SOIL AND INDOOR RADON CONNECTION IN STEI-BAITA AREA (ROMANIA)

C. Cosma[1], B. Papp[1], D.C. Nită[1], A. Dinu[1], R. Begy[1], C. Sainz[2]

[1] Faculty of Environmental Science, "Babeş-Bolyai" University, Cluj-Napoca, Romania

[2] Department of Medical Physics, Faculty of Medicine, Univ. of Cantabria, Santander, Spain

Introduction

I. Methods of soil radon measurements

II. Special method of soil permeability measurements

III. Preliminary results of soil radon and permeability measurements in Stei-Baita area

IV. Conclusions

V. About the IRART project

10th INTERNATIONAL WORKSHOP on the GEOLOGICAL ASPECTS OF RADON RISK MAPPING,
September 22-25, 2010 Prague, Czech Republic

INTRODUCTION. Some results about indoor radon measurements in Transilvania, focusing to Stei (Bihor) area

- TOTAL PERIOD OF 2003-2010: 1702 RADON MEASUREMENTS BY TRACK DETECTORS CR-39
- 2009-2010: 389 RADON MEASUREMENTS BY TRACK DETECTORS CR-39 ARE PERFORMED AND IN PROGRESS IN CLUJ, BISTRITA, ALBA AND MURES COUNTY

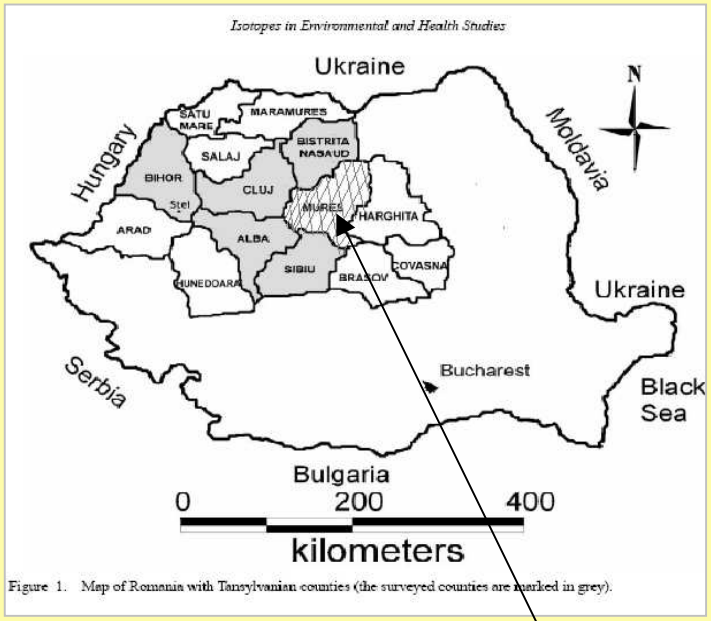


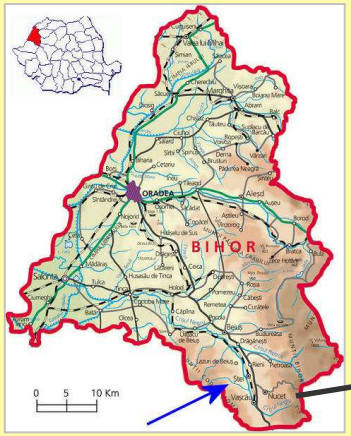
Figure 1. Map of Romania with Tansylvanian counties (the surveyed counties are marked in grey).

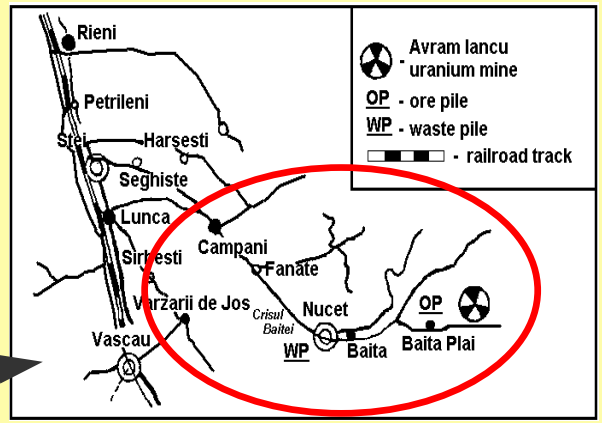
Current measurements 2010

District	Nr of the investigated houses	A.M. [Bq/m^3]	Range [Bq/m^3]	Investigation season
Cluj	350	126	20-690	Summer-winter
Bihor (Stei)*	209	129	25-1005	Summer-winter
Bihor (Băiţa)	580	247	15-3998	All seasons
Bistrita	120	69	18-293	Spring-summer
Sibiu	45	86	15-234	Spring-winter
Alba	9	87	27-303	Spring-winter
Total	1313	124	15-3998	All seasons

IN BIHOR DISTRICT WAS IDENTIFICATED A ZONE BY MUCH HIGHER RADON CONCENTRATIONS FROM ROMANIA

BIHOR, zone of the uranium mine in Ştei-Băiţa:
Integrated radon measurements: 2003 – 2008



