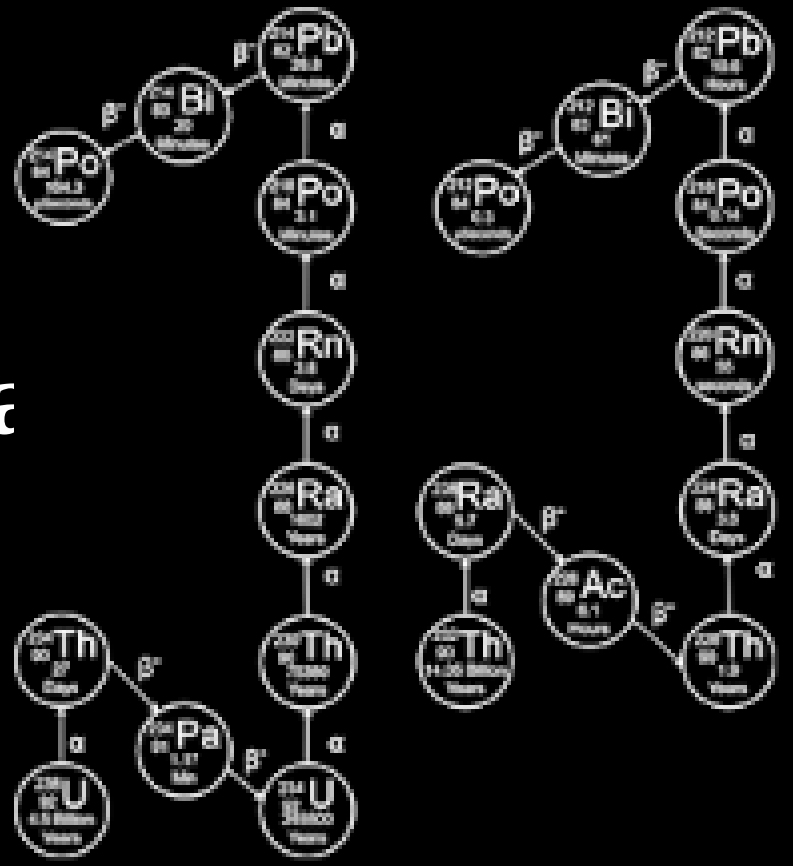
ARISTOTLE UNIVERSITY OF THESSALONIKI
FACULTY OF ENGINEERING
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
SECTOR OF ELECTRICAL ENERGY
NUCLEAR TECHNOLOGY LABORATORY



Preliminary results of radon exhala measurements in Northern Greece

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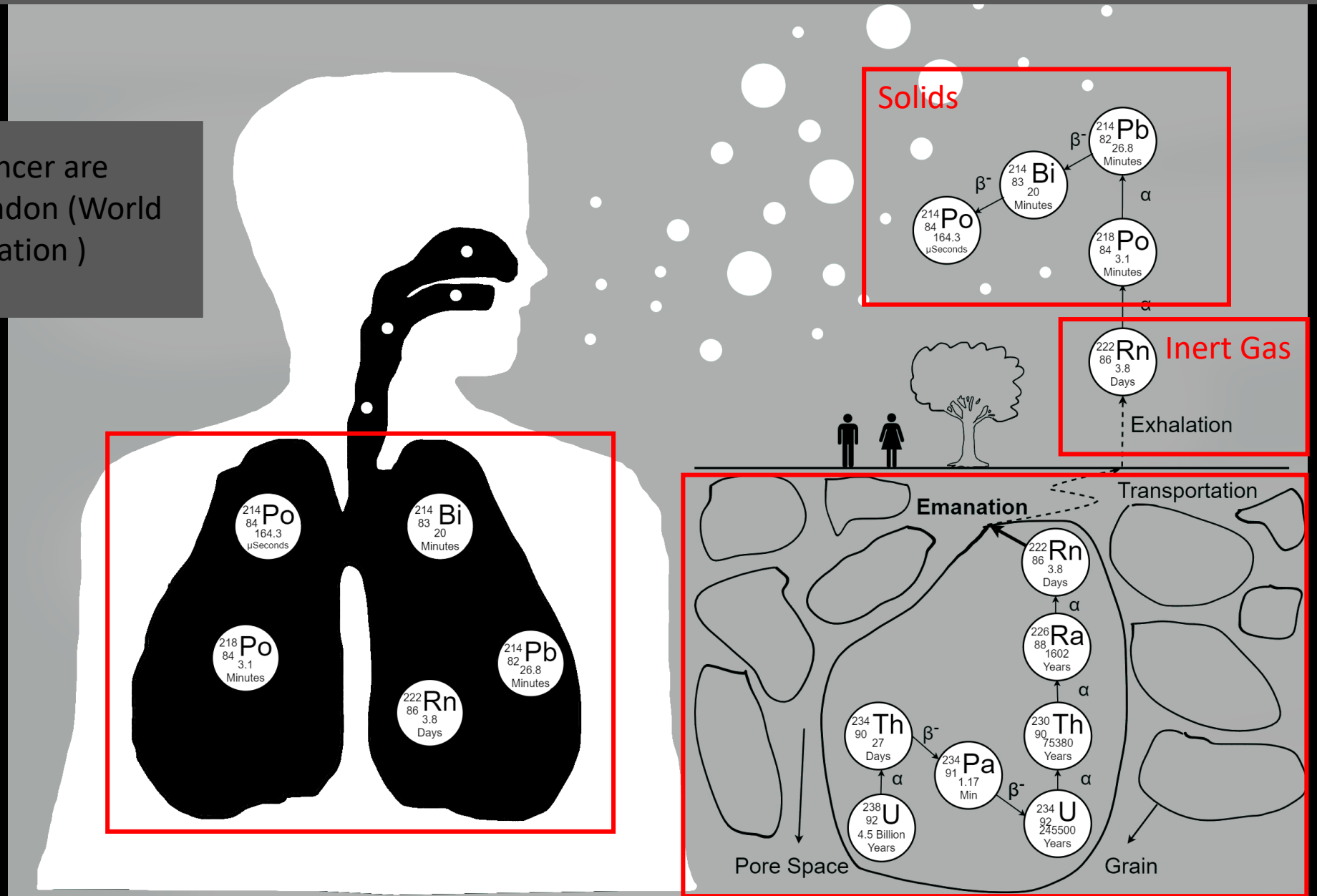
Radon Exhalation

