



Chemical Fingerprint of Outdoor PM2.5 in Malta

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Intro: RESPIRA (EU Funded Italia- Malta 0713) indicated that living in Malta is a risk factor for asthma.

Aim: To determine the chemical profile of PM2.5 in Malta, and compare with reference values.

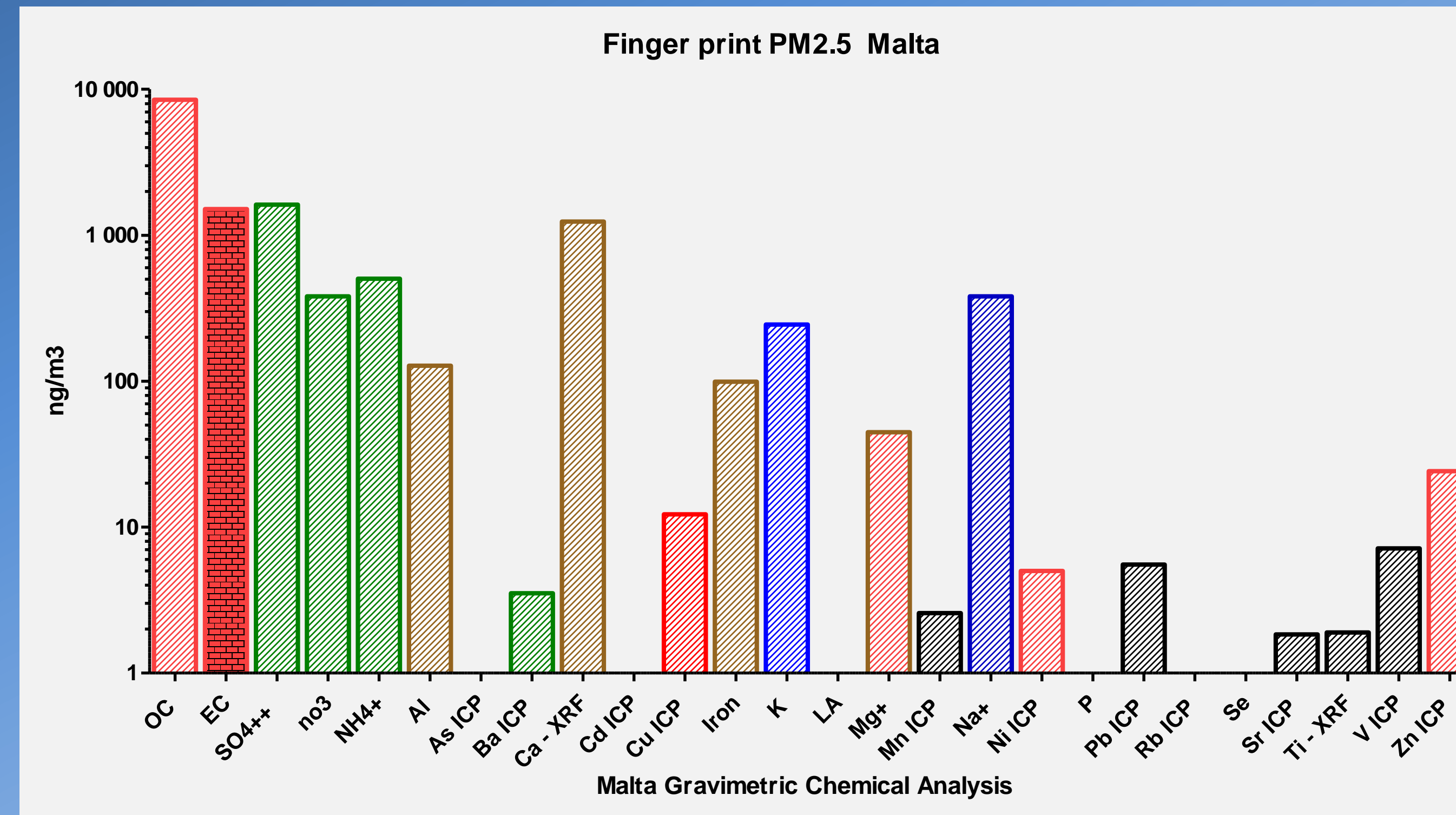
Methods: Using FAI pumps at 10l/min/48hr, samples were collected on Teflon and Quartz filters from 6 schools and 46 homes in Malta. Total ICPMS measurement (Residual+extracted), X ray Fluorescence, and thermo-optical methods(TO) were used for analysis by CNR in Rome. Aeroqual IQM60 counters were used for total PM2.5 mass. All data in ng/m3, Mean, (1st to 3rd quartile) of all 48 hour measurements.

Results: Higher than reference values: (TO): Elemental Carbon Mean 1513(620-1946), ng/m3, Organic Carbon 8480(3190-11490). Using ICPMS, Fe 99.3(33.6-154.6), Vanadium 7.14(2.1-9.0), Ni 5.0(1.9-5.7), Cu 12.2(2.35-8.28), Zn 24.16(10.9-28.2). Lower than reference: SO4⁺⁺ 1621(446-2449), Nitrate 382(178-446), NH4⁺ 504(170-687), Ba 3.52(0.85-3.7), Arsenic 0.37(0.19-0.42), Sn (0.16-0.56), Cd 0.62(0.15-0.88), Sb 0.99(0.27-1.08), Rb 0.55(0.23-0.86). No difference: Pb 5.54(1.87-6.54), Mn 2.57(1.40-3.56), Sr 1.84 (0.19-3.04). Using XRF and higher, Ca Mean 1241 Q1-Q3(466-1494), Al 127.6(93-178.6), Si 44.4(25.251) K 244(109.3-249.5), Na 382(183-487) Cl 252 (64.8-393). Total PM2.5 in microg/m3 41.1(13.9-15.7).

