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Environmental and Health effects of particulate material by perforation in mina CastrovirreynaCompañía S.A. – Unidad San Genaro Perú.

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Abstract: *This research assesses the impacts of drilling dust on mining fronts using a comprehensive methodology: production, environmental, safety and occupational health at the Castrovirreyna Company S.A. – Unidad San Genaro located in the Province of Castrovirreyna, Department of Huancavelica at a height of 4,450 meters above sea level, which conducts underground mining activities of polymetallic minerals (Ag, Pb, Zn, Fe and Cu), with a mineralogical analysis of the rock: Magnetite (sizes up to 0,775 mm), Hematite (0,250 mm), Ilmenite (0,250 mm), Rutile (0,175 mm), Leucoxene (0,185 mm in length), Pyrite (0,045 mm), Chalcopyrite (0,055 mm) and Goethite. The report of measurement and analysis of sample M2 of code LDRX (M2017-014-002) by diffraction and fluorescence of X-rays realized in the laboratory of X-ray diffraction of the Faculty of Physical Sciences of the Greater National University of San Marcos with the BRUKER Diffractometer model D8-FOCUS whose result is the presence of Silica (Si) 2.965%, Chlorine (Cl) 91.076%, Potassium (K) 0.413%, Calcium (Ca) 0.171%, Titanium (Ti) 0.076%, Iron (Fe) 3.725%, Copper (Cu) 0.036%, Zinc (Zn) 0.058%, Arsenic (As) 0.065%, Strontium (Sr) 0.023%, Barium (Ba) 0.556% and Lead (Pb) 0.838% Weight . The contamination observed in the workers shows a correct use of their PPE, this dust pollutant is also released through artificial ventilation. (Art. 88, 234 D.S.024-2016-EM). Explosive odor is verified with the gas measurement equipment (Drager) registered within the maximum permissible limits of NO 25 ppm, CO_2 5,000 ppm, CO 25 ppm, O2 19.5% (Article 246 DS024-2016-EM) , the pH of the groundwater is 5.5..*

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I. Introduction

The mining activity resulting from the drilling process generates air and water contamination, which is detrimental to the mining worker; in the particular case of Cambalache's small polymetallic underground mining, pollution is very pronounced, mainly due to the generation of dust, which, without the proper use of personal protective equipment, would be a cause of occupational diseases ranging from mild to severe, depending on the length of time spent there. Activity¸ such a drawback motivates the investigation to determine the contaminants found in the breathableand inhalable particles in order to prevent the degradation of the health of the mining workers.

II. Methodology

Process of weighing of filter for the collection of samples

Initial weight of the membrane disc filter (mixture of cellulose acetate and cellulose nitrate) of 0.5 μm and 37 mm diameter with an approximation of 0.01 mg = 0.0099 g. The filter was conditioner before being weigh in a controlled humidity chamber at a constant temperature for a minimum of 24 hours.

Tableno 1 Study of the enclosure where the analytical balance is located

	Tuesday	Wednesday	Thursday	Friday	Final average
Temperature °C	16	14	14	14	14.5
Humidity %	54	64	67	68	63
Pressure mbar	690.5	689.8	689.8	690.2	690.1

Figure no1 *Weighing of filter*

The pre-weighed filters were place in the two-piece polystyrene cassette or cassette, which were place in the nylon cyclone to sample the breathable dust fraction. The sample was collect by passing a known volume of air: 2,000 cc / min with the help of the GILIAN PLUS pump.

Figure no2*Passing Air Volume*

Ventilation process
Natural and forced ventilation with fans of 1,200 cubic feet / minute.
Personal protectiveequipment (PPE)
Equip Worker was protecting with PPE.
Drilling process
It was make in a section of 7ft wide by 8 ft high, with the Jackleg equipment with advance bar ATTLAS COPCO, using a 6-foot long bore with 38 mm diameter.
Environmental pollution
Gas measurement equipment (Drager).
Microscopic study
Photomicrography or microscopic photography that needed an image-magnifying device with a 200X, 40X and 63X magnification microscope.
Analysis of samples by diffraction and X-ray fluorescence.
We use a diffractometer Brand BRUKER Model D8-FOCUS.

