

# Preliminary survey of artisanal and small scale gold mining (ASGM) in China

- Case study in Lingbao, Henan province and Tongguan, Shaanxi province, by CAS and NRDC, August 2014

## 中国的小金矿开采（案例研究）2014 年-中科院地化所，自然资源保护协会

Mercury (Hg) is considered a worldwide pollutant(Mason, Fitzgerald et al. 1994), because  $Hg^0$  is the predominant form of atmospheric Hg, which has a long residence time in the atmosphere(Lin and Pehkonen 1999).Gold (Au) extraction by amalgamation, as a traditional technique with simple equipment and skills, is used popularly in many parts of the world, which causes serious Hg contamination to the environment. In this report, we provide the latest research results on gold amalgamation of two large goldfields in China – Lingbao of Henan province and Tongguan of Shaanxi province. We also provide further research and policy suggestions to improve this situation.

本研究于 2014 年 6-8 月期间，调查了中国两个大型金矿区（河南灵宝和陕西潼关）的混汞采金行为现状。为控制污染，改善环境，本研究也提出了相关技术和政策建议。



### I. Lingbao of Sanmenxia city, Henan province 案例一、河南灵宝

#### General description:

At the foot of Mountain Xiaoqinling (小秦岭), Yuling town (豫灵镇) and Yangping town (阳平镇) are two famous gold production towns in China and two major gold mining areas in Lingbao, a county-level city under Sanmenxia city, Henan province. 灵宝市隶属河南省三门峡市，其位于小秦岭脚下的豫灵镇和阳平镇是两个久负盛名的采金重镇。



i. The type of mining ore is hard rock-altered rock type deposit and quartz vein type gold deposit. The mining and processing of ore are not taking place at the same place, the mining in situ, and the processing occurs in the villages.



**Figure 1** An open-pit mining at Dahu village on July 5, 2014.  
阳平镇大湖村的露天金矿



**Figure 2** A typical family mill at Dahu village on July 6, 2014.  
阳平镇大湖村一个典型的家庭炼金作坊

ii. In these two towns of Yuling and Yangping, the processing scales are small like family workshops. The owners usually hire two or three people from other poor areas to run the workshops or run them by themselves. As the international gold prices decreased and the local governments strictly control illegal Au mining and processing, only one was found active among approximately 50 existing workshops. The main equipment is mills and crucibles. Gold workers use underground water as their sources of water. After smelting, slag was stacked into nearby open pits, or transported to some distance away from those smelting workshops. At processing places, there were often two or three skilled processors. All workshops are situated in the villages in family units.

Some people understood that the processing in their family is harmful to themselves so they will send their family members to other dwelling places where the environment is good, and then they employ migrant workers to do the work. However, some native people did not pay too much attention to the processing, and their family members including women and children are in one small family yard with the workshop.





**Figure 3.** Facilities for burning amalgam at Songcun village, July 2014.

豫灵镇宋村的家庭作坊里煅烧汞齐的简易设备



**Figure 4.** Pit-furnace of the family mill at Songcun village, July 2014.

豫灵镇宋村的家庭作坊里煅烧汞齐的简易坑炉



**Figure 5.** A full view of a family shop at Dongshe village, July 2014.

董社村家庭作坊全貌



**Figure 6.** Dark smoke from a family shop at Sizhuang village, July 2014.

寺庄村家庭作坊中黑色烟雾

iii. Mercury will be used during the processing. The natives indicated that the owners bought Hg from the local Hg retailers who purchased a large quantity of Hg from Guizhou province.

iv. In Yangping County, there exists the Xiaohai River flowing through Dahu village receiving water discharged from their dressing mill. In Yuling town, there exists the Xiyu River, as the border of Henan and Shaanxi province, the water from which will be brought directly into the Yellow River. The big reason for concern is that a lot of slag was stacked along the river. During a heavy rain the slag along the river can be poured into the river easily.



