• ROCKS

Geological environmental factors

Partial Monitoring System - Geological Factors (PMS - GF) as part of environmental monitoring in Slovakia, is focused mainly on so-called geological hazards or harmful natural or anthropogenic geological processes that threaten the natural environment and eventually the humans.

From 1.1.2006 data are monitored:

01: Landslides and other slope deformation

02: Tectonic and seismic activity of the territory

03: Anthropogenic sediments of environmental loads sediments

04: Impact of mineral exploitation upon environment

05: Monitoring of the volume activity of Radon in the geological environment

06: Stability of massifs underlying historic objects

07: Monitoring of stream sediments

08: Volume unstable soils

Summary of the major outcomes from the monitoring activities in 2008:

In 2008, monitoring of three basic types of **slope movements** was carried out – slides (15 localities), creep (4 localities), and signs of activated falling movements (9 localities). Sites in the territory of the projected pumped-storage hydroelectric plant of Ipeľ together with the stabilisation water levy in Handlová form an individual category of specific cases of the environment stability assessment process.

In 2008, reports from seismic stations supplied for interpretation more than 5 390 tele-seismic, regional, or local seismic phenomena. 70-80 earthquakes were localised with the epicentre in the focal area of the Slovak Republic. Macro-seismic monitoring in Slovakia were detect 3 earthquakes in 2008, one with epicentre in Banska Bystrica and two in the east of Slovakia.

In 2008, the following localities were included to subsystem **anthropogenic sediments**: Myjava, Modra, Šulekovo, Bojná, Krompachy – Halňa, Šaľa, Chalmová a Poša. Increase in chlorides and ammonia ions was confirmed at the Šaľa site. Analyses carried out for the Poša site confirmed a decreasing trend in elution of the major contaminant - arsenic. Almost the whole area of the Bojná landfill has shown intense ground water contamination over a long time period (chlorides, ammonia ions, sulphates, and boron). Although the Myjava site was recultivated in 2006, it remains to be a long-term source of contamination(ammonia ions, Zn, Ni). The Halňa landfill was shut down in 1999. Subsequent ground water monitoring showed exceeded limits for a number of elements (As, Cd, Ni, B, Zn, Sb). In 2008, changes to mechanical properties at 2 sludge beds of the Slovak Electric Power Plants - ENO (Nováky - Original, and Chalmová - Definite). In 2008, identification sheets were developed for other

five sludge beds, ore waste deposited in the sludge bed of Rudňany and fly ashes in Zvolen, Žilina, Snina, and Sereď.

Monitoring of the **impact of the mining activities on environment** in the area of the brown-coal upper-Nitra territory was carried out for the system of four most important mine shafts (Handlová pri Rybe, the Cígeľ mine, Hlboká, and Lehota pod Vtáčnikom). Increased values in total mineralisation figures of water outflow from mines were recorded (within the interval of 500 – 750 $mg.l^{-1}$); however, these are comparable to the water figures for local recipients (500 – 700 $mg.l^{-1}$). Contents of potentially toxic elements (As, Se, Cu, Zn, Pb, Hg) in water are relatively low. The area of magnesite and talc extraction includes the sites of Jelšava, Lubeník, Hnúšťa - Mútnik, and Košice - Bankov, which have been entered into the monitoring system. Alcalisation of soils and damage to vegetation at the regional level represent the common and major environmental issue in the areas of extraction and treatment of magnesite and talc. Another major environmental issue is the surface stability above the extracted parts of the deposit, and the magnitude of surface collapses. The great number of sites afflicted by extraction of ores include the following sites under monitoring: Rudňany, Slovinky, Smolník, Novoveská Huta, Rožňava, Nižná Slaná, Banská Štiavnica, Hodruša, Kremnica, Špania dolina, Dúbrava, and Pezinok. Active mining works still continue only at the gypsum deposit in Novoveská Huta. The continuing environmental impacts shown at these sites include instability of the rock massif, contamination of surface water courses by mining water outflows, leaching from dumps and sludge beds and, in the case of operated facilities for thermal treatment of ores, also level of pollution of the territory, with negative impacts on the quality of soil, vegetation cover, and air quality. The danger of sudden gushing water from abandoned mines situated above inhabited areas has been a specific issue since 2008. For example, this involves periodic sudden outflows of mine water from the mine of Nová Štôlňa located in the extraction territory of the city of Spišská Nová Ves, above the city's local residential area of Pod Tepličkou.