10% of lung cancer are attributed to radon (World Health Organization)



Research Area

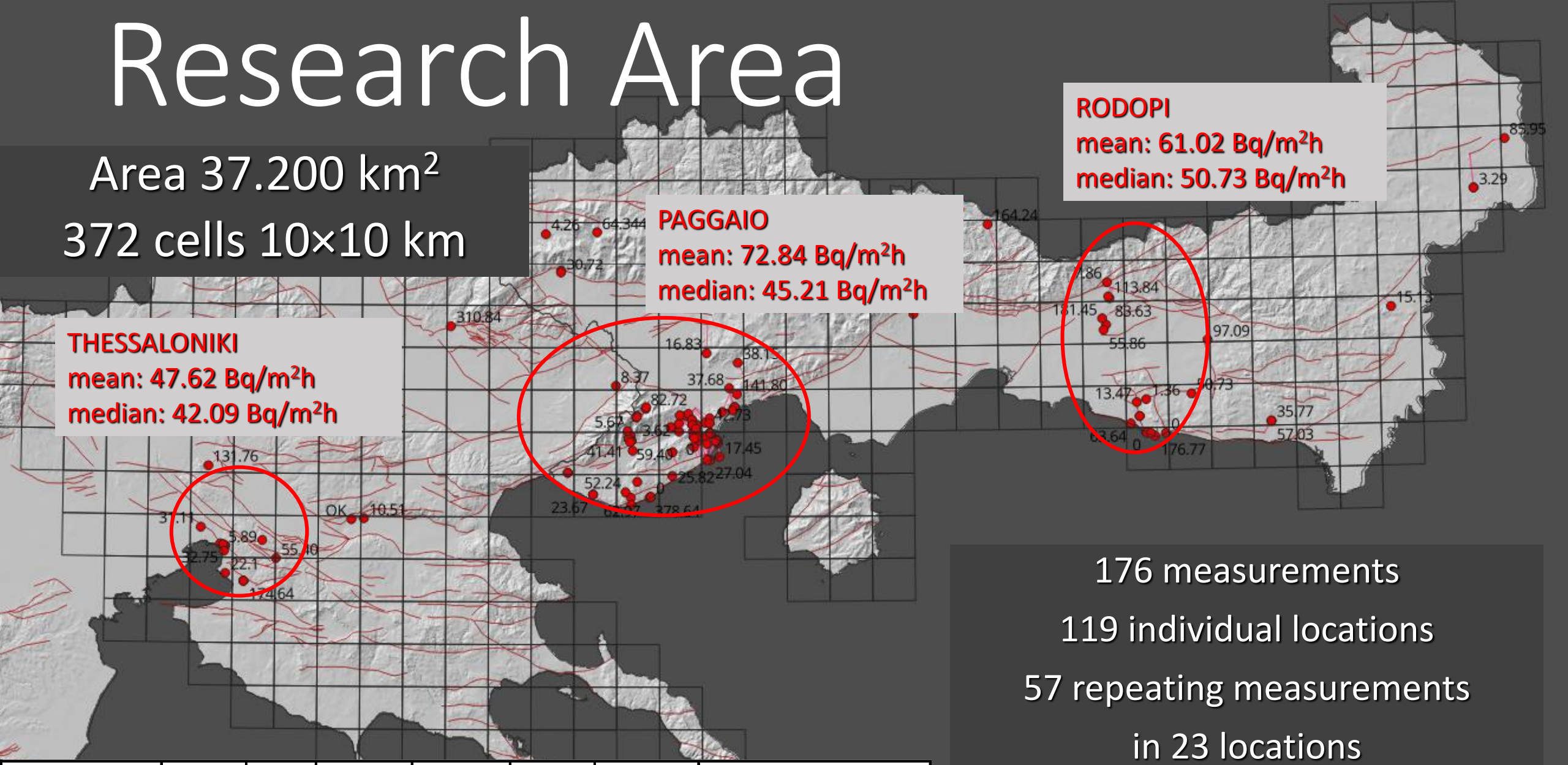
Area 37.200 km²

372 cells 10×10 km

RODOPI
mean: 61.02 Bq/m²h
median: 50.73 Bq/m²h

PAGGAIO
mean: 72.84 Bq/m²h
median: 45.21 Bq/m²h

THESSALONIKI
mean: 47.62 Bq/m²h
median: 42.09 Bq/m²h



176 measurements

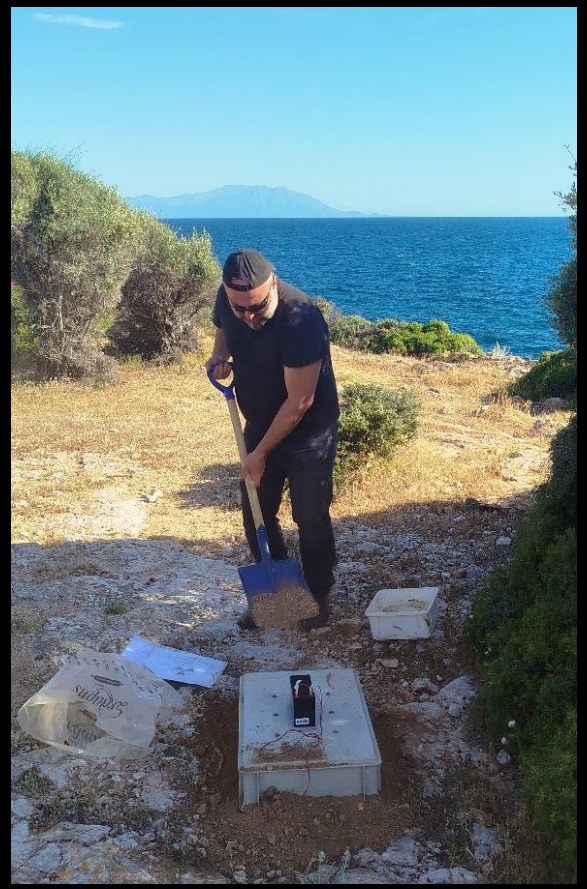
119 individual locations

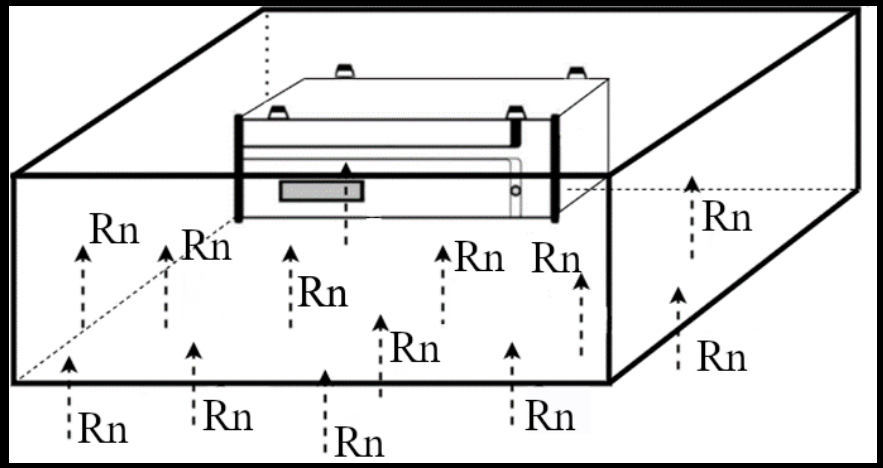
57 repeating measurements

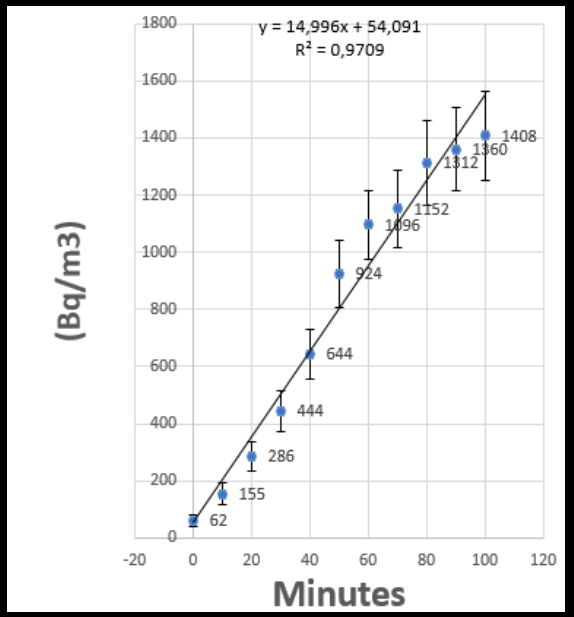
in 23 locations

3.62 – 432 Bq/m²h

	count	min	max	range	mean	median	standard deviation
Rodopi	11	6.86	113.84	106.98	47.62	50.73	34.35
Paggaio	100	3.62	356.14	352.52	72.84	45.21	70.22
Thessaloniki	9	22.1	174.64	152.54	61.62	42.09	44.31







