



Determination of radon activity in well and natural spring water sources in the granite rich region of Central Anatolia, (Turkey)

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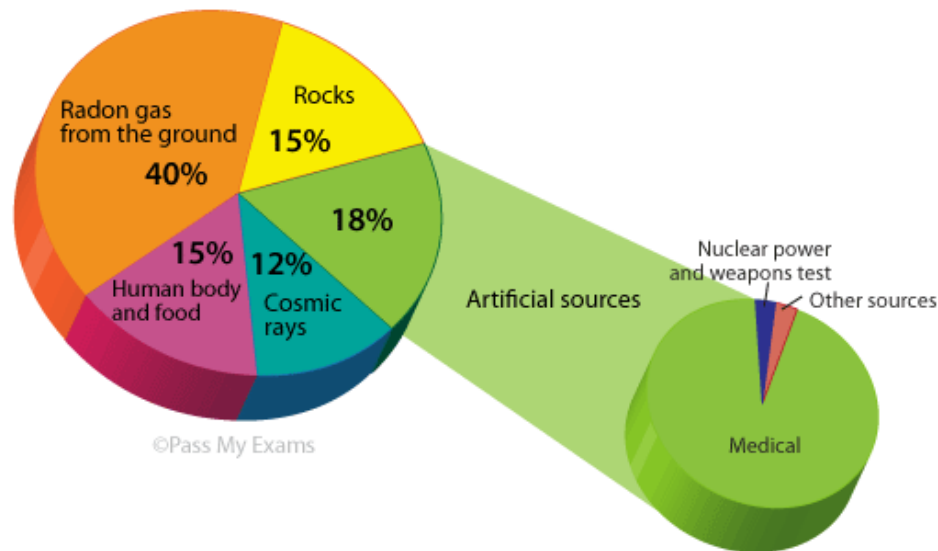
Outline

- **Radon**
- **Radon and Geology**
- **Material and Methods**
- **Results**

What is Radon?

Background Radiation

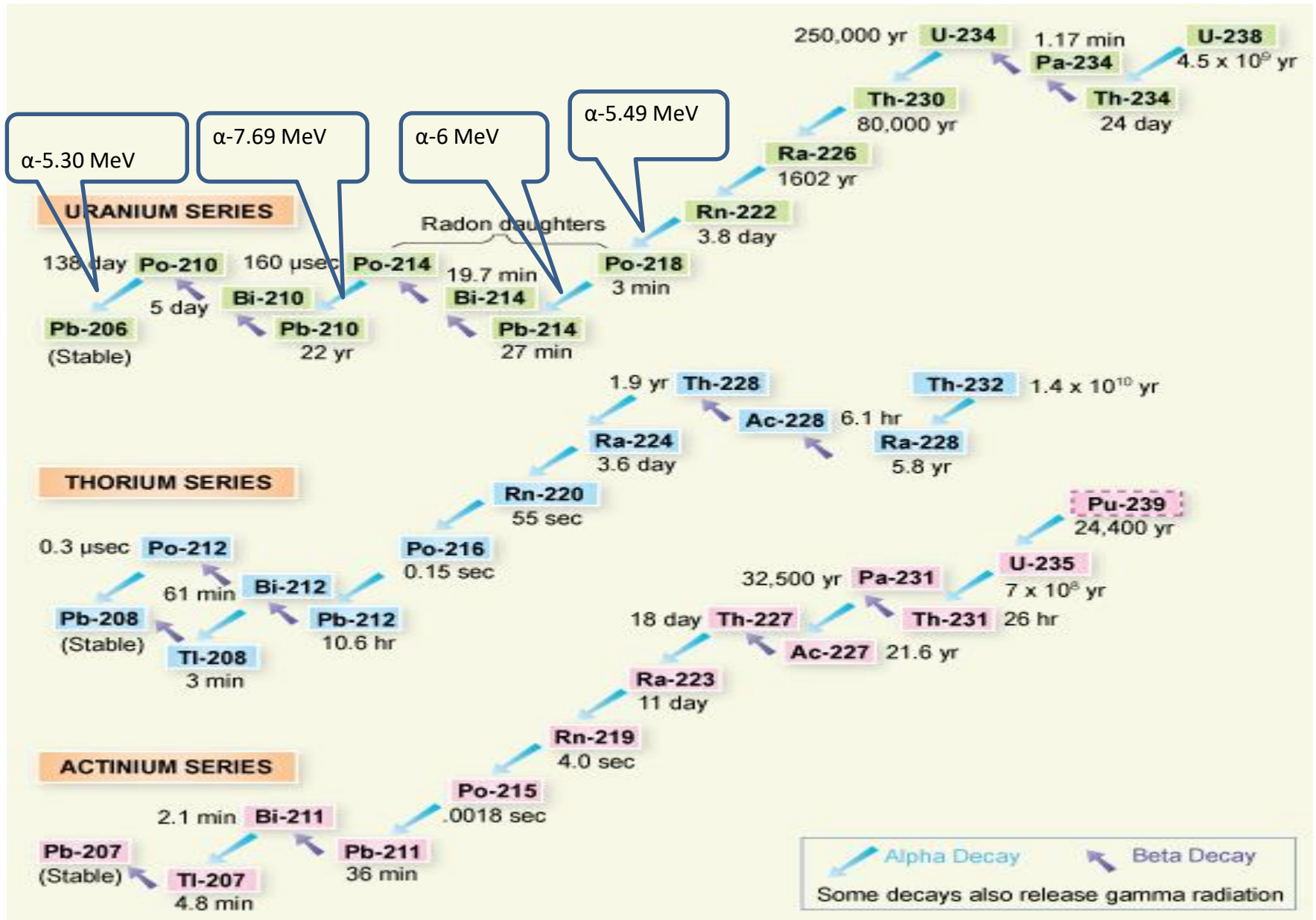
Rn	86 (222)
Density	9.73 g/L
Boiling point	-62°C
Melting point	-71°C
F.E. Dorn, 1900	
<i>California Geological Survey Mineral Resources and Mineral Hazards Mapping Program</i>	
(Xe) 4f ¹⁴ 5d ¹⁰ 6s ² 6p ⁶	
Radon	



