SUMMIT RESEARCH

3rd year

Vehicle-related emissions versus natural sources: how to distinguish their contribution?

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PhD course in Environmental Science and Engineering

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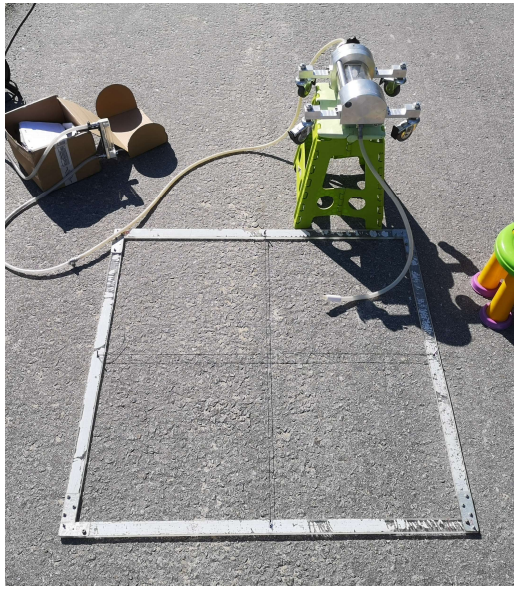
Research challenges and sampling methods

Challenges:

- ❑ Chemical characterisation of PM_{10} sources;
- ❑ Identification of **hotspots** to measure one specific source type;
- ❑ **Natural origin** *vs* **anthropogenic activities**.



Road dust collection on pavement sections:

- ❖ 1 m^2 road sections were chosen to collect deposited dust,
- ❖ Onsite **resuspension chamber** to collect dust subject to resuspension + PM_{10} filters
- ❖ 3 sites (roads) nearby 3 **extraction caves** (different geological composition) in Northern and Central Portugal
- ❖ 3 **parking spaces** in the Aveiro area, both indoor and outdoor
- ❖ **Laboratory procedures** (analyses for determination of carbonaceous matter, metals and metalloids, geomorphology)

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Dust loadings (mg PM_{10} m^{-2}) &
Emission factors (g veh^{-1} km^{-1})

Results obtained

What does RD show?
What does EF mean?

Sampling location and characteristics			RD_{10} (mg m^{-2})	EF (g veh^{-1} km^{-1})
Cantanhede - Portunhos	**Pedreira do Arocal**: extração e transformação de pedra de calcáreo	Entrada/acesso à exploração (pelo lado dto)	610.28	8281
		Zona de saída na via de acesso à exploração (lado esq)	436.89	6317
		Via dta da estrada municipal a 30-50 m da entrada da exploração	73.70	1494
Arcozelo (Ponte de Lima)	**Pedreira João Rodrigues Gonçalves**: extração e transformação de pedra de granito	Estrada de acesso à pedreira	37.64	863
	Pedreira INERBRITAS: extração e transformaçao de pedra de granito	A frente da entrada inferior da pedreira	160.20	2798
	Acima da pedreira INERBRITAS	-	156.22	2746
Aguada de Cima (Águeda)	**Sorgila SA**, estrada de acesso às pedreiras :extração e transformação de areias e argilas	Faixa de saída da fábrica - berma da estrada	238.49	3714
		Faixa direita da estrada	102.25	1932

Sampling location and characteristics			RD_{10} (mg m^{-2})	EF (g veh^{-1} km^{-1})
Aveiro	Parque de estacionamento **Ana Vieira**	início da subida do -1 para R/C; piso liso com algumas ranhuras largas; lado esquerdo	25.66	634
		20 cm mais acima do m2 anterior, pneus do lado esq., na mesma subida	34.03	799
		pneus do lado dto	23.86	598
		topo da subida, lado dto, piso + rugoso	15.96	432
		corredor do R/C, piso liso, lado dto	29.83	711
		saída, junto à máquina de leitura de cartões	12.74	361
		Zona de saída, junto à máquina de leitura de cartões, piso muito liso	1.84	75
Aveiro	Parque de estacionamento **Campus UA**	Após entrada do parque, acesso aos lugares de estacionamento	8.90	269
		À esquerda da entrada, no acesso aos lugares de estacionamento	17.92	475
		Zona de saída, muita areia solta	28.52	683
Aveiro	**FORUM** Aveiro	Cais de carga e descarga de camiões, zona de rotonda. Atenção: carga e descarga de materiais texteis, recolha centralizada de lixo do CC	14.03	390
			27.74	677

