Some investigations about radon in groundwater from El-Hodna Chott region (Algeria)

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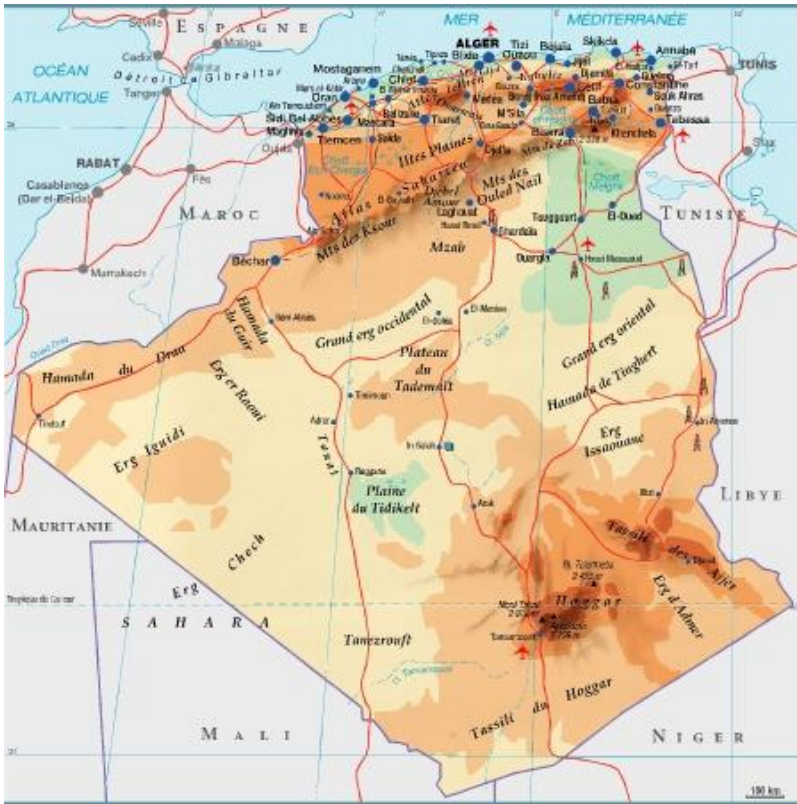
Where I am From??



Location: 36°42’N 3°13’E
Area :2,381,741 km²
Population : 37,100,000

Intoduction

The concentration of water naturally dissolved radon varies over a wide range depending upon location and the environmental conditions where the samples occur.

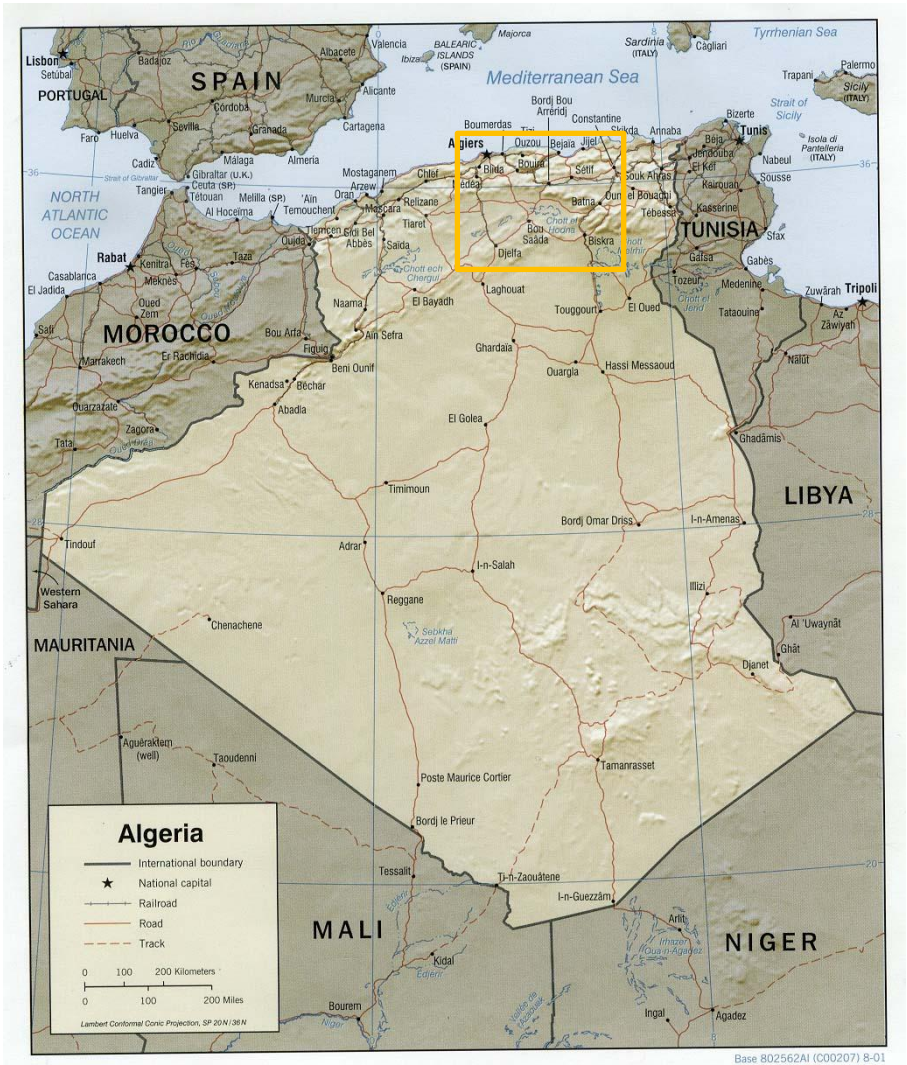
- In surface waters, radon levels are generally very low, in the range of a few Bq/l.
- In underground water, radon concentration ranges from 1 to 50Bq/l for sedimentary aquifers, from 10 to 300Bq/l in very deep wells and from 100 to 50000Bq/l for crystalline rocks groundwaters

In Algeria, drinking water is harvested in most of the time from surface waters but in some inland semi-arid and arid areas, groundwater is used as the main drinking water source.

This is the case for the investigated region of El-Hodna Chott area in the north east of Algeria, where measurements of water radon concentrations have been performed.

Localisation

The Hodna plain, about 200km south-east of Algiers, is one of many depressions that exists in the North-African high plateaus extending from Tunisia to Morocco.

