The use of mercury for gold recovering in the artisanal gold mining from the Mapiri river basin, Apolobamba, Bolivia

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Introduction

Mining activity is very important in Bolivia since colonial times. Artisanal and small-scale mining activities are abundant in the protected area of Apolobamba, La Paz; near the border with Peru. The most important rivers are the Suches, in the border with Peru, that drain to the Titicaca Lake and the Mapiri river, that is afluent to the Amazonas.

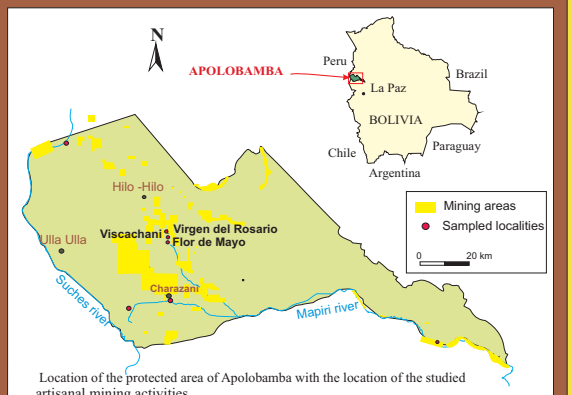
In the northern part of this area gold is mined from hydrothermal veins. Here mercury is used to recovery gold by obtaining an Hg-Au amalgam. The use of mercury causes an environmental impact in the area. otherwise, in the south part of the Mapiri basin gold is in placer-type deposits and it is obtained by mechanical techniques without mercury.

The present work is a preliminary study of the contamination of the Mapiri river basin in the Apolobamba area. In the head of the basin, located at more than 4000 m above sea level, about 15 tones of Hg are discharged in the environment every year (Hentschel et al (1999).

Sampling

We have sampled several mining sites from this area, in particular the ones known as Viscachani, Flor de Mayo and Chojlaya, located in the proximity of the head area of the Mapiri river.

All these mining sites were in activity during the present sampling campaign.The processing of gold takes place near the mines, where the mines also live.



Location of the protected area of Apolobamba with the location of the studied artisanal mining activities.

Analytical methods

The content of several metals were measured in the ACTLABS laboratory by XRF (Se, As, Cu, Zn, Cd, Pb, Hg) in tailing samples from the different gold mining sites .

In addition mercury concentrations in water and in vegetation close to the processing areas was determined by atomic absorption spectrometry with Zeeman effect (LUMEX RA-915 Equipment) in the Universidad castilla-La Mancha.

The concentration of mercury also was determined in the air along the study area with a portable LUMEX RA-915.

View of the large tailings of the Flor de Mayo mining activity.

Extraction of gold at Viscachani. Mercury is mixed with water and mineral in ball mills where gold amalgam with mercury.

After the extraction of gold by amalgamation with mercury, tailings still are rich in gold. Many women of the area work to recover gold from them.

Results

Tailings are mainly constituted by quartz with minor contents of clay minerals and sulphides. Gold content, after recovery with mercury, is high, 4.56 -10.35 ppm (Table 1).

The Hg content of the tailings is 149-1027 ppm, lixiviable Hg ranges from 30.10 to 859.94 ng/l. Water released from the tailings contains 0.1 - 5.7 ppb of Hg.

The analysed vegetation, which is typical of the area, has high Hg contents, from 162 to 219 ppm.

The measurement of the Hg content in the air is negligible except close the mining activities, where it can reach high values (eg. 4.4 ppm in Viscachani).

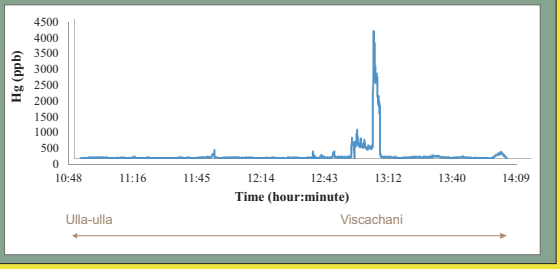
In addition there is a high As content in all the studied tailings, except in those from Viscachani, the concentrations of this element is up to 18540 ppm. The Pb content usually ranges from 337 to 939 ppm. The Chojlaya mining site tailing has exceptionally high values of heavy metals: Pb content is between 2.26 and 3.27 wt.%, Cd from 160 to 228 ppm, Zn from 194 to 794 ppm, Cu from 847 to 1052 ppm and Se from 105 to 187 ppm (Table 2).

