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Overview of Geological Factors with Impact on Pressure Balance in Deep Wells

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Abstract

The factors with impact on the balance of pressures inside deep wells are: geological factors, modification of fluid density, influence of structural arrangement of strata and influence of pressure and fracturing gradients. At higher depths, generally over 4000 m, where there are also very high temperatures and pressures, the temperature diminishes the density of the drilling fluid while a higher pressure makes density be higher. Effects do not eliminate each other but one of them becomes prevailing.

Key words: *lithology, pressure, density, temperature, pressure and fracturing gradients*

Introduction

Temperature and pressure affect the density of the drilling fluid bot in the well and in the annular space. Anomalies may occur also depending on lithology or on the structural arrangement of geological strata: inclined strata, diapires, faulted or of other nature. In certain rocks that has more difficult to drill, low pressure fluctuations may lead to drilling accidents, lost circulations, gasification of the drilling fluid, or even total loss of control over the well. Loosing/locking circulation may cause also the drill string to be stuck, or cuttings afflux, key hole. Drill pipe being stuck originates in sticking of the string due to differences of pressure given by the specific weight of the mud and stratum pressure. If the former is higher no problems occur but if the latter is higher, then drill pipe sticking occur as well as instabilities in the walls of the borehole, crumbling falling over the drill string and sticking it.

On Colibaşi oilfield, the following occur as **drilling problems:** losses of drilling fluid in Surface Miocene, Dacian and Oligocene; instability of borehole walls in: Dacian, Pontian, Meotian and Oligocene; shrinkage of borehole in Pontian and Meotian; hold fast on borehole, corrections and possible borehole stuck in Pontian, Meotian and Oligocene; gasification of drilling fluid in surface rock formations that may be mitigated by maintaining density to minimum values and its increase only in need.

Contaminating agents for drilling fluid resulted from a survey of the lithological column reveal the presence of gypsum originated in Lower Miocene and possible prevailingly pelitic sequences that may by spreading charge the drilling fluid with solid materials.

Drilling fluid contaminating agents and difficulties in drilling the oilfield Caragele. There is a trend of losing drilling fluid in surface formations (approximately until 300m depth), in wells drilled on the oilfield as well as on adjoining oil fields that motivated fastening of the surface casing at higher depth than required by the values of fluid pressures in strata. Trends of gasification of the drilling fluid in crossing the possible potential of lenticular reservoirs of Pontian and Meotian. At crossing of lithostratigraphic sequence during drilling the phenomenon of drilling fluid contamination with foreign bodies can take place due either capacity of marl dispersion or sand fineness.

On Piscuri- Filipeşti Oilfield, sector Filipeşti there is also an anticlinal strongly tectonised by a system of longitudinal and cross faults punctured by digitations of salt diapires. Reservoirs have sheet-deposits, tectonically and stratigraphically screened. Other wells drilled and that supplied information has: 20MP (1985), 603 MP (years 80), 533MP and 535 MP (1937), 105 Filipeşti (2010).

Among the most frequent drilling difficulties there has: instability of borehole walls (in Dacian and Pontian) and coal contamination.

The contaminant for drilling fluid is caused by coal intercalations–specific agent, especially on interval 714 – 975m (Dacian) that can be counteracted by treating the drilling fluid with specific materials. It is likely that the prevailingly pelitic sequence may spread out in the fluid and ball it out with solid materials that could alter its properties which require permanent control of the contents of solids.

The Methods of expressing formation pressure has differentiated into two categories: evaluation of pressure in pores by immediate methods and evaluation of pressure in pores by retarding methods. Evaluation of pore pressure during drilling is done depending on: mechanical advance rate in drilling, d exponent and d_c exponent.

The Penetration rate may show the possibility of entering an area of transition towards a pressure anomaly formation. It is applicable whenever the drilling practice and the lithological nature stay approximately constant. Firstly the penetration rate shall be determined on advance intervals depending on drillability, as follows: 0.5-1 m for low drillability intervals, 2-3 m in average drillability formations (in high drillability formations – soft rocks – advance feed intervals 9-10m = feed piece length); the values of penetration rate has presented into rectangular coordinates depending on the average depth of the feed interval; tracing of the normal trend of changing the penetration rate value (proper to each bit) while considering the first 2-3 determinations; marking on diagram of the current next points and interpretation of results in each case – should the rate value be higher than normal, then the possible pressure anomaly is positive – if it is lower than normal, the possible pressure anomaly is negative.