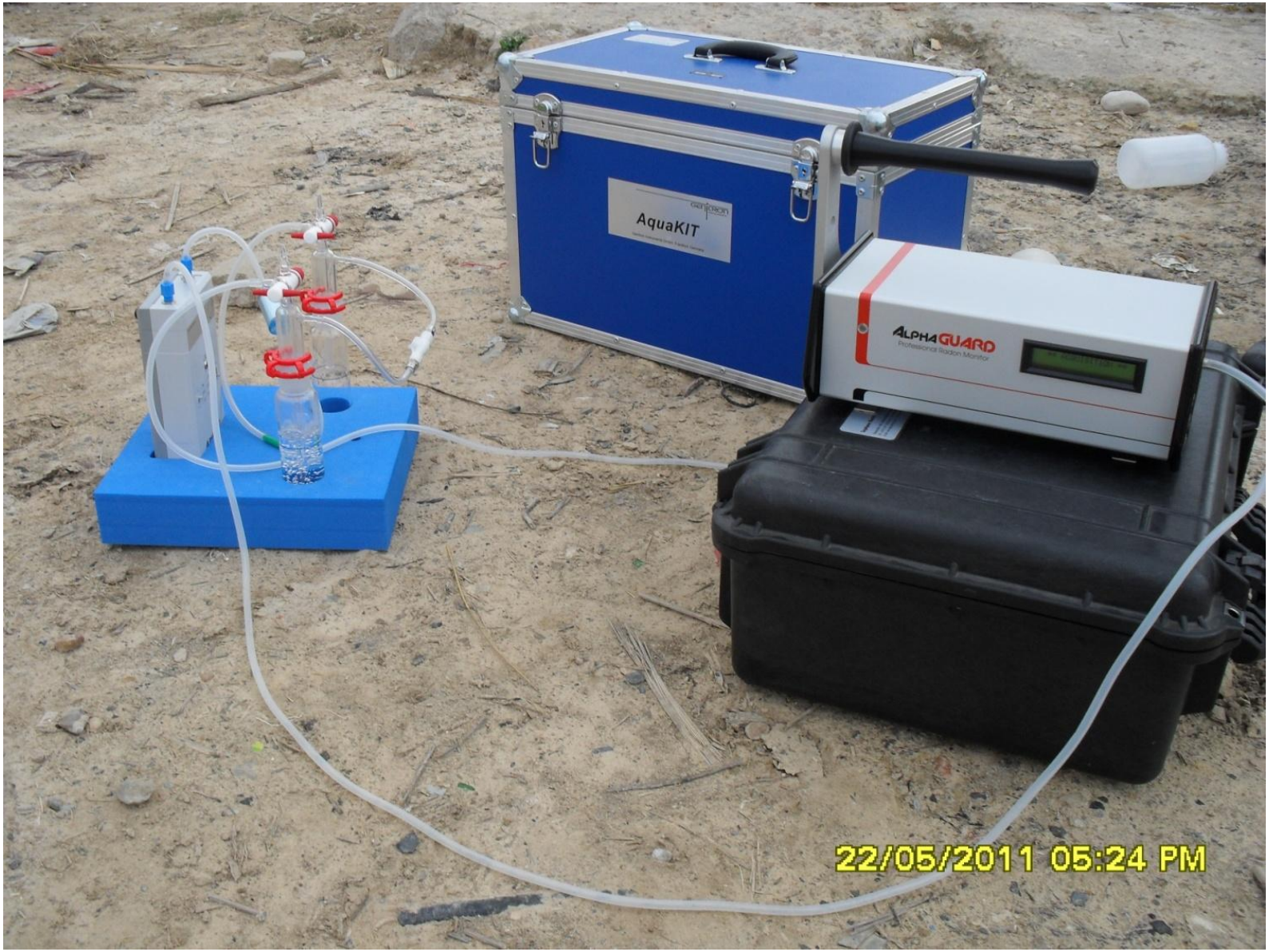


Geological context

The Hodna catchment area is about 26.000km^2 with the Chott El-Hodna right in the middle.

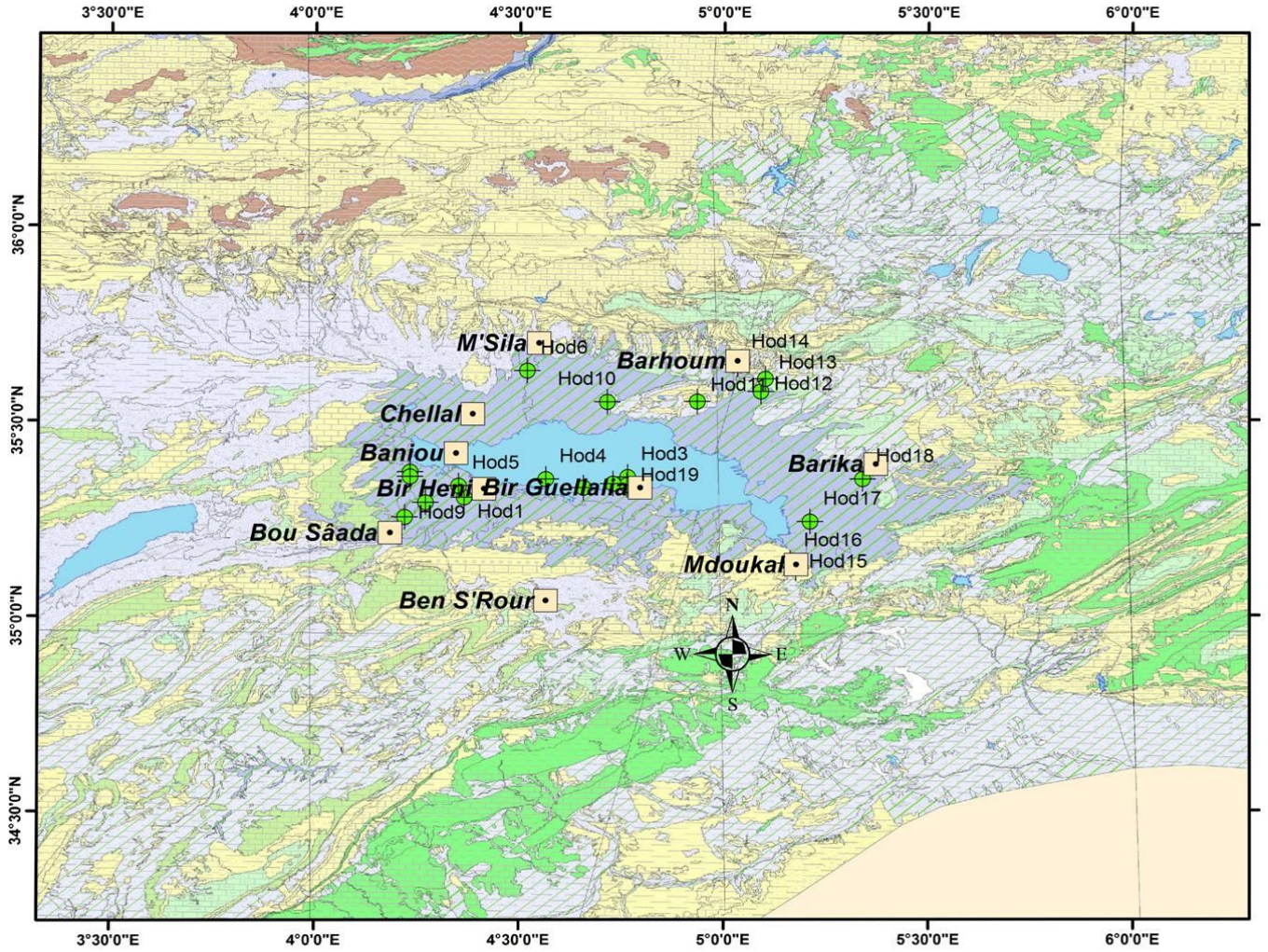
It is a semi-arid salt plain of more than 1000km^2 occurring at an elevation of 400m above mean sea level, where the runoff water convoyed by wadis rapidly evaporates leaving salt deposits.

Experimental procedure



Sampling

- 18 Groundwater samples (15 from M'sila and 03 from Batna), was carried out around the whole considered basin in Batna and M'sila districts,



Sampling

- A measurement time cycle of 1 min has been used in this flow mode.

