ISSN 1028-6845

BGJ BANGLADESH GEOSCIENCE JOURNAL VOL. 24, P. 57-71, 2018

Seismic Velocity and Geological Correlation in the Rashidpur Structure, Surma Basin, Bangladesh

MD. MOINUL ISLAM[1,2], MD. HASAN IMAM[2*] & DELWAR HOSSAIN[2]

Abstract

The study emphasizes on a systematic analysis of the velocity distribution done by applying Dix formula on reported stacking velocities of the Rashidpur Structure, Surma Basin, Bangladesh. Small but systematic interval velocity variations are found which seem to be related to lithology, density, porosity, depth of burial, pressure, interstitial fluid, compaction and tectonic activity of the region. Apparently, there is no sharp velocity contrast at the formation boundaries in any of the studied wells in this structure. Lower velocity relative to the average formation velocity by as much as 3-7% indicates gas bearing zones in the Boka Bil and Bhuban formations in three wells. Depth to the overpressure zone in Rashidpur-4 well is 3680m, but the velocity data analysis reveals that the change in velocity is gradual.

Keywords: Velocity data, lithology, depth of burial, Rashidpur Structure, Surma Basin.

Introduction

Knowledge of velocity is essential in determining lithology, depth, dip and location of seismic reflectors. Based on interpreted geophysical data, the Bengal Basin in Bangladesh is divided into three different regions; the western shelf area, the central foredeep and the eastern folded belt. The Bengal foredeep area is also divided into several sub-basins. The Surma Basin is the northern most sub-basin of the Bengal foredeep, occasionally described as Sylhet trough (ALAM 1972, HOSSAIN *et al*. 2019). While lithology is the most obvious factor affecting velocity, the ranges of velocity of different types of rock overlap so much that it does not provide a good basis for distinction by itself (SHERIFF & GELDART 1995). Porosity appears to be the most important single factor and the dependence on the depth of burial and pressure relationship makes velocity sensitive to these factors also. Density variations play a significant role in velocity variations and high densities usually correspond to high velocity (SHERIFF & GELDART 1995). Velocity appears also to vary slightly with temperature, decreasing 5-6%/100°C (MEISSNER 1986). Porosity generally decreases with increasing depth of burial and hence velocity increases with depth. GASSMAN (1951) found from theoretical consideration the formula V=CZ1/6 (where, V is

Author's Address: MD. MOINUL ISLAM[1,2], MD. HASAN IMAM[2*] & DELWAR HOSSAIN[2], [1]Sylhet Gas Fields Limited (A Company of Petrobangla), Panichara Chiknagul, Sylhet-3152, Bangladesh, [2]Department of Geological Sciences, Jahangirnagar University, Dhaka 1342, Bangladesh. *E-mail: himam@juniv.edu*

Seismic P wave velocity, Z is depth and c is empirical value) and this relationship is partly confirmed by laboratory experiments and observation (SHERIFF & GELDART 1983).

In some cases, trapped formation liquid creates abnormal or overpressure situation, resulting in less effective stress than normal in such cases. On the other hand, areas subjected to recent structural uplift may show higher velocity than normal, because of irreversible effect of porosity. The most direct method of determining velocity requires the use of a deep borehole. Seismic refraction and reflection estimations are much quicker and less expensive to do but do not have a high accuracy as deep wells. A combination of one or more wells and a grid of seismic lines is normally a good basis for mapping the velocity variation in a region.

The north-south trending Rashidpur structure in the Surma Basin is (at the surface) a narrow anticline about 40.25 km long and 4.83 km broad (PAVRE 1961). It lies between latitudes 24°08′ N to 24°32′ N and longitudes 91°29′ E to 91°44′ E (Fig. 1). Contour of Upper Boka Bil Sand also shown in this figure. An integrated interpretation of the seismic and other geophysical data considering the available geologic information in terms of hydrocarbon potential of this structure is available in KABIR and HOSSAIN (2009). The Rashidpur anticlinal structure shows only a few interfaces that may generate significant reflections (medium category reflectors) down to the depth of 4 km, while the rest correspond to the category of weak reflectors (HOSSAIN 2000).

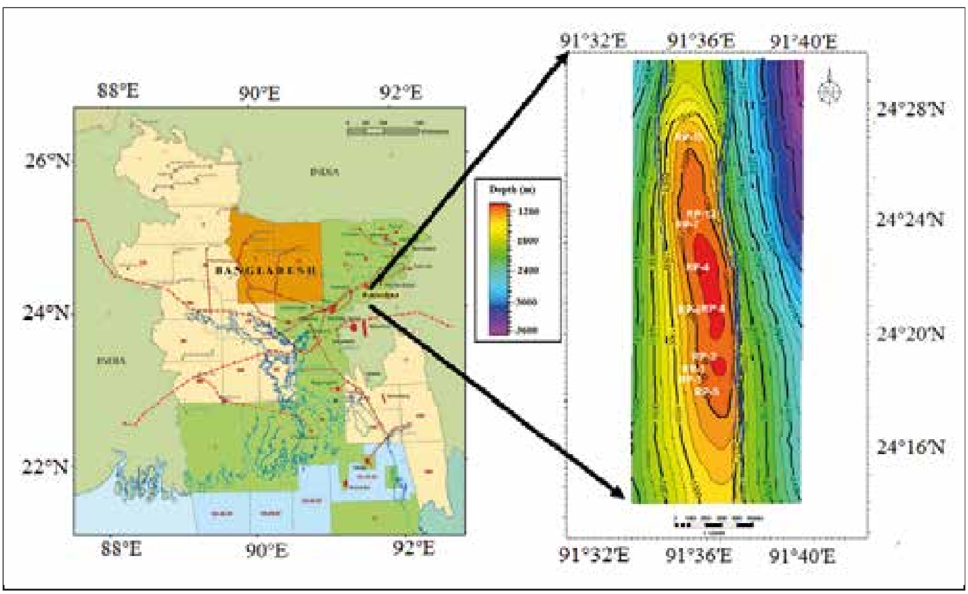

Fig. 1. Location map of the study area and subsurface contour map of the Rasidpur Structure.

