RESEARCH ARTICLE OPEN ACCESS

Assessment of Shale Gas Potential in Disang Shale of Upper Assam Basin.

Swapan Kumar Bhattacharya
K.D.M.Chair Professor, Dept.of Applied Geology Dibrugarh Univrsity.

ABSTRACT:
Neither any subsurface sample nor even any subsurface location is known for Disang Shale existence. However huge outcrop samples are known to exist which appear to grey or black colour with occasional good amount of TOC and high maturity but not always proved to be good source rock. Because these are surface samples the source rock characters of HI, PI are not expected to be proved because samples are possibly acted by oxidation or biodegradation due to which SI, S2, TOC and Tmax values are supposed to be changed. Therefore subsurface Disang shale is not proved whether to be a source rock or not. Also because its subsurface location is not known its maturity is also not expected. However because of its colour and TOC existence it is assumed to be possible source of the available hydrocarbons in the basin. Attempt is made here to evaluate possible shale gas potential if it is a source rock or not. It is known that shale gas in a shale is possible to exist if the shale is a source rock and ultimately failed primary migration or even if it is not a source rock but could store some migratory oil and achieved maturity of gas window to convert stored oil to gas and also failed primary migration. Primary migration of oil & shale porosity is assumed for Disang Shale equivalent to Barnett Shale of USA. The calculated amount shows the expected shale gas potential of 575.87 million tonnes of shale gas if it had thickness of 3 km around 2 kmx1km areal extent and it worked as a true source rock with parameters same as outcrop sample MCR-2 in Assam-Arakan Basin. If it was not a source rock but received migratory oil then the expected shale gas potential is 339.15 million tonnes around the same 3km by 2kmx1km shale extent.

Date of Submission: 17-11-2017 Date of acceptance: 28-11-2017

I. INTRODUCTION

Disang Shale in Upper Assam Basin is available as huge black shale outcrops in the eastern part of major thrust belts of Naga & Disang thrusts (Dasgupta et.al, 2008). Earlier studies of outcrop samples have already proved Disang Shale was deposited in marine environment and GSI opined Disang Shale is present only in the geosynclinal part of Upper Assam Basin but not present in the Shelf part of Upper Assam Basin. Because of its marine sedimentation and black colour with organic matters it is considered as source rock of the available hydrocarbons in this basin. Although its source potential is not yet confirmed because subsurface samples of Disang Shale are not yet available for analysis. Finally based on the source possibility, attempt is made using TTI calculations to find if conditions of shale gas generation is achieved or not and ultimately assessment is made to evaluate its potential. Assessment of shale gas potential is also made if migratory hydrocarbon remained stored. In this present research work the main problem was that no subsurface sample could be achieved and even predicting conditions could not be available for subsurface conditions. However assessment of potential is made based on assumptions of subsurface conditions. Because the subsurface nature of Disang Shale is not available a few characters are assumed from the Barnet Shale results of USA. Particularly the condition of primary migration of generated oil is assumed to be more than twice the pore volume and the porosity is assumed to be 6% equal to Barnet Shale of USA. Once the subsurface Disang Shale is discovered then these properties can be rectified.

TTI Evaluations for maturity confirmation:

TTI for Disang Shale is calculated using stratigraphy published by GSI suggesting Disang Shale is deposited only in the geosynclines of Upper Assam Basin. Calculation attempt is made using thickest samples of all the horizons making 16km depth of the Disang shale bottom. Because the depth is not function of TTI calculation the maximum thickness of the horizons are not ignored. Although it is true that depth variations may result change of profile gradient of the burial history which will also be affected by interval width of temperature to compromise the TTI variations. Actually shallower horizons are supposed to have lower TTI because of lower temperatures at the base. But for my calculation I have assumed bottom temperature at

16km the base of Disang shale of 150deg.C. I have also verified using 150deg.C at a depth of 5km to check changes of TTI values. Although it is known that thickest horizons of all the formations are not occurring in same place it is used to calculate using available thickest horizon thickness with base temperature of 150 deg.C. Stratigraphy & Burial Cuve for TTI Measure:

Formation	Age	Thickness
Alluvium	Recent(0 – 0.5 my)	200m
	Unconformity (0.5 –2.5my)	
Dihing	Pliocene((2.5 – 4.0my)	900m
	Unconformity (4.0 – 5.0my)	
Dupitila	Mio-Pliocene (5.0 – 7.0my)	800m
	Unconformity (7.0 – 9.5my)	
Tipam & Surma	Up & Lr Miocene (9.5 – 22.5my)	5km
	Unconformity (22.5 – 27.5my)	
Barail	Oligocene –Er Eocene(27.5 – 34.5my)	6.1km
Disang	Eocene – Mid Paleocene(34.5 -38.5my)	3km

$20^0C – 30^0C$ = 1.75my X 0.00390625 = 0.0068359375
$30^0C – 40^0C$ =1.75my X 0.0078125 = 0.013671875 + 0.0068359375 = 0.0205078125
$40^0C – 50^0C$ = 1.5myX 0.015625 = 0.0234375 + 0.0205078125 = 0.0439453125
$50^0C – 60^0C$ =1.5my X 0.03125 = 0.046875 + 0.0439453125 = 0.0908203125
$60^0C – 70^0C$ = 1.5my X 0.0625 = 0.09375 + 0.0908203125 = 0.1845703125
$70^0C – 80^0C$ =1.5my X 0.125 = 0.1875 + 0.1845703125 = 0.3720703125
$80^0C – 90^0C$ = 1.5my X 0.25 = 0.375 + 0.3720703125 = 0.7470703125
$90^0C – 100^0C$ =7.5my X 0.5 = 3.75 + 0.7470703125 = 4.4970703125

$100^0C – 110^0C$ =3.25my X1 = 3.25 + 4.4970703125 = 7.7470703125
$110^0C – 120^0C$ =3.25my X 2 = 6.5 + 7.7470703125 = 14.2470703125
$120^0C – 130^0C$ = 3.5my X 4 = 14 + 14.2470703125 = 28.2470703125
$130^0C – 140^0C$ =6.25my X 8= 50 + 28.2470703125 = 78.2470703125
$140^0C – 150^0C$ = 3.75 X 16 = 60 + 78.2470703125 =138.2470703125

From the above analysis it is now clear that if Disang Shale is lying close to 150^0C, then it must not have attained maturity of gas window. It is known that

- TTI = 3 = 0.5Vro = Start of oil Window
- TTI = 180 = 1.35Vro = Start of wet gas window
- TTI = 900 = 2.0Vro = Start of Gas window

It is therefore reasonable to find conditions to achieve TTI over 900 to confirm shale gas possibility.

If the depth of temperature of 150^0C corresponds to 5 km the maturity should be in gas window. It has been verified by petromod modeling. This is because the temperature gradient become much higher of 26^0C compared to 8.125^0C of 150^0C at 16km. Therefore possibility of shale gas in Disang Shale can be expected to a depth of around 5km in areas having 26^0C gradient or over.

Same stratigraphic data is also used to build a petromod 1D model. 150deg.C at 16km depth is made using particular heat flow and the corresponding Vro also suggest oil window thus confirming the TTI results. Further check of maturity is made using temperature of 150deg.C at 5km depth. The stratigraphy used for 5 km modeling is shown below.

Age [Ma]	Name top/well pick	Depth [m]	Thickness [m]	Event type	Name layer/event	Paleodeposition/ erosion [m]	Lithology	PSE
0.00	Alluvium	0	200	↓ Deposition	Alluvium		Clay-dominated lithotype	Overburden Rock
0.50	Unconformity-1	200	0	– Hiatus				
2.50	Dihing	200	300	↓ Deposition	Dihing		Sandstone (clay rich)	Overburden Rock
4.00	Unconformity-2	500	0	– Hiatus				
5.00	Dupitila	500	700	↓ Deposition	Dupitila		Conglomerate (quartzitic)	Overburden Rock
7.00	Unconformity-3	1200	0	– Hiatus				
9.00	Tipam	1200	1500	↓ Deposition	Tipam&Surma		Sandstone (typical)	Reservoir Rock
22.50	Unconformity-4	2700	0	– Hiatus				
27.50	Barail	2700	1000	↓ Deposition	Barail		Sandstone (subarkose, clay rich)	Reservoir Rock
34.50	Disang	3700	1300	↓ Deposition	Disang		Shale (black)	Source Rock
38.50	Basement	5000						

Possible calculation of Shale Gas potential if it is a source rock.

If the subsurface Disