NATURAL RADIONUCLIDES IN UNDERGROUND WATER IN UKRAINE

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Uranium isotope ratio $^{234}/_{238}$

Ca. 100 samples of Ukrainian water was examined for uranium $^{234}/_{238}$ isotope ratio during 1992-1993 using ICP MS technique. It shows most values exceeding **5.0** and even **30.0 and 43.0** for some of the samples.
Application of calorimetric or luminescence methods for analyzing U-alphas on base of (^{238}U) – under-estimation of the total activity of uranium is of 2.0 to 10-15 times.

K. Shiraishi, Y. Igarashi, Y. Yamamoto, T. Nakajima, I.P. Los, A.V.Zelensky and M.G. Buzinny. Concentration Of Thorium And Uranium in Freshwater Samples Collected In Former USSR. Journal of Radioanalitical and Nuclear Chemistry, Articles, Vol.185, N.1 (**1994**)157-165.

Measurement approach

Since 1988, when we get **Quantulus,** we studied natural radioactivity of underground water following Salonen i.e. 30 day for each sample.

LSC-92 : Zelensky A.V., Buzinny M.G., Los' I.P. Measurement of Radium-226, Radon-222, and Uranium-238, 234 in Underground Water of the Ukraine with Ultra Low-Level Liquid Scintillation Counter. In Liquid Scintilla-tion Spectrometry 92. Proc. of Int. Conf. on Advances in LSC, LSC 1992. Vienna, Austria, 14-18, 1992. Eds. J.E. Noakes, Franz Schönhofer & H.A. Polach. Radiocarbon. Tucson 1993, pp. 405-411.

After a while (since 1997) for routine analyses we use **uranium after TBP extraction**, **Rn-222** by its *extraction in toluene*, **Ra-226** by Rn *extraction in toluene*, using pre-concentrated (100-200 ml) samples in Teflon vial after 7-10 day equilibration (72%-84%).

In case we find elevated levels of **Rn-222**, **U**, **Ra-226** we do measurements of **Ra-228**, **Pb-210** and **Po-210**.

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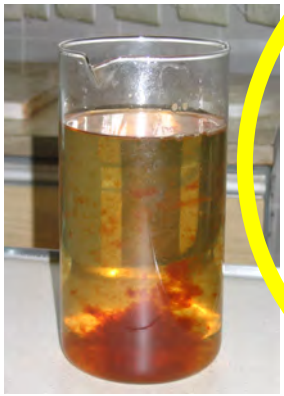
Trace of sample in lab today: U-analyze

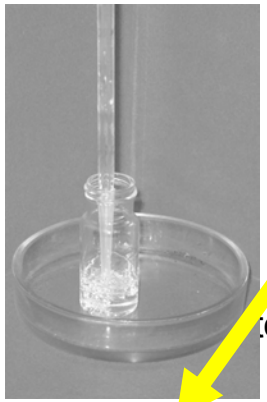
Water + FeCl +HNO_3 > Heat (boiling) + ammonium hydroxide+ wait for precipitation > filtrate > solubilize > **TBP** in toluene extraction + neutralization by adding ammonium nitrate + bubling + toluene based scintillator > **counting**







