# THE ECOLOGICAL MANAGEMENT OF REGHIN GEOMORPHOLOGICAL SITE

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***Abstract.*** *This study presents the reflex of the direct correlation between the tectonics and the lithology of the Transylvanian Depression (the Romania's intercarpathian depression where the Mureş hydrographic basin lies) reflected into the development of Mureş River terraces, into the terrace deposits' structure and texture; this correlation has a direct influence on the organical pollutants' storage and dispersion at the level of fluvial terrace deposits (through industrial operations it had become a contaminated site). After several historical and recent anthropic activities, following the lack of an appropriate legislative framework for pollution prevention and soil and subsoil there were found 1682 contaminated and historical potentially contaminated sites in Romania. Hazards and risks analysis determined by terrace deposits contamination implies the specialised management of soil and underground water contamination. The identification of the risks' negative effects on human health and over the environment involves determining pollutants migration potential and setting up the adequate measures for hazards effects mitigation to an acceptable risk level. The used study methodology belongs to the applied geomorphology, allowing data analyse, quantification and integration based on the agreed algorithms for environment evaluation.*

*The results of sampling and monitoring have been incorporated into a detailed quantitative risks analysis that reflects hazards size and losses production probability. The methods we used are those who best define receptors' characteristics; their mathematical foundation is based on the site's morpho-hydrological characteristics.*

*The surfaces and volumes of contaminated soil and underground water were classified using the pollutants' impact ratio according to the terrace deposits type (structure and texture) and, by using the mathematical interpolation, there were made the vertical and longitudinal contaminants dispersion map.*

*The study confirms the direct relation between the site's morpho-hydrological characteristics and the behaviour of dangerous substances – hydrocarbons (physical – chemical properties, ways of storage, migration, natural dilution, etc.); this relation can be determined using the connection between pollution source – path of propagation – receptor.*

**Key words**: *contaminated site, applied geomorphology, terrace deposits, pollutants, protected area.*

**Introduction**

According to the oldest tectonic and hydrographic connection line between the Transylvanian Plateau and the Pannonian Depression, the Mureş River has created a much extended drainage basin in the central part of Romania. After it leaves the Topliţa – Deda Defile, inside the Văleni tectonic Depression, formed between the peak of Şieu – Şinioara anticline and the Gurghiu Mountains, the valley takes the form of an alluvial plain with high slopes on the western side, becoming a huge dejection cone rich in high quality underground waters [20]. The geographical and mathematical position of this hydrographic basin brings him a great geomorphological and geological diversity, and also an uneven variation of the climatical and hydrological elements from an area to another.

The Mureş's longitudinal profile intersects from east to west (according to the flow direction) the morphostructural unit of double tectonic affinity folds [16], the diapir anticlines and synclines – brachisynclines and brachianticlines – carved into Badenian, Sarmatian and Pannonian deposits (The Subcarpathian Hills of Reghin); the central morpho-structural unit of gas doms, inner-domes basins (Ernei, Corunca, Ogra-Sânpaul, Bogata de Mureş); the western unit of the diapir folds, with faulted diapir anticlines and synclines, massive stocks, diapir columns (Stâna de Mureş – Gura Arieşului, Ocna Mureş – Turda, Ruşi – Blaj – Ocnişoara, Păuca – Alămor – Ocna Sibiului) [11], [12], [13]. The diapir area from the north- east part of the Transylvanian Depression (Figure 1) includes the diapir anticlines of Praid – Sovata – Ibăneşti şi Teleac – Brâncoveneşti – Jabeniţa – Sărăţeni – Sigmir [6].

