

Composition and origin of particulate matter In The Antarctic Region



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AntartidaCA3

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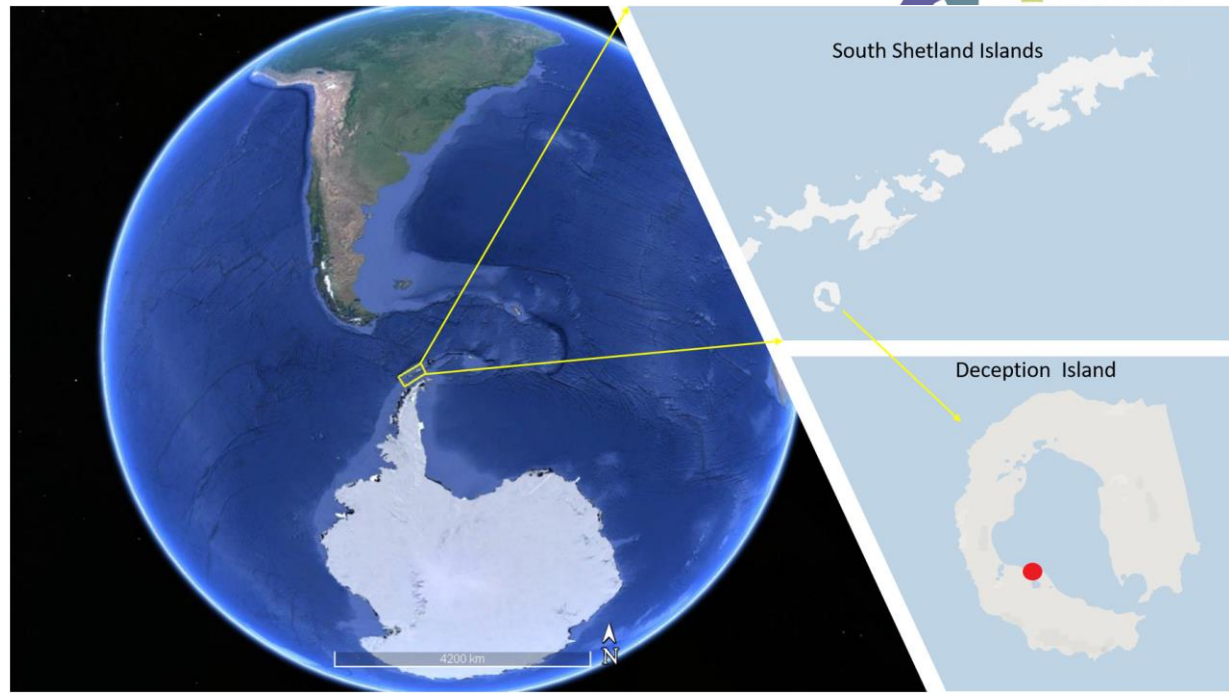
1. Introduction

- **Aerosols** are **suspended particulate matter** ($PM_{2.5}$ or PM_{10}) and act as **climate drivers**.
- **Antarctica's environment and ecosystem** can negatively be affected by PM, although its isolation.
- The study of atmospheric aerosols in the Antarctic region is important to understand their **impact** on the icy continent.
- It is essential to **identify** them and **determine** both the **natural** (sea salt, mineral dust, biogenic emissions, volcanoes, etc.) and the **anthropogenic sources** (fossil fuel combustion, mining, smelting, construction, agriculture, etc.) of Antarctic aerosols.

