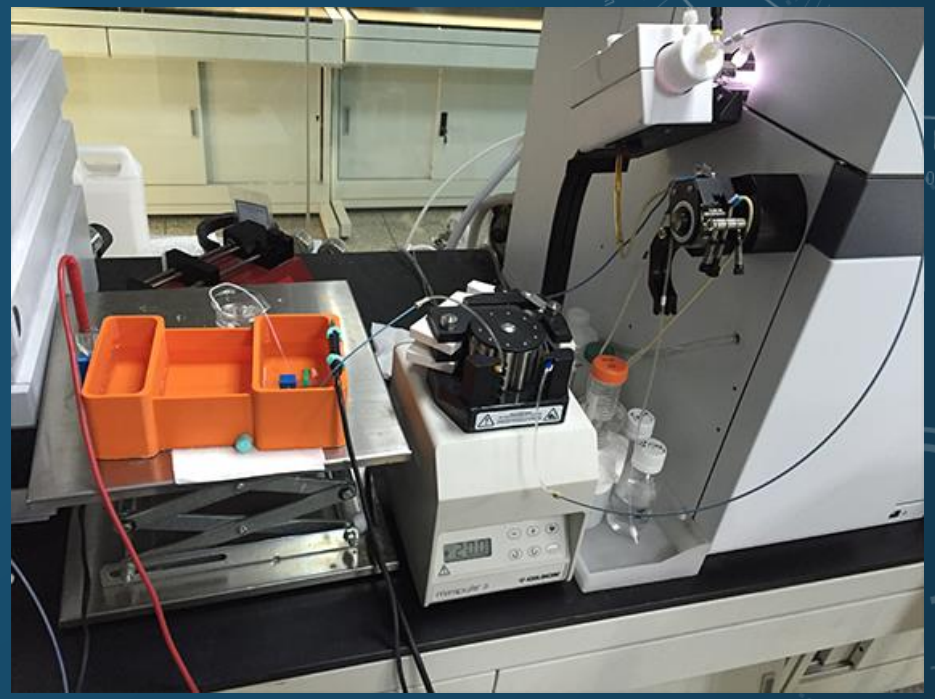



2nd dimension

Yan X., et al. *Talanta*, 2018, 184, 404

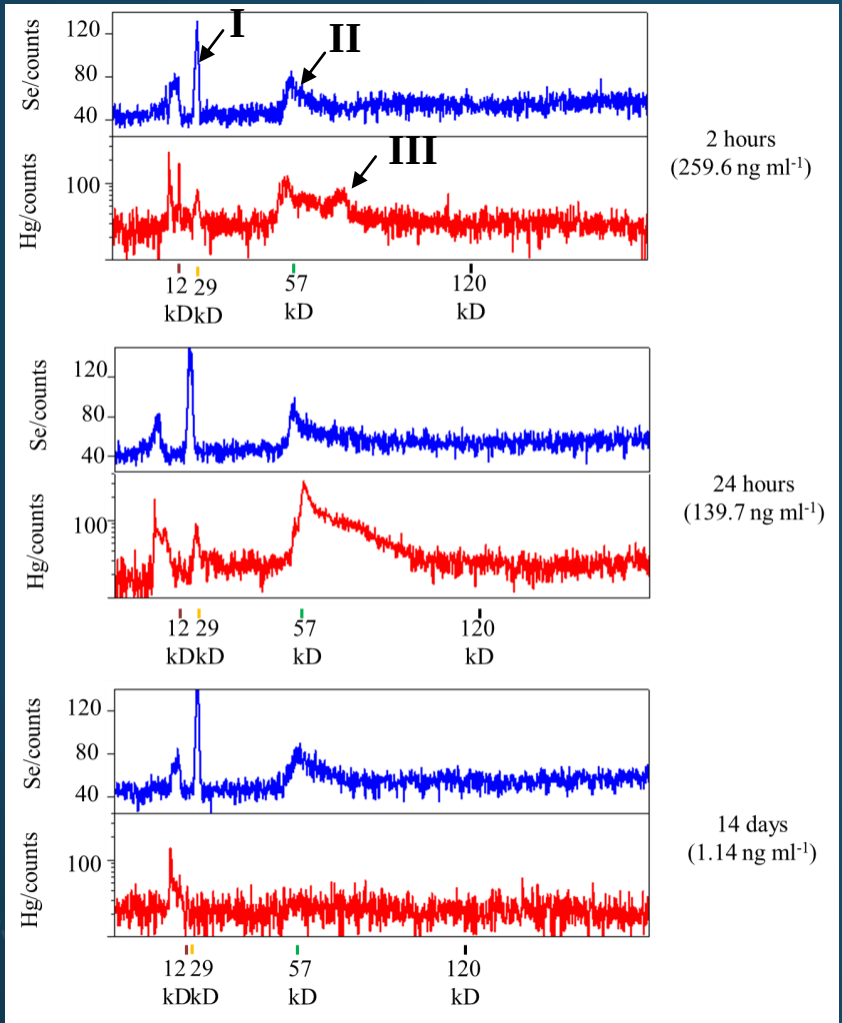
# FABRICATION OF NEW COLUMN GE SYSTEM FOR ANALYSIS OF METALLOPROTEINS



Wang D., et al. *Talanta*, 2019, accepted
Hu L., et al. Environ. Sci. Technol, 2017, 51, 3597

