Atmospheric aerosols analysis close to the mining area of Aljustrel (SW Portugal)

Ana Barroso [1,2], Sandra Mogo[2,3,4], Manuela Silva[1,5], Victoria Cachorro[4], Ángel de Frutos[4]

[1]Department of Earth Sciences, University of Coimbra, Coimbra, Portugal.
[2]University of Beira Interior, Covilhã, Portugal.
[3]Institute Dom Luiz (IDL), University of Lisbon, Lisbon, Portugal.
[4]Universidad de Valladolid, Facultad de Ciencias, Fisica Teórica Atómica y Óptica, Valladolid, Spain.
[5]Centre for Earth and Space Research of the University of Coimbra.

Objectives

- Individual characterization of PM_{10} particles;
- Quantification of potentially toxic elements (PTE) in the air close to Aljustrel mine;
- Determination of their possible local sources.

Study location and methodology:

- Aljustrel active mine (SW of Portugal);
- One of the mining centers of Iberian Pyrite Belt (IPB);
- Exploitation of volcanogenic massive sulfides deposits – high risk of contamination;

Fig. 1 – Study area of Aljustrel.

Fig. 2 - identification of the sampling points P1 and P2 (yellow circle) and the mineral processing facility (red line).

- Samples were collected in two periods of 2018:(1) from July 10 to 17 and (2) from November 1to 9.
- Two points of collection were selected at the southeast of the ore processing plant.
- For each measuring point, we used a filter based technique in which particles were continuously deposited onto a filter (polycarbonate or silica), at a controlled flow with a rotameter and a gas meter.

Results:

- PM_{10} mass concentration observed was 20 to 47 μg m^{-3} (July) and 4 to 23 μg m^{-3} (November).
- In SEM-EDX were analyzed 9 samples and identified 2006 particles.
- The particles identified were classified into: organic (34%), mineral (41%), and aggregate (25%) particles.

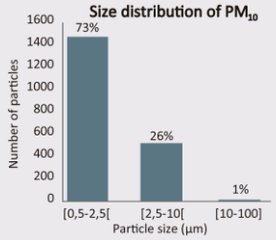


Fig. 3 - Size distribution of all the PM analyzed in SEM-EDX.

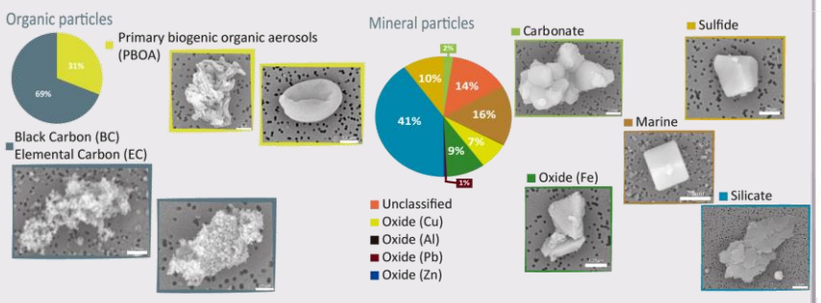
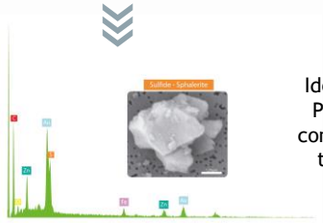


Fig. 4 - Classification of the particles organic and mineral particles identified in SEM-EDX analysis.

Techniques used:

SEM-EDX	ICP-MS	Air trajectory model
• Size • Morphology • Chemical composition	Chemical concentration of Ca, Na, Fe, Mn, As, Cd, Cu, Sb, Pb, and Zn.	Analysis of the air masses trajectories for the sampling period.
	Identification of PTE levels and comparation with the European Directive.	Identification of the possible sources of PM_{10} trough their trajectories and types of particles identified.



- The Principal Component Analysis (PCA) allowed to distinguish two sources: the geogenic elements (CP1), and the elements related to the ore minerals (CP2 to CP5).

Table 1 - Results of principal component analysis of data from chemical composition of PM_{10} analyzed in SEM-EDX.

Variables	PCA1	PCA2	PCA3	PCA4	PCA5
O	**0,833**	-0,066	-0,087	0,174	-0,151
Al	**0,695**	-0,222	-0,240	-0,229	0,070
Si	**0,767**	-0,233	-0,401	-0,122	-0,022
S	0,373	0,327	**0,685**	-0,088	0,154
Mn	0,064	-0,148	0,048	0,394	**0,670**
Fe	**0,546**	0,257	**0,526**	-0,003	0,217
Cu	0,201	0,064	0,234	**0,641**	**-0,613**
Zn	0,071	0,482	0,092	**-0,502**	-0,224
As	0,060	**0,770**	-0,388	-0,005	0,022
Pb	0,067	**0,625**	-0,424	0,359	0,198
Eigenvalue	2,26	1,52	1,37	1,05	1,01
Total variance (%)	22,60	15,22	13,69	10,52	10,14
Cumulative variance (%)	22,60	37,82	51,51	62,03	72,17

n = 1836 of the total particles analyzed in SEM-EDX

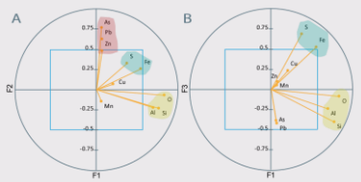


Fig. 5 - Representation of the first (A) and second (B) factorial plans.

- ICP-MS results indicate that daily elemental concentration in the samples collected in July is higher than in November.
- The concentration of some pollutes (As, Cd, and Pb) were compared with their limits in the European legislation and only As exceeds its limit.

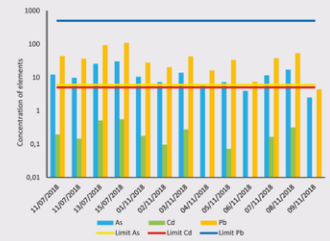


Fig. 6 - Comparison between the detected concentration and the limit value defined European Directive.

Final comments:

- Individual characterization of 2006 particles shows that most of them are smaller than 2.5 μm and based on the chemical composition was possible distinguish the following classes: PBOA, BC/EC, carbonates, sulfides, oxides, silicates, and marine aerosols.
- The PM_{10} mass concentration, for the two periods, is always lower than the limit of 50 μg m^{-3} established in the European Directive (Directive 2008/50/CE of May 21) and only the concentration of As exceeds the limit value defined in the legislation.
- According to the type of particles detected and the air mass trajectory models were identified two probable origins: the natural that is associated with resuspension of particles from the soils and marine intrusions, and the anthropogenic which is related to ore exploration and burning of biomass or fossil fuels.
- Finally, this work shows a strong relationship between PM_{10} analyzed and the ore exploited in Aljustrel, indicating implications in the quality of the air for the resident population. Even if some limits are not exceeded, the continuous exposition over many years is a potential hazard.