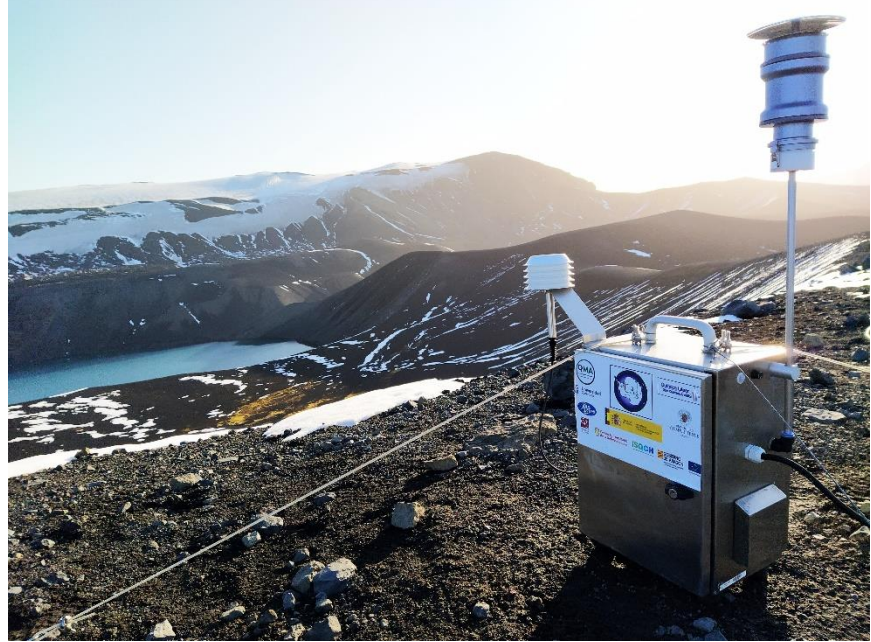


2. Methodology

- Aerosol and soil samples were collected on **Deception Island** (Spanish Research base “Gabriel de Castilla”, South Shetland Islands, Antarctic region) in the 2016/2017 antarctic campaign.
- Atmospheric PM was collected through a **low volumen sampler** in circular quartz microfiber filter papers.
- Soil samples were analysed by **LIBS** (laser induced breakdown spectroscopy). PM in filters was chemically analysed using Inductively Coupled Plasma-Mass Spectrometry (**ICP-MS**) and Inductively Coupled Plasma-Atomic Emission Spectroscopy (**ICP-AES**).
- Air mass backward **trajectories** and polar contour **maps** were implemented to better understand the potential local and remote sources of PM.



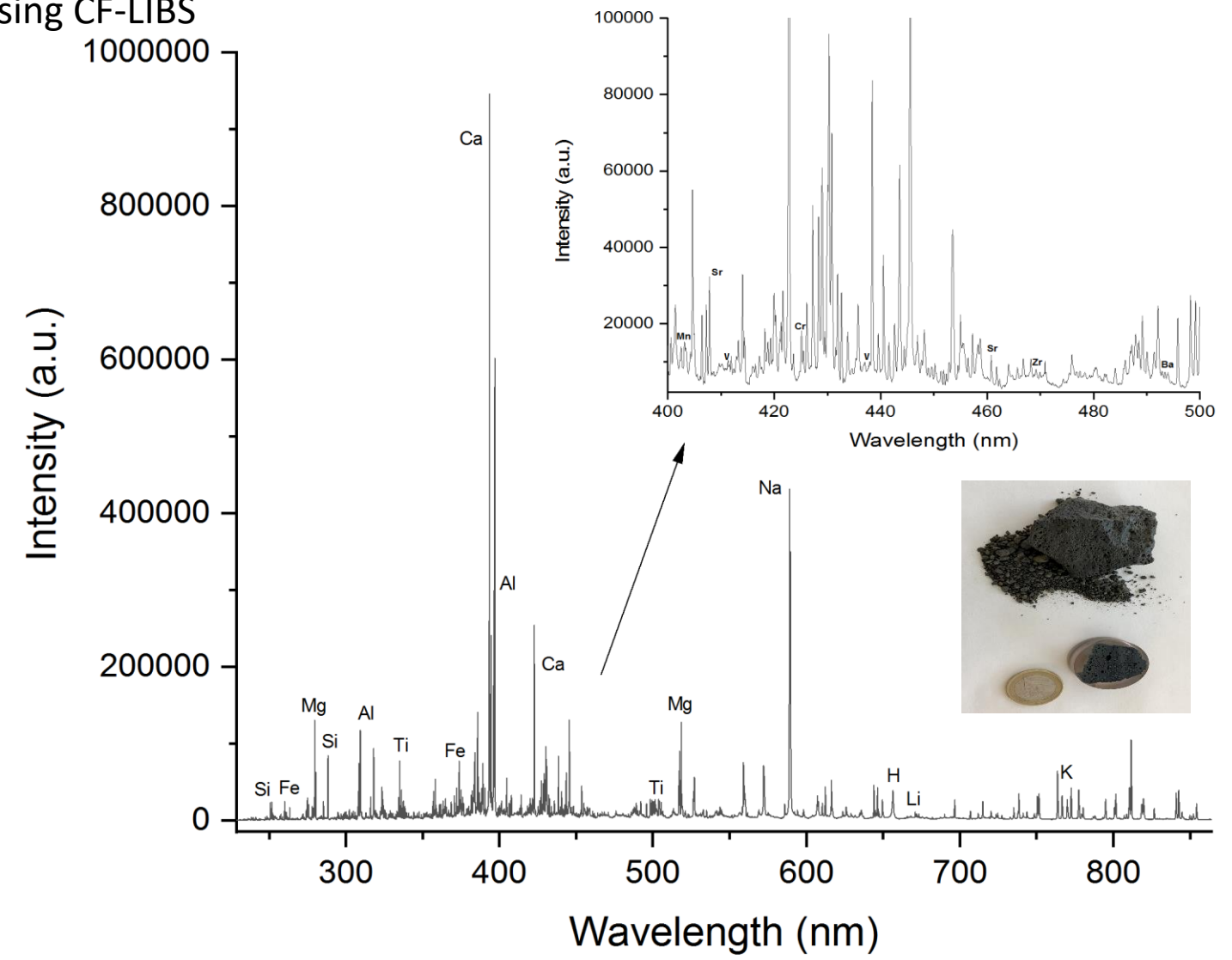
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3. Results

