Proceedings of the
International Conference on Mechanical Engineering and Renewable Energy 2011
(ICMERE2011) 22- 24 December 2011, Chittagong, Bangladesh

ICMERE 2011-PI-067

GAS ZONES DETECTION AND IDENTIFICATION OF GAS WATER CONTACT OF NARSINGDI GAS FIELD USING SFT TOOL AND RESISTIVITY WITH GAMMA RAY LOG

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Abstract: *The Narsingdi gas field is located in Narsingdi (NR) district which lies in north-eastern part of Bangladesh. It is bounded by longitude: 90^{0}97″54.052′ E & latitude: 24^{0}90″30.152′ N, and covered by Meghna river flood plain. This research shows the gas zones detection and identification of Gas Water Contact (GWC) of Narsingdi gas field using Sequential Formation Tester (SFT) tool and Resistivity with Gamma Ray Log. Resistivity log shows the higher resistivity value and Gamma Ray log indicates lower responses in sandstone or hydrocarbon (gas) bearing zones. From the research, three gas zones are present in NR#2 which encountered upper gas sand, new gas sands and lower gas sand in the depth interval of 2902.5-2910.5 m (ss), 2978-2983.5 m (ss) & 2989-2999 m (ss), and 3153-3172 m (ss), respectively. Some additional gas sands also identified in the wireline log but these are too thin and not considered commercial. SFT tool shows slightly lower pressure response (pressure gradient) in the gas zones than the water zone in the formation depth. From SFT tool the pressure gradient ranges 0.05-0.08 psi/ft which conformed as gas bearing zones, and 0.442-0.457 psi/ft at 3023-3025 m (measure depth) which indicates water sand zone and GWC in NR#2. These are also confirmed by Resistivity and Gamma Ray log responses. This GWC (fluid contact) depth (2999 m, ss) is more reliable to calculate the reservoir area using seismic depth structure map and others for estimating volumetric reserve, reservoir modeling and well test analysis.*

Keywords: Narsingdi Gas Field, SFT, Resistivity Log, Gamma Ray Log, Gas Zones and GWC.

1. INTRODUCTION

Bangladesh is a young deltaic sedimentary basin and meets the geologic requirements for generation and accumulation of natural gas in the subsurface. The country has a proved natural gas rich province in the eastern part. The Narsingdi Gas Field (NGF) is one of them which located about 25 km north of Meghna gas field and about 50 km north of Bakhrabad gas field. It has been discovered by Petrobangla in 1990 by the well. The gas field is covered by Meghna river flood plain and bounded by longitude: 90^{0}97″54.052′E & latitude: 24^{0}90″30.152′N [1]. Hydrocarbon bearing zones detection and fluid contact identification is the crucial task to get the reservoir thickness and area (i.e. reservoir volume) for estimating Gas Initially In Place (GIIP) in Petroleum field. A well log is a continuous record or measurement of the geophysical characteristics of formations during the drilling or production phase of a well [2]. Wireline log is gives the significant sub-surface data which is mostly used to detect the hydrocarbon bearing formation, Petrophysical analysis, Formation evaluation, reservoir characterization and so on.

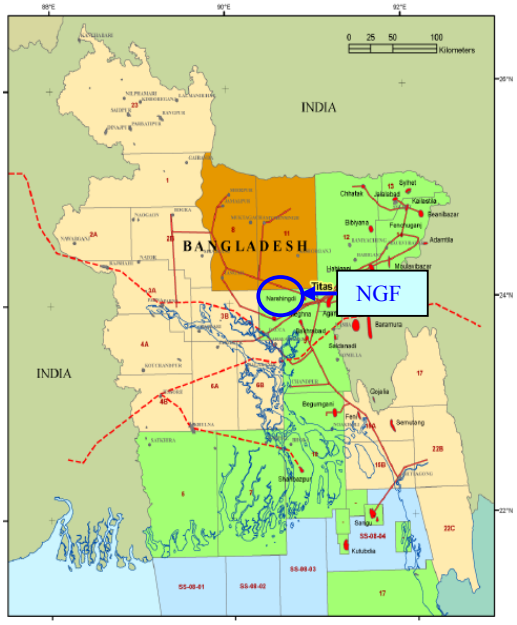

Fig.1: Location map of NGF (RDMD, Petrobangla)

