Journal of Georgian Geophysical Society,
Issue (A), Physics of Solid Earth, v.15a, 2011-2012, pp. 128-137

Radon and thoron measurements in West Georgia

[1] Janja Vaupotič, [1] Mateja Bezek, [2] Nino Kapanadze, [2] George Melikadze, [2]Teona Makharadze, [2]Zurab Machaidze, [2]Mariam Todadze

[1] Jožef Stefan Institute (JSI), Ljubljana, Slovenia (Mateja Bezek, Janja Vaupotič)

[2] M. Nodia Institute of Geophysics (GI MES), Ivane Javakhisvili Tbilisis State University, Tbilisi, Georgia (Nino Kapanadze, George Melikadze)

Abstract

The Jožef Stefan Institute, Slovenia and M. Nodia Institute of Geophysics, Ivane Javakhisvili Tbilisis State University, Georgia performed joint measurements of radon (^{222}Rn) and thoron (^{220}Rn) at selected places in Georgia using RTM1688-2 continuous radon/thoron monitor (Sarad, Germany) and a set of alpha scintillation cells with an alpha counter (SMM, Czech Republic). Radon in indoor air was measured in indoor air at some places in Tskaltubo, in cave air in the Sataplia Cave and Prometheus Cave, and in thermal waters in Tskaltubo areas. The highest radon concentrations in the air have been found in karst caves, up to 3100 Bq m^{-3}. In thermal waters, the highest radon concentration of 93.8 Bq dm^{-3} was found in thermal water in a health resort, measured from the pipe in bathroom.

Introduction

The Jožef Stefan Institute, Slovenia and M. Nodia Institute of Geophysics, Ivane Javakhisvili Tbilisis State University, Georgia performed joint measurements of radon in indoor air, karst caves and in thermal waters at different locations in Georgia, in the period from June 26 to July 16, 2012, within the international project entitled "Balkan, Black Sea, Caucasus, Caspian Network for Complex Research of Earthquake's Forecasting Possibilities, Seismicity and Climate Change Correlations" (BlackSeaHazNet).

1. Measurements performed by the Jožef Stefan Institute, Slovenia (IJS, SLO)

The research group of the Jožef Stefan Institute (PhD Student Mateja Bezek and Prof. Janja Vaupotič) performed measurements of radon (^{222}Rn) and thoron (^{220}Rn) using a portable RTM1688-2 Radon/Thoron Monitor (Sarad, Dresden, Germany) (Figure 1). Air is pumped at a flow rate of 0.3 dm^3 min^{-1} through the chamber in which the high voltage between the wall and a silicon detector causes the positively charged ^{218}Po and ^{216}Po ions, created by ^{222}Rn and ^{220}Rn alpha transformations, respectively, to deposit on the detector. Based on α-spectrometry, activity concentrations of ^{222}Rn and ^{220}Rn are calculated, stored in the internal memory and later transferred to a personal computer for data evaluation [1-3].

Figure 1. RTM1688-2 portable Radon/Thoron Monitor

1. 1. Radon and thoron measurements indoors

Indoor radon and thoron measurement have been carried out in Tbilisi and Tskaltubo. Average duration of measurement was 24 hours, with continuous recording of concentrations ones an hour. Results are summarised in Table 1 and graphically presented in Figures 2 to 5.

Table 1. Average radon (C_{Rn}) and thoron (C_{Tn}) concentrations in indoor air and C_{Tn}/C_{Rn} ratio

Place	**Date in 2012**	**C_{Rn} in air Bq m^{-3}**	**C_{Tn} in air Bq m^{-3}**	**C_{Tn} / C_{Rn}**
Tbilisi – Guest house (1st floor)	24.6. 11:26 – 25.6. 20:26	12.9 ± 5.4	7.2 ± 5.5	0.56
Tbilisi – Tunnel (underground)	26.6. 11:42 – 27.6. 11:42	115 ± 20	28.7 ± 16.5	0.25
Tbilisi – Turkish bath (ground floor)	27.6. 12:55 – 28.6. 16:55	10.0 ± 5.5	6.6 ± 4.6	0.66
Tbilisi – Institute of Geophysics (basement)	29.6. 14:55 – 2.7. 14:55	101 ± 17	13.4 ± 10.1	0.13
Tbilisi – Private house Melikadze (basement)	2.7. 17:53 – 4.7. 10:53	190 ± 24	17.3 ± 11.8	0.09
Tskaltubo – Hotel Imereti (guest room, 1st floor)	12.7. 00:01 – 12.7. 9:01	34 ± 10	6.3 ± 6.0	0.19
Tskaltubo Health Resort (room with swimming pool)	12.7. 11:39 – 12.7. 12:29	1110 ± 115	681 ± 475	0.08