Monitoring of the **volume activity of radon** in geological layers in 2008 continued at 14 sites distributed all over the whole Slovak territory (7 sites for radon in soil and 7 sites for radon in groundwater). Monitoring of soil radon in 2008 were carried out at six sites that showed middle to high radon risk (Bratislava - Vajnory, Banská Bystrica - Podlavice, Košice-KVP, Novoveská Huta, Teplička, and Hnilec). Sampling and radon measurement in water was carried out at thesee springs of the Malé Karpaty mountains, on the outskirts of Bratislava - Mária spring, Zbojníčka spring, and Himligárka spring, at Bacúch – spring of Božena Němcová, and at Sivá Brada near Spišské Podhradie – spring of St. Ondrej, spring Oravice near the OZ-1 bore hole, and in Zemplín – the Ladmovce bore hole - preliv. Monitoring outcomes of the radon volume activity in ground water point to the fact that the middle values of radon concentration for springs monitored in 2008 are higher than in the previous years. Complex outcomes of radon monitoring from 2008 and the previous years show that the changes recorded for the radon volume activity within the geological environment are either short-lived (seasonal), long-term (counted in years), and random (local, temporal, climate, etc.)

In 2007, **monitoring of stability of rock massifs** below historic objects concentrated on the following sites: Spišský, Strečniansky, Oravský, Uhrovský, Trenčiansky and Lietavský castles, castle Devín and the Church of st. Juraj in Kostaľany under Tríbeč.

Within **stream sediments monitoring** was exceeding the reference concentration (Category A) at 35 sites. Exceeding the limite concentration of the B category (expextation of contamination) was detected at 12 sites. Exceeding the limite concentration of the C category was detected (exceeding of this limit suggests impact of demolition activities) at Nitra - Chalmová (Hg), Štiavnica - river mouth (Pb), and Hornád - Krompachy (Hg) sites. Alluvial sediments of the rivers of Váh, Hron, Muráň, Danube, together with the majority of water courses of the East-Slovakian lowland and the adjacent territories are in fact free of contamination, and concentrations of substances represent mainly their natural contents. Monitoring (over the last 13 years) has clearly shown substantially and permanently contaminated water courses of Nitra, Štiavnica, Hornád, and Hnilec. Contamination of the alluvial sediments of Ondava, typical for its increased levels of arsenic was not detected in 2008.

Partial information system

In 2008, data obtained from measuring the monitoring points were gradually stored and processed within the Partial information system of geological factors (PISGF). The data were then exported into a transparent level that enables spatial view of the monitoring outcomes in the form of maps, charts, as well as organized tables. Selected data from the information system are accessible for all interested professional and lay persons at the partial monitoring system website for geological factors (http://dionysos.gssr.sk/cmsgf). The Partial Monitoring System website for geological factors is connected to and accessible also from the SGIDS (www.geology.sk) and Enviroportal website (http://enviroportal.sk/).

Geothermal energy

At present, there are 26 designated geothermal areas in Slovakia, taking up 27 % of the state's territory. To this day, 120 geothermal wells have been made in these designated areas, analysing 1 787 $l.s^{-1}$ of water with the outflow temperature of 18 - 29°C. Geothermal water was detected through wells with the depth of 92 – 3.616 m. Yield at the free overflow from these wells fluctuated within the interval of tenths of a litre to 100 $l.s^{-1}$. Dominating are water types of Na-HCO_3, Ca-Mg-HCO_3-SO_4 and Na-Cl with the mineralisation of 0,4 - 90,0 $g.l^{-1}$. Thermal output of geothermal water used up to its reference temperature of 15°C is 306.8 MW, which represents 5.5 % of the total mentioned geothermal energy potential in Slovakia.

Regional **geothermal survey** was conducted in line with the approved Strategy of geothermal energy use in Slovakia by the end of 2008, which involved the following territories: Galanta, Komárňanská vysoká kryha, Liptovská basin, Košicka basin – site Ďurkov, Popradská basin, Skorušinská plane, sites

in Galanta, structures in Ďurkov, Žiarska basin, Hornonitrianská basin, Topoľčany záliv, Banovská basin, and the Humenský ridge.

