Historical Mining Areas and Their Influence on Human Health

Stanislav Rapant*, Veronika Cvecková, Katarína Fajcíková

State Geological Institute of Dionyz Stur, Mlynská dolina 1, 817 04 Bratislava, Slovak Republic
*corresponding author stanislav.rapant@geology.sk

GEOHEALTH

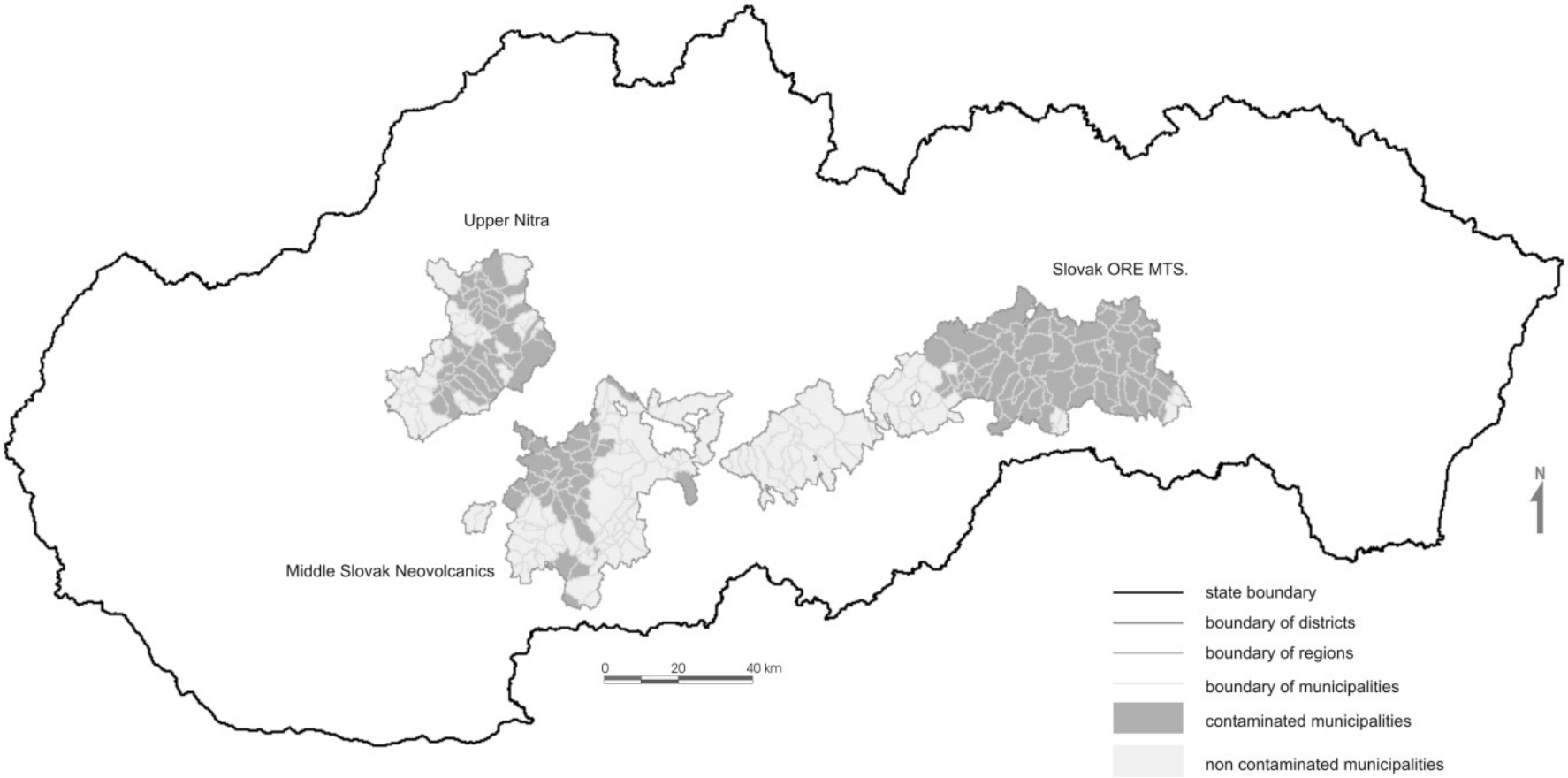
The impact of geological environment on health status of residents of the Slovak Republic.