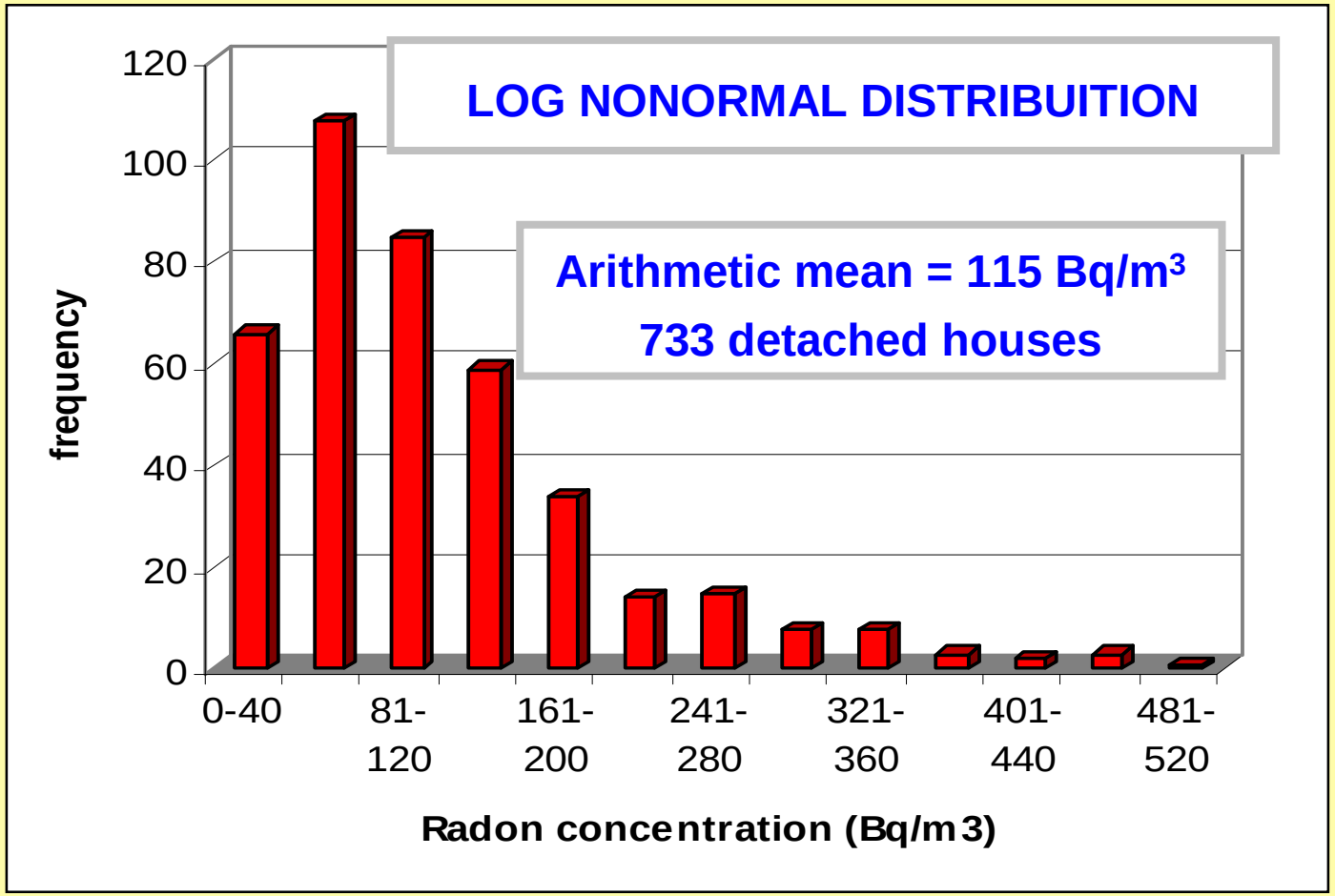


Nr of the investigated houses		580
A.M. [Bq/m³]		247
Median [Bq/m³]		116
G.M. [Bq/m³]		121
G.S.D. [Bq/m³]		2.26
Range (Min-Max) [Bq/m³]		10 - 3998
% of the houses by radon concentrations between intervals [Bq/m³]	0 - 99	36 %
	100 - 199	34 %
	200 - 399	17 %
	400 - 599	4 %
	600 - 799	3 %
	800 - 1000	2 %
	1000 - 3988	4 %

Some houses built by uranium waste from mines Baita Plai and Avram Iancu

THIS ZONE WAS CATEGORIZED AS **"RADON-PRONE AREA"**, ACCORDING TO THE INTERNATIONAL CRITERIA FOR RADON EXPOSURE. **(over 13 % of houses have radon concentration value highest that 400 Bq/m³).**