Conclusion: Chemical fingerprint of PM2.5 probably reflects combustion of low sulphur crude oil product by cars and power plant, mixed with background soil and marine salt.

Reference values: 48,591 observations for 187 countries

Spatial and Temporal Variation in PM2.5 Chemical Composition in the United States for Health Effects Studies, Michelle L. Bell, Francesca Dominici, Keita Ebisu, Scott L. Zeger, and Jonathan M. Samet, Environ Health Perspect 115:989-995 (2007)



Variable	location	Mean	StDev	Minimum	Maximum	IQR	P value
K - XRF	Malta	244.2	250.1	14.2	1346	132.2	p=0.0001
	US	79.2	2.41	23.1	275	27.4	
Na+ (IC)	Malta	383	262	68	1456	304	p=0.0001
	US	128	51	37.2	509	58.2	
Cl- (IC)	Malta	252	204	10	881	328	p=0.0001
	US	24.8	2.3	3.25	300	4.91	

Marine component

Variable	location	Mean	StDev	Minimum	Maximum	IQR	pvalue
Al-XRF -	Malta	127.63	70.98	8.46	375.15	85.65	p=0.0001
	US	29.2	1.48	10.2	171	11.4	
Si-XRF -	Malta	443.7	314.9	69.8	1782.8	258.2	p=0.0001
	US	105	4.7	35.1	454	49.6	
Ca - XRF	Malta	1241	1249	190	6601	1029	p=0.0001
	US	57	3.56	12.4	450	36.5	
Mg+ (IC)	Malta	44.68	28.99	3.17	139.1	39.1	p=0.0001
	US	15.3	0.43	7.17	67.6	3.28	

Local geological component

Variable	location	Mean	StDev	Minimum	Maximum	IQR	P value
EC - ng/m3	Malta	1513	1382	77	6766	1327	p=0.0001
	US	629	19.6	166	1742	283	
OC - ng/m3	Malta	8480	7740	1170	31230	8300	p=0.0001
	US	3823	100	967	12120	1372	
Nickel ICP ng/m3	Malta	5.004	4.472	0.611	20.036	3.793	p=0.0001
	Us	1.85	0.17	0.33	20.2	0.86	
Cu ICP ng/m3	Malta	12.26	27.16	1.36	148.38	5.93	p=0.024
	Us	3.98	0.22	1	23.5	2.46	
Zn ICP ng/m3	Malta	24.16	23.26	6.07	126.25	17.37	p=0.002
	Us	14	0.98	1.59	130	7.67	

High levels fossil fuel combustion

Variable	location	Mean	StDev	Minimum	Maximum	IQR	P value
Pb ICP ng/m3	Malta	5.54	8.91	1.01	64.24	4.67	p=0.594
	US	4.89	0.21	1.63	23.6	1.82	
Iron ng/m3	Malta	99.28	73.39	13.24	311.81	120.97	p=0.18
	US	85.7	3.91	15.39	437	44.4	
Vanadium ng/m3	Malta	7.14	6.614	0.154	24.535	6.994	p=0.18
	Us	5.64	0.11	1.96	7.4	1.23	

No difference

Variable	location	Mean	StDev	Minimum	Maximum	IQR	P value
Mn ICP ng/m3	Malta	2.568	1.404	0.505	7.809	2.153	
	US	3	0.22	0.71	32.2	1.41	p=0.027
Ti - XRF	Malta	1.901	2.608	0	14.583	1.439	
	US	5.33	0.16	1.69	16.2	1.15	p=0.0001
Cd ICP ng/m3	Malta	0.6172	0.5923	0.0481	3.0772	0.7289	
	Us	5.51	0.11	2.16	7.18	0.71	p=0.0001
Barium ICP ng/m3	Malta	3.524	5.815	0.256	38.88	2.815	
	Us	24.2	0.48	9.98	39.4	7.34	p=0.0001
Sn - TIN ICP ng/m3	Malta	0.3756	0.2948	0.0884	1.308	0.4072	
	Us	10.18	0.19	4.34	15.7	1.15	p=0.0001
As ICP ng/m3	Malta	0.3677	0.3413	0.0948	1.9964	0.2293	
	Us	1.7	0.4	0.6	4.46	0.58	p=0.0001
Rb ICP ng/m3	Malta	0.5485	0.382	0.0801	1.7269	0.6258	
	Us	0.99	0.02	0.41	1.33	0.07	p=0.0001
Sb ICP ng/m3	Malta	0.988	1.945	0.113	13.22	0.811	
	Us	11.1	0.23	3.4	17.7	2.41	p=0.0001
Sn ICP ng/m3	Malta	0.3756	0.2948	0.0884	1.308	0.4072	
	Us	10.18	0.19	4.34	15.7	1.15	p=0.0001
NH4+	Malta	503.6	453.3	41.4	1876.8	517.5	
	US	1543	42.6	227	3889	729	p=0.0001
SO4++ IC	Malta	1621	1551	53	5664	1984	
	Us	3698	102.4	658	6604	2020	p=0.0001
NO3- IC micr/m3	Malta	382.2	318.7	25.2	1654.4	267.9	
	Us	1733	84.9	327	10017	1298	p=0.0001

Low levels – low sulphur fuel combustion