3.1 Soil samples: Multielemental analysis using CF-LIBS

- **6 soil samples** from different parts of Deception Island were analysed
- **720** measurements per sample
- Delay Time = 1900 ns, Gate Width = 3650 ns, Energy = 45 mJ



3. Results

3.1 Soil samples: Multielemental analysis using CF-LIBS

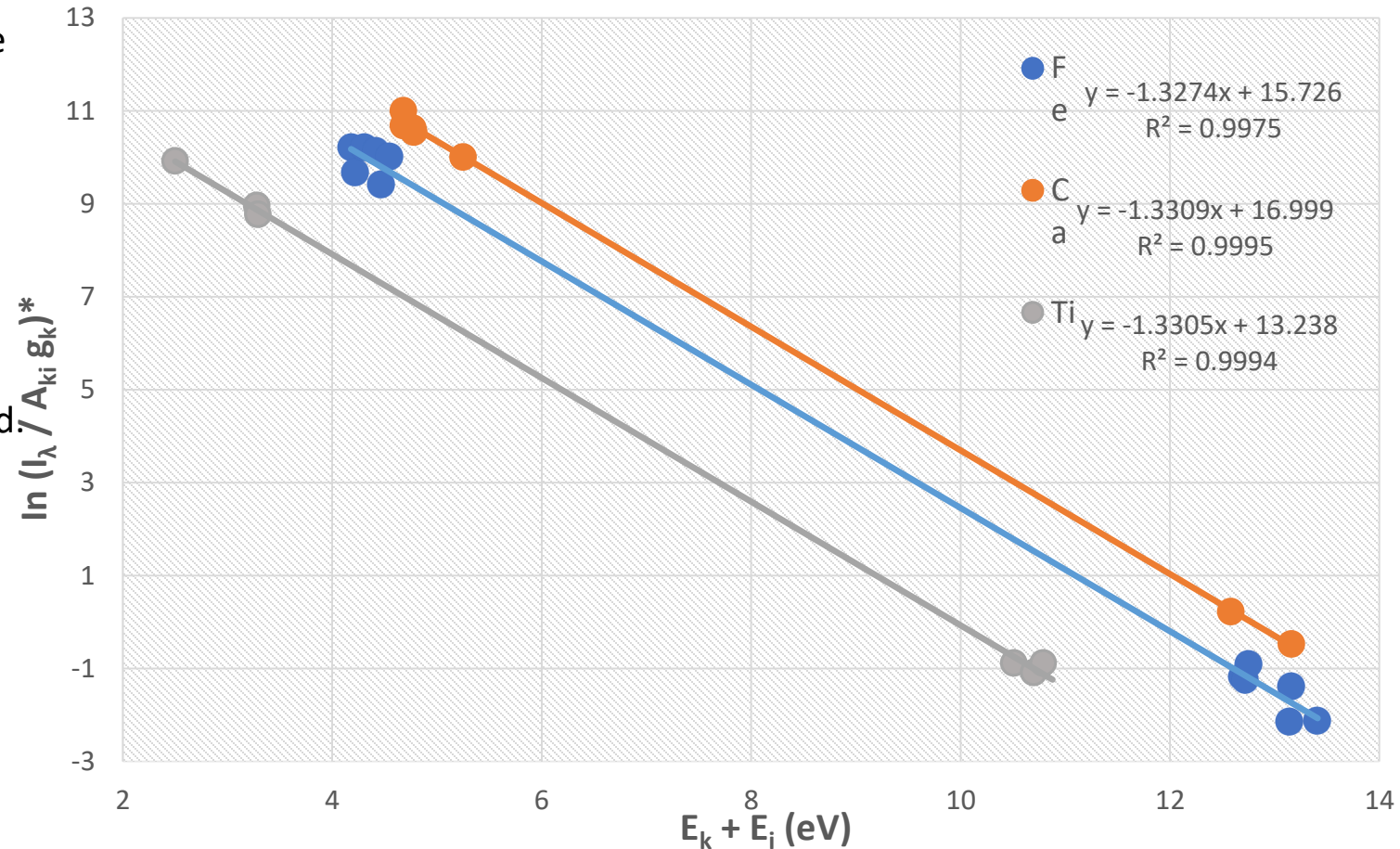
- No need of calibration standards. Estimation of T_e and N_e to determine composition.
- N_e was obtained from the hydrogen line.
- T_e was estimated using the Saha-Boltzman plot.
- Relative abundance of each element was obtained.
- **LTE** verification using Mc Whirther Criterium:

$$N_e \text{ (cm}^{-3}\text{)} \geq 1.6 \times 10^{12} T_e^{1/2} (\Delta E)^3$$

Mean of the 6 samples:

$T_e = 9024 \pm 54 \text{ K}$

$N_e = 8.3 \pm 0.1 \times 10^{16} \text{ cm}^{-3}$



3. Results

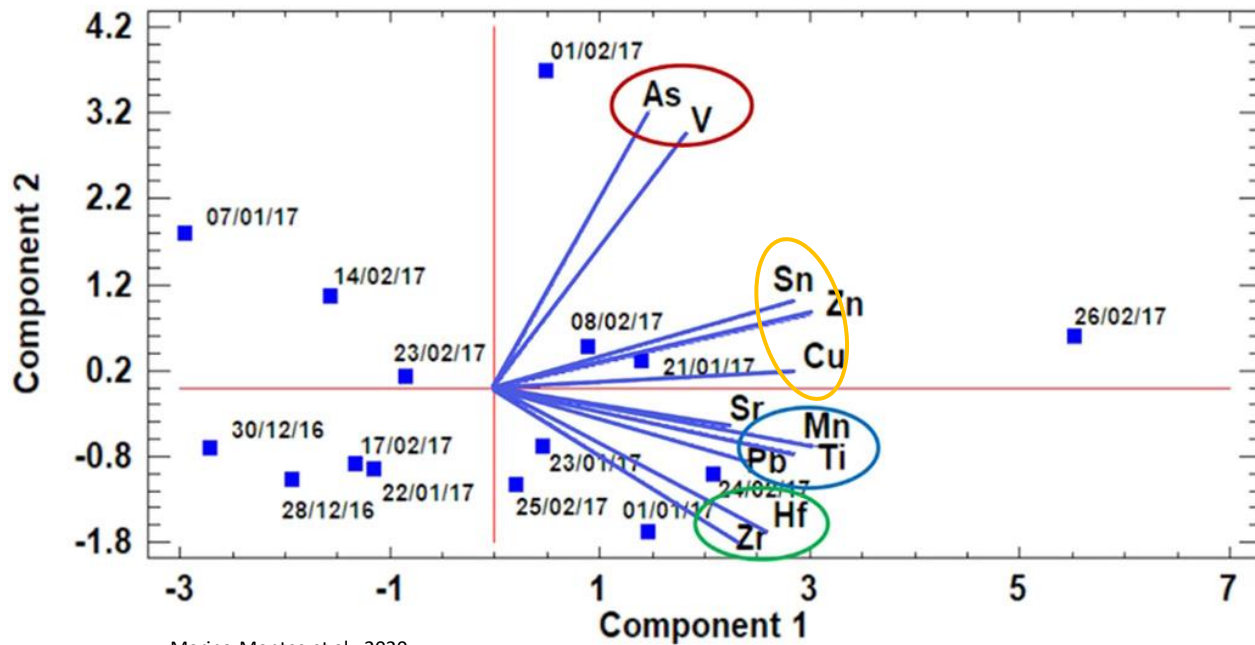
3.1 Soil samples: Multielemental analysis using CF-LIBS