- The study was undertaken during the dry season (May–June 2011).
- mean relative humidity is ranged from 21% to 78.5%
- mean temperature variations is from 20°C to 38°C
- pH, temperature and conductivity of the water samples were measured in the field using a portable water-analysis kit model: multi 340i [WTW germany]

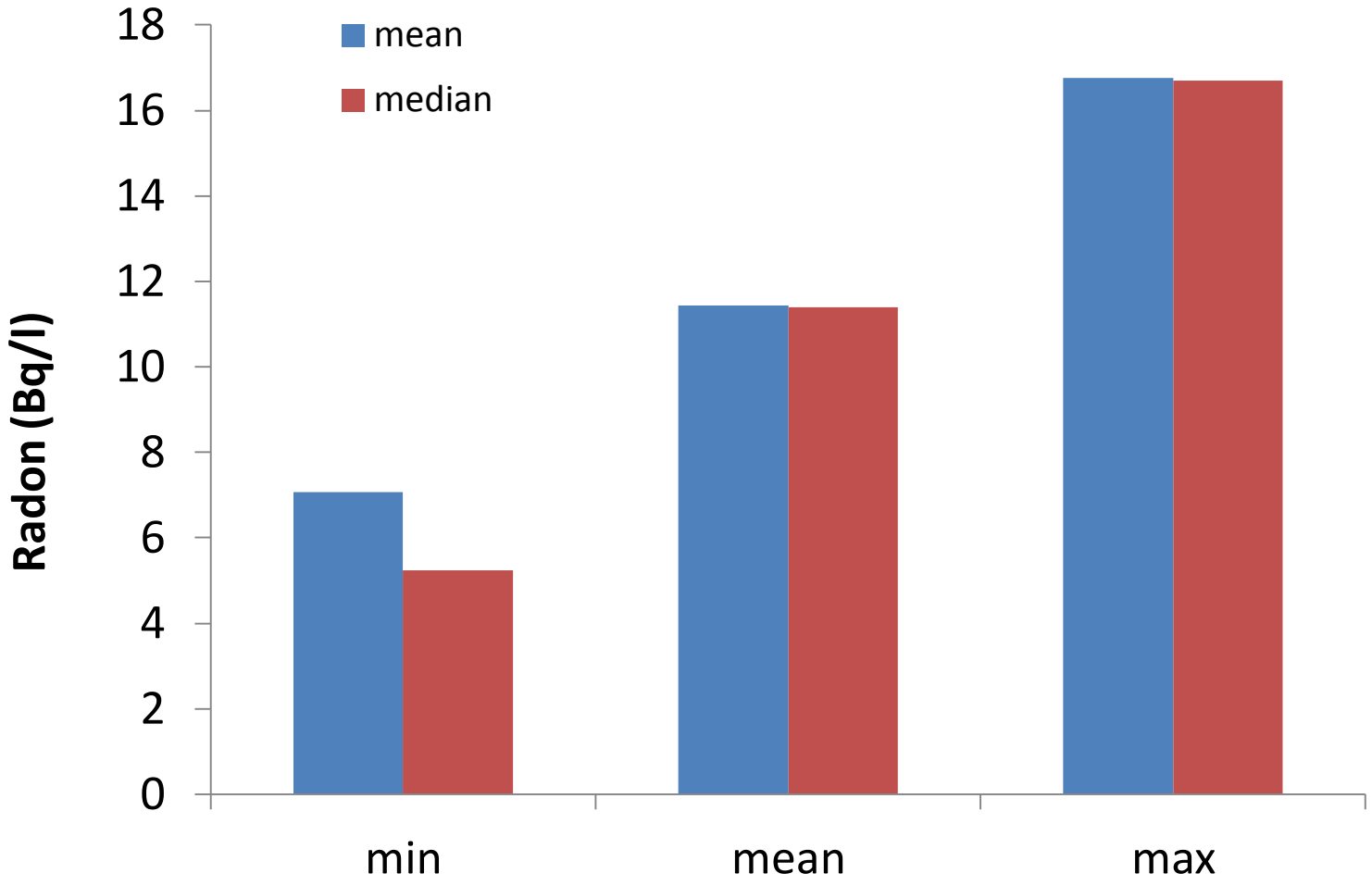
Determination of the ^{222}Rn concentration in water

$$C_{Water} = \frac{C_{Air} \cdot \left(\frac{V_{system} - V_{sample}}{V_{sample}} + K_{Os}(T) \right) - C_0}{1000}$$

- C_{Water} is the ^{222}Rn concentration in the water sample [Bq/l];
- C_0 and C_{Air} are the radon concentrations [Bq/m^3] in the measuring setup respectively before and after introducing the water samples;
- V_{system} and V_{sample} are respectively the interior volume of the measurement assembly [1138.5ml] and the volume of the water sample [100ml];
- k_{Os} is the radon distribution coefficient depending on temperature. It is equal to 0.254 at 20°C as calculated using Hunyadi's formalism