The Rashidpur Gas Field is located about 18 km NE from Sylhet town and about 230 km northeast of Dhaka. It was discovered by Pakistan Shell Oil Company (PSOC) in 1960. RP01 well was the first gas discovery. Structurally this field is an elongated asymmetrical anticline with simple four-way dip closure and is mainly producing from sandy reservoir units. Twelve wells have been drilled in the Rashidpur Structure through several phases since 1960 by Pakistan Shell Oil Company (PSOC), Petrobangla and recently by the Sylhet Gas Fields Limited. This study offers insight into the manipulation of seismic velocity with a view to delineating some lithologic information in the Rashidpur Structure.

Materials and Methods

The present investigation was carried out using the available velocity data of the area collected from Bangladesh Petroleum Institute (BPI). The seismic velocity data has been collected for different seismic lines (Fig.2). The depth values have been obtained by simple conversion of TWT into depth using well time-depth information. The density value has been found using GARDNER's rule (SHERIFF & GELDART 1995). In the last twenty years, a considerable amount of seismic data has been acquired in various parts of Bangladesh including the Rashidpur Structure. The reflection data is shot by various agencies and with different parameters. The multifold coverage varied from 6 to 24-fold, the geophone spacing ranges from 50 m to 200 m, and spread lengths up to 3200 m. The sample interval is 2 or 4 msec, and the record length is 5-7 seconds.

Typical processing sequence are demultiplexing and amplitude recovery, editing and CDP gather, statics, deconvolution, dynamic correction, muting, CDP stack, time-variant deconvolution and filtering, velocity analysis, and migration. Constant velocity stack (CVS) is used as velocity analysis for most of the lines.

In an n-layered earth, the so-called root mean square velocity (V_{rms}) is given by (AL-CHALABI 1979)

$$V_{rms}^2 = \frac{\sum_{i=1}^{n} \mathrm{Vi}^2 \tau \mathrm{i}}{\sum_{i=1}^{n} \tau \mathrm{i}}$$

Where V_i = the interval velocity of i-th layer and τ_i = the two-way traveltime for seismic energy propagating perpendicularly through the i-th layer.

The interval velocity in various layers was calculated using Vrms in Dix formula. The above consideration shows that this approximation is good. It is preferred to plot the average velocity against depth to the middle of the layer to get a more continuous distribution, as it is thought that such a curve reflects the trend in the size of the steps often is chosen irregularly and arbitrary basis (RAHMAN & AUSTEGARD 1991).

The individual stacking velocities exhibit random errors, which have been tried to reduce by averaging the velocity distributions from 4-5 nearby velocity analysis. In this way, some very unrealistic values could be filtered. Also, the reflection time (TWT)-depth curves were calculated and plotted (Fig. 3). In most cases, these data are not much scattered and, therefore, calculation of an average TWT-depth curve was not necessary.