III. Results and discussion

The ventilation is to ensure a breathable atmosphere for the mining workers, with natural and forced ventilation with ventilators of 1,200 (Pies3 / min) (Article 248 of the D.S. 024-2016-EM). It is evident that the air speed (23 m / min) complies with the D.S. 024-2016-EM, Art. 248.

Figure no3*Drillingtube*

The driller, his assistant, the laborer and the investigator were supervised by safety (Art. 38 and 44), were verify that the workers comply with the identification of hazards, risk assessment and control measures (IPERC), which must perform at the beginning of each task. It is make in order to minimize the existing risks through the use of their tools and personal protective equipment (PPE), it was also noted that they are responsible for their safety and that of their colleagues during the drilling process time that was 2:30 hours, and we realized the reason for their responsibility is due to the constant training and inspections of their work by the supervisors.

Figure no4 *Drilling Process preparation*

The drilling was performed in a section of 7ft wide by 8 ft high, with the Jackleg equipment with advance bar ATTLAS COPCO, using a 6 foot long bore with 38 mm diameter, obtaining an average drilling depth of 5.6 feet (1.71 m) representing 95% compared to 6 feet of the hole, from this depth particles are released in the form of detritus of various granulometries which are sampled for the respective analysis.
Environmental pollution has been observing that workers make correct use of their PPE.
The dust contaminants are releasing by artificial ventilation (Art. 88, 234 D.S.024-2016-EM) and natural.
The explosive odor is verify with the gas measurement equipment (Drager) registering within the maximum permissible limits of:
NO 25 ppm, CO_2 5,000 ppm, CO 25 ppm, O_2 19.5% (ART 246 D.S.024-2016-EM).
The pH of the groundwater was 5.5.

Microscopic study of two (0_2) rock samples on two polished sections and two thin sections
Microscopic description. The sample is composed of the opaque minerals that are mention below: Magnetite, Ilmenite, Hematite, Rutile, Leucoxene, Pyrite, Chalcopyrite, Goethite and Bargains (see Table 2).

Table no2 *Sample Minerals Composition*

Mineral	% Hypogens	% Supergens
Magnetite	3.00	
Ilmenite	Trz	
Hematite	Trz	
Rutile	0.01	
Leucoxene		0.01
Pyrite	Trz	
Chalcopyrite	Trz	
Goethite		Trz
Bargaing	96.98	
Total	100.00	

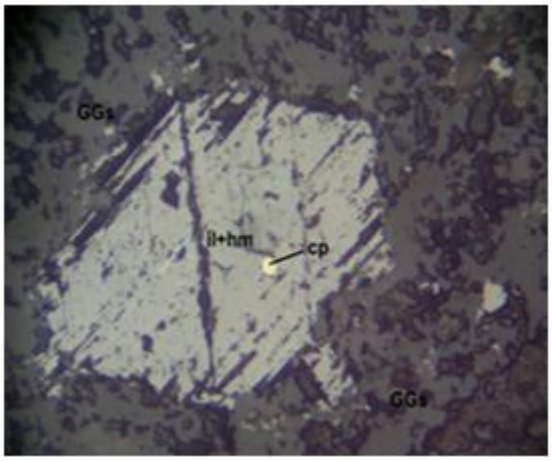
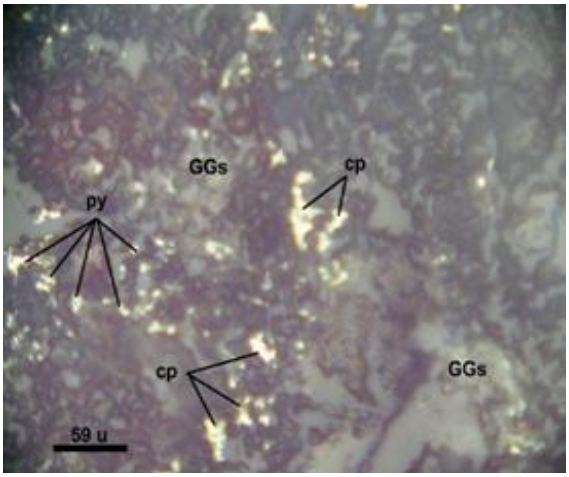
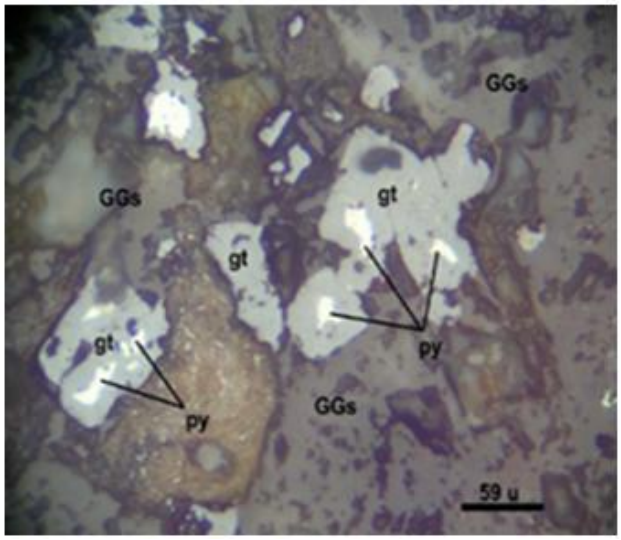


