

Mercury in human hair and blood samples from people living in Wanshan mercury mine area, Guizhou, China: An XAS study

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Introduction

The town of Wanshan was one of the mercury mining areas in China, where the main source of environmental mercury was the emission of elemental mercury vapor (Hg^0) from a mercury-mining plant, which had produced a huge amount of mercury for more than 50 years, although it was closed in 2001. The average concentration of mercury in the air in this area is still slightly higher than USA EPA reference concentration for chronic mercury exposure (RfC is 0.0004 mg/m^3).

In this study, quantitative speciation of mercury by XANES and structural study of mercury by EXAFS in human hair and blood samples from individuals living in Wanshan mercury mine, Guizhou, China were conducted. The determination of total mercury and methylmercury concentration was also conducted with an alternative analytical technique and compared with the results from XANES analysis.

Experimental

Sample preparation for XAS

Blood and hair samples were collected in 2003, which was approved and supported by the local Committee of Human Subjects and the local hospital. Hair samples were sequentially washed according to the IAEA recommended protocol. Then they were dried at room temperature, ground with ball mill and pressed into pellets for XAS study. Blood samples of at least 10 mL were collected. The separated red blood cells (RBC) and serum were lyophilized and pressed into pellets for XAS study in fluorescence mode.

X-ray absorption spectroscopy

Hg L-edge X-ray absorption spectra were operated at 1W1B of the Beijing Synchrotron Radiation Facility (BSRF, for hair samples), and BL-9A or 12C at the Photon Factory. S K-edge X-ray absorption spectra were recorded at BL-11B at PF (for both hair and blood samples) using total electron yield mode with double-crystal Ge[111] monochromator.

Least-squares fitting of the XANES spectra using $\text{Hg}(\text{Cys})_2$ and CH_3HgCys as primary components was done through WinXAS 3.1. The EXAFS oscillation $\chi(k)$ was also quantitatively analyzed by curve-fitting using

WinXAS 3.1 and ab initio theoretical phase and amplitude functions were calculated using the program FEFF version 8.0.

Results and discussion

The Fourier Transformed k^3 -weighted Hg L_{III}-edge EXAFS spectra of hair, RBC and serum samples of these mercury miners with the selected reference compounds are shown in Fig. 1.

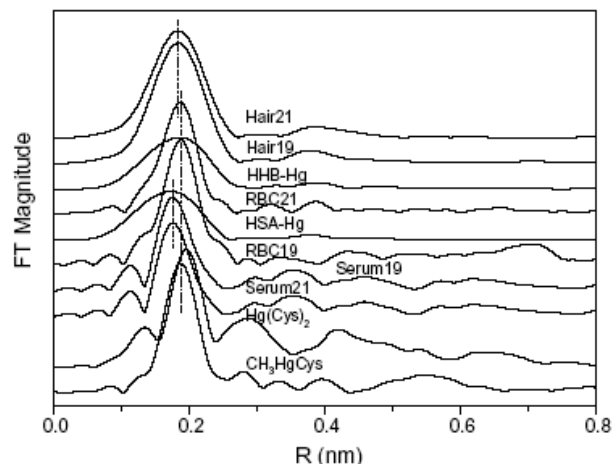


Fig. 1. The Fourier transformed k^3 -weighted Hg L_{III}-edge EXAFS spectra of hair, RBC and serum from people living in Wanshan with the selected reference compounds.

Quantitative speciation and structural information of Hg in hair, RBC and serum samples from people living in Wanshan were studied using X-ray absorption spectroscopy. Curve-fitting analysis revealed that the Hg–S bond length and coordination number in hair were $0.248 \pm 0.002 \text{ nm}$ and 3.10. The Hg–S bond length and coordination number in RBC were $0.251 \pm 0.003 \text{ nm}$ and 4.09, while they were $0.228 \pm 0.002 \text{ nm}$ and 4.08 in serum, respectively. The combined techniques of XANES and EXAFS applied in this work should be also valuable, for study of speciation, structural and binding information of other elements.

References

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