Register of geological mapping

Registers of geological mapping (as of December 31, 2008)

Registers of	Accumulation in 2008	Total number
Surveyed territories	44	558
Surveyed territories drafts	50	568
Landslides	82	11 488
Wells	3 156	741 151
Hydro-geological wells	361	23 675
Landfills	6	8 460
Map drawing and purpose mapping	47	9 768
Geophysical mapping	625	5 376
Abandoned mining works	1	16 571

Source: SGI DS

Abandoned mining works

Pursuant to **Act No. 44/1988 Coll. on protection and exploitation of mineral deposits (Mining Act),** as amended, MoE SR also ensures searching for abandoned mining works. The State Geological Institute of Dionýz Štúr in Bratislava was commissioned to maintain the Register.

Abandoned mining works as of December 31, 2008

Type of abandoned mine	Number
Mining shaft	4 875
Pit (hole)	517
Chute	65
Cut, excavation	88
Pingo	3 987
Pingo field	109
Pingo draw	128
Dump	6 125
Old randing	205
Sink mark	293
Placer	20
Tailings dump	10
Other	155
Total	**16 577**

Source: SGI DS

Survey territories

Under the geology legislation and pursuant to the GS SR status - the GEOFOND department keeps the register of survey areas for selected geological activities. In 2008, there were 44 survey areas and 50 registered proposals to designate a survey area. As of December 31, 2008, there were 157 recognised areas.

Energy deposits (state to the date 31st December 2008)

Raw material	Number of deposits included into balance	Number of free balance deposits	Number of deposits for mining	Unit	Balance deposits free	Geological deposits
Anthracite	1	1	0	tis. t	2 008	8 006
Bitumen sediments	1	1	0	tis. t	9 780	10 797
Brown coal	11	6	4	tis. t	138 596	461 391
Flammable natural gas – gasoline gas	8	6	3	tis. t	198	395
Lignite	8	3	1	tis. t	111 966	619 110
Non-resinous gases	1	0	0	mil. m^3	0	6 380
Underground stores of natural gas	9	0	0	mil. m^3	0	2 246
Crude oil non-paraffinic	3	3	0	tis. t	1 632	3 422
Crude oil - semi-paraffinic	8	3	4	tis. t	132	6 395
Uranium ores	2	1	0	tis. t	1 396	5 272
Natural gas	39	22	12	mil. m^3	8 663	26 037
Total	**91**	**46**	**24**		-	-

Source: SGI DS

Minerals deposits balance

Ore deposits (state to the date 31st December 2008)

Type of ore	Number of deposits included into balance	Number of free balance deposits	Number of deposits for mining in 2005	Unit	Balance deposits free	Geological deposits
Sb ores	9	1	0	thous. t	85	3 276
Complex Fe ores	7	2	0	thous. t	5 751	57 762
Cu ores	10	0	0	thous. t	0	43 916
Hg ores	1	0	0	thous. t	0	2 426
Poly-metallic ores	4	1	0	thous. t	1 623	23 671
Wolfram ores	1	0	0	thous. t	0	2 846
Gold and silver ores	11	5	1	thous. t	26 830	32 363
Fe ores	2	2	1	thous. t	14 476	18 743
Total	**45**	**11**	**2**		**48 765**	**185 003**

Source: SGI DS

Non-metallics deposits (state to the date 31st December 2008)

Minerals and minerals based products	Number of deposits included into balance	Number of free balance deposits	Number of deposits for mining	Unit	Balance deposits free	Geological deposits
Anhydride	7	5	2	thous. t	659 097	1 250 290
Asbestos and aspestos rock	4	1	0	thous. t	1 808	3 711
Baryte	6	2	2	thous. t	9 226	12 676
Bentonite	23	17	9	thous. t	29 031	42 179
Cast basalt	5	5	1	thous. t	22 774	39 949
Decorative rock	23	14	3	thous. m3	11 398	25 503
Diatomite	3	2	0	thous. t	6 556	8 436
Dolomite	20	20	9	thous. t	607 710	634 177
Precious stones	1	1	0	ct	1 205 168	2 515 866
Graphite	1	0	0	thous. t	0	294
Halloysite	1	0	0	thous. t	0	2 249
Rock salt	4	4	1	thous. t	838 841	1 349 823