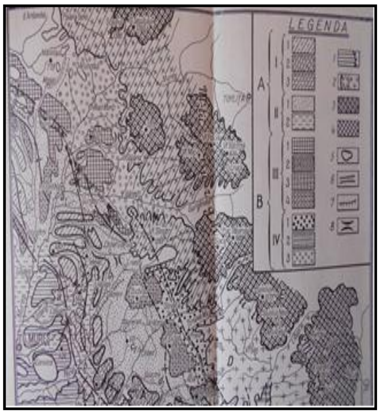


Figure 1. Praid-Sovata-Ibaneşti and Teleac-Saraţeni-Sigmir anticlines (after Mac, 1972)

The faults' tectonic diapirism was highlighted using seismic and gravimetric profiles [14], but also by using geomorphological profiles o highlight lower terraces bed deformation at Brâncoveneşti [10]. The site's geological perimeter is placed on the Bistriţa Sheet [15], the area's central – southern sector, in the depression between the Transylvanian Subcarpathians and the Transylvanian Plateau, on the left bank of the middle Mureş River. The local river macro morphology presents well developed, asymmetrical floodplains and river terraces, with a gradual transition to the hills. The basin's local particularities, required by the geological structure that is present in the relief's evolution degree and aspect, in the use of land and in the population degree, allowed the individualisation of many mountainous and hilly subunits [18].

The sedimentary surface has a domes structure, but from place to place there appear monocline structures with high altitudes in east (over 650 m) and low in west (350 – 400 m). This site, placed in the industrial area and inside the town of Reghin (owned by the "X" Society), represents an old fuel deposit placed at the level of the Mureş River alluvial plain with a relative altitude of 2 – 5 m (absolute altitude of 365-370 m), no significant slopes (below 5°), a gentle land cover with no humps, fragmentations or major land undulations.

The relief's nowadays aspect is the consequence of land's relative recent evolution in a soil with clay and marl, with intercalations of Helvetian sandstones. The new formations belong to geological Quaternary – Upper Holocene period and are represented by alluvial and adobe rocks that form the terrace and flood plain area stratification (sand, gravel with boulders) and the hill base (muddy, dusty adobe rocks).

The human's actions inside the Mureş hydrographic basin have a big influence on the waters chemical composition, due to the mining activities of subsoil resources (raw metals, salt, mineral waters etc.), to the technological processes that create waste waters, the discharge of sewage from households, the use of chemical in the local agriculture, lifestock farms, etc. The most significant modifications of water quality inside Mureş basin are determined by the chemical industry, by the wood processing industry, the food industry, the building materials industry, by the urban and rural settlements, and by the agriculture.

From the environmental point of view site, SE direction lies at a distance of 647 m from the protected natural area "ROSCI 0320 Mociar" located in a site of Community interest and the eastward, at a distance of 857 m, lies the protected natural area „ROSCI 0368 Râul Mureş între Deda şi Reghin" (Figure 2). The two sites of Community interest and feature the moist area on the river Mureş (jud. Mureş) in the Continental biogeographical region, housing and protects amphibian species Bombina variegata, Triturus cristatus Triturus vulgaris, ampelensis, invertebrate species Isophya Osmoderma eremita, stysi and mammal species Lutra lutra At EU level, these species with habitat on the sites of Community interest "NATURE 2000" are protected under article 4 of Directive 2009/147/EC, is listed in annex II to Directive 92/43/EEC.

The main purpose of the network "NATURA 2000" is to find solutions to allow economic activities "friendly" with the environment, biodiversity protection and at the same time is not to prohibit human activities, free movement of persons or to restrict the right to property [17], [19].

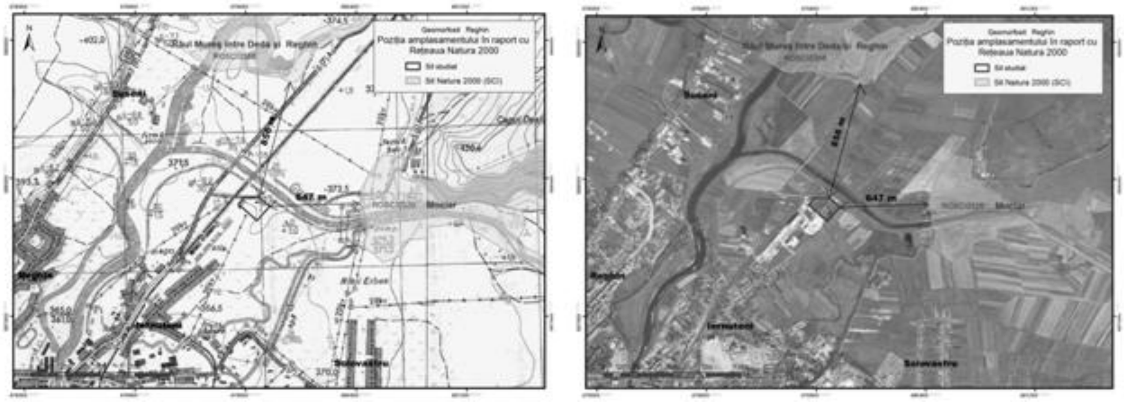

Figure 2 The sit position toward Natura 2000

The terraces are the most morpho-dynamically stable and the most favourable for technological and urbanistic constructions. In 1976, on a barren field of 24.191 $m^2$ from the Mureş alluvial plain in the north-eastern side of the town, there was built a fuel storage and distribution deposit. The deposit has been authorised and it carried on as a main activity the storage, manipulation and commerce of solid, liquid and gas fuels. The deposit's technological flux is represented by procurement of petroleum products and of cylinders, their storage and sell to the own distribution network or to other distributors. The deposit's supplying is made using CF oil tankers and tank trucks that come from the national refineries. The oil cars are shunt on the railway inside the deposit, in front of the specially designed vents. From this point, using the pump house, the fuels are transferred into horizontal and vertical, underground and cylindrical overground, storage and service tanks (Figure 3, Figure 4).

Figure 3 Deposit's condition before demolishing

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Figure 4 Currently status of land

**Material and method**

In accordance with environmental legislation in force, after the deposit's closure and demolition, the environmental authority from that area required the conducting of intrusive investigations to determine the extent of soil, subsoil and underground water contamination around the site.

In 2006, after the sales from the Reghin deposit had stopped, some studies were made to obtain the required environmental permit. The technological components with possible impact on environmental factors degradation were the oil separator, the buried and above-ground tanks, oil shed; used oil dump; pump house with annexes; the technological networks, the sewerage networks; the emptying, transferring and vents pipes; the pumps; the fuel discharge openings; the pumping stations; the water-channel homes; the railway line; the drawbridge and the capacitors station. Their operation and exploitation manner, together with the vulnerabilities determined by the age of equipment and facilities, are the main routes for environmental pollution through spills due to the imperfection of oil tanks walls, to wastewater infiltration from the deposit's platform, to uncontrolled waste disposal, etc.

The soil's quality evaluation in the study area was made after stopping the activity inside it, but before the demolition, using 10 geotechnical control drills to a depth of 5 m, with soil and subsoil samples taken at 0,5, 2,5 and 5 m; the lab analysis concentrated on the specific indicator – total oil hydrocarbons.

Analyses conducted on 41 soil samples taken from site , in 2006, of the ramp cf , a repository of oils and oil separator showed exceedances of total petroleum hydrocarbons concentration indicator ( TPH ) . Intervention threshold values for soils use " less sensitive " , .1000 mg / kg ( ord 756 697 ) in 8 samples and the values of the threshold for soils to use " less sensitive " , 2000 mg / kg ( ord 756/1997 ) were exceeded in 11 samples , with a maximum of 7,591 mg / kg.

In order to determine the degree of soil pollution site Reghin the analytical determinations results were compared to the indicator Total Petroleum Hydrocarbons ( TPH ) with standard values of the Minister of water, forests and environmental protection no. 756 of november 3, 1997 , regulations on environmental pollution assessment . Reference values for trace chemical elements in soils , organic compounds, expressed in ( mg/kg dry weight) for the three levels of soil evaluation "less sensitive" ( industrial and commercial ). Taking into account that at the time of the survey the oil depot was demolished therefore , it could not have been carried any complex intrusive investigation through in areas with high pollution potential (the fleet of tanks, pump house, oil depots, and so on). So the insight about the pollution is partial, context in which, based on preliminary results showed of the territorial environmental authority has ordered further investigation after demolition.