$$C_i(t) = C_0 e^{-\lambda t} + \frac{EA}{V\lambda}\left(1 - e^{-\lambda t}\right)$$

$$C_i = \frac{EA}{V(\lambda_{Rn}+\lambda_V)} + C_0$$

$$C_i = \frac{EA}{V(\lambda_{Rn}+\lambda_v)}$$

$$E = \frac{dC}{dt}\frac{V}{A}$$

Ci: Indoor Radon Concentration at time t(h)
C0: Initial Radon Content
λ: radon decay rate
E: Radon Flux (Exhalation) from soil
A: Exhalation Surface
V: Volume of Chamber

Spatial Database (QGIS software)

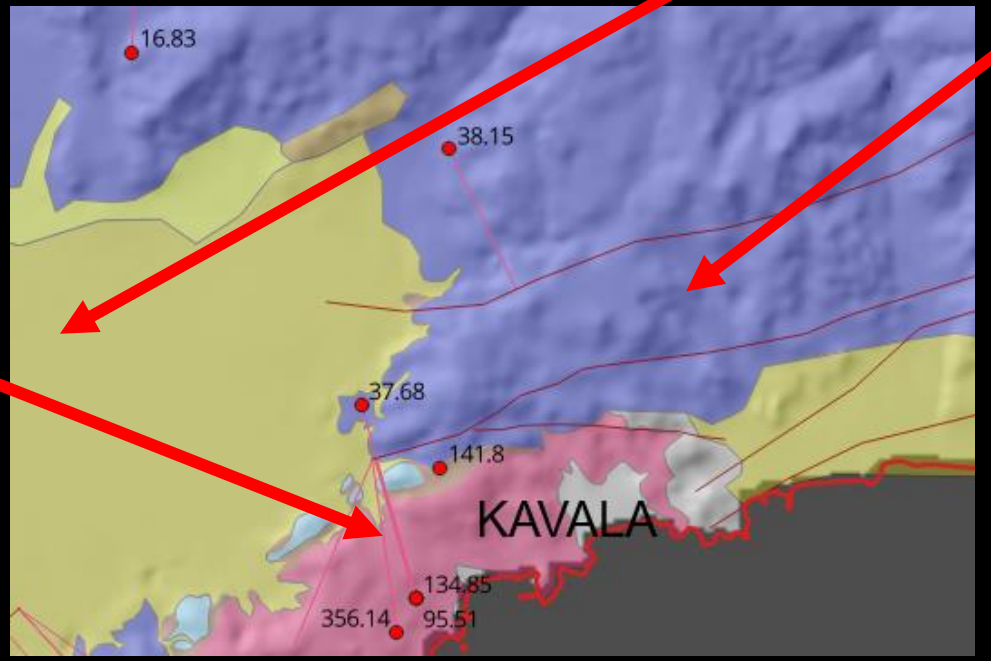
Information stored in the Spatial Database

- Location (description, coordinates, and height)
- Radon Data (Free Air Concentration, Geogenic Exhalation)
- Geologic data (lithology, faults, rock mass condition)
- Meteorological Data (temperature, humidity, and atmospheric pressure)