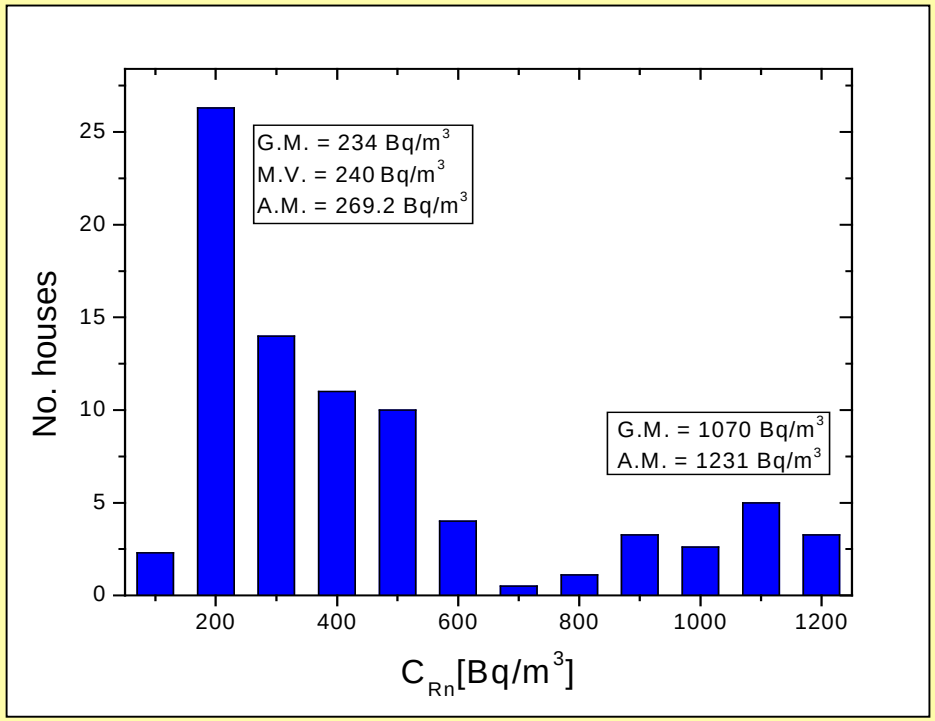
RESULTS: Region of Transylvania

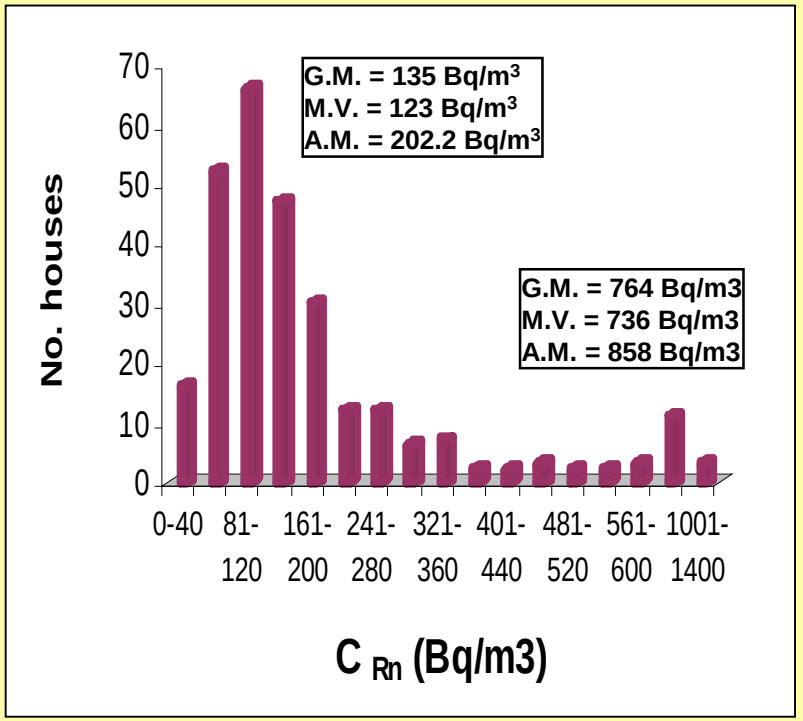


This distribution excluded the values obtained in Baita Stei area.

RESULTS: Stei-Baita area

Double log – normal distribution





Lucas cell-grab sample

(*C. Cosma and Gh. Sandor, 1998*)

CR-39 track detectors: 2003 - 2007
-integrated measurements-
(580 detached houses)

(*C.Cosma et al. 2009*)

This double Log Normal distribution means that there are two independent sources of indoor radon: soil and normal building material (first maximum) and the second is coming from uranium waste used in building constructions.