The Exponent *d* shall be set out by using a nomogram (between Vm, N, Ds and Gs) or with relation:

$$d = \log (0.5464\ V_m/N) / \log [0.065\ G_s/(D_s\text{-}X)] \qquad (1)$$

where: D_s – diameter of rock bit, mm; V_m – penetration rate, m/h; G_s – thrust, tf; N – rotational speed, rot/min; X – void factor, except for diamond and insert tooth bits, in which X = 25.4 mm. Procedure is the following:

During drilling at 1.5-3 m (on common drillability) or at 9-10m = the feed piece (on higher drillability) penetration rate is determined (provided that the displacement practice should be volumetric, and differential pressure on borehole bottom should not exceed 70 kgf/cm^2), d is calculated with formula/ or the above nomogram, points has marked corresponding to values obtained for d at average rate of the feed interval $d(H)$; after representation of a sufficient number of points (initially 3-5) the line of natural trend is traced (in parallel to an imaginary straight crossing two points: M_1 (H = 0 m; d = 1.4) and M_2 (H = 1500 m; d = 1.7) and inscribes as average through several points M_i (H_i, d_i) placed in the area already identified to have normal pore pressure (line of normal trend, usually being one for the entire well, however there has cases that shifting of it is demanded at the same slope on changing of bit diameter, high variations of the drilling practice, etc.); the value of pore pressure shall be determined by the method of equivalent depth by applying the below formula:

$$p_p = \Gamma_l \cdot H_i - H_\ell (\Gamma_1 - \Gamma_h), \text{ kgf/cm}^2 \quad (2)$$

The Exponent d_c is a correction of exponent *d*, depending on mud specific weight γ_f ,kgf/dm^3 which drilling is conducted with. It is given by expression:

$$d_c = 1.07\ d\ /\ \gamma_f \quad (3)$$

Procedure is the same as for exponent *d*, except that values for d_c has used. The pore pressure shall be established by the equivalent depth method. The closest to reality is the relation:

$$p_p = H_l [\Gamma_1 - (\Gamma_1 - \Gamma_h)\ (d_{ci}/d_{cn})^{1.2}], \text{ kgf/cm}^2 \quad (4)$$

where d_{ci} is the current value of exponent d_c and d_{cn} is the value of exponent d_c on the line of natural trend, at the concerned depth, the nomogram could be used of the ratio d_{ci}/d_{cn} versus $(d_{ci}/d_{cn})^{1.2}$. Under normal circumstances, if drilling depth increases, then also the rotation resistant momentum will gradually increase. If the drilling practice is constant and the resistant momentum has high fluctuations, it is possible to cross an abnormal pressure area associated with a diminution of the pore pressure that could be remedied.

Also increases of frictions in drilling control (upwards or downwards depending on the kind of pressure) show a large area of transition towards abnormal pressure.

Evaluation of pore pressure by retarding methods is based on the parameters of drilling fluid and of marl in the cuttings. They have: change in the mud gas content, which could show anomaly in pressure and raise of fluid volume in tanks which shows positive anomaly.

The temperature gradient considers rock porosity, temperature of formations and geothermal gradient get changing in areas of transition of pressure anomalies under constant conditions of flow rate, and temperature of the fluid in well derivation can seize a change of the geothermal gradient and pressure anomaly.

Density of marl in the cuttings shall be measured and represented, the normal trend is traced for raise in marl density and pore pressure is expressed by the equivalent depth method.

Pressure and Fracturing Gradients

The Gradient of hydrostatic pressure, Γ_h is affected by concentration of salts, gas and solids in the fluid column and that is different depending on the temperature gradient. An average typical gradient of 0.10kgf/cm^2/m is used for clean and slightly mineralized water and 0.107410 kgf/cm^2/m for saturated salty water.

The Gradient of lithostatic pressure, Γ_l, is determined per each lithological interval in the stratigraphic column. It has values within 0.231-0.312 kgf/cm^2/m and considers: thickness of interval h_i, m; average porosity m_i decimal, specific gravity of pore fluid γ_{fi}, kgf/dm^3, specific gravity of the rock γ_{ri}, kgf/dm^3. The apparent specific gravity is calculated per each interval and Γ_l is determined with relations:

$$\gamma_{ri} = (1-m_i)\ \gamma_{ri} + m\ \gamma_{fi}, \text{ kgf/dm}^3 \quad (5)$$

$$\Gamma_{li} = 0.1\sum(\gamma_{ri}\ h_i)\ /H_i, \text{ kgf/dm}^3 \quad (6)$$

The Geothermal Gradient stands for the raise of temperature versus the temperature of the neutral layer for the depth unit. It is expressed into ºC/m, and has values within 0.015-0.038 and is determined with relation:

$$\Gamma_i = (t_i - t_0) / H_i \tag{7}$$

where t_i is the temperature of layers at H_i depth, and t_0 is the temperature of the neutral layer.

