08 - MINERALOGICAL AND CHEMICAL DATA ON THE GEOSCIENCE MUSEUM COLLECTION SAMPLE 2478: Zn-Pb ORE

http://gmga.com.br/08-mineralogical-and-chemical-data-on-the-geoscience-museum-collection-sample-2478-zn-pb-ore/

10.31419/ISSN.2594-942X.v62019i2a8MLC

Dados mineralógicos e químicos sobre a amostra 2478 de minério de Zn-Pb do Museu de Geociências

Marcondes Lima da Costa[1]

Glayce Jholy Souza da Silva Valente[2]

Pabllo Henrique Costa dos Santos[3]

[1] *Instituto de Geociências da Universidade Federal do Pará, Pesquisador do CNPq e Membro Titular da ABC e curador do Museu de Geociências,* marcondeslc@gmail.com

[2] *PNPD-PPGG, Instituto de Geociências da Universidade Federal do Pará,* glaycej@yahoo.com.br*;*

[3] *Doutorando do PPGG e técnico do Museu de Geociências, Instituto de Geociências da Universidade Federal do Pará,* phsantosgeo@gmail.com

ABSTRACT

The beautiful sample 2478 recently incorporated into the collection of the Geosciences Museum of the Federal University of Pará represents Marcos Paro's Zn-Pb ore, and is composed of ferrous sphalerite and galena, as well as pyrrhotite, amorphous silica, chlorite, phengite, Ca-phosphates, quartz and carbonaceous material. Galena and sphalerite occur in both coarse and fine crystalline aggregates, dispersed in the matrix of chlorite, phengite and siliceous carbonaceous material. The data presented are partial, since they were obtained only from a small aliquot of the sample.

Keywords: Sphalerite ferroan, galena, pyrrhotite, phengite, chlorite, Ca-phosphate, Marcos Paro.

INTRODUCTION

The beautiful sample donated to the Geosciences Museum by geologist Paulo Afonso Ribeira Barbosa (Santa Elina Mining Company) and prof. Dr. Roberto Vizeu (FAGEO-UFPA) in July 2019 represents the Zn-Pb ore of the Target DM-1, Mina Marcos Paro, in the municipality of Nova Brasilândia D´Oeste, State of Rondônia (Figure 1 A). The sample was filed under number 2478 in the collection of the Geosciences Museum of the Federal University of Pará.

Figure 1 - The sample collection 2478. A) Natural and B) Cut and polished. Longer length = 7.5 cm.

ANALYTICAL METHODS, RESULTS AND DISCUSSIONS

The sample was then sectioned into two parts, and the cutting surfaces were carefully polished (Figure 1 B). In this way you have a natural view of the broken and polished surface, which allows you to also evaluate the aspects of the metallic shines of their minerals, mostly sulphides of Zn, Pb and Fe. The polished surface became beautiful, too.

X-RAY DIFFRACTION MINERALOGY

The sample was then submitted to X-ray diffraction analysis (D 2 Phaser Bruker Diffractometer) (Figure 3). The minerals identified were: ferrous sphalerite, galena and pyrrhotite, in decreasing order of abundance, sphalerite and galena, respectively the ores of Zn and Pb. The pyrrhotite confers magnetism to the sample. Phengite, chlorite and possibly crandallite (?) were still determined.

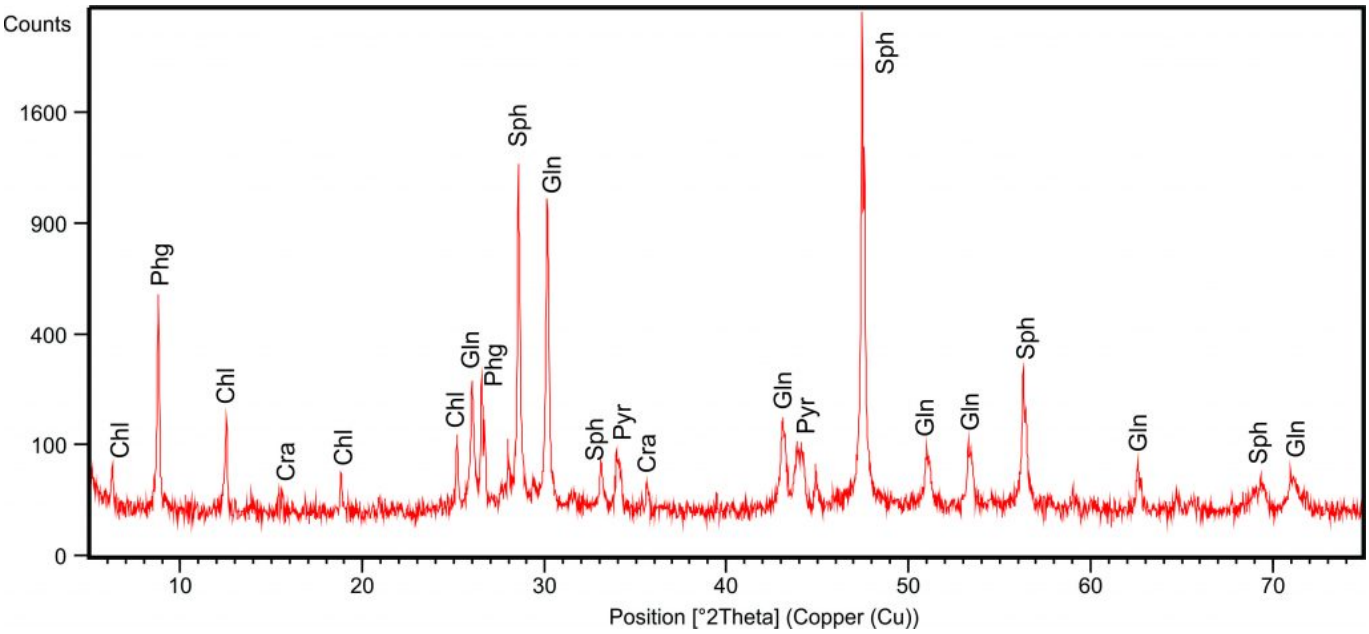


Figure 2 - XRD analysis of the Museum collection sample Nr. 2478, Zn-Pb ore from Mina Marcos Paro. Legend: Chl (chlorite); Phg (phengite); Cra (crandallite); Gln (galena); Sph (sphalerite); Pyr (pyrrhotite).

CHEMICAL COMPOSITION BY XRF $_{\text{portable}}$ (Bruker S1 Turbo)

The bulk chemical composition analyzes however semi-quantitative results (Table 1) demonstrate the chemical nature of the ore, dominated by Zn and Pb sulphides, as well as iron, respectively sphalerite, galena and pyrrhotite. But furthermore, they show the presence of variable and sometimes expressive concentrations of SiO_2, Al_2O_3, CaO and K_2O and even MgO (not indicated in the table due to the very high uncertainty of the method), are in agreement with the presence of phengite and chlorite, identified by DRX, too. On the other hand, P_2O_5 levels ranging from 1.6 to 4.37% are surprising. By XRD it was inferred mineral from the crandallite group (Ca, Pb), however, although the chemical analyzes show expressive CaO content, it was not always found a positive relationship between the values ??of this element and Pb with those of P_2O_5. It is likely that it may contain Fe and / or Al phosphates, or simply Ca phosphate. It is necessary to intensify and refine XRD mineralogical analyzes.

Table 1 - A chemical composition (by Bruker portable FRX) of Zn-Pb ore from Mina Marcos Paro, Nova Brasilândia do Oeste-RO, Santa Elina Ore Company (Geoscience Museum collection Nr. 2478).

Analyzes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**

$Al20_3$	19,7	4,8	3,3	3,9	8,5	9,5	5,4	3,8		8,66	6,0	5,19
SiO_2	15,5		62,1	3,5	8,3	3,7	20,1	49,9	3,2	3,35	6,2	4,03
P_20_5	2,72	3,9	1,66	3,3	2,9	4,1	2,48	1,79	4,03	4,05	4,37	2,48
S	27,6	41,8	21,9	38,5	38,5	44,8	35,2	27,7	47,9	45,8	33,5	41,6
K_2O	1,4					2,8	1,16	0,01			0,47	0,08
CaO	4,9	2,9	0,24	2,1	0,07		0,25	0,65			3,84	0,28
MnO	0,16	0,26	0,147	0,19	0,42	0,22	0,22	0,21	0,3	0,21	0,23	0,24
Fe_2O_3	15,8	20,8	14,7	17,5	48	44,3	20,3	15,5	68,8	42,7	23,5	23,2
Cu	1,2	0,23	0,48	0,16	0,26	0,03	0,13	0,84	0,1	0,03	0,21	0,59
Zn	11,0	45,1	8,07	27,8	14,9	2,9	20,5	13,2	9,7	3,02	15,0	31,1
As	2,83	0,8	0,43	0,66	0,69		1,14	0,51	0,35	0,1	2,2	1,2
Pb	13,9	3,88	0,17	3,2	2,61		3,14	0,4	0,9		8,12	2,14

SEM MICRO-MORPHOLOGY AND TEXTURES; EDS MINERAL CHEMICAL COMPOSITON

Analyzes by scanning electron microscopy with energy dispersive x-ray fluorescence spectrometry (SEM / EDS, HITACHI / TM 3000 / Oxford Instruments / SwiftED3000; non-metallized sample and low vacuum) confirm the presence and content range of the elements obtained by Portable XRF and mainly also reinforce the presence of Mg and P_2O_5. And thus, attests to the presence of chlorite, probably Fe-Mg-Al, and Ca phosphate, which is apparently not apatite (not yet identified in the first x-ray diffractograms), the possibility for monetite, Ca (HPO_4). This confirms the consistent levels of phosphorus in the small whole sample.