Radon concentrations in indoor air of selected places range from 12.9 to 1110 Bq m^{-3} and thoron concentrations from 6.3 to 681 Bq m^{-3}. In the guest house and in the Turkish bath in Tbilisi high Tn/Rn ratio was observed.

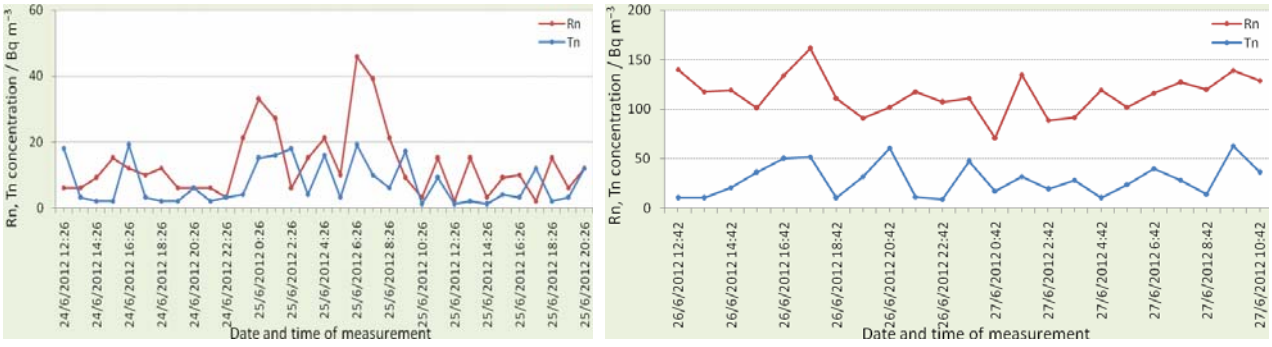

Figure 2. Radon and thoron concentrations in a guest house (1st floor) in Tbilisi and in an underground tunnel in Tbilisi

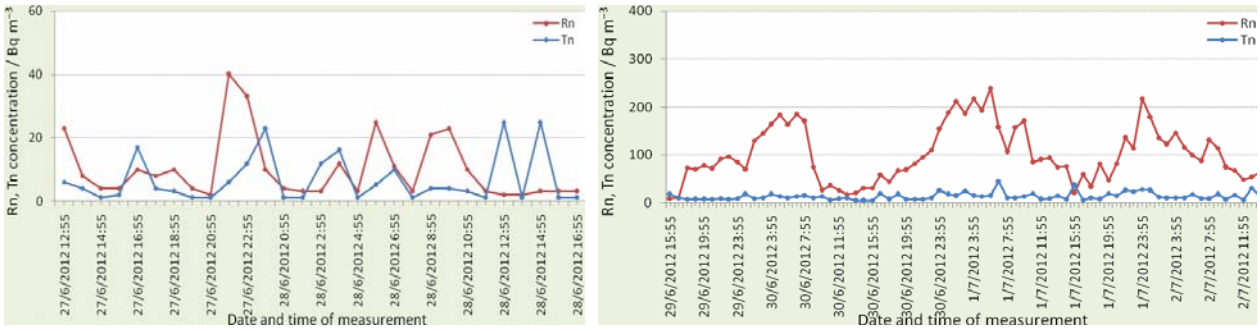

Figure 3. Radon and thoron concentrations in the Turkish bath (ground floor) in Tbilisi and in the basement of the Institute of Geophysics in Tbilisi