In 2009, investigations were continued by conducting intrusive activities of the execution of 20 soil sampling wells, construction of eight monitoring wells, pumping tests were carried out, desanding sampling wells and 20 groundwater samples and 60 soil samples, laboratory tests had been made to determine the concentration of pollutants such TPH, BTEX and toxic heavy metals

Table 1 Localising the drillings in the geomorphological site of Reghin

| Drilling sampling | X | Y | Z | Hydrostatic level |
|---|---|---|---|---|
| PR-1 | 587837,70 | 479671,39 | 369,22 | 367,42 |
| PR-2 | 587811,67 | 479670,48 | 369,96 | 367,57 |
| PR-3 | 587837,59 | 479649,43 | 369,14 | 367,46 |
| PR-4 | 587784,77 | 479740,55 | 369,05 | 367,44 |
| PR-5 | 587813,07 | 479710,92 | 369,33 | 367,41 |
| PR-6 | 587821,18 | 479730,73 | 369,24 | 367,50 |
| PR-7 | 587708,80 | 479667,35 | 369,23 | 367,54 |
| PR-8 | 587846,52 | 479591.21 | 369,90 | 367,53 |
| PR-9 | 587813,53 | 479564,79 | 369,13 | 367,47 |
| PR-10 | 587859,89 | 479634,37 | 369,29 | 367,45 |
| PR-11 | 587754,21 | 479623,71 | 369,02 | 367,44 |
| PR-12 | 587731,93 | 479643,83 | 369,40 | 367,46 |
| PR-13 | 587811,97 | 479646,23 | 369,16 | 367,54 |
| PR-14 | 587818,80 | 479599,14 | 369,19 | 367,50 |
| PR-15 | 587729,20 | 479651,28 | 369,64 | 367,49 |
| PR-16 | 587804,77 | 479758,90 | 369,24 | 367,48 |
| PR-17 | 587789,44 | 479651,93 | 369,83 | 367,48 |
| PR-18 | 587785,09 | 479691,97 | 369,58 | 367,51 |
| PR-19 | 58760,415 | 479701,215 | 369,11 | 367,42 |

The drillings (dry drilling with protective tubing) were done in the perimeter of old fuel deposits (Table 1), the main sources of pollution of the aquifers and the soil; the matrix analysis of the correlations between the type of deposit and the area of pollution was made through GIS methodology.

The volume/mass debits have values between 1-8 l/s/m (most frequently 1-2 l/s/m), the filtration coefficients have values up to 100 m/day, and the hydraulic conductivity/transmission have values up to 600-700 $m^2$/day. The body of water is supplied mainly from rainfall, efficient infiltration having values of about 31.5-63 mm/year, being drained by the hydrographic network. It is also possible to supply this body of subterranean water from the river, on certain areas, in times of floods. The meadow and terrace alluvial deposit is mainly made of sands, rocks and, in places, of clay-sands, silts, clays, thin sandy-clays, with a lenticular aspect. Specialised analyses were made on the soil samples taken from the PR1 and PR14 drillings, seen as representative and relevant for establishing the homogeneity of the granulometry of the investigated surface, the results of which are presented in Table 2.

Table 2. Granulometric Analysis

| **Sample code** | **Granulometric fraction** | | | | |
|---|---|---|---|---|---|
| | **Gravel (t%)** | **Sand (t%)** | **Gritty Dust (t%)** | **Silty clay, mud (t%)** | **Ic** |
| PR-1/1 1m | 0,00 | 10,32 | 42,11 | 46,56 | |
| PR-1/3 3,0m | 30,26 | 39,79 | 4,49 | 25,47 | |
| PR-14/1 1,0m | 2,10 | 12,05 | 45,80 | 40,05 | |
| PR-14/2 2,0m | 40,21 | 31,05 | 25,80 | 2,94 | 1,05 |

The granulometric analysis emphasises a certain lack of homogeneity of the studied surface, despite the fact that there are layers of all the granulometric fractions in the samples taken. This leads to the idea of a possible influencing, even changing of the flowing direction of the subterranean water, through the fact that larger rocks, that require supplementary energy to move are covered by a fine mud which influences and alters the geometry of the pores and, implicitly, the flowing direction of the first aquifer that transports solubilized pollutants.