Location Code	Date	alphaguard	x (m) longitude	y (m) (latitude)	Free Air Concentration (Bq/m3)	Concentration Inside Radon Box (Bq/m3)			Exhalation (Bq/m-2.h-1)	R2	Lithology	Bedrock
						min	max	average concentration				
XAN001	17/04/2026	EF2318	573827.7078867314	4552791.936424305	33	32	502	286.64	46.12	0.9618	ROCK	granite
XAN002	18/04/2026	EF2318	591277.2656512188	4574178.514963912	34.25	46	1640	1099.83	164.24	0.9510	ROCK	granite
XAN003	19/04/2026	EF2318	584502.0210306699	4577625.697588641	380	82	1400	647.1	164.39	0.9354	TOPSOIL	granite
THE014	03/03/2026	EF1876	416057.1022201644	4489963.197013447	44.68	27.63	848	383.56	83.11	0.9650	SEDIMENT	mads
THE014	04/03/2026	EF1876	416057.1022201644	4489963.197013447	24.85	33	1800	791.27	174.64	0.9748	SEDIMENT	mads
THE015	08/03/2026	EF1876	416052.31691977516	4489956.297642942	64.63	31.13	1424	558.78	72.84	0.9542	SEDIMENT	mads
KAV064	27/04/2026	EF2318	522205.61826427997	4523531.446783079	45.33	51	222	133.3	17.32	0.84	ROCK	granite
KAV027	09/05/2026	EF2318	517061.5841782096	4520196.2550149895	44	31	1120	578.4	122.65	0.9641	ROCK	granite
KAV065	17/05/2026	EF2318	508793.02978485444	4513209.922139312	34.5	44	476	227.3	43.73	0.9104	ROCK	gneiss
KAV066	23/05/2026	EF2318	527276.0436022838	4522861.490927899	41	46	516	242.3	56.32	0.9488	ROCK	gneiss
KAV067	24/05/2026	EF2318	532268.6822714956	4533852.498761645	53	62	1408	803.91	141.80	0.9709	ROCK	gneiss
ROD014	30/05/2026	EF2318	626413.8158676709	4532028.672681612	23	26	192	111.34	13.47	0.8164	ROCK	marble
ROD015	30/05/2026	EF2318	628801.0706627187	4524818.196290152	45.5	29	179	113.27	16.36	0.9149	ROCK	μάρμαρο
ROD012	30/05/2026	EF2318	627115.6006089891	4528749.929211789	51.7	30	76	48.4	3.62	0.5506	ROCK	marble
ROD016	31/05/2026	EF2318	629756.3207231745	4524797.080741625	34.5	32	156	64.6	9.27	0.6060	ROCK	granite

Lithology Map vs Reality

1. **Granite:** Solid Magma, high exhalation expected
2. **Marble**, low exhalation expected
3. **Sediments**, product of erosion of different lithologies variable exhalation expected

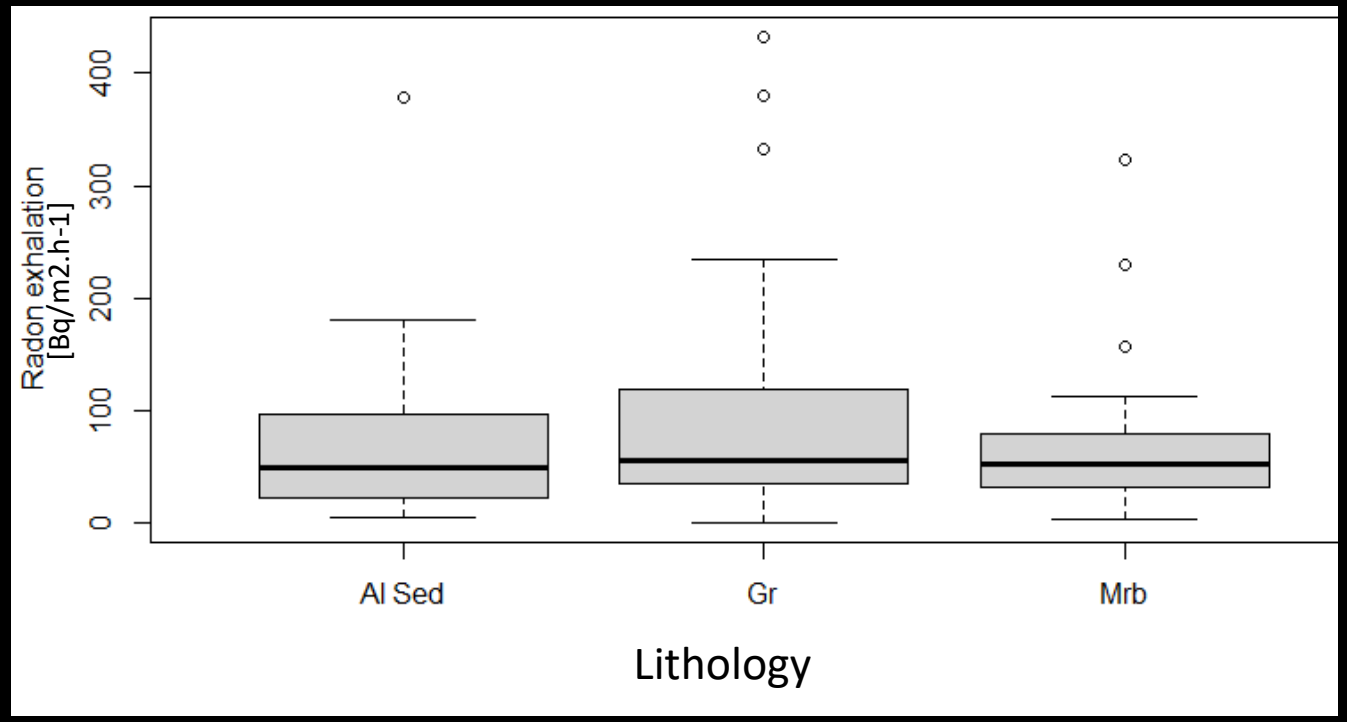


Legend

- Granite
- Marble
- Sediments

Lithology

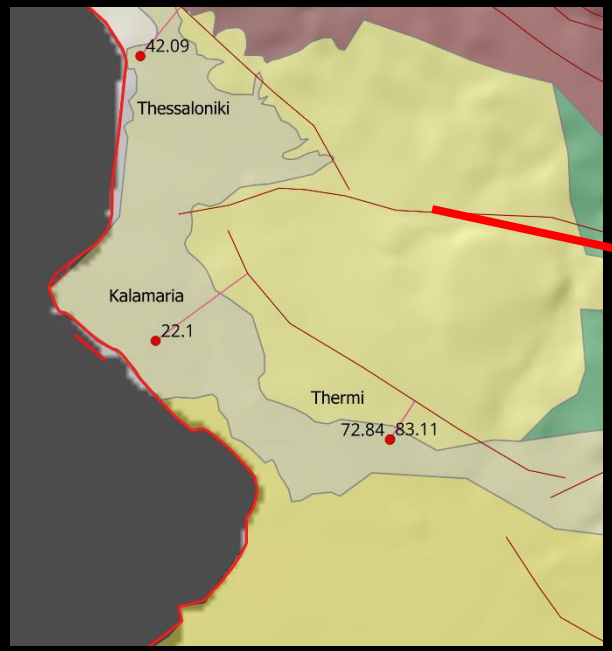
	n	mean	sd	median	min	max	range
AlluvialSediments	14	76.64	99.26	49.08	5.55	378.64	373.09
Granites	41	95.55	97.66	55.75	0.84	432.03	431.19
Marble	27	70.52	70.55	52.85	4.26	323.66	319.4



