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Ascensional Pollution Resulted from Mining Activities

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Abstract

Mining activities, like all other parts of the production industry, inevitably generate substances that can pollute the environment and can become risk factors for human and animal health. The paper shows the main aspects of the way in which deep pollution becomes surface pollution, due to the infiltration in the soil of harmful chemical compounds, their transfer towards deep waters and, respectively, their ascension to other locations by means of supplying rivers, lakes (springs), wells or hydro-geological wells.

Key words: *mining, sterile, coal, dump, pollutants, ascending.*

Introduction

In the mining activity obtaining solid fuels, metals and metalloids is the main purpose, the final outcome of the mining industry being to obtain useful substances as well as wastes with various hazardous degrees. The pollution resulted from this activity firstly depends on the nature of the substances making up the sterile coal (sedimentary, eruptive and metamorphic rocks) but also on the type of the useful substance.

Mining activities for producing coal is very developed, being an alternative to energy production, but its exploration and usage has powerful non-ecological outcomes.

It is well known the fact that, for classifying coals, what is taken into consideration is the carbon (C), hydrogen (H), oxygen (O), nitrogen (N) and phosphor (P) content as well as the caloric power:

T – **Peat coal:** C 50%; H 6%; O 33%; N 3%; P 1% (possibly);

CB – **Brown coal:** C 69%; H 5,5%; O 25%; N: 0,8%; P 1% (possibly);

H – **Pit coal:** C 82%; H 5%; O 13%; N 0,8%; P 1% (possibly);

A – **Anthracite:** C 95%; H 2,5%; O 2,5%; N: traces; P 1% (possibly).

The organic nature of the coals is accepted by most specialists, but it should be mentioned that during the World War II from superior coals (pit coal, but especially anthracite) gasoline with high octane value was obtained, gasoline that was used as fuel; this is one of the arguments of the organic theory regarding the origin of oil (but what about natural gas?).

Sources of ascending pollution in the mining activity

In the mining activity, the lateral walls and the cover are held (holders made of wood, metal and prefab coats); these are assembled as the open-cast face (coal mining), but the sealing is precarious: on the cover and the lateral walls of the gallery vertical descendant, horizontal or inclined infiltrations are produced, which deposit on the bed, from where the inclinations are produced with inclination angles that depend on the tectonics of the area (faults, crevices etc.). During the exploration, a mixture made of sterile and useful coal is extracted from the gallery; the sterile coal is deposited in dumps, and the (processed) useful coal is transported to the beneficiaries. The wastes are, then, solid, liquid and gaseous.

Pollution resulting from solid wastes that reach mining galleries depends on the type of rocks.

The consistency and granulation of the rocks is different, but, from the pollution point of view the most dangerous ones are those that dissolve, being powders, with very low granulation, easily inhalable; in contact with the air in the mine, products with immediate, medium or high effects result; if there is sand in the useful coal cover, its granulation may be 0,001÷20,0 mm with an average density of 2200 kg/m^3; in the case of cover clays, these have consistency (compared to sand), porosity, permeability, resistance to compression and shearing, cohesion and leaking limit.

The solid waste formed from the mining sterile coal in mines or pits extends on surfaces of 10÷600 ha! ***The dumps*** are placed on it, whose height (that may reach hundreds of meters) depends on the settlement method and the natural slope angle of the settled material. Trying to give some areas made of dumps to agriculture has had partial or no results at all.

Apparently, and especially in the case of some dumps with reduced content of pollutants, these should not bring about big difficulties; in reality, reduced contents of sulphur, coal, sulphide or sulphate, in contact with the water resulting from normal rains form harmful substances that infiltrate into the soil and from this point to the pollution of surface aquifer areas the steps are small, but sure to occur.

Pollution resulted from liquid wastes is also connected with the nature of the rocks: in case or eruptive and metamorphic one, the penetration of water into the galleries and from here, after the pollution, in the bedding of the gallery, is only accidental; in the case of sedimentary rocks, the inflow is sometimes so strong that draining from the gallery is needed, by means of horizontal or accessional vertical drilling. To these waters, the ones resulted from the working process are also added: the wet perforation of the useful ore; water resulting from the cooling of the compressors and other equipment; water used to the hydraulic flushing. The analyses of the waters resulting from a mining gallery showed contamination with coal dust, in quantities varying from a mine to another, from a gallery to another, or even in the same gallery; these are unpurified because of the formation or the way to the gallery (faults and other tectonic incidents) and, in addition to the above mentioned substances, they may contain mineral salts (ferrous sulphate, ferric sulphate, nickel sulphate, magnesium sulphate, arsenic or its compounds.

For the mine waters in Romania, their allowable values and their components values are specified, these being: suspensions 608 mg/l; fixed wastes 2000 mg/l and pH = 6÷8,5; chrome and its compounds 70 mg/l; manganese 40 mg/l; chlorides 500 mg/l; calcium 300 mg/l; magnesium 100 mg/l; iron 5,0 mg/l.

If tectonic accidents or other reasons (uncontrolled discharge, mine abandonment without respecting the existing norms a.o.) made these waters get into rivers (most often) or in aquifer sands and not only, the following consequences would occur:

- The quantity of solid suspensions of the water increases and its aspect is changes (this is often noticed in lakes, rivers a.o.).

- The transparency is reduced.

(Both consequences occur if, through faults or other drains, the infested waters get into aquifer areas with high consistency: some limestones, sandstones a.o.).

- The content of heavy metals increases and the initial oxygen content changes in the water in which the discharging was made. If the water is an internal lake with its own springs or it was formed from accumulation of rivers, two phenomena which are difficult to fight against occur: the heavy metals settle on the bottom of the lake and harm the sub-aquatic plants, with serious consequences on the animals. The second supposes the existence of some hydro-geological wells whose reservoir is an aquifer that feeds from the infested lake. In these conditions, the ascending pollution has the trajectory mine – lake – hydro-geological wells!

In the mining industry the gas resulting from coal production is usually classified into three categories (valid both in Romania and globally):

- ***The reservoir gas contained in coal layers and surrounding rocks*** which is released into the gallery during work; its composition is: methane, nitrogen, heavy hydrocarbons, sulphuratted hydrogen, sulphur dioxide, dioxide and carbon oxide.

- ***Gas resulting from blast process*** formed as a result of inherent detonation in the gallery: carbon dioxide and oxide, oxygen, nitrogen oxide, sulphur dioxide and sulphurrated hydrogen. Their volume and composition depend on the detonation speed, humidity, density and fineness of griding of explosives, but the mentioned products are very harmful. When in contact with the water vapours in the mine, they form droplets which settle on the bed and from this moment ascending pollution is certain to occur.

- ***Burning gas*** are those resulting from self-heating and self-ignition of coal reservoirs produced due to oxidation, dry distillation and gasification; these may also result from, depending on the case, because of natural gas ignition in the mine (methane with ethylene, acethylene, sulphur oxide and dioxide). If in small quantities and do not fire up, the mentioned substances mix with water and the mentioned circuit, neglected by lots of people, occurs again!

Depositing sterile coal in dumps

The sterile coal in dumps may result from the surface or mining uncovering, the used names being *internal dumps* and *external dumps*.

– *Internal dumps* are usually placed in the free space after extracting the useful substances from the pits.

– *External dumps* (fig. 1) are mainly specific to coal mines and suppose sterile coal depositing outside the galleries, o bigger or smaller surfaces, depending on the reserves; when designing external depositing, one should keep in mind the access possibilities of transport means. The form of the external dumps may be conic or fanned, and the dumps steps may be 5÷60 m high, depending on the deposited substances' properties, but also on the form of relief where the dumping is made. The dump steps are made by lateral expansion and successive high lifting.

Solid wastes resulted from reservoir access transversal galleries, vertical mine wells or galleries connecting the wells and exploration areas of the mine (airing wells, raisers, water collection basins, main transport galleries a.o) represent *provisory dumps* and are placed outside mineralized perimeters; after stopping the underground mining exploration, these soils are used for shutting the mine, also called *filling operation*.

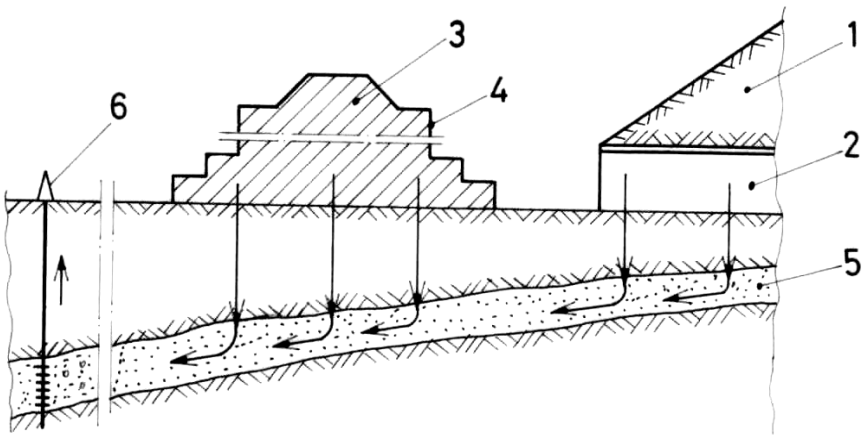

Fig. 1. Scheme of ascending pollution resulting from mining galleries.

1 – gallery cover; *2* – mining gallery; *3* – sterile coal external dump;
4 – dumping step; *5* – aquifer layer; *6* – hydro-geological well;
← direction of current lines (a well, a lake, a river, or the sea may be in the place of the hydro-geological well).

Ore reservoirs

Due to various occurring conditions, exploration methods, compared to coal reservoirs, are multiple (over 170 exploration methods are known); the technical particularities are the following:

- Irregular mineralization of the reservoir, many times, makes impossible the delimitation from the surrounding rocks.
- The mineralized area usually has a higher hardness than that of the surrounding rocks.
- Both cover and bed areas and lateral walls are made of compact and resistant rocks, which make possible either the work without support, or easily made supports.
- Metal-bearing mines only accidentally present dangers caused by mine gas occurrence.
- Ore reserves are lower than coal ones.
- Coal mining (work place) is usually conducted with explosives and the ore transport is made with trolleys, on short distances.
- The mineralogical composition and content variation in useful components suppose special units for pre-washing, separation and chemical treatment, outside the mine, in stations that consume a lot of water and chemical substances.

It can be stated that mining explorations are not ecological; more, ore preparation units have degrees of ecological danger that are sometimes higher than the ones in the coal mines. In the most optimistic case (if one considers that the pollution of ore galleries does not have a high risk degree), the preparation part is still to be discussed, as the pollutant substances are directly discharged in the flowing water, or have the route preparation unit – aquifer layer – hydro-geological well. Unlike coal reservoirs, the existence conditions of the ore ones are quite different.

Main minerals are: quartz, feldspars, feldspathoids and amphiboles. All these have a lower or higher content of Si, Ca, Na, Al, Fe and Mg; most of the compounds can be found in rocks known as granites and basalts.

Secondary minerals result from the alteration of main mineral; in this group can be included:

- *Chlorites* which are hydrated silicates of Al, Fe and Mg;
- *Talc* and *serpentine* – hydrated silicates of Mg;
- *carbonates* with known varieties such as calcite, aragonite, dolomite and zeolites;
- *caolin* (china clay) mainly used in china factories.

Accessories minerals in which the following groups can be included:

- *granates* which contain Al, Fe and Cr, but also Fe, Ca, Mn; they have high hardness and are used as abrasive materials;
- *sulphates* (gypsum and barytine).

Halogen minerals (rock salt and fluorine used as ornament because of its varied colors).

Minerals occur in nature associated or not and they are called ***rocks;*** according to their formation they are *eruptive (magmatic), sedimentary* **and** *metamorphic.*

Magmatic rocks were formed by means of consolidation of magma – hot and melted substance, made of a mixture of silicates, metallic oxides, water and gas vapors – eruptive rocks, most spread in the Earth's crust, constitute almost 90% of its composition.

Sedimentary rocks were formed from the disaggregation, alteration, transport and sedimentation of the existing material under the action of external agents (water, wind, temperature); in some sedimentary rocks remains of animals and plants (fossils) can be found.

The chemistry of sedimentary rocks is characterized by the mechanical separation of insoluble elements (Si, Al, Fe) by the soluble ones (K, ca, Na). in the category of sedimentary rock are included (in order, from the surface of the soil to its depth): loess, gravel, debris, sands, sandstones, clay, marl, chemical precipitation rocks (gypsum, salt stone, calcites and travertine), dolomites, phosphorites and guano (these rocks do not burn); coals are also sedimentary rocks, but they burn!

Metamorphic rocks were formed by means of the transformation (metamorphosis) of eruptive and sedimentary rocks under the action of high temperatures and pressure, but also because of movements in the earth's crust. The most known metamorphic rocks are: gnais, mica-schists, quartzite, phylitte and crystalline calcites (marble

Reservoirs of mineral useful non-metal-bearing substances

In this category, the main substance is the sodium chloride (NaCl); the exploration method implies mechanical or hydraulic cutting of some pieces of the salty massive which are transported to mills or salt factories. Salt flowing imposes the same constructions to other mining galleries, and the issues of ascenssional pollution occur especially through dissolution and wells.

Present mining explorations

As resulting from the name, in this field work, but only depending on the reservoir, open explorations can be made, which can be staged into:

- preparing the surface;
- dewatering of the reservoirs by means of wells;
- opening the reservoir by digging access ways (called ditches);
- uncover the reservoir (removing sterile coal surface layer);
- forming at the surface cutting works and preparation stations (if the case).

From the point of view of ascending pollution, this is the most non-ecological exploration method. In order to support this statement, we will consider the most known example for Romania, when in Căliman Mountain a reservoir containing sulphur has been explored in an open way! After uncovering it, the first rain generated the catastrophe: the dissolved sulphur mixed with water formed concentrated sulphuric acid, in some weeks all the plants and animals on the mountain being destroyed and the works were stopped. For remaking the habitat, the uncovered area was covered with soil and, at present, the nature is recovering, but the recovery is quite difficult !

Conclusions

Mining explorations, as part of the extractive industry, constitute an important pollution source of the environment. The pollution, greatly neglected or "unrecognized" may lead to very harmful effects on ecosystems and populations, even to ecological disasters.

Depending on the nature of the reservoirs in the mining industry – coal, salt, metal or non-metal bearing minerals, pollutants may differ, but, generally, they naturally infiltrate in the water resulting from rains and technological processes, hydro-geological wells, even rivers and lakes. That is why the term of ascending pollution is used, showing the way in which contaminated agents, the ones existing or infiltrated into the soil, become surface pollutants, risk agents for humanity and environment. .

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Poluarea ascensională provenită din activităţi de minerit

Rezumat

Activităţile miniere, ca toate celelalte componente ale industriei extractive, generează în mod inevitabil substanţe care pot polua mediul şi pot constitui factori de risc pentru sănatatea umană şi animală. Lucrarea prezintă aspectele principale ale modului în care poluarea din adâncime se transformă în poluare de suprafaţă, prin infiltrarea în subsol a unor compuşi chimici nocivi, transferul acestora către ape de adâncime şi, respectiv, ascensiunea acestora pe alte locaţii prin alimentări de râuri, lacuri (izvoare), fântâni sau sonde hidrogeologice.