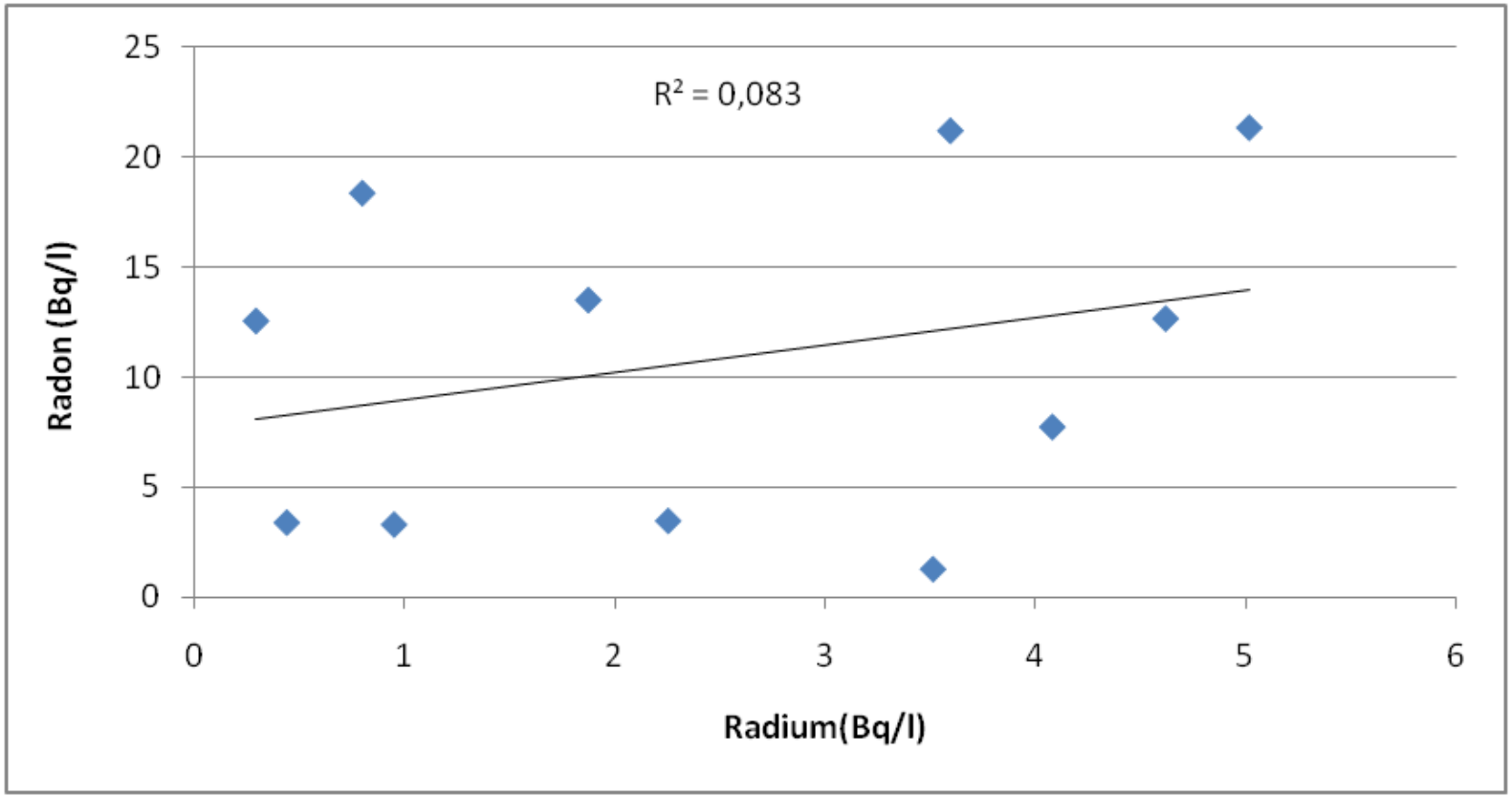
Ref.	Name and Geographic Location	C_{Water} (Bq/l)
Hod1	M'cif (35°18’5.55"N ; 4°21’43.92" E)	3.2 – 3.5 (3.3)
Hod2	M'cif (35°19’35.49"N ; 4°39’15.94"E)	2.2 – 4.0 (3.2)
Hod3	Bir Hannet (35°21’12.82"N ; 4°45’46.21"E)	2.8 – 4.0 (3.5)
Hod4	M'cif (35°20’52.75"N ; 4°33’46.63"E)	3.0 – 3.8 (3.4)
Hod6	Mezrir (35°37’34.06"N ; 4°31’2.04"E)	12.7 – 14.0 (13.5)
Hod7	Maârif (35°22’0.81"N ; 4°13’48.84"E)	17.5 – 19.7 (18.4)
Hod8	Maârif (35°21’19.71"N ; 4°13’48.8"E)	16.0 – 29.9 (21.2)
Hod9	Bousâada (35°15’5.76"N ; 4°13’2.44"E)	14.5 – 34.4 (23.4)
Hod10	BouHmadou (35°22’43.98"N ; 4°42’47.11"E)	6.0 – 18.1 (12.7)
Hod11	Ain Khadra (35°32’49.38"N ; 4°55’58.53"E)	14.5 – 32.6 (21.3)
Hod12	Ain Khadra (35°34’21.29"N ; 5°0’20.94"E)	2.5 – 33.1 (21.7)
Hod13	Magra (35°36’15.94"N ; 5°6’0.38"E)	7.3 – 20.1 (12.6)
Hod15	M'doukal (35°7’12.06"N ; 5°10’27.56"E)	4.8 – 12.9 (7.8)
Hod16	M'doukal (35°7’58.14"N ; 5°9’38.95"E)	0.1 – 4.1 (1.3)
Hod17	Bitam (35°14’21.57"N ; 5°12’33.03"E)	5.6 – 17.0 (9.7)
Hod18	Barika (35°20’53.1"N ; 5°20’15.17"E)	7.8 – 23.1 (12.8)
Hod20	M'cif (35°20’10.34"N ; 4°43’37.1"E)	4.9 -16.5 (10.2)
Hod21	Bousâada (35°17’18.17"N ; 4°16’5.86"E)	2.1 – 11.2 (5.9)

RESULTS (1) : The average ^{222}Rn concentration groundwater for the 18 measured boreholes



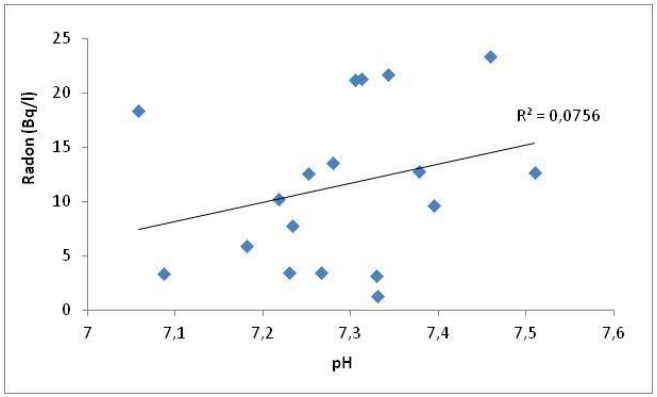
General scale: all the measured data

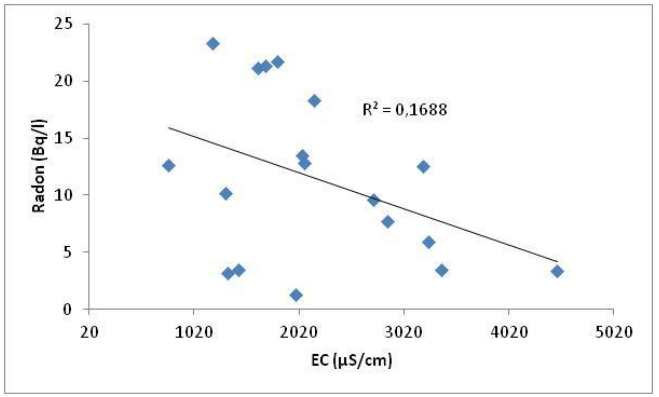
RESULTS (2): Correlation between Radon concentration and Radium concentration ?