I. METHODS OF SOIL RADON MEASUREMENTS

A. LUK 3C: - scintillation detection with Lucas cell(145 mL);

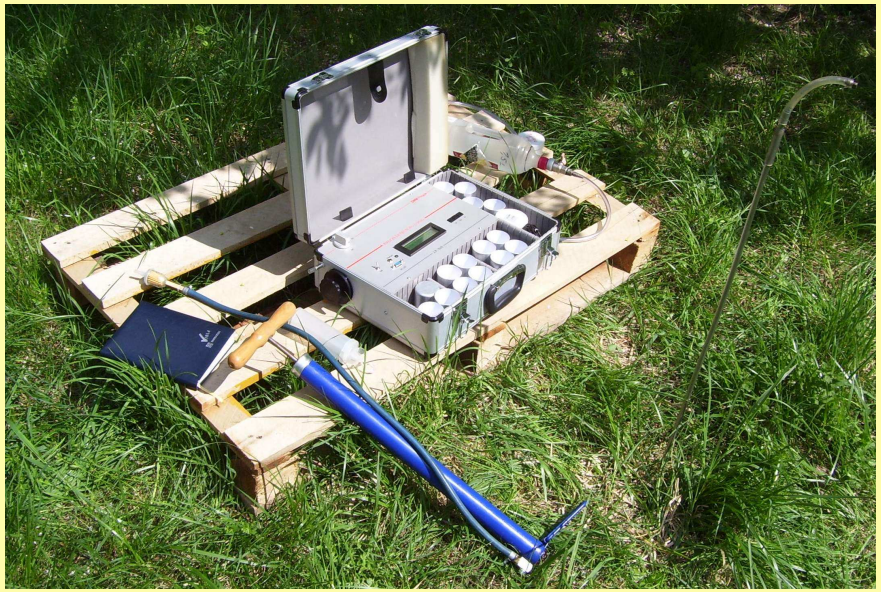
- determines Rn concentration directly from ^{222}Rn decay;

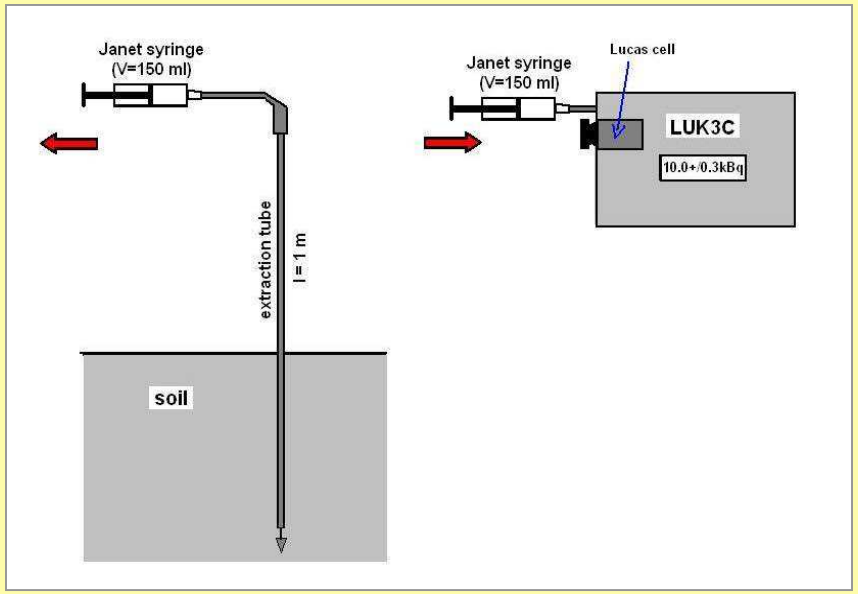
- detection efficiency: 2.2 counts /sec/ 1 Bq;

- sampling of soil gas: by Janet syringe (150 mL);

- sampling tube: h = 1m; d = 7 mm; D ≈ 80 cm;

- measuring time: ≈ 15 min / measurement;





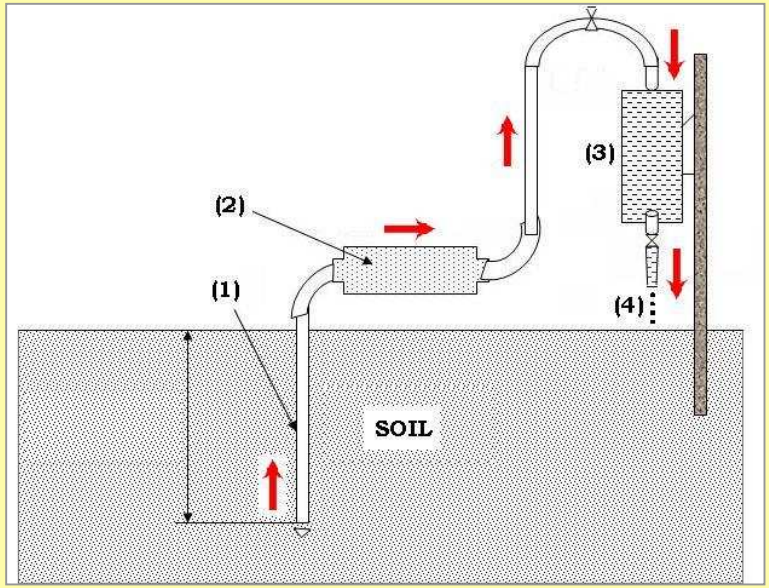
B. Active charcoal (passive pumping)