The thickness of the sedimentary coverture varies from 2 to 7 m. In the Reghin area, the strata with the largest thickness can be found in the meadow of the left bank of the Mureş. The hydrostatic level, found generally at depths of 1-5 m in the meadow and 3-10 m in terraces is free, but locally, due to the coverture made of weakly-permeable deposits, may become ascending.

The site in Reghin represents an aquifer stationed in the alluvial deposits of the meadow and terraces of the Mureş. From the perspective of lithology, these deposits are made of gravels and rocks, sand-based gravels and also compact purple clay-shale, with a lenticular spread. South of the confluence between the Mureş and the Beica stream, the aquifer is characterised by greater values of the hydraulic gradients (0.0034 – 0.2) compared to the aquifer found between the Mureş River and the Apalina Channel. We have noticed that the greatest values of hydraulic gradients are found close to the confluence of the Mureş River and the Beica stream.

The aquifer's unloading is made towards the Mureş. Certain sectors have the possibility to replenish the aquifer from the Mureş River in times of high debits. Due to the fact there is no direct link between the aquifers localised in alluvial deposits situated on both sides of the Mureş River, the draining of both is made by the river's bed, and that is why the depth of the piezometric surface varies even according to the water-level of the aforementioned river.

The entering of a pollutant from the surface into the soil and then into the aquifer is done through the aerating area in an unsaturated regime and then through filtration in a saturated one. In case a spillage of the pollutant occurs, a body of impregnation is formed at the surface of the soil due to the phenomena of convection, dispersion, adsorption, precipitation and biological activity.

The direction and speed of the pollutant depends mainly of its viscosity, the morphology of the terrain and the soil's permeability and, respectively, of the rocks is the aquifer stratum. The pollutant can be filtered, adsorbed, made volatile, precipitated, biodegraded or even stopped by an impermeable barrier in the unsaturated area. When a pollutant reaches the aquifer, it disperses, adheres or is adsorbed by the soil particles from the saturated or/an unsaturated area with an effect in concentration dilution. A certain parameter, called retardation factor, which is used to describe the tendency of the rock to adsorb the pollutant, acts in this process. The density, viscosity, solubility, chemical stability of dangerous substances, fuels and derivatives in the case of the analysed site are characteristics which influence the dispersion in the aquifer [2].

These pollutants can be harmless or very toxic, represented by substances that are or not water-mixable. The spatial dispersion of the pollutants is also influenced by the geometry of the pores and the heterogeneity of the porous environment [3].

**RESULTS AND DISCUSSIONS**

The mechanisms of mechanical dispersion of the hydrocarbons in the analysed site have, as a base: the pollutant’s viscosity, where the flowing speed of the aquifer presents variations in the pores’ section; thus, the particles move faster along the axis that along the walls of the pores; the differences of the pores in the transversal section determine different average speeds, so the particles will move faster in some pores than in others; the tortuosity makes some particles to move on a shorter path than others. These differences cause variations of the speed of flowing of the aquifer in longitudinal and transverse directions, with an effect on the spreading of the pollutant [4], [5], [8], [9].

The non-mixable substances do not mix with water and are propagated as a separate phase. They are found under the acronym NAPL (Non Aqueous Phase Liquids). In turn, NAPL is of two types: LNAP, when the density is lower than that of water and DNAPL, when the density is higher than that of water. This effect is very important in the investigation, inventorying and monitoring process of the establishment, especially when evaluating the associated risk and drafting the decontamination project. The transport mechanism of non-mixable pollutants is not fully known, being the focus of researchers. Maps with the pollutants’ dispersion have as an interpolation base the results of laboratory attempts for chemical analyses corroborated with the morpho-hydrogeological characteristics of the studied site.

Aliphatic hydrocarbons (TPH) and aromatic hydrocarbons (BTEX) that were identified in the soil (Table 3). This aspect is constituted as an argument in proving the role of the structure and the texture of terrace deposits in the dispersion of organic pollutants (Figure 5, Figure 6) [1], [7].

Table 3 Aliphatic and aromatic hydrocarbons analysis in soil

| No. | Sample code/depth | | TPH STAS 21470-94:2001 | | | BTEX STAS 21470-92:1998, STAS 21470-93:1998 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | C5-C8 mg/kg | C9-C40 mg/kg | TPH mg/kg | Benzene mg/kg | Toluene mg/kg | Ethyl benzene mg/kg | Xilene mg/kg | Total alkylbenzen mg/kg | Total BTEX mg/kg |
| | | | Acredited analysis i: yes, n: no. | | | | | | | | |
| | | | | i | i | i | i | i | i | i | i |
| 1 | PR-1 | 1,0 m | < 5 | 1080 | 1.080 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | < 0,1 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | PR 8 | 1,5 m | < 5 | 3280 | 3.280 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | < 0,1 |
| 26 | | 2,0 m | < 5 | 1670 | 1.670 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | 1,2 | 1,2 |
| 32 | | 1,7 m | < 5 | 914 | 914 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | < 0,1 |
| 33 | PR 10 | 2,2 m | < 5 | 3740 | 3.740 | < 0,1 | < 0,1 | 0,12 | 0,28 | 2,1 | 2,5 |
| 34 | PR-11 | 1,0 m | < 5 | 1310 | 1.310 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | < 0,1 |
| 35 | | 1,5 m | 36 | 9780 | 9.810 | < 0,1 | 0,18 | 0,15 | 0,54 | 2,9 | 3,7 |
| 36 | PR-12 | 1,0 m | < 5 | 2350 | 2.350 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | < 0,1 |
| 37 | | 1,5 m | < 5 | 4390 | 4.390 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | 1,6 | 1,6 |
| 38 | | 2,0 m | < 5 | 8420 | 8.420 | < 0,1 | < 0,1 | < 0,1 | 0,2 | 4,9 | 5,2 |
| 39 | | 2,4 m | 127 | 1975 | 1.990 | 0,26 | 0,04 | 2,3 | 5,2 | 42 | 50 |
| 46 | PR 15 | 1,5 m | < 5 | 2260 | 2.260 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | 0,23 | 0,23 |
| 48 | | 2,5 m | 145 | 5240 | 5.390 | < 0,1 | < 0,1 | 0,24 | 0,81 | 2,9 | 4,0 |
| 53 | PR-17 | 1,0 m | 8,1 | 3100 | 3.110 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | 0,38 | 0,38 |
| 57 | PR-19 | 1,5 m | 5,4 | 3530 | 3.540 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | < 0,1 |
| 59 | PR-20 | 1,0 m | < 5 | 1810 | 1.810 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | < 0,1 | < 0,1 |

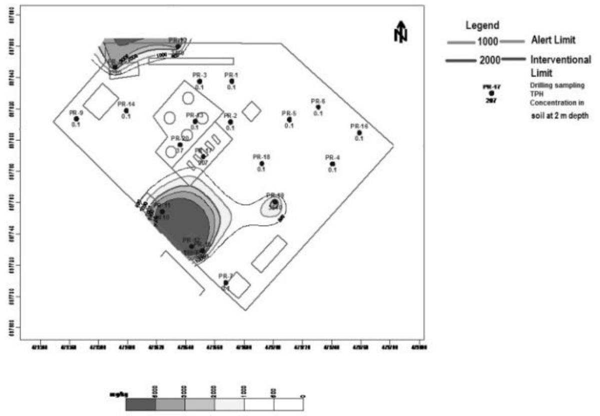

Figure 5. TPH Concentration in soil at 2 m depth

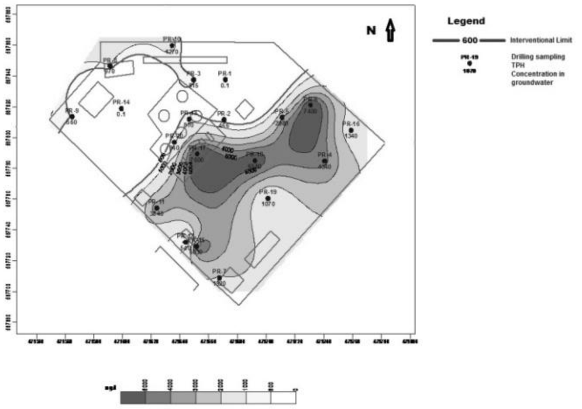

Figure 6. TPH Concentration in groundwater

## CONCLUSIONS AND DISCUSSIONS

The pollution with hydrocarbons of the soil and water-table from the area of economical and industrial objectives (storage and distribution deposits of petrol products) situated in morpho-sites on the terrace deposits of the Mureş River is mainly due to the accidental leakage of petrol products, the non-standard storage or dangerous waste and residues, the precarious state of the equipment (pipes, basins, reservoirs etc.). The petrol contamination of low-depth subterranean water is made in time, persuasively, continuously for as long as the source is active and takes place in well set phases:

- the migration of the contaminated agent from the source to the unsaturated area with its subareas "the water in the soil", of atmospheric provenance and capillary, situated over the first phreatic and its cantoning, in the form of a residual floating layer, "the pollutant floater" in the area of capillary fringe.
- the transfer of residual hydrocarbons in the phreatic water by solubilisation and percolation generates a chemical pollution by increasing the content of toxic organic substances in the subterranean water, corroborated with the harmful effect produced by the bio-degeneration of the hydrocarbons stored in the vegetable soil or in the subsoil covering the phreatic.

The polluting mechanisms of the ROMU03 body of subterranean water, of a permeable porous type, located in the meadow and terrace alluvial deposits, of Quaternary age, of the upper course of the Mureş, in the area of the studied site and the downstream vicinity have developed according to the algorithm: the pollutant's migration;

From the source, the pollutant infiltrates the soil, vertically, under the effect of gravity, at times, favoured by meteoric rain. The manner of vertical migration in the soil, through the unsaturated layers down to the surface of the subterranean water also depends upon the granulometric homogeneity of the porous environment. The pollutant migrates on an unpredictable direction through the layers with a fine composition, while through coarse layers, vertical migration takes the shape of a pear. In the event that the quantity of pollutant spilled on the soil's surface surpasses the retention capacity, it reaches, in various intervals of time, in the fringes of the capillary area and slows its vertical movement, and it even stops, taking a lenticular shape on the surface of the first phreatic table.

- the solubilisation and percolation favour the exchange between the petrol by-product and the subterranean water;

At the moment when contact between the petrol by-product and water is made, a transfer of water-soluble hydrocarbon takes place, a process influenced by and correlated with the flowing speed of the water. The quantity of pollutant is continuously subjected to a selective process of washing, having as an end the diminishing, in time, of the quantity of product and implicitly the deterioration of the subterranean water body's quality of water.

- the dispersion of residual fuel, in the form of iridescence or strata in its "free phase";

The mechanism of attracting solubilised hydrocarbons in the phreatic water generates the contamination by the dimension in terms of surface and volume of the subsoil, of the saturated area to the superior limit of the impermeable stratum of the aquifer. The major consequence of the pollutant's dispersion is the reduction of the quality of the product left at the surface of the water and the increase, in time, of its density and viscosity.

- the ascending evolution, in time, of the pollutant transfer in subterranean water;

The results of the analysis of subterranean water samples taken from the site are reported to the intervention values stated in the Government Issue No. 449/2013, regarding the alteration and the amendment of the annex to the Government Issue No. 53/2009 for approving the National plan of protecting subterranean waters from pollution and deterioration, act which regulates the maximum limit of dangerous petrol substances identified in the water source. In the case of the soil, the results of the laboratory research have for reference the intervention values imposed by the Order of the Ministry of Agriculture, Forests and Environment Protection No. 756/1997, according to the category of "less sensitivity" to which soil pertains.

The evaluation, integration and interpreting all the relevant information clearly emphasise the fact that the site, Reghin, is contaminated with petrol by-products and specific measures are urgently needed. The ecologic management imposes an associated-risk-evaluation, the establishing of decontamination target-limits and the optimal method of remediation, materialised in a project.

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