# MERCURY-BINDING PROTEINS IN RAT BLOOD PLASMA




**I. Glutathione peroxidase-3**

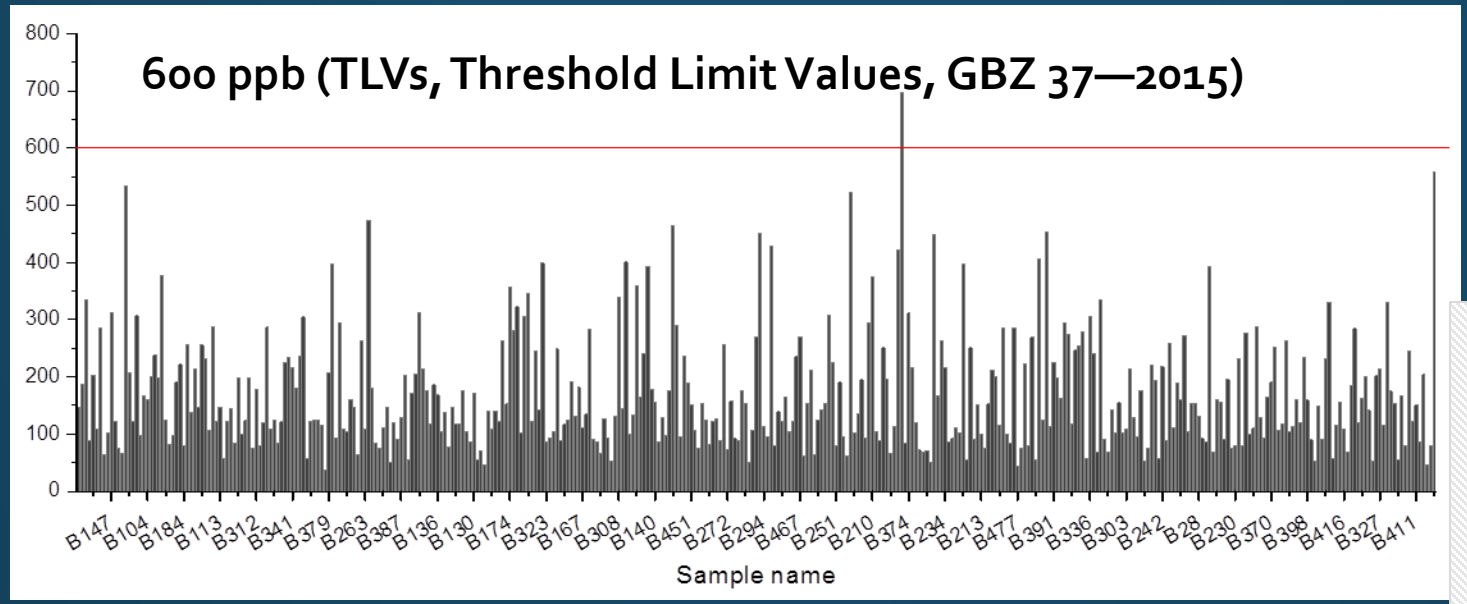
**II. Selenoprotein P**

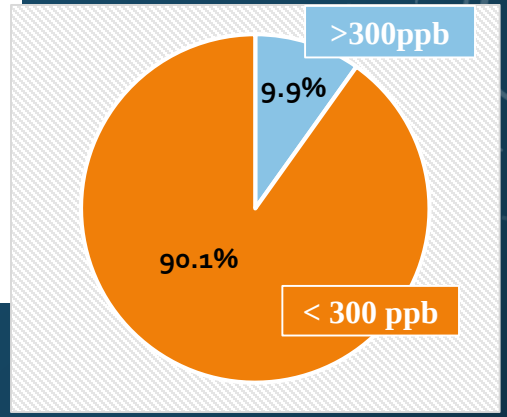
**III. Serum Albumin**

- Selenoproteins played important roles in Hg binding in rat plasma

Li, Y., et al. *Chem. Comm.*, 2018, 54 , 7439

# Metal-binding protein in blood of occupational workers




Lead smelting plant, 375 blood samples

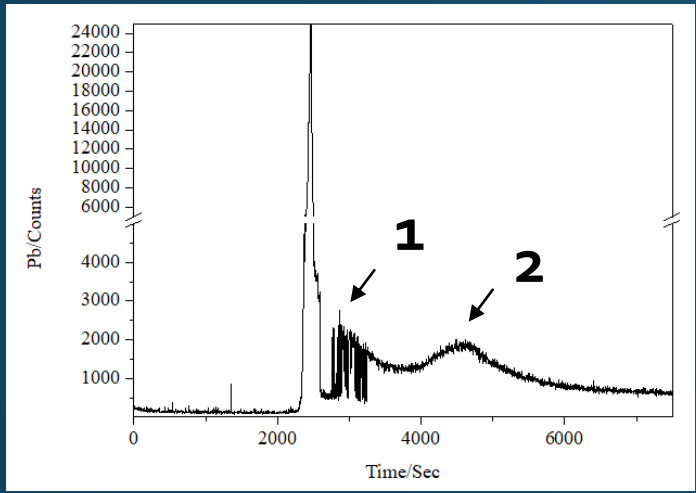
