Environmental impact of coal handling in the coastal area of Gijon (Northern Spain): A petrographic approach

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Introduction

Organic petrography contributes to the environmental pollution studies through e.g., identification of organic particulates/particles derived from activities related to coal such as coal mining, preparation, transport, blending, management and shipment, storage and utilization (e.g., Suárez-Ruiz et al., 2012).

The importance of solid organic particles (particularly those from coals, its by-products and residues from utilization) in the environment derives from the existing relationships between these particulates and the concentration of the PCBs, PAHs, and PCDD/Fs organic pollutants (Yang et al., 2008). The coal and solid residues of coal utilization (chars and coke particles) also contain some hazardous trace elements (such as Hg, As, V, Se, etc.).

The coastal area of Gijon (Northern Spain) is one example of a polluted area related with coal handling. Gijon city is surrounded (Figure 1) by a coal power plant, a coal park, a cement industry using coal as a fuel, a steel industry with coke plants, and the activities developed at the El Musel, a commercial seaport that manages about 7 million tons of coal and coke per year (Port Authority of Gijon 2018). These industrial activities are among others, the source of carbonaceous dust storms affecting the city and the coast.

Figure 1: Left) Gijon city on the Cantabrian coast and location of samples (red points); Right) Pollution by coal and some coke at San Lorenzo Beach.

Objective, Sampling and Study Methods

The objective was to determine via petrographic analysis the environmental impact of coal handling transport, storage and utilization on the coastal area (San Lorenzo Beach, Cimadevilla, La Calzada and West Gijón as the most polluted parts of Gijon City, Figure 1).

Samples were taken from: the San Lorenzo Beach in April 2018 (samples M14-M18, M23) and the windows and buildings (May-June 2018) in Cimadevilla (samples V1-V3), La Calzada (V4-V6) and West Gijon (V7) neighborhoods.

All the samples were prepared for petrographic analysis following a modified procedure of the ISO 7404/2 (2009). Petrographic analysis were conducted in optical microscopy, reflected white and polarized light (+ 1λ retarder plate), and oil immersion to identify the type of organic particulates in the samples. Point count determinations and vitrinite reflectance measurements were performed following the ISO 7404/3 (2009) and 7404/5 (2009), respectively.

Results

All the samples from San Lorenzo Beach, and the Windows and Buildings contained anthropogenic solid particles made up of different coal ranks, chars and coke (Table 1, Figure 2) in varying amounts. The distribution and percentages of these components in the samples depend on their geographical location and the proximity to the sources of pollution.

Table 1: Petrographic characteristics of the organic anthropogenic fraction from San Lorenzo Beach (samples M) and from Windows and Buildings (samples V)

Samples	Vitrinite Reflectance (%)	Composition (%, vol. mmf.) Coal	Chars	Coke
M14a	0.88	100.0	0.0	0.0
M14b	0.86	100.0	0.0	0.0
M15	1.22	100.0	Traces	0.0
M16	1.23	94.0	6.0	0.0
M17	1.37	90.5	Traces	9.5
M18	1.15	93.4	0.0	6.6
M23	1.22	98.5	Traces	1.5
V1	1.45	78.1	13.1	8.8
V2	1.34	60.9	33.7	5.4
V3	1.17	70.3	22.5	7.2
V4	1.35	51.5	46.5	1.9
V5	1.07	51.8	46.6	1.6
V6	0.61	44.9	51.8	3.3
V7	1.22	64.4	21.8	13.9

San Lorenzo Beach: Coal is the main component of the organic fraction, ranging from 90% to 100%, followed by coke particles (0.0-14%) and chars (from traces to 6.0%). The dominant organic particle size is between 0.5-2.0 mm. However, in some areas of the beach rounded fragments of coals (M14 sample) of higher size are also found (Ø: ~2-4 cm) which is probably linked to a greater influence of tides and waves.

