Summary of the thesis entitled:

"GEOECOLOGICAL MONITORING OF RESTRUCTURED MINING PERIMETERS"

Introduction

Geoecology is part of the sciences group about the earth (geo-sciences), the concept derived from three Greek words Ge-earth, Ecos-house and Logos-study. Given the nature of its object of study, natural and technical transformation of the landscape, the emergence and development of Geoecology is closely linked by Ecology and Geography. The proximity of geography and ecology reached very large areas of intersection, respectively defining the concepts of "ecosystem" and "geosystem". The difference between the two concepts is the fact that Geosystems [VB Sochava introduced in 1963], as object of physical geography, has a spatial character while the ecosystem has a functional character; ecosystem has a small number of structural links and relationship between the components and places the human factor at most as a secondary factor, with influence on the qualitative and quantitative state of the population, while geosystem has more links inside it, human is not a component being only an external factor influencing its development. Therefore, unlike the Ecosystem, the Geosystem include macroclimate mezoclimate and microclimate conditions (geoecological) that depend on the geographical location where located or developing living organisms (living conditions). In its meaning geographical environment is an expression, a manifestation of quality of the geosystem as a load size with its living resources and Geoecology is "the science of all complex interconnections between living communities' and their environment factors". [C. Troll 1938] Basically, Geoecology is a geographical approach of ecology studies at different spatial scales. Mining, through its main scope, exploitation of mineral resources of the earth, put its mark on both the geographical (spatial) side, by stripping and shaping the landscape, and the environmental side, by disrupting the natural balance, producing large amounts of mining wastes, generating a wide range of pollutants, affecting the natural environment by deforestation, closing valleys with dams or watercourses moving. Thus, although extractive activities are usually associated only to local environmental perceptions, they are the most visible and publicized. Doing so, in time, mining has entered a deep decline due to an allocation of exaggerated modifying effects on the landscape, morphology (topography), water, air, soil, flora and / or fauna, while the geographic landscape has not been observed, measured, evaluated and interaction in an integrated manner with the environment.

Chapter 1 - Definitions and general concepts.

Geoecological factors are highly variable and may be useful or not for the environment or people. Thus, monitoring has the role to detect flows and trends in enlargement, the composition, structure and operation of the systems, being different from the simple inventory, which is a specific activity for measuring the presence, abundance or distribution, in time, but does not envisage a comparison with a predefined standard. In other words, monitoring is a scientific activity aimed to deciphering the behavior and functioning of the systems that help predict the moment of changes, to identify or diagnose problems and their source. Monitoring flows and trends seeks to quantify and suggest long term strategies to follow. Geoecological monitoring of the restructured mining perimeters is defined as tracking the natural-technical aspects of whole, direct, cumulative and synergistic effects, related to systemic units within the mining activities were developed by a scientific, systematic and holistic approach. The interdisciplinary character of Geoecology do this using research methods specific to the various sciences that are composing it, so that designing of the geoecological model ensure sustainable development and take the best practices available. Best Practices (BAT) were established by compiling information from many sources, especially from specialized publications in Australia, which is a valuable source of information on environmental management. BAT does not contain sufficient references to geoecological monitoring, covering only partial the issues (strictly follow mine area). However, the principles embedded by best practices and fundamental principles for the mining sector (originated in Guides Berlin) are influenced by combining administrative control regulations and mining management and can be improved.

Chapter 2 - Theoretical background. The basis of documentation

For the restructured mining activities Geoecology documented in specific disciplines related to mining, geology, informatics, remote sensing, or topography, combining with complementary base disciplines such as geography, ecology, hydrographic and so on. Geoecological research in our country is reflected in a relatively small number of studies, but with scientific value. We can say that in our country are concerns in the various fields of knowledge which form the concept of Geoecology. Geographers and geologists were among the first scientists who made observations and research, important contributions being made by I. Băncilă, "Geology of Carpathians" [1958] Ianovici V. et al., with "Geological evolution ore mountains "[1969] The geology of the Western mountains and [1976] Gr. Posea [1976] M. Buză [1979 2000] P. Tudoran [1983] P. Cocean [1988; 2000] was also among the first to perform geoecological research. Geoecological research focused on other regions was performed by P. Tudoran with "Country of Zarand. Geoecological Study"[1983], M. Oncu [2002] with "Geoecological study of the Mureş corridor", while N. Baciu [2006] published "Transylvanian Plain. Geoecological study". The first work with reference to Geoecology of mining perimeters in our country was carried out by S. Duma" Geoecological study of mining in the Southern Apuseni Mountains, Poiana Ruscă Mountains and Sebes Mountains".

Chapter 3 - Environmental risk assessment

The risk of significant pollution in an area (event) may lead to the need to draw up an assessment to determine the likelihood of damage; not all perimeters affected by a causal factor/pollutant will pose identical risks/dangers and will not require the same countermeasures. Since the concept of "risk of environmental impact" is not used in literature, currently, worldwide, and the "environmental risk assessment" is not defined in the national regulatory documents the concepts just keep generic character and can be used by the context, for each type of evaluation, as appropriate.

"Risk assessment" is made under Regulation (EC) No. 1488/94 of 28 June 1994 of "establishing principles for assessment of risks to people and the environment of some existing substances" under Regulation (EEC) No. 793/93. The general methodology of risk assessment is regulated by ministerial APPM order No. 184/1997", for carrying out environmental audit procedure". Risk assessment process involves identifying and, where appropriate, characterize, dose (concentration) - effect (response) and level of exposure. Once completed the risk assessment the assessor shall review the various results and produce integrated results overall toxicity of the substance. This evaluation involves, however, an assessment of the quality (source, path, target/receptor etc.) and quantitative (probability, severity, etc.). Qualitative analysis requires setting in advance a set of evaluation criteria that will be applied to each causal factor/pollutant, in a systematic way, in order to demonstrate a causal relationship between them and the components of the ambient target/ receptor. According to the specialty literature, as prior to switching to quantitative analysis (quantification of risk), the analysis of source-path-receiver (SPR), prepared in qualitative analysis step, to be evidenced by a tree chart to view the action, the danger and the effects. It can be considered another risk scale too: low, medium, high, very high. Subsequently, the risk can design a matrix of intersections of the rows and columns which are selected box containing the calculated values of the impact. Quantification of risk posed by exposure to danger can be done using mathematical formulas by typing in a matrix different classification scores (notes) granted by the evaluator, given by the causal factor for the importance, its likelihood and severity of exposure to the hazard. Risk matrix is a tool of representation, comparison and ranking of scenarios and it is recommended by the European Commission for modeling and risk assessment in the Member States. A feature of the modeling is the lack of a universal pattern (with general applicability), being a process consisting of a succession of procedural steps deemed necessary to convert a script into a conceptual model, and then in a graphical and/ or value, having multiple forms of approach. Some mathematical formulas can be constructed by the evaluator (especially statistical models), but in most cases he can choose from the literature, there are enough equations that accurately describe the effects of a wide range of stressors. When we do not have enough data (indicators) may assimilate by extrapolating (replacing a measuring point/test with an evaluation) or formulating hypotheses (calculated by applying standard procedures). For data collection of the set/sets of indicators from whom will start logic construction we need to use as more appropriate operational tools that can deliver valuable results.

Chapter 4 - The environmental impact

The impact identification represents a set of prospecting operations for interactions and emphasizes the effects, safe and possible results of human activity on the environment (environmental components) in a geographical perimeter. The main goal is to research the environmental situation before and after the anthropogenic actions. In this sense, the evaluation process starts from evidence (emphasis) of significant impacts of human activities on environmental components. That is why, we can examine the results to similar situations and/or examine the expected impact based on adequate descriptive tools. Highlighting (prediction) impacts is performed to a reference state. Usually, the research is based on descriptive tools taken the form of checklists (control), which are summarized existing information about environmental effects of human actions and assessed plausible and probable. The lists may be embedded in the matrix form, and by defining links between actions and effects are obtained analysis matrix.; containing possible impacts expressed in qualitative appreciations, transposed by conventional signs ("x", "an", "+", "0", "-"...), and quantitative assessments, transposed by numerical values ("0", "1", "2" ...). The literature shows a variety of matrix impact models that are developed continuously according to the practical needs. Among these we remark the simple and complex interaction matrix models. A simple interaction matrix shows on the vertical axis the human actions and on the horizontal axis the natural components. The complex matrix is an interaction model consisting of a assembly of simple matrix coaxially arranged, which comprises several sequences of human actions or the decomposition of causal relations. Another usual model is the networks model, similar with simple matrix model. It is more flexible because the nodes arrange the elements of the sequential process. Networks used in impact analyses are represented by the flow charts or multiple relational chains, which highlights the components of the interdependence of human actions and environmental impacts including cumulative and synergistic effects. An improved model is represented by the great dams' matrix (Sorensen, 1971) which is an "inverted" table with dual input, similar to simple matrix method used in conjunction with networks (using both the matrix and the network). Such matrix allow specific actions highlighting for various types of geographic areas by identifying primary impacts on the environmental components, while the graphs allow networks conjunction with secondary impacts, highlighting the relationships between them and basic actions including measures for intervention.

Chapter 5 - Measuring pollutants emissions

The general principle, recommended prioritizing the significant aspects of the many possible environmental problems is maximum impact - maximum priority. The selection and ordering the possible issues is influenced by a number of factors and criteria for analysis and selection. Generally, the prioritization is done in stages starting with cheap and simple solutions and then with those that require more complex and expensive technical and economic details. A monitoring system includes all the tools and activities on existing information, measurement, data collection, processing (interpretation) and information dissemination. Currently, the delimitation of the impact is depending on the pollutant concentration measured or estimated. The limit of affected area is the less concentration zone or equal to concentration limit. The pollutants to be monitored are usually established by in-situ measurements of the individual parameters (concentration, density, etc.), by measuring the global parameters such as pH, turbidity or conductivity and comparison with reference data. These decisions are based on scientific and financial availability of measurements of a pollutant, but also the amount (magnitude) the overall impact, cost of the measurement process can be an important decision criterion.

Chapter 6 - Parameters and indicators in monitoring

Integrated analysis of the mining perimeters with restructured activity and geographic landscapes in correlation with the analysis procedures of the geographic field, found in the literature related to ecology and mining; all items must be selected for their relevance, based on the conducted research. With the development of GIS and remote sensing could be extended quickly the landscape research by considering specific elements of the geographical environment such as scale and heterogeneity, in conjunction with a conceptual model specific to geographic analyses called Patch - Corridor - Matrix (PCM), which may conceptualize the mining activities in the form of mosaics composed of a number of fundamental elements named patches (Pete), discrete or continuous. Given that the mining perimeters are heterogeneous due to special mining construction (tailing ponds, landfills, quarries, deposits etc.) this concept is treated for use in geoecological monitoring within application of the conceptual model and the associated methodology. For clarity, within the methodology for assessing the geoecological factors may be used the mining overall stability indicator, the indicator of naturalness, human pressure, environmental transformation, support capacity of the territory, artificiality of the landscape, and so on. Ecological indicators (environment) measure different physical-chemical properties and/or biological, showing in a systemic manner the relationship between natural ecosystems and human activity. Environmental indicators are very diverse even if they monitor the same process, being data frequently used for complex environment assessment. By processing environmental indicators are obtained environmental indexes that relate to different value scales. Therefore it must take into account the main favorable and unfavorable elements of the important factors such as geo-topography, air, water, biota, soils and anthropogenic component that generate ability/inability of the landscape, considered in the monitoring ecology of landscape. Landscape ecology aims to study causal relationships between biota (living communities) and the environment, structured as a landscape mosaic. [Troll, 1971 quoted Wu, 2006] Turner (1990, 2001, 2005), improves the definition of Troll showing that, in defining the landscape ecology analysis should focus on "mutual understanding interactions between spatial heterogeneity and ecological processes." Thus, Turner changed the term "environment", considered vague, with the term "spatial heterogeneity", highlighting the practical importance of quantification of uneven distribution of existing features in a complex landscape. The term heterogeneity is associated with a conceptual model called patch Corridor-Matrix model (PCM), conceptualizing areas in the form of mosaics composed of a number of basic elements called Spots (Patch), discrete or continuous [Forman, 1995, quoted by Lindenmayer, 2005]. The matrix is the dominant component (type) of the landscape and, therefore, it play the most important role in the system function. The plot/patch is a landscape element represented by a homogeneous complex (structural and functional), non-linear, which differs abruptly into surrounding landscape (outcrops, debris, windfalls, exploitations, landfills, ponds, pits, etc.) while the corridor is a linear landscape element that can be defined based on the structure or function that fulfills. Indicators should capture the entire causal chain, for which, in practice, are grouped to achieve a "photo" of the relevant impact of human activity.

Chapter 7 - Investigation techniques

The problem of environmental monitoring is universal and includes both the biological component and geophysics, based on the grouping proposed by the professor and academician I.P. Gherasimov, are three steps (1) bioecological monitoring (hygienic, toxicological), which includes the tracking influences of the surrounding environment to human health, (2) geoecological monitoring (geosystemic and natural-economic), includes tracking the natural systems changes and their transformation from natural-technical causes and (3) biosphere monitoring, includes tracking biosphere parameters evolution on a global scale. Meanwhile Geoecology is a geographical approach of ecology studies at different spatial scales. Usually the Geosystem consider the geographical complex and its dynamics, occupying areas of tens square kilometers to hundreds square kilometers, the Geofacies will reflect features of the local ensemble and corresponds to a homogeneous area, characterized by its own physiognomy, whose expansion space will be lower (one to dozen square kilometers), while the Geotop represents the lowest level of analysis (under one square kilometer). Geosystems analyze, in addressing environmental problems, require prior knowledge of system structure, identifying several types of ecological information that should definitely monitor: air emissions, noise levels, discharges into water, extraction of groundwater, drinking water, production or processing of waste, the amount of wastewater generated, soil, consumption of energy and raw materials, the transport of dangerous accidents / incidents significant release of pollutants, contamination with radioactive materials, radiation emission, land use, the use of fertilizers, pesticides or sludge resulting from wastewater treatment and road construction. The various techniques of investigation appropriate for these spatial benchmarks are recommended to be geochemical, water quality, soil, sedimentological, mineralogical, petrographic, dissolved oxygen, turbidity, acidity, morphometry, topography, as appropriate.

Chapter 8 - Assessment of a set of specific indicators

There are a large number of indicators used in environmental analysis. Traditionally, addressing environmental problems requires the identification of several types of information that should be monitored from an ecological point of view: air emissions, noise levels, discharges into water, extraction of groundwater, drinking water, production or processing of waste, wastewater volume generated, soil, consumption of energy and raw materials, the transport of dangerous substances, accidents/incidents with significant release of pollutants, contamination with radioactive materials, radiation emission, land use, the use of fertilizers, pesticides or sludge resulting from wastewater treatment and the construction of roads. Meanwhile Geoecology is a geographical approach of ecological studies at different spatial scales; within the representative Romanian school contribute to the foundation of geographical delimitation (regionalization) into physical-geographical units' integrator and geoecological referring to the "physiognomy", "structure" and "dynamic" of geosystemic unit. Geoecological monitoring includes tracking changes of natural systems and their transformation from natural and technical causes. The main set of indicators is composed of indicators of landscape (natural, human pressure, environmental transformation, hemorobic), geomorphology, geophysical, geochemical, hydrate (hydrological, hydrogeological), geographic elementary (environmental, employment and land use, perception, history, economic), geo-mining (topography, particle size, stability, geometry, energy relief, geology, important resources), climate and weather, as appropriate.

Chapter 9 - Case study

To test the selected indicators was chosen as a case study the Călimani Sulphur open pit, jud. Suceava, regarding the situation recorded before any closure and rehabilitation activities (1993-2009) began. The case study deals with geoecological aspects, ecology of different geographical systems (region, geosystem, geofacies, geotop), previously identified based on information's obtained in-situ and from various specific sources regarding Călimani National

Park. It is appreciated the physiognomy, structure and dynamics of geographic units, in this case the Călimani mountain region, various geosystems, heterogeneous array of landscape, the mining area and other homogeneous subsystems from Călimani National Park. With an area of approx. 300 ha the mining perimeter fall within geofacies category containing geotopes (spots) as mining dumps, open pit, enclosures etc. In addition we found many geotopes due windfalls, deforestation, landslides, wildfires, involution of vegetation, tourism or others human activities such as grazing. Thus, for the different areas identified as being homogenous, as special workings (dumps, open pit, enclosures), the analysis covers the geometry, foundation, as well as the stability of artificiality, hemeroby and naturalness and access. By relating the general landscape information with specific regarding to mining activities deemed to be potentially dangerous, it could highlight the full range of system behavior between the operating suspensions until starting new activities. It has also been revealed anthropogenic influences from other natural-technical measures such as climatic phenomena, deforestation, grazing, etc. Analysis of different patches (spots) showed that after removing woody vegetation (forest inability) due to secular accumulation of humus (pedological ability), grasslands have a high yield (vegetation ability). Because grazing (anthropogenic inability) and under the influence of climate (natural inability), natural lands were degraded, leaving instead unproductive lands with no vegetation (vegetation inability) which arose debris (lithological inability) with fields of rolling stones (physiognomy inability) etc. As a result lands have not presented any economic interest and were abandoned (social and cultural inability). Material transport corridors are hydraulically, aerial and geo-mechanical activities. Gravitational sedimentation of the fine material due to natural topography (terrain inability), water flow (hydraulic inability), the windy climate (aerial inability), the freeze-defreeze phenomenon (climate inability), allowed the onset of secondary successions of the vegetation with the replacement of natural specific vegetation (landscape and identity inability). Following the analysis performed showed that the general index of hemeroby for whole area of the national park, present a "moderately altered, semi-natural" degree of human intervention, while constructions from mining system qualifies as "stable". Hydrological indicators confirm that, in terms of geoecological point of view, the rivers are a tributary to the natural slightly acidic background, there are disruptions due to rainfall regime, but has the potential to recover owing oxygenation and spatial extent. Geoecological matrixes were prepared for open pit and Calimani National Park in the set of indicators selected and appreciated. Generally, the Călimani national park Geosystem, including the open pit, on the basis of the proposed methodology, shows a semi-natural state confirming the hemerobical assessment of the basic matrix (forest) "semi-natural moderately impaired". The results were checked by comparing with data presented in other studies and digitized maps of the region Călimani mountains.

Chapter 10 - Monitoring and evaluation of environmental impacts. Methods/ models of conceptual monitoring

According to OUG no. 195/2005 regarding "environmental protection", "environmental monitoring" is defined as "surveillance, prediction, warning and intervention to assess systematically the dynamics of the environmental quality characteristics, in order to know the state of quality and their ecological significance, evolution and social implications of the changes, followed by appropriate action." In other words, the monitoring means supervision at regular intervals and specified period of time, with a well-defined goal, the state of a quantity, an attribute or a task in a well-defined space, the evaluation and / or repeated measurements to determine the implications and effects of generated by stress and measures required for rebalancing. To understand natural systems requires designing layouts called "models" starting from preexisting information (issues). The "concept" is based on the synthesis of knowledge and available information, the observations made in situ and experience and professional judgment while "diagrammatically" model is based on an explicit scheme of interconnections between structural components, attributes and processes specific to evaluated system. Environmental Impact Assessment (EIA) is used in our country since 1996 when the Law of "environmental protection" no. 137/1995 introduced the "Environmental Agreement" as a regulatory document. The environmental permit is an administrative document issued by the competent authority which establishes the conditions and, where appropriate, measures to be followed in a project. EIA is a tool used in planning strategies and projects, and its use was adopted by the international financial institutions (WB, EBRD, etc.). In any EIA, however, assessments can be subjective partially or totally due to several factors, such as lack or inadequacy of baseline data, within the time required for the acquisition and analysis of information, the terms of reference considered for EIA and / or capacity of the assessors to cover a wide range of issues. For diminish subjective assessments and assessments to become more accurate, it is recommended, in addition to predefine how analyzes are effectuated and criteria by which shall be made, the application of methods / conceptual models to integrate math (MERI, Folchi, LEOPOLD). MERI conceptual model has been defined by Pastakia (1998) and consists of a matrix evaluation designed so that the subjective can be made semi-quantitative, and thus provides both a rapid assessment and recording can be re-evaluated whenever changes occur. MERI is based on a standard predefinition of the most important criteria for "Evaluation of Environmental Impact" (EIA) and the means by which the values of semi-quantitative / quantitative allocated to each of these criteria may be compared with, so as to result a score that reflects more accurately the forecast of the impact.

Chapter 11 - Conceptual Geoecological model

Geoecological monitoring (systemic, natural and economic) includes tracking changes of natural systems and their transformation from natural-technical reasons. The parent of "Landscape Ecology", Carl Troll, defined this concept as "a combination of spatial analysis - horizontal (geographical) and functional analysis - vertical (ecological)". In this context, the landscape is an generic intuitive notion referring to human perception on a particular physical environment, more or less diversified, represented by manifestations of spatial sensorial organization of geographical environment, defined by the elements and structures of natural components and man, and individually analyzed by the following distinctive features:

- structure, influenced by the physical shape and organization (scale) of various spatial systems,
- changes in structure, influenced by the dynamics and function of various streams of energy (solar, wind, chemical, hydraulic), time and manner of development and operation of systems.

So landscapes can represent some physical, ecological and geographical features that integrate their sets generated by natural processes or human intervention [after Naveh, 1987]. Thus, the structure of geographical landscape is influenced by two factors:

- main, which includes topography and climate, and
- secondary (derivatives), which includes soils, vegetation, wildlife, hydrology, human intervention and according to some authors, fires vegetation (natural).

To an accurate description of landscape character we can integrate the three elements defining the environment: abiotic, biotic and cultural. The element abiotic represent the basic level (within, or matrix) that includes "the gradients of natural landscape" as lithology, the topographical and soil (ground), hydrography, climate, were biotic element represents the complex interactions that exist between the flora and fauna and the base matrix, while culture is the element at which the human factor (sometimes positive, sometimes negative) interfere in the landscape. By reorganization of the Geosystem concept model proposed by Preobrajenski, Rougerie and Beroutchachvili, and supplementing with natural-specific technical elements, has been designed a new conceptual model built like a Geoecological Pentagram. How intervention will be nearby to the natural causes, represents changes in the landscape. The interaction (interference) of the defining elements, at a time, outlined the physiognomy characteristics and landscape units, based on the activities and changes in the geographical environment. So, given the complexities of the extractive sector, evaluating intersections of action process evaluated (with a lower or higher decomposition) and any amendments (more or less detailed), established by following the principle source-pathway-receptor, can be done most easily by using a conceptual model matrix and/or network (graph). A succession of matrix intersects information regarding to elementary actions and different changes, by following successive phases in increasing depth. Based on these findings and analysis options, the proposed geoecological evaluation method of mining perimeter with restructured activity is found in the form of a complex matrix of interactions, consisting of a set of simple matrix coaxially arranged as a sequence of decomposition for 75 specific actions of natural-technical mining activities, properly grouped to reflect stages of development of a mining project, as follows: natural actions, prospecting, exploration, construction, operation and closure. For the landscape structure (factors) and changes in the structure of the landscape (impact) are proposed two lists (sets) including abilities / inabilities that can be adjusted according to the type of the analyzed system. The proposed method consists in a succession of four sequences (simple matrix) as follows:

- the first sequence, contain passed relevant actions, picked from the specific natural-technical 75 actions, highlighting the inabilities or abilities on geographical space,
- in the second sequence are placed in relation the landscape structure, characteristic of the different types of use of the area (geographic area) with the changes created by the effects of the abilities/inabilities identified (changes in the structure of the landscape); here, by representing the network of interactions, Sørensen type matrix, is simulated the chain of events, cumulative and synergistic actions,
- in the third matrix, is achieved spatial differentiation of the landscape, putting into relationship the changes with disrupted geoecological systems, and insert geoecological score,
- in the fourth matrix, is achieved functional differentiation of different systems depending on the restrictions (inabilities) or favorability (abilities) in geographical spatial planning and geoecological highlighting indicators recommended or activities necessary to substantiate the monitoring program.

Complex Geoecological Matrix, proposed, can be expanded with other sequences considered important by the assessor to put into one logical guide the conceptualization. Another novelty of the proposed conceptual model is the introduction of PCM references regarding to landscape structure (actions), respectively the changes in the landscape (assimilated to impact factors), in conjunction with components of mining operations (natural and technical).

Chapter 12 - Original scientific contributions

Theoretical and applied contributions of this study are:

- approaching the geoecological issue for mining as a new direction of research and work into a basic framework, optimal from industrial (economic), environmental and natural resources risk management point of view,
- analyze the legal framework and best available techniques,
- analyze changes in natural systems and their transformation from natural-technical causes, within a restructured mining perimeter,
- proposing the concepts of abilities and inabilities for mining geoecological studies, given the limited time of extractive activities and the achievement of a new geoecological balance after their termination,
- adapting the PCM model, which conceptualizes areas as mosaics to the mining geoecological field,
- for the first time, were designed schematically, diagrammatically and graphically conceptual models and a method of geoecological analysis as a complex matrix (coaxial), applicable to the assessment of the perimeters with restructured mining activities,
- were designed correlation tables for the geoecological evaluation of mainframe systems,
- for the first time, it was introduced inside a coaxial complex matrix a Sørensen sequence, which illustrates the characteristic actions of various types of abilities/ inabilities, identifying primary changes of the structure of the landscape, while the graphs allow networks conjunction

with secondary changes, highlighting the relationships between them and basic actions including measures for monitoring;
- were selected and integrated specific indicators/indexes applicable mining Geoecology
- were proposed complementary techniques of ecological engineering, such as: improvement, mitigation of creating or bio-manipulation, as options work for mine closure with restructuring activities in addition to rehabilitation and recovery currently applied,
- was introduced the concept of naturalization defined as achieving a new balance of geoecological, natural, evolutionary by accepting the new geographical and ecological dimension and redefining of the advantages and disadvantages of social, economic and landscape caused by the new environment,
- were opened new directions, for future geoecological research as Extractive Geoecology, by applying the proposed model for other extractive industries (oil, gas),
- was proposed the application of geoecological the principle in industry, where toxicological influences (bioecological) can be adequate managed, to demonstrate the real and benefic result generated by a proper functioning of industry and not a distorted one.