Pressure and fracturing gradients were evaluated upon the geophysical investigation survey, information obtained from running of drilling and production process in the above-mentioned wells depending on the lithological type and the depth at which the formations beforehand described has estimated to be encountered. Values of such have shown in the Sheet of complex featuring of the stratigraphic column and of substantiating the casing diagram and the drilling fluid programme.

The next figure shows the regional values of the geothermal gradient and temperature values that has subnormal.

Fig. 1. Regional values of the geothermal gradient

Maintaining of the well in safety is achieved by classic methods used and by control and maintenance of the mud parameters at certain values.
Density of drilling fluid is affected by temperature that develops due to frictions between fluid particles, fluid and rocks, fluid and drill string or casings and finally due to the geothermal scale. That is valid even if temperature may be deemed constant in certain depths because of the consistency of the geological formation or of the thickness of some layers such as Kliva or Tarcău sandstone, encountered on oil fields: Colibaşi, Caragele or Piscuri- Filipeşti.

Conclusions

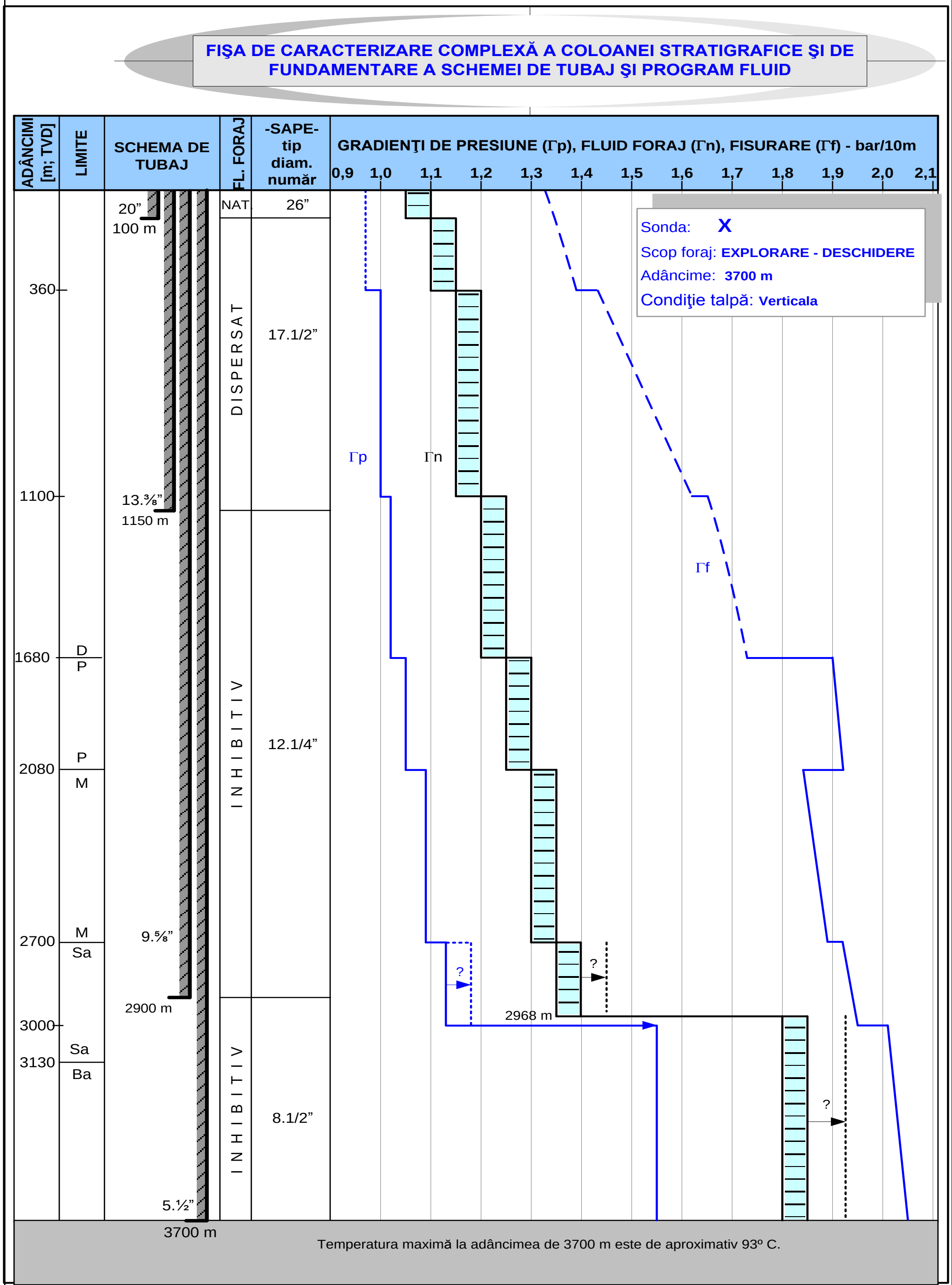
Site data about pressures and temperatures in static and dynamic conditions have been obtained also by means of the drilling cuttings brought on top by the drilling fluid, determinations in strainer assays, records of temperatures, pressures and of other parameters showing that temperature effect on pressure in annular space affects the possibility of accurately estimating density as well as other parameters.