Oxides (%), elements (ppm)	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
SiO ₂	46.25 ± 5.01	52.66 ± 5.13	54.86 ± 1.16	50.38 ± 1.92	51.29 ± 2.76	49.26 ± 2.68
Al ₂ O ₃	19.09 ± 1.69	18.19 ± 1.80	17.19 ± 0.81	19.38 ± 0.61	18.90 ± 1.97	20.86 ± 1.35
Fe ₂ O ₃	11.77 ± 1.41	9.93 ± 1.44	8.98 ± 0.21	9.74 ± 0.28	9.81 ± 0.68	10.92 ± 0.63
CaO	9.03 ± 1.28	7.74 ± 1.24	7.28 ± 0.49	8.09 ± 0.99	8.16 ± 0.77	6.97 ± 0.89
MgO	5.83 ± 1.89	4.99 ± 1.21	4.49 ± 0.47	4.90 ± 0.22	4.14 ± 0.32	4.34 ± 0.62
Na ₂ O	3.83 ± 0.60	3.04 ± 0.35	3.45 ± 0.14	3.37 ± 0.37	3.97 ± 0.33	3.21 ± 0.38
TiO ₂	3.25 ± 0.34	2.58 ± 0.39	3.09 ± 0.16	3.44 ± 0.39	3.05 ± 0.31	3.64 ± 0.42
K ₂ O	0.96 ± 0.15	0.87 ± 0.35	0.67 ± 0.03	0.71 ± 0.07	0.68 ± 0.10	0.80 ± 0.10
Mn	5203 ± 1689	2937 ± 926	3589 ± 889	3663 ± 1139	1303 ± 495	2697 ± 580
V	921 ± 351	1202 ± 419	1324 ± 665	556 ± 313	598 ± 177	1277 ± 328
Sr	526 ± 232	259 ± 56	308 ± 61	291 ± 42	329 ± 21	248 ± 65
Zr	177 ± 139	221 ± 62	191 ± 78	164 ± 69	221 ± 116	220 ± 89
Ba	75 ± 38	44 ± 9	40 ± 11	39 ± 9	44 ± 15	57 ± 14
Li	18 ± 5	8 ± 1	10 ± 1	9 ± 1	8 ± 1	11 ± 1

3. Results

3.2 Filter samples: Principal Component Analysis

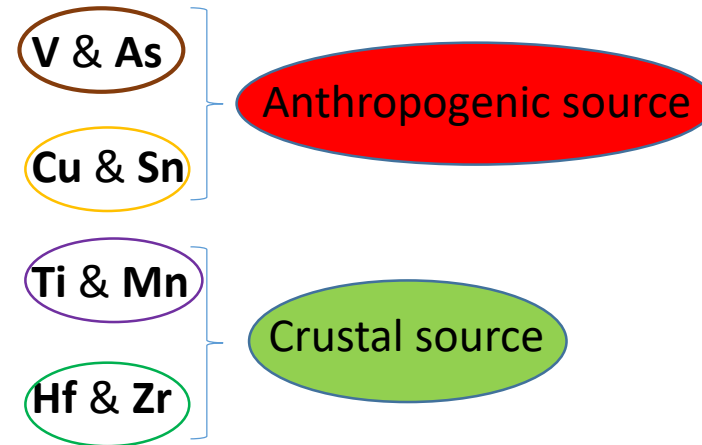
Principal Component Analysis (PCA)