Radon (Rn-222) is the first and most important **natural source of the radiation** which people are exposed.

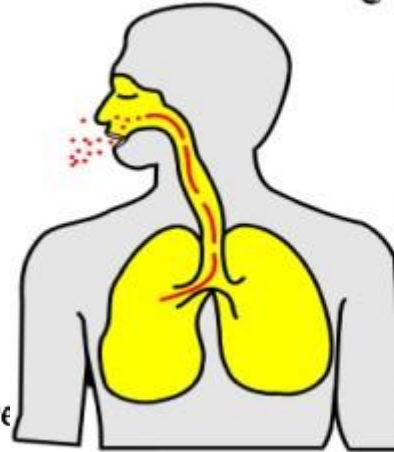
Radon is **tasteless, odourless, colourless** and radioactive **noble gas** (is the heaviest known gas) that comes from naturally occurring uranium in the soil.

U-238 Natural Decay Chain



Radon and cancer

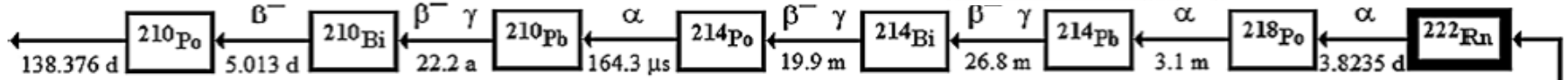
Radon Is A Lung Cancer Causing Gas



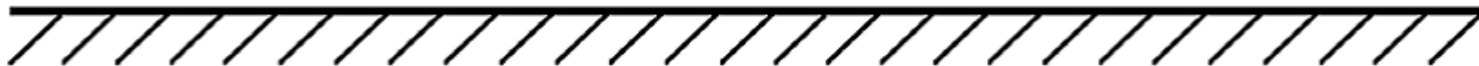
- Radon decay products inhaled.
- Particles irradiate lungs.
- Irradiation can cause lung cancer.