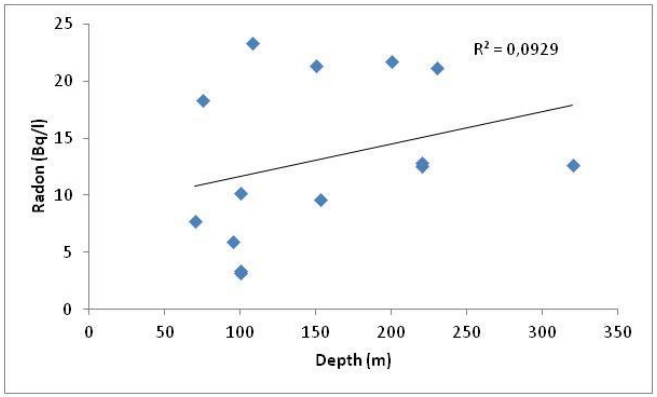


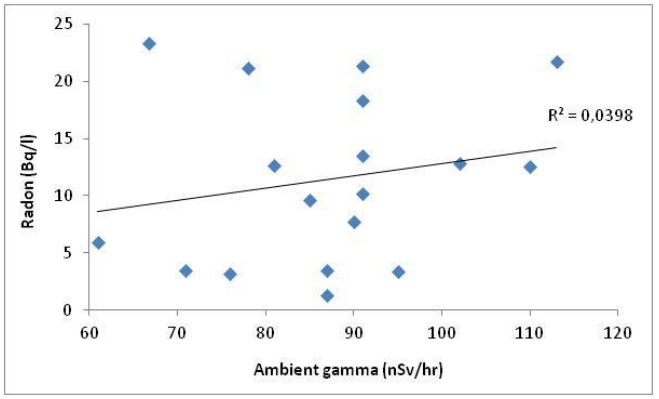
Radon vs. Radium

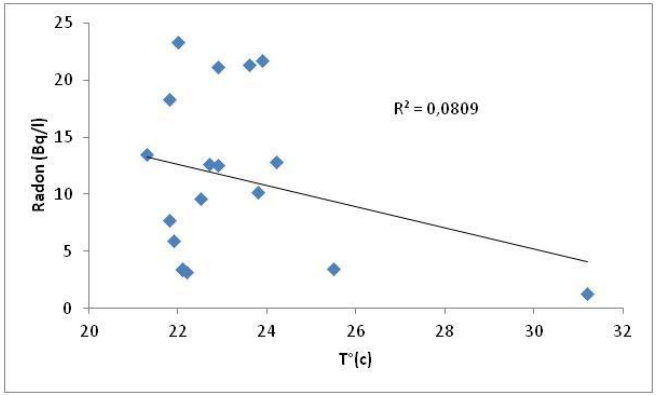
RESULTS (3): Correlation between Radon concentration and physicochemical parameters of water ?