There are two wells have been drilled till now of NGF named NR#1 and NR# 2. NR#1 was drilled to a total depth of 3450 meter in 1990 and production through this well commenced on 25th July 1996 for lower gas sand. NR#2 was drilled in the crest following new depth contour map (Figure-2) in October 2006 and started production on 18th February 2007. This well was drilled successfully to a depth of 3285m [8&9]. Interkomp Kanata Management (IKM, 1991) [10] studied about Geological, Geophysical and Petrophysical Analysis of the Narsingdi (Belabo) Gas Field well (NR#1) based on seismic data, well data and log data. This study was unable to identifying the GWC of this field. Thus the present research will show the hydrocarbon bearing (gas) zones detection and GWC identification of Narsingdi gas field (NR#2) using Sequential Formation Tester (SFT) tool and Resistivity with Gamma Ray log.

2. STRUCTURAL SETTING OF NARSINGDI GAS FIELD

It is the northernmost culmination or closure along the Bakhrabad lineament. It is structurally the lowest among the three culminations (Bakhrabad-Meghna-Narsingdi) and represents only mild compression. The tectonic dips of the flanks are barely 1^0 compared to 6^0 in Meghna and 15^0 in Bakhrabad structures. The axis of Narsingdi structure is offset from Meghna structure by 20^0. It is separated from the later by a transverse fault. The very gentle of the structure is likely to have secondary role in pooling or trapping the gas. The gas pooling in this field is more importantly controlled by stratigraphy, i.e. facies changes from sand against shale. In this respect NGF is a structure-stratigraphic combination trap rather than purely structural trap. The pooling of gas is less effective in Narshingdi gas field compared to Meghna and Bakhrabad gas fields. The reservoirs of the gas field are sandstone belonging to the Surma group stratigraphic unit [1]. The depth structural contour map has been shown in Figure 2.

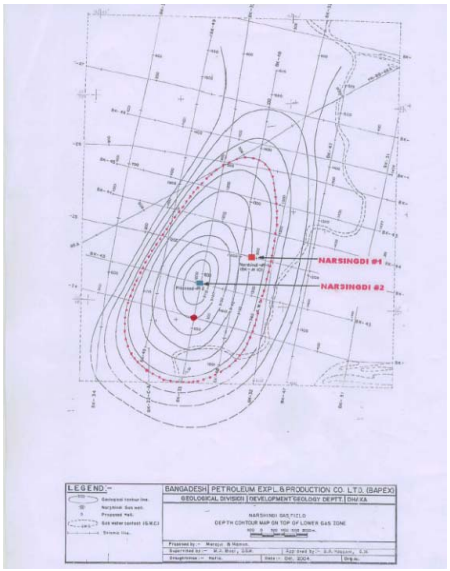

Fig. 2: Structural contour map of NGF (BAPEX, 2009)

3. MATERIALS AND METHODS

The gamma ray log is a measurement of the total gamma ray intensity in the wellbore. Gamma radiation within the wellbore reflects the activity of the different formations that surround the well. This log can be used to identify different formations and to determine their depth and thickness. It distinguishes between potential hydrocarbon-bearing formations (sands, carbonates) and shale. It is the complementary log of resistivity and porosity logs [3, 4 & 6]. Resistivity logging is a method of well logging that works by characterizing the rock or sediment in a borehole by measuring its electrical resistivity. Resistivity is a fundamental material property which represents how strongly a material opposes the flow of electric current [11]. Resistivity logs are electric logs which are used to detect the presence of hydrocarbon and water in rocks. When the rock is fully saturated with water, the resistivity is R_0. On the other hand, the resistivity of the rock partially saturated with hydrocarbons which is denoted by R_t. The presence of hydrocarbon can be detected electrically when the true resistivity, R_t is greater than the R_0 [3, 4, 5 & 6]. SFT tool is generally used for determine reservoir pressure, identify gas and oil reservoir boundaries, monitor reservoir intercommunication, indicate areas of pressure depletion, estimate formation permeability, determine chemical concentrations and reservoir fluid properties, etc [12]. Hydrocarbon bearing formations can be confirmed by SFT tool which gives the pressure response with respect to formation depth. The pressure gradient of hydrocarbon zone is lower than the water sand zone in the Formation. The SFT-IV test tool (Figure-3) is used for gathering the quality formation data required to evaluate reservoir potential and plan well completions and is part of our comprehensive line of Wireline formation testing services. This service includes a full suite of open hole test tools designed to allow the best possible test in any formation under any condition [13].