Atmosphere

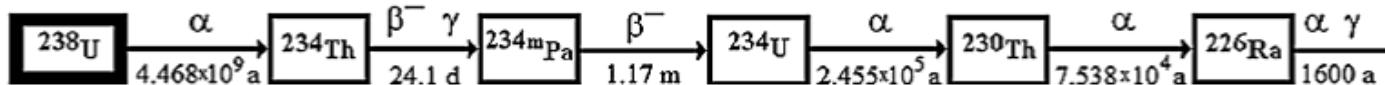
CERTI ©



Attachment to aerosol particle



Soil

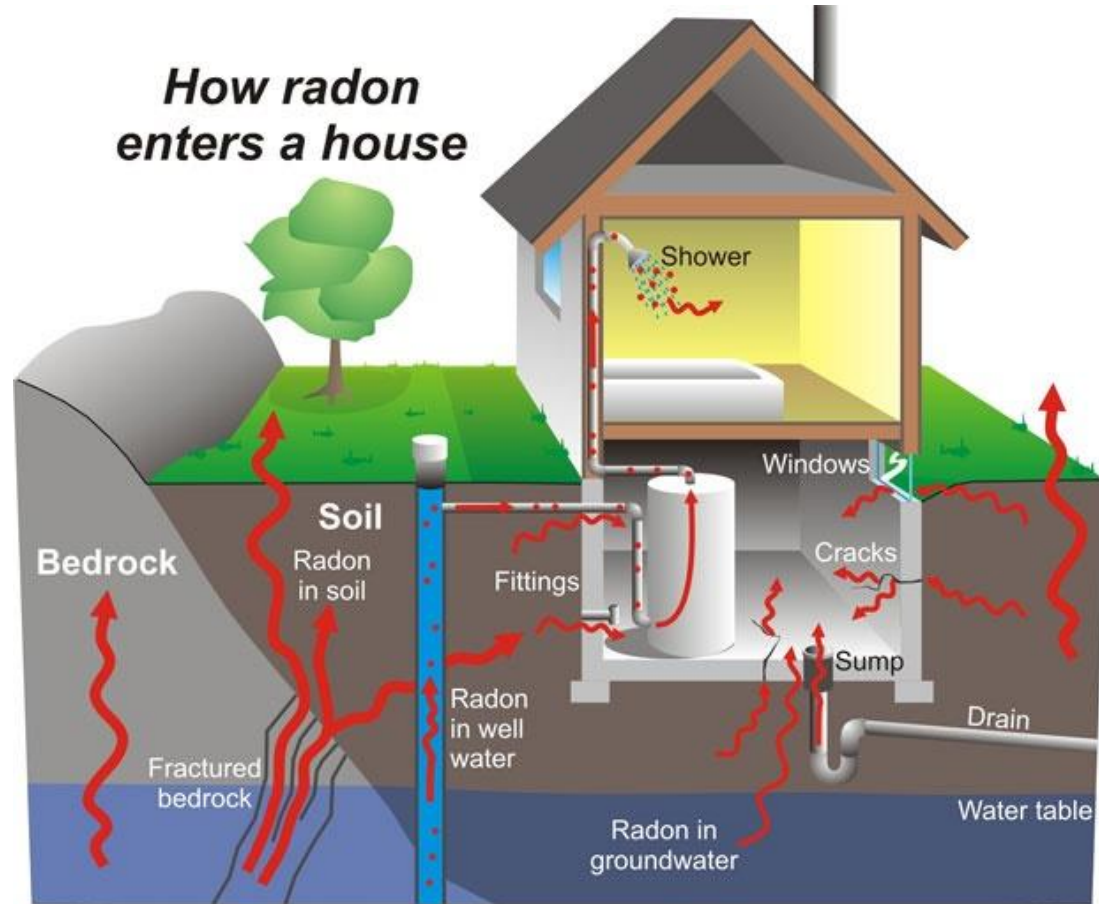


Radon and cancer

- For this reason, some national and international organizations make regulations on radon concentration for environmental health especially for cancer risk. Radon has been established to be a **Group 1** and **Group A** human **carcinogen**, according to the classification used by the International Agency for Research on Cancer (**IARC**) and by the US Environmental Protection Agency (**EPA**), respectively.
- While the World Health Organization (WHO) recommends that the upper limit of water radon activity as **100 Bq/l**, USEPA recommends it as **11.1 Bq/l**.

How does Radon Enter a Home?