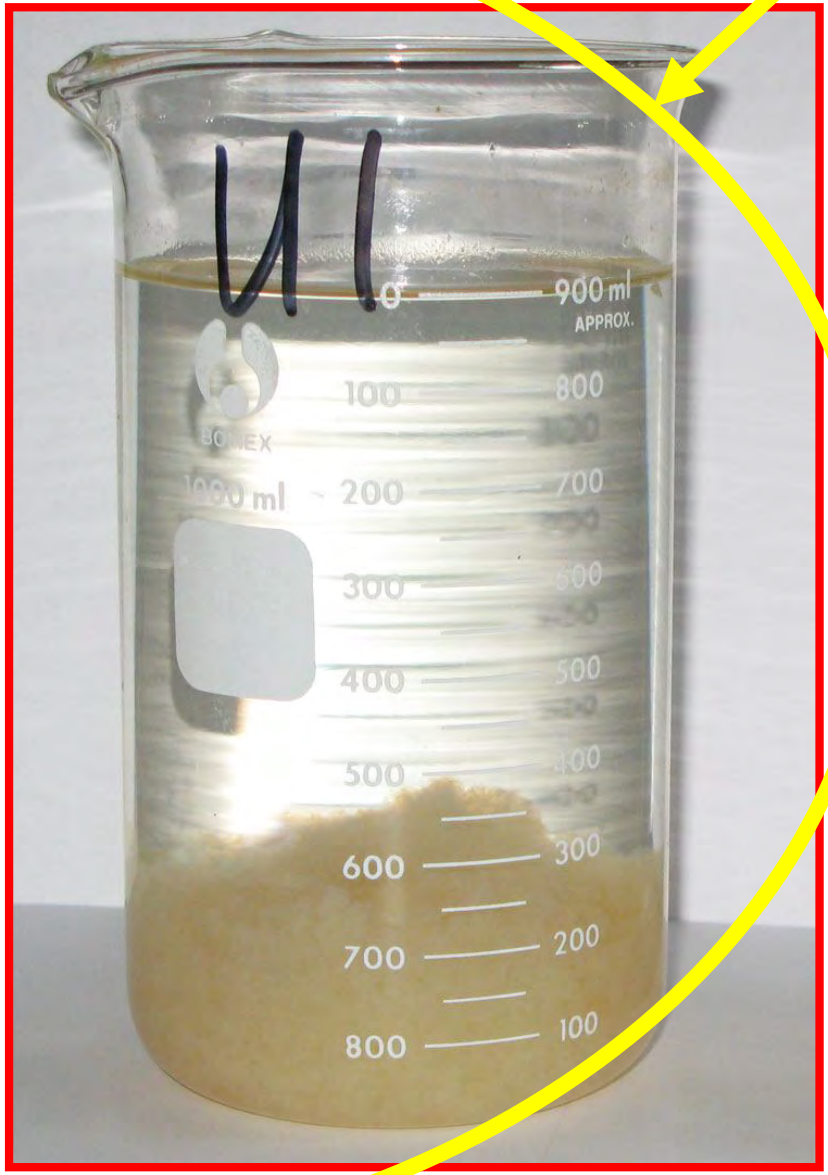




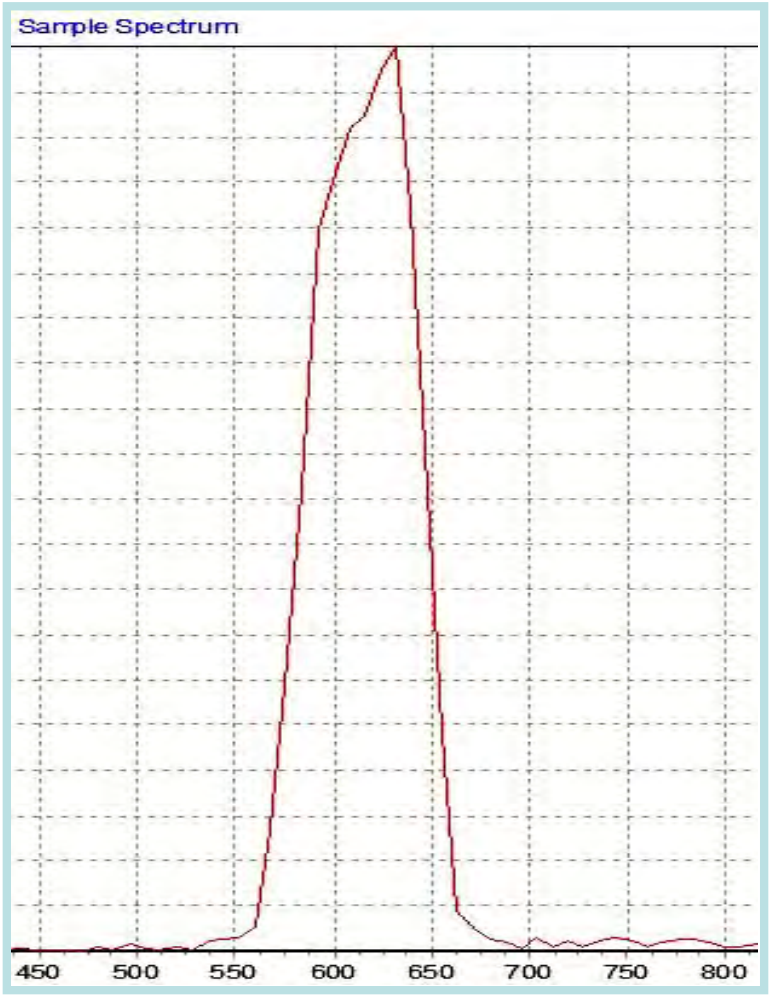

LS s e

Conventional sample

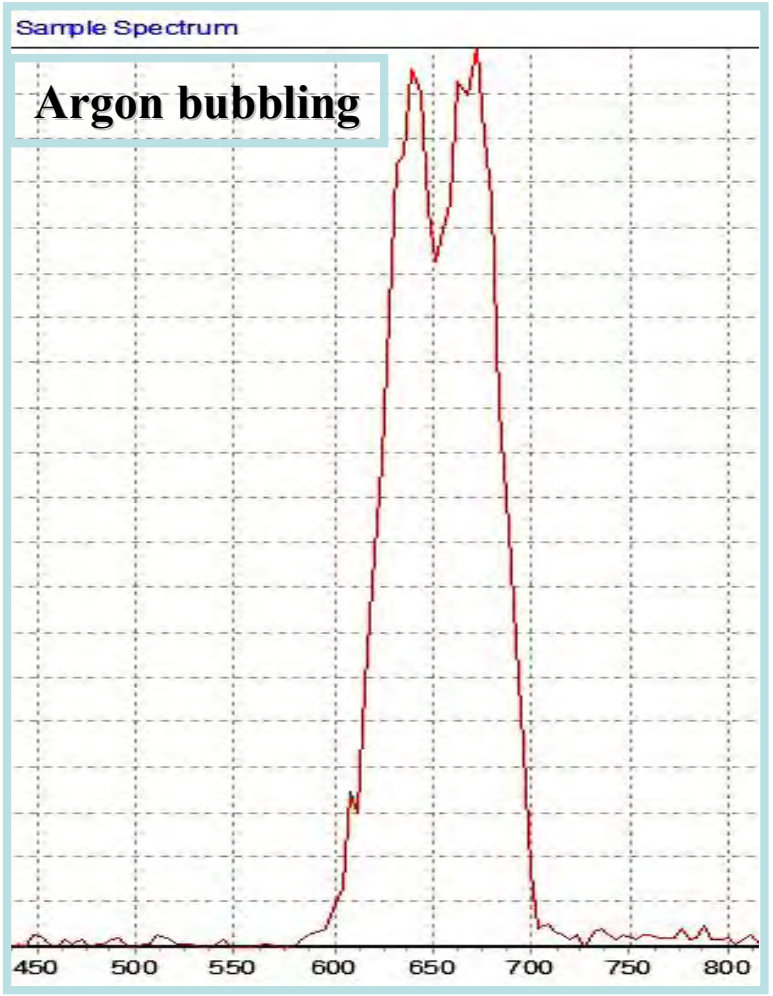
Rare sample (1%)



U spectra in toluene based cocktail measured in Teflon vial



a) Conventional spectrum of Uranium