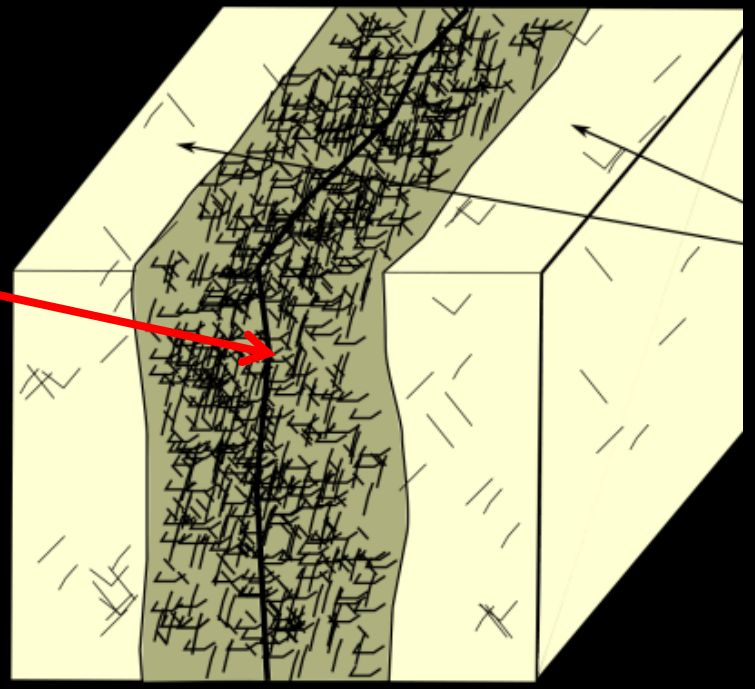
Al Sed: Alluvial Sediments, Gr: Granite, Mrb: Marble

A Kruskal–Wallis test showed no statistically significant differences in radon concentrations among the three lithologies ($\chi^2(4) = 3.85$, $p = 0.427$).

Fault on map vs in Reality



On map



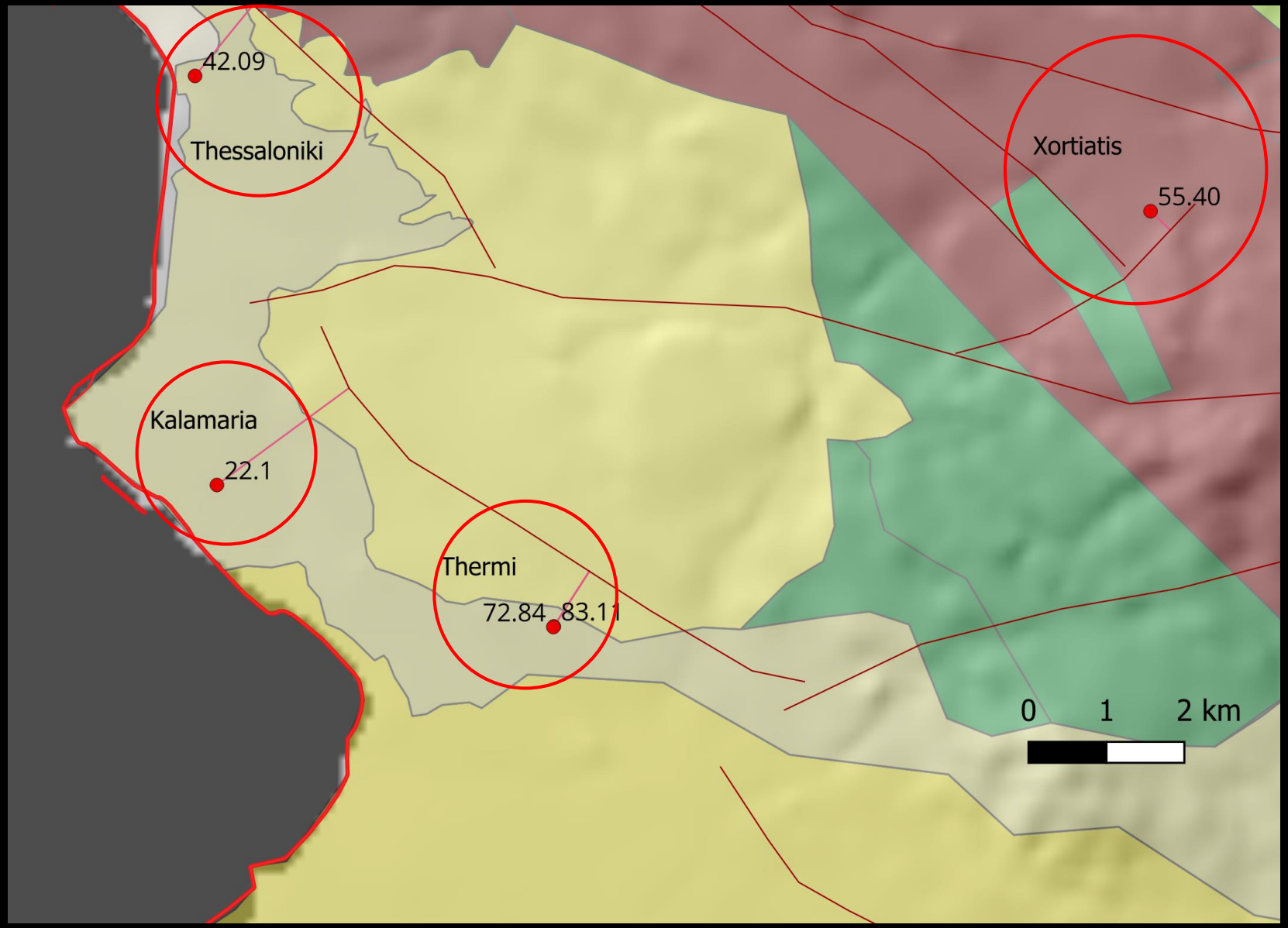
sketch

Mitchell and Faulkner (2009)