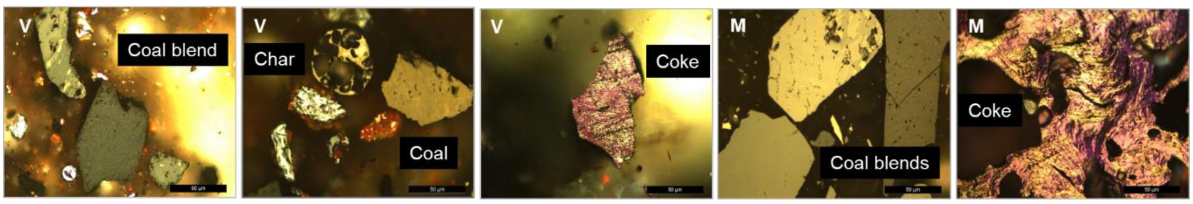

Figure 2: Images of the anthropogenic organic particles in V and M samples. Optical microscopy. Long side of the images: ~200 µm

Windows and Buildings Airborne Particles: The organic fraction ranges from 14.0 to 40.0% being inorganics the predominant component in these samples. In the organic fraction coal is again the main component (45-78%), followed by chars (13-52%) and coke particles (2-14%). The high amounts of chars might be due to the proximity of the cement and the thermal power plants that are burning coal. The highest content in coke particles in some samples seem to be due to the proximity of the steel factory and the coke plants (Figure 1).

With the exception of M14a,b (from the San Lorenzo Beach) that are made up of large fragments of single coals, coal particles in all the samples (M and V) are blends of coals made up of subbituminous A coal, bituminous coals (low, medium and high volatile contents) and anthracite (Figure 3). The predominant coal rank is the bituminous coal. In samples from windows and buildings, anthracite coal rank is also significant.

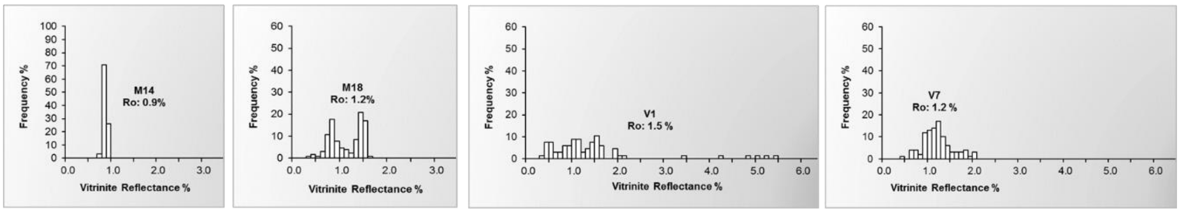

Figure 3: Reflectance distribution for coals in some M (San Lorenzo Beach) and V (Windows and Buildings) samples

Conclusions

All the samples from the sites San Lorenzo Beach and Windows and Buildings, contain an anthropogenic organic fraction (coal, chars and coke) which represents a significant environmental impact. The distribution of these anthropogenic particles in the samples makes possible to track the pollution sources:

1- Windows and Buildings are polluted by airborne particles (Ø: >60 µm) where coal probably comes from the coal handled at the El Musel Seaport, Aboño Coal Park and other parks located at the facilities using coal. The high content in chars seems to be sourced by the cement and the thermal power plants located near to the sampled sites. The contribution of coal heaters that eventually still exist cannot be ruled out. The source of the coke particles could also be from handling coke at the El Musel seaport, although the high coke content in some samples points to the nearby steel factory as the main source.

2- San Lorenzo Beach. This site can also be polluted by organic airborne particles but the great particle size of the samples suggest that the main source of pollution could be the Aboño Coal Park but overall the loading and downloading of coal (and coke) from vessels at the El Musel Seaport. Currents, tides and waves are responsible for periodically dragging the material to the beach (Figure 1 right). This seems to be confirmed by the predominance of coal being the coke in very low percentages and chars almost non-existent. The potential contribution of some coal particles from a shipwreck in the vicinity of the beach 32 years ago cannot be ruled out.

References

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