30th SEGH International conference,
Newcastle, 30. June - 4. July 2014

The main objective of this study was to assess how, and to what extent, the PTE contamination of the geological environment might influence the health status of residents living in the historical mining areas.

Impact of potentially toxic elements (PTE) on health status of population has been studied in three historical mining areas

Contaminated and non-contaminated areas of the Slovak Republic



AREA DESCRIPTION

Middle Slovak Neovolcanics

ore extraction from middle age Pb, Zn, Cu, As, Au,

neogene andesites, basalts and their pyroclastics

Slovak Ore Mts.

ore extraction from middle age As, Sb, Pb, Zn, Cu, Hg, Au

paleozoic, metamorphic rocks (metavolcanics, metasediments) and various magmatic rocks

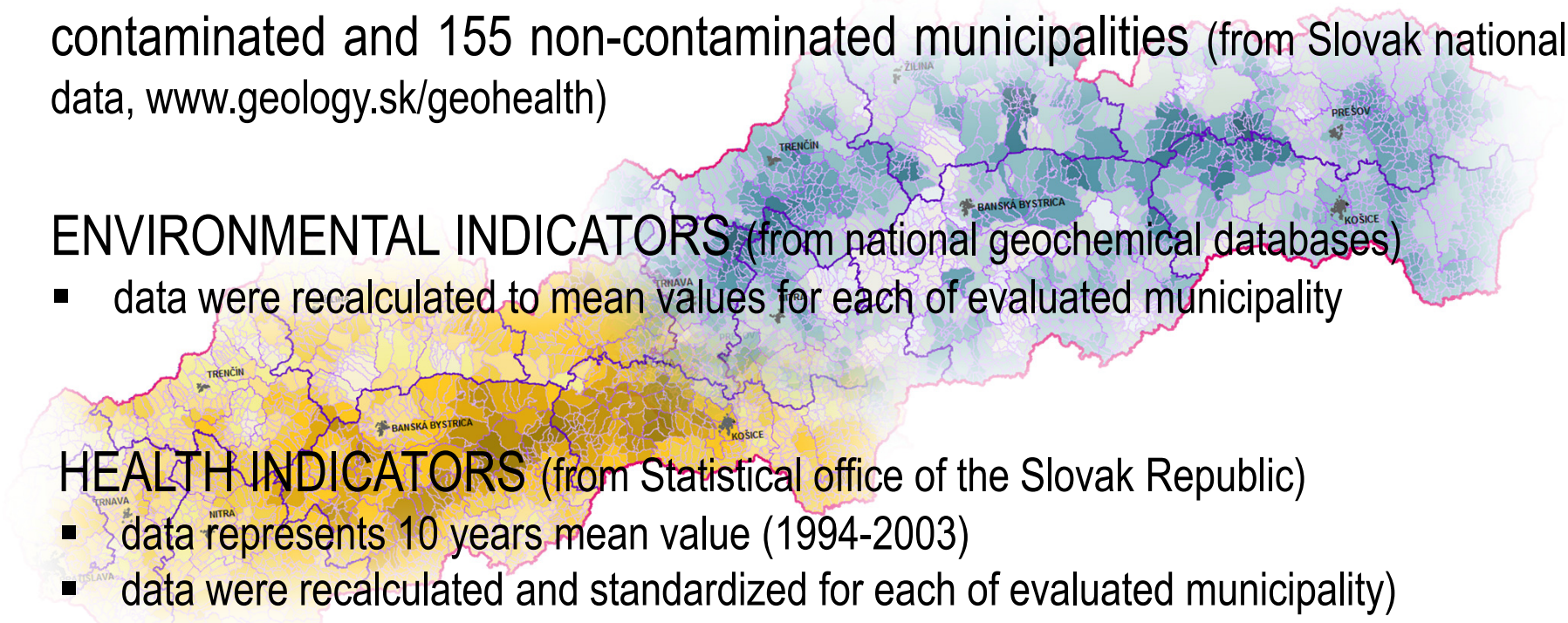
Upper Nitra region

- brown coal exctraction more 100 years As: 0.8-0.9 %, S: 2 %
- power plant from 1993 intensive filters, decrease of emissions about 98 %

tertiary sediments (sandstones, clays, silts) in depression surrounded core and volcanic mountains

