



HAL
open science

ABATI - Airbone pollution by vegetation and tree samples bio-sensor In two constricted OHMi with different human activities

Jean-Philippe Bedell, Méлина Macouin, Helena Sant'ovaia Mendes Da Silva, Mustapha B. Sagna, Priscilla Duboz, Nuno Durães, Eduardo Ferreira da Silva, Yann Philippe Tastevin

► To cite this version:

Jean-Philippe Bedell, Méлина Macouin, Helena Sant'ovaia Mendes Da Silva, Mustapha B. Sagna, Priscilla Duboz, et al.. ABATI - Airbone pollution by vegetation and tree samples bio-sensor In two constricted OHMi with different human activities. International Symposium of LabEx DRIIHM 2023, Jun 2023, Strasbourg, France. , 2023, 10.34972/driihm-22249c . hal-04171147

HAL Id: hal-04171147

<https://hal.science/hal-04171147v1>

Submitted on 26 Jul 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

ABATI - Airborne pollution by vegetation and tree samples bio-sensor in two constricted OHMi/human activities



Projet inter-OHM: Estarreja et Téssekéré



Jean-Philippe Bedell^{1*}, Mélina Macouin², Helena Sant'Ovaia Mendes da Silva³,
Mustapha B. Sagna⁴, Priscilla Duboz⁵, Nuno Durães⁶, Eduardo Ferreira da Silva⁶, Yann Philippe Tastevin⁵

¹ OHMi Estarreja, Univ Lyon, Université Claude Bernard Lyon 1, CNRS, ENTPE, UMR 5023 LEHNA, F-69518 Vaulx-en-Velin, France; ² Géosciences Environnement Toulouse, CNES, CNRS, IRD, Université Toulouse 3, 14 avenue Edouard Belin 31400 Toulouse, France; ³ Departamento de Geociências, Ambiente e Ordenamento do Território (DGAOT), Faculdade de Ciências da Universidade do Porto, Porto, Portugal; ⁴ Université Cheikh Anta Diop de Dakar, Faculté des Sciences et Techniques, Dakar, Sénégal; ⁵ OHMi Téssekéré, IRL CNRS, 3189 ESS, UCAD, Faculté de Médecine, BP 5005 Dakar, Sénégal; ⁶ OHMi Estarreja, Université Aveiro, Departamento de Geociências, Aveiro, Portugal

Background

- Air pollution is a major health problem through exposure to ambient (outdoor) air pollution and airborne particles (PM).
- Airborne contaminants can have natural (wind-blown mineral dust) and anthropogenic (road traffic, industrial activities, domestic cooking and heating origins (Hoffmann et al., 1999; Petrovsky & Ellwood, 1999; Knab et al., 2001; Jordanova et al., 2010).
- Vegetation acts as a natural collector of these particles, called a biocollector (Verosub & Roberts, 1995).
- Leaves and tree bark are effective passive pollution collectors, as they provide a large surface area for trapping particles.
- Biomonitoring via the magnetic properties of tree leaves has been suggested by several authors as a good approach to measure pollution levels in cities with good spatial and temporal coverage (e.g. Matzka and Maher, 1999; Mitchell et al., 2010; Jordanova et al., 2010; Kardel et al., 2011).
- Magnetic methods have the advantage of being fast, easy to implement, inexpensive and non-destructive, allowing the processing of many samples, facilitating the spatialisation of contamination. This makes them a promising complementary technique to specialised monitoring stations.
- Magnetic properties include magnetic susceptibility and isothermal saturation magnetisation.
- The use of vegetation as a monitor of air pollution also has the advantage of proposing participatory science schemes (NanoEnvi-Toulouse project, AirGeo-Belmont Forum) based on the human-nature relationship, thus limiting possible "eco-anxiety" effects and enhancing the effect of vegetation (Great Green Wall type programme).