SEM / EDS analyzes also show that sphalerite does contain Fe (sphalerite ferroan), ranging from 5 to 20% of Zn content, which corresponds to 7 to 14% of Fe (Table 2), however a good portion of total iron may be represented by pyrrhotite and chlorite.

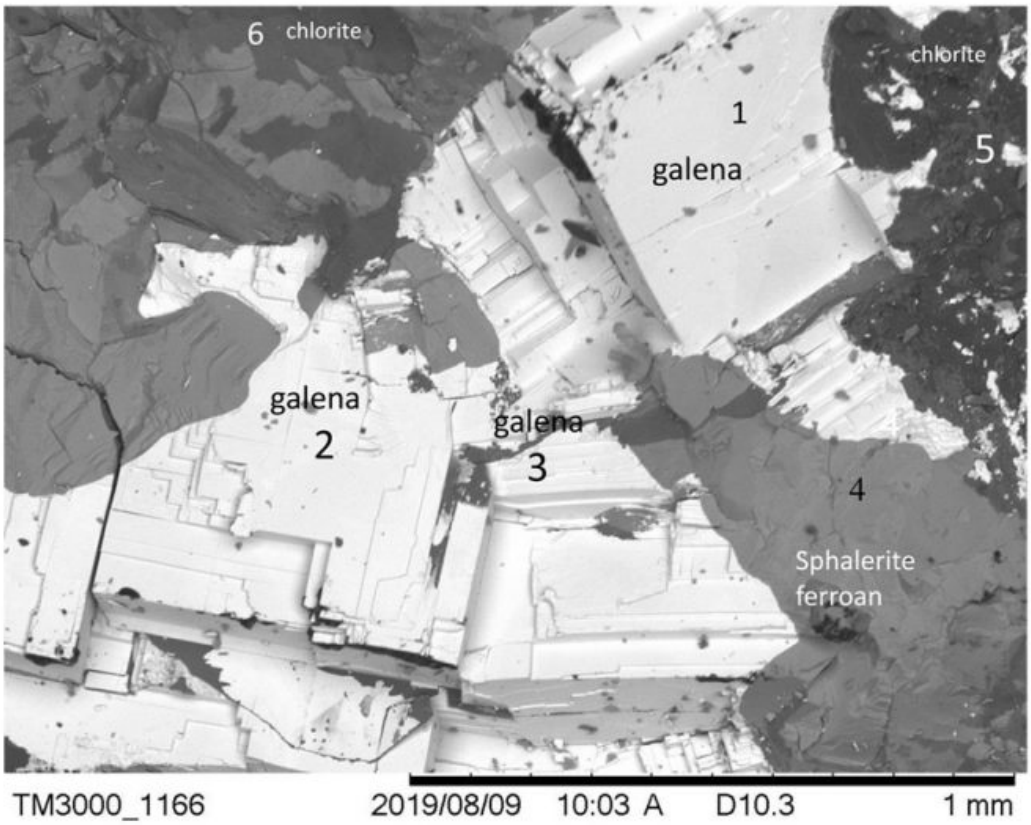
Table 2 - Chemical composition of ferroan sphalerite “CRYSTALS” of Zn-Pb ore from Marcos Paro after SEM/EDS.

Analyzes	1	2	3	4	5	6	7
Carbon	10.216	7.686	7.141	9.264	6.570	6.508	6.458
Oxygen	1.905	2.677	-	-	3.323	2.903	-
Aluminum	0.350	-	-	-	-	0,335	-
Silicon	0.599	0.518	-	0.330	1.121	0.929	0,496
Sulfur	27.222	26.408	28.686	27.334	26.738	27.633	30.200
Iron	9.749	7.225	8.787	14.700	10.917	6.889	8.058
Zinc	49.959	54.724	55.385	48.373	51.331	54.803	54.789

Galena masses are chemically homogeneous according to these same analyzes (Figures 3 and 6) when in coarse and cleavable grains, while fine grains are dispersed in chlorite (Figure 3), amorphous silica (Figures 4 and 5), in the same way as sphalerite, and partly pyrrhotite. Pyrrhotite is often fine grains (Figures 7 and 8). The intergrowth between the amorphous silica matrix and carbonaceous matter, generally containing tiny sphalerite and partly galena granules, and even pyrrhotite. But sphalerites usually contain or are intergrown with carbonaceous organic matter (Table 2 and figures 4 and 5).