Kaolin	14	11	3	thous. t	50 903	59 790
Ceramic clays	38	34	5	thous. t	115 227	190 110
Quartz	7	6	0	thous. t	301	327
Quartzite	15	12	0	thous. t	17 448	26 950
Magnesite	10	6	3	thous. t	759 006	1 156 680
Talc	6	3	0	thous. t	93 709	242 178
Mineralized I - Br waters	2	1	0	thous. m^3	3 658	3 658
Pearl stone	5	5	1	thous. t	30 216	30 536
Pyrite	3	0	0	thous. t	0	14 839
Gypsum	6	4	3	thous. t	49 224	93 460
Sialitic raw material	5	2	2	thous. t	109 269	122 632
Glass sands	4	4	2	thous. t	411 158	589 884
Mica	1	1	0	thous. t	14 073	14 073
Building rock	134	131	83	thous. m^3	648 534	764 992
Gravel sands and sands	26	22	15	thous. m^3	135 402	155 097
Brick clay	40	36	12	thous. m^3	103 547	127 741
Techn. usable miner. crystals	3	1	0	thous. t	253	2 103
Limestone – unspecified	30	27	13	thous. t	1 943 382	2 303 066
High-content limestone	10	10	4	thous. t	3 195 519	3 359 441
Limestone-marl	8	7	2	thous. t	165 531	167 783
Zeolite	6	6	2	thous. t	106 012	111 236
Foundry sands	14	7	1	thous. t	277 940	508 632
Refractory clays	9	6	1	thous. t	3 093	5 318
Feldspars	7	7	1	thous. t	17 648	18 886
Total	**501**	**423**	**180**		-	-

Source: SGI DS

Classification of mineral deposits by state of extraction (state to the date 31st December 2008)

Extraction symbol	Characteristics	Number of deposits
1	*Deposits with developed extraction activity* include exclusive mineral deposits sufficiently open and technically apt for extraction of industrial deposit.	219
2	*Deposits with fading extraction activity* include extraction mineral deposits where extraction activity will cease in a near future (within 10 years)	33
3	*Deposits before completion* include exclusive mineral deposits with documented deposits that give basis to one of the construction phases (starting with the projection phase)	37
4	*Deposits with ceased extraction* include exclusive mineral deposits with definitely or temporarily stopped extraction activity.	96
5	*Non-extracted deposits* include documented exclusive mineral deposits soon **to be** constructed and extracted.	56
6	*Non-extracted deposits* include documented exclusive mineral deposits **with no plans** for their extraction.	180
7	*Surveyed deposits* include deposits of exclusive and non-exclusive minerals with various degree of mapping.	16

Source: SGI DS

Non-reserved mineral deposits (as of December 31, 2008)

Raw material	Number of listed deposit sites	Number of sites with extraction activities
Other raw material	20	2
Building stone	162	52
Gravel sands and sands	223	99
Brick clay	58	1
Total	**463**	**154**

Source: SGI DS

Other raw material deposits (as of December 31, 2008)

Raw materail	Number of listed deposit sites	Number of sites with extraction activities
Shale	3	0
Floating sand	1	0
Waste rock	6	1
Clays	1	0
Sialitic raw material and marl	6	0
Tuff	2	0
Dried sludge – brucit	1	1
Total	**20**	**2**

Source: SGI DS

- **Ground water volumes**

Ground waters deposits in the SR (state to the date December 31, 2008)

Category	A	B	C	Total
Efficient deposits of the ground waters (l.s-1)	-	**191,63**	**4 020,95**	**4 212,58**
Efficient amounts of the ground waters (l.s-1)	-	-	**13 313,76**	**13 313,76**

Source: SGI DS

Legend:
C calculated on the basis of assessment of the existing hydrogeological mapping
B calculated on the basis of hydrogeological mapping with long-term extraction test
A calculated on the basis of hydrogeological mapping with semi-operational test