Data Article

Dataset of Polycyclic aromatic hydrocarbons and trace elements in PM2.5 and PM10 atmospheric particles from two locations in North-Western Greece

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\section*{Abstract}
This work presents information regarding PM10, PM2.5, Polycyclic Aromatic Hydrocarbons (PAHs), and trace elements that were obtained from two sampling stations, located in the region of Western Macedonia (North-Western Greece), over the course of a 12-month period. The first sampling station was located near the village of Pontokomi (Station 1) and the second (Station 2) in the rural area of Petrana (Fig 1). Specifically, for each location, daily particulate samples PM10 (total 58 samples) and PM2.5 (total 64 samples) were collected. Moreover, and again for each location, 50 samples (22 PM10 and 28 PM2.5) were further analyzed for the determination of 15 (PAHs) and 72 samples (36 PM10 and 36 PM2.5) were further analyzed for the determination of a total of 17 trace elements. Thus, a total of approximately 10 samples per month was obtained from each sampling station (122 samples per sampling station over the course of 12 months). The samples were collected using two low volume samplers, LVS 3.1 and PNS16T-3.1 (Comde-Derenda GmbH). Trace elements were trapped using 47 mm glass fiber filters and were re-

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covered using microwave extraction; for their determination, the graphite furnace atomic absorption spectrometry (GFAAS) technique was utilized. The PAHs were trapped with 47 mm quartz fiber filters and were analyzed using dichloromethane extraction followed by gas chromatography–mass spectrometry.

This region of Western Macedonia has historically been the center of electricity production in Greece. Lignite is mined in open-cast mines and used as feed in a number of thermal power plants. At its peak, which was in the 1990’s, the areas produced close to 70% of electricity in Greece. Since then, electricity production (and related activities) are in decline as, due to Greece’s EU commitments, the region has entered a transition, post-lignite process.

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**Specifications Table**

| Subject | Environmental science |
|---------|------------------------|
| Specific subject area | Environmental chemistry, Air pollution, Air monitoring and quality |
| Type of data | Table Figure |
| How the data were acquired | Low volume (2.3 m³ h⁻¹) LVS 3.1 and PNS15T-3.1 from Comde-Derenda GmbH, Agilent 7890A Gas Chromatograph and Agilent 5975C Mass Spectrometer, DB5-MS (30 m × 0.25 mm × 0.25 μm) column and an Agilent 7683B Automatic Liquid Sampler. ZEEnit 700 – Analytic Jena GmbH combined with Zeeman graphite furnace atomizer |
| Data format | Raw Analysed |
| Description of data collection | The sampling of suspended particulate matter in both stations was carried out at a height of 4m from the ground and according to EN12341 standard gravimetric measurement method for the determination of the PM10 and PM2.5 mass concentration. The dataset was collected from October 2017 to November 2018. |
| Data source location | City/Town/Region: West Macedonia Country: Greece Latitude and longitude for collected samples/data: 40.406530° and 21.768110°; Station 1, 40.290150° and 21.863800°; Station 2. |
| Data accessibility | Mendeley Data 10.17632/97yn9np7fx.1 https://data.mendeley.com/datasets/97yn9np7fx/1 [1]. |

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**Value of the Data**

- Exposure to particulate pollution and especially to fine and ultrafine particles, is one of the greatest environmental risk to human health [1,2].
- Specific, PM-bound PAHs and heavy metals effect human health so this data can provide useful information for future epidemiological studies.
- The data could be used in assessing the degree of risks associated with heavy metals and PAHs exposure.
- The data provided can be a useful addition to the existing literature, as it can be used for the estimation of the sources of heavy metal and trace element pollution.
- The European Union has established ambient air quality standards for certain toxic elements, such as lead, cadmium, arsenic, nickel, and mercury. For these reasons the chemical composition of PM is a subject of great scientific interest, especially in an area with intensive lignite
burning for power generation. The data provides information about adsorbed PAHs to inhalable particles (PM$_{10}$ and PM$_{2.5}$ fractions) in an industrial area where electricity is produced from lignite.

