ON THE IMPACT OF OIL DRILLING ACTIVITIES ON THE AGRICULTURAL LANDS IN THE LOVRIN COMMUNE AREA (TIMIS COUNTY)

IMPACTUL ACTIVITĂȚII DE EXTRACȚIE A PETROLULUI ASUPRA TERENURILOR AGRICOLE DIN ZONA COMUNEI LOVRIN, JUD. TIMIŞ

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Abstract: *The purpose of this paper is to present the situation of the agricultural lands in the Lovrin area as a result of oil drilling activities. To do so, we characterize the natural conditions of development and evolution of soils in the studied area as well as the main factors determining their pollution. We also describe the main measures taken to recover soil balances.*

Rezumat: *Scopul acestei lucrări este prezentarea situației terenurilor agricole din zona localității Lovrin, în urma activității de exploatare a petrolului. În acest scop vor fi caracterizate condițiile naturale de formare şi evoluție a solurilor din arealul cercetat, precum şi principalii factori care determină poluarea acestora. Se vor descrie şi principalele măsuri care se vor lua pentru refacerea echilibrului din sol.*

Key words**:** *oil, impact, soil, drills, pollution, extraction*
Cuvinte cheie: *petrol, impact, sol, sonde, poluare, extracție*

INTODUCTION

The activity we are referring to consists of the exploitation, collection, separation, intermediary storage, and removal of oil hydro-carbon deposits on a drill site.

Exploiting oil hydro-carbons from the Lovrin structure is done through exploitation of oil mills, of the Lovrin separation park, of the crude oil treatment warehouse in Satchinez, of the de-gasoline station in Calacea, and of the injection station in Satchinez.

MATERIALS AND METHOD

The oil structure of Lovrin is located in the low, subsidence Banat Plain. The fact that this plain has been shaped by a huge quaternary glacier determined its position and water carrying layer shape, the amount and quality of the water in the area, as well as the expansion of oscillation levels over certain time intervals.

The Banat Plain is a relief unit of an exclusively accumulative origin. Over a crystalline fundament rifted and submersed in the Badenian there set a Pliocene-Quaternary sedimentary cover of variable thickness formed of a succession of fluvial and lake deposits (loams, sands, pebbles).

The Lovrin area is surrounded by the low subsidence Banat Plain, more exactly in the **Teremia-Pesac Plain**, a component of the low alluvial pro-luvial deposit **Mureş Plain**.

From a geological point of view, surface deposits are from the Neosoic (Quaternary) and are represented by the superior and inferior Pleistocene, while depth one which is of interest due to its hydro carbon accumulations is part of the inferior Pannonian and of the fissured fundament.

The hydro carbon deposit in the Lovrin structure is fixed in the crystalline fundament.

The geological formations crossed by the exploitation drill are:

- **Pliocene**, with the following lithologic features: coarse detritus facies, mainly sandy, with intercalations of pebbles, loams, sandy or grit stone marl and, sometimes, with thin coal layers;

- **Miocene**, with the following lithologic features: coarse detritus facies made up of conglomerates and micro-conglomerates with elements of crystal shale, grit stone, chalk, marl-chalk, and loams;
- **Crystal fundament**, with the following lithologic features: sericit-chloritous shale, quartzite, mica shale, gneiss, and intrusive bodies (granites and granodiorites).

Lithologically, this perimeter is evenly constituted of a succession of slightly sandy sands, slightly dusty sands with medium evenness, and very even sands.

The low subsidence plain is characterised by the almost total lack of one's own hydrographic network.

The hydrographic network the settlement belongs to is the **Aranca hydrographic basin**.

Permanent water courses draining the area are Galațca and Giucoşin, to which converge the existing drainage canal network.

The Aranca hydrographic basin covers the old watercourses and branches of the Holocene Mureş grouped around the Aranca rivulet.

The depth at which the phreatic level is constitutes, in general, another criterion of separation of geo-morphological units and overlaps them.

In the low divagation plain, the aquiferous is located 1.5-3 m deep down and has a direct impact on soil evolution.

Low depth phreatic layer is polluted; pollution thus makes this water over 90% not potable.