The little possibilities of operation featuring many deep wells show considerable hazard. Within such difficult environment, small fluctuations of pressure may convert into very costly circulation losses, drill string getting stuck, and even up to the total loss of control over the well.

Table 1. Complex featuring of stratigraphic column

SHEET OF COMPLEX FEATURING OF STRATIGRAPHIC COLUMN AND SUBSTANTIATING THE CASING DIAGRAM AND FLUID PROGRAMME

DEPTH (m TVD)	LIM.	CASING DIAGRAM	DRILL.	DIAMOND BITS, NO.	PRESSURE GRADIENTS ( ); DRILLILNG FLUID ( ); FRACTURING ( ) - bar/10m	



Well X
Scope of Drilling: EXPLORATION OPENING
Depth: 3700 m
Bottom condition: vertical

SPREAD OUT

INHIBITIVE

INHIBITIVE

Maximum temperature at 3700 m depth is approximately 93^{0}C

Table 2. Comparative analysis per oil fields (I): Colibaşi oilfield

LITHOLOGY	Depth, m	Pressure Type	Drill. Fluid Type
Levantine+ Dacian sands, clay, sandy sandstones, coals	0- 700 thick.350-650	Normal P-res.=28-32at	-spread, water based
Romanian (L III+II), productive on southern flank at Moreni D has 6 blocks: Drăder (Dr), Moreni (Mo), Dinterm, Gross (Gr) and Group I (GrI). Dr has 25% of vol., Dr III is productive on both flanks, Dr II prod. on left flank (grey sands in N, sandy sands in S) Dr. Ochiuri the most imp. productive block Dr. din D (90% of resources+11% of reserves); divided into: DrIII, DrII, DrI. Gathering: quartz sand12-15int/5-6 intervals	thickness: 200 thickness: 70 thick:90 on N flank 60 on S flank thick: 2-4 S fl. thick1015 N fl.	Abnormal Γ_p=0.97-1.03 at/m Γ_{fis}=1.35-1.7 G_t=0.03°C/m	ρ=1.1-1.2 kg/ dm^3 filtrate 3-5mm fluid gasification in surface formations; restrictive rate in surface formations
Meotian: Ochiuri, G. Ocniţei. has four blocks: MIII, Mint, MII and MI. MIII, and MI psamitic facies, sandst., calcar. sand MIII- highest: vol. and reserves	thick:120 thick:10-45	Abnormal Abnormal	treated wt. CaCl, KCl ρ=1.2-1.4 kg/ dm^3
Pontian wt. lithofacies prevailingly marly. It is the protective formation.	800-1300 thick:500-600	Γ_p=1.07 at/m Γ_{fis}=1.85-1.95	Incr. density ρ= 1.21-1.4 Filtr. low
Miocene = productive block of Burdigalian, composed of carbonaceous sandst., siliceous sandst.: Mi productive= layer ends; except: Ochiuri field	1300-2000 thick:10-30;V thick:50-60	Γ_p=1.4-1.35 at/m Γ_{fis}=1.78-1.9	Not tr.in Up. Mioc., tr. wt. KCl. (Low Mioc.) Lost fl. in Surf. Miocene.
Oligocene productive, on Colibaşi field, wt. 8 horizons: - marly-calcareous brown, bitumen - upper disodile (disodilic shales wt. sand interc.) - Pucioasa stratum wt. Fusaru sandstone - Vinetişu: siltitic marls, calcareous sandstones. - lower disodils: disodilic shales and fragm.fish scales - lower Kliwa sandst: altern.: sandst. wt. disod. shales - Podu Morii:intercal. of brown clays-marls - upper Kliwa sandst:, 3 level: low, med, upp, altern. Kliwa sandstone, disodil., to whitish sands	2000-2800 thick1300-1500 thick: 30-40 thick: 40-50 gros550-1100 thick:175-200 thick: 100 thick:120 thick: 700	Normal Γ_p=1.2-1.3 at/m Γ_{fis}=1.9-2.05 Abnormal	KCl based drill. fluid Glydrill ρ= 1.15-1.34 Filtrate 2-3mm
Neogene. Miocene wt. Aquitanian-Burdigalian strata	thick: 370		
Cornu strata, Aquitanian Burdigalian wt. 3 levels of low sandst. wt. Operculine, wt. Pectene	thick:25-30		ρ= 1.2-1.37
Lower saliferous form. wt.: breccia, quartzite mica-shales, grey-calcar. sandst., limestones			
Formation Brebu, wt. two horizons: one wt. conglomerate and other sandy-micro-conglom.	thick:450-550		
Form.Vărgata, wt. four horizons: - brown sandy-coarse wt. evap., salt breccia - brown sandy-marly, calcar.sandst., marly anhydrite - grey, sandy-marly: calcar.sandst., marls, sand., gypsum - shaly: marls sand. grey-greenish, calcar. shales	thick:750-800 thick: 1000 thick: 950 thick: 1050 thick: 300	 Normal	KCl based drill. fluid Glydrill
Badenian- contin. of Low Mi: wt. four horizons: - marls- tuffs wt. globigerina, orbulina saturalis - upper saliferous formations wt. spiroplectamines	thick: 10-15 thick: 1-600	Γ_p=1.7-1.73 at/m Γ_{fis}=2.05	
- shales wt. radiolars wt. spiroplectamines - marls wt. Spiratela Bullimina and Bolivina, tuff d	thick: 70 thick: 200		Filtrate 2-3mm