1. Data Description

The dataset has been published online in the Mendeley data repository [1]. The data presented were collected from two locations in Western Macedonia located in North-Western Greece. The first location was near the village Pontokomi (Station 1) and the second in a rural area of Petrana (Station 2), for a period of one year (December 2017 to November 2018). The location of the stations is shown in Fig. 1.

The concentrations of 17 trace elements (Al, Mn, Fe, Ni, Cu, Zn, Sn, Pb, Si, Mg, Cr, As, Na, K, Ca, Sr, Cd) of 72 samples from each location (36 PM$_{10}$ and 36 PM$_{2.5}$) were determined.

Moreover, 50 samples from each location (22 PM$_{10}$ and 28 PM$_{2.5}$) were analyzed for PAHs. The PAHs concentrations determined were: Acenaphthene (Ace), Fluoranthene (Fl),
Naphthalene (Np), Benzo(a)anthracene (B[a]An), Benzo(a)pyrene (B[a]Py), Benzo(b)fluoranthene (B[b]Fl), Benzo(k)fluoranthene (B[k]Fl), Chrysene (Chry), Acenaphthylene (Acy), Anthracene (An), Benzo(ghi)perylen (B[ghi]Pe), Fluorene (F), Phenanthrene (Ph), Dibenzo(a,h)anthracene (D[ah]An), Indeno(1,2,3-cd)pyrene (IpPy), Pyrene (Py) and benzo[e]pyrene (B[e]Py).

The average values for the sampling days concerning temperature (Temp), Relative Humidity (RH), wind speed (WS) and wind direction (WD) are also provided.

The mean values and standard deviation for the two sampling locations concerning the 17 trace elements that were found PM10 and PM2.5-bound are shown in Table 1. These values are in good agreement with previous studies carried out in the area.

Table 2 presents mean concentrations with standard deviation for fifteen particle-bound PAHs that were detected and quantified. These values are in good agreement with previous studies carried out in the area [2].

Table 1
Mean concentrations and Standard Deviation (SD) of trace elements bound in PM10 and PM2.5 particles in different sampling stations (ng m⁻³).

|   | Station 1 |        | Station 2 |        |
|---|-----------|--------|-----------|--------|
|   | PM10      | PM2.5  | PM10      | PM2.5  |
| Al| 383±348   | 71±65  | 95±92     | 28±37  |
| Mn| 9±5       | 4±2    | 4±2       | 2±1    |
| Fe| 311±281   | 61±38  | 101±63    | 26±14  |
| Ni| 7±6       | 3±2    | 4±2       | 2±1    |
| Cu| 22±13     | 19±13  | 21±12     | 9±5    |
| Zn| 22±8      | 16±7   | 19±7      | 9±4    |
| Sn| 132±91    | 129±89 | 96±56     | 54±36  |
| Pb| 12±28     | 6±5    | 5±3       | 3±2    |
| Si| 1473±1371 | 274±241| 438±400   | 109±125|
| Mg| 381±431   | 59±50  | 107±84    | 22±19  |
| Cr| 7±3       | 5±2    | 4±1       | 2±1    |
| As| 40±24     | 38±21  | 24±13     | 16±8   |
| Na| 105±50    | 97±51  | 157±73    | 79±32  |
| K | 74±59     | 24±12  | 33±19     | 18±10  |
| Ca| 2149±2117 | 269±230| 827±573   | 130±123|
| Sr| 102±572   | 5±3    | 4±2       | 2±1    |
| Cd| 41±26     | 40±26  | 30±14     | 20±12  |

Table 2
Mean and SD of concentrations (in pg m⁻³) for particulate PAHs in Petrana and Pontokomi bound in PM10 and PM2.5 samples.