Figure no5*Submental crystal of ilmenite (il) interspersed with hematite (hm), including chalcopyrite (cp), is thus disseminated in the gangue (GGs). 200X.*



Figureno 6 *Tiny anhedral crystals of chalcopyrite (cp) and pyrite (py) are scattered in the gangs (GGs). 200X.*



Figureno 7*Anhedral magnetite crystal (mt), are strongly deformed, so their cleavages are not with their original directions. 200X.*

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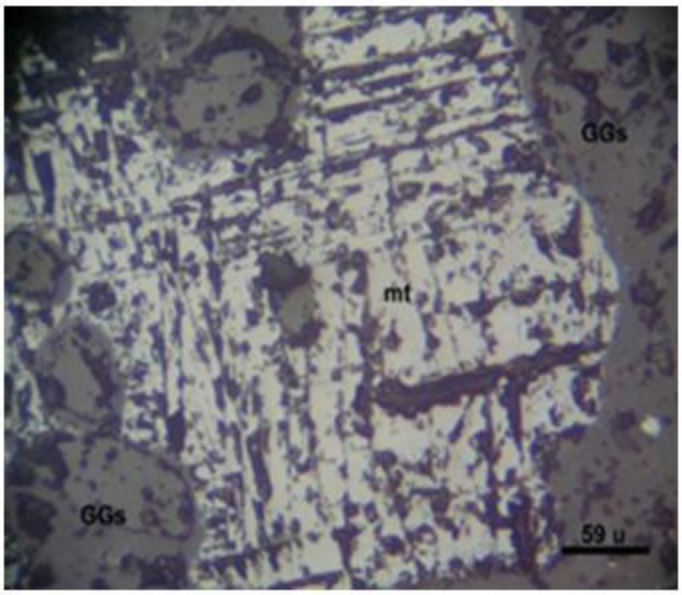

Figure no8*Anhedral crystal of rutile (rt) shows alteration to leucoxene, it is disseminated in the gangue (GGs). 200X.*

Measurement and Analysis of samples by diffraction and X-ray fluorescence.
Made with the Diffractometer Brand BRUKER Model D8-FOCUS of the Faculty of Physical Sciences of the Universidad Nacional Mayor de San Marcos whose results are (see table 3):

Table no3 Percentage by weight of the elements present in the sample

					%W							
Specimen	Silicon	Chlorine	Potassium	Calcium	Titanium	Iron	Copper	Zinc	Arsenic	Strontium	Barium	Lead
M2017-	Si	Cl	K	Ca	Ti	Fe	Cu	Zn	Ar	Sr	Ba	Pb
014-002	2.965	91.076	0.413	0.171	0,076	3.725	0.036	0.058	0.065	0.023	0.556	0.838

The current OSHA permissible exposure limit (PEL) for respirable dust containing crystalline silica.
The current OSHA PEL for respirable dust containing crystalline silica (quartz) for general industry is as follows
PEL = (10 mg/m³) / (2.965%+2) = 2.014 mg/m³ = 0.002014 mg/L = 0.002014 ppm.
The National Institute for Occupational Safety and Health (NIOSH)
The permissible exposure limit recommended by NIOSH for respirable crystalline silica is 0.05 mg / m³ (50 µg / m³)

Table no3 DRX Results

OSHA	NIOSH	DIFRACTION AND X-RAY FLUORESCENCE		
		Silicon (mg/m³)	Lead (mg/m³)	Arsenic (mg/m³)
PEL = $\frac{10\frac{mg}{m^3}}{\%\ silice+2}$	PEL = 0.05 mg/m^3	PEL = 2.014	PEL= 3.524	PEL= 4.843

IV. Analysis and discussion of results

Discussion of the microscopic study of rock samples on two polished sections and two thin sections
Table 3 shows a greater percentage of Hipogens minerals in the Vein Nivel Power 740 and Nivel 845 Nivel 740 in the cruise union.