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Widening the scope: results and next steps

	Cave 1	Cave 2	Cave 3	Parking 1	Parking 2	Parking 3
Majority elements	Geoaccumulation index (Igeo)					
Al	-5.0	-2.7	-3.1	-3.2	-4.8	-3.6
Ca	1.3	-1.9	-1.7	0.7	1.1	0.3
Fe	-4.5	-2.5	-3.2	-1.6	-3.0	-2.0
K	-4.3	-0.9	-2.3	-2.0	-4.2	-2.3
Mg	-3.4	-3.4	-5.5	-3.0	-4.6	-3.5
Mn	-4.6	-3.2	-3.7	-2.4	-3.7	-2.6
P	-3.9	-1.3	-3.6	-1.0	-2.8	-0.9
S	-1.4	-2.8	-3.7	0.6	-1.8	0.7
Ti	-4.6	-2.3	-3.5	-2.1	-4.4	-2.5
Minority elements						
Li	-3.1	1.0	-1.6	-0.7	-2.9	-1.2
Cr	-2.6	-1.6	-1.4	1.3	0.4	0.6
Ni	-2.4	-1.1	-1.5	0.4	-0.7	-0.1
Cu	-1.5	-0.2	-0.9	4.5	2.9	3.4
Zn	0.2	1.2	1.0	4.7	2.8	4.5
As	-1.9	1.5	0.7	0.6	-2.0	1.3
Se	2.4	2.9	2.8	2.8	0.9	3.1
Rb	-3.6	0.7	-1.8	-1.2	-3.1	-1.7
Sr	0.2	-2.9	-4.0	-1.4	-2.7	-2.2
Mo	-4.2	-0.1	-1.4	2.4	0.9	1.2
Cd	-0.7	0.6	-0.6	2.0	0.8	2.0
Sn	-4.0	0.3	-1.9	3.7	2.5	1.5
Sb	-0.1	0.2	1.0	5.4	3.1	4.6
Cs	-2.7	0.8	-1.6	-0.6	-2.7	-1.1
Ba	-6.4	-4.5	-4.6	-2.0	-3.8	-2.4
Pb	-3.0	-0.4	-0.4	2.5	-0.4	2.0
Bi	-0.3	2.4	0.3	7.8	3.9	5.0
Th	-4.2	0.1	-2.3	-2.0	-3.2	-2.5
U	-2.3	1.6	-0.9	-0.7	-1.6	-0.9

What does the Geoaccumulation index tell?

Class 0	<0	Uncontaminated
Class 1	0-1	U. To moderately contaminated
Class 2	1-2	Moderately contaminated
Class 3	2-3	Moderately to heavily contaminated
Class 4	3-4	Heavily contaminated
Class 5	4-5	H. To Extremely contaminated
Class 6	>5	Extremely contaminated

- **Majority elements** are mostly geogenic: higher concentrations but low contribution from anthropogenic sources;
- **Minority elements** with much lower concentrations but greater variability: traffic-related metals (Cu, Zn, Mo, Cd, Sn, Sb, Bi) show clear contamination patterns in parking areas rather than roads within cave areas.

Next steps?

- Data input to national and international databases;
- Reports and scientific publications with a focus on both academic sector and policymakers.

SCIENTIFIC DISSEMINATION

Articles:
To be submitted to MDPI group.

Other communications (conference abstracts):
Yet to be scheduled.

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