**Figure 7.** A view of Dahu village, July 2014.



**Figure 8.** Slags along a river bordering Henan, Shanxi and Shaanxi, July 2014.



**Figure 9.** The dirty water flows directly to the Yellow River, July 2014.

污水经西峪河排入黄河



**Figure 10.** A truck is transporting ore waste, July 2014.

卡车运载着废矿渣，预灵镇

v. Because of the illegal sources of the ores, they always have no ore plant in situ. Miners use trucks to transfer ore to ore plant.

vi. From the workers in the workshops, they said if they work without break they can get about 1ton ore smelted per 12hours, and then it takes them about one hour to get a crucible of raw gold.

vii. They always piled the tailings on some wasteland, or poured them into some dry ditches. The ditches that they used would act as tailings pools.



**Figure 11.** A deep ditch has been filled up, July 2014.

预灵镇的一条深沟已经被废矿渣填平



**Figure 12.** Shops engaged in separating Hg from gold and gold collecting.

阳平镇街头经营金汞分离和收购黄金的店铺很多

viii. Quite a number of owners use amalgamation to get gold. They put amalgam into a crucible, and then distill them. At last, Hg is transformed into the air, and gold is left as raw gold.

ix. As the gold price fell, most of them did not run their workshop or they have no business. During boom times, workshops can get some hundreds kilograms of ore to smelting, or they melted for themselves. They will sell the raw gold or get them purified in the county. Some private business man from south China will buy the gold in a higher price.



## II. Tongyu town, Tongguan county, Shaanxi province 案例二、陕西潼关

Tongyu town (桐峪镇) is located in Tongguan county, at the Xiaoqinling area bordering Shaanxi and Henan provinces. Gold is the local pillar industry. 在陕西省潼关县，黄金开采是位于小秦岭脚下的桐峪镇的支柱产业。



We choose four villages-Xiaokou, Lijia, Yaoshang, and Tongyu, in Tongyu town as our studying sites.

我们选择 4 个村子作为研究点—小口村、李家村、窑上村和桐峪村。

i. The type of mining ore is hard rock. The mining and processing are in different places. The mining is in situ; however, the processing is usually in private workshops. The overall appearances of workshops, are similar to those in the first site, are simple sheds and easily to be recognized. Just four or five people are needed to operate a workshop. The water they used is groundwater. And most of owners there choose a pond or dig a pond as their tailings pond.



**Figure 13.** General appearance of a mining factory in Tongyu town.

桐峪镇一个典型的金矿厂



**Figure 14.** General appearance of workshops

桐峪镇一个典型的炼金作坊

ii. About twenty people worked as a team carried on mining activities there. Usually four or five trucks there wait for transporting the rocks. Two or three transferred rocks from the pit mouth to the trucks there. Most of the miners are employed from another place, the other part are the relatives of the owners, which were invited to manage the gold mine. Generally, small scale mining activities are conducted by village-owned and private-owned mines. Village-owned mines are funded from the village, and private-owned mines obtained money from some native rich man.

iii. The Hg source is not clear according to the miners. They just know their boss bought Hg from Wanshan in Guizhou province.

iv. Most of the pits are near water, and the waste water from them becomes a small stream.

v. Usually the small scale mines have no processing factory. Some of them will transport their rocks to some official processing factories; and some choose to deal with rocks in simple way in the private workshops.

vi. Workers use rollers, ball mills, and crucibles in their workshops. They use ball mills to crush the rocks, and then put rocks into rollers. After then adding Hg into roller while the roller is rotating. About 0.005-0.01 gram of Hg is added into per 1kg rocks. After this step, gold has dissolved in Hg and form into alloy-amalgamation. If the Hg combined enough gold, amalgamation will settle to the bottom of rollers. Then they use clothes to cover the amalgamation to squeeze the Hg to get coarse amalgamation. Similarly as mentioned above, they put amalgamations into crucibles; heat them to obtained coarse gold. A small workshop usually can get hundreds kilograms of ore at most. The workers there said they can process 100-300 kilos of ore per hour, and they put about 300-500 hundred kg per batch. Usually they put Hg 3-5 times mass of the gold. In most cases, they cannot get so much ore every time.



**Figure 15.**The rollers they used in **Lijia village**, Tongyu Town.

桐峪镇李家村一个混汞碾子



**Figure 16.**The ball mills they used in Lizhuang village, Tongyu Town.

桐峪镇李家村一个球磨机

vii. The owners usually choose some natural ponds or dig some ponds to store the tailings.