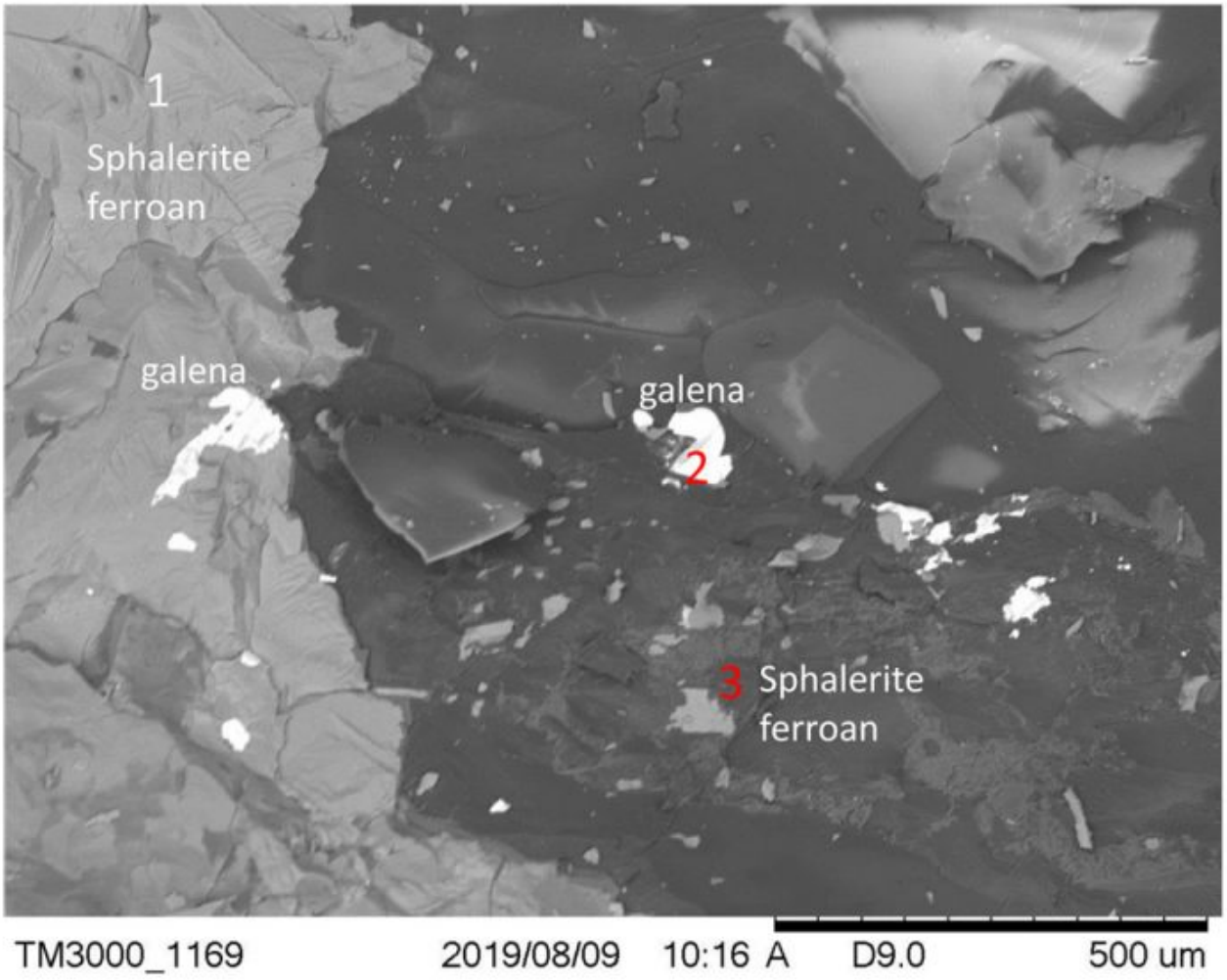
Chlorites tend to be ferrous, partly magnesian, partly alumina, and are also associated with carbonaceous organic matter and the sulfides of Zn and Pb (Figure 3). Phengite occurs locally (Figure 8).

Ca-phosphate, probable monetite, was inferred from the chemical analyzes of the masses dominated by amorphous silica and carbonaceous organic matter. For the time being, its grains (Figures 4 and 5) are not individualized as crandallite, the latter identified by XRD.



