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THE LATEST TECHNOLOGIES IN ROMGAZ – A REAL GUARANTEE FOR A FUTURE DEVELOPMENT

1. INTRODUCTION

The need for implementing the latest technologies applied in the world oil and gas industry, has determined Romgaz to intensify the efforts in this direction, through a real acquisition campaign started with almost two years ago. The main items considered very important in our specific domain are related to the following:

- **cement evaluation** with last generation cement bond logs (Ultrawire Radial Bond Tool – RBT);
- **production logging** (GR, CCL, sensors for pressure, temperature, density, flowmeter), an ideal tool for a better understanding of the reservoir behaviour;
- **casing inspection** (Multifinger Imaging Tool and Magnetic Thickness Tool very useful for detecting the casing damages, sand control, well completion, etc);
- **fluid level checking** (echometer);
- **wellbore visualization** (downhole video-camera).

Beside the necessary equipments (**logging truck, several tools** and **accessories**), Romgaz has also purchased the software packages which allow to perform now our own interpretations. The whole logistic and specialists belong to a Romgaz subsidiary, SIRCOSS, especially designed in wells workovers jobs and special operations.

Our papers will reveal not only the main equipments and devices recently acquired, but also the real advantages of using them in different situations, by exposing some case studies, which helped us to take the best decisions and to save the wells.

2. CEMENT EVALUATION

Well cementing represents an essential aspect which should be treated with much responsibility during the drilling process, because a poor hydraulic isolation between producing and non – producing zones can result in unwanted water, fluid migration in the annulus

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and therefore in some cases can compromise the safety and integrity of the whole well. For these reasons, our company decided to acquire Ultrawire Radial Bond Tool, one of the last generation available on the market, in order to perform a good quality job that can provide the correct diagnosis regarding the casing cementing.

Radial Bond Tool uses acoustic signals to evaluate the cement condition and has the following components:

- a piezoelectric crystal which generates acoustic energy that travels at different speeds as a wavefront through mud, casing cement and formation;
- a radial amplitude receiver at 3 ft (1 m) from the transmitter is a segmented piezoelectric radial receiver; each segment captures the returning acoustic energy, converts it into an electrical signal and determines the casing – cement bond, generating a cement map;
- an omni directional piezoelectric receiver at 5 ft from the transmitter is used to record the waveform trace and generates a Variable Density Log (**VDL**) to evaluate the cement – formation bond.

For depth correlation are run additional tools as gamma ray (**GR**) and casing collar locator (**CCL**). Beside these, the other curves displayed on the log are:

- **amplitude measurement** made within a specific window called "Gate", which corresponds to the casing arrival or "E1". The highest point within the "Gate" is the amplitude;
- **travel time curve** (also known as arrival or Transit Time) is the time between the firing of the transmitter and the first point that the signals meets a fixed detection level;
- **variable density log** (VDL) allows the qualitative interpretation of the casing – cement and cement – formation bonds;
- "**cement map**" where the amplitude of each segmented crystals at 3 ft is converted into a colour or gray scale.

We want to illustrate through the example presented below the first RBT log recorded with the Romgaz equipment (Figs 1, 2).

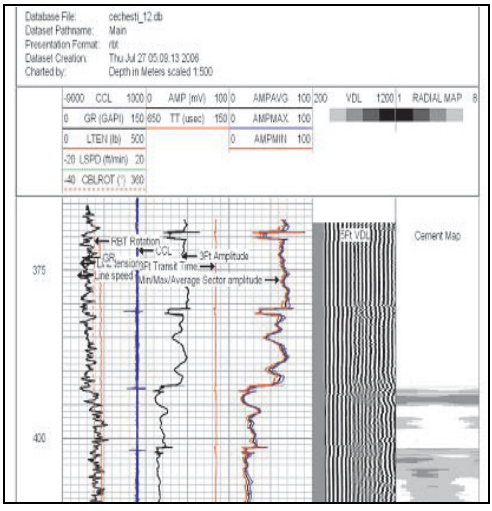

Fig. 1. RBT log – Well X Cechesti – top of the log

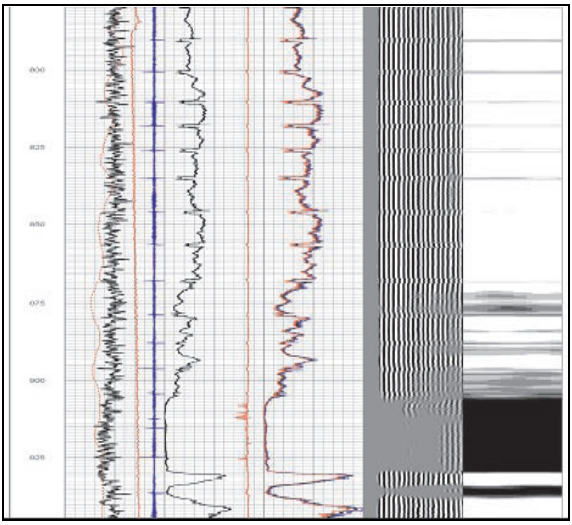

Fig. 2. RBT log – Well X Cechesti – fragment

The images show very clear the zones with good and poor cement bond, by the right side colour map: white means free pipe, grey – poor bond and black – good cement bond.

3. PRODUCTION LOGGING

For a more scientific reservoir management it is necessary to increase the knowledge degree of the reservoir behaviour, by measuring the several physical parameters which actually define the well production profile as: flow rate, fluid density, temperature, and in situ pressure in the wellbore,. Finding the water entry points is very significant within the production profile, allowing the water isolation and so increasing the gas flow rate. The tool which can offer this advantage is **PLT** (Production Logging Tool), recently acquired by ROMGAZ . It can be run in flowing and shut in well conditions. In order to measure the reservoir parameters mentioned above, the tool string comprises a lot of sensors for pressure, temperature, density, flow rate, which are briefly described in this section. Of course the well known GR curve and casing collar locator (CCL) are used for correlation.

The **GR** (gamma ray) measures the natural radiation level in the wellbore. Like CCL is used for depth correlation, to recognize the formation types, the radioactive scale depositions.

The **CCL** (casing collar locator)responds to changes in metal volume such as perforations or completion items and it is very useful for depth correlation.

The **QPG** (quartz pressure gauge) measures the downhole flowing and shut in pressure and how it changes with a flow rate change.

Temperature indicates the fluid movement inside (and outside) of the wellbore and temperature changes can identify the fluid type and the volume and direction of flow.

Differential pressure density is our available tool for measuring density which is an effect a 2 ft high "U" tube with silicon oil being one side of the "U" tube and the wellbore being the other. By measuring the differential pressure, the average density of the well fluids. can be calculated.

The **fluid velocity** in the well is measured with a turbine (spinner) impeller.

Knowing the fluid velocity and tubing size, volumetric flowrates can be computed.

Romgaz has purchased two types of flowmeters:

1) Caged Fullbore Flowmeter (CFB),
2) Continuous Spinner Flowmeter (CFS).

CFB is closed in tubing and opens up in casing to present a large diameter impeller and has high sensitivity. It can be run in high deviated and horizontal wells,in the casing of different sizes: **4½ '', 5'', 5 ½'', 7''** and **9 5/8''**. It is protected by a springbow cage.

CFS rotates continuously and is typically used in tubing and in casing for high rate gas wells. It has roller bearings and is available in sizes of **1,375'', 3,125''**.

The images presented bellow illustrate the PLT log display for one well located in Transylvanian Basin, on the Rusi gas field (Figs 3, 4).

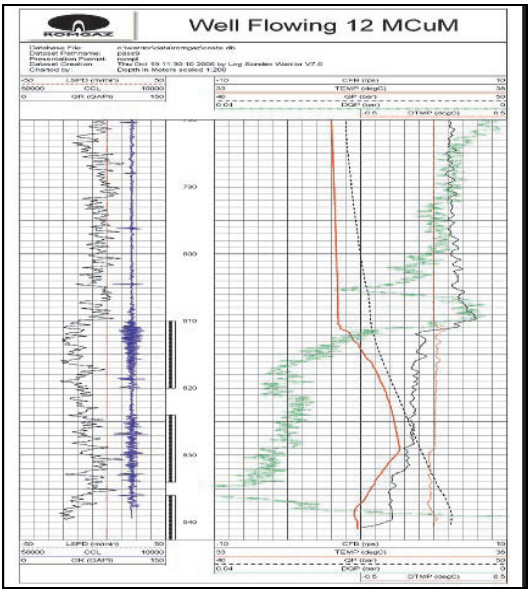

Fig. 3. PLT log – Well X Rusi

After running the log, PLT interpretation is the next very important step, which provides actually the well profile and helps in understanding the phenomenon happened in reservoir, using the PLT interpretation software. Before rate calculations, the main steps are represented by a qualitative analysis of the log and performing the spinner calibration, which is the most important feature of the interpretation process. We want to illustrate

a case study, represented by a PLT recorded in one well, from gas field Bunesti (in Transylvanian Basin), where the interpretation determined us to perform a partial isolation, by cementing the bottom two intervals (Fig. 5). The result was a considerable increasing of the gas flow rate from 4500 stcm/day to almost 14.000 stcm/day.

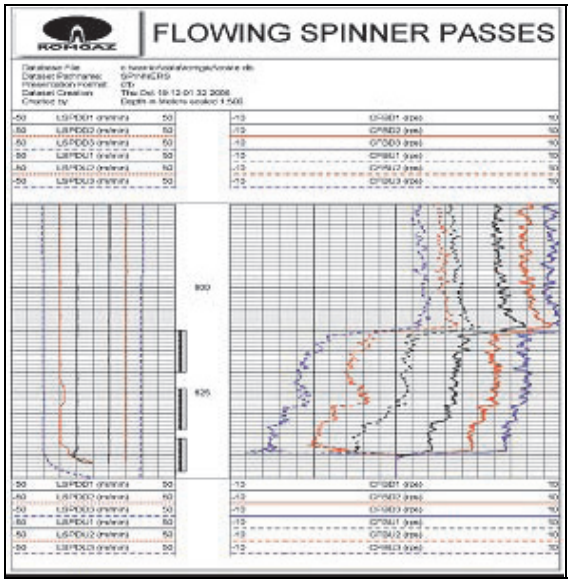

Fig. 4. PLT log – Spinner passes – Well X Rusi

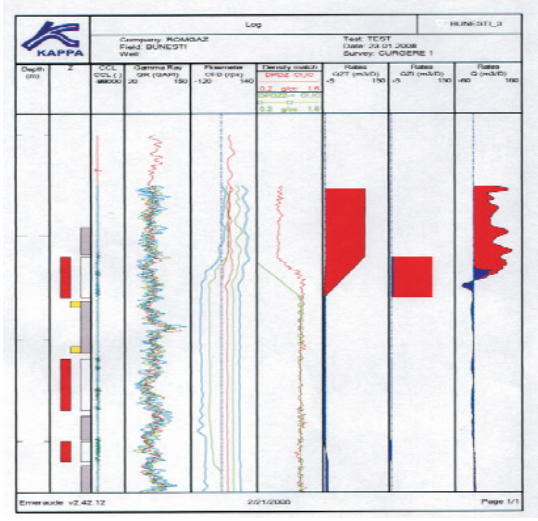

Fig. 5. PLT log interpretation – Well X Bunesti

4. CASING INSPECTION

The prime use for casing inspection tools is to record data to enable to maximize production or recovery from the field, or to provide information to optimally manage the field. The main advantages of using these type of tools consist in:

– solving the problems regarding the tubular corrosion,
– location of possible scales on the wall casings – broken or damaged tubular material,
– confirming the well completion – nipples, packers, screens, valves etc.

4.1. Multifinger Imaging Tool (MIT)

The tool which can really solve these above issues is **MIT** (*Multifinger Imaging Tool*) also recently purchased by Romgaz and available in two types: 24 and 40 fingers.

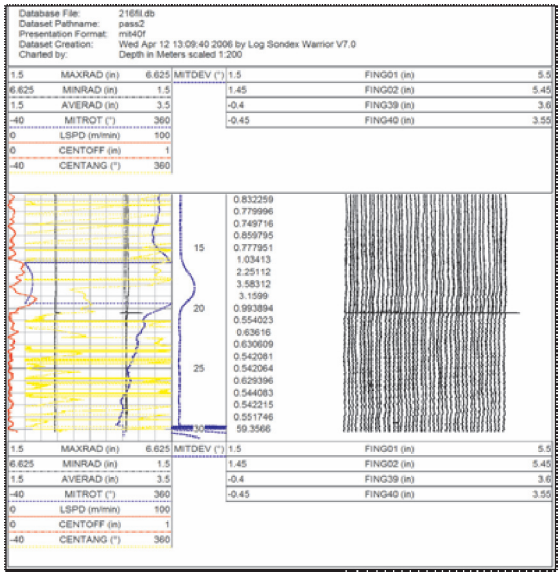

Fig. 6. Well X Filitelnic

The tool measures tubular internal diameter using spring loaded fingers and has an onboard inclinometer which is used to denote well deviation and to re-orientate the data to match the orientation of the well tubulars. The log interpretation is realized with special softwares: MIT pro which can provide a statistical analysis of the couplings and MIT view which can easily generate a 3D suggestive visualization. One interesting application was run in well X in Filitelnic field, also in Transylvanian Basin, which has been affected by land slides near the surface. The onboard inclinometer of the tool was able to identify the casing damage, by increasing inclination from below 1 degree to more than 3 degrees on the interval: 16–19 meters (Fig. 6). Figure 7 presents other casing affected by this serious phenomenon in the well X Noul Sasesc, which illustrates very clear the casing damage in

two zones, due to the presence of sharing plane here. For this reason, the well has been abandoned. 3D image (Fig. 8) emphasizes a serious casing penetration (corrosion) in the well Y Filitelnic (zone coloured in red).

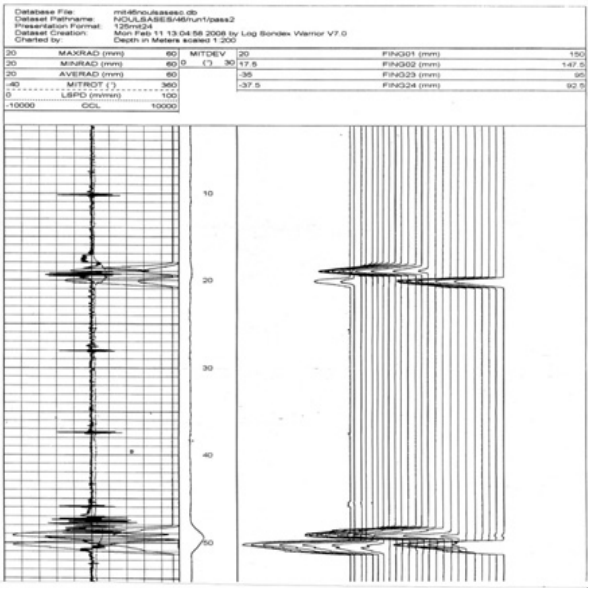

Fig. 7. Well X Noul Sasesc

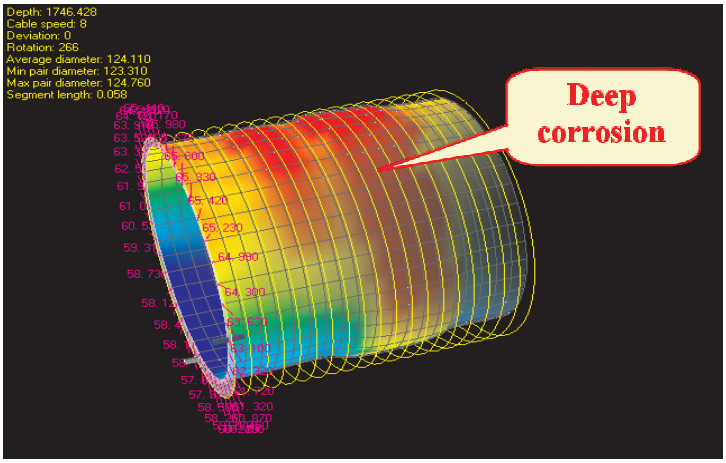

Fig. 8. Well Y Filitelnic

An accurate validation of the well completion represents a very important element in general, but in most particular case in sand control applications.

4.2. Magnetic Thickness Tool (MTT)

Another tool available in Romgaz designed to investigate variations of metal thickness within downhole tubulars is MTT. The main features are represented by the inspection of tubing and casing for internal and external metal loss, measuring absolute wall thickness, detecting pitting and gradual wall loss. 3D visualisation provide powerful qualitative images of well condition Up to now we didn't run a MTT log but we hope to perform in the near future.

5. ECHOMETER

A quick checking of the wellbore fluid level is an initial step for deciding the well status and doing future jobs. It uses a gas gun assembly and pressure transducer. The pressure transducer permits a faster and more accurate determination of the casing pressure buildup rate which is necessary to determine the casing annulus gas flow rate. The computer utilizes the acoustic data and casing pressure buildup data in conjunction with the well's data base to calculate the well analysis.

6. DOWNHOLE VIDEO-CAMERA (DHV)

The downhole video (DHV) service allows to get clear images of the wellbore environment to diagnose problems in a wide variety of applications. DHV services are used mainly in cased-hole situations. The two major cased hole applications are for characterizing wellbore fluids, especially entry points, and for inspecting downhole mechanical equipment. Few examples are shown in the Figures 9 and 10.

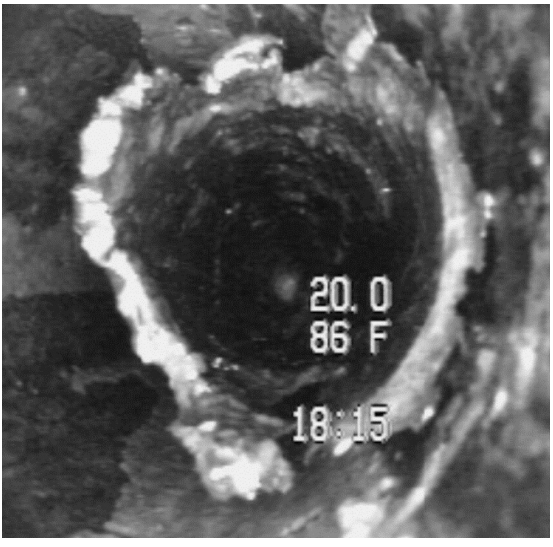

Fig. 9. Detonated tubing – Well X Urziceni

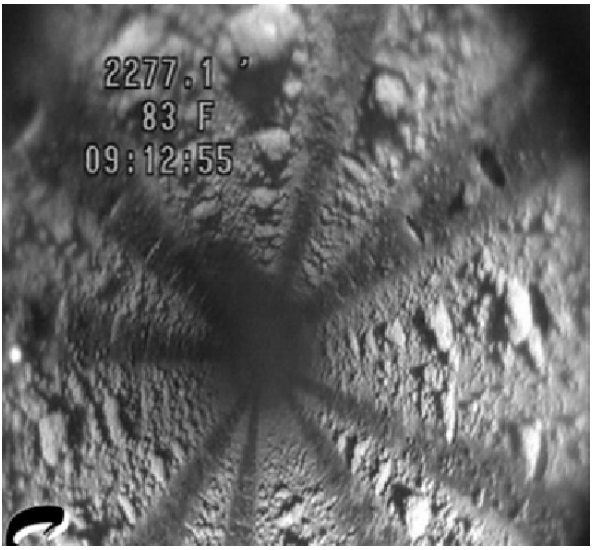

Fig. 10. Scales on screens – Well X Bilciuresti

7. CONCLUSIONS

Even if we don't have a long experience in applying these new methods, we continue to improve our knowledge by more and more practice and periodical training in the fields and in the office, for interpretation. A major investment like this, will represent a real guarantee for the Romgaz development in the future, due to the reducing the financial costs, by using the own equipments and specialists, and certainly by the consistent benefits in taking the optimum decisions regarding the mature gas fields rehabilitation, a major target of our present strategy.

These above reasons encourage us to believe that Romgaz will continue the acquisition campaign in the next period .

REFERENCES

[1] Sondex, Ultrawire Radial Bond Tool, User Guide, V1.0, November, 2005
[2] Sondex, Multifinger Imaging Tool, User Guide, V1.0, May, 2004
[3] Sondex, Standard length and short compact production logging toolstrings, User Guide, V1.0, February, 2006
[4] Romgaz Archive