MATERIAL

Set of the environmental indicators (mainly PTE) for soils and ground/drinking water and health indicators (43) for each 138 contaminated and 155 non-contaminated municipalities (from Slovak national data, www.geology.sk/geohealth)



ENVIRONMENTAL INDICATORS (from national geochemical databases)

- data were recalculated to mean values for each of evaluated municipality

HEALTH INDICATORS (from Statistical office of the Slovak Republic)

- data represents 10 years mean value (1994-2003)
- data were recalculated and standardized for each of evaluated municipality)
- health indicators were compiled according to ICD 10th Revision (www.nczisk.sk)

Evaluated health indicators of the Slovak Republic

No.	Indicator	Description of indicator	Method of calculation	Unit	Mean SR
		Demographic indicators describing age structure of municipalities			
1	LEp	life expectancy at birth – population	cumulative calculation of all years of life during lifetime / No. of living persons at the beginning of the year	years	72.60
2	LEm	life expectancy at birth – men			67.44
3	LEw	life expectancy at birth – women			77.07
4	A60+	proportion of population at age 60 and more	100 x (number of people aged 60 and over / number of inhabitants)	%	15.38
		Crude mortality, premature			
5	SMRp	population	indirect age-standardized mortality rate of inhabitants to the Slovak standard (19 age groups)	%	100
6	SMRm	men			100
7	SMRw	women			100
8	PYLL100	potential years of lost life	100, 000 x [the sum of the years of people up to the age of nearly 65 years (deaths at age between 1 to 64 years) / number of inhabitants]	years	4,033.0
		Relative mortality for selected cause of death			
9	ReC00-C97	malignant neoplasms	100 000 x [No. of deaths for selected cause / number of inhabitants]	No. of deaths per 100 000 inhabitants	212.79
10	ReC15-C26	malignant neoplasms of gastrointestinal system			76.14
11	ReC16	malignant neoplasms of stomach			15.20
12	ReC18-C20	malignant neoplasms of colon and rectum			24.24
13	ReC30-C39	malignant neoplasms of respiratory system			45.19
14	ReC50	malignant neoplasms of breast			24.80
15	ReC64-C68	malignant neoplasms of urinary system			11.25
16	ReC81-C96	malignant neoplasms of orgnas for haematopoiesis			13.28
17	ReC91-C95	all leukemia			6.20
18	ReC00-D48	all neoplasms			213.62
19	ReE00-E99	endocrine, nutritional and metabolic diseases			14.38
20	ReI00-I99	diseases of the circulatory system			531.05
21	ReI21-I25	ischaemic heart disease			269.82
22	ReI63-I64	cerebral infarction and strokes			63.57
23	ReJ00-J99	diseases of respiratory system			58.08
24	ReK00-K93	diseases of the digestive system			45.83
25	ReN00-N99	diseases of urinary and reproductive system			13.69

Evaluated health indicators of the Slovak Republic

No.	Indicator	Description of indicator	Method of calculation	Unit	Mean SR
		Standardized mortality for selected cause of death			
26	SMRC00-C97	malignant neoplasms	indirect age-standardized mortality rate of inhabitants to the Slovak standard (19 age groups)	%	100
27	SMRC15-C26	malignant neoplasms of gastrointestinal system			100
28	SMRC30-C39	malignant neoplasms of respiratory system			100
29	SMRC81-C96	malignant neoplasms of organs for haematopoiesis			100
30	SMRE00-E99	endocrine, nutritional and metabolic diseases			100
31	SMRI00-I99	diseases of the circulatory system			100
32	SMRI21-I25	ischaemic heart disease			100
33	SMRI63-I64	cerebral infarction and strokes			100
34	SMRJ00-J99	diseases of respiratory system			100
35	SMRK00-K93	diseases of the digestive system			100
36	SMRN00-N99	diseases of urinary and reproductive system			100
		Potential years of lost life for selected cause of death			
37	PYLLC00-C97	malignant neoplasms	100, 000 x [the sum of the years of people up to the age of nearly 65 years (deaths at age between 1 to 64 years) / number of inhabitants]	years	1,005.20
38	PYLLC15-C26	malignant neoplasms of gastrointestinal system			242.26
39	PYLLC30-C39	malignant neoplasms of respiratory system			186.2
40	PYLLI00-I99	diseases of the circulatory system			866.19
41	PYLLI21-I25	ischaemic heart disease			396.32
42	PYLLJ00-J99	diseases of respiratory system			172.69
43	PYLLK00-K93	diseases of the digestive system			334.80

Methods

In historical mining regions health status of residents living in contaminated and non-contaminated areas was compared.

Compared areas:

- Similar gelogical structure
- Similar socioeconomic level of resident population
- Only difference – in PTE contents

Unemployment rates in assessed areas in 2001 and 2011

Region	unemployment rate in %			
	Contaminated area		Non contaminated area	
	2001	*2011*	*2001*	*2011*
Upper Nitra	19.09	14.81	19.14	15.20
Slovak Ore Mts.	27.32	25.65	32.20	25.78
Middle Slovak Neovolcanics	25.90	23.19	24.21	24.86
Slovak Republic	*2001*		*2011*	
	19.2		13.6	

Source: www. statistics.sk

Methods

Contaminated and non-contaminated areas were delineated based on PTE contents in **soils** (Slovak limits for soils)

PTE groundwater/drinking water contents were similar, relatively low and in major cases below the limit values for Slovak Drinking Water Standards

Results

Selected values of environmental indicators in contaminated and non-contaminated areas of the Slovak Republic
(mean values for all municipalities)

	MIDDLE SLOVAK NEOVOLCANICS		UPPER NITRA		SLOVAK ORE MTS.	
	Contaminated area	Non contaminated area	Contaminated area	Non contaminated area	Contaminated area	Non contaminated area
Soils						
As	11.03	7.06	32.38	16.90	96.68	13.14
Cd	3.34	0.60	0.24	0.34	0.79	0.31
Cu	35.67	19.18	19.15	17.91	139.89	22.68
Hg	0.16	0.08	0.15	0.10	3.03	0.18
Pb	91.42	29.63	37.65	29.95	118.34	26.26
Sb	2.96	1.53	1.23	0.97	76.79	2.36
Zn	134.14	78.40	88.32	72.75	89.81	74.59
Ca	1.14	0.96	1.47	1.55	0.65	0.91
Mg	0.73	0.59	0.95	0.91	0.69	0.84
carbonates	0.86	1.21	1.74	2.14	0.62	0.22
Groundwater						
As	0.00194	0.00160	0.02096	0.00194	0.01217	0.00165
Cd	0.00139	0.00286	0.00444	0.00818	0.00054	0.00205
Cu	0.00263	0.00239	0.00129	0.00169	0.00413	0.00112
Hg	0.00014	0.00012	0.00015	0.00014	0.00016	0.00013
Pb	0.00198	0.00106	0.00107	0.00193	0.00163	0.00104
Sb	0.00024	0.00021	0.00019	0.00023	0.00941	0.00048
Zn	0.17592	0.25344	0.20046	0.15462	0.12486	0.12066
Ca	43.87	48.98	63.32	93.82	38.33	33.02
Mg	11.75	13.25	18.65	25.72	14.09	9.88
Ca+Mg	1.58	1.77	2.34	3.40	1.54	1.23

Contents of PTE in soils are significantly 2-5 x higher in contaminated areas

Characteristics of population health status in contaminated and non-contaminated areas

(data recalculated according to number of inhabitants in respective municipalities)