| PAHs/location | Petrana |         | Pontokomi |         |
|---------------|---------|---------|-----------|---------|
|               | PM2.5   | PM10    | PM2.5     | PM10    |
| Ace           | 95±140  | 94±72   | 93±192    | 74±70   |
| F             | 46±23   | 78±33   | 43±19     | 57±29   |
| Ph            | 117±58  | 255±209 | 133±101   | 247±215 |
| An            | 22±23   | 49±87   | 39±63     | 41±66   |
| Fl            | 165±143 | 401±587 | 180±202   | 551±780 |
| Py            | 192±141 | 404±409 | 202±158   | 505±590 |
| Chry          | 134±198 | 290±388 | 105±103   | 266±324 |
| B[a]An        | 221±291 | 487±621 | 205±192   | 495±589 |
| B[k]Fl        | 335±365 | 562±473 | 275±275   | 443±520 |
| B[b]Fl        | 453±484 | 667±576 | 362±387   | 611±650 |
| B[e]Py        | 335±235 | 578±592 | 363±273   | 400±386 |
| B[a]Py        | 251±262 | 548±500 | 216±195   | 363±377 |
| IpPy          | 201±171 | 418±324 | 154±145   | 251±243 |
| dB[a,h]An     | 59±120  | 179±226 | 51±105    | 63±92   |
| B[ghi]Pe      | 364±327 | 709±468 | 237±197   | 339±308 |
| ΣPAH          | 2931±2454 | 5715±4349 | 2558±1942 | 4617±4562 |
Table 3  
Molecular diagnostic ratios of PAH concentrations of PM$_{2.5}$ and PM$_{10}$ particles.

| Ratios/location | Petrana PM$_{2.5}$ | Petrana PM$_{10}$ | Pontokomi PM$_{2.5}$ | Pontokomi PM$_{10}$ |
|-----------------|--------------------|--------------------|----------------------|--------------------|
| BF$_{5}$/[ghi]Pe | 5.80               | 1.67               | 2.67                 | 2.55               |
| Ipy/(Ipy+[ghi]Pe) | 0.36               | 0.35               | 0.37                 | 0.36               |
| B[a]An/[B[a]An+Chry] | 0.65               | 0.63               | 0.66                 | 0.67               |
| Fl/[Fl+Py] | 0.45               | 0.44               | 0.44                 | 0.48               |
| B[e]Py/[a]Py | 1.95               | 1.92               | 5.17                 | 1.71               |
| CPAH/ΣPAH | 0.92               | 0.89               | 0.97                 | 0.99               |

Diagnostic ratios for PAHs, such as BF$_{5}$/[ghi]Pe (BF$_{5}$: B[bf]Fl + B[k]Fl), Fl/[Fl+Py], Ipy/[B[ghi]Pe+Ipy], B[a]An/[B[a]An+Chry), B[e]Py/[a]Py and CPAH/ΣPAH (CPAH: Fl + Py + B[a]An + Chry + B[e]Py + BF$_{5}$ + B[a]Py + B[ghi]Py + Ipy; ΣPAH: Total PAH concentration) are presented at Table 3. The PAH ratios have been used as confirmation indicators of the source that emits the pollution into the urban atmosphere in many studies [3,7].

2. Experimental Design, Materials and Methods

2.1. Particulate Sampling

Sampling was carried out for a period of one year (December 2017 to November 2018) for 24 h ambient sampling. The daily particulate samples were carried out in two locations in North-Western Greece. They were collected in the industrial area of the open-cast mines near the village of Pontokomi (Station 1) and of the rural area of the village of Petrana (Station 2). The samples were collected using two low volume samplers, LVS 3.1 and PNS16T-3.1 (Comde-Derenda GmbH) with 47 mm glass fiber filters and quartz fiber filters (for metals and PAHs analysis respectively), obtained from Whatman (Whatman International Ltd.). The sampling was carried out according to the EN12341 standard gravimetric measurement method for the determination of the PM10 and PM2.5 mass concentration.

Field blank samples were prepared, stored, extracted and analyzed using the same procedure as that used for the field samples. The precision of the method was calculated using the relative standard deviation (RSD) for the measurement of filter blanks spiked with known amounts of reference standard for metals and PAHs analysis. It was found that the RSD values were very satisfactory as they ranged between 2.1-4.6%. Calibration curves were acceptable when correlation coefficients were greater than 0.99. Quality Control (QC) standards were analyzed before each sample run, after each group of 10 analyses, and at the end of each set of analysis.