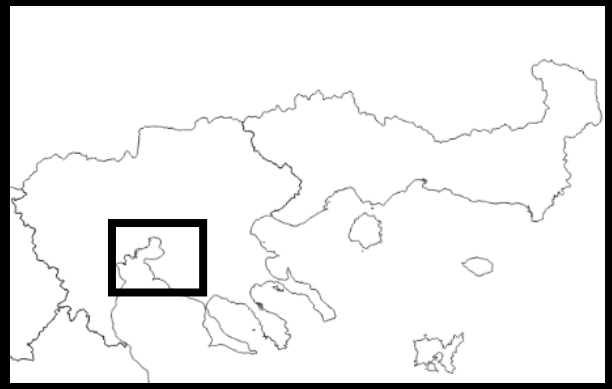
In reality

John Wiley

Distance from fault zones vs radon exhalation



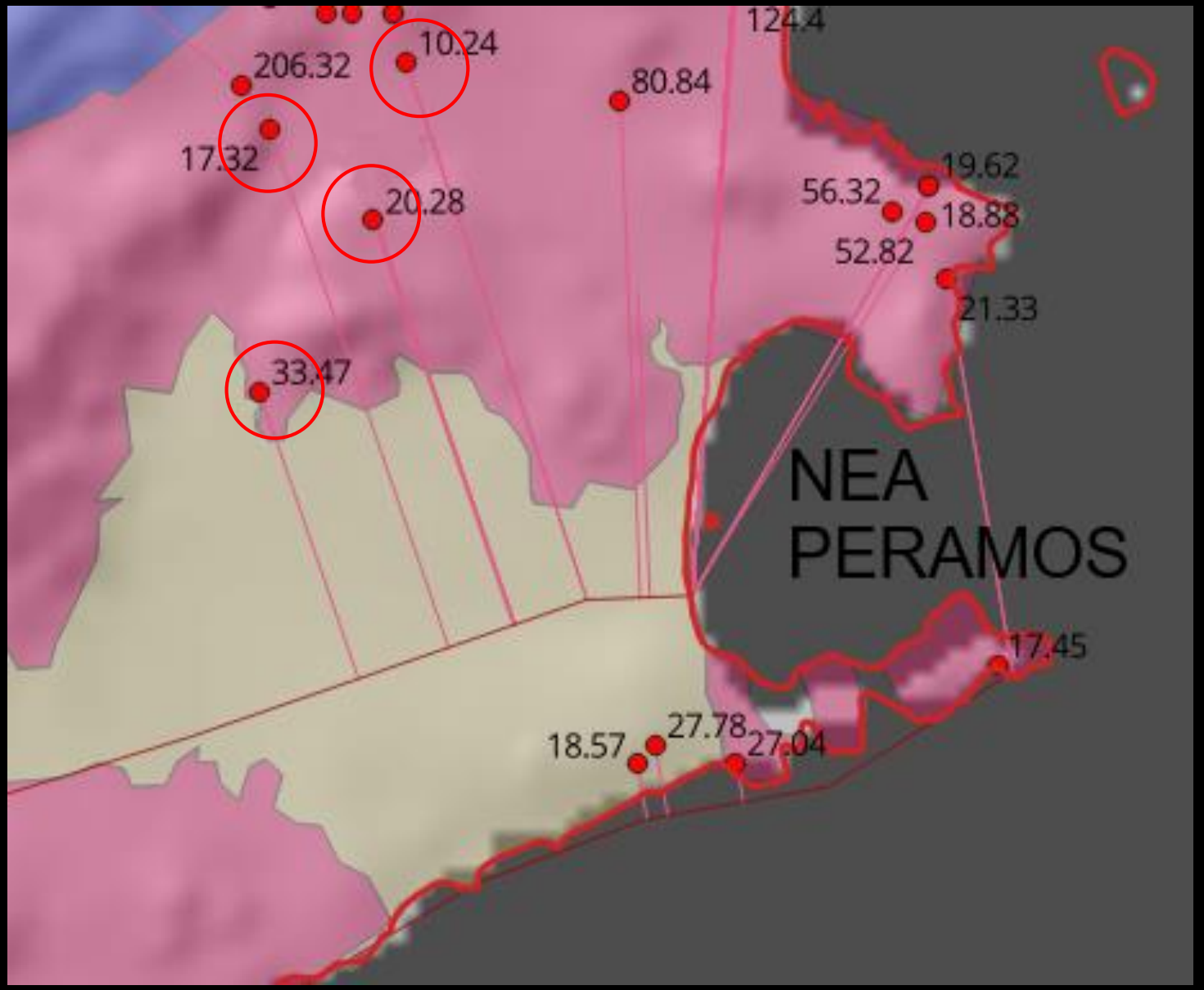
Thessaloniki



Legend

- Green Schist
- Ophiolites
- Sediments Marls
- Sediments Red Clays

Distance from fault zones vs radon exhalation

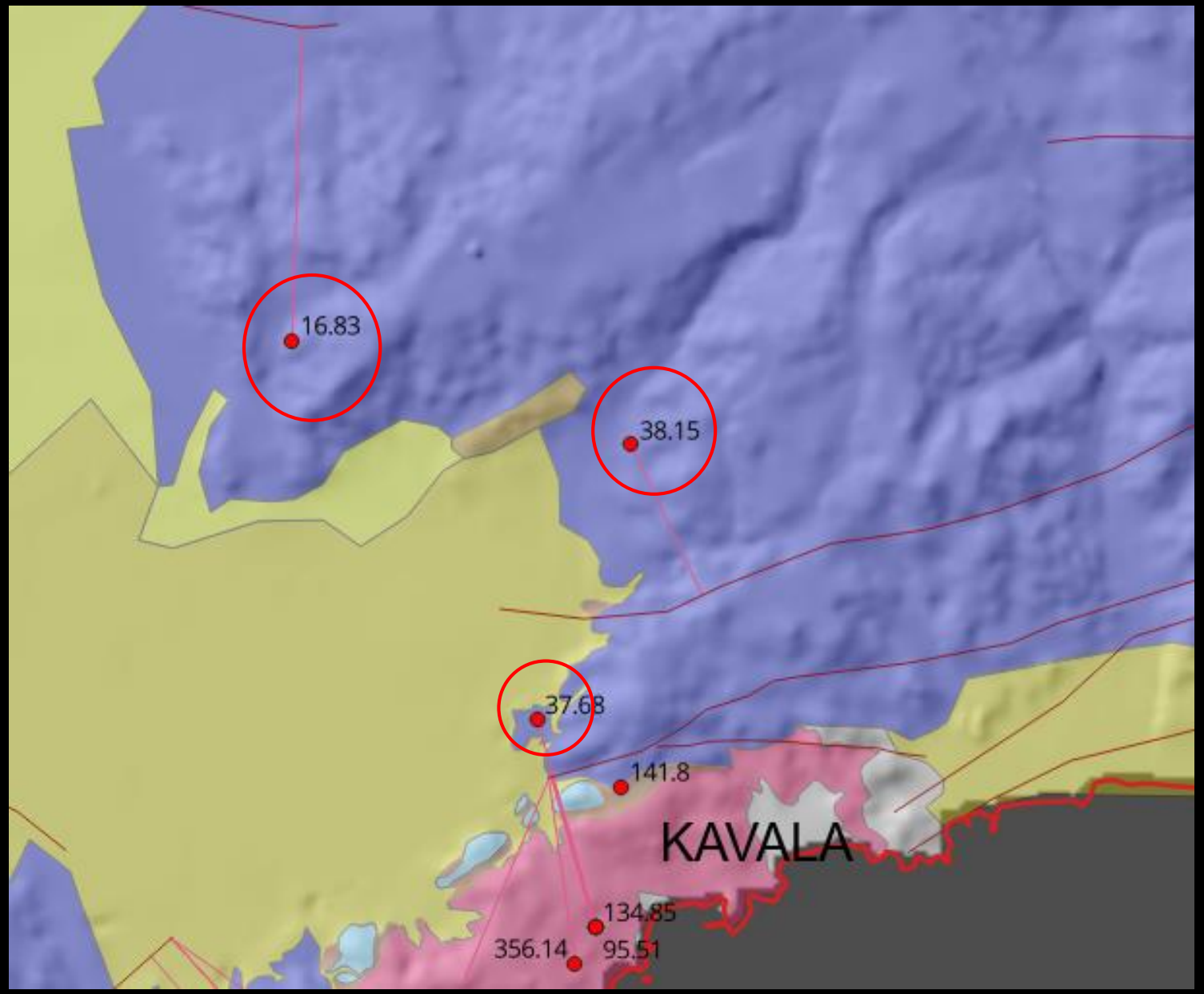


Paggaio Region –
Nea Peramos

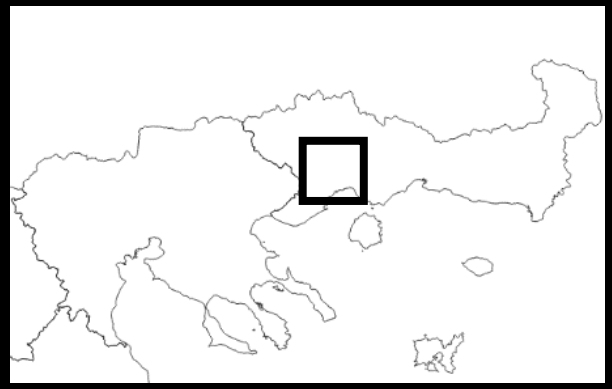
Legend

- Granite
- Gneiss/Marble
- Sediments