	MIDDLE SLOVAK NEOVOLCANICS		SLOVAK ORE MTS.		UPPER NITRA	
	1*	2*	1*	2*	1*	2*
LEp	71.10	70.99	71.12	71.53	73.55	73.45
LEm	65.78	66.10	66.49	66.99	69.75	69.62
LEw	75.96	75.65	72.88	74.95	77.06	77.13
A60+	18.16	17.89	15.31	16.91	17.87	17.99
SMRp	112.40	112.15	112.25	110.32	94.98	94.38
SMRm	122.67	117.58	115.75	111.37	94.07	91.57
SMRw	105.94	107.21	110.60	109.88	94.74	96.03
PYLL100	5,244.41	5,049.83	4,527.48	4,985.29	3 485.95	3 504.16
ReC	252.60	240.31	211.78	229.03	223.96	238.11
ReC1526	85.26	96.23	70.73	72.94	77.28	94.21
ReC16	14.24	20.72	14.30	15.34	22.60	20.90
ReC1820	27.41	32.32	24.46	20.60	23.02	28.49
ReC3039	55.44	46.94	45.58	51.67	50.09	43.19
ReC50	21.46	29.31	24.51	33.53	23.87	24.96
ReC6468	16.07	8.46	12.02	13.40	9.60	10.98
ReC8196	14.07	13.98	12.75	15.26	11.66	12.74
ReC9195	6.05	8.11	6.13	6.74	4.78	5.21
ReC00D48	241.58	242.61	212.62	229.40	223.83	240.48
ReE	21.52	16.63	17.45	16.49	20.92	14.73
ReI	760.28	668.37	582.93	682.26	613.95	617.30
ReI2125	392.94	310.74	355.31	363.62	288.70	280.75
ReI6364	141.29	108.41	46.26	126.98	55.71	79.70
ReJ	82.12	101.82	73.29	79.76	52.40	49.87
ReK	87.79	74.58	42.05	48.67	52.40	42.30
ReN	17.62	15.99	11.57	17.83	12.21	10.66
SMRC	103.88	100.01	104.66	99.71	93.86	98.75
SMRC1526	98.08	112.33	97.17	88.23	90.88	107.90
SMRC3039	114.40	93.69	110.51	102.84	98.88	83.05
SMRC8196	91.45	92.29	97.83	110.76	79.44	87.30
SMRE	119.57	103.60	131.67	109.24	129.10	89.61
SMRI	119.99	108.75	114.98	116.24	98.25	98.33
SMRI2125	100.30	104.62	137.26	118.20	91.62	86.94
SMRI6364	168.81	140.90	74.89	174.76	75.50	102.84
SMRJ	113.31	146.33	132.39	129.35	77.81	72.34
SMRK	127.85	151.96	99.01	96.85	96.77	82.22
SMRN	114.16	101.85	89.87	118.10	78.32	63.89
PYLLC	1,216.72	1,101.53	1,062.55	1,126.65	925.65	975.03
PYLLC1526	306.04	277.58	220.23	272.70	201.33	280.05
PYIIC3039	242.30	227.34	200.19	232.48	193.05	151.50
PYIII	1,170.12	1,182.35	1,116.08	1,365.40	778.44	839.03
PYLLI2125	578.20	555.64	596.50	728.38	360.04	350.23
PYLLJ	245.71	286.85	272.24	266.66	74.51	71.90
PYLLK	585.14	596.79	391.31	415.26	351.55	219.86
sum_neg	13,670,19	13,137,34	11,679,16	13,012,17	9,431,74	9,461,49

Note: 1* - Contaminated area
2* - Non contaminated area
sum_neg: SMRV - PYLLK

	MIDDLE SLOVAK NEOVOLCANICS		SLOVAK ORE MTS.		UPPER NITRA	
	1*	2*	1*	2*	1*	2*
ReC	252.60	240.31	211.78	229.03	223.96	238.11
ReI	760.28	668.37	582.93	682.26	613.95	617.30
ReJ	82.12	101.82	73.29	79.76	52.40	49.87
ReK	87.79	74.58	42.05	48.67	52.40	42.30
ReN	17.62	15.99	11.57	17.83	12.21	10.66
SMRC	103.88	100.01	104.66	99.71	93.86	98.75
SMRI	119.99	108.75	114.98	116.24	98.25	98.33
PYLLC	1,216.72	1,101.53	1,062.55	1,126.65	925.65	975.03
PYIII	1,170.12	1,182.35	1,116.08	1,365.40	778.44	839.03
sum_neg	13,670.19	13,137.34	11,679.16	13,012.17	9,431.74	9,461.49