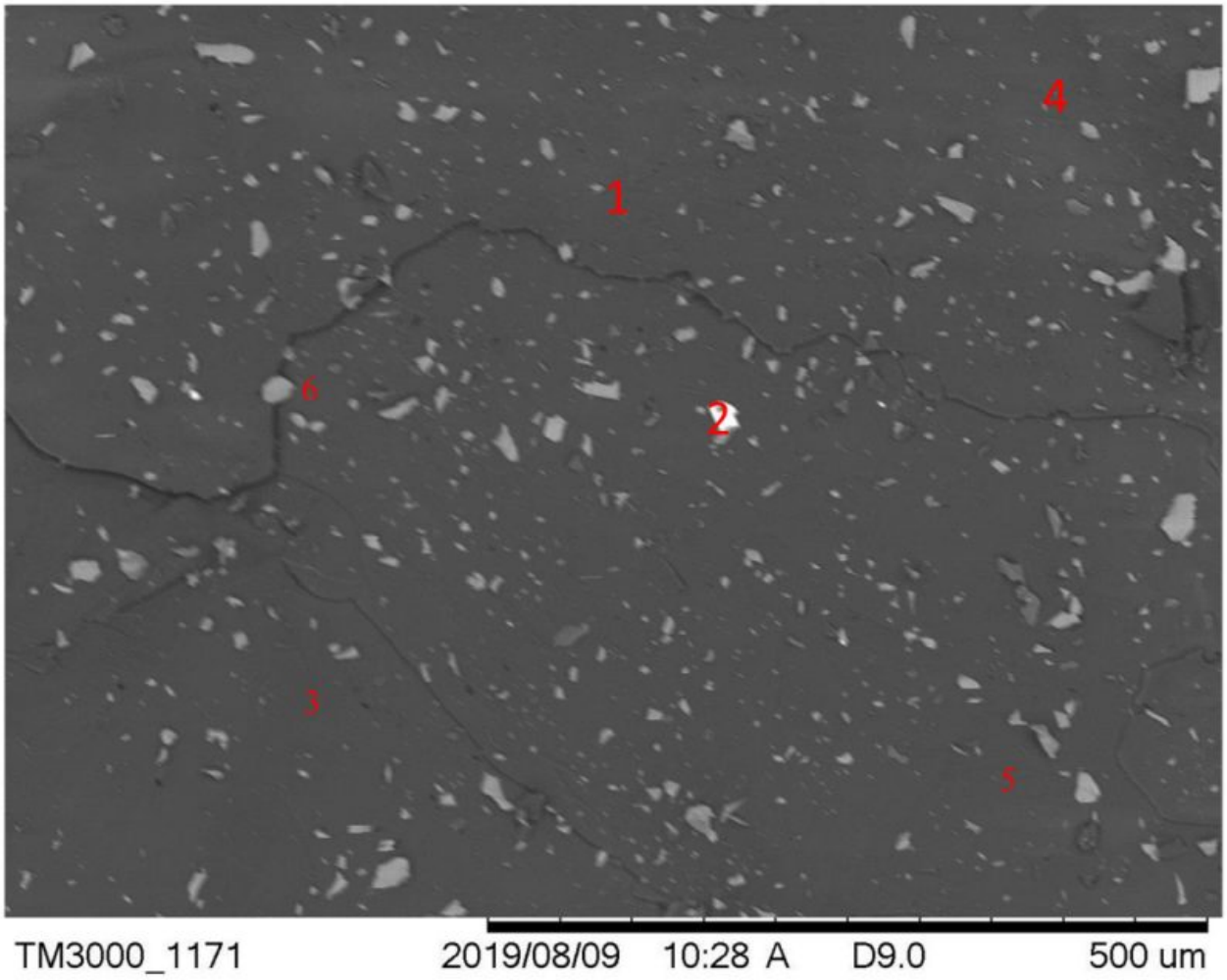
Analyzes/	1	2	3	4	5	6	Theoretical galena	Theoretical sphalerite	Theoretical pyrrhotite
Carbon					5.726	5.872			
Oxygen	11.848	-			48.704	51.052	-		
Aluminum	0.693	-				5.496	-		
Silicon	1.599	-		0.330	14.760	9.752	-		
Sulfur	11.929	14.641	14.215	27.334	0.885	1.659	13.40	33.06	37,67
Iron	2.740	-		14.700	14.806	23.694	-	2.88	
Zinc	6.006	-		48.373	-	0.922	-	64.06	62,33
Lead	65.186	85.359	85.785	-	3.618	-	86.60		
Sodium					3.254	-			
Magnesium					0.335	1.154			
Calcium					0.392	0.400			
Mineralogy	Galena, Sphalerite ferroan, sulphate?	Galena	Galena	Sphalerite ferroan	Chlorite ferroan, pyrrhotite, OM	Chlorite ferroan, sphalerite, Pyrrhotite, OM	GALENA	SPHALERITE	PYRRHOTITE

Figure 3 - SEM images and EDS chemical analyzes on mineral grains of Zn-Pb ore from Marcos Paro illustrating the composition of galena, sphalerite, pyrrhotite, chlorite and possible presence of carbon organic matter (OM) and the theoretical chemical composition of galena, sphalerite and pyrrhotite for comparison.