Sarmatian is pre-Meotian; has five associations:			
-Upp.Bessarabian wt. associations wt. Bolivinae -Low.Bessarabian wt. associations wt. Paramysis -Upp.Volhinian -Low.Volhinian wt. associations of Miliolidae -Buglovian, wt. asoc. Anomalino of Badenensis			Some wells of Colibaşi field used a CaCl based 2nd fluid.
Buglovian is prevailing. pelitic wt.: grey marls and sandy sandstones	thick: 50	Normal	
-Volhinian basic: sandy sandstones, marls -Low. Bessarabian is the 1st floor of Sarmatian wt.: intercalations of sands and marls	thick:100-150 thick:200-250		
-Upp. Bessarabian wt. yell.-sandy and calcar.sands.	thick: 50-400		ρ= 1.3-1.37
Pliocene. Me is contin. and discont., wt.: sands and sandst. altern. wt. marls. Upp. and low. E.; after sandy blocks of MI, MIII Lower Me is dominated by sands altern. salm. waters, on sedim. M.int, MIII and Upper Me wt. grey-yell. sands altern. Wt. oolitic marls	thick:150-250	Γ_p=1.2-1.3 at/m Γ_{fis}=1.9-2.05	Filtrate low: 2-3mm
Pontian has three blocks: marly-clayish, sandy-marly, marls grey; sands wt. hydrocarb. at Măgurele (written P and P1)	thick: 50-500		
Dacian has two horizons: a lower one (slightly salm.) and another upper wt. freshwater.	thick:400-500	Abnormal	
Romanian closes the stratigraphic sequence wt. marls, strata of lignite (bottom) and sands-gravel	thick: 1000		ρ= 1.35-1.4
Quaternary wt. sediments across the entire region by alluvia and proluvia wt.: gravels, sands, sandstones trovants wt. intercal. of clays, marls wt. lignite layers.	thick: 1000		Filtrate wt. Low values: 1- 1.5mm

Table 3. Comparative analysis per oil fields (II)**:** Piscuri-Filipeşti oilfield

