# Mercury Emission to Atmosphere from Geologically Enriched Area in Southwest Guizhou, China

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**Abstract:** More and more attention are being paid to mercury natural enriched areas since these areas are huge atmospheric sources. Mercury emission fluxes from soil were measured in Lanmuchang Hg-Tl mine area, southwest Guizhou, China. The results showed that mercury exchange between soil and air in this area are greatly stronger than the background areas. Mercury concentration in soil is a dominate factor impacting mercury emission. Various environmental factors have strong impacts to mercury emission too.

**Key words:** mercury, Lanmuchang Hg mine, exchange fluxes, environmental factors

## INTRODUCTION

Geologically mercury enriched area has been thought as a huge atmospheric mercury source in a long time[1, 2]. There are three mercuriferous belts associated with plates tectonic boundries. Many big mercury mines locate in these mercury belts, such as Almadén, Spain, Mt. Amiata, Italy, Wanshan, China and so on. In the past several years, with the development of mercury fluxes measurement technology, considerable progress has been made in understanding mercury geochemistry in these mercury mines. Most studies showed that mercury emission from those mercury enriched area is greater than predicted. FERRARA ET AL. (1998) estimated the total mercury emission rate to atmosphere from Almadén in the range 600—1200g $h^{-1}$ by Lidar technique.

The province of Guizhou (N24°30'—29°13', E103°1'—109°30', 1100m above sea level, subtropical humid climate) in Southwestern China is a most important mercury product center over the world. There are 88100 tonnes of cinnabar deposits in Guizhou, which are approximately 70 % of total in China. Lanmuchang Hg-Tl mine (as shown in Fig. 1) located in southwest Guizhou, is a typical faults-controlled mineralized Hg-Tl deposits. Lanmuchang normal fault and Huangnijiang reverse fault controlled this mineralized belt. The regional karstic topography mainly includes peaks, karstic graves, valleys and so on. The hills are bare in Lanmuchang, and are covered by a little of shrubs and crop. The main minerals containing Hg, Tl, As are cinnabar, sulfides lorandite, realgar, orpiment, and arsenopyrite and pyrite. The maximum Hg grade


**Figure 1.** Sampling sites of Hg fluxes in Lanmuchang Hg-Tl mine district.

reaches 3 wt. %, and is between 0.08 wt. % and 0.3 wt. % normally. Through geological exploration, the total mercury reserve is about 3140 tonnes in Lanmuchang Hg-Tl mine. According to recordation, from Ming Dynasty to 1958, mercury had been smelted in a long period in this area. We measured Mercury emission fluxes from soil in this area using Dynamic Flux Chamber-Automatic Mercury Analyzer Method in December of 2002 and May of 2003, respectively.

## RESULTS AND DISCUSSION

All sampling results are summarized in Tab. 1. Even though there is no anthropogenic activity in a long time in Lanmcuchang Hg mine, the natural emission of mercury from mercury geologically enriched soil has resulted in high mercury content in the ambient air (209.8˘Ŕ79.1 ng˘¤m$^{-3}$ in sampling site F3 in warm season). The maximum of mercury emission flux reaches 10543.7 ng m$^{-2}$ h$^{-1}$, and the maximum of average mercury emission flux is 2283.3˘Ŕ2434.2 ng m$^{-2}$ h$^{-1}$ (n=152) in five sampling sites. On the other hand, atmospheric mercury deposits quickly too, the maximum dry deposition flux is 1502.6 ng m$^{-2}$ h$^{-1}$. The results show that mercury exchange between soil and air in this area is much stronger than that in background areas. At the same time, it is shown in Tab. 1 that Hg emission fluxes from soil change with season.

It has been accepted widely that mercury evaporated from soil was elemental mercury ($Hg^0$) and a small portion of methyl mercury. Factors controlling the emission of volatile $Hg^0$ from soil are various. The dominating factor is obviously the concentration and speciation of mercury in matrix, and other physical factors such as solar radiation, soil temperature, TGM in air near soil surface can influence as well $Hg^0$ emission strongly.

Sunlight induced Hg emission from soil has been proved by many field and laboratory studies. Our measurement results obviously supported this conclusion. It is shown from Table 1 that the light intensity of solar radiation correlated significantly with the Hg

**Table 1.** Hg fluxes, average inlet air Hg concentration, total Hg concentration in soil and average light intensity in all sampling sites.