Fig. 3: Sequential Formation Tester tool [13]

The present research, hydrocarbon (gas) zones detection & gas water contact have been identified by mainly SFT

tool and Gamma ray log with resistivity logs. The available log data are Caliper Log, Gamma Ray (GR) with Resistivity and porosity logs of Narsingdi well#2. The summarized methodology of this study is shown in flow chart-1.

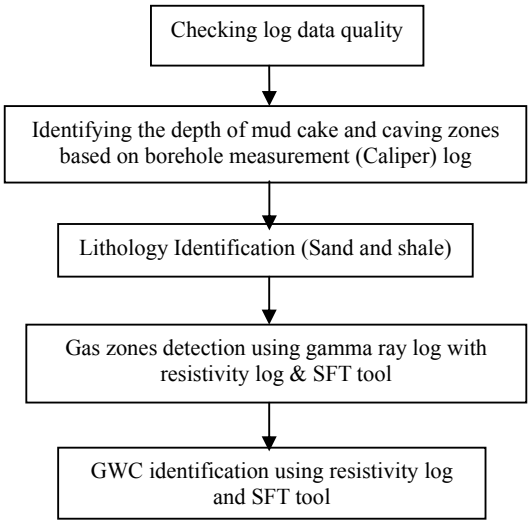

Fig. 4: Flow chart-1 for hydrocarbon (gas) zone detection

4. RESULTS OF DATA ANYLYSIS AND DISCUSSIONS

The quality of log data of NR#2 is good. In this well, Caliper log shows borehole caving and washout is presence within the shale zones but absence in sand zones. Mud-cake is present which indicates permeable sand zone. The value of GR response is ranges from 85-98 API in sand zone and above 100 API in Shale zone of this field (Figure-5). The true resistivity, R_t (above 9 ohm-m) is higher of hydrocarbon bearing sand zones than the shale zone for virgin/un-invated formation. Cross-over also present between Spectral density log and Dual spaced Neutron log which indicates the hydrocarbon bearing sand. According to the log data analysis, there are three commercial accumulations of gas sands have been detected which are different

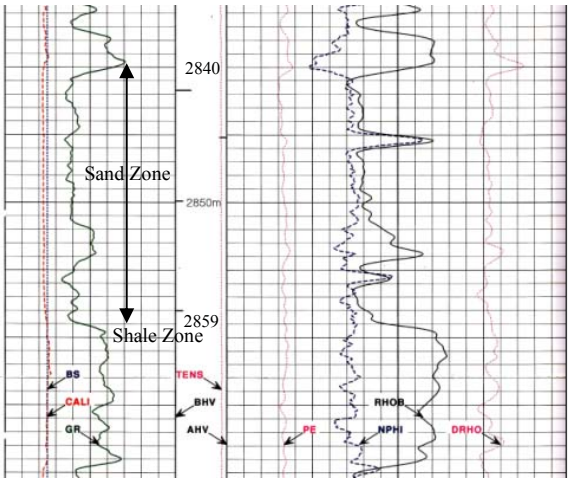

Fig. 5: Porosity log with GR log of NR#2, BGFCL

depositional environment named as upper gas sand, new gas sands (1 & 2) and lower gas sand there are several sand zones present. Some thin gas bearing sands also present by log interpretation in this field which are not commercial. The depth intervals of aforementioned potential sand zones have been shown in Table-1. All dept intervals of sand zones are converted from measure depth (MD) to MSL (Mean Sea Level) or SS (Sub Sea).

Table-1: Depth interval of hydrocarbon bearing sands

Depth interval, meter (ss)	Thickness, meter	Sand name & Status
2902.5-2910.5	8.0	Upper gas sand
2978.0-2983.5	5.5	New gas sand-1
2989.0-2999.0	10	New gas sand-2
3153.0-3172.0	19	Lower gas sand (Producing)

From log data analysis, the lower gas sand of NR#2 has been increased by 5m from NR#1. The sand thickness varies from well to well which has been shown in Figure-6. Two commercial accumulations of gas sands have been discovered which are of different depositional environment of NR#1. The drilled section penetrated these two main gas sands and other four thin gas bearing sands of minor interest. The Two major sands are 9.5m and 14m thick. Thickness of minor sands ranges from 0.6m to over 7m of NR#1 [7&8]. But in NR#2, the gross thickness of new gas sands is 15.5 m which can't found from NR#1.