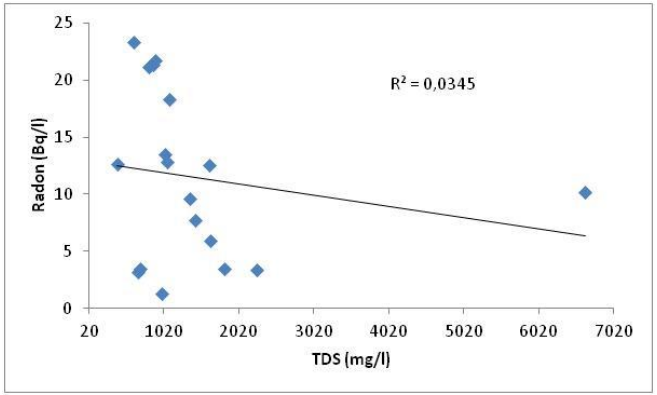




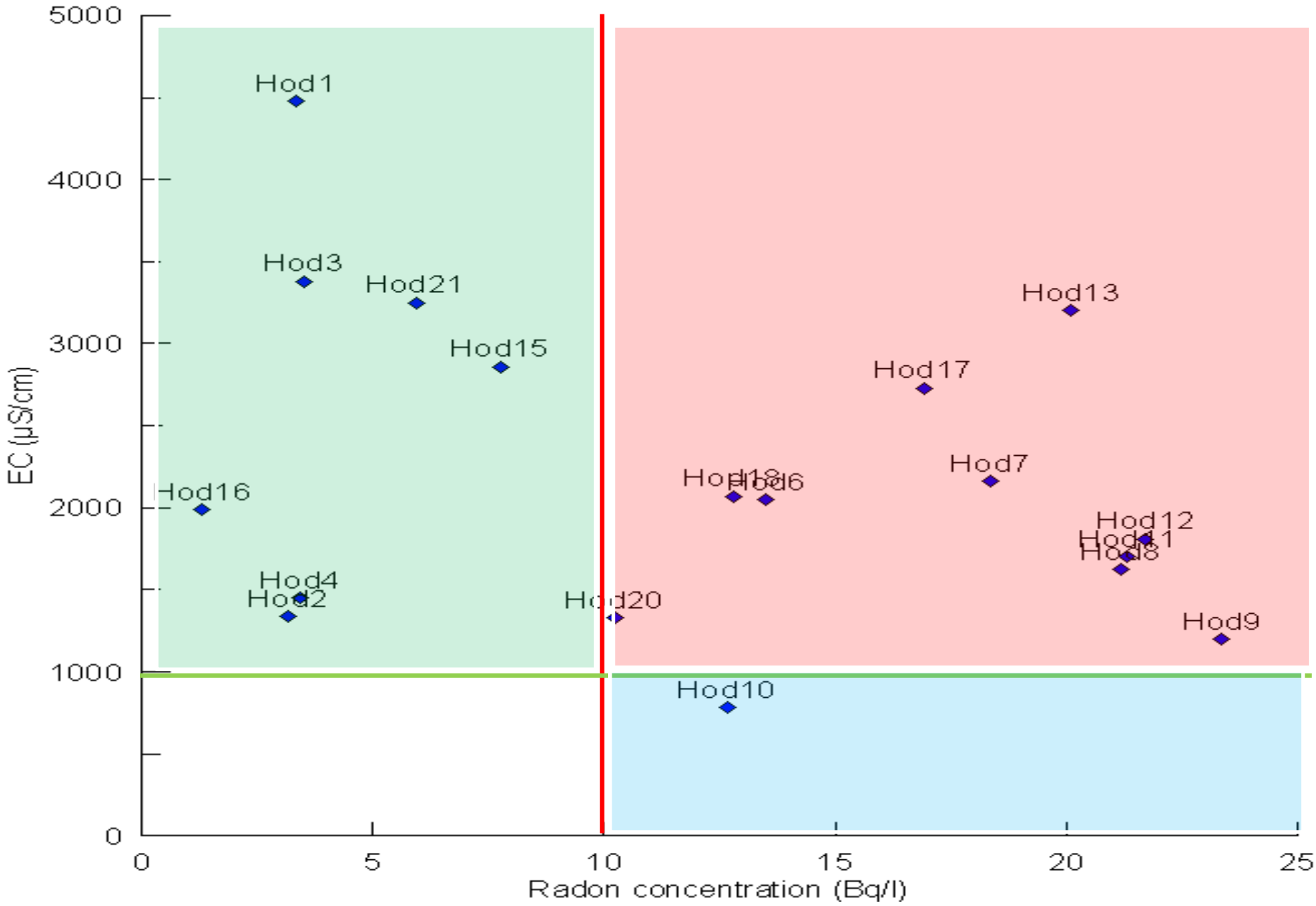




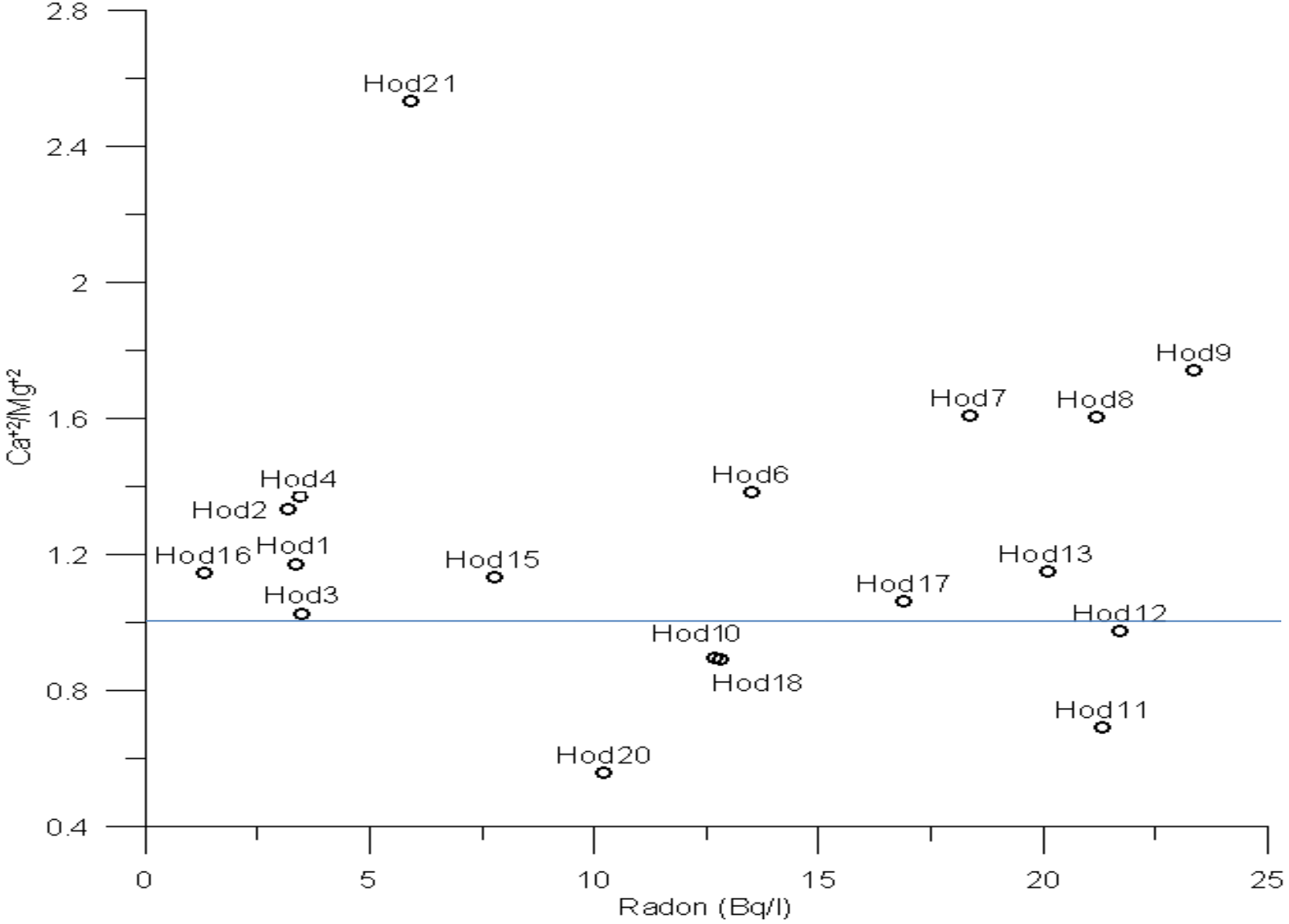




Discussion (1): EC Vs Radon concentration