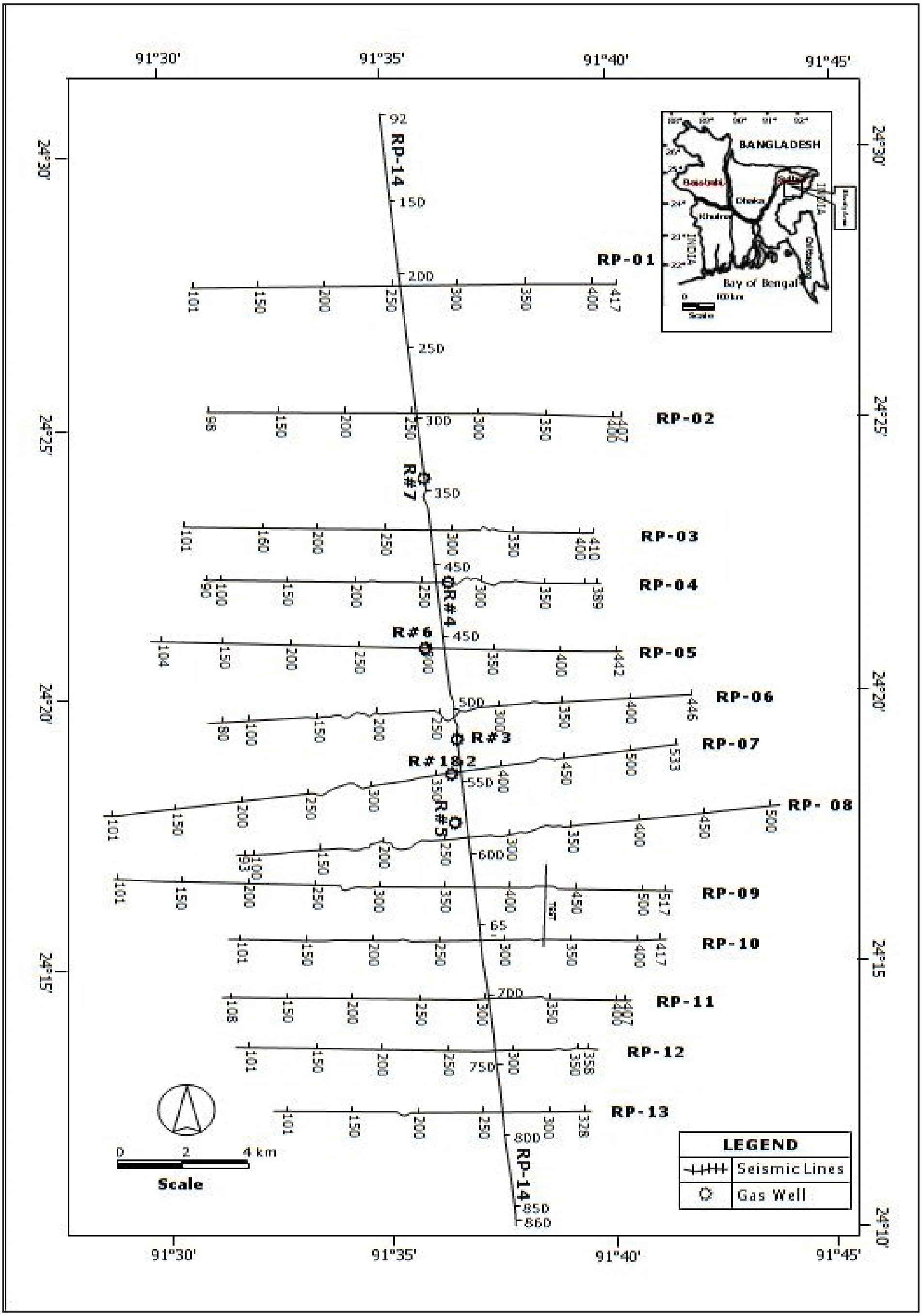

Fig. 2. Map showing the orientation of 2D seismic lines of the Rasidpur Structure (modified after Kabir and Hossain 2009).

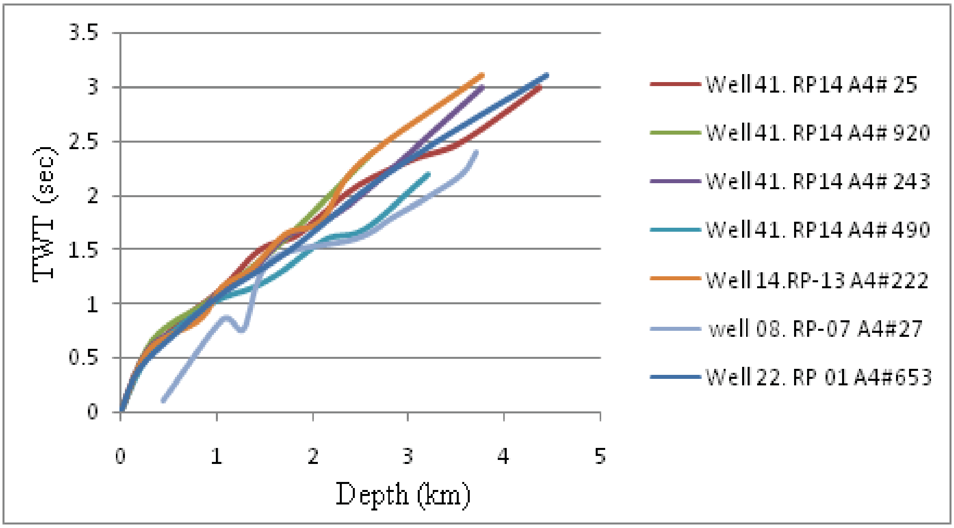

Fig. 3. TWT vs. Depth Graph of available data at the Rashidpur Structure.

Statistically, it is difficult to calculate the accuracy of the velocity distribution, but from the degree of similarity between the individual velocity analysis and comparison with sonic log it is believed that the velocities down to 6 km depth are accurate within 0.5 km/s using standard deviation at each km depth level. The velocity analysis gets less accurate with increasing depth, because the normal move out correction is less sensitive upon the velocity for deep events, and also because the signal-to-noise ratio generally decreases with depth (RAHMAN & AUSTEGARD 1991). In many cases, it is impossible to see reliable reflectors in the lower part of the seismic section. Regional refraction data are not acquired onshore in Bangladesh.

The weathering or low velocity layer in Bangladesh is few meters to 50 m in thickness and with velocity ranging from 500 to 1500 m/s. It is important to know the details of this layer for computing reliable static values to be used in the processing of data. GARDNER *et al.* (1974) conducted a series of empirical studies and determined the empirical relationship between velocity and density logs and the 3D effective porosity model. The permeability logs were upscaled using the harmonic averaging method. Rockworks and Petrel softwares were used for lithologic correlation and porosity and permeability modeling in order to predict factors that might be responsible for changes in velocity in the subsurface.

Results and Discussion

V_{rms} has been calculated from the stacking velocity and interval velocity is calculated from the Dix equation. From GARDNER's equation, corresponding density has also been calculated. From the consideration of the effects of lithology, density, porosity and pressure on velocity tentative lithology is interpreted and all the result of different wells of Rashidpur and adjacent area are listed in table 1, 2, 3, 4, 5, 6 and 7. There is appreciable overlap in the velocities in various rock types, owing mainly to variations in porosity, so that velocity value alone is not sufficient to unequivocally distinguish rock types. It is observed from seismic surveys that velocities generally increase with depth but there are some anomalies seen in the data that might be associated with anomalous geologic, including lithologic factors.

Table 1. Data of Well 41. RP-14 A4 # 25

Average Depth (km)	Root mean square velocity (km/s)	Total Two-way time (s)	Interval velocity (km/s)	Thickness of the interval layer (km)	Average TWT (s)	TWT of the interval layer (s)	Density (g/cm^3)	Interpreted Lithology
0	1.75	0	1.75	0	0	0	2.001	Sandstone
0.208	1.85	0.45	1.85	0.416	0.225	0.45	2.029	Sandstone
0.632	2	0.85	2.1565	0.431	0.65	0.4	2.108	Sandstone
1.021	2.15	1.12	2.566	0.346	0.985	0.27	2.202	Sandstone
1.45	2.3	1.5	2.694	0.512	1.31	0.38	2.229	Sandstone
1.808	2.4	1.62	3.411	0.205	1.56	0.12	2.364	Shale
2.057	2.5	1.8	3.265	0.294	1.71	0.18	2.339	Shale
2.48	2.7	2.1	3.678	0.552	1.95	0.3	2.409	Shale
3.05	3	2.34	4.895	0.587	2.22	0.24	2.588	Shale
3.556	3.2	2.5	5.327	0.426	2.42	0.16	2.643	Calcareous Shale ?
4.36	3.5	3	4.722	1.181	2.75	0.5	2.56	Shale