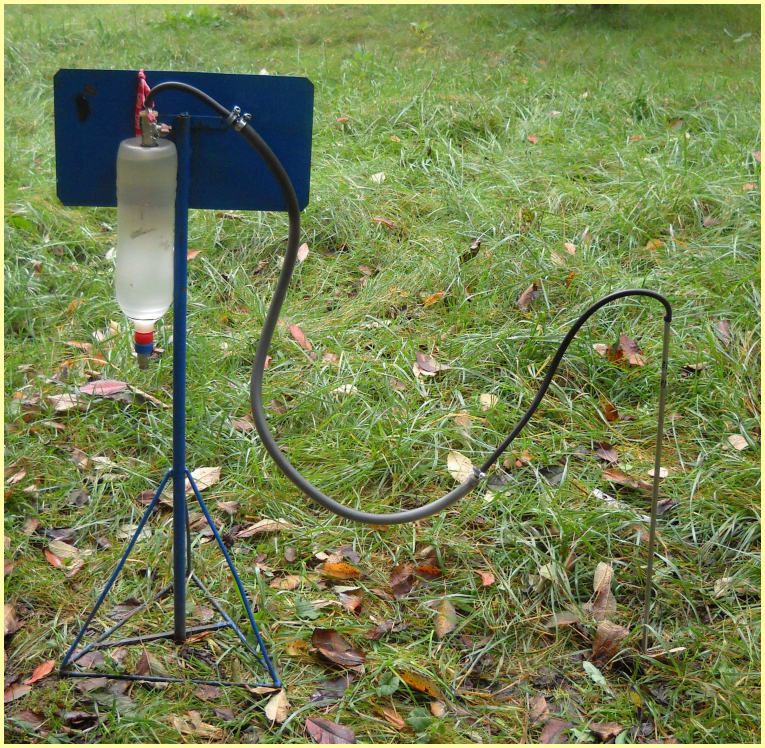
(1) Sampling tube: h = 1m; d = 7 mm; D ≈ 80 cm;

(2) Active charcoal: m= 50 gr;

(3) Plastic bottle: V=1.45 L;

(4) Tap, for water flow out.



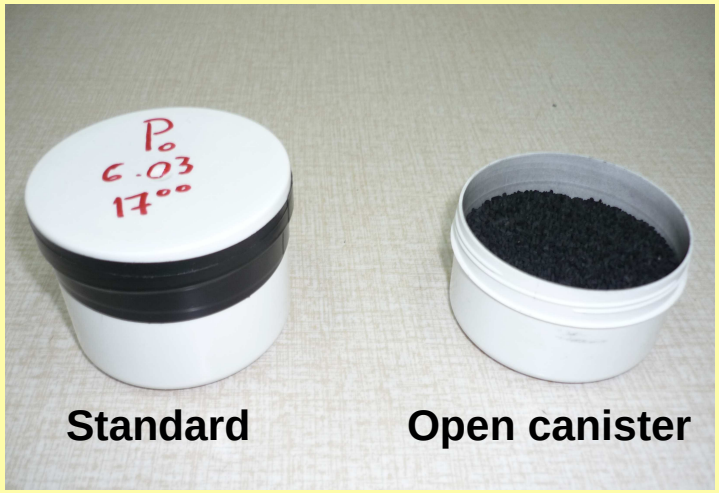


Soil radon potential (H)

$$H = F(C, t_s)$$

Advantages: - very simple;
- not power supply necessary;
- indication of the permeability (empty time);
- can be developed for soil radon potential