**Figure 17.** A reservoir area for tailings.  
桐峪镇一个用来堆放废矿渣的水库

viii. Generally, they called the final gold-coarse gold.

ix. The production of gold is not sure, and it all depends on the amount of gold ores they can get. Sometimes they can get several kilos ores, sometimes they keep shut down for a longtime. There are many gold shops in the county, and the workshop owners there usually have stable gold shops to sell their gold. And they just said the gold shops will help them to sell gold, and now the pure gold price is less than 230 yuan per gram. Sometimes the gold shops can get some pure gold, if not they will refine the gold again.

### III. Results 调查结果

From the survey, small artisanal gold mining activities in some places were found. At one of the sites investigated, the mercury is apparently used for whole ore amalgamation, and the amount of mercury involved could be substantial depending upon the quantity of ore available for processing.

However, we were surprised to see that the situation has greatly improved than previous research (Feng, Dai et al. 2006, Li, Feng et al. 2009, Wu, Xu et al. 2010). Though this phenomenon of small artisanal gold mining still exists, the number is going down with the development of native economy and the increase of local people's awareness. Many people there have the awareness that using Hg to extract gold is illegal. However, to analyze the deep-seated reasons, livelihood may be the main cause for participants in Tongguan and Lingbao small gold mining areas. For some innocent residents there, no rights will be guaranteed to go up against the local illegal rich and the local illegal power. The local government bears the important responsibility in promoting economy and regulation.

调查表明，小型的金矿开采活动在一些地方仍然存在。在其中一个调查点，很明显，汞被用于混汞采金的全过程，而且，汞的使用量可能很大，汞的使用量和矿石的用量成正比。

但是，与之前研究发现相比（冯新斌等 2006，李平 2009），情况已经有所改观。随着当地经济发展和当地人的环境意识的提高，混汞炼金作坊和私人采矿的数量逐渐下降。许多当地人认识到使用汞炼金是违法行为。但是，究其深层原因，生计问题可能是促使灵宝和潼关两地小型采金活动和混汞炼金行为依然存在的原因。对于当地无辜村民来说，与当地违法采金和炼金行为斗争时，权利得不到保障。当地政府应当在促进经济发展和维护法律尊严上承担起责任。

### IV. Future work and suggestions 对下一步工作的建议：

中国的小规模黄金开采中正在使用汞，虽然看起来要比以前的调查中发现的少，但是汞的用量也许仍然是重要

的。本研究只限于两个地理区域；所以还需要额外的调查以确定汞在中国小规模黄金开采中的应用性质和程度。就本研究所调查的两个区域而言，今后还需在一些方面进一步开展工作，以使这些区域彻底告别汞的使用，无论是通过引入无汞的生产工艺或是通过推广其他替代生计。人们应保持高度警觉，确保在当地采取一系列措施以后，汞不再被使用。

我们建议，未来的研究者和相关政府部门在今后应该在有小金矿开采的区域系统采集样品，掌握当地污染的具体情况。

未来的研究可以从灵宝和潼关两个地区中选择两个点作为研究区域，进行详细的环境调查，了解从小型金矿开采和冶炼过程中汞的释放量。进而，对汞对当地居民和生态系统产生的影响进行环境风险评估。当地政府也应加强宣传，强调汞的危害：汞一旦释放到环境中后的强毒性，来提升公共意识。希望通过长期的工作，当地混汞炼金行为会完全消失。在不久的将来，创造一个绿色健康的环境。

Mercury use in small-scale gold mining in China is ongoing and may still be significant, although it appears to be less than found in previous investigations. This research was limited to two geographic areas; additional investigations are needed to determine the full nature and magnitude of this mercury use in China.

With respect to the two areas researched, further work is needed to transition these areas into mercury free processes, either through different production processes or alternative livelihoods. Greater vigilance will be needed to ensure mercury is no longer used after these outreach activities are conducted.

In future, we recommend selecting the two sites of Lingbao and Tongguan as the study areas to investigate environmental contamination of Hg released from the artisanal gold mining and processing activities. Further studies should be conducted on the risk assessment to understand Hg impacts on residents and ecosystems as well. The local government should stress the toxicities of Hg once be released into the surroundings to promote public awareness. Hope after a long-term commitment, the use of Hg in gold mining will fade away completely. A green and healthy environment will be created in the near future.

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