Apparently, there is no sharp velocity contrast at the formation boundaries in any of the studied wells. Fluctuations in interval velocity are strongly related to lithological variations, porosity distribution and compaction. Velocity-depth distributions of all the wells of Rashidpur and adjoining area show a gradual increase of velocity with depth, reflecting normal trend of velocity increment with depth and compaction. The gradual increase of velocity might result from the fact that the Tipam Sandstone is relatively thin and shallowly buried. This is also because of the variations in compaction, porosity and lithology of the stratigraphic units. For example, the Tipam Sandstone is composed of medium to fine grained massive

Table 2. Data of Well 41. RP-14 A4 # 920

Average Depth (km)	Root mean square velocity (km/s)	Total Two-way time (s)	Interval velocity (km/s)	Thickness of the interval layer (km)	Average TWT (s)	TWT of the interval layer (s)	Density (g/cm^3)	Interpreted Lithology
0	1.75	0	1.75	0	0	0	2.001	Sandstone
0.335	2	0.67	2	0.67	0.335	0.67	2.069	Sandstone
0.87	2.15	1	2.426	0.4	0.835	0.33	2.172	Sandstone
1.27	2.35	1.27	2.976	0.402	1.135	0.27	2.285	Sandy Shale
1.72	2.5	1.6	3.008	0.496	1.435	0.33	2.291	Sandy Shale
2.632	2.8	2.4	5.32	1.326	2	0.8	2.6425	Calcareous Shale?
9.396	2.6	7	5.302	12.194	4.7	4.6	2.64	Calcareous Shale?

Table 3. Data of Well 41. RP-14 A4 # 243

Average Depth (km)	Root mean square velocity(km/s)	Total Two-way time (s)	Interval velocity (km/s)	Thickness of the interval layer(km)	Average TWT (s)	TWT of the interval layer (s)	Density (g/cm^3)	Interpreted Lithology
0	1.75	0	1.75	0	0	0	2.001	Sandstone
0.283	1.95	0.58	1.95	0.566	0.29	0.58	2.056	Sandstone
0.722	2.1	0.84	4.401	0.312	0.71	0.26	2.52	Shale
1.062	2.2	1.14	2.458	0.369	0.99	0.3	2.178	Sandstone
1.363	2.3	1.3	2.915	0.233	1.22	0.16	2.274	Sandstone
1.718	2.45	1.62	2.983	0.477	1.46	0.32	2.286	Sandstone
2.095	2.6	1.76	3.94	0.276	1.69	0.14	2.45	Shale
2.504	2.9	2	4.529	0.543	1.88	0.24	2.538	Shale
3.771	3.3	3	3.981	1.991	2.5	1	2.45	Shale

Table 4. Data of Well 41. RP-14 A4 # 490

Average Depth (km)	Root mean square velocity (km/s)	Total Two-way time (s)	Interval velocity (km/s)	Thickness of the interval layer (km)	Average TWT (s)	TWT of the interval layer(s)	Density (g/cm^3)	Interpreted Lithology
0	1	0	1.9	0	0	0	2.042	Sandstone
0.313	2.275	0.55	2.275	0.626	0.275	0.55	2.137	Sandstone
0.935	2.5	1	2.75	0.619	0.775	0.45	2.24	Sandstone
1.393	2.7	1.16	3.713	0.297	1.08	0.16	2.415	Sandstone
1.704	2.9	1.32	4.066	0.325	1.24	0.16	2.4708	Sandy Shale
2.14	3.1	1.6	3.907	0.547	1.46	0.28	2.446	Shale
3.207	3.5	2.2	4.108	1.027	1.95	0.5	2.477	Shale
9.75	4.6	7	5.024	12.058	4.6	4.8	2.6	Calcareous Shale?

Table 5. Well 14. RP-13 A4 # 222

Average Depth (km)	Root mean square velocity (km/s)	Total Two - way time (s)	Interval velocity (km/s)	Thickness of the interval layer (km)	Average TWT (s)	TWT of the interval layer(s)	Density (g/cm^3)	Interpreted Lithology
0	1.85	0	1.85	0	0	0	2.004	Sandstone
0.297	1.95	0.58	1.95	0.566	0.29	0.58	2.156	Sandstone
0.832	2.12	0.86	3.01	0.312	0.71	0.26	2.42	Shale
1.062	2.22	1.16	2.58	0.369	0.99	0.3	2.258	Sandstone
1.363	2.35	1.32	2.815	0.233	1.22	0.16	2.284	Sandstone
1.718	2.45	1.64	2.983	0.477	1.46	0.32	2.288	Sandstone
2.095	2.67	1.77	3.99	0.276	1.69	0.14	2.46	Shale
2.504	2.97	2.3	4.529	0.543	1.88	0.24	2.638	Shale
3.771	3.35	3.1	3.981	1.991	2.5	1	2.75	Shale

Table 6. Well 08. RP-07 A4 # 27

Average Depth (km)	Root mean square velocity (km/s)	Total Two-way time (s)	Interval velocity (km/s)	Thickness of the interval layer (km)	Average TWT (s)	TWT of the interval layer (s)	Density (g/cm^3)	Interpreted Lithology
0.43	1.717	0.1	7.71	0.086	0.05	0.1	2.01	Sandstone
1.052	2.215	0.85	2.79	0.566	0.29	0.2	2.16	Sandstone
1.27	2.279	0.76	2.95	0.312	0.71	0.36	2.52	Shale
1.56	2.405	1.4	2.847	0.369	0.99	0.48	2.258	Sandstone
2.458	2.813	1.6	2.947	0.233	1.22	0.26	2.294	Sandstone
2.842	2.45	1.8	3.491	0.477	1.46	0.2	2.298	Sandstone
3.232	2.67	2	3.681	0.276	1.69	0.14	2.56	Shale
3.565	2.97	2.2	4.084	0.543	1.88	0.3	2.648	Shale
3.712	3.35	2.4	4.019	1.991	2.5	0.5	2.85	Shale