# HEAVY METAL-BINDING PROTEIN IN BLOOD CELLS

It was observed that multiple metals associated with hemoglobin, which include Pb, Fe, Ag, Ni and Bi.

# HEAVY METAL-BINDING PROTEIN IN BLOOD CELLS

A tiny of Cd and Bi was observed to associated with hemoglobin.

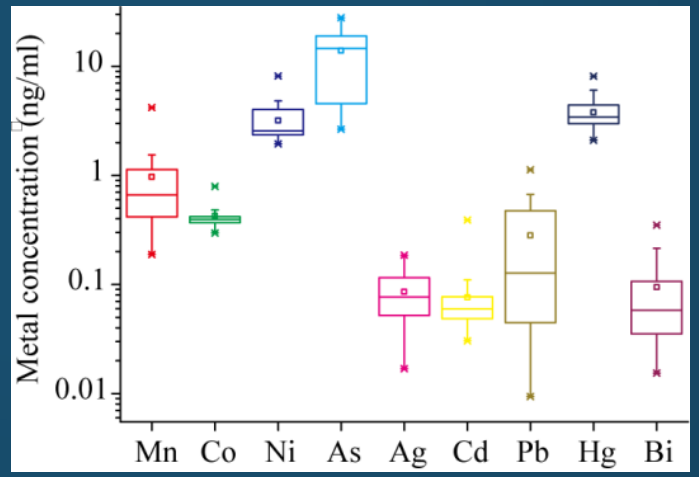
# LEAD-BINDING PROTEIN IN BLOOD PLASMA




| Peak No. | Protein identification | Detection frequency |
|---|---|---|
| 1 | Hemoglobin | 100 % |
| 2 | Apolipoprotein A I | 100 % |