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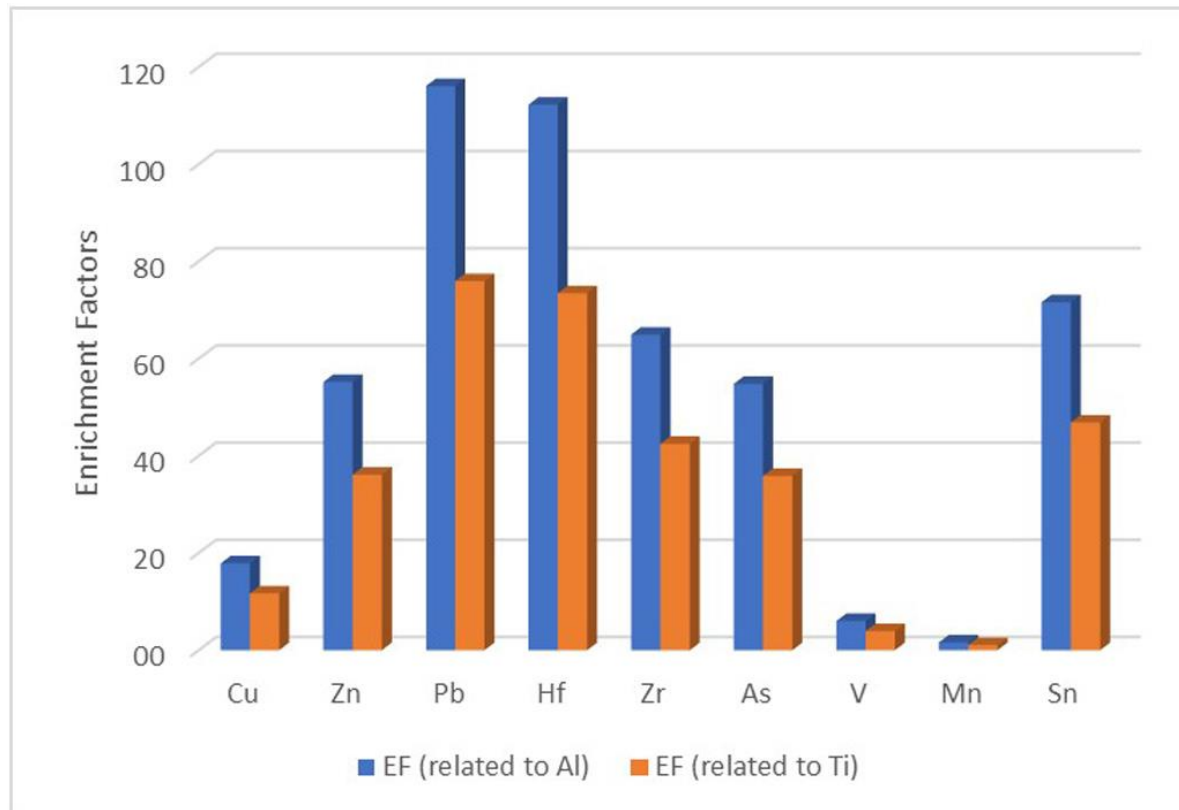
High vector relationship implies a similar source

High significant correlations were found between:



3.2 Enrichment factor

Enrichment factor (EF)



Calculated EF values **below 5** are explained as having a **crustal origin**, whereas values **higher than 10** correspond to **Supplementary sources**.