LITHOLOGY	Depth, m	Pressure Type	Drill. Fluid Type
Levantine (L): coarse deposits, gravels, sandst. and coarse sands and taimen fauna. Dacian (D) wt. depos.in arinitic facies, marls, sands, clay, sandy sands., coals (Dr.)	0- 1700 thick.350-650 coals, interv. 714- 975	Normal Normal	Natural, water based
Romanian (L III+II), productive on S flank at Moreni D has six blocks: Drăder (Dr), Moreni (Mo), Dinterm, Gross (Gr) and Grup I (GrI). Dr has 25% of vol., DrIII is productive on both flanks, DrII is productive on left flank (grey sands in N and sandy sands in S) Dr. Ochiuri is the most import. Productive block. Dr. of D (90% of resources) divided into: DrIII, DrII,DrI. Gathering: quartz sand12-15 intervals /5-6 intervals	thickness: 200 thickness: 70 thick:90 on fl. N 60 on flank S thick:2-4 fl.S gros1015fl.N	Abnormal Γ_p=0.97-1.03 at/m Γ_{fis}=1.33- 1.75 Γ_t =3°C/m	ρ=1.25 kg/dm^3 filtrate 3-5mm spread fluid, gasification of fluid in surface formations contaminated wt. coals: Drăder (Filipeşti)
Pontian wt. lihtofacies prevailingly marly wt. marls, low sandy marls, finely micaceous. It is a form. protect. accum. of hydrocarb. in Meotian	1022-1722 thick:500-600	Abnormal Abnormal	treated wt. CaCl, KCl ρ=1.21-1.25kg/dm^3
Meotian has predominant sabulous facies wt. grey-yell. sands, marls and oolitic sandst.. It has 1-3 cockle shells between marls and sands	1722-1912 thick:500-600	Γp=1.05-1.07 at/m Γfis=1,9-2	Increased density ρ= 1.21-1.25 filtrate low
Miocene = productive block of Burdigalian, composed of carbonaceous sandst., siliceous sandst.: Mi productive= layer ends; except: Ochiuri field	 thick:10-30;V thick:50-60	Γ_p=1.4-1.35 at/m Γ_{fis}=1.78-1.9 Γ_t =3.8°C/m	Not tr. in Upp. Mi, KCl tr.(Low Mi.) Fluid loss - Surf.Mi.

Helvetian encountered in the final part of well and is devel.into marly facies. Sect. Piscuri-Filipeşti anticl. strongly tectonised by longit. and cross faults, punct. by salt diapires, subordon. clays - Podu Morii field: alternation brown clays-marls -upper Kliwa sandstone, three levels: lower, med, upp, alternat.sandst.Kliwa disodil, disodil., to white sand	1912-1915 thickness:1300 -1500 thick:175-200 thick: 100	Normal Γ_p=1.2-1.3 at/m Γ_{fis}=1.9-2.05 Abnormal	ρ= 1.30-1.32 KCl based drill.fl. Glydrill ρ= 1.32-1.34 Filtrate 2-3mm
Neogene. Miocene wt. Aquitanian-Burdigalian strata.			
Strata of Cornu, Aquitanian Burdigalian wt. 3 levels of sandstones: lower wt. Operculine, wt. Pectene	thick:25-30		ρ= 1.32-1.37
Lower salilferous formation wt.: breccia, quartzites, mica-shales, grey calcareous sandstones., limestones			
Formation Brebu, wt. two horizons: one wt. conglom. and another sandy-microconglom.	thick:450-550		
Formation Vărgată, wt. four horizons: -brown sandy-coarse wt. evaporite, salt breccia -brown sandy-marly, sandstones calc, marls, anhydrite -grey, sandy-marly: calcar. Sandst., marls, sand, gyps. -shaly: marls sand.grey-greenish, calcar. shales.	thick:750-800 thick: 1000 thick: 950 thick: 1050 thick: 300	Normal	KCl based drill. fl. Glydrill
Badenian- contin. of Low. Mi: wt. four horizons: -marls- tuffs wt. globigerina, orbulina saturalis -upper saliferous formations wt. spiroplectamine	 thick: 10-15 thick: 1-600	Γ_p=1.7-1.73 at/m Γ_{fis}=2.05	
-shales wt. radiolars wt. spiroplectamine -marls wt. Spiratela Bullimina and Bolivina, tuff d	thick: 70 thick: 200		Filtrate 2-3mm
Sarmatian is pre-Meotian; has five associations:		Γ_t = 4°C/m	ρ=1.36-1.45
-Upper Bessarabian wt. associations wt. Bolivinae -Lower Bessarabian wt. associations wt. Paramysis -Upper Volhinian - Lower Volhinian wt. associations of Miliolidae -Buglovian, wt. asoc. of Anomalino Badenensis			Gasification during drilling and in circ. drill. fluid ρ=1.98-2.10
Buglovianis prevailingly pelitic wt.: marls grey and sandy sandstones	thick: 50	Normal	
-Basic Volhinian: sandy sandstones, marls -Lower Bessarabian is the first floor of Sarmatian wt.: intercal, of sands and marls	thick:100-150 thick:200-250		
- Upper Bessarabian wt. yellowish-sandy and calcareous sands.	thick: 50-400		ρ= 1.95-1.97
Pliocene. Me contin. and discount., wt.: sands and sandst. altern. wt. marls. It is upp. and low.upon sandy blocks MI, MIII. Lower Me dominated by sands altern. wt. salm. waters, in sedim. M.int, MIII and upper Me wt. grey-yellowish sands altern. wt. oolitic marls	thick:150-250	Γ_p=1.1-1.15 Γ_p. current= 0.6-0.5 Γ_{fis}=1.9-2.05 Γ_{fis}. current= 1.75-1.80	Filtrate low: 2-3mm Pelitic mat. may spread in drill. fluid
Pontian has 3 blocks: marly-clayish, sandy-marly, marls grey; sands wt. hydroc. at Măgurele (P; P1)	thick: 50-500	Γ_t = 4°C/m	Instab. of drill. fluid by density increase
Dacian has two horiz.: low.(slightly salm.) and upp. wt. freshwater.	thick:400-500	Abnormal	
Romanian closes the stratigr. sequence wt. marls, strata of lignite (bottom) and sands and gravel.	thick: 1000		ρ= 1.98-2.10
Quaternary wt. sediments across entire region by alluvia and proluvia wt.: gravel, sands, sandstones, trovants wt. intercal. of clays, marls wt. lignite strata.	thick: 1000		Filtrate wt. low values: 1- 1.5mm