Distance from fault zones vs radon exhalation



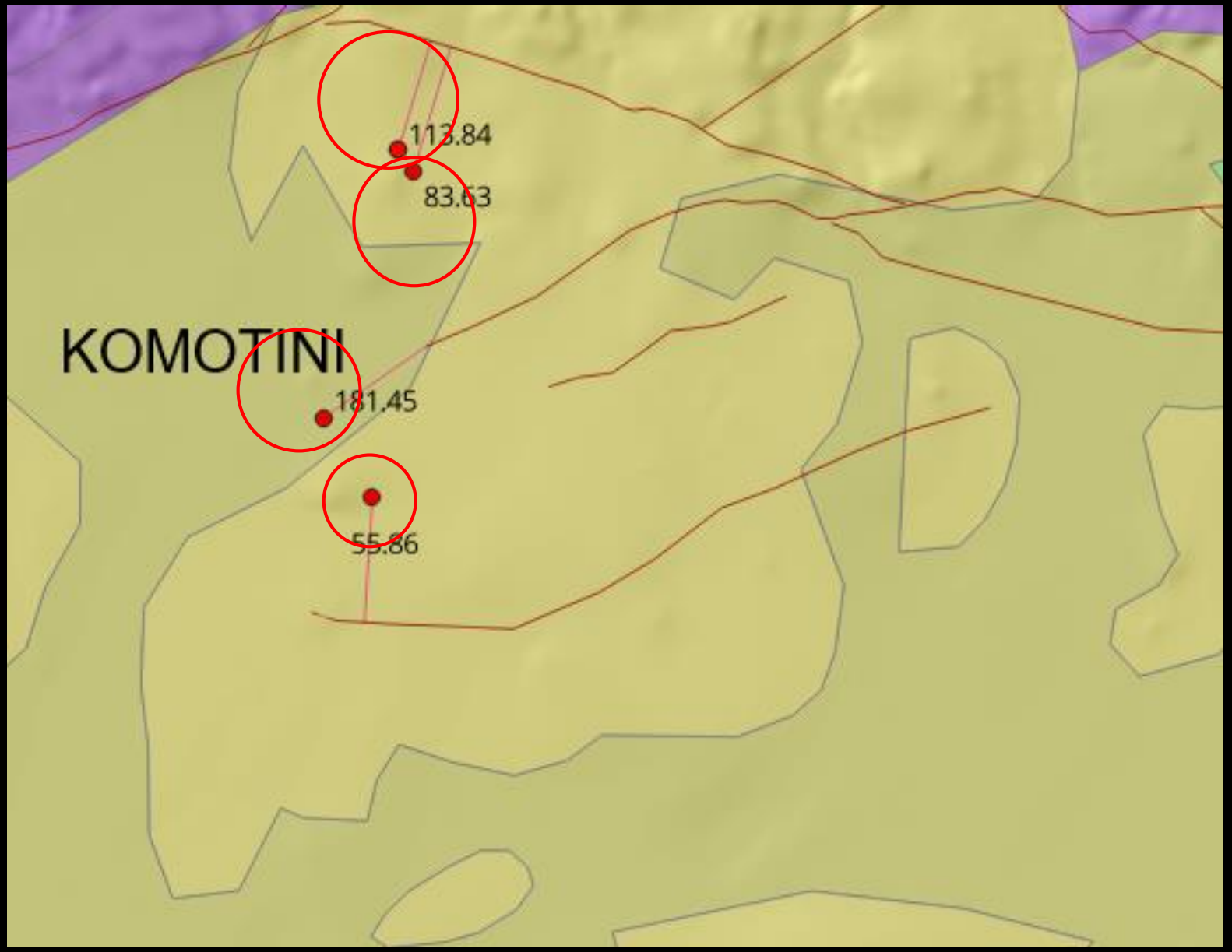
Paggaio Region – Lekani



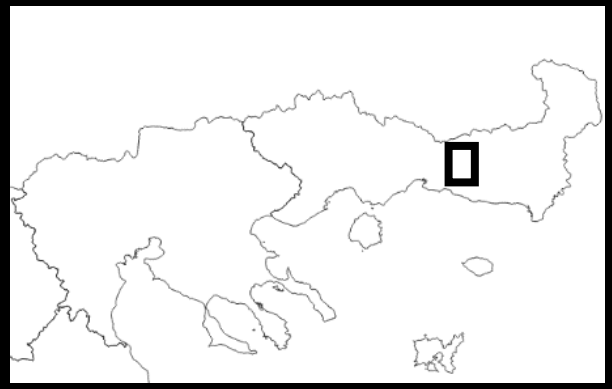
Legend

- Granite
- Gneiss/Marble
- Sediments

Distance from fault zones vs radon exhalation



Rodopi Region – Komotini

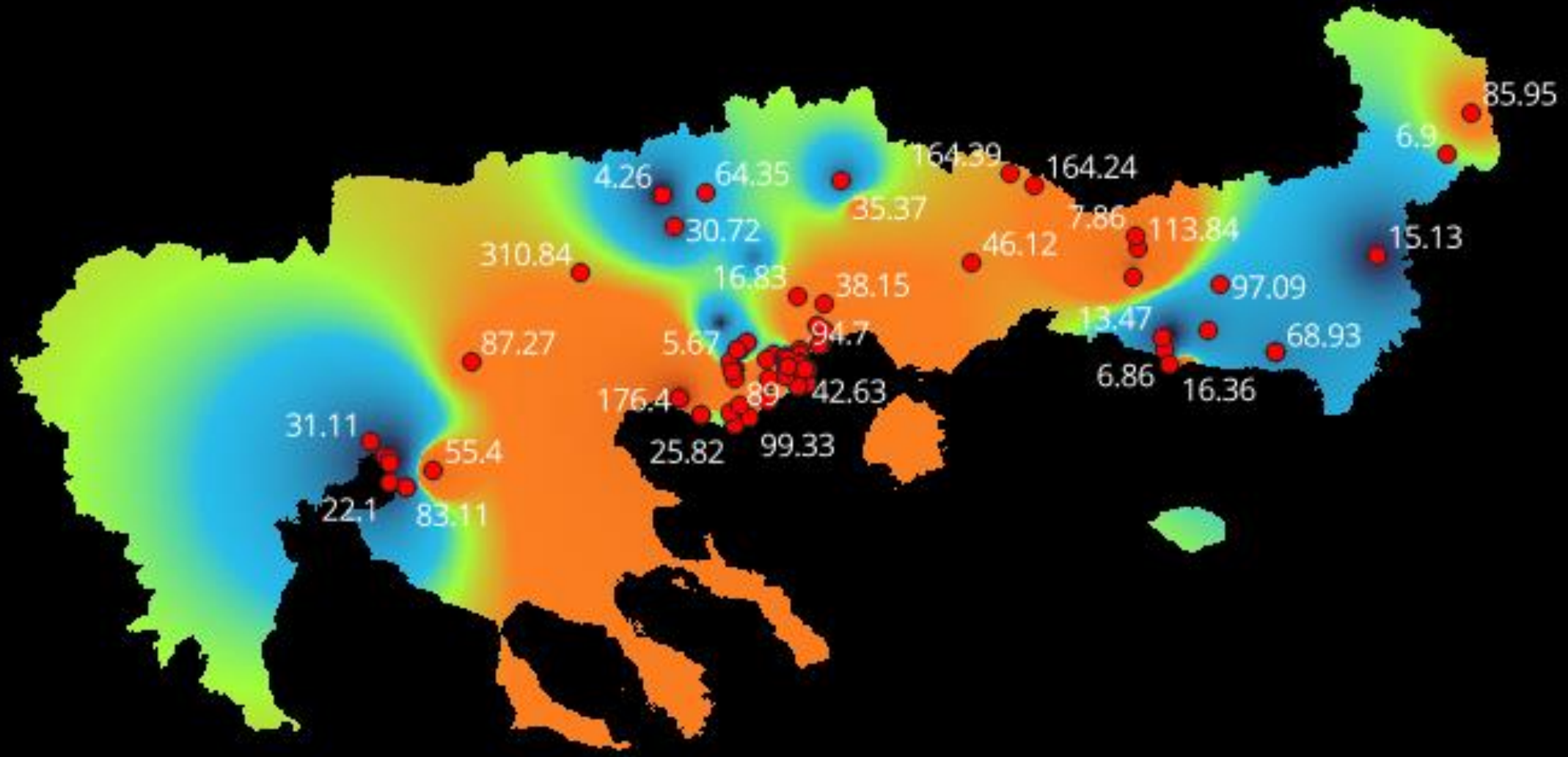


Legend

Gneiss

Sediments

Current Radon Exhalation map based on Inverted Distance Weight Interpolation (IDW)



Conclusion

- Measured Radon Exhalation rates in the research area range from 3.62 – 432 Bq . m^{-2} .h^{-1}
- Lithology alone does not influence Radon Exhalation Rates, but significant differences are observed considering the outliers.
- Radon Exhalation Rates show a tendency to rise when approaching fracture zones, i.e. faults, provided that the surface lithology remains the same
- Radon exhalation measurements are potential tools for locating buried fault systems

Thank you!

Questions