Table 7. Well 22. RP-01 A4 # 653

Average Depth (km)	Root mean square velocity (km/s)	Total Two-way time (s)	Interval velocity (km/s)	Thickness of the interval layer (km)	Average TWT (s)	TWT of the interval layer (s)	Density (g/cm^3)	Interpreted Lithology
0	1.7	0	1.7	0	0	0	2.014	Sandstone
0.185	1.9	0.39	1.9	0.37	0.195	0.39	2.256	Sandstone
0.561	2.1	0.72	2.314	0.382	0.55	0.33	2.42	Shale
1.07	2.6	1.1	3.349	0.636	0.91	0.38	2.558	Sandstone
1.778	3	1.5	3.894	0.779	1.3	0.4	2.384	Sandstone
2.822	3.22	2.22	3.693	1.309	1.8	0.72	2.488	Sandstone
4.448	3.6	3.1	4.416	1.943	2.65	0.88	2.56	Sandstone

sandstones with some shale and siltstone, whereas the Boka Bil and Bhuban formations are composed of alternation of sandstone, mudstone and some siltstone. Intraformational velocity fluctuations are related to lithological and porosity variations within the formation, and the presence of hydrocarbons affects velocity and density. Gas-bearing zones in the Boka Bil and Bhuban formations in three wells show lower velocity relative to the average formation velocity by as much as 3–7%.

Composite well log responses confirm the presence of two gas sand horizons in the Rashidpur Structure (Fig. 4). Sonic log derived velocity (Table 8) appears to drop against these horizons and is comparable with seismic velocity data. Velocity data over 9 km depth could not be compared with sonic log derived velocity data because sonic log data is not available at that depth. So, velocity over 5 km/sec might be calcareous Shale. Middle Gas sand present only in well RP-07.

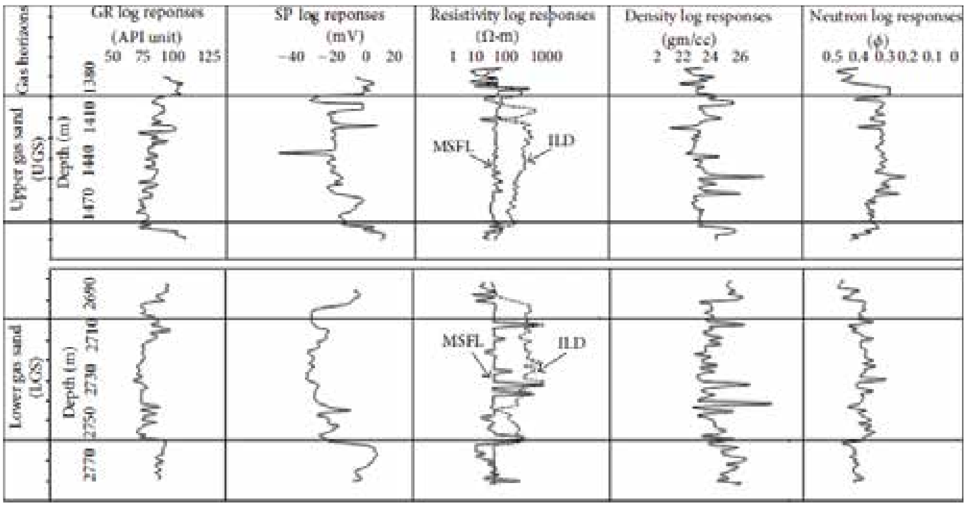

Fig. 4. Composite well log responses in the gas sand horizons of the well RP #4 (after Islam *et al.* 2014).

Table 8. Sonic log derived velocity data (after Islam et al. 2014).

Depth range (m)	Thickness (m)	Velocity (m/sec)	Density (g/m^3)
1332–1380	48	2562	2206
1380–1462	82	2177	2156
2630–2706	76	4320	2414
2706–2761	55	3413	2332

Interpreted lithology can be correlated with a geological section showing correlation between seven wells in the Rashidpur Structure (Fig. 5) along line RP-14. A seismic zonation of Rashidpur structure is presented in Fig. 6. The Upper Marine shale (UMS), Upper Gas Sand (Upper Boka Bil) (UGS), Middle Gas Sand (Lower Boka Bil) (MGS) and Lower Gas Sand (Upper Bhuban) (LGS) are shown in the seismic zonation scheme (Fig. 6). As mentioned earlier, the gas bearing horizons in the Bhuban and Boka Bil formations show relatively lower velocity than the adjacent zones.

The regional geology understanding suggests that Rashidpur field was in subaqueous delta front setting during both the Boka Bil and Bhuban deposition time. The marine and tidal influence is more in the Rashidpur field in comparison to the

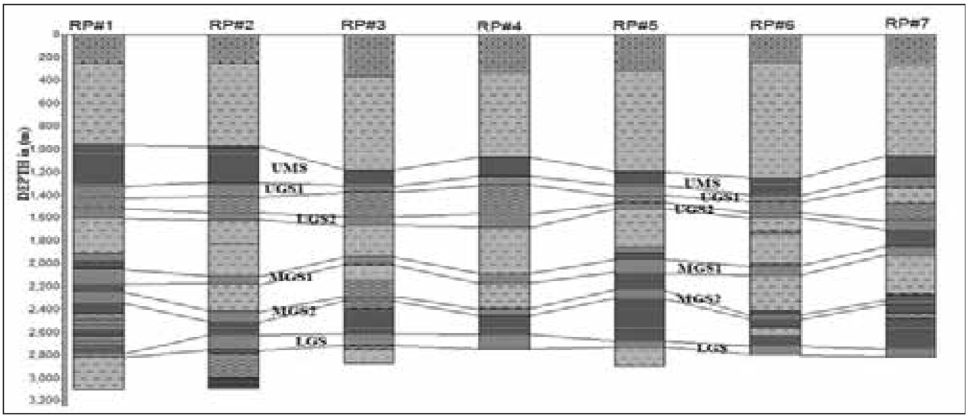

Fig. 5. A geological section showing correlation between seven wells in the Rashidpur Structure along the RP-14 line.