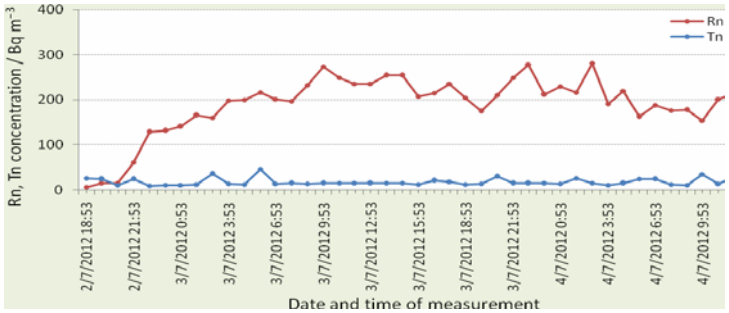

Figure 4. Radon and thoron concentrations in the basement of the private house Melikadze

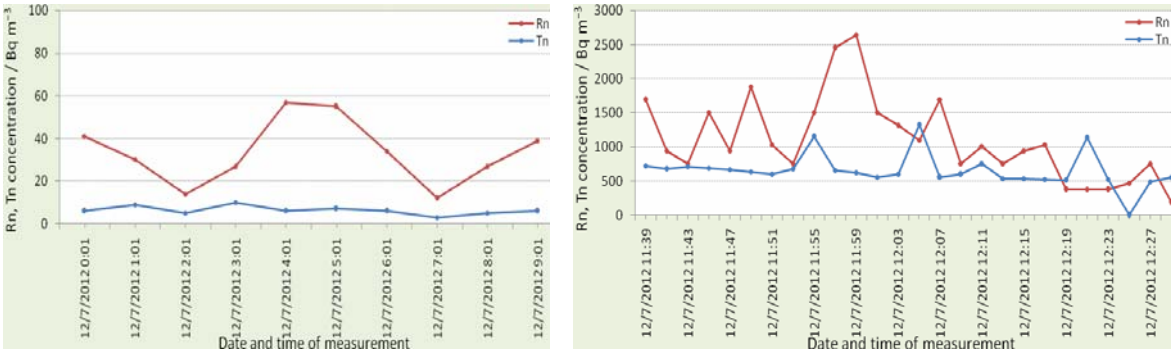

Figure 5. Radon and thoron concentrations in the first floor of the Hotel Imereti and in the room with swimming pool in the Health Resort 2 in Tskaltubo

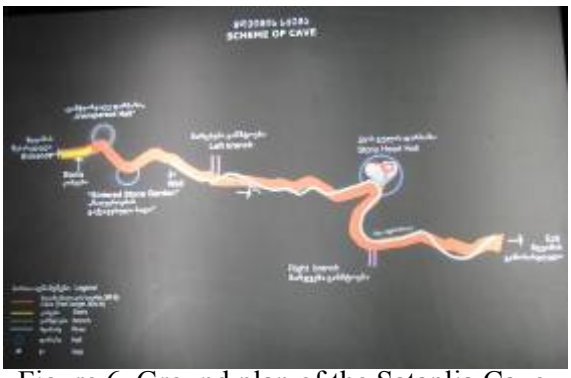

Figure 6. Ground plan of the Sataplia Cave

Figure 7. Ground plan of the Prometheus Cave

1. 2. Radon and thoron measurements in karst caves

Radon and thoron measurements have been performed in two karst caves in Tskaltubo area: (i) Sataplia Cave and (ii) Prometheus Cave. Ground plans of both caves are presented in Figures 11 and 12. Results are summarised in Table 2 and graphically presented in Figures 6 and 7.