The two main objectives of the project are:

1- to develop a methodology using plants as collectors to spatialise and monitor airborne particles

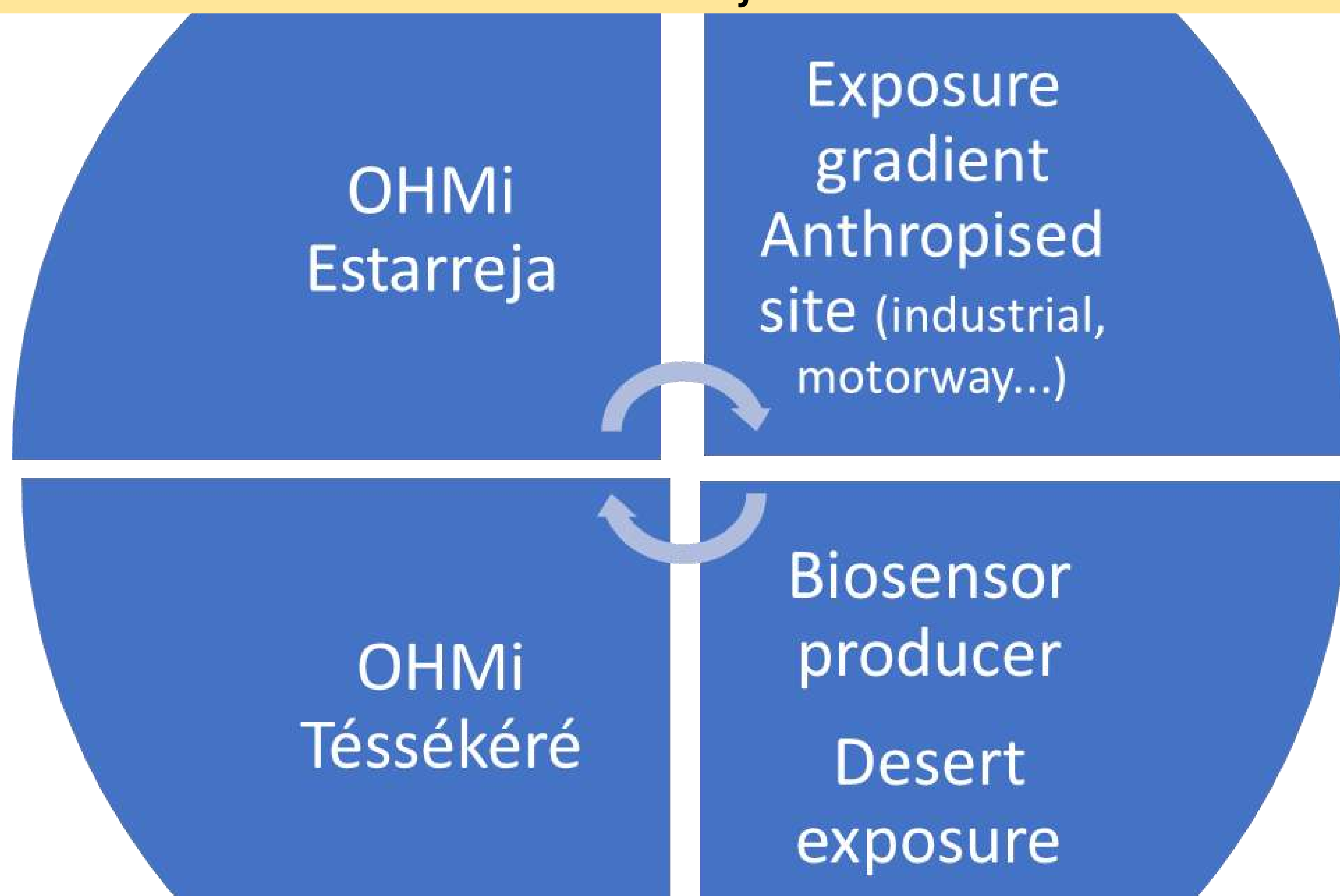
2- to characterise and identify geochemical and magnetic signatures of both anthropogenic and natural sources of particles.