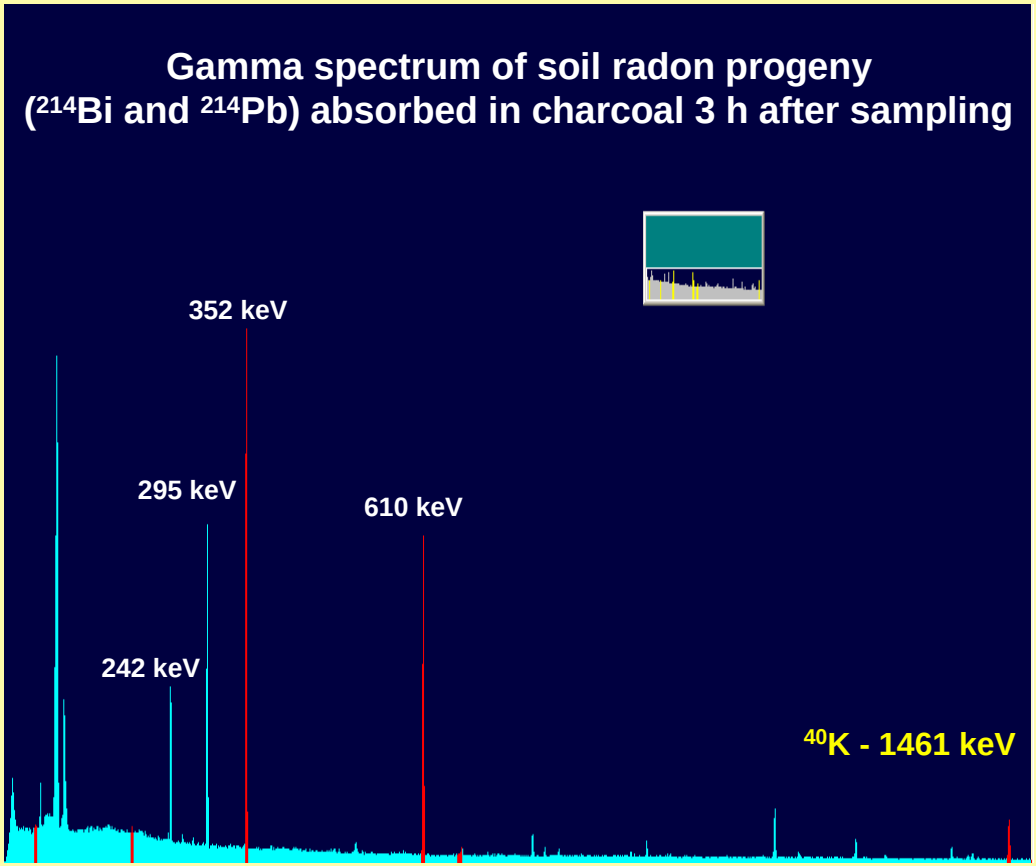
B1. Calibration of the active charcoal method



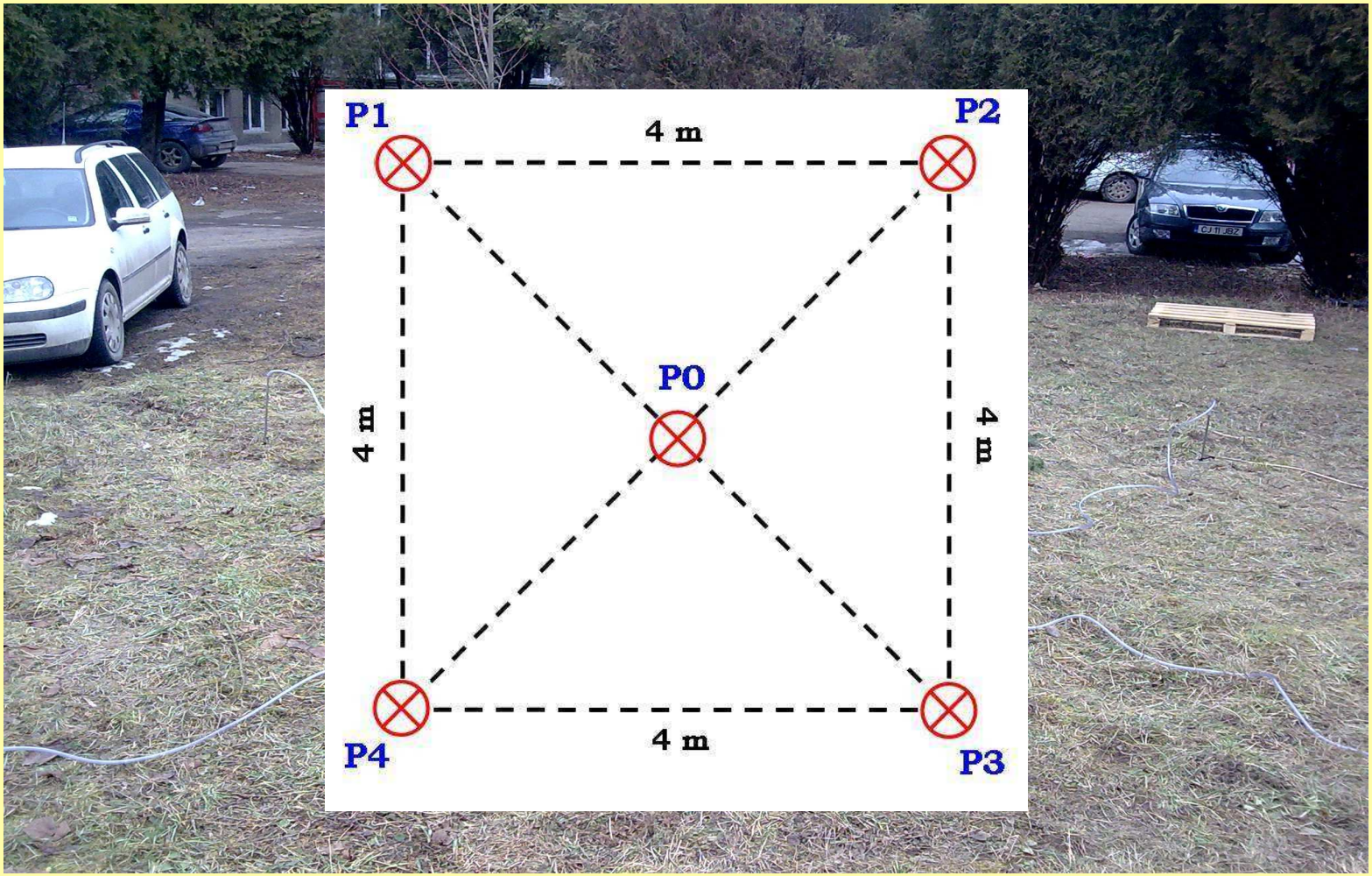
Standard cansiter contains:

3.3 Bq/mL $RaCl_2$ solution (10 mL)

$\Rightarrow$ 33 Bq (^{222}Rn)



Impoving the sampling: Simultaneously extraction from 5 points (a square with a side of 4 m)



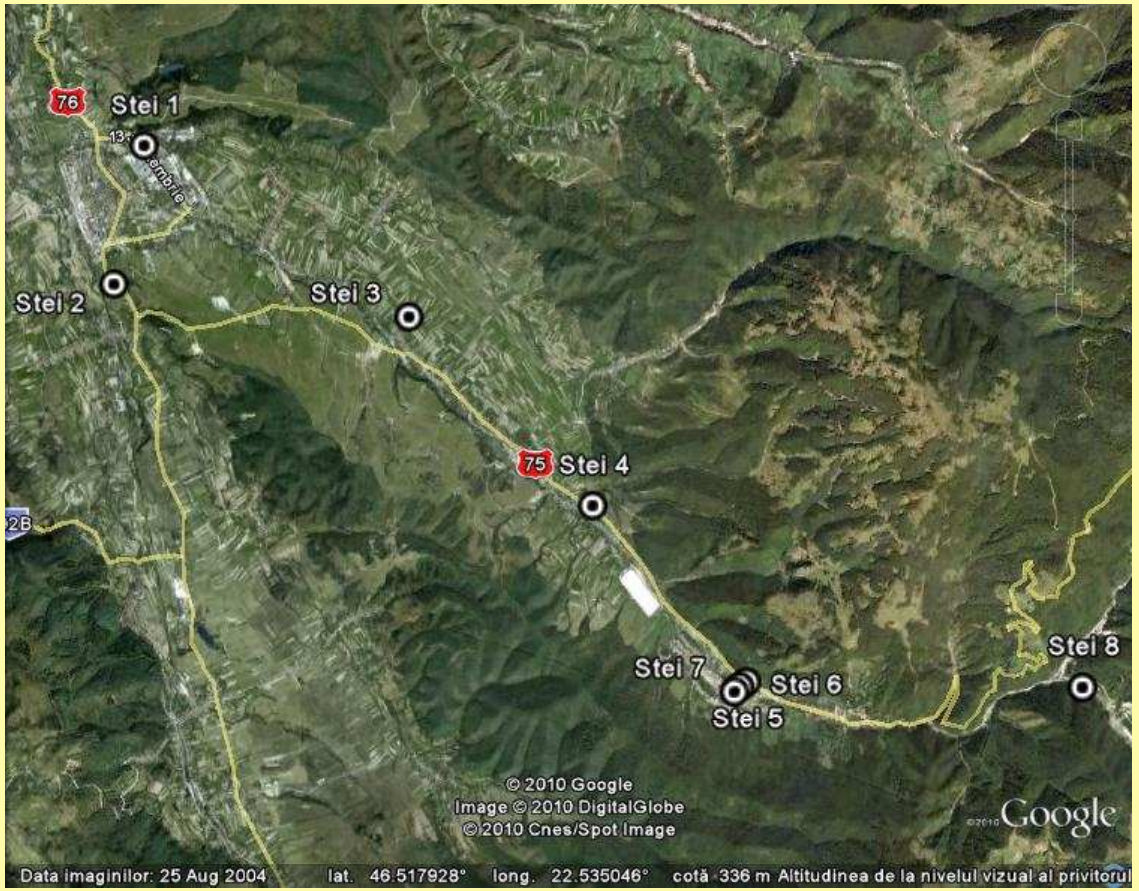
The method and results published in: Acta Geophysica, Cosma et al, 2010

C. Method by track detectors (CR 39):

- closed in bore-hole at h ≈ 40 cm depth and diameter d ≈ 10 cm;
- exposure time ≈ 1 or 2 days;

Exposition			Measurement results			
			CR 39		LUK3C	
Start	Stop	Time [hour]	Rn conc [kBq/m^3]	Average [kBq/m^3]	Rn conc [kBq/m^3]	Average [kBq/m^3]
31.08. 13:00	02.09. 15:00	50	16.8	14.9 ± 1.2	16.2 ± 0.4	13.6 ± 0.3
			14.7		12.5 ± 0.4	
			13.3		12.1 ± 0.5	
02.09. 15:30	07.09. 17:30	122	15.5	17.7 ± 1.5	12.7 ± 0.7	10.6 ± 0.4
			17.8		9.0 ± 0.6	
			19.9		10.2 ± 0.6	

III. PRELIMINARY RESULTS OF SOIL RADON AND PERMEABILITY MEASUREMENTS IN STEI-BAITA AREA (in 4th of september 2010)



a. Radon concentration measurements by Lucas cell and active charcoal;
b. Soil permeability measurements by the special method;
c. ^{226}Ra and ^{210}Pb concentration measurements by gamma spectrometry from collected soil samples;

Place	Depth [cm]	Rn conc [Bq/m^3]	t_{flow} [sec]	K·10^{-12} [m^2]	^{210}Pb [Bq/kg]	^{226}Ra [Bq/kg]
Stei (1)	80	44.1 ± 1.9	80	1.8	53	55
	80	40.2 ± 1.9	56	2.7		
	60	22.3 ± 1.0	14	11.6		
Lunca Stei (2)	60	26.1 ± ??	180	0.8		
Campani (3)	70	53.5 ± 2.6	18	8.9	105	70
	70	54.5 ± 2.6	14	11.6		
	70	63.4 ± 2.9	14	11.6		
Fanate (4)	60	58.1 ± 2.7	200	0.7	-	-
Nucet – Popas (5)	50	61.3 ± 2.8	20	7.9	-	-
Nucet - Cris Baita (7)	70	27.1 ± 1.3	12	13.7	72	52
Baita Plai (8)	40	462.9 ± 13.3	13	12.5	351	852
	40	398.5 ± 12	17	9.4		
	40	446.1 ± 13	15	10.7		
Nucet (waste) (6)	80	2.9 ± 0.4	32	4.8	-	-
	80	5.7 ± 0.5	30	5.2		

- at Campani (3c), the Rn measurement by active charcoal method give a value of 62.1 ± 2.5 kBq/m^3

IV. CONCLUSIONS

- **From the indoor measurements, the Stei-Baita area can be categorized as "RADON-PRONE AREA". (Over 13 % of houses have radon concentration value highest than 400 Bq/m^3).**

- **From the 580 measurements performed in houses, the trend of the results has a double log normal distribution, caused by two main independent sources: soil and normal building material, and the second is coming from uranium waste used in building constructions.**

- **The three methods for soil measurements were inter-comparated, and the results have good correlations.**

- **The new applied method for permeability measurements is in good correlation with the Radon-Jok permeameter, and this method can be developed for radon potential measurements (multi point extraction).**

- **Based on preliminary soil radon measurements in Stei-Baita area (at the measured depth), the results show a high radon risk.**

- the team -

- measurements and workers -

- at the entrence of the Baita Plai uranium mine -

- the older building of the Baita Plai uranium mine -

- very high value of the measured gamma dose -

UNIUNEA EUROPEANĂ

GUVERNUL ROMÂNIEI

Instrumente Structurale 2007 - 2013

UNIVERSITAS NAPOCENSIS ROMÂNIA 1581 TRADITIO NOSTRA UNACUM EUROPAE VIRTUTIBUS SPLENDET BABEŞ-BOLYAI

IRART

SECTORAL OPERATIONAL PROGRAMME "INCREASE OF ECONOMIC COMPETITIVENESS"
PRIORITY AXIS 2 – Research, Technological Development and Innovation for Competitiveness
Operation 2.1.2: „ Complex research projects fostering the participation of high-level international experts"

IMPLEMENTATION OF RADON REMEDIATION TECHNIQUES IN DWELLINGS OF BĂIȚA URANIUM MINE AREA/ IRART

Project POS CCE ID 586 - SMIS 12487/ 160/ 15.06.2010
The European Regional Development Fund

IMPLEMENTATION PERIOD: ***15 JUNE 2010 - 15 JULY 2013***
BUDGET: 1 192 000 EURO

Objective: DEVELOPMENT OF EFFICIENT MITIGATION SOLUTIONS AGAINST POPULATION EXPOSURE TO RADON THROUGH INNOVATIVE RESEARCH WITH INTERNATIONAL COOPERATION

- **the pilot house as a working prototype of a construction solution for protection against radon emissions**
- **implementation of mitigation solutions in the 20 selected houses**

UNIUNEA EUROPEANĂ

GUVERNUL ROMÂNIEI

Instrumente Structurale 2007 - 2013

Project Manager: Prof. Univ. Dr. **Carlos SAINZ**, CANTABRIA UNIVERSITY, Santander, Spain

Co-Director of Project: Prof. Univ. Dr. **Constantin COSMA**, BABEŞ-BOLYAI UNIVERSITY, Romania

Responsible of Project: Dr. Ing. **Alexandra DINU**, BABEŞ-BOLYAI UNIVERSITY, Romania

CONTACT: **www.irart.ro**

BABEŞ-BOLYAI UNIVERSITY

Faculty of Environmental Science

Fântânele 30, 400294 Cluj-Napoca

Romania

Tel: 004-0264-307030

Fax: 004-0264-307032

E-mail: sainzc@unican.es

constantin.cosma@ubbcluj.ro

alexandra.dinu@ubbcluj.ro


THANKS FOR YOUR
ATTENTION !