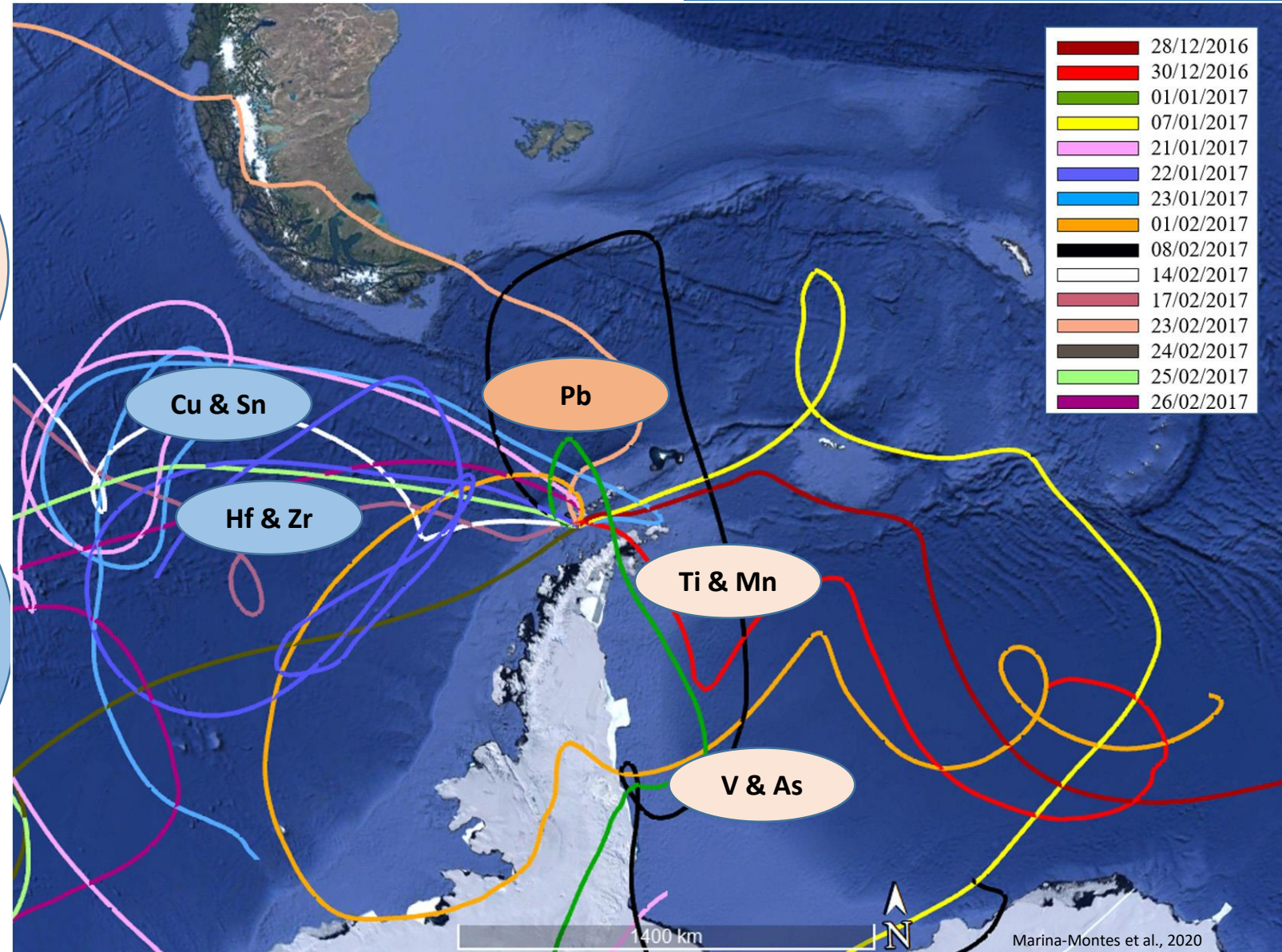
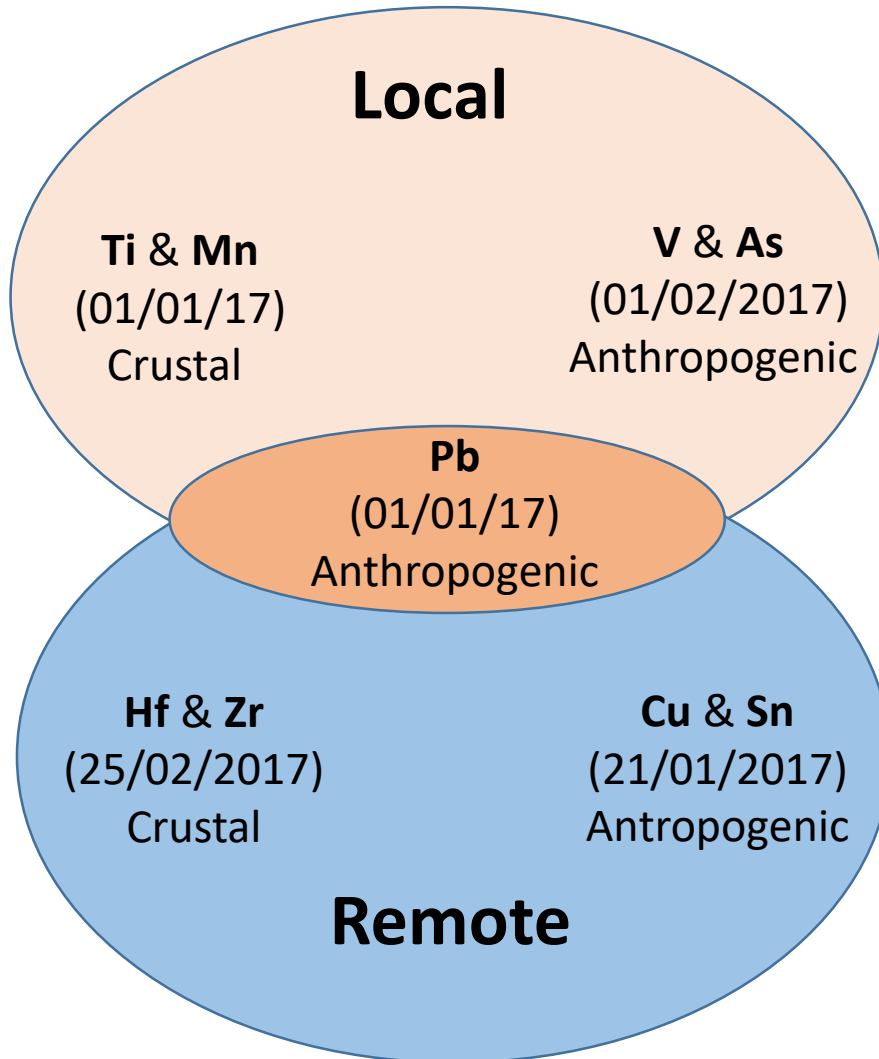
Mn Local crustal source