How radon enters a house



- **Cracks** in solid floor
- **Construction joints**
- **Cracks** in Walls
- **Gaps** in Suspended Floors
- **Gaps** around **Service Pipes**
- **Cavities** Inside Walls
- **Construction Materials**
- **THE WATER SUPPLY**

Radon in Water



Radon is **soluble** in water and its solubility **increases** rapidly with **decreasing temperature**.

The radon gas later **escapes from the water and goes into the air**, raising the room's radon content. An average concentration of radon in water of **10 kBq.m⁻³** implies a contribution of **1 Bq.m⁻³** to radon in air.

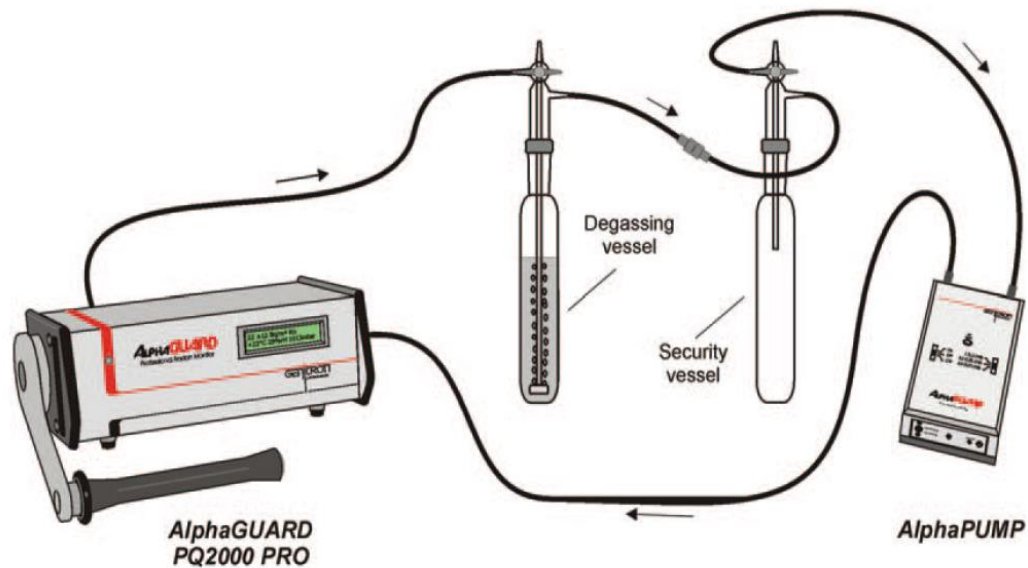
Radon and Geology



- A high ^{222}Rn potential has been reported in **granites**, metamorphic rocks and various types of sedimentary rocks.
- **Acidic rocks** like **granites** and rhyolites are characterized by higher radium concentration.
- Radon is usually present in significant concentrations in those groundwater that have been **in contact with granite rocks**, slates, as well as sandstone and limestone.