This development of biomonitoring also aims to estimate the role of vegetation in the capture and retention of particles at the local (city) and regional scales. Our objective is to test different types of vegetation (leaves and bark) as recorders and sequesters of particles.

Initial results:

• 40 bark samples (mainly *Eucalyptus*)

- The magnetic susceptibility varies between $-6.4 \cdot 10^{-9}$ and $1.9 \cdot 10^{-8} \text{ m}^3 \cdot \text{kg}^{-1}$
- The highest values are measured in the bark of trees located near a motorway.



- 28 samples (various species including *Balanites aegyptiaca* and *Acacia*)
- Magnetic signature strongly impacted by the eolian contribution due to the input of high coercivity magnetic minerals (hematite and goethite type).
- Estimation of magnetic parameters in progress

Material et methods:

Magnetic data will be acquired on the plant samples in order to assess the concentrations of magnetic minerals (iron oxides). In particular, magnetic susceptibility and isothermal remanent magnetisation (IRM) will be measured. Magnetic susceptibility is a measure of the magnetic response of a material to an external magnetic field. The necessary equipment (kappabridges) is available in France (Toulouse) and Portugal. The GEt laboratory (Toulouse) has recently acquired an Agico KLY-5 kappabridge, which has increased sensitivity and allows the simultaneous acquisition of real and imaginary magnetic susceptibility. This offers the advantage of detecting superparamagnetic particles, allowing the tracing of nano-sized particles, known to have the greatest impact on health. Remanence (MRI) is acquired by exposing a sample to a magnetic field at room temperature. The resulting coercivity spectra allow the identification of magnetic grain populations (size and composition) that serve as a specific signature of a particle source. The equipment is available in laboratories in France and Portugal. Geochemical data will be measured on samples selected from the magnetic measurements. After digestion, the contents of major and trace elements (especially metals) will be acquired by ICP-MS.

Conclusion:

The estimation of the capture of ambient air particles by plants will allow to:

- propose easy-to-implement biomonitoring methods,
- propose passive biosensors for areas without vegetation and set up participatory processes involving local stakeholders in the long term,
- and estimate the role of vegetation in the retention of airborne particles in different environments.

Références:

- Hoffmann, V., Knab, M., Appel, E., 1999. Magnetic susceptibility mapping of roadside pollution. *Journal of Geochemical Exploration* 66: 313-326.
- Jordanova, D., Petrov, P., Hoffman, V., Gocht, T., Panaiotu, C., Tsacheva T., Jordanova, N. 2010. Magnetic signature of different vegetation species in polluted environment. *Studia Geophysica et Geodaetica*. 54(3): 417-442.
- Kardel, F., Wuyts, K., Maher, B.A., Hansard, R., Samson, R. 2011. Leaf saturation isothermal remanent magnetization (SIRM) as a proxy for particulate matter monitoring: Inter-species differences and in-season variation. *Atmospheric Environment* 45: 5164-5171.
- Knab, M., Appel, E., Hoffmann, V. 2001. Separation of the anthropogenic portion of heavy metal contents along a highway by means of magnetic susceptibility and fuzzy c-means cluster analysis. *European Journal of Environmental and Engineering Geophysics* 6: 125-140.
- Matzka, J., Maher, B. A. 1999. Magnetic biomonitoring of roadside tree leaves: identification of spatial and temporal variations in vehicle-derived particulates. *Atmospheric Environment* 33: 4565-4569.
- Mitchell, R., Maher, B.A., Kinnersley, R. 2010. Rates of particulate pollution deposition onto leaf surfaces: temporal and inter-species magnetic analyses. *Environmental Pollution* 158: 1472-1478.
- Petrovsky, E., Ellwood, B.B., 1999. Magnetic monitoring of pollution of air, land and waters. In: Maher, B.A., Thompson, R. (Eds.), *Quaternary Climates, Environments and Magnetism*. Cambridge University Press, Cambridge, pp.279-322.
- Verosub, K.L., Roberts, A.P. 1995. Environmental magnetism: Past, present and future. *Journal of Geophysical Research* 100(B2): 2175-2192.