Occupational workers, 10 blood plasma samples

# Metal-binding protein in human blood plasma

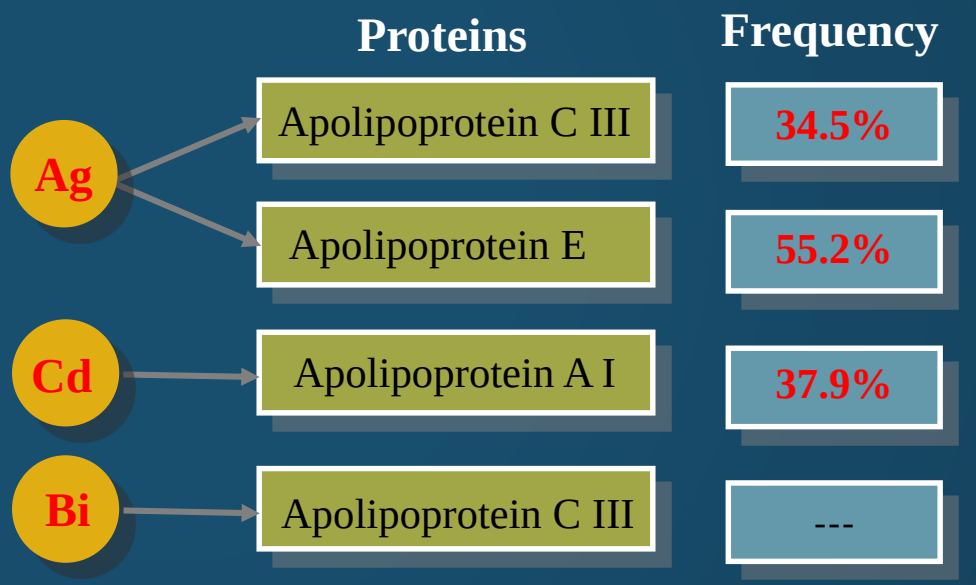




Residents, 29 blood plasma samples

# METALLOPROTEOME PROFILES OF HUMAN PLASMA

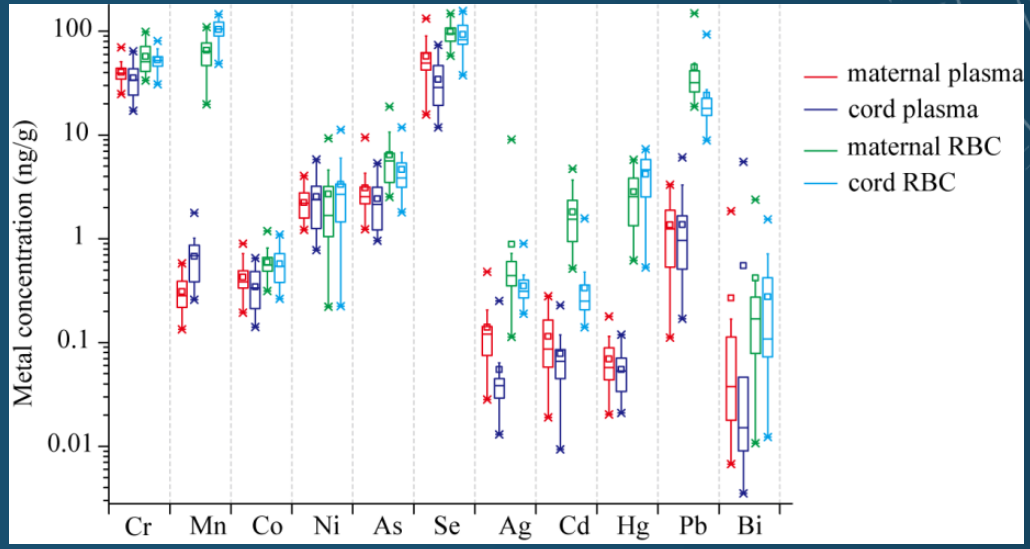
Hg Pb Cd Ag

As Cr Bi ……




**Ag- and Cd-binding protein were frequently detected in residential blood plasma.**

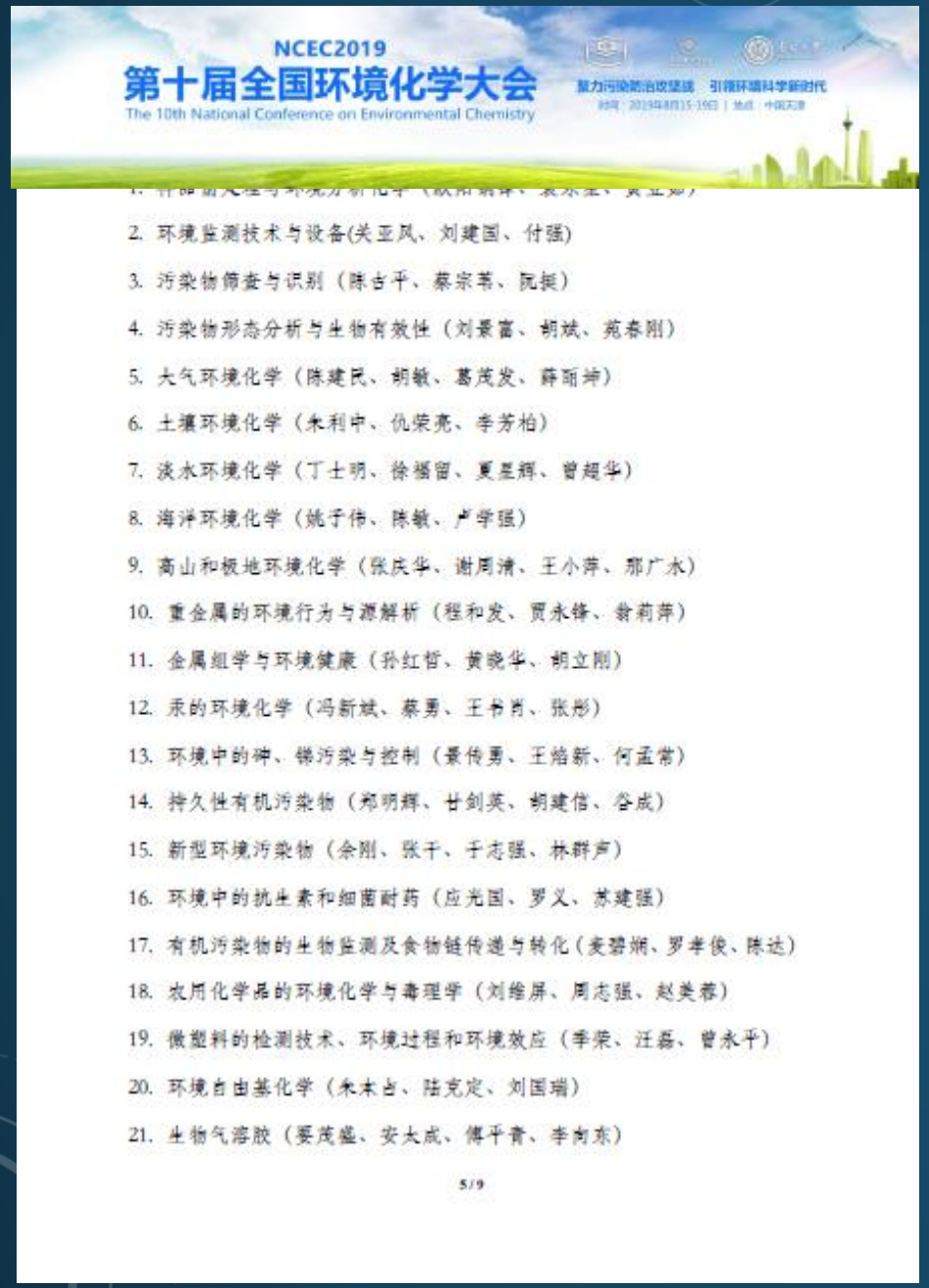
# CADMIUM-BINDING PROTEIN IN MATERNAL AND CORD BLOOD PLASMA




Cd-binding protein could be observed in cord blood plasma

# SUMMARY

- Blood cells played importance role on the transportation of heavy metals in human and rat, in which hemoglobin probably is a main carrier to retain heavy metals in blood;
- Cd- and Ag- binding proteins in human blood plasma were frequently detected in residential blood plasma. It implied a potential health concern on these two metals and deserved further investigations.
- Gel electrophoresis-ICP MS is a practical method for investigation of metalloproteins in biological samples.

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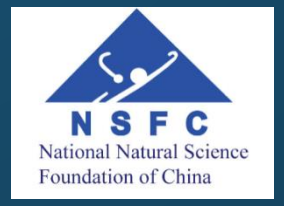
# “金属组学与环境健康”分会场

# 新春愉快！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