Table 4. Comparative analysis per oil fields (III): Caragele oilfield

LITHOLOGY	Depth, m	Pressure Type	Drill. Fluid Type
Dacian (D) wt. deposits in politic facies, marls, sands, clay, sandy sandstones, coals	0- 1700 thick.350-650	Normal	Natural, water based
Romanian (L III+II), productive on S flank, at Moreni. D has six blocks: Drăder (Dr), Moreni (Mo), Dinterm, Gross (Gr) and Grup I(GrI). Dr has 25% din vol., Dr III e productive on both flanks.,DrII prod.on left flank (grey sands in N and sandy sands in S) Dr. Ochiuri is the most import. productive block Dr. of D (90% of resources+11% of reserves); divided into: DrIII, DrII, DrI. Gathering: quartz sand12-15int/ 5-6 intervals	thickness: 200 thickness: 70 thick:90 pe fl.N 60 on flank S thick:2-4 fl.S gros1015fl.N	Abnormal Γ_p=0.97-1.03 at/m Γ_{fis}=1.33- 1.75 Γ_t =3°C/m	ρ=1.25 kg/ dm^3 filtrate 3-5 mm, fluid spreading, gasification of fluid in surface formations; contamin. wt. coals: Drăder (Caragele)
Pontian wt. lithofacies prevailingly pelitic wt. marls slightly sandy marls, finely micaceous; and two psam. blocks wt. altern. of sands, marly sands, marls	1670-2020 thick:500-600	Abnormal Abnormal	treated wt. CaCl, KCl ρ=1.21-1.25kg/dm^3
Meotian has prevail. sabulous facies wt.fin.micaceous sand and/or calcareous sandstones. Subord. pel. interc. : marls, marly fine/very fine micaceous sands	2020-2500 thick:500-600	Γ_p=1.05-1.07 at/m Γ_{fis}=1,9-2	Increased density ρ= 1.21-1.25 filtrate low
Miocene = product. block of Burdigalian, composed of carbonaceous sandst., silic. sandst.: Mioc. prod.= layer ends; except: Ochiuri field	1300-2000 thick:10-30;V thick:50-60	Γ_p=1.4-1.35 at/m Γ_{fis}=1.78-1.9 Γ_t =3.8°C/m	Not tr. in Upp.Mi. KCl tr. (Low.Mi.) Fluid loss Upp.Mi.
Oligocene prod. on Colibaşi field, wt. 8 horizons -marly-calcareous brown, bitumen -upper disodile (shales disodil.wt. intercal. sand.) - Pucioasa strata wt. Fusaru sanstone -Vinetişu: siltitic marls, calcareous sandstones. -low.disodile: shales disodil. and fragmen.fish scales -low.of Kliwa sandst.: altern. sandst. wt. disodil.shale - Podu Morii field: alternat. of brown clays -marls -upp.of Kliwa sandst.on three levels: low, med.,upp., altern. Kliwa sandst.wt. disodile to whitish sands	2000-2800 thick.1300150 0 thick: 30-40 thick: 40-50 gros550-1100 thick:175-200 thick: 100 thick:120 thick: 700	Normal Γ_p=1.2-1.3 at/m Γ_{fis}=1.9-2.05 Abnormal	ρ= 1.30-1.32 KCl-based drilling fluid Glydrill ρ= 1.32-1.34 Filtrate 2-3mm
Neogene. Miocene wt. strata Aquitanian-Burdigalian.	thick: 370		
Strata of Cornu, Aquitanian Burdigalian wt. three levels of sandstones: lower wt. Operculine, wt. pecten	thick:25-30		ρ= 1.32-1.37
Lower salif. form. wt.: breccia, quartzite, mica-shales, grey-calcar.sandstones, limestones			
Form. Brebu, wt. two horizons: one wt. conglom. and another sandy-microconglomerates	thick:450-550		
Form.Vărgată, wt. four horizons: -brown sandy-coarse wt. evaporite, salt breccia -brown sandy-marly, calcar.sandstones, marls anhydr. -grey, sandy-marly: calcareous sandstones, marls, sand. -shaly: marls grey-greenish sand, calcar.shales	thick:750-800 thick: 1000 thick: 950 thick: 1050 thick: 300	 Normal	Drill. fluid based onKCl Glydrill
Badenian-contin. of Low. Miocene wt. four horizons: -marls- tuffs wt. globigerina, orbulina saturalis -upper saliferous formations wt. spiroplectamine	 thick: 10-15 thick: 1-600	Γ_p=1.7-1.73 at/m Γ_{fis}=2.05	

-shales wt. radiolars wt. spiroplectamine -marls wt. Spiratela Bullimina and Bolivina, tuff	thick: 70 thick: 200		Filtrate 2-3mm
Sarmatian is pre-meotian; has five associations:		Γ_t = 4°C/m	ρ=1.36-1.45
-Upp.Bessarabian wt. associations wt. Bolivinae -Low.Bessarabian wt. associations wt. Paramysis -Upper Volhinian -Low. Volhinian wt. associations of Miliolidae -Buglovian, wt. asoc. Anomalino de Badenensis			Gasification during drilling and in circ. drill. fluid ρ=1.98-2.10
Buglovian is prevailingly pelitic wt.: grey marls and sandy sandstones	thick: 50	Normal	
-Volhinian basic: sandy sandstones, marls -Low. Bessarabian is the first floor of Sarmatian wt.: intercal. of sands and marls	thick:100-150 thick:200-250		
-Upp.Bessarabian superior: yellowish-sandy and calcareous sand.	thick: 50-400		ρ= 1.95-1.97
Pliocene. Me contin. and discont., wt.: sands and sandst. altern. wt. marls. Upp. and low.; upon sandy blocks MI, MIII. Low.Meotian domin. by sands altern. wt. salm. waters in sedim. M.int, MIII and Upp. Meotian wt. grey-yell. sands altern. wt. oolitic marls	thick:150-250	Γ_p=1.1-1.15 Γ_p. current= 0.6-0.5 Γ_{fis}=1.9-2.05 Γ_{fis}. current= 1.75-1.80	Filtrate low: 2-3mm
Pontian has three blocks: marly-clayish, sandy-marly, marls grey; sands wt. hydrocarb.at Măgurele (written P and P1)	thick: 50-500	Γ_t = 4°C/m	Instab. of drill.fluid by density increase
Dacian has two horizons: low. (slightly salmastre) and upper, wt. freshwater.	thick:400-500	Abnormal	
Romanian closes stratigr. sequence wt. marls, strata of lignite (bottom), sand., gravel. (top).	thick: 1000		ρ= 1.98-2.10
Quaternary wt. sediments across entire region by alluvia and proluvia wt.: gravels, sand. sandstones, trovants wt. interc.de clays, marls wt. lignite.	thick: 1000		Filtrate wt. low values: 1- 1.5mm

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O trecere în revistă a factorilor geologici care influenţează echilibrul presiunilor în sondele adânci

Rezumat

In general, problemele mai importante care au fost tratate in acest articol sunt: principalii parametri si metodele de exprimare a presiunii de formaţie; caracterizarea complexă a unei coloane stratigrafice; analiza comparativă pe cele trei structuri: Colibaşi, Caragele și Piscuri-Filipeşti; principalele pericole și accidente de foraj ce pot să apară la sondă.