Analyzes	1	2	3
Carbon	6.570	4.239	6.508
Oxygen	3.323	19.824	2.903
Aluminum		0.330	0.335
Silicon	1.121	4.134	0.929
Phosphorus		0.689	-
Sulfur	26.738	9.310	27.633
Calcium		1.534	-
Zinc	51.331	1.070	54.803
Lead	-	58.872	-
Iron	10.917	-	6.889
MINERALOGY	Sphalerite ferroan, Silica amorphous OM	Galena, sphalerite, Sílica amorphous, Ca-phosphate, OM	Sphalerite ferroan, OM, Silica amorphous

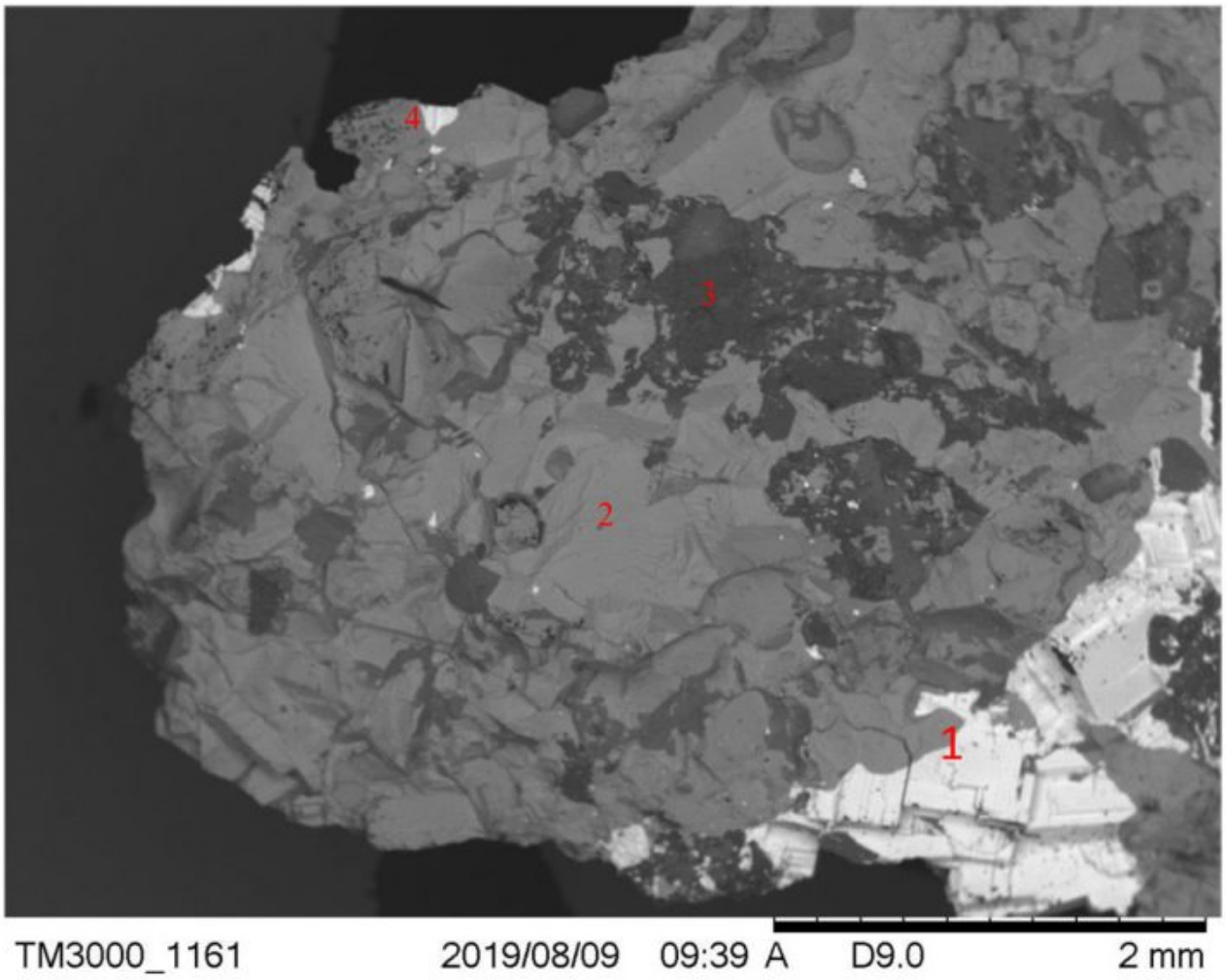
Figure 4 - SEM images and EDS chemical analyzes on mineral grains of Zn-Pb ore from Marcos Paro illustrating the composition of galena, sphalerite ferroan, silica amorphous, Ca-phosphate and possible presence of carbon organic matter (OM).