Table 2. Radon (C_{Rn}) in thoron (C_{Tn}) concentrations in the Sataplia Cave and Prometheus Cave

Place	Date in 2012	C_{Rn} in air Bq m^{-3}	C_{Tn} in air Bq m^{-3}	C_{Tn} / C_{Rn}
Sataplia Cave				
1. At the entrance, at the cave map	10.7.2012 14:53	1771 ± 266	69 ± 48	0.04
2'. At the end of left branch	10.7.2012 15:13	1995 ± 279	347 ± 239	0.17
2. At the point of left branch	10.7.2012 15:23	2428 ± 316	75 ± 52	0.03
3. Stony heart	10.7.2012 15:43	3094 ± 340	127 ± 88	0.04
3'. At the end of right branch	10.7.2012 15:53	3021 ± 332	85 ± 59	0.03
4. Exit (16 steps before the door)	10.7.2012 16:13	3075 ± 338	109 ± 75	0.04
Prometheus Cave				
1. Colchic Hall	11.7.2012 15:30	193 ± 87	27 ± 19	0.14
2. Medea's Hall	11.7.2012 16:00	880 ± 185	61 ± 42	0.07
3. Hall of Love	11.7.2012 16:20	988 ± 198	41 ± 28	0.04
4. Pass	11.7.2012 16:40	1472 ± 236	55 ± 38	0.04
5. Prometheus Hall	11.7.2012 17:00	1094 ± 208	53 ± 37	0.05
6. Iberia	11.7.2012 17:20	1297 ± 220	144 ± 88	0.11
7. By the Lake	11.7.2012 17:30	1444 ± 231	107 ± 74	0.07

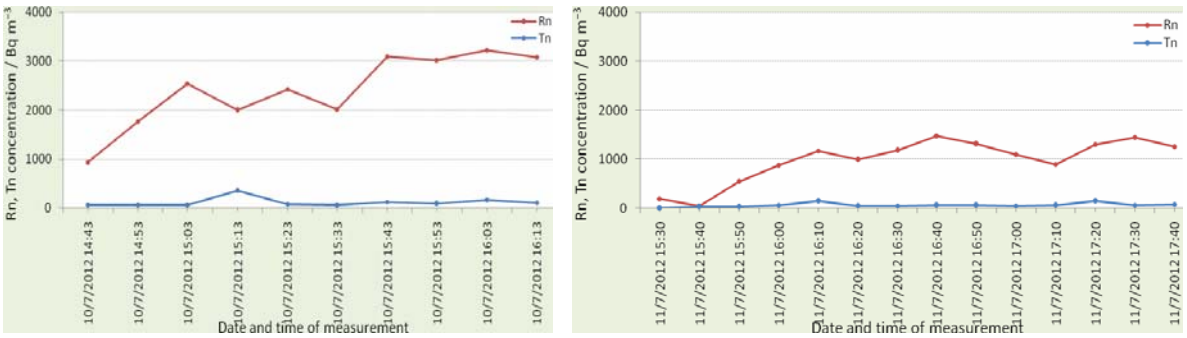

Figure 8. Radon and thoron concentrations in the Sataplia Cave and in the Prometheus Cave

Higher radon and thoron concentrations have been detected in the Sataplia Cave, ranging from about 1800 to 3100 Bq m^{-3} and from 69 to 347 Bq m^{-3}, respectively. In the Prometheus Cave, radon concentration ranged from 193 to 1472 Bq m^{-3} and thoron concentration, from 27 to 144 Bq m^{-3}. There is a relatively low thoron ratio in both caves.

1.3 Radon measurements in thermal waters

Radon has been measured in some selected thermal waters at the Tbilisi and Tskaltubo areas. For that purpose, about 1.5 dm^3 of water was sampled either directly from the borehole or from the bath (as in Health Resort 1 and Health Resort 2 in Tskaltubo) into a plastic vessel (volume 3.5 dm^3) . Water sample was continuously bubbling in a closed loop with the RTM1688-2 monitor for about 20 to 30 minutes to expel the majority of radon from water into air [4]. On the basis of the final radon concentration detected in the air after bubbling was stopped, radon concentration in water was calculated. Results are summarised in Table 3.

Radon concentration in thermal waters ranged from 1.3 to 93.8 Bq dm^{-3}. These values seem to be too low, especially in cases when radon in thermal water was measured directly from the borehole. Because the team was not able to use their sampling system specially designed for such measurement, a great portion of radon might have been escaped during sampling. Therefore, the results in Table 3 should be considered as preliminary and measurements should be repeated with the proper equipment.