Remote crustal source

Remaining elements

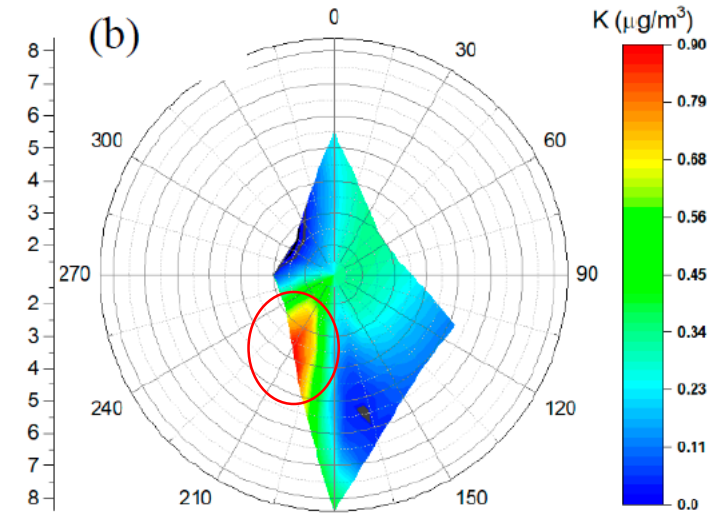
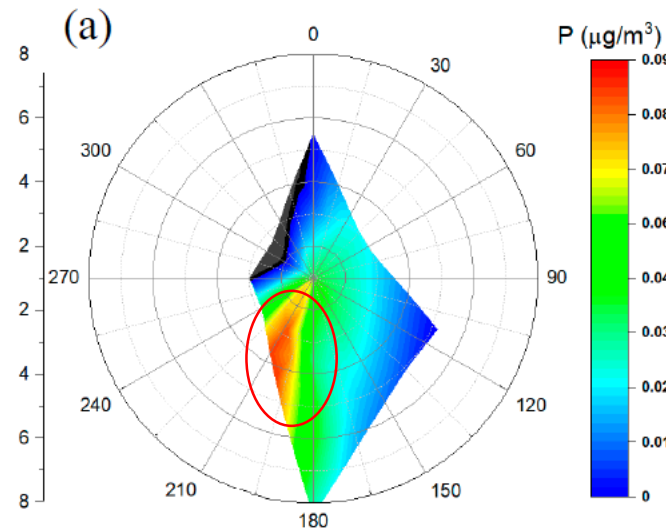
Anthropogenic source

3.3 Air mass backward trajectories

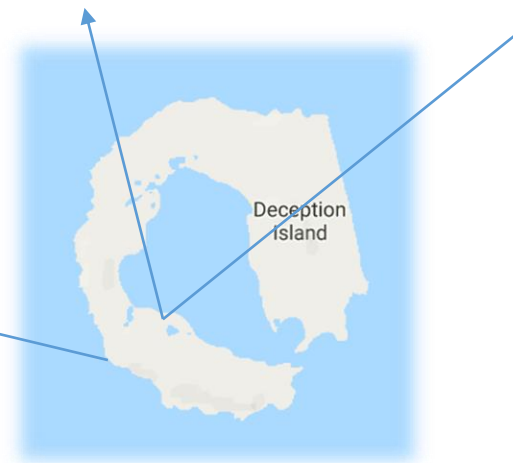


3.4 Polar contour maps

P & K: Natural Source (Guano from Pinguin Colony)



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Punta de la Descubierta pinguin colony (Deception Island)

4. Conclusions

Potential Sources

Anthropogenic

- **V & As:** combustion of fossil fuels, produced mainly from the Gabriel de Castilla base, adjacent research station and tourist cruises.
- **Cu & Sn:** the highest Cu and Sn concentrations correspond with pathways crossing South America and Drake's passage (high maritime traffic zones).
- **Pb:** anthropogenic pollution from local (combustion of fossil fuels on the base/adjacent research station and/or local tourist cruises) and remote sources (transport from the upper atmosphere from remote places, such as Patagonia).

Natural

- **Ti & Mn:** resuspension of local soils.
- **Hf & Zr:** resuspension of remote soils.
- **P & K:** excrement (guano) in Punta de la Descubierta penguin colony (Deception Island).

Most air masses were transported following the Antarctic Circumpolar Pattern



Thanks for listening! Any questions?



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