THE ECONOMY OF MINERAL RESOURCES IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

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Abstract: The authors present in the paper the mineral resources identified on the territory of Bacau County, in the first phase of research of the project "Research on a systemic approach of sustainable development at administrative-territorial level" and proposals for their sustainable valorization through technologies available in international practices.
The paper presents proposals of ecological reconstruction of run-down sites, as well as ways of inclusion in the economic circuit of certain yet unexploited resources, the valorization of the latter offering ecological products in demand on the domestic and international markets on the channel of sustainable valorization of resources.

Keywords: mineral resources, ecological recovery, valorization channels, externalities, sustainable development.

1. INTRODUCTION

It could be appreciated that mineral resources have an outstanding role in the economy of Bacau County. Economic outcomes should also be considered in a social context, as by valorizing mineral resources new jobs will be created, horizontal industries and industrial services would be stimulated and supported, localities depending upon a single mineral resource or its valorization would get an economic base.

Geological data are not very optimistic concerning some resources such as crude oil and associated/free gases. Privatization of SC PETROM SA and the leasing of oil fields induce factors of uncertainty as to the future of crude oil resources in the county's economy.

A functional market economy - which becomes the reality of future Romanian economy – would presumably phase out coal resources from the county's economy. Recovery of sites affected by coal mining could provide only a few jobs for those laid-off from the open-cast mines.

Mineral waters – largely present on the county's territory – should bring a substantial contribution to local economies. The transition period, economic involution, the de-industrialization process, privatization of economic units (parts of large industrial compounds), extra-economic interests (a common feature of countries with high corruption rates), politics interfering with management etc. resulted in dysfunctions of the valorization channels, which now develop outside the typical parameters of a market economy, and industrial compounds cannot benefit of any results of research & development, education etc.

2. INVENTORY AND EVALUATION OF MINERAL RESOURCES

Bacau County has a diverse and significant potential of mineral resources (Table 1), most of which are economically valorized; as a result geological reserves are dwindling in volume.

Mineral resources in Bacau County. Table 1

Resource	unit	Reserve C2	Note
Condensate and free gas			Lack of data at ANRM. Resources leased to SNP PETROM SA.
Crude oil and associated gases			
Crude oil, associated gases and free gases			
Free gas			
Crude oil			
TOTAL CRUDE OIL			
Lignite	Thou t	5487	Without Comanesti leased to SNC PLoiesti
Rock salt	Thou t	1103741	Without Gura Slanic and Tg. Ocna leased to SNS Bucuresti
Potash salt	Thou t	100	
Gypsum	Thou t	264	
Common clay	Thou t	5466	
Sand and gravel	Thou t	50000-100000	
Sandstone	Thou t	2011	
MINERAL WATERS			
Slanic Moldova	m^3/ day	800 – water; 26 – CO_2	Leased to Perla Moldovei
Targu Ocna	m^3/ day	17 – water	Leased to Primaria Tg. Ocna
Moinesti	m^3/ day	94 – water	Free for concession
Sarata	m^3/ day	108 - water	Free for concession

Source: ANRM (National Agency for Mineral Resources), August 2004

2.1. Recoverable resources of crude oil and condensate. This is a general trend in Romania, where resources exploitable through the natural energy of deposits have been extracted in a proportion of 85% and those extracted by methods of increased recovery factor – in over 41%. The quality of oil is of the category paraffine-naphtene-base low in sulphur. According to estimates of the American Prospecting Department, Romania has about 200 million tons of oil reserves, in various conditions of extraction [1], with an envisaged 101 million tons to be extracted over the period 2002-2010 [2].

The reserves of liquid hydrocarbons (oil and natural gas) discovered so far on the territory of Bacau County [3] are grouped in four areas, very diverse in terms of volumes and work-force needed for their primary valorization. These areas are: Zemes-Moinesti, Vest Tg.Ocna, Tescani, Gaiceanca-Glavanesti and Oniscani. The decline of oil and gas production may be mitigated in the long-term by geological research, exploring in detail the areas and the necessary depths of extraction by specialized studies [3]. In the first three areas, gaseous hydrocarbons associated to the deposits are made up of various mixtures of methane, ethane, propane and butane, methane having a share of 60-90% of the total. In the Gaiceanca-Hurulesti-Negulesti and Glavanesti perimeters, deposits of gases are predominant, made up exclusively of methane, and the oil in these areas is made up of very light liquid hydrocarbons (condensate).

2.2. Coal resources are situated almost entirely in the Comanesti area as deposits of lignite disposed in moderate-depth strata of usually 1 m, locally attaining 2 m. Reserves off balance [3] are estimated to be of 3,200 million tons. Beside this basin, there are areas with coal deposits in Bacau County at Caiuti, Pralea, Negoiesti (Trotus) and Parvulesti (Casin), of which Pralea is the most important one. Total reserves (C2) are estimated at 5,487 million tons, without the deposit at Comanesti belonging to SNS PLoiesti.

2.3. Rock-salt reserves are well represented in the sub-Carpathian hilly areas, but only a few deposits are exploited. One of these is situated at Tg. Ocna with balance-reserves of 132 million tons and 97 million tons off-balance. The Gura Slanicului deposit is exploited through water-flooding method providing for the Chemical Plant of Borzesti. The reserves exceed a billion tons (C2 category).

2.4. Reserves of potash salts can be found in several areas. One of them is situated at Galben – Targu Ocna, Schitu Frumoasa - Tazlau (reserves of 200 million tons of rock with a medium contents of 10% K_2O); the whole hilly pre-Carpathian area between Schitu Frumoasa-Poduri-Targu Ocna and Sarata-Onesti-Casin is an area with probable potash salts. C2 reserves are significant: 7500 million tons at Cucuieti and 100 million tons at Galben – Targu Ocna.

2.5. Gypsum reserves are widely spread in the county. Gypsum is on the surface at Onesti (Dealul Perchiu), Targu Ocna, Barzanesti-Halogiu, Orasa-Sandulesti. Gypsum strata are of several metres and the reserves exceed the consumption need of the county (as building material); it is also used in agriculture as addition in fodder. C2 reserves are estimated at 264 thou tons, and unclassified reserves at 218 thou tons.

2.6. Sulphur reserves are linked to gypsum reserves. Their estimation should be completed, as they have a high economic value and are of interest at county and national levels.

2.7. Rocks that can be used as building material are of a wide array, the most important ones being:

- Siliceous sandstone (Kliwa type) can be found in the Zemes-Moinesti-Targu Ocna-Slanic area. Extractions at Biserica, Gura Slanicului and Valea Uzului;
- Limy sandstone (Tarcau type) is on the Trotus valley. The amount of the two types of sandstone is of 2011 thou tons (C2 reserves);
- Volcanic tuff are in the areas: Clejea-Racaciuni and Buhaci-Ruseni / Racatau-Slobozia Noua. Volcanic tuff strata in the deposits have a depth of 10-20 m.
- Mono-limestone does not have significant reserves; of economic importance could be the area Zemes-Schitu Frumoasa and the sources of Tazlaul Mare river;
- Marl, clay and loess make up the covering layer on the terraces of the main rivers of the county; the balance reserves are 5466 thou tons;
- Sands: main extractions in the Doftana area;
- Alluvial deposits (gravel, sand / ballast) are situated in the alluvial planes in deposits of 50-100 million tons.

2.8. Mineral water reserves represent a real wealth for Bacau County. By their diversity in terms of chemical composition, their distribution all over the county, their therapeutic benefits (proved and probable) these resources may play an important role in the county's economy, contributing to its development (improving health conditions of the population, providing jobs etc.). Some of them are renewable resources (plain water for instance) with a stable domestic and external market, needing low investment for valorization.

Existing mineral waters can be divided in several groups depending on their contents in minerals, namely:

- natrium-chloride (alkaline) and alkaline/chloride, aerated;
- natrium-chloride, highly mineralized;
- natrium-chloride, iodized;
- sulphide or salted-sulphide;
- vitriolic.

3. CHANNELS FOR THE SUSTAINABLE VALORIZATION OF MINERAL RESOURCES

The efficiency of valorization of mineral resources depends on the valorization channels, which define the economic/social/ecological optimum at territorial level and are the support of production integration (vertical and horizontal); they build up tradition in the domain and the added value, the additional intelligence to be found in the final product can reach significantly high values.

The oil extraction – petrochemical products channel. This is well represented in the county's economy. The oil of the region has been directed to two refineries (Darmanesti and Onesti), the newer one – Onesti – being integrated with the petrochemical installations of CAROM – Onesti (bivynil-styrene rubber, solvents, polystyrene, olefin, butadiene rubber etc.). The refinery of the system provided oil-based fuel to the market. The end of the privatization process, the uncertain evolution of Romanian industry (further de-industrialization or a new start for re-industrialization?), halted the process of valorization of mineral resources as an objective in itself; individual and group interests prevail as against the county' and national ones. For the above reasons no assessment can be made concerning the future evolution of the economic units of the chemical compounds that are the infrastructure of valorization channels.

However, the following considerations might influence the county's overall economy:

- positive externalities that evolved over time (especially in the last 50 years) should be turned to account; we have in view new human settlements (e.g. the town of Onesti), fully equipped (housing, transportation networks, schools, hospitals, public institutions etc.); alternatives for the crumbling, disorganized and malfunctioning valorization channels should be sought and found;
- negative externalities are significant and long-lasting, costly and dangerous for the environment; categories of negative environment externalities related to oil extraction, transport and processing are:
    - soil pollution around oil-drillings;
    - decrease of agricultural land by areas of drilling, building access roads and creating deposits;
    - soil/subsoil pollution through oil leakages from the refineries;
    - deposits of silt at the refineries;
    - ground water pollution through waste water with phenol from S.C. CAROM S.A. in the 1960s and 70s;
    - depletion of existing oil fields without explorations uncovering new ones.

Coal valorization channels had as unique finality the transformation of coal in thermal energy. Interest for coal mining in Romania and in Bacau county is at its lowest, due to the high cost of extraction, quality of the coal, ecological constraints, the emergence of nuclear energy (modules 2 and 3 at Cernavoda), decreasing industrial consumption.

What is left from the "historic" coal mining activity of the last 60 years in Bacau County?

- works for the closing down of mines, compulsory actions which lack financing;
- derelict land at the former sites that need rehabilitation;
- job-less people in need of alternative activities;
- dirt-heaps, cinder yards to be economically managed through the best available technologies at international or national levels (for instance in Germany);
- the rising interest of public authorities for research on un-conventional valorization of coal, such as underground coal distillation, liquefying through bio-technologies;
- new research issues for R&D units of high education institutions in Bacau County in order to revive interest for coal-valorization in the long-term;
- an opportunity for businesses in the field of ecological reconstruction, cinder-yards and dirt-heaps rehabilitation, new un-conventional procedures of mining.

Rock-salt valorization channels. Large geological reserves of rock-salt used to have two main channels of valorization:

- extraction, conditioning, marketing as such in various assortments of NaCl;
- extraction by water-flooding and chemization (natrium-chloride products, organic chlorides, PVC, pesticides, solvents, bleaching products, liquid chlorine, hydrogen etc.) in the Borzesti compound.

Arrears at CHIMOPLEX Borzesti, obsolete equipment, polluting potential for the area, speak against continuing, modernizing and extending the chemical valorization of rock-salt. E.g. if in year 1999, 86,123 tons of 100%caustic soda were obtained, in year 2002 the quantity was 76,940 tons. In the same year 1999 1,067 tons of 100% pest-killers were reported, but after just three years production dropped to 379 tons. Foreign investors could contribute to the modernization of technologies of extraction and conditioning and to new market opportunities. Local and county decision makers should develop policies for attracting such investors for the large amount of mineral resources. Over the last 40-50 years, auxiliar activities to salt extraction were devised and implemented. The interior of salt mines (Targu Ocna) was used for therapeutic, sports and tourist purposes. These types of activities may be diversified and extended, becoming positive externalities (salt-sculpture camps, a larger set of therapies, toxic waste deposits, a salt-museum etc.).

Missing channels in the valorization of mineral resources in Bacau County

Among the un-valorized and insufficiently valorized mineral resources we could mention:

- Mineral waters. They are classified in 14 groups, according to their chemical composition. Sources specific for the above classes and the huge potential they represent for the county's economy, for population health, can be put to account through development projects of local interests, tourism, related activities (packaging, drilling transport, building facilities, accommodation, road up-grading etc.).
- Potash salt deposits can be found to the North of Schitu Frumoasa, Cucuieti, Tuta, Gura Slanicului, Tazlau. The reserves are estimated at 7.6 million tons of rock/type C2 in the perimeter Cucuieti and Galben – Targu Ocna. At Frumoasa Tazlau the reserves are estimated at 200 million tons of rock with a 10% content of potash peroxide. Under the potash-salt rock there are deposits of high pressure gas [3], which should be priorily extracted.

Technological tests for the complete valorization of potash ore at Tazlau – Schitu Frumoasa revealed that from a ton of raw ore can be obtained: 58 kg of magnesia, 350 kg of sodium sulphate, 393 kg of rock salt and 157 kg of potash concentrate of which over 50% is potash peroxide. In the 1970' the deposit had been considered economically exploitable, its valorization depending on de extraction of the pit gas in the underground. It is important to stress the importance of potash salt reserves, because from the 1970's new developments occurred on the market: the development of ecological agriculture and its perspectives for Romanian agriculture would introduce in the market a new category of substances namely "Fertilizers and soil meliorators", as defined by the European Union's Regulations in the Directive no 2092/1991 and 1804/1999 and Emergency Ordinance of the Romanian Government no 34/2000. The list presenting the substances which can be used in ecological agriculture recommends the use in ecological agriculture of fertilizers such as:

- Raw potash salt (kainite, silvinite); these could be identified with the resources at Galean – Targu Ocna, where kainite and silvinite are associated with rock salt. The depth of the deposit is between 100 and 230 m.
- Potash sulphate containing magnesium sulphate; resources at Tazlau – Schitu Frumoasa may be considered as being in this category.

- **Gypsum reserves**. Gypsum is widely present in Bacau County in various forms of mixtures (mixed with earth or other substances); it rarely is white and clear, in most cases being coloured by impurities. Gypsum is used locally for building plaster (when the raw material is impure), for modeling (when the material is pure) or as plaster for flooring. Gypsum may also be used as soil amendment for vegetables (bean, pees) and fodder (lucerne and clover), thus being useful as a natural fertilizer for ecological agriculture (see Emergency Ordinance no 34/2000). In the future, production of "rigips" (plaster board) will have a large market not only in Bacau County but all over the country, with export opportunities. In Romania there is a potential demand of about one million new housing and about two million housing should be renovated, refurbished and modernized etc. Thus the new material – rigips – would become indispensable for the new building techniques of housing. Beside plaster, the cellulose support may be ensured by the paper plant and the wood processing plants of the county etc.

- **Sulphur resources**. The study developed 1971 by the Oil, Gas and Geology Institute [3] mentioned superficial existence of suplphur at Casin, Targu Ocna, Oituz, Poiana Sarata, Harja, Moinesti, Salont, Racaciuni, but these resources have not been sufficiently studied. In small quantities, they may be of

interest at local level, used as disinfectant in rural households, pesticide for wine grapes, additives for sheep-food to improve the quality of wool, bleaching of wool, silk and cotton, fertilizer for ecological crops etc. The study of the resources, their location, quality, properties of soil, are pre-conditions for the offers to be made to possible investors, especially on the local level.

4. CONCLUSIONS

It is difficult to speak about valorization of mineral resources in an economic process that aims to being developed within the parameters of sustainable development. Mineral resources are by definition exhaustible, countering the concept of sustainable development and preservation of access to future generations to those resources. The current model of civilization is based on the exhaustion of mineral resources, some of them at a high rate (e.g. oil), postponing the achievement of sustainable development. This contradiction between the finite character of mineral resources and society's aspiration to be developed on a sustainable track (in correlation with nature), is being answered by scientists, ecologists, religious leaders etc. by solutions that are not always harmonized.

For the mineral resources of Bacau County, the following types of objectives and policies or economic development strategies might be taken into consideration:

- ecological reconstruction of derelict land in the oil drilling, natural gas and coal mining areas;
- correct, preventive management of salt exploitation by water flooding, the example of Ocnele Mari (Valcea County) may be a good guidance for decision makers in Bacau County's economy;
- applying environmental quality criteria in industrial technologies as stipulated in national practice (emissions and imissions);
- bringing "to life" "ecologically destroyed" rivers such as Trotus, downstream of Borzesti;
- management of underground waters; study and assessment of pollution; special care for pollution by oil products, phenols, various pesticides;
- stimulating the production of fertilizers for ecological agriculture;
- therapeutic valorization of mineral waters for the benefit of the county's population;
- extension of the practice using inactive or un-productive salt mines with a view to improving people's health.

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