Table 2. Composition in heavy metals of tailings from gold mining and veins in the Apolobamba potected area (ppm).

Sample	Location	Type	Cr	Ni	Cu	Zn	As	Se	Mo	Cd	Hg	Pb
P 3	Viscachani	Tailing	0	0	17	50	22	21	18	5	210	302
Q 1'	Flor de Mayo	Tailing	87	23	36	475	18540	0	17	39	255	939
Q 4	Flor de Mayo	Tailing	28	0	2	99	4388	0	16	19	149	337
R 4	Chojlaya	Tailing	192	45	1052	194	456	187	8	228	232	32704
R 5	Chojlaya	Tailing	103	30	847	794	1000	105	26	160	1027	22627
R 12	Chojlaya	Vein gouge	537	38	5001	498	613	163	34	207	4	29999
R 6-3	Chojlaya	Vein gouge	318	0	0	38	0	49	28	0	0	4138
R 13	Chojlaya	Vein	231	10	11	100	7	28	35	39	0	234
R 14	Chojlaya	Vein	258	21	35	141	16	25	34	48	0	396
R 6.1	Chojlaya	Selected mineral	2120	636	684	781	19298	757	59	6387	388	291837

Table 1.
Content in Au, Hg, As of tailings from the Apolobamba potected area (ppm).

Sample	Location	Au	Hg	As
M1	Tailing head Tuichi	1.75	75	1790
M2	Tailing head Mapiri	8.40	122	20
M3	Tailing head Mapiri	9.88	364	13462
M5	Tailing lower Mapiri	0.02	2	28
M6	Tailing lower Mapiri	4.56	-	-
M7	Tailing lower Mapiri	7.50	-	-
M8	Tailing lower Mapiri	10.35	-	-
M10	Tailing lower Mapiri	0.04	-	-



Graphic of the measurement in situ with the LUMEX portatil spectrometer, of the Hg content in the air along the road from Ulla Ulla to

Discussion and Conclusions

The artisanal gold mining activities in the northern part of the Mapiri river basin use mercury to the gold recovery processment. They led to an intense environmental pollution, mainly related to mercury and arsenic contents. Mercury pollution is due to the use of this element to do an amalgame with gold as a recovery tecnique.

Tailings from Chojlaya also are rich in heavy metals as Pb, Cu, Cd and Se. These contents produce contamination of soils and water.

Vegetation of the area is very effective in capturing Hg, then it could be used as a fitoremediation system to reduce the contamination of mercury in the water courses of the area. In addition, in the surroundings of Viscachani large deposits of bentonite occur. These clays could also be used to reduce the Hg and As pollution in water by making barriers .

As content is important in several mine sites. Arsenic come from the destruction of arsenapyrite, wich is present as an abundant mineral in many locations of mining activity. In addition to the enviromental contamination caused by this component, the content of As makes difficult the amalgamation of gold and mercury; in these cases more mercury is necessary to added to obtain the amalgamation and gold recovery. Then, in these cases the use of mercury is specially non effective in gold recovering.

After processing, tailings still contain important amounts of gold suggesting that the amalgamation method is not effective to gold recovering. In some places silver sulphosalts are abundant, then Ag could be in ecomomic contents. The Ag content should be investigated and took into account when exploitation.

More research should be done to quantify other possible metals that could be of economic interest, as silver. In addition, an alternative method to the use of mercury should investigated to be used torecovery gold in these exploitations, according to the sustanability concept.

Typical vegetation of the area which absorbs important contents of Hg.

View of the bentonite deposits from Viscachany.

References

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