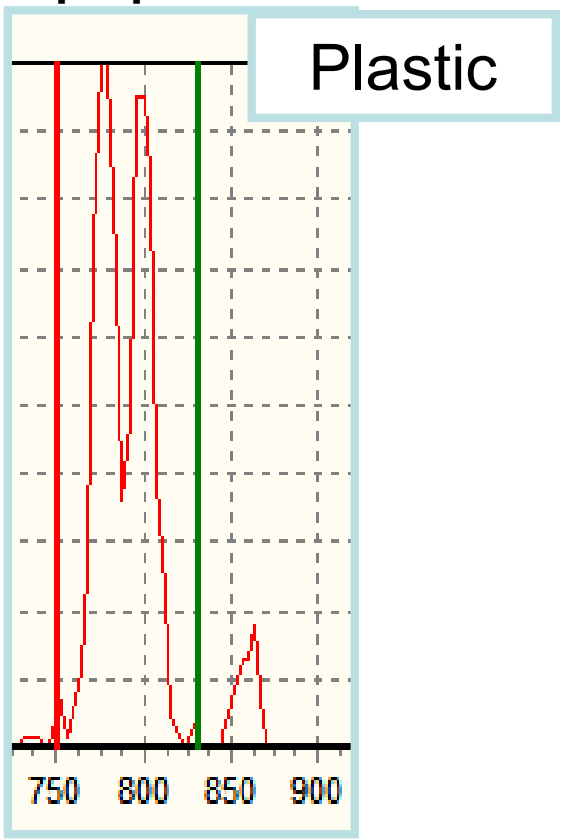
b) High resolution spectrum of Uranium

^{222}Rn & ^{226}Ra(^{222}Rn) measurement

(10 ml water (solution) + 10 ml toluene based LS cocktail)

^{222}Rn +^{218}Po

10+ minutes after sample preparation



Solution:

Preconcentration of 100-**200** ml !!!!!