Analyzes	1	5	3	4		2		6
Carbon	6.538	4.387	-	5.058	Carbon	-	Carbon	-
Oxygen	55.777	55.331	56.026	64.991	Oxygen	19.115	Oxygen	38.316
Silicon	26.991	34.885	42.786	29.951	Silicon	7.381	Aluminum	0.469
Phosphorus	4.232	2.184	-	-	Sulfur	9.965	Silicon	18.853
Calcium	6.462	3.212	-	-	Zinc	1.039	Sulfur	10.281
Zinc	-		1.188	-	Lead	62.500	Iron	13.766
	-						Zinc	18.315
MINERALOGY	Silica amorphous, Ca-Phosphate, OM	Silica amorphous, Ca-Phosphate, OM	Silica amorphous, sphalerite (?)	Silica amorphous, OM		Galena, sílica amorphous, sphalerite (?)		Sphalerite ferroan, Chlorite ferroan, Sílica amorphous

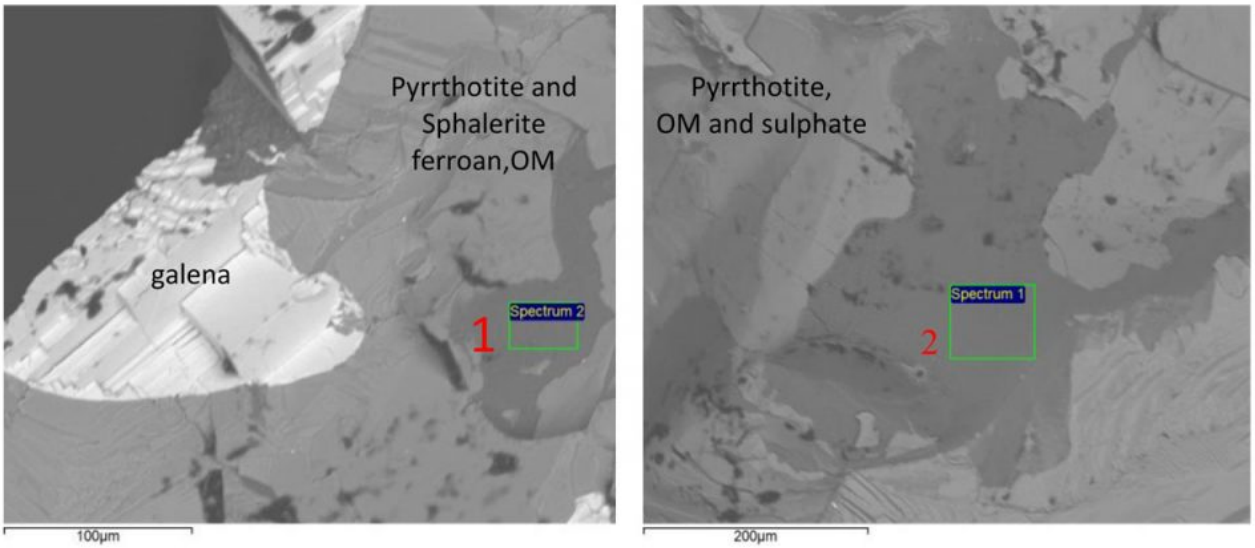
Figure 5 - SEM images and EDS chemical analyzes on mineral grains of Zn-Pb ore from Marcos Paro illustrating the composition of silica amorphous, galena, sphalerite ferroan, Ca-phosphate and possible presence of carbon organic matter (OM).

The presence of sulfates (Al and/or Fe) was inferred from the chemical analysis of EDS (Figures 3 and 6). In the sulphide domain mass, analyzed by both XRD and SEM / EDS, no quartz was detected, although SiO_2 content is disconnected from Al_2O_3 and alkalis. These silica contents are assumed to be amorphous silica, always bound to expressive carbon contents, considered to be representative of organic material. However, quartz is visible to the naked eye in the hand sample, in pockets and venules.