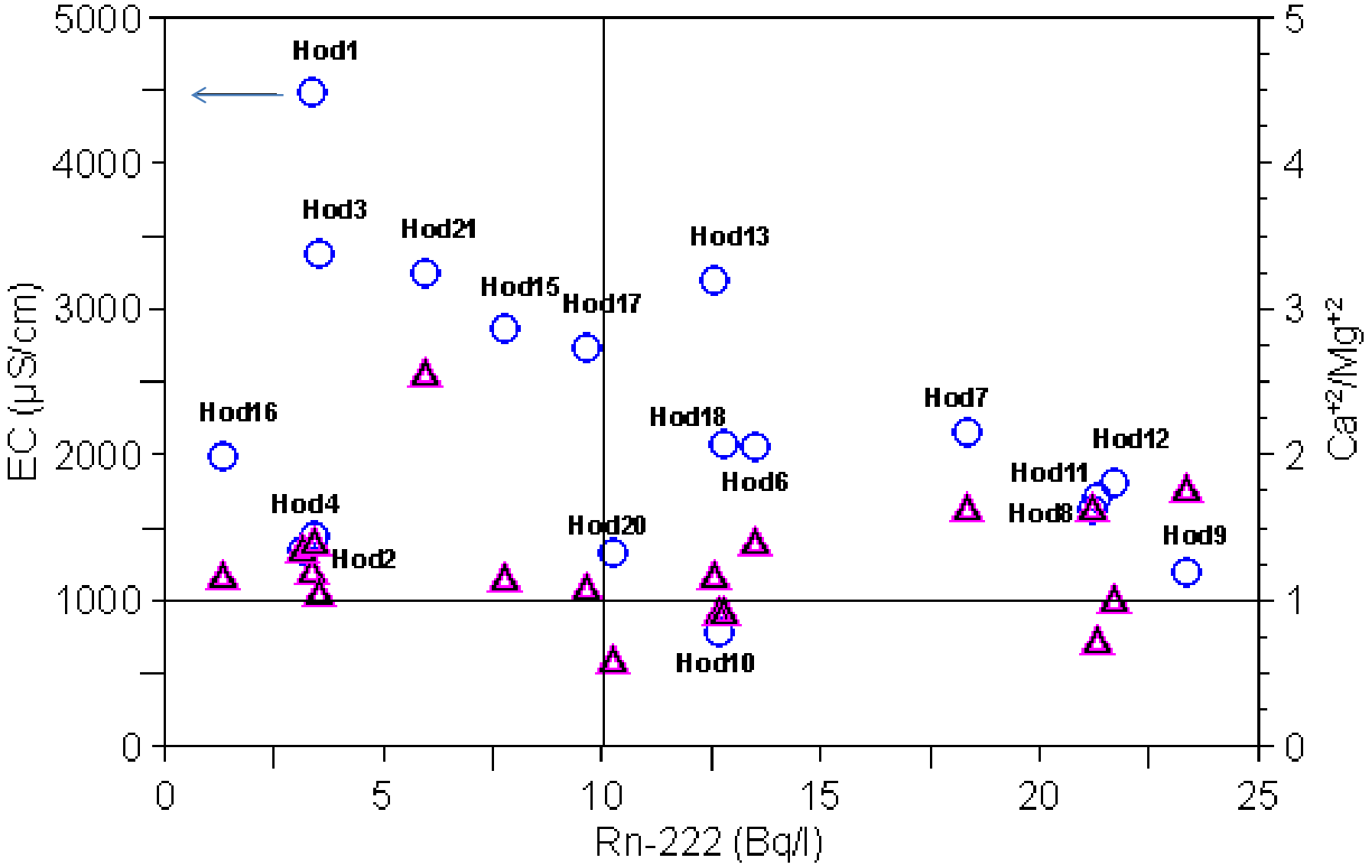


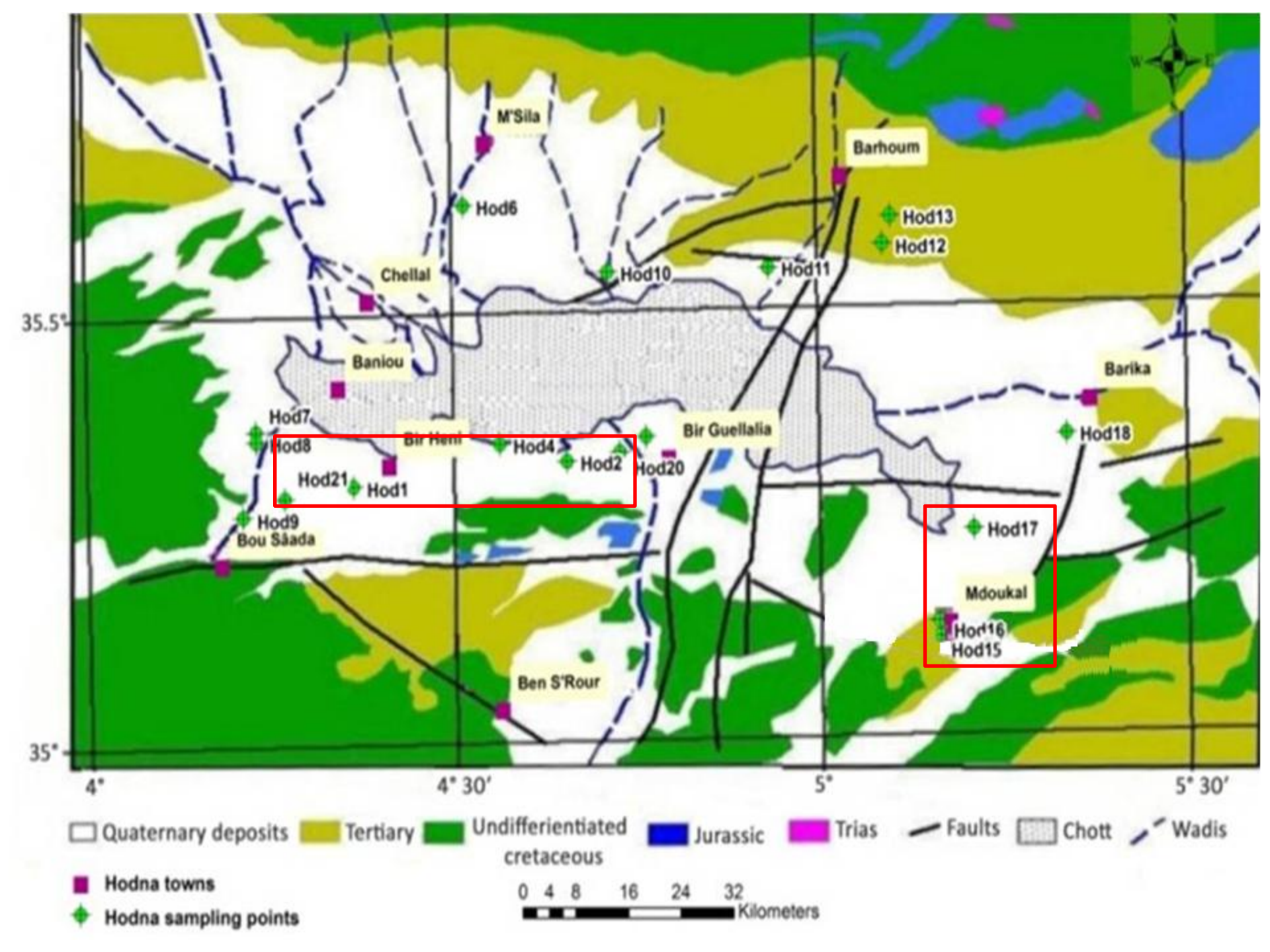
Discussion (2): Ca^{+2}/Mg^{+2} Vs Radon concentration