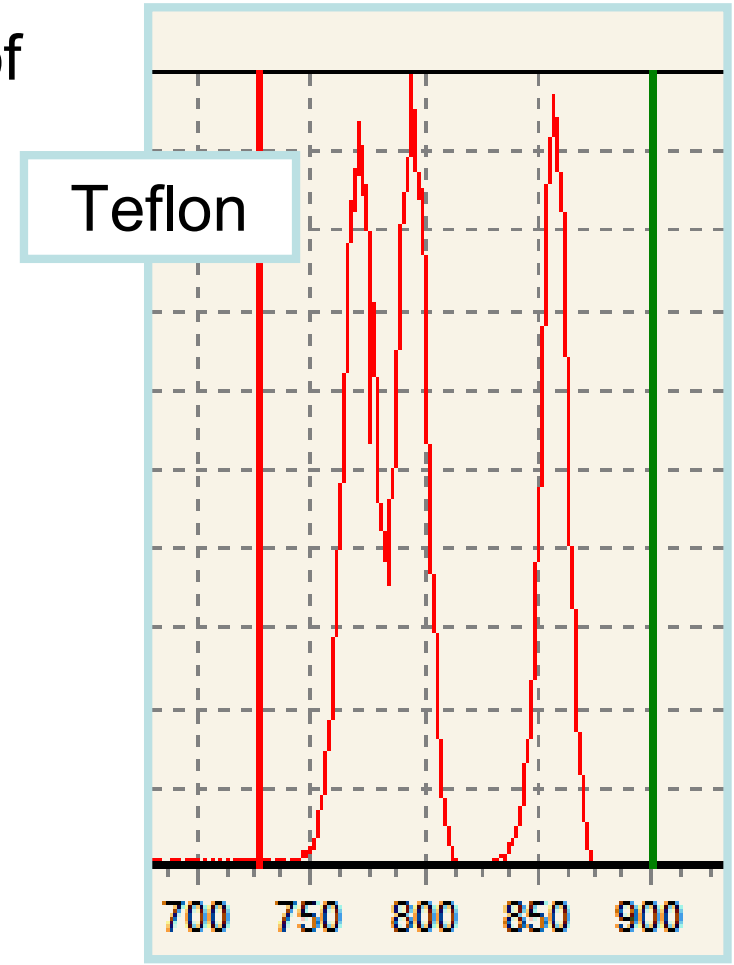
^{222}Rn growth

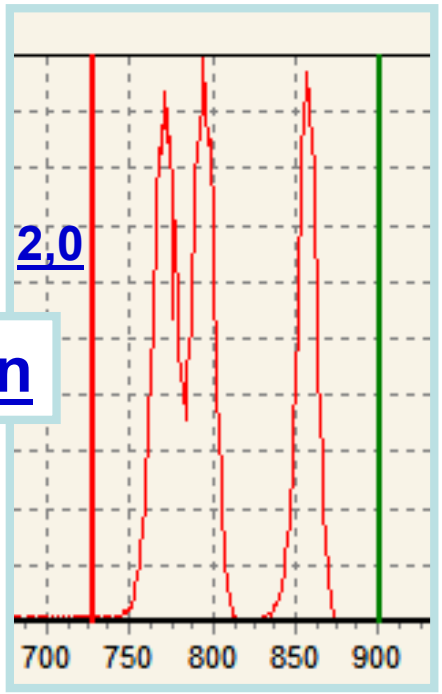
7-10 days

or

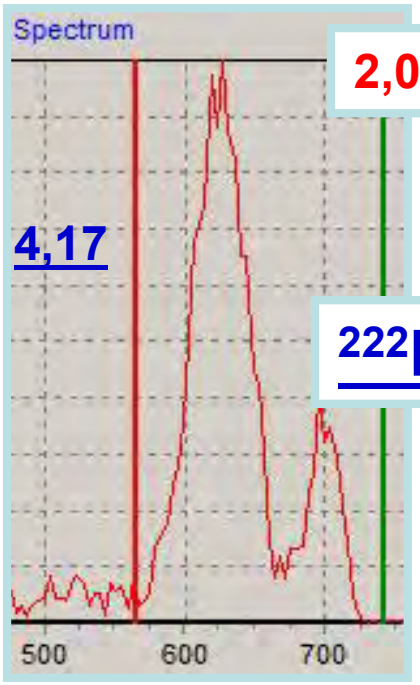
72% to 84%

^{222}Rn+^{218}Po+^{218}Po





^{222}Rn



2,04 !!!!

^{222}Rn ???

1,57 !!!!