Table no4: Comparison of results

1. MINERALS	2. VETA PODER NIVEL 740		3. CX UNION 845 NIVEL 740		4. PIQUE NIVEL 740	
	5. HIPOGENS 6. %	7. SUPERGENS 8. %	9. HIPOGENS 10. %	11. SUPERGENS 12. %	13. HIPOGENS 14. %	15. SUPERGENS 16. %
17. Magnetite	18. 3.00	19. --	20. 1.00	21. --	22.	23.
24. Ilmenite	25. Trz	26. --	27.	28.	29.	30.
31. Hematite	32. Trz	33. --	34. --	35. 0.01	36.	37.

38. Rutile	39. 0.01	40. --	41. 1.00	42. --	43.	44.
45. Leucoxene	46. --	47. 0.01	48.	49.	50.	51.
52. Pyrite	53. Trz	54. --	55. 0.07	56. --	57.	58.
59. Chalcopyrite	60. Trz	61. --	62. 0.05	63. --	64.	65.
66. Goethite	67. --	68. Trz	69.	70.	71.	72.
73. Bargaing	74. 96.98	75. ---	76. 97.86	77. --	78.	79.
80. Psylomelan	81.	82.	83. ---	84. 0.01	85.	86.
87. Plagioclase	88. --	89. --	90. --	91. --	92. 81.97	93. --
94. Chlorite	95. --	96. --	97. --	98. --	99. ---	100. 10.00
101. Calcite	102. --	103. --	104. --	105. --	106. --	107. 5.00
108. Sericite	109. --	110. --	111. --	112. --	113. --	114. 0.05
115. Opaque Minerals	116.	117.	118.	119.	120. ---	121. 3.00
122. Total	123. 100.00		124. 100.00		125. 100.00	

Analysis by Diffraction and X-ray Fluorescence

Discussion of the spectrum of the sample:

The coded sample "M2017-014-002" = M2, the GILLAIN PLUS suction pump, was graduated at 2000 cc / min in a time of one hour, which allowed to obtain 12 chemical elements of which the highest percentage is chlorine with 91.076% w, Iron (Fe) with 3.725% w, Silicon (Si) with 2.965% w, lead (Pb) with 0.838% w, Barium (Ba) with 0.556% w, Potassium (K) with 0.413 % w, Calcium (Ca) with 0.171% w, titanium (Ti) with 0.076% w, arsenic (as) with 0.065% w, zinc (Zn) with 0.058% w, copper (Cu) with 0.036% w and strontium (Sr) with 0.023% w.

V. Conclusion

The minerals Magnetite, Ilmenite, Hematite, Rutile, Leucoxen, Pyrite, Chalcopyrite, Goethite and Gangas were found in the sample, in the X-ray diffraction and fluorescence analysis, the following were found:
Silicon (Yes) 2.965%, Chlorine (Cl) 91.076%, Potassium (K) 0.413%, Calcium (Ca) 0.171%, Titanium (Ti) 0.076%, Iron (Fe) 3.725%, Copper (Cu) 0.036%, Zinc (Zn) 0.058%, Arsenic (As) 0.065, Strontium (Sr) 0.023%, Barium (Ba) 0.556% and Lead (Pb) 0.838%. The elements Arsenic, lead and silicon are the riskiest in the health of workers, however it is observed that mine workers make good use of their personal protective equipment (PPE), and comply with the regulations of D.S. 024-2016- EM.
The drilling process with adequate water pressure helps to reduce dust contaminants.
The air velocity measured with the Anemometer on the drilling front was 23 m / min, compared to the D.S. 024-2016-EM. Art. 248 is within the permissible limits (20 m / min).

The constant and responsible trainings significantly influence that the worker complies with the proper use of their PPE, minimizing the risks.
The actions to respect the rules and that the worker contributes on their own initiative, are ingredients for the minimization of pollution in their work area.

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