Polluting factors are mainly organic compounds or their degradation compounds, i.e. ammonia, nitrites, and nitrates, above the admitted potability limit. Hydro-geological features of the area, i.e. the lithological structure with increased permeability and with a low depth of the phreatic layer favour the penetration of pollutant compounds into the phreatic layer.

The results of monitoring underground water quality by drilling at large depths by the Banat Water Office in Timişoara between 2003 and 2006, they have found values above admitted limits (STAS 1342-91) in the oil drilling area of the following indices: iron, ammonia, manganese, and phosphates.

Due to the diversity of the subjacent area, there are lots of specific topo-climates over smaller areas in the Banat climate. Topo-climates are related to relief forms, and within them, to the pedo-geographical, and geo-botanical structure of the area.

The Sânnicolau Mare topo-climate, the Lovrin oil structure belongs to, is characterized by a climate close to the steppe one, with annual mean **temperatures** of 10.8^0 C and a large number of tropical days (40).

Atmospheric precipitations are characterised by a rather uneven distribution of the precipitations both per months and per geographical areas, with altitude as a determining factor.

The mean precipitation amount is low (544.3 mm) and the number of rainy days is low (< 110). The distribution of precipitations per characteristic areas shows very low amounts (below 70 mm in the interval September-October; below 210 mm in the interval November-March; below 210 mm in the interval May-August).

The lowest annual mean rain value in the Banat area is in the Sânnicolau Mare area (550 - 600 mm), the annual aridity index being below 26.

From the point of view of the vegetation, the village area is located in the sylvo-steppe to the semi-moist steppe area.

Of the vast forests existing long ago, only some patches or isolated samples of such species as *Quercus robur* (English oak), *Ulmus foliacea* (elm), *Fraxinus excelsior* (ash), *Acer campestre* (field maple), *Salix alba* (white willow) and *Salix fragilis* (crack willow), *Populus alba* (white poplar), and *Tilia* spp. (linden) survive the massive deforestations meant to reclaim arable lands.

To also note the presence, in the Large Park in Lovrin, of two protected samples of *Taxus baccata* (yew), over 50 years old.

Bushes, present particularly along the roads, are represented by *Crataegus monogyna* (common hawthorn), *Ligustrum vulgare* (European privet), *Prunus spinosa* (blackthorn), *Rosa canina* (dof rose), *Morus alba* (common mulberry) and *M. nigra* (black mulberry).

Spontaneous grassy vegetation is represented, on grasslands, by associations formed of such species as *Lolium perenne* (perennial ryegrass), *Cynodon dactylon* (Bermuda grass), *Festuca pseudovina* (pseudovina), *Artemisia austriaca* (wormwood), *Lotus corniculatus* (bird's-foot trefoil), *Euphorbia cyparissias* (cypress spurge), *Dactylis glomerata* (orchard grass), *Alopecurus pratensis* (golden foxtail grass).

In the depressions, where soils are affected by moisture excess (mainly those in the Galațca corridor), dominate such hygrophilous species as *Typha latifolia* (broadleaf cattail), *Phragmites communis* (reed), *Juncus* spp. (rush), *Ranunculus* spp. (lesser celandine), *Potentilla* spp. (buttercup shrub).

On soils affected by salting appear mainly such species as *Statice gmelini* (marsh beet), *Artemisia* var. *salina* (fish feed), *Plantago* spp. (plantain), *Camphorosma ovata*.

Dominant soil features, soil chemical conditions, crop types, and pollution

Though the low Banat Plain relief is very little varied, soil cover has a wide diversity due too the diverse lithology of the area, to the influences of the phreatic level, or to the meso- and micro-relief forms.

The soil cover in the spreading cone of the Banat water courses is characterised by a wide variety due to both the diverse soil faction rocks and micro-relief. The higher parts are occupied by phreatic chernozems – moist or gleyied – while low ones are occupied by swamps or gleyic soils. At the contact of the cone with the divagation plain, in the areas before the valleys, there is a rather continuous strap of solonetz and solonetzised soils.

The vast hydro-ameliorative works have determined the lowering of the phreatic level over almost the entire area of the low plain. The old pedo-geographical conditions have changed, and the soils evolve gradually, loosing their relic character, particularly on hydromorphous ones.