Sample		II	III	I	II/I	Eq	II	III	II III		I	Over
S1.9	8	133,5	174	40,5	3,30	76,6%	7,45	7,15	7,30		4,41	1,66
S2.9	8	72,5	96	23,5	3,09	76,6%	4,05	3,94	3,99		2,56	1,56
S3.9	8	5,3	7	1,7	3,12	76,6%	0,30	0,29	0,29		0,19	1,58
S1.9	10	144,7	191,3	46,6	3,11	83,7%	7,39	7,19	7,29		4,64	1,57
S2.9	10	76,9	103,8	26,9	2,86	83,7%	3,93	3,90	3,91		2,68	1,46
S3.9	10	5,45	6,94	1,49	3,66	83,7%	0,28	0,26	0,27		0,15	1,82
S4	4	25	31	6	4,17	51,6%	2,07	1,89	1,98		0,97	2,04

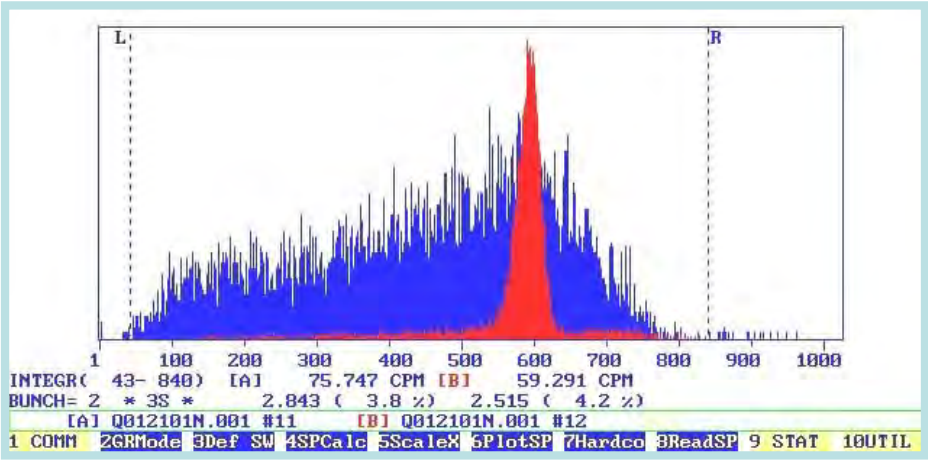
^{210}Pb(Bi)+^{210}Po on metal disk

Thermostimulated deposition onto metal disk

Measurement approach for LSC

A.E. Bakhur, L.I. Manuilova, T.M. Ovsjannikova. Po-210 and Pb-210 in environment. Methods of determination. ANRI. N.1. 2009. p. 29-39. (In Russian)

Buzinny M. Simultaneous determination of ^{210}Po and ^{210}Pb using LS technique. International Topical Conference on Po and Radioactive Pb isotopes. Sevilla, Spain, October, 26-28, 2009: Book of Abstract, 2009. – P. 45.



Intercomparison

Lab results of comparison ^{210}Po activity measurement in water samples (Bq/L) in frame of IAEA-CU-2007-09 World Wide Opened Proficiency Test (**IAEA, 2007**)

Sample	Target value	Lab value	Precision	Acceptance
1	52.8±1.4	43.0±5.4	Yes	Yes *
2	101.6±2.8	75.8±7.9	Yes	No *
3	52.8±1.4	42.2±5.3	Yes	Yes *
4	101.6±2.8	82.9±8.9	Yes	Yes *
5	0,1±0.01	0.41±0.06		No **