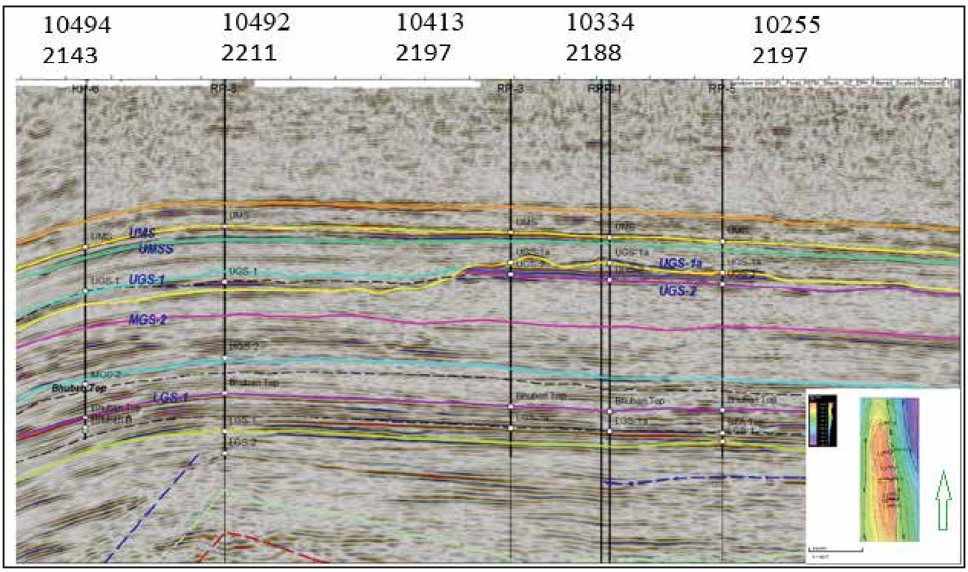

Fig. 6. Zonation scheme based on well and seismic data for the Rashidpur field.

Sylhet and Kailashtila fields. This delta front depositional setting causes reservoir bodies to be more heterogeneous and less continuous, which is quite visible in the wells of the Rashidpur field. A geological section showing porosity model is shown in (Fig. 7) and a geological section showing permeability model is shown in (Fig. 8). These two figures show that in the reservoir sand porosity and permeability vary with depth. The porosity slightly decreases with increasing depth and velocity gradually increases with depth except two gas sand horizons where velocity suddenly dropped. The velocity decreases because of higher amount of porosity and gaseous hydrocarbon filling the pore space. Thus, we can compare how velocity is affected by porosity and

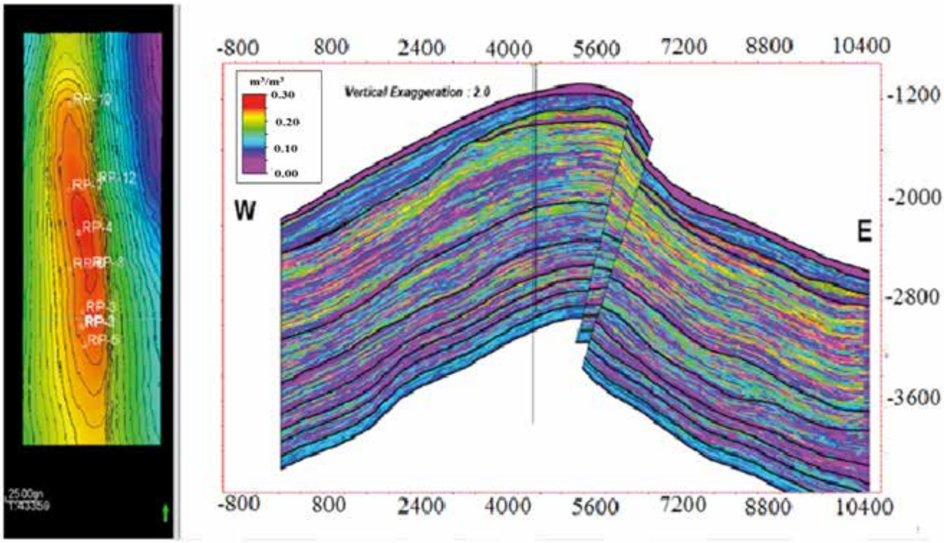

Fig. 7. Cross section showing porosity model [modification after Reviewing of 3D Seismic Survey Data and Reports of the Sylhet (Haripur), Kailashtila and Rashidpur Structures of SGFL, 2018]

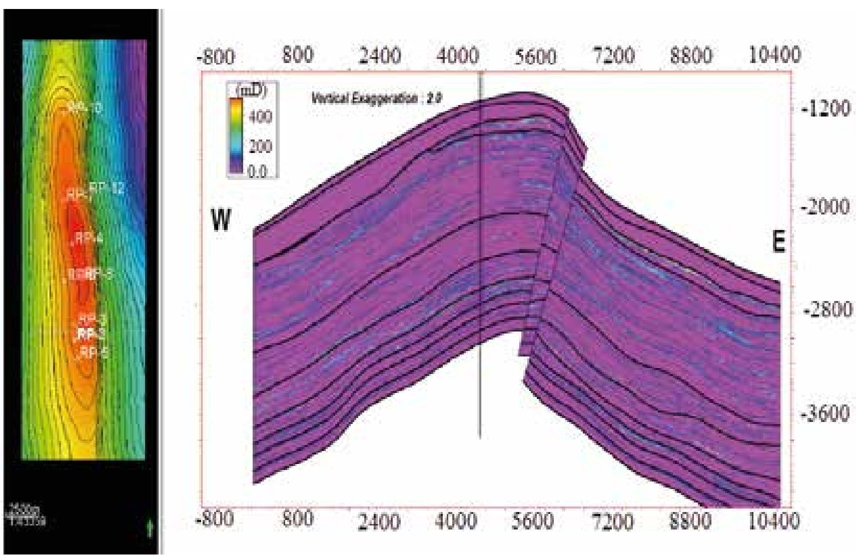

Fig. 8. Cross section showing permeability model modification after Reviewing of 3D Seismic Survey Data and Reports of the Sylhet (Haripur), Kailashtila and Rashidpur Structures of SGFL, 2018]