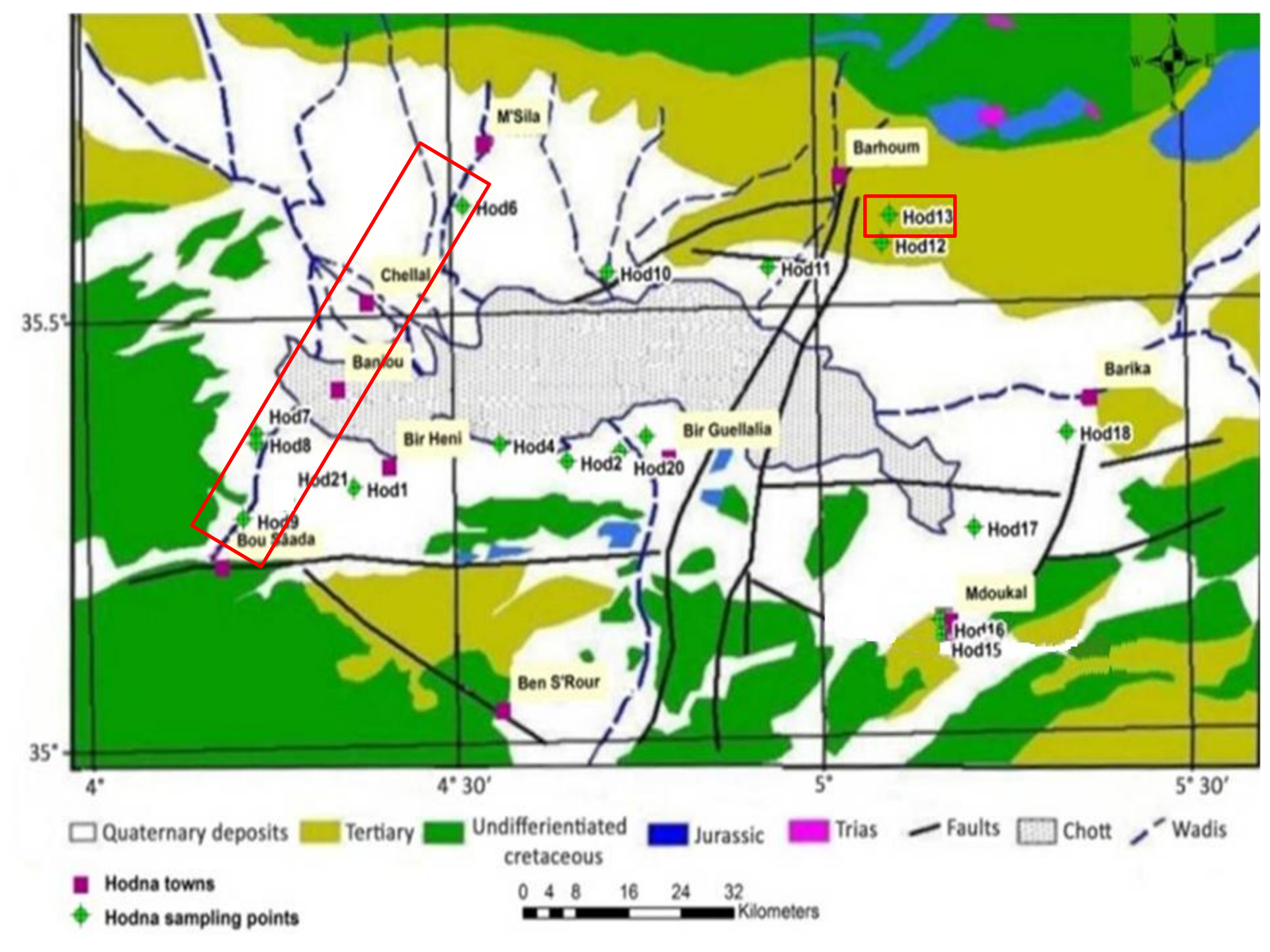


EC vs. Radon

Ca^{+2}/Mg^{+2} vs. Radon




M'Sila
Barhoum
Hod6
Hod13
Hod12
Chellal
Hod10
Hod11
35.5°
Baniou
Barika
Hod7
Hod8
Bir Guellalia
Hod18
Hod4
Hod2
Hod20
Hod21
Hod1
Hod17
Hod9
Bou Sâada
Mdoukal
Hod16
Hod15
Ben S'Rour
35°
4°
4° 30′
5°
5° 30′
Quaternary deposits
Tertiary
Undifferientiated cretaceous
Jurassic
Trias
Faults
Chott
Wadis
Hodna towns
Hodna sampling points
0 4 8 16 24 32
Kilometers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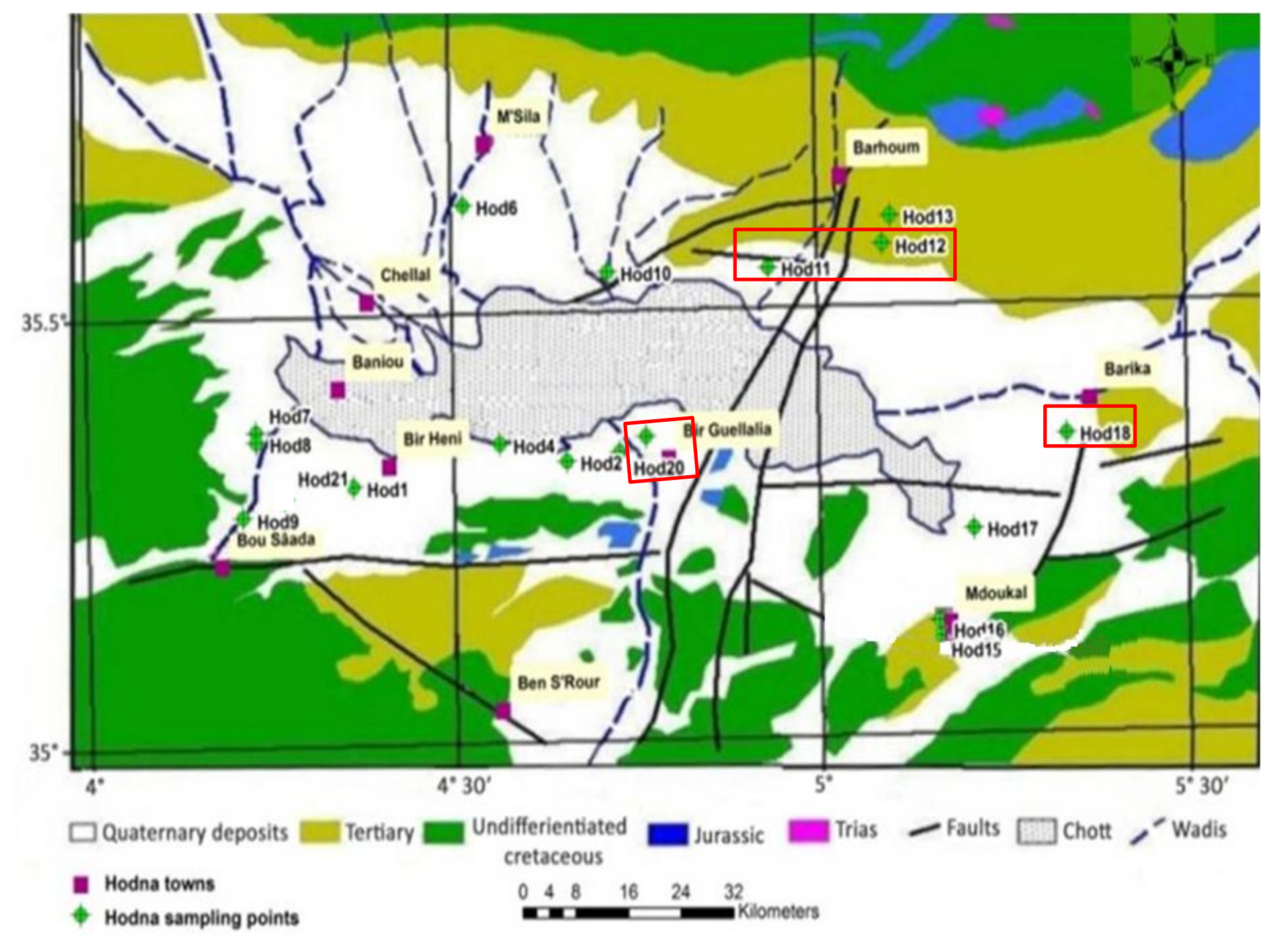
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0 4 8 16 24 32
Kilometers

Health Risk

$$D_{Rn} = C_{Rn} \times G \times L$$

- *C* is the measured activity of ^{222}Rn in water [Bq/l],
- *L* is the volume of water intake for one individual per one year – depending on the age [l/year], [730 l/year]
- *G* is the conversion dose factor for ^{222}Rn,
- [G= 3.5×10^{-6} mSv/Bq] (adult).

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Code	Range (mSv/y)	D_{moy} (mSv/y)	γ rate (nSv/hr)
Hod1	0,01 – 0,01	0,01	95,00
Hod2	0,01 – 0,01	0,01	76,00
Hod3	0,01 – 0,01	0,01	87,00
Hod4	0,01 – 0,01	0,01	71,00
Hod6	0,03 – 0,04	0,03	91,00
Hod7	0,04 – 0,05	0,05	91,00
Hod8	0,04 – 0.08	0,05	78,00
Hod9	0,04 – 0,09	0,06	66,74
Hod10	0,02 -0,05	0,03	81,00
Hod11	0,04 – 0,08	0,05	91,00
Hod12	0,01 – 0,08	0,06	113,00
Hod13	0,02 – 0,05	0,03	110,00
Hod15	0,01 – 0,03	0,02	90,00
Hod16	0,00 – 0,01	0,00	87,00
Hod17	0,01 – 0,04	0,02	85,00
Hod18	0,02 – 0,06	0,03	102,00
Hod20	0,01 – 0,04	0,03	91,00
Hod21	0,01 – 0,03	0,02	61,00

Water types: Algeria

Water type	Radon activity (Bq/l)	References
Ground waters	0.05–34.35	This work
Thermal waters	0.10–211.4	Not communicated yet
Spring waters	5.31–10.65	Not communicated yet
Tap water	0 – 0.27	Not communicated yet

Water type: Groundwater

Radon activity (Bq/l)	References	Country
0.05–34.35	This work	Algeria
0.89–35.44	Alabdulua' ali (1999)	Saudi Arabia
24.00–40.00	Hopke et al. (2000)	USA
25.47–784.11	Lima and Bonotto (1996)	Brazil
0.95–36.00	Marques et al. (2004)	Brazil

Conclusion

- Groundwater samples collected from boreholes around El-Hodna Chott in Algeria have been studied regarding radon concentrations.
- The radon levels that were found (0.1-34.4Bq/l) are mainly lower than the limit fixed by the European drinking water directive (100Bq/l) (EC 2001).
- El Hodna Chott is an sedimentary aquifer, because Well bored have Radon concentration in the range (10-50 Bq/l).
- it could be deduced that high radon concentrations are associated to the presence of identified major or hypothetical faults.

Thank You for your kind attention