Table 3. Radon (C_{Rn}) concentrations in thermal waters

Place	Comment	Date in 2012	C_{Rn} in water* Bq dm^{-3}	C_{Rn} in gas** Bq dm^{-3}
Tbilisi Spring water (cold)	Gas from borehole	4.7.2012 16:35		5.6 ± 2.8
	Water from borehole	4.7.2012 16:44	2.4 ± 1.2	
Tskaltubo 6 (T = 43.7 ºC)	Water from borehole	10.7.2012 11:36	17.6 ± 3.9	
Tskaltubo Health Resort 1	Water from bathroom pipe	10.7.2012 12:09	93.8 ± 9.3	
Tskaltubo Health Resort 2	Water from swimming pool	12.7.2012 11:07	37.3 ± 2.2	

*Due to the difficulties with water sampling, most probably the majority of waters have significantly higher radon concentrations as reported

**Gas was sampled directly from the borehole

2. Measurements performed by the M. Nodia Institute of Geophysics, Georgia (GI MES, GE)

The research team from the Nodia Institute of Geophysics, Ivane Javakhisvili Tbilisis State University, Tbilisi, Georgia (Prof. George Melikadze, Dr. Teona Makharadze, PhD Student Nino Kapanadze) measured radon concentrations, gamma dose rate and the concentration of free ions in the air of karst caves [5, 6], and radon concentration in thermal waters [7, 8].

Radon concentration was measured by alpha scintillation technique. For that purpose, air is sampled directly into a scintillation cell (SC) using a pump or syringe, while from water samples radon is degassed and transferred into a scintillation cell. Most often, alpha activity is measured three hours after sampling when secular equilibrium between radon and its decay products has been reached. Commercially available scintillation cells are made of different materials, are of different size and have different efficiency. The system used was produced by SMM Company, Prague, Czech Republic (Figure 9 a).

Gamma dose rate has been measured with a Radiation Monitor (Atomtex, Belarus) (Figure 9 b) and free ions with an Air ion counter (AlphaLab Inc., USA) (Figure 9 c).

a) b) c)

Figure 9. a) Alpha scintillation cell and counter, b) Gamma dose rate monitors and c)Air ion counter

2. 1. Radon measurements in karst caves

Radon was measured in the Sataplia and Prometheus Caves. At each location, air was sampled in parallel into two scintillation cells. Results are presented in Table 4. In the Sataplia Cave, radon concentrations, ranging from about 1100 to 2300 Bq m^{-3}, are higher than in the Prometheus Cave. In the Prometheus Cave maximum radon concentration reached 1200 Bq m^{-3}. At seven locations there is a good agreement between results of the parallel samples and in the remaining three, the difference is too high. Therefore, a new calibration of the scintillation cells is foreseen.

Table 4. Radon (C_{Rn}) concentrations in Sataplia Cave and Prometheus Cave

Place	**Date in 2012**	**SC number**	**C_{Rn} in air Bq m^{-3}**
Sataplia Cave			
1. At the entrance, at the cave map	10.7.2012 14:40 10.7.2012 14:43	6 8	1284 ± 119 1446 ± 125
2. At the point of left branch	10.7.2012 15:01 10.7.2012 15:02	5 4	1539 ± 129 1524 ± 129
3. Stony heart	10.7.2012 15:35 10.7.2012 15:35	10 3	2285 ± 157 1039 ± 106
4. Exit (16 steeps before the door)	10.7.2012 16:02 10.7.2012 16:03	7 9	2274 ± 157 1582 ± 325
Prometheus Cave			
1. Colchic Hall	11.7.2012 15:30 11.7.2012 15:31	10 15	472 ± 72 372 ± 63
2. Medea's Hall	11.7.2012 15:55 11.7.2012 15:59	9 11	961 ± 102 764 ± 93
3. Hall of Love	11.7.2012 16:15 11.7.2012 16:16	8 5	940 ± 101 1133 ± 111
4. Pass	11.7.2012 16:29 11.7.2012 16:30	2 6	756 ± 91 1113 ± 110
5. Prometheus Hall	11.7.2012 16:50 11.7.2012 16:51	3 7	700 ± 87 916 ± 100
6. Iberia	11.7.2012 17:10 11.7.2012 17:11	14 1	1164 ± 112 1115 ± 110

The results of gamma dose rates and concentration of free ions are summarised in Table 5.

Table 5. Gamma dose rate ($\dot{D}$) and free ion number concentration (C^+ and C^-) in Sataplia Cave and Prometheus Cave

Place	**$\dot{D}$ nSv h^{-1}**	**$\dot{D}$ µR h^{-1}**	**C^+ cm^{-3}**	**C^- cm^{-3}**
Sataplia Cave				
1. At the entrance, at the cave map	22	0.043	27000	193000
2. At the point of left branch	70	0.250	29000	333000
3. Stony heart	130	0.062	20000	170000
4. Exit (16 steps before the door)	60		27000	21000
Prometheus Cave				
1. Colchic Hall	250	150	5000	3900
2. Medea's Hall	45	105	15000	16000

3. Hall of Love	49	17	18000	18500
4. Pass	600	99	15000	14000
5. Prometheus Hall	606	12	15000	17000
6. Iberia			24000	16000

2.2 **Radon measurements in thermal waters**

Radon was measured in twelve water samples, mostly thermal waters, sampled directly from boreholes, usually in parallel, using two scintillation cells. Results are presented in Table 6. Generally, there is a good agreement between results of the two parallel measurements. However, also results obtained with scintillation cells are most likely too low due to radon degassing during sampling.

Table 6. Radon (C_{Rn}) concentrations in thermal waters

Place	**Comment**	**Date in 2012**	**SC number**	**C_{Rn} Bq dm^{-3}**
Tskaltubo Health Resort 1	Indoor air	10.7.2012 12:07	1 2	1.1 ± 0.1 0.4 ± 0.1
	Water from bathroom pipe	10.7.2012 17:34	14	9.1 ± 0.8
Tskaltubo 6 (T = 43.7 ºC)	Water from borehole	10.7.2012 17:23	11	1.7 ± 0.3
Sataplia river	Water from river	10.7.2012 17:43	15	3.6 ± 0.5
Sataplia water under stalagmite	Water from under stalagmite	10.7.2012 17:50	16	1.3 ± 0.3
Prometheus Cave, lake	Water from lake	11.7.2012 19:13	17	0.9 ± 0.2

3. Comparison of radon results obtained by IJS, SLO and GI MES, GE

Intercomparison measurements of radon in air (karst caves) and radon in thermal waters (some boreholes) have been performed, comparing results obtained with radon/thoron monitor RTM1688-2 (IJS, SLO) and scintillation cells (SC) (GI MES, GE). Results are summarised in Table 7a for karst caves and in 7b for thermal waters.

Table 7a. Comparison of radon concentrations (C_{Rn}) obtained by RTM1688-2 (IJS, SLO) and SC (GI MES, GE) in the air of Sataplia Cave and Prometheus Cave

Place	**RTM1688-2 C_{Rn} in air Bq m^{-3}**	**SC C_{Rn} in air Bq m^{-3}**	**SC / RTM1688-2**	**SCn1 / SCn2**
Sataplia Cave				
1.	1771 ± 266	1284 ± 119 (SC6) 1446 ± 125 (SC8)	0.73 0.82	**0.89**
2.	2428 ± 316	1539 ± 129 (SC5) 1524 ± 129 (SC4)	0.63 0.63	**1.01**
3.	3094 ± 340	2285 ± 157 (SC10) 1039 ± 106 (SC3)	0.74 0.34	**2.20**
4.	3075 ± 338	2274 ± 157 (SC7) 1582 ± 325 (SC9)	0.74 0.51	**1.44**
Prometheus Cave				
1.	193 ± 87	472 ± 72 (SC10) 372 ± 63 (SC15)	2.45 1.93	**1.27**

2.	880 ± 185	961 ± 102 (SC9) 764 ± 93 (SC11)	1.09 0.90	**1.21**
3.	988 ± 198	940 ± 101 (SC8) 1133 ± 111 (SC5)	0.95 1.15	**0.83**
4.	1472 ± 236	756 ± 91 (SC2) 1113 ± 110 (SC6)	0.51 0.76	**0.68**
5.	1094 ± 208	700 ± 87 (SC3) 916 ± 100 (SC7)	0.64 0.84	**0.76**
6.	1297 ± 220	1164 ± 112 (SC14) 1115 ± 110 (SC1)	0.90 0.86	**1.04**

Table 7b. Comparison of radon (C_{Rn}) concentrations in thermal waters obtained by RTM1688-2 (IJS, SLO) and SC (GI MES, GE)

Place	**Comment**	**RTM1688-2** C_{Rn} **Bq dm^{-3}**	**SC** C_{Rn} **Bq dm^{-3}**
Tskaltubo 6 (T = 43.7 ºC)	Water from borehole	17.6 ± 3.9	1.7 ± 0.3 (SC11)
Tskaltubo Health Resort 1	Water from bathroom pipe	93.8 ± 9.3	9.1 ± 0.8 (SC14)

As seen in Tables 7a and 7b, RTM1688-2 monitor shows significantly higher radon concentrations than SC at the majority of sampling points in air in karst caves and in thermal waters.

Conclusions

1. Radon concentrations in indoor air of selected places range from 12.9 to 1110 Bq m^{-3} and thoron concentrations from 6.3 to 681 Bq m^{-3}. In the guest house and in the Turkish bath in Tbilisi high Tn/Rn ratio was observed.
2. Higher radon and thoron concentrations have been detected in the Sataplia Cave, ranging from about 1800 to 3100 Bq m^{-3} and from 69 to 347 Bq m^{-3}, respectively. In the Prometheus Cave, radon concentration ranged from 193 to 1472 Bq m^{-3} and thoron concentration, from 27 to 144 Bq m^{-3}. There is a relatively low thoron ratio in both caves.
3. Radon concentration in thermal waters ranged from 1.3 to 93.8 Bq dm^{-3}. These values seem to be too low, especially in cases when radon in thermal water was measured directly from the borehole. Because the team was not able to use their sampling system specially designed for such measurement, a great portion of radon might have been escaped during sampling. Therefore, the results in Table 3 should be considered as preliminary and measurements should be repeated with the proper equipment.
4. Intercomparison measurements of radon in air (karst caves) and radon in thermal waters (some boreholes) have been performed, comparing results obtained with radon/thoron monitor RTM1688-2 (IJS, SLO) and scintillation cells (SC) (GI MES, GE). Results are summarised in Table 7a for karst caves and in 7b for thermal waters. RTM1688-2 monitor shows significantly higher radon concentrations than SC at the majority of sampling points in air in karst caves and in thermal waters.

References

[1] Saso Dzeroski, Ljupco Todorovski, Boris Zmazek, Janja Vaupotic, Ivan Kobal
Modelling Soil Radon Concentration for Earthquake Prediction**.** [Citation Graph (0, 0)][DBLP]
Discovery Science, 2003, pp:87-99 [Conf]

[2] Janja Vaupotic “Levels of nanosize radon decay products in indoor air: a comparison for different environments” Radon Center, Department of Environmental Sciences, Jozef Stefan Institute, Ljubljana, Slovenia Coll Antropol 32:99-104. 2008
[3] Janja Vaupotic “Nanosize radon short-lived decay products in the air of the Postojna Cave” Jozef Stefan Institute, Radon Center, P O Box 3000, 1001 Ljubljana, Slovenia
Sci Total Environ 393:27-38. 2008
[4] Kobal Ivan, Vaupotic J, Kozak K, Mazur J, Birovljev A, Janik M, Celikovic I, Ujic P, Demajo A, Krstic G, Jakupi B, Quarto M, Bochicchio F (2006): High natural radiation exposure in radon spa areas: a detailed field investigation in Niška Banja (Balkan region) (Article) Journal of Environmental Radioactivity, (2006) vol.89 (3) 249-260
[5] Saakashvili N., Tabidze M., Tarkhan-Mouravi I., Khelashvili E., Amiranashvili A., Kirkitadze D., Melikadze G., Nodia A., Tarkhnishvili A., Chikhladze V., Lominadze G., Tsikarishvili K., Chelidze L. – Climatic, Aero – Ionizing and Radiological Characteristics of the Health Resort – Tourist Complex of Tskaltubo City, Papers of the Int. Conference International Year of the Planet Earth “Climate, Natural Resources, Disasters in tne South Caucasus”, Trans. of the Institute of Hydrometeorology, vol. No 115, ISSN 1512-0902, Tbilisi, 18 – 19 November, 2008, pp. 31 – 40 (in Russian).
[6] N. Saakashvili, M. Tabidze, I. Tarkhan-Mouravi, A. Amiranashvili, G. Melikadze, V. Chikhladze. “To a question about the organization of ionotherapy at the health resorts of Georgia”. Modern problems of using of health resources, Collection of scientific works of international conference Sairme-June 10-13, 2010, Collection of scientific works is refereed in abstract E-journal of “Tekhinform”.
[7] Avtandil G. Amiranashvili, Tamaz L. Chelidze , George I. Melikadze , Igor Y. Trekov , Mariam Sh. Todadze, “Quantification of the radon distribution in various geographical areas of West Georgia”, Journal of Georgian Geophysical Association, №12, 2008.
[8] George I. Melikadze, Avtandil G. Amiranashvili, Kahha G. Gvinianidze, David G. Tsereteli, Mariam Sh. Todadze “Correlation Between Radon Distribution and prevalence of lung Cancer in West Georgia”, “Environment and Recourses”, Association of Academics of Science in Asia Workshop, 25-27 September 2009, Izmir, Turkey, pp 176-180

(Received in final form 27 December 2012)

Измерение Радона и Торона в западной Грузии

Иания Вауротик, Матея Безек, Нино Капанадзе, Георгий Меликадзе, Теона Махарадзе, Зураб Мачаидзе, Мариам Тодадзе

Резюме

Словенским Институтом им. Иозефа Штефана и Институтом Геофизики им. Нодиа, Тбилисского Государственного Университета им. Иване Джавахишвили были проведены совместные измерения Радона (222Rn) и Торона (220Rn), с помощью прибора непрерывного мониторинга RTM1688-2 Радона/Торона (изготовления (Sarad Германия) и детекторов альфа датчиков с альфа счетчиком (SMM Чешская республика) Западной Грузии. Внутренние измерения радона были проведены в некоторых местах в Цкалтубо, в пещерах Сатаплия и Прометей и термальных водах Цкалтубо. Самые высокие концентрация радона в воздухе были зафиксированы в карстовых пещерах, до 3100 Беккерелей куб. мет. В термальный водах самые высокие значения радона- 93.8 Беккерелей куб. м, были зафиксированы сливной в трубе радоновых ванн.

რადონისა და თორონის გაზომვები დასავლეთ საქართველოში

იანია ვოროუტიკ, მატეა ბეზეკ, ნინო კაპანაძე, გიორგი მელიქაძე, თეონა მახარაძე, ზურაბ მაჩაიძიე, მარიამ თოდაძე

რეზიუმე

სლოვენიის იოსეფ შტეფანის სახ ინსტიტუტის და ივანე ჯავახიშვილის სახ. თბილისის სახელმწიფო უნივერსიტეტის, ნოდის გეოფიზიკის ინსტიტუტის მიერ ერთობლივად ჩატარდა რადონისა და თორონის გამოკვლევები დასავლეთ საქართველოში. კველევების გამოყენებული იქნა რადონისა და თორონის სამონიტორინგო ხელსაწყო RTM1688-2 (Sarad, გერმანია) და ალფა სინტილიაციური დეტექტორები, ალფა მთვლელით (SMM ჩეხეთის რესპუბლიკა). რადონის შიდა გაზომვები განხორციელდა წყალტუბოს რაიონში, სათაფლიისა და პრომეთეს მღვიმეებში და წყალტუბოს თერმალურ წყლებში. რადონის ყველაზე მაღალი მნიშვნელობები დაფიქსირდა მღვიმეების ჰაერში, 3100 ბეკერელი კუბ. მეტრში. თერმალურ წყლებში ყველაზე მაღალი-93.8 ბეკერელი კუბ. მეტრში დაფიქსირდა ვანებიდან გამომავალ წყალსადენში.