permeability with depth. No correlation can be suggested between seismic velocity and porosity for a single rock type due to limited data. Occurrence of overpressure has frequently been reported in several exploratory wells in Bangladesh (KHAN & HUSAIN 1980). Fig. 9 reveals that that the Rashidpur Structure lies in zone C. Depth to the overpressure zone in the Rashidpur-4 well is 3680 m (AHMED 1985). But from the

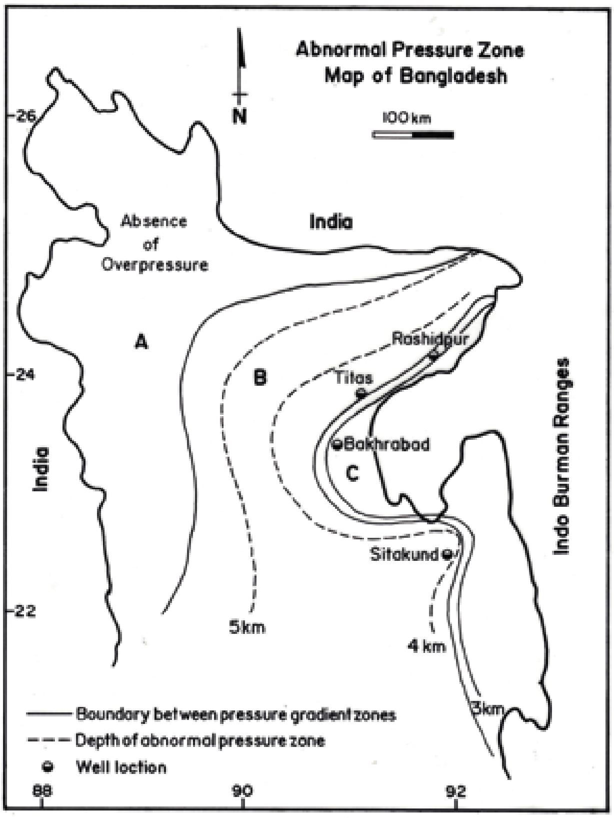

Fig. 9. Distribution of overpressure zone in Bangladesh. [Zone A: normally pressured, Zone B: abnormal pressure at depth of 3000–6000 m and Zone C: abnormal pressure at depth of 1000–3000 m] (KHAN & HUSAIN 1980).

velocity data it is identified that the change is gradual. This may be due to error of velocity data at greater depth. The available interval velocity (V_i) vs Depth and V_{rms} vs Depth data of the Rashidpur Structure have been computed by RAHMAN & AUSTEGARD (1991).

Conclusion

The gradual increase in velocity with depth in the Rashidpur and adjoining areas can be explained in terms of increased compaction; the trend may be affected by variations in porosity and lithology of the stratigraphic units. Intraformational velocity fluctuations are related to lithological, porosity and pore fluid variations within the formations involved. The gas-bearing zones in the Surma Basin show velocity lowering by 3-7% relative to average formation velocity. Velocity analysis appears to be helpful in delineating subsurface geology, especially lithology and over-pressured zone. Therefore, the more velocity analysis done, the better the subsurface interpretation one may expect. Only one key strike line is available in this structure. Collecting more strike lines is required for better geologic correlation.

Acknowledgements

One of the authors MD. MOINUL ISLAM thanks the Director General, Bangladesh Petroleum Institute (BPI), for providing him with necessary permission and support to carry out this study.

References

AHMED, I., 1985, Overpressure phenomenon and geological controls in Bangladesh gas fields with reference to the Sitakund test drilling; *Unpublished M.Sc. Thesis*, University of Dhaka, Dhaka, 72 p.

ALAM, M., 1972, Tectonic Classification of Bangladesh; *Geological Society American Bulletin*, **83**, 519-522.

AL-CHALABI, M., 1979, Velocity determination from seismic reflection data. In: Fitch A.A. (ed.) *Developments in geophysical exploration methods-1*; Applied Science Publishers Ltd., London, 1-68.

ALI, M. & ISLAM, S.M.N., 1978, Seismic refraction investigation in Nawabganj-Badarganj areas Rangpur district, Bangladesh; *Records of the Geological Survey of Bangladesh*, **1**(3), 1-11.

CHAKRABORTY, S., 2018, Reviewing of 3D Seismic Survey Data and Reports of Sylhet (Haripur), Kailashtila and Rashidpur Structures, *Sylhet Gas Field Report*, pt. 4b, 248 p.

GASSMANN, F., 1951, Elastic waves through a packing of spheres; *Geophysics*, **16**, 673-685.

GARDNER, G.H.F., GARDNER, L.W. & GREGORY, A.R., 1974, Formation velocity and density - the diagnostic basics for stratigraphic traps; *Geophysics*, **39**, 770–780.

HOSSAIN, D., 2000, On the application of common-depth-point shooting in the Surma basin, Bangladesh: a case study of the Rashidpur structure; *Journal of Geological Society of India*, **55**, 149-156.

HOSSAIN, M.S., KHAN, M.S.H., CHOWDHURY, K.R. & ABDULLAH, R., 2019, Synthesis of the Tectonic and Structural Elements of the Bengal Basin: In: Mukherjee, S. (ed.) *Tectonics and Structural Geology: Indian Context*; 1st Ed., Springer International Publishing AG, 135-218.

