Atmospheric aerosols are solids or liquids suspended in the atmosphere and are typically much less than 100 µm in size.

Dust, smoke, smog, are common terms we use to refer to atmospheric aerosols.

Toxicological studies are still striving to identify which aerosol component or group of components are most responsible for the effects on human health proven by epidemiological studies.

Metalliferous particles are emerging as one of the groups of PM components most implicated in negative human health effects.
CHARACTERISTICS TO OBSERVE IN PATHOGENIC PARTICLES

- Number / mass
- Size / morphology
- Surface chemistry

Contact surface
Lung location
Bioreactivity with cells & fluids ("oxidative stress")

“Blue asbestos“
CROCIDOLITE (RIEBECKITE)
Asbestiform amphibole
$\text{Na}_2(\text{Fe}_3\text{Al})_2(\text{Fe}_2\text{Mg})_3[\text{Si}_8\text{O}_{22}](\text{OH})_2$
Fibres penetrating lung tissue
DNA oxidative damage caused by metalliferous particulate matter

DNA Plasmid Assay: TD50
The most metalliferous samples (SE and SW/SW) do the most DNA damage.
PM metal hotspots: four examples from Spain

1. Former mining areas e.g. Almadén
2. Heavy industry e.g. Puertollano
3. Recreational e.g. Las Fallas fireworks
4. Modern urban cocktail
Average values

- Almadenejos (Retorting plant)
- Cuevas (Mine waste)
- Almadenejos (Pig sty)
- Parking Univ.
- Parking Super.
- Asparagus
- Pig hair

<table>
<thead>
<tr>
<th>Location</th>
<th>Average Hg µg/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almadenejos</td>
<td>100000</td>
</tr>
<tr>
<td>Cuevas</td>
<td>94769</td>
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<tr>
<td>Almadenejos</td>
<td>5776</td>
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<tr>
<td>Parking Univ.</td>
<td>407</td>
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<tr>
<td>Parking Super.</td>
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<tr>
<td>Asparagus</td>
<td>48</td>
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<tr>
<td>Pig hair</td>
<td>9</td>
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</table>

Note: The diagram compares the average Hg concentrations across different locations.
2. Industrial hotspot PM metal contaminants revealed from source apportionment studies

Puertollano
### SOURCE APPORTIONMENT

<table>
<thead>
<tr>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
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<tbody>
<tr>
<td>PM$_{10}$</td>
<td>PM$_{2.5}$</td>
<td>PM$_{10}$</td>
<td>PM$_{2.5}$</td>
</tr>
<tr>
<td>Ti 0.99</td>
<td>SO$_4^{2-}$ 0.90</td>
<td>Sb 0.93</td>
<td>Cl 0.80</td>
</tr>
<tr>
<td>Rb 0.97</td>
<td>NH$_4^+$ 0.90</td>
<td>Pb 0.89</td>
<td>Na 0.77</td>
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<tr>
<td>Al$_2$O$_3$ 0.97</td>
<td>NO$_2$ 0.80</td>
<td>As 0.70</td>
<td>Mg 0.41</td>
</tr>
<tr>
<td>Mn 0.94</td>
<td>PM$_{10}$ 0.74</td>
<td>Zn 0.62</td>
<td>Co 0.29</td>
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<tr>
<td>Fe 0.93</td>
<td>OM-EC 0.67</td>
<td>Co 0.53</td>
<td>Zn 0.28</td>
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<tr>
<td>Li 0.91</td>
<td>Ni 0.58</td>
<td>Cl 0.41</td>
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<tr>
<td>Sr 0.87</td>
<td>V 0.52</td>
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<tr>
<td>Ca 0.83</td>
<td>K 0.30</td>
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<tr>
<td>K 0.78</td>
<td>Ba 0.29</td>
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<tr>
<td>P 0.77</td>
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<tr>
<td>Ba 0.70</td>
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<tr>
<td>Mg 0.62</td>
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<tr>
<td>PM$_{10}$ 0.63</td>
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</tr>
</tbody>
</table>

### CHEMICAL COMPOSITION OF PUERTOLLANO COALS

- **Normal concentration range in coals (Swaine, 1990)**
- **Puertollano**

![Graph showing chemical composition of Puertollano coals](image-url)
Las Fallas Valencia

3 PM metal contaminants in fireworks

LAS FALLAS 2005

TSP (µg/m³) vs Hour

15/03/05 16/03/05 17/03/05 18/03/05 19/03/05 20/03/05

Firework Displays
4. Urban PM metal contaminants

Canary Islands

Las Palmas

Barcelona

Llodio

Tarragona

Huelva

Alcobendas

Altitude (masl) | Latitude | Longitude
---|---|---
667 | 40° 32' 42"N | 03° 37' 39"W
24 | 41° 25' 30"N | 02° 11' 47"E
20 | 28° 08' 04"N | 15° 24' 49"W
10 | 37° 15' 21"N | 05° 56' 24"W
122 | 43° 08' 42"N | 02° 57' 44"W
20 | 41° 07' 29"N | 01° 14' 52"E
London, December 1952
4000 deaths in 4 days
50 years later.....

“Inhalation of atmospheric PM reduces European human life span by 8.6 months”
WHO 2000
Range of average PM$_{10}$ levels in urban Spain ($\mu$g/m$^3$)

- AQG
- AQG + c.3%
- AQG + c.9%
- AQG + c.15%

Spain (urban-traffic sites)  Italy (urban-traffic sites)  Germany (urban-traffic sites)