| Sampling site | Time | | Hg flux (ng $m^{-2}$ $h^{-1}$) | | | Average inlet air Hg content (ng $m^{-3}$) | Soil Hg content (ng $g^{-1}$, dry wt) | Average light intensity (W $m^{-2}$) | $n_{emission}$ | $n_{deposition}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | Form | To | Max | min | Average | | | | | |
| F1 | 2002-12-4 | 2002-12-5 | 3525.5 | 694.7 | 919.4±1137.9 | 48.6±40.8 | 223 000 | 257 | 71 | 10 |
| | 2003-5-17 | 2003-5-18 | 1508 | 553.6 | 241.7±376.6 | 42.0±28.9 | | 54 | 70 | 9 |
| F2 | 2002-12-5 | 2002-12-6 | 2097.4 | 8.3 | 482.3±517.7 | 24.5±13.0 | 247 000 | 161 | 64 | 1 |
| | 2003-5-15 | 2003-5-16 | 6922.3 | 1502.6 | 782.7±1711.8 | 117.8±43.3 | | 217 | 51 | 22 |
| F3 | 2002-12-6 | 2002-12-8 | 3864.3 | 222.3 | 861.9±807.1 | 31.7±7.8 | 614 000 | 30 | 113 | 0 |
| | 2003-5-6 | 2003-5-8 | 10543.7 | 622.9 | 2283.3±2434.2 | 209.8±79.1 | | 145 | 147 | 5 |
| F4 | 2003-5-9 | | 1047.4 | 153.4 | 247.0±326.3 | 35.6±8.5 | — | 182 | 27 | 4 |
| F5 | 2003-5-13 | 2003-5-15 | 4717.8 | 279.4 | 729.2±1039.5 | 43.6±27.4 | 291 000 | 79 | 104 | 4 |

emission fluxes in all sampling sites, and the correlation coefficients are greater than 0.82, $p<0.05$. There is a positive correlation between mercury concentration in ambient air and mercury flux during daytime, and a negative correlation between them at night, respectively (Figs. 2 and 3). From the linear equation of mercury deposition and mercury

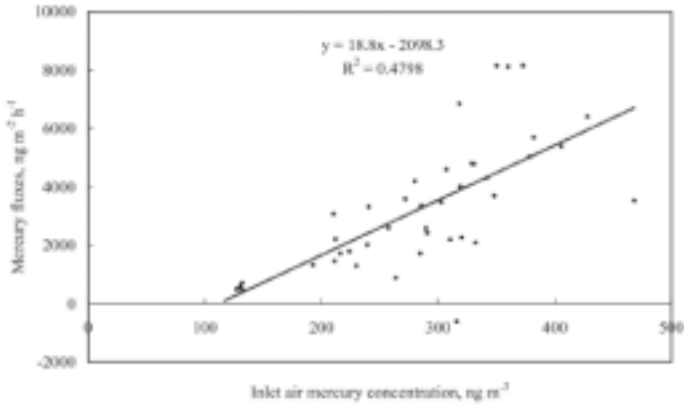


**Figure 2.** The plot of mercury fluxes versus inlet air mercury concentration in the sampling site of F3, Lanmuchang in May, 2003 (in daytime).

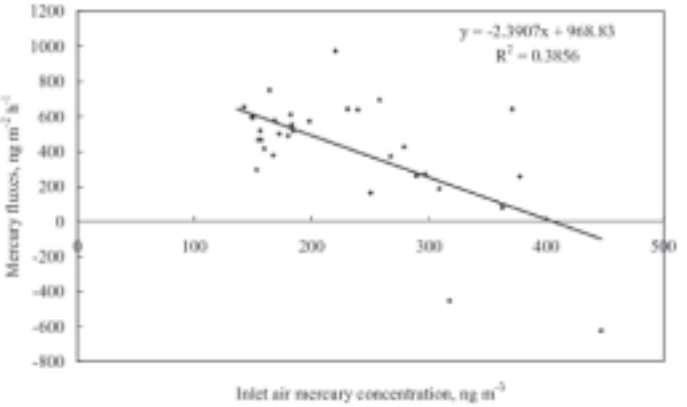


**Figure 3.** The plot of mercury fluxes versus inlet air mercury concentration in the sampling site of F3, Lanmuchang in May, 2003 (in night).

concentration, we estimate that about 16 % of total gaseous mercury flowing through the field chamber is absorbed by soil surface. Rainfall event facilitated mercury emission, this indicated that physical degassing of soil and photo-reduction of $Hg^{2+}$ were approaches of mercury diffusing from soil.

## CONCLUSIONS

Geologically mercury enriched area in global mercury belts in southwest Guizhou is a huge atmospheric source of mercury. In this area, a great amount of $Hg^0$ (of several hundred to tens of thousand ng per square meter per hour) are evaporating from soil to atmosphere. The strong $Hg^0$ emission from soil will definitely lead the elevation of mercury concentration in ambient in geologically mercury enriched area.

Mercury exchange between soil and air is bi-directional and is controlled by many factors including geological, meteorological, biological, anthropogenic conditions. In all factors, mercury contents in substrate and light intensity play a significant role in accelerating mercury emission from the substrates, whereas mercury concentration in ambient air may constrain mercury diffusion from soil effectively.

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