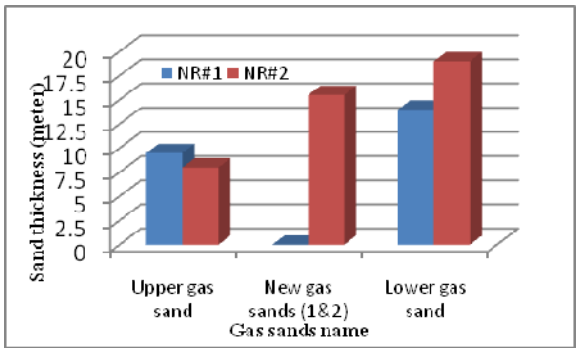

Fig. 6: Sand thickness variations of Narsingdi gas field

On the other hand, SFT tool shows slightly increases of pressure response (pressure gradient) with respect to formation depth. From SFT tool, the pressure gradient ranges 0.05-0.08 psi/ft which conformed as gas bearing zones and 0.457 psi/ft at 3023 m (measure depth) in Figure-7 but pressure gradient increases from 3023 m to above 3025 m which indicates water sand zone of NR#2. These are also confirmed by Resistivity and Gamma Ray log responses. The GWC depth is 2999 m (ss) or 3023 m for new gas sand of NR#2. The accuracy of formation pressure response is depends on proper installation, speed and proper fool out of SFT tool. The density of hydrocarbon as oil and gas are less than water. Theoretically, the pressure gradient is assumed for water, oil and gas are 0.45, o.35 and 0.08 psi/ft, respectively [7].

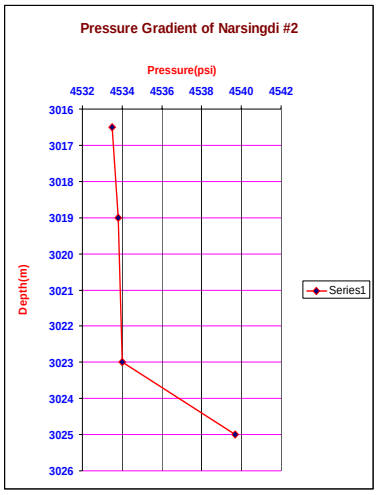

Fig. 7: Depth versus Pressure of new gas sand-2

5. CONCLUSIONS

The Narsingdi gas field area is covered by Meghna river flood plain and the reservoirs of this field are sandstone belonging to the Surma group stratigrapic unit. At the time of drilling, an exploration well and discovering a new reservoir, the main aims are to determine the position of the fluid contacts and hydrocarbon bearing sands detection. There are three gas sands have been detected which named as the upper sand, new sands and lower sand within the depth range of about 2902 to 3172 m (ss) of NR#2. The gross gas sand thickness of the two gas zones is about 42.5 m. Also some additional gas sands identified in the Wireline log but these are too thin and not considered as commercial. SFT was conducted in the interval of 2989-2999 m (ss) which showed gas bearing but Gas Water Contact (fluid contact) has been found at 2999 m (ss) of NR#2 using SFT tool and Resistivity log. This depth of GWC will be more helpful to determining the reservoir area as well as reservoir volume for reservoir analysis of this field. Production is continuing only from lower gas sand and there is no production from upper gas sand yet. After depletion of lower gas sand by production, this well can be completed from new gas sands and upper gas sand, respectively.

6. REFERENCES

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[13] http://www.hlsasia.com/sys19.html (Date of access 27/07/2011)

7. NOMENCLATURE

Symbol	Meaning	Unit
API	American Petroleum Institute	-
BAPEX	Bangladesh Exploration and Production Company Limited	-
BGFCL	Bangladesh Gas Field Company Limited	-
ft	Feet	-
GWC	Gas Water Contact	-
GR	Gamma Ray	-
IKM	Interkomp Kanata Management	-
MD	Measure Depth	-
m	Meter	-
NPHI	Neutron porosity	Percentage
NR	Narsingdi	-
NGR	Narsingdi Gas Field	
NR#	Well no. of Narsingdi gas field	-
psi	Pound force per square inch	-
RHOB	Bulk density	gm/cc
R_t	True resistivity	ohm-m
SFT	Sequential Formation Tester	-
SS	Sub Sea (ss)	-