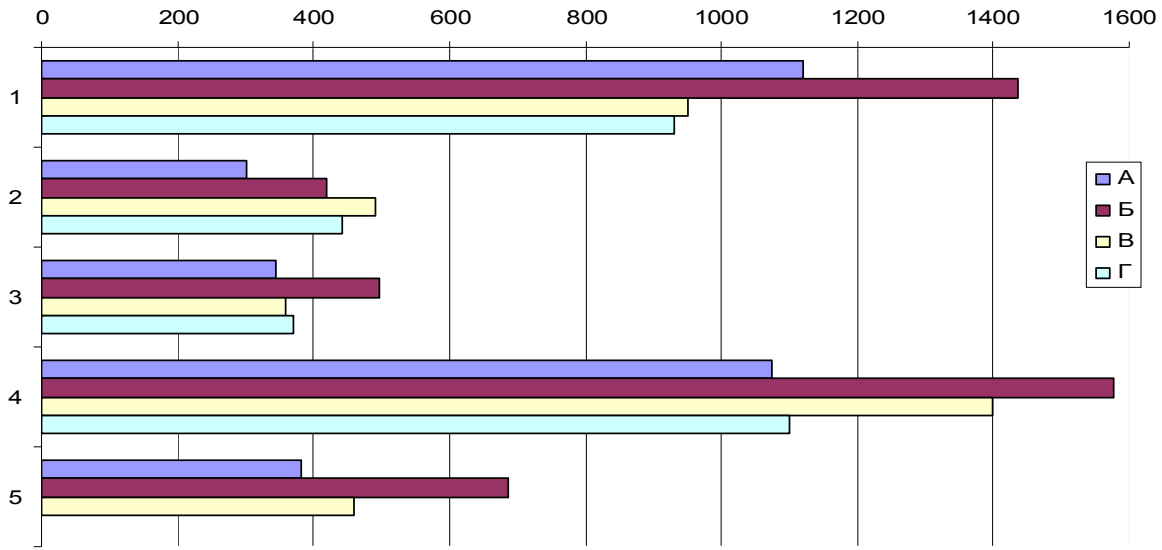
* Systematic shift (overestimation of counting efficiency)

** Overestimated background because of radon in toluene

Intercomparison for uranium, radium and lead-210 in water samples

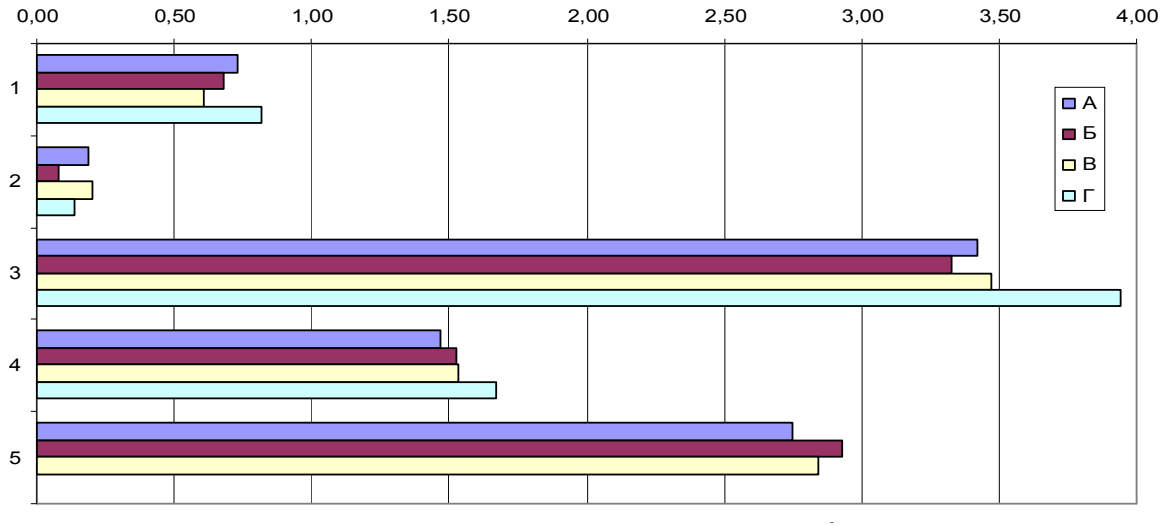
IHME						
Sample \ Nuclide	**Total alpha (beta)**	**U by TBP**	**Ra by Salonen 50 ml**	**Emanation 200 ml**	**Po/Bi placed on disk**	**Pb-210 by gamma**
U	**0,65±0,07**	**0,72±0,07**	**<0,05**	**<0,001**		
Drinking water:	**6,98±0,72**	**5,25±0,73**	**0,076±0,010**	**0,078±0,007**	**1,10±0,25 1,19±0,25**	
Radium	**0,68±0,07**		**0,55±0,05**	**0,64±0,08**	**0,71±0,08 0,50±0,15**	
Po-210 Pb-210	**0,55±0,06**		**0,015**	**<0,001**	**0,54±0,09 0,57±0,09**	**0,68±0,09**
SSM						
Sample \ Nuclide	**Total alpha Total beta**	**U, Salonen**	**Ra-226**		**Po-210 Pb-210**	**Pb-210 by gamma**
U		**0,76±0,007**	**<0,05**			
Drinking water:	**α 7,51±0,08 β 5,81±0,06**	**7,31±0,07**	**0,2±0,002**		**β 2,35±0,02**	
Radium			**0,52±0,005**			
Po-210 Pb-210					**α 0,67±0,007 β 0,75±0,008**	**0,71±0,1**