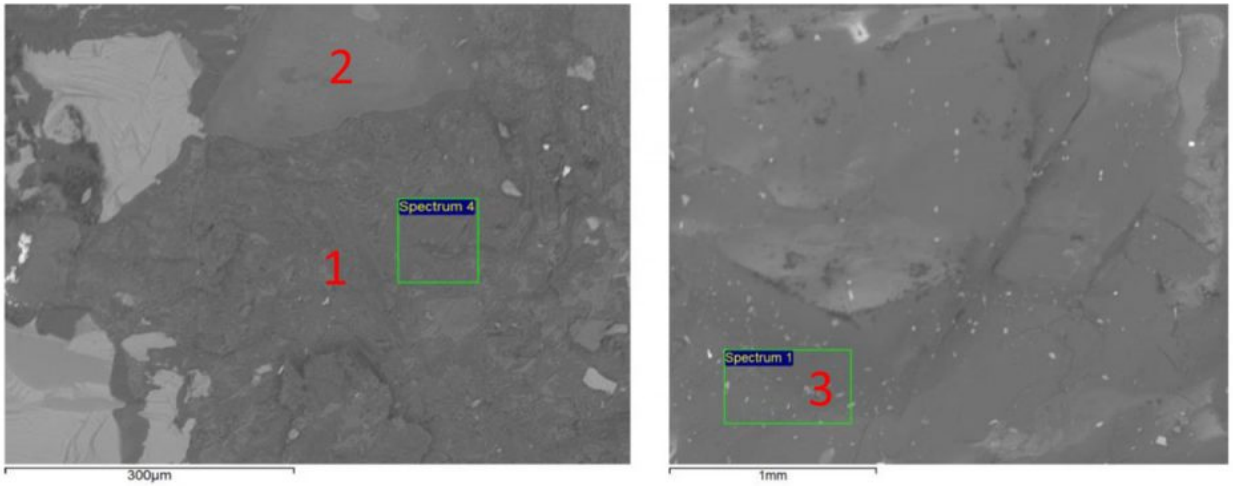
	1	2	3	3	4
Carbon	-	7.141	Carbon		39.227
Oxygen	9.708	-	Oxygen	50.823	9.565
Aluminum	0.933	-	Sodium	3.103	
Sulfur	12.891	28.686	Aluminum	10.809	1.634
Iron	2.992	8.787	Silicon	18.928	
Arsenic	0.055	-	Sulfur	1.070	9.529
Tantalum	2.370	-	Potassium	1.572	-
Lead	71.051	-	Calcium	0.978	-
Zinc		55.385	Iron	10.774	7.518
			Zinc	1.944	13.458
			Lead	-	19.069
MINERALOGY	Galena, pyrrhotite, anglesite	Sphalerite ferroan, OM (?)		Phengite, pyrrhotite, sphalerite	Galena, sphalerite, OM (?), Sulphate (?)

Figure 6 - SEM images and EDS chemical analyzes on mineral grains of Zn-Pb ore from Marcos Paro illustrating the composition of galena, sphalerite ferroan, pyrrhotite, sulphate minerals (?) and possible presence of carbon organic matter (OM).



	1 (green rectangle)	2 (green rectangle)
Carbon	8.770	6.146
Oxygen	41.994	46.815
Magnesium	0.695	0.815
Aluminum	5.118	6.432
Silicon	7.786	10.714
Sulfur	6.744	0.661
Iron	26.523	26.440
Zinc	2.370	1.976
MINERALOGY	Chorite, pyrrhotite, sphalerite ferroan (?), OM (?)	Chorite, pyrrhotite (?), sphalerite ferroan (?), OM (?)

Figure 7 - SEM images and EDS chemical analyzes on mineral grains of Zn-Pb ore from Marcos Paro illustrating the composition of chlorite, sphalerite ferroan, pyrrhotite, and possible presence of carbon organic matter (OM).



1	1 (Green rectangle)	2	3 (green rectangle)
Carbon	-	5.163	5.261
Oxygen	55.188	38.358	53.434
Sodium	2.227	-	-
Aluminum	13.227	6.121	-
Silicon	20.452	9.383	37.747
Sulfur	0.341	1.270	0.971
Potassium	3.893	-	-
Calcium	0.437	-	-
Iron	4.236	33.053	0.463
Zinc	-	6.652	2.124
MINERALOGY	Phengite, pyrrhotite (?)	Chlorite ferroan, sphalerite, OM	Silica amorphous, OM, sphalerite ferroan

Figure 8 - SEM images and EDS chemical analyzes on mineral grains of Zn-Pb ore from Marcos Paro illustrating the composition of phengite, chlorite ferroan, silica amorphous, sphalerite ferroan and possible presence of carbon organic matter (OM).

CONCLUSIONS

Sample 2478 is an excellent and beautiful example of Zn-Pb ore to ferrous sphalerite and galena, associated with pyrrhotite, a very thin amorphous silica mass with a high content of carbonaceous material (?). Galena and sphalerite can form thick masses, but they are also very common as small grains distributed without distinction in the mass of amorphous silica, chlorite and even phengite, which may contain pyrrhotite. Quartz has been identified mesoscopically in sub centimeter pockets and/or venules

aggregates as remobilizations. This complex mineralogical assembly suggests that Zn-Pb mineralization was initially associated with a sedimentary package rich in carbonaceous and siliceous organic matter, in addition to phosphates, subject to remobilization and concentration by hydrothermal action under very reducing conditions. The data obtained from very rapid and still partly semi-quantitative analysis recommend that advanced and systematic studies be implemented if they are not already in progress or even completed. Unfortunately, in a first scan without much tenacity in the literature no data related to this ore were found.

Acknowledgements

The authors thank geologists Geol. Paulo Afonso Ribeiro Barbosa of Mining Santa Elina and Prof. Dr. Roberto Vizeu for the memory of the UFPA Geosciences Museum, when they donated such a beautiful and significant mineral sample. To CNPQ for the support with productivity scholarship and grant (Proc. 305015/2016-8) and to PNPD-PPGG for granting PDR scholarship to the second author. All analyzes were performed at the LAMIGA IG / UFPA laboratories.


10.31419/ISSN.2594-942X.v62019i2a8MLC