Materials and Methods

Schematic view of the experimental set-up



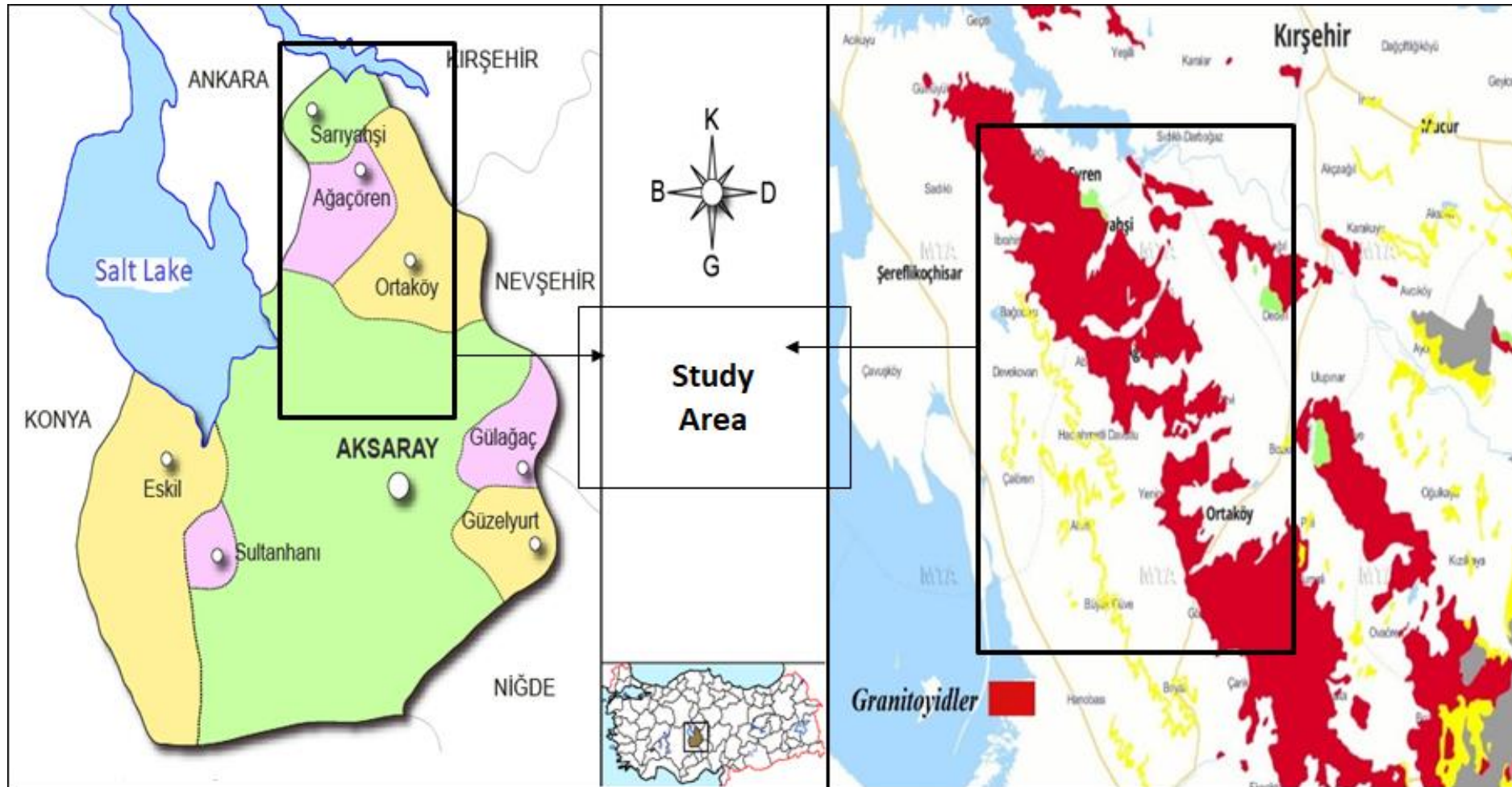
Water radon concentration measurements were carried out by using **AlphaGUARD PQ 2000 PRO** radon monitoring system.

Ingestion:

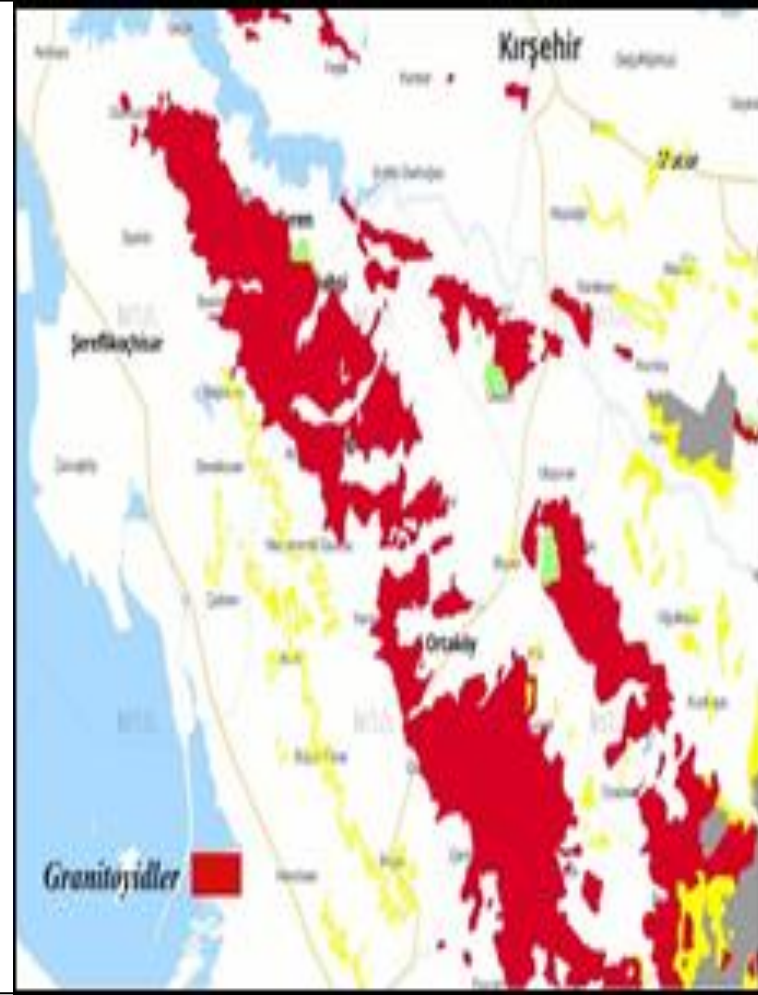
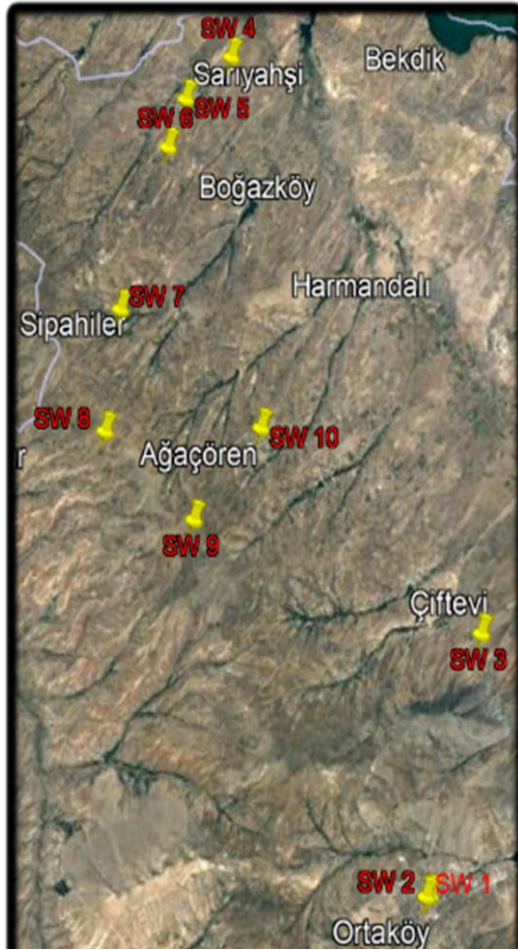
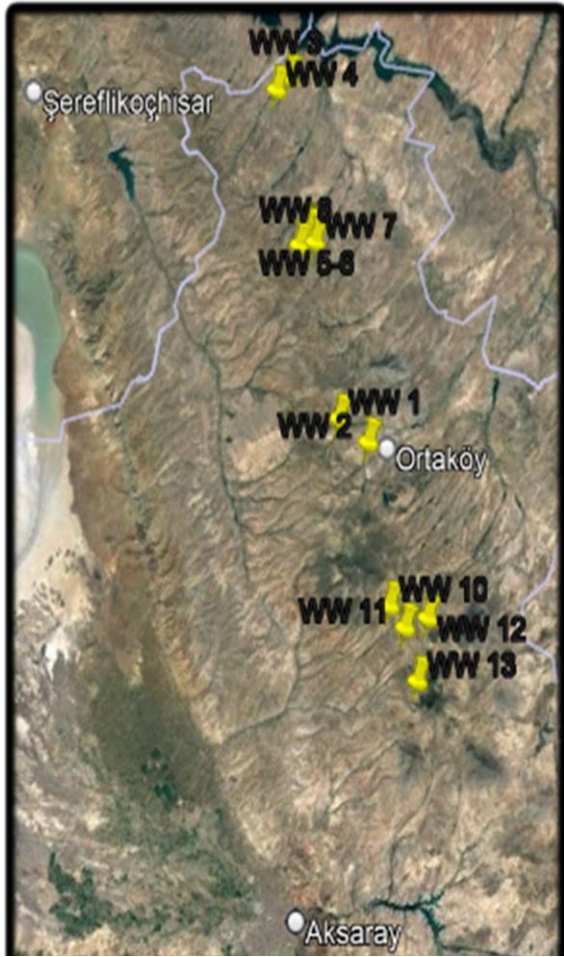
$$10 \text{ kBq m}^{-3} \times 60 \text{ l y}^{-1} \times 10^{-3} \text{ m}^3 \text{ l}^{-1} \times 3.5 \text{ nSv Bq}^{-1} = \mathbf{0.002 \text{ mSv}}$$

Study Area

- Study area in the Central Anatolian Region of Turkey, on the E and SE of Ankara, there is a magmatic and metamorphic rocks assemblage known as "Central Anatolian Crystalline Complex".
- Central Anatolian Granitoids have monzogranite, quartz monzonite, granite and granodiorite composition in general.



Study Area

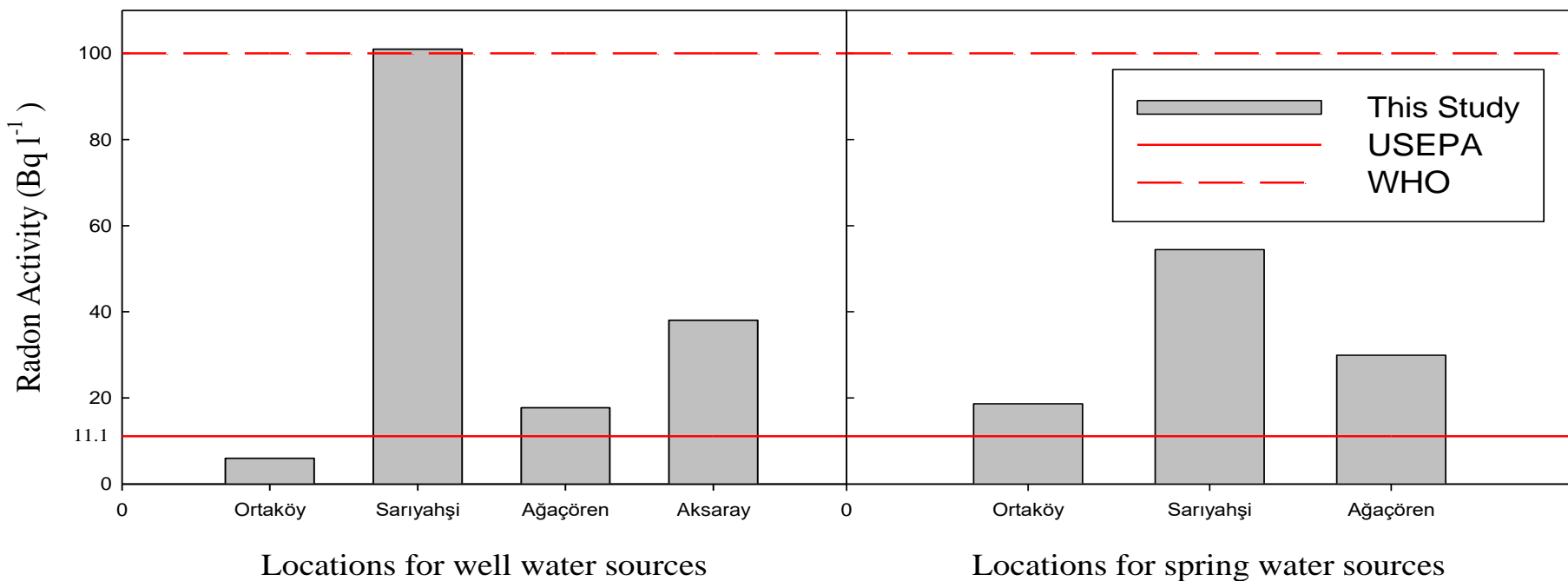


RESULTS

Sample No	Location	Coordinates	Deep (m)	Radon Activity (Bq/l)	AED for Ingestion (mSv)
WW1	Ortaköy	38° 44' 11" N, 33° 59' 11" E	60	0.83±0.09	0,0001
WW2	Ortaköy	38° 43' 28" N, 34° 01' 34" E	90	11.10±0.44	0,0023
WW3	Sarıyahşi	38° 59' 19" N, 33° 51' 13" E	102	171.67±10.59	0,0360
WW4	Sarıyahşi	38° 58' 35" N, 33° 50' 29" E	24	30.27±7.20	0,0063
WW5	Ağaçören	38° 52' 20" N, 33° 54' 47" E	17	13.67±3.45	0,0028
WW6	Ağaçören	38° 52' 20" N, 33° 54' 47" E	30	22.36±0.36	0,0046
WW7	Ağaçören	38° 51' 58" N, 33° 55' 15" E	72	5.93±0.53	0,0012
WW8	Ağaçören	38° 51' 37" N, 33° 54' 10" E	35	25.37±1.15	0,0053
WW9	Ağaçören	38° 52' 29" N, 33° 54' 39" E	24	21.25±1.92	0,0044
WW10	Aksaray-Çekiçler	38° 36' 22" N, 34° 05' 03" E	40	103.56±7.71	0,0217
WW11	Aksaray-Borucu	38° 35' 35" N, 34° 06' 24" E	60	28.09±3.90	0,0058
WW12	Aksaray-Yanyurt	38° 36' 17" N, 34° 07' 53" E	52	2.91±1.59	0,0058
WW13	Aksaray-Koyak	38° 33' 21" N, 34° 07' 55" E	32	17.60±2.43	0,0058

Sample No	Location	Coordinates	Radon Activity (Bq/l)	AED for Ingestion (mSv)
SW1	Ortaköy	38° 44' 08" N, 34° 02' 15" E	18.63±1.43	0,0039
SW2	Ortaköy	38° 44' 11" N, 34° 02' 21" E	25.01±2.96	0,0052
SW3	Ortaköy	38° 49' 26" N, 34° 02' 26" E	12.26±0.69	0,0026
SW4	Sarıyahşi	38° 59' 42" N, 33° 51' 35" E	17.45±1.04	0,0036
SW5	Sarıyahşi	38° 58' 35" N, 33° 50' 29" E	143.70±2.53	0,0301
SW6	Sarıyahşi	38° 57' 30" N, 33° 50' 16" E	27.16±4.29	0,0057
SW7	Sarıyahşi	38° 53' 58" N, 33° 49' 53" E	29.50±3.70	0,0061
SW8	Ağaçören	38° 51' 28" N, 33° 50' 12" E	53.85±0.76	0,0113
SW9	Ağaçören	38° 50' 11" N, 33° 53' 22" E	22.95±1.03	0,0048
SW10	Ağaçören	38° 52' 20" N, 33° 54' 47" E	12.91±0.63	0,0027

COMPARISON WITH INTERNATIONAL STANDARDS



Comparison with Other Studies

Water Type	Radon Concentration (Bq/L)	Country
Well water	0.42-28.82	Turkey (Afyon)
Well water	1.46–63.64	Turkey (Bursa)
Well water	1.44–27.45	Turkey (Konya)
Well water	0.01-11.51	Poland
Well and Spring water	0.91–49.6	Lebanon
Well water	1.78–39.75	Mexico
Hot Spring Water	3.18 - 46.9	India (Bakreswar)
Hot Spring Water	18.64-8507.48	Tailand (Gulf)
Spring Water	<2.5 - 274	Slovakia
Spring Water	0.34-341	Kosovo
In This Study(Well-Spring)	0.83-171.67	Turkey (Central Anatolia)

Results

- The most of the water sources we analyzed have **higher radon activity levels than USEPA standards**, yet **only a few are above WHO standards**.
- Although it is expected to have a positive correlation between underground water depth and radon concentration, **this is not seen in our data**. This can be explained by the variation in the surface structure of the water sources.
- It can be interpreted that groundwaters with **low radon concentration** have **less interaction with granitic rocks and/or aquifers** are units with different composition and origin, but groundwaters with **high radon concentration** (SW5, SW8, WW3 and WW10) **interact with granitic rocks for a longer time**.

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Thank you for your attention...

Peace at the home peace in the world...

Mustafa Kemal ATATÜRK