MANAGEMENT OF REHABILITATION OF PRODUCTIVE INFRASTRUCTURE OF SECTIONS WITH HIGH RISK OF DEGRADATION

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ABSTRACT

In the extraction process, over time, it was found that there are a number of inconsistencies between the cumulative of the extracted gas and the forecast one. Due to the fact that the recovery factor is not at the level of the forecasted one, it was considered that complex inventories and investigations of all aspects involved in the process of natural gas production were considered, namely: improving the performance of the gas wells, of the separation, collection and gas transport, gas drying stations, gas compression stations, and last but not least the improvement of the human factor's performance, all these aspects being materialized in a technical-economic project for the rehabilitation of a gas structure. The rehabilitation of mature natural gas fields begins with the acquisition, processing, correlation and interpretation of all production data and geological data to determine the dimensions of the porous-permeable collectors, interpretations that rebuild areas of interest for future exploitation in accordance with the new gas reserves. Established with the new possibilities of exploitation of gas wells and surface infrastructure.

Keywords—*management;risk; style; recovery factor; rehabilitation*

I. Introduction

For the most accurate estimation of the natural gas reserve in a deposit, the most accurate values of the porosity, permeability and saturation in fluids are needed, values that are obtained after analyzing the core samples, but also from the core diagrams of each well. .

The most important geophysical method for mapping areas that may contain hydrocarbons is seismic prospecting, which consists of producing at certain points in the area under analysis, some elastic waves that propagate deep, returning to the surface after contact with separate boundaries. of the investigated layers, thus recording their arrival time on the surface.

When conducting seismic surveys, information about neighboring collectors, of small dimensions that have not been known until now, will be seen, besides information related to the shape and dimensions of the collector being investigated.The formatter will need to create these components, incorporating the applicable criteria that follow.

II. Assessing The Potential Of A Productive Horizon

Assessing the potential of a productive horizon, and predicting different extraction rates can be done through two-dimensional numerical models. The use of two-dimensional models elucidates which areas are drained in different percentages of the horizon, and if an opportunity to increase the operating size is possible by digging new probes.The two-dimensional numerical model applicable to the gas horizon has as theoretical support the differential equation of diffusion [1],[2]:

$$k_x \frac{\partial^2 U}{\partial x^2}+k_x \frac{\partial^2 U}{\partial y^2}+q = c\frac{\partial U}{\partial t} \quad (1)$$

The main characteristic of the natural gases exploited from the Transylvanian depression is given by the higher calorific value of over 10.4 Kwh / mc, and the percentage of methane in the gases is over 99%, which is why it can be considered a single component gas.

The implementation of the whole scenario of reactivation of natural gas wells, in conjunction with the drilling of new wells, or the deepening, the resetting of some of them, must lead to maximum values of the gas recovery factor. The discretization network is chosen based on the geometry of the spectrum of the current lines, the purpose of the study and the type of differential equations correlated with the initial conditions. In general, the rectangular lattice of constant or variable pitch is preferred. A rectangular network of constant pitch can be sized so that any block in the network does not contain more than one probe, or certain blocks include more probes, as desired, either to study the performance of the probes and the distribution of pressure, or to analyze the overall behavior of a deposit. The purpose of the rectangular variable step network is to reduce the step in the immediate vicinity of the well, which is achievable by changing variables, and aims to study the effects of pressure gradients in a certain area in the immediate vicinity of a well.Solving the equation with finite differences including for the two-dimensional space implies its notation in each inner node of the network, we arrive at a system of algebraic equations. of the form

III. Management Of Horizon Exploitation Through The Model Used

The calculation of the pressure values from all the blocks of a productive surface wanted to be analyzed by using two-dimensional numerical models is the engineering way in tracking the behavior of the productive formation. The result obtained by numerical modeling is improved with the help of observations related to the production behavior of the wells in association with the interpretation of the production data. These models give an overall picture with the distribution at a given moment of pressure throughout the production horizon.

If there are differences in the dynamic pressures of the wells on the same objective it means that there is a certain pore blockage. Thus it is advisable to carry out dynamic investigations in all the wells on the horizon to see the updated values regarding the defining parameters in the gas extraction process.

The reconfiguration of the geological models in the three-dimensional space, and then the simulation of the gas movement in the permeable porous environment is summarized in the following stages:

- Construction of the database that includes the parameters of each well on the deposit;
- Seismic interpretation;
- Geological modeling and facies modeling with the purpose of the 3D geological model, the stage in which the structural maps are also prepared.

Petr Petrophysical modeling, where the petrophysical parameters of the core are zonal values, which make up the starting points in the attribution of the average values throughout the hydrodynamic unit. In the petrophysical modeling, the results of the PNN investigations carried out in the wells are taken into account.

- Evaluation of current resources and reserves;
- Modeling and numerical simulation, where the specific is given by the simulation of the production history and the comparison of data with those existing on the site.:

REHABILITATION OF THE PRODUCTIVE INFRASTRUCTURE OF THE SECTIONS

Here we can talk about the rehabilitation of the natural gas production infrastructure, as well as the modernizations necessary to increase the recovery factor, to fulfill the production plan, but also for the need to deliver gas under quality conditions imposed by ANRE, mentioning the following aspects that must be met. :

- Separation of probes

Most of the probes were produced on the same pipeline, and the correct tracking of the parameters was not possible, which is why they went to their separation, and currently we have 17 separations to complete. The probes being separated can be measured with a flow calculator, and the calibration of the impurities is done correctly.

- Unscrewing, and cleaning the impurities separators

Most of the separators were clogged and we went through their digging, cutting and cleaning, and mounting them again.

- Establishing the direction of gas consumption

We have gas structures that can be directed to several directions of consumption, according to requirements.

- Real-time data automation and transmission

This year we have finished installing multivariable sensors on each probe and flow calculators on each group of probes, plus data transmission panel, so that the behavior of the probes can be monitored in real time from the computer of the technological engineer.

Annual maintenance of surface infrastructure, which includes gas pipelines, natural gas drying stations, natural gas compression stations, transmission, centralization and tracking parameters of dynamic wells, objectives to be pursued, inspected , corrects by the employees of the Company, or by third parties in collaboration with the services provided within the Gases Production Units, in order to maintain the production capacities in a continuous flow.

There is a lot to talk about here, but we will deal in particular with the probe-inflow area system, which is the connection area between the infrastructure mentioned above and the gas deposit itself. The inflow area of the probe layer corresponds to the perforated range.

Besides the fact that the well is a mining construction, it represents the production / injection system of the hydrocarbons, but also the source of confirmations / infirmations of the geological and physical models built, so that the rehabilitation of the productive installations is dependent on the positive results obtained in the process of stimulating the inflow. of gas.

Following the technical inspections of all the wells, and of the productive infrastructure of a gas structure, we will select the wells that require reactivation or simple intervention operations on them, the operations being executed both in the well and in the area of well-stratum influx. The rehabilitation of the natural gas wells requires the imposition of complex operations in the productive area as well as in the well, where the rehabilitation of the system of influence of the stratum-probe depends on the safety in operation of the well, for which specific investigations are carried out.

The construction of the natural gas wells represents practically a well dug up to several thousand meters tubed with steel bins, where on the outside there is cement paste for consolidation and selective exploitation of the objectives. The tubular material is chosen so that it can withstand the entire life of a probe, all the forces acting on it. The probe is then equipped and put into operation.

Of the range of tubular material with which a well is equipped, the tubing and the operating column, due to agents such as: oxygen, sands, hydrogen sulfide, carbon dioxide, are the most exposed to corrosion. Agents are found in fluids circulating or stationary in the tubular material during operations and RK operations, or come from the layers communicated with the operating column.

The tubular material is subjected to the action of pressure and temperature, and on the tubing lining it acts the dynamic efforts of bending, torque and traction, being able to generate changes in the diameters of the column and of the tubing, cracks, or even breaks.

The degradation of the columns and the tubing of the probes is based on mechanisms of destruction that can be eliminated by applying the methods:

- Elimination of the causes of aeration of circulating fluids;
- Use of corrosion inhibitor;
- Increased ph value;
- Use of oxygen and hydrogen sulphide consumers;

Most natural gas wells are equipped with D = 27/8 inch tubing and D = 51/2 inch operating columns. Checking the integrity of the extraction pipe lining is done by deep or surface blasting, and by surface diagnostics, pressure tests and metallographic expertise. Column patterning is a coarse method for determining the inside diameter, so an effective method is to insert multifinger devices into the well using a geophysical cable [3]. [5].

Fig. 1 Types of multifinger devices

The accuracy of the column investigation is high the higher the number of sensors. The sensors of the device are arranged truncated, and the vertical movement of the sensors generates an electrical signal [4].[5].

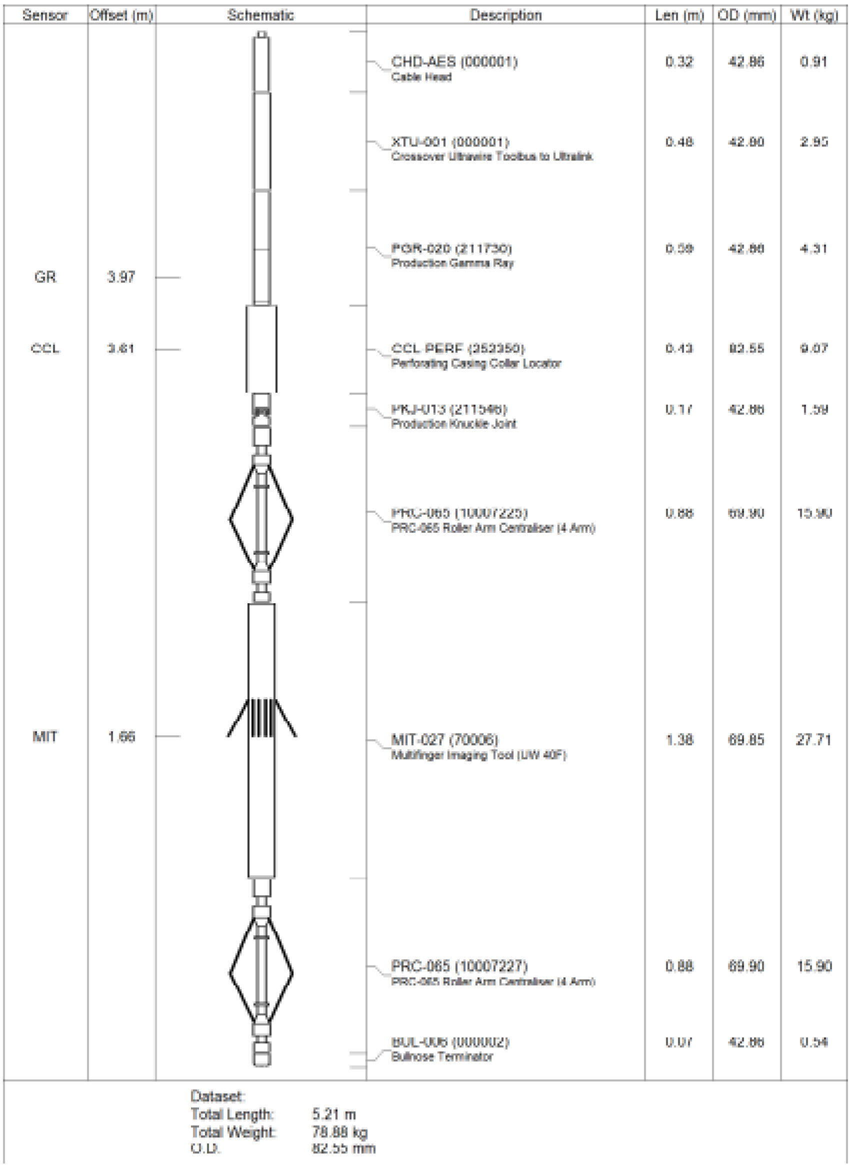

Fig. 2Sketch multifinger device

Inspection of the tubular material of the columns of the probes using the multifinger equipment identifies problems as:

- Increasing the inner diameter of the columns, thus decreasing the wall thickness, due to the action of erosion and corrosion;
- Exact determination of the areas with deposits inside the pipe;
- Location of equipments with nipples, packers, circulation valves;
- Detection of cracks;
- Pipe deflections

After analyzing the data from the probe "Z" with the characteristics mentioned below, the results were obtained:

Data of the analyzed probe:
WHAT THE. 2.9 / 16 " x 210 atm. snubbing.
Col. 5.½ " x 1595m.

- Mass flange distance = 3.20m.
- OGL; 881m. (879m deposit)

- Perf; 856-836 = 16m. selective.
- The barges with the highest penetration:
- Penetration of 100.00% (6.00mm) in drill 86 at depth 839.0m
- Penetration of 100.00% (6.00mm) in bead 87 at depth 853.9m
- Penetration of 100.00% (6.00mm) in drill 88 at depth 856.3m
- Penetration of 90.42% (5.43mm) in drill 85 at 836.4m depth

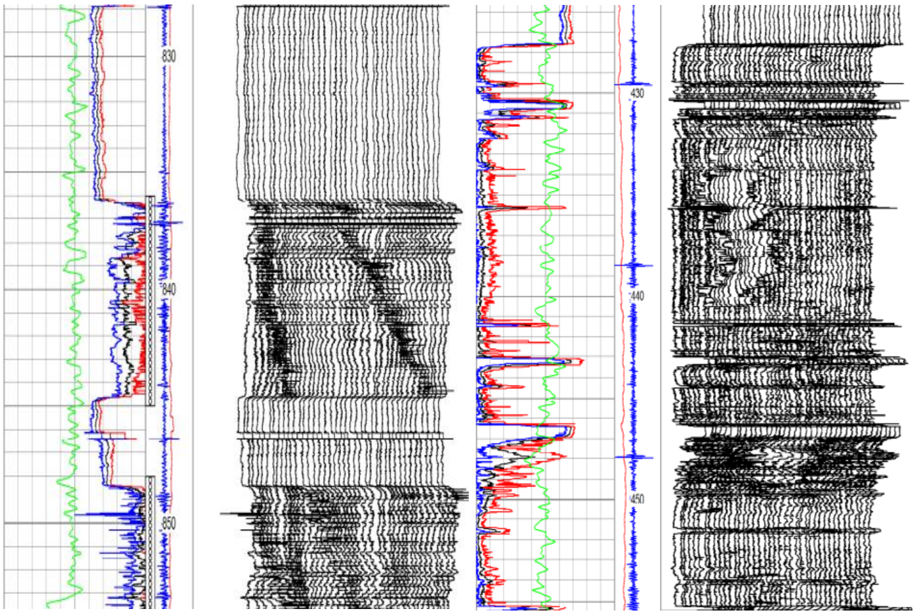

Fig. 3Diagrams resulting from the investigation with the multifinger device

- The casing with the highest penetration:
- Penetration of 100.00% (6.00mm) in drill 86 at depth 839.0m
- Penetration of 100.00% (6.00mm) in bead 87 at depth 853.9m
- Penetration of 100.00% (6.00mm) in drill 88 at depth 856.3m
- Penetration of 90.42% (5.43mm) in drill 85 at 836.4m depth. The range 427.6m-480.7m presents deposits / cement ring (in the work program it is mentioned that in 2008, cementation under pressure was executed to repair a detected break at 435m). For this reason, a valid analysis could not be performed on this range because the inside diameter on this area is 114-115mm. It is recommended that this area be cleaned to repeat the multifinger operation and determine the condition of the 5 ½ column of the probe.
- In case of detection of certain special situations such as loss of material in certain areas, cracks or cracks, the isolation of the sensitive area is applied with the help of a packer, by piping the respective column, allowing the work to continue. For technical-economic reasons, a certain portion of the initial trajectory of the well must be given up and a new, directed trajectory must be drawn from a set depth.

With the help of cementing acoustics, by introducing equipment into the well, Radial Bond Log, we can analyze the situation of the cementation of the column [2].

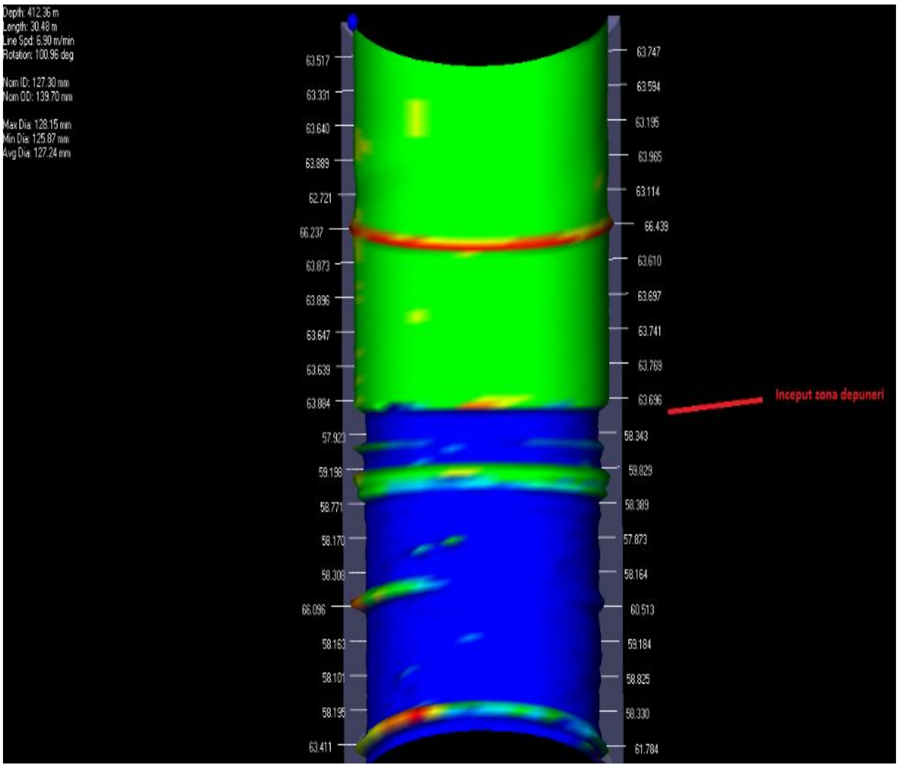

Fig. 4 Highlighting a deposit

IV. MANAGEMENT NVESTIGATION OF PRODUCTIVE GAS WELLS

a) By the production core method.

Natural gas wells have porous-permeable layer perforations on portions from several meters to hundreds of meters. Initial gas production was obtained by opening the layers with similar hydrodynamic parameters, and when the energy of the open layers decreased, they were added to other layers, so that a probe had opened and communicated several layers, which produced different natural gases as well. water, thus transferring gaseous mass from one layer to another. Due to the errors of measurement of the length of the geophysical cable with the help of the signal required for detonation, the massive perforations communicate non-productive areas of natural gas and aquifers, so errors of measurement of several meters at great depths lead to the complete failure of the area where there is natural gas corners.

Reaching the very high recovery factors, in some cases over 90%, the exploitation of all the porous-permeable layers of the deposit, the passing of the receptivity tests, can be the premises of the massive stocks of reservoir water, which is unusable, and must be reinjected into the wells with this deposit. destination.

- The new methods of investigation can detect all the layers potentially producing fluids, as well as the contribution of each one in the total flow of the well, both gas and water.
- Understanding the behavior of the deposits can be done by the production logging method, known as Production Logging Tool (PLT). The principle of this method consists in determining the apparent speed of movement of the fluid near the perforations, and then of the flowmeter, the flowmeter that detects the different local velocities of the fluids coming out of the layer, having in its composition a number of blades centered on an axis so that rotate due to the fluid ascension flow as well as the oscillation of the device's movements in the fluid mass. The

purpose of this investigation is to make available to the engineers involved in the reactivation documents necessary to understand the behavior of the respective deposit.

- The first purpose of the production core is given by determining the location of the sources of water and those of natural gas, where the solution of the inflow of the reservoir water can be solved by cementing under pressure the perforated area, and then the reinforcement of the porous-permeable layer.
- Methods of hydrodynamic investigation of natural gas wells:

From the necessary steps to be carried out for the rehabilitation of a deposit, we deduce the dependence on the need to reevaluate the hydrodynamic parameters of the wells. The importance is given by determining the maximum flows that a well can have and the factors that limit these flows, by the coefficients of resistance to the gas filtration to the productive area and the determination of the potential flows of the wells. These hydrodynamic research methods are divided into two categories according to the hydrocarbon motion regime in the porous-permeable environment, thus distinguishing investigations of the formations in the stationary and non-stationary motion regime.

Closing probes investigation:

With the help of the method it is desired to reassess the physical and hydrodynamic parameters of the production layer, namely: effective permeability, flow capacity, productivity indices, phase mobility, static pressure. The permeability of the area adjacent to the zone, the flow capacity of the fluids in that area, are dependent on the size of the skin factor, which is very important in evaluating the wells performance. Specific to this type of research is the fact that the probe is in production for a high period of time so that in the area of inflow layer-well the pressure is evenly distributed, and then the probe is closed to recover the static pressure.
After interpreting the parameters from the surface of the wells (static pressure at tubing and column, dynamic pressure at tubing and column, before and after the depressogenic organ (nozzle, nozzle), flow, impurities), a procedure is established for further investigations of the well, of the area influx and surface infrastructure.In order to determine the value of the average static pressure of the horizons of the gas structure, the static pressure measurements are carried out at the eruption head of the wells, using the formula [3]:

$$P_{zmed}^{(t)} = \frac{\sum_{i=1}^{n} Padz\, hz}{\sum_{i=1}^{n} hz} \quad (2)$$

Where,
Padi - is the value of the static depth pressure of the probe z
hz - the effective stratigraphy of the layer
The above relationship is applicable also for the gas horizons put in communication, but the accuracy of the result is given by the interpretation of the bottom measurement in the wells in which there is communication between the horizons.
The gas storage coefficient is given by the ratio between the variation of the volume of gas in the well and the variation of pressure in the well of the well [3]:

$$c = \frac{\Delta Vs}{\Delta p} = \frac{Q \cdot bg \cdot \Delta t}{\Delta p} \quad (3)$$

bg - the volume factor of the gases

The time of storage of fluids in the well can be determined from the relation:

$$t_{ad} = \frac{k \cdot t_c}{m \cdot \mu \cdot \beta_T \cdot r_s^2} \quad (4)$$

β_T - is the total compressibility coefficient of the fluid

The decrease of the skin factor will generate significant increases of the recovery factor, a skin factor that can be calculated under the conditions of non-stationary gas filtration, taking as a basis the pressure value at one hour after the closure of the well, as follows [2]:

$$S = 1.151\left(\frac{P^2_{\Delta t=1h}-P^2_{\Delta t=0}}{i} - log\frac{k}{m\cdot\mu\cdot\beta_T\cdot r_s^2} - 0.351\right) \quad (5)$$

The skin factor is composed of a multitude of factors, taking into account all the aspects related to the porous-permeable layer in the area of layer-probe influx [2].

$$S = S_b + S_p + S_{\overline{h}} + S_S + S_\partial \quad (6)$$

Probe factors are:

S_b - due to the blockage;

S_p - due to imperfection after opening mode;

S_h - due to imperfection after the degree of openness;

S_S - due to the exploitation at high differential pressures defending the non-linear motion around the well;

S_∂ - due to the oblique trajectory of the gas well;

The investigation of the probes at the opening consists of producing a probe for a certain period of time at a constant flow rate and with the recording of the variation of the depth pressure, thus obtaining the stabilization curve of the bottom dynamic pressure.

The isochronous investigation of the probes is a complex method that consists in alternating the closing and opening of the probe at equal times, with the recording of static and dynamic parameters.This method being very flexible does not destabilize the gas production over a certain investigated horizon, the closing and opening times being of the order of several hours.

CONCLUSIONS

Natural gas production is a complex activity, which has been proven over the course of more than 100 years of exploitation of the deposits that contain these hydrocarbons, as well as the dependence on certain factors and conditions.

Romania has the largest market for natural gas in Central Europe and was the first country to use natural gas for industrial purposes. The natural gas market reached record size in the early 1980s, following the implementation of government policies aimed at eliminating the dependency on imports. The application of these policies has led to an intensive exploitation of internal resources, resulting in the decline of domestic production.

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REFERENCES

[1] Giura, Lucian, Contributii la istoria gazului metan din România, Ed. Univ. Lucian Blaga, Sibiu 1998

[2] Avram, Lazar, Maloș, Mihail, Combaterea dificultăților și accidentelor tehnice de foraj, Ed. Univ. Petrol Gaze din Ploiești 2013

[3] Ştefănescu, Dan Paul,Practica extracţiei gazelor naturale. Vol I, Vol II. Ed. Univ. Lucian Blaga, Sibiu

[4] Ştefănescu, D. P. – Introducere în Reabilitarea Zăcămintelor Mature de Gaze Naturale – Teorie şi Studii de Caz, Editura Universităţii "L. Blaga", Sibiu, 2011

[5] Ştefănescu, D. P. – Introducere în Reabilitarea Zăcămintelor Mature de Gaze Naturale – Teorie şi Studii de Caz, Editura Universităţii "L. Blaga", Sibiu, 2012