ISLAM, A.R.M.T., HABIB, M.A., ISLAM, M.T. & MITA, M.R., 2013, Interpretation of wireline log data for reservoir characterization of the Rashidpur Gas Field, Surma Basin, Bangladesh; *OSR Journal of Applied Geology and Geophysics*, **1**, 47–54.

KABIR, A.S.M.S. & HOSSAIN, D., 2009, Geophysical Interpretation of the Rashidpur Structure, Surma Basin, Bangladesh; *Journal of Geological Society of India*, **74**, 39-48.

KHAN, M.A.M. & HUSAIN, M., 1980, A look at the geology of Bangladesh gas field; *Oil and Gas Journal,* **78**, 92-95.

MEISSNER, R., 1986, *The Continental Crust: A Geophysical Approach*; International Geophysics Series. Academic Press, London, 435 p.

PAVRE, G., 1961, Geological interpretation of wells Rashidpur-1 & 2; *Unpublished Report*, Oil & Gas Development Corporation, Pakistan Shell Oil Co. Ltd., **1**, 162 p.

RAHMAN, M. & AUSTEGARD, A., 1991, Velocity distribution in Bengal Basin, Bangladesh, Bangladesh Petroleum Institute; *Unpublished Report,* **12**, 25 p.

REZA, A., ISLAM, T. & HABIB, A.R., 2014, Identification of Gas Sand Horizons of the Rashidpur Structure, Surma Basin, Bangladesh, Using 2D Seismic Interpretation, Hindawi Publishing Corporation; *International Journal of Geophysics*, **4**, 1-10.

SHERIFF, R.E. & GELDART, L.P., 1983, *Exploration Seismology, Data Processing and Interpretation*; Cambridge University Press, 221 p.

SHERIFF, R.E. & GELDART, L.P., 1995, *Exploration Seismology*; Cambridge University Press, Cambridge, 608 p.

Accepted 16 June, 2019

সুরমা অববাহিকার রশিদপুর স্ট্রাকচারের ভূতাত্ত্বিক এবং ভূকম্পীয় বেগের পারস্পরিক সম্পর্ক নিরূপণ

মোঃ মঈনুল ইসলাম, মোঃ হাসান ইমাম এবং দেলোয়ার হোসেন

সারসংক্ষেপ

গবেষণাটিতে বাংলাদেশের সুরমা অববাহিকার রশিদপুর স্ট্রাকচারের উপর প্রকাশিত স্ট্যকিং বেগগুলির উপর ডিক্স সূত্র ব্যবহার করে ভূ-অভ্যন্তরের বিভিন্ন স্তরে ভূকম্পীয় বেগ বন্টনের একটি সুষম বিশ্লেষণের উপর জোর দেয়া হয়েছে। এই এলাকাতে ক্ষুদ্র কিন্তু ধারাবাহিক বেগ বৈচিত্র লক্ষ্য করা যায় যা শিলালক্ষণ, ছিদ্রতা, ঘনত্ব, ব্যাপ্তিযোগ্যতা, গভীরতা, চাপ, অন্তর্বর্তী তরল, সন্নিবিষ্টতা এবং এই অঞ্চলের গঠনাত্মক ক্রিয়াকলাপ সম্পর্কিত বলে মনে হয়। এই গবেষণায় দেখা যায় টিপাম বেলেপাথর আনুপাতিকভাবে পাতলা এবং কম গভীরতায় হওয়ায় এতে বেগ তুলনামূলকভাবে কম এবং গভীরতা বৃদ্ধির সাথে শিলার ঘনত্ব বৃদ্ধি পেয়েছে সেই সাথে ভূকম্পীয় বেগও ধারাবাহিক ভাবে বৃদ্ধি পেয়েছে।

এই গবেষণায় দ্বি-মুখী গমন সময় থেকে গভীরতা নির্ণয় করা হয়েছে এবং গার্ডনারের সূত্র ব্যবহার করে শিলার ঘনত্ব নিরূপন করা হয়েছে এবং তা সনিক লগ থেকে প্রাপ্ত বেগ উপাত্তের সাথে তুলনা করা হয়েছে। দেখা যায় সনিক লগের বেগ উপাত্ত এই গবেষণায় ব্যাবহৃত বেগ উপাত্তকে সমর্থন করে। যেহেতু ভূকম্পীয় বেগ স্তরসমষ্টির ছিদ্রতা এবং ব্যাপ্তিযোগ্যতার উপর নির্ভরশীল তাই খননকৃত কূপের কার্যকর ছিদ্রতা এবং ব্যাপ্তিযোগ্যতা উপাত্ত থেকে দুটি নকশা তৈরী করা হয়েছে। নকশা হতে দেখা যায় ছিদ্রতা এবং ব্যাপ্তি যোগ্যতা গভীরতা বাড়ার সাথে কিঞ্চিত কমে কিন্তু বেগ দুইটি গ্যাস বালি ছাড়া ধারাবাহিকভাবে বাড়ে। দৃশ্যত, এই উর্ধ্বভাঁজটিতে অধীত কূপগুলিতে বিভিন্নস্তর সমষ্টি সীমানা গুলিতে তীক্ষ্ণবেগ বৈষম্য নেই কিন্তু গবেষণায় ব্যবহৃত তিনটি কূপেই ভূবন ও বোকাবিল স্তরসমষ্টিতে ৩-৭% বেগ বিতরণ কম আছে যা হাইড্রোকার্বনের উপস্থিতি নির্দেশ করে। পূর্ববর্তী গবেষণা হতে জানা যায় রশিদপূরের গড় উচ্চচাপ গভীরতা প্রায় ৩৬৮০ মিটার কিন্তু সেই গভীরতায়ও বেগের ক্রমিক পরিবর্তন লক্ষ্য করা যায়।