Black soils are deeply humid soils, dark coloured, with a coarse, glomerular, or small sub-angular polyedric structure, well developed, with low acid – low alkaline reaction, and optimal nutrient content. All this make them very fertile, which makes them very useful to agriculture.

Chernozems have formed in a warm, dry, and semi-moist climate, with a high radiative balance, intense evapo-transpiration, and moderate precipitations (550-650 mm), under a sylvo-steppe phyto-coenose strongly turned by man by cultivation, and on Holocene accumulative relief forms (chernozems of low plains). They are formed mainly on **loess and loess deposits**. Most chernozems in Banat are hydromorphous, and have evolved under the influence of a phreatic level between 2 and 3 m.

The pedo-genesis factor interaction resulted in a series of features that have divided chernozems into about 65 land units. Under the impact of the phreatic water, differently positioned, and of the forms of micro-relief, we can identify in the morphology of the chernozem soil profile **gleysation** processes with different intensity degrees: strong, moderate, low, very low, and absent.

From the point of view of the granulometric composition of the soil in the studied area we can say that they have a medium texture (clayish).

Soils in the area are low carbonate, with medium humus content (3-5%), which provides them with a higher humus content; total nitrogen content is medium (0.14-0.20%), and the C:N ratio is high.

Soil reaction is neutral and low alkaline at the surface, turning moderately alkaline deep in the soil. At the surface are dominant calcium and magnesium ions (>80%), and deep in the soil the natrium ion share increases (5-13%).

Chernozems are well and very well supplied with nutrients. Phosphorus and potassium have high values (over 70 ppm and 200 ppm respectively), and micro-elements (in their mobile form) can be found in balanced amounts.

Physical and physical and mechanical features of chernozems in the Banat Plain are optimal. Apparent density has higher values (1.4-1.5 g/cm^3) only in the worked horizon, possibly also in the set portion; total porosity and aeration porosity are medium, and consistency, plasticity, adherence, and compactness are low. In these conditions, hydro-physical indices have medium values, chernozems retaining large amounts of water that satisfy plant needs during summer. Nevertheless, these last years, on the ground of long droughty periods, these soils also have been affected by drought.

Suitability and favourability of these soils are differentiated depending the gleysation degree and type of crop. In the case of the arable lands, they have medium suitability corresponding to class 2, with passages to class 1 of favourability for maize or vegetables, or class 3 for potato and trefoil.

In the area of the location studied, soil **micro-element** (total forms) supply compared to standard values is as shown in Table 1.

Table 1

Soil micro-element (total forms) supply compared to standard values

Micro-element	Soil content* (ppm)	Supply*	Normal value (ppm)	Alert threshold (ppm)	
				Sensitive use type	Less sensitive use type
			Order of the M.A.P.M. 756/1997		
Cr	< 80	low	30	100	300
Mo	2 – 3	high	2	5	15
Mn	600-800	medium	900	1500	2000
Fe	20000 – 25000	low	-	-	-
Co	15 – 20	low	15	30	100
Ni	30 – 40	medium	20	75	200
Cu	21 – 30	medium	20	100	250
Zn	51 – 70	medium	100	300	700
Cd	< 1	medium	1	3	5
Pb	< 20	low	20	50	250

**literature data*

Soils in the Banat Plain have, on the whole, high heavy metal contents – 1.2-4.3 times higher than mean contents in other parts of the country. Maximum values are characteristic for cadmium (Cd), cobalt (Co), and chromium (Cr), but the rest of the elements are also close to the maximum admitted limits. The causes that have favoured heavy metal accumulations can be explained by the geo-chemical fund of the rocks and parental materials in the mountain area and on the way they have been carried towards the west, to the piedmont and plain areas.

RESULTS AND DISCUSSION

Under normal conditions, oil drilling activities will not affect the soil if we take into account that working platforms are covered by concrete plaques, and that waste and rain waters are collected by an organised system in indoor spaces.

If activities on the facility are professionally carried out with respect for the management standards of substances, hazardous preparations, and wastes, there is no major pollution of the soil.

Accidental pollution sources can appear as a result of small or big defections with liquid leakage on the soil (because of lack of tightness, because of overflow from tanks that are not emptied in due time), or when regulations concerning the storage of equipments/chemical substances used in the conditioning of the drill fluid (direct soil storage, and not in chemical barracks or on platforms specially designed for equipments). As a result of works to be done in the area, there is danger of pollution by inorganic pollutants, mainly with metal ions (aluminium). Other pollution sources can be uncontrolled leakage of crude oil and the action of volatile organic compounds.

As for soil pollution during the drilling, it can be caused by fertilisers and phyto-sanitary products applied in improper conditions on the agricultural lands in the area.

To ensure soil protection, we shall monitor through physical and chemical analyses soil features in the area, both before and after work is finished, and try to re-establish the initial situation in the area.

Soil will be affected mainly by the reclamation of the land necessary for the drilling yard because of the settings and rocking. Reclamation of the soil for agriculture will be done by recovery works of the productive potential of the soil with chemical and organic fertilisers.

Pollutants during drills and exploitation that can affect the soil accidentally are:

- detritus, not dangerous, will be stored in the detritus tank;
- drill fluid, with local and limited effects;
- crude oil, in case of eruptions and/or overflows: it is easy to detect and observe, recovery of the infested areas (with no pollution source) taking months or even years. In this case, exposure time is an important factor, since quick removal of the hydro-carbons from the place of the accident allows quicker recovery of the eco-system, even with minimal man-made interventions.

Very serious defections could be constituted by crude oil and/or water eruptions, when all environmental factors are polluted.

The drill square place is located in a plain area, which raises no problems of stability, since there are no geo-tectonic phenomena that cause possible problems for its use.

CONCLUSIONS

The technological process of extracting hydro-carbons can lead to soil and sub-soil pollution, and implicitly of the phreatic water on the long run or over limited periods of time during the exploitation.

Interventions on the soil should not aim at replacing not even partially its functions (feeding animals directly) but at enhancing pedo-genetic processes generating fertility. Here are a few measures meant to diminish the impact:

- the layer removed from the square drill area at the beginning of the works will be preserved within the square drill area and will be used in recovering at the end of the activities, after the area is cleaned from materials and drill equipments and after soil analyses are done to point out absence of pollution within the perimeter;

- observing environmental protection standards during the exploitation activities in accordance with environmental protection regulations;
- quickly intervening in case of accidental defections to eliminate damage cause and diminish damage;
- collecting all accidental spillage, keeping chemical preparations in proper places to avoid soil damage;
- managing the land in accordance with project specifications:
  - general terracing to manage the surface of the drill square area through different digging, levelling, finishing, filling, and land compacting works;
  - delimiting the access and crossing road of the drill square area by super-structuring with 20 cm of stones, 2 cm of sand and pre-fabricated concrete plaques;
  - digging ditches to surround the drill square area to abduct rain water and washing water from the drill platform to the waste water tanks, from where they must be periodically removed;
  - water-proofing waste water tanks;
  - water-proofing with loam the stick platform and the chemical barrack platform and the spill collection ditches;
  - building drill underground from armed concrete, thus ensuring the proper tightness, and the ditch collecting accidental spills from concrete on sand bed.

Applying chalk amendments and phosphorus fertilizers, and choosing less sensitive crops are means of removing mobile aluminium toxicity from the soil.

To remove the phyto-toxic effect of the crude oil (organic acids and volatile organic compounds) we will ensure a complex of micro-organisms and fungi that improve assimilation processes of some components that are useful to soil, we will neutralize the soil with calcium hydroxide and calcium carbonate, we will improve the aeration and drainage systems of the soil through soil analyses.

Pollutions can be partial or total, in which case soil can be reclaimed or not for agricultural use. Lands can be definitively reassigned to agriculture only when accidents having resulted in pollution are isolated and have a little intensity, and depollution is done in due time and soil analyses show absence of pollution effects.

When drilling new drills after finishing drill works and recovery of the land used for drilling we will get to the depollution stage of the site. In case pollution is minimal or insignificant, we will proceed to recovering vegetation in the area.

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