Note: 1* - Contaminated area
2* - Non contaminated area
sum_neg: SMRV - PYLLK

DISCUSSION

No significant differences between health indicators in contaminated and non-contaminated areas were observed in any of the tree regions

Summary health indicators – sum_neg

Middle Slovak Neovolcanics
13,670 – 13,137

Upper Nitra region
9,431 – 9,461

the same

Slovak Ore Mts.
11,697 – 13,012
It is in opposite (better situation is in contaminated area)

GEOLOGICAL ENVIRONMENT

Middle Slovak Neovolcanics, Slovak Ore Mts. - built by silicate rock

Upper Nitra region: 40-45 % flysh sediments, 20 % carbonates
20 % volcanic rocks, 20 % granitic rocks

Contens of Mg and Ca

have determining impact on health status of Slovak residents

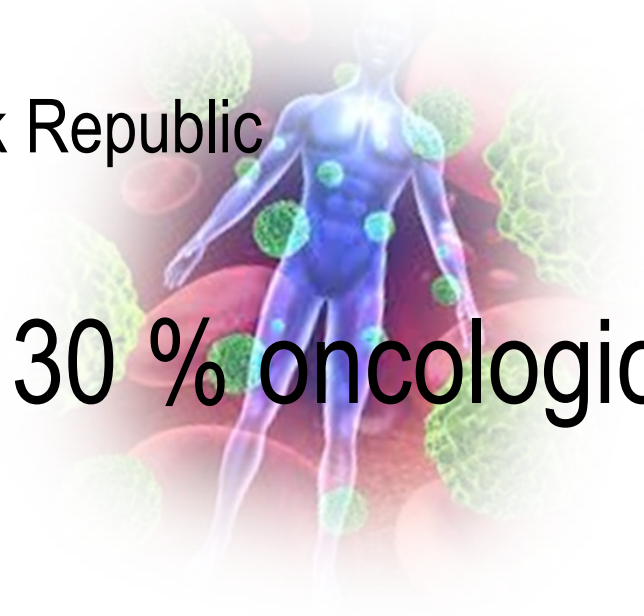
High contents – favorable status
Low contents – unfavorable status

In Upper Nitra region groundwater as well as soil contents of Ca, Mg are approximately twofold higher.

Ca, Mg contents in drinking water vs. *CVD and oncological mortality*

Mortality in the Slovak Republic

50 % CVD



30 % oncological

Conclusion

We found no significant impairment of the health of the population living in the areas with higher PTE contamination compared to non-contaminated areas. Surprisingly, no significant differences between the health status of population living in contaminated areas and that living in non-contaminated areas were observed. Finally, we can conclude that if groundwater/drinking waters used for drinking purposes show no PTE contamination, the local population inhabiting these historical mining areas might be at much lower risk than has been, in general, reported so far.

Thank you for your attention

This research has been performed within th project LIFE10 ENV/SK/000086" The impact of geological environment on health status of residents of the Slovak Republic", which is financially supported by the EU's funding instrument for the environment: Life+ programme.

SEGH 2015

THE LINKING BEETWEN ENVIRONMENT AND HEALTH

June/July 2015, State Geological Institute of Dionyz Stur, Bratislava, Slovak Republic

The International European Association Society for Geochemistry and Health in collaboration with the Slovak association of Geochemists, project GEOHEALTH is pleased to announce.

31th INTERNATIONAL CONFERENCE THE SOCIETY FOR ENVIRONMENTAL GEOCHEMISTRY AND HEALTH

30th SEGH International conference,
Newcastle, 30. June - 4. July 2014