2.2. Trace metal Analysis

Analytical determinations of 17 trace elements (Al, Mn, Fe, Ni, Cu, Zn, Sn, Pb, Si, Mg, Cr, As, Na, K, Ca, Sr, Cd) were performed using the microwave extraction procedure (using an extraction solution of 5.55 % HNO$_3$, 16.75 % HCl) followed by quantitative analysis of graphite furnace atomic absorption spectrometry technique, using a ZEEnit 700 – Analytic Jena GmbH combined with Zeeman graphite furnace atomizer [2].

For calculation of the calibration curve, the stock standard solution of the target element (Merck) was used with various concentrations.

The limit of detection (LOD) values was calculated as three (3) times the standard deviation, and the limit of quantitation (LOQ) values was calculated as ten (10) times the standard deviation of results obtained from the analysis of 10 ppb stock standard solutions. The LOD values
(μg L⁻¹) were Al(21.0), Mn(0.4), Fe(8), Ni(1.3), Cu(1.2), Zn(0.6), Sn(20.0), Pb(0.2), Si(5.0), Mg(0.2), Ti(40.0), V(50.0), Cr(0.1), As(20.0), Na(0.3), K(0.6), Ca(0.5), Sr(1.3), Cd(1.3).

2.3. PAHs Analysis

Solution of Acenaphthene-d10, Chrysene-d12, 1,4-Dichlorobenzene-d4, Naphthalene-d8, Pyrene-d12 was added to all samples as an internal standard and was obtained from Chiron (Chiron AS).

PAHs were recovered using dichloromethane extraction. It is noted that the recovery rates for the 17 PAHs ranged from 76% to 105%. Their determination was carried out via gas chromatography–mass spectrometry (GC–MS) using an Agilent 7890A gas chromatograph (GC) and an Agilent 5975C Mass Spectrometer (MS). The GC was equipped with an DB5-MS column (30 m × 0.25 mm × 0.25 μm) and an Agilent 7683B Automatic Liquid Sampler. During measurements of PAHs the MS was operated in the electron impact (EI) mode at 70 eV. For all compound groups, the MS was operated in selected ion monitoring mode (SIM) with two ions monitored for each compound. The setting of the GC/MS instrumental parameters followed closely those reported in refs. [4,5]. To determine PAHs, 1 μL of each sample was injected into the GC inlet in the splitless mode.

The NIST Standard Reference Material 1647c containing 16 PAHs was used to identify the following compounds: Acenaphthene (Ace), Fluoranthene (Fl), Naphthalene (Np), Benzo(a)anthracene (B[a]An), Benzo(a)pyrene (B[a]Py), Benzo(b)fluoranthene (B[b]Fl), Benzo(k)fluoranthene (B[k]Fl), Chrysene (Chry), Acenaphthylene (Acy), Anthracene (An), Benzo(ghi)perylen (B[ghi]Pe), Fluorene (F), Phenanthrene (Ph), Dibenzo(a,h)anthracene (D[ah]An), Indeno(1,2,3-cd)pyrene (IPy), Pyrene (Py), plus benzo[e]pyrene B[e]Py.

It is noted that Nap, Acy were not detected during analysis. This may be due to their high volatility, which means that these compounds can be easily lost during their storage, transportation, or recovery process.

Ethics Statements

The raw data of this study is provided in full compliance with ethical requirements for publication in the Data in Brief journal. This study does not involve any human or animal subjects.

CRediT Author Statement

Vasilios Evagelopoulos: Supervision, Data curation, Visualization, Methodology, Writing - Original draft preparation; Nikolaos Charisiou: Investigation, Writing - Review & Editing; Stamatis Zoras: Conceptualization, Validation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Dataset of Polycyclic aromatic hydrocarbons and trace elements in PM2.5 and PM10 atmospheric particles from two locations in North-Western Greece (Original data) (Mendeley Data).
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