Lab Intercomparison for natural radionuclides in water



Radon

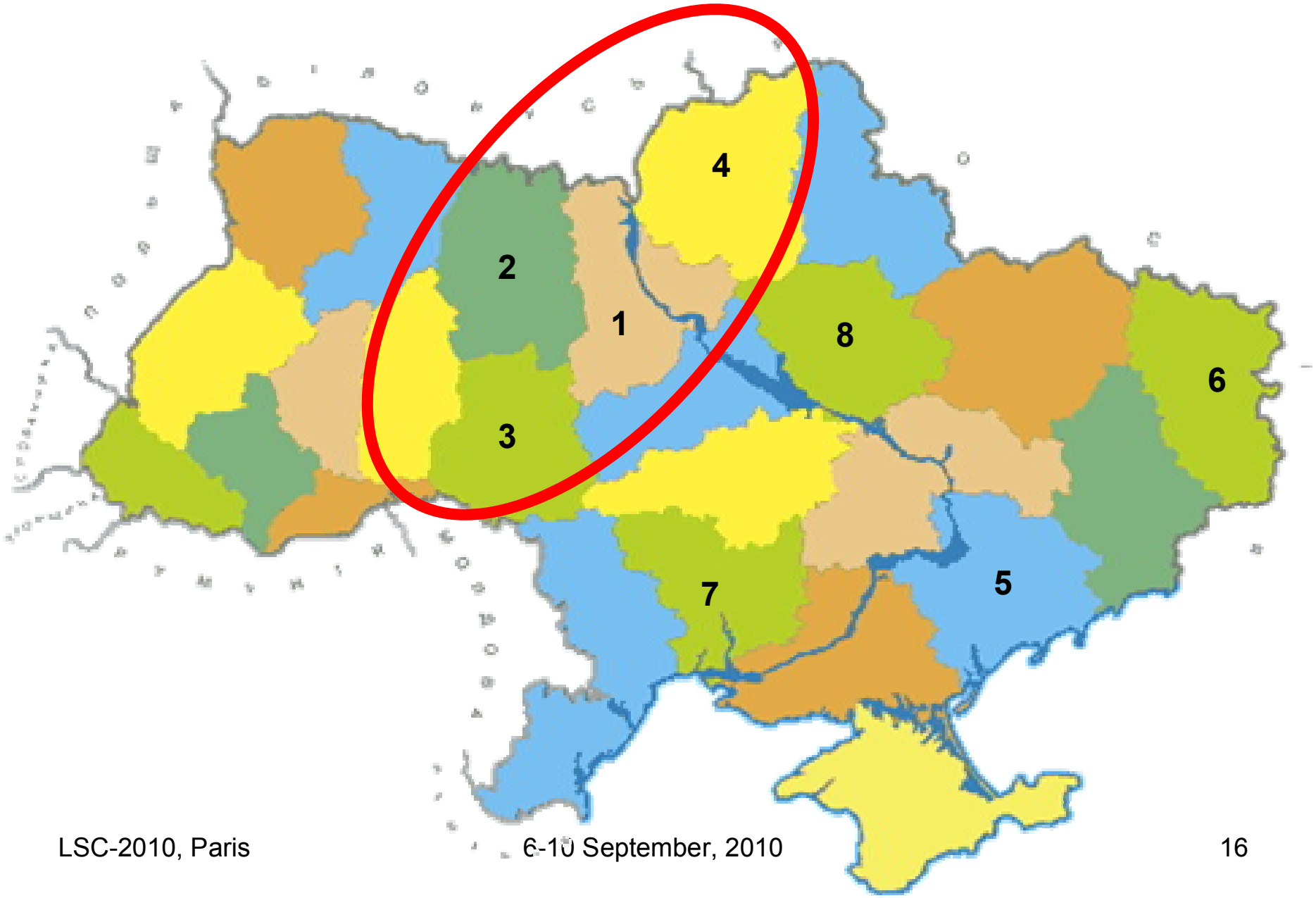
Average	SD	%
1000	104	10%
467	33	7%
359	14	4%
1191	181	15%
422	54	13%



Uranium

Average	SD	%
0,71	0,09	12%
0,15	0,05	18%
3,54	0,27	8%
1,55	0,09	6%
2,84	0,09	3%


ТЕКТОНІЧНА БУДОВА
Масштаб 1:6 000 000
Волино-Подільська плита
Львівська западина
Український щит
Дніпровсько-Донецька западина
Донецька складчаста споруда
Причорноморська западина
Кримський п-ів
Київ
Чернігів
Суми
Харків
Полтава
Житомир
Рівне
Луцьк
Львів
Тернопіль
Хмельницький
Вінниця
Івано-Франківськ
Чернівці
Черкаси
Кіровоград
Дніпропетровськ
Запоріжжя
Луганськ
Донецьк
Миколаїв
Херсон
Одеса
Сімферополь
Севастополь
о. Зміїний (Україна)
Дунай
Дністер
Прут
Дніпро
Десна
Сейм
Псел
Ворскла
Оріль
Самара
Інгулець
Вовча
Сіверський Донець
Каховський канал
Керченська протока
Сиваш
Салгир
Київське вдсх.
Канівське вдсх.
Черкаське вдсх.
Дніпродзержинське вдсх.
Дніпровське вдсх.
Каховське вдсх.
Печенізьке вдсх.
Червоноосківське вдсх.
Дністровське вдсх.


4
2
1
8
6
3
7
5

Data obtained
(drinking water)

Region	N	Rn-222				Ra-226				Uranium			
		Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
Kiev	**178**	24,3	82,3	0,3	**705**	0,04	0,10	0,001	**0,81**	0,12	0,40	0,002	**3,7**
Zhytomyr	**123**	60,5	83,1	0,9	**500**	0,32	0,71	0,004	**3,64**	0,27	0,81	0,002	**8,1**
Vinnytsa	**75**	21,1	21,3	0,7	**105**	0,02	0,02	0,003	**0,12**	0,43	1,82	0,009	**15,3**
Chernihiv	**27**	3,2	2,3	1,0	**12**	0,02	0,01	0,001	**0,05**	0,03	0,05	0,002	**0,21**
Zaporizhzhia	**23**	7,7	8,3	0,5	29	0,12	0,32	0,01	1,42	0,04	0,08	0,004	0,3
Luhansk	**20**	9,3	15,5	1,0	62	0,02	0,04	0,003	0,2	0,09	0,13	0,003	0,42
Mykolaiv	**18**	4,4	2,3	0,5	8	0,02	0,02	0,007	0,09	0,04	0,04	0,003	0,15
Poltava	**13**	9,1	7,9	1,3	25	0,05	0,05	0,010	0,22	0,01	0,01	0,004	0,02

Radionuclides high levels?

- **Initial high level source (rock, crack, water chemistry),**
- Violation of working conditions of well,
- Violations of the sampling,
- No action or violation of treatment.

RADIATION REGULATION FOR WATER (bottled water)

Surface water:

- Total alpha - activity **0.1** Bq/L
- Total beta - activity **1.0** Bq/L
- Isotope analyses in case.

Wells, drilled wells:

- ^{226}Ra - **1.0** Bq/L,
- ^{228}Ra - **1.0** Bq/L,
- ^{222}Rn - **100** Bq/L;
- Uranium (total activity) – **1.0** Bq/L

INDUSTRIAL IMPACT:

(mines, production of uranium, rare earth, fertilizers)

Uranium:

Water in vicinity of uranium processing sites:

- Underground – wells, local drilled wells (1.0 – 1500 Bq/L),
- Surface - reservoirs, rivers (0,1 – 10 Bq/L)

Mine waters up to 50 Bq/L.

Radium:

- Up to 5-10 Bq/L for mine waters.

Example of systematic remediation

Myronivka district, Kiev region

(Myronivka town and surrounding villages)

Initially for consumption was used water mostly deep drilled wells, ca 100+ m):

Rn-222 – 300-1000+ Bq/L, (100 Bq/L)

Ra-226 – 0.5-10.0 Bq/L, (1.0 Bq/L)

U – 0.5-10.0 Bq/L. (1.0 Bq/L)

After 20 years

All the sources was switched to water of 20-50 m wells, and ***no problem now (Radiation)***.

PERSPECTIVE

Directions of safewater (natural radioactivity):

- Measure natural radioactivity of water,
- Information provision,
- Propagation of modern analytical equipment,
- Development and adaptation of methods,
- Cover problems of water purification,
- Cover all territory of Ukraine.

Our contribution - organization of laboratory information support: http://safewater.narod.ru, development of measurement methods, training of personnel, intercomparison of results.

Acknowledgements

We thank Sergei Zvarich for initiation of our U by TBP method for LSC.

We thank Sanitary stations staff of Kiev, Zhytomyr, Vinnytsa, Chernihiv, Lugansk, Mykolaiv, Poltava regions for help.

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I thank SSM for support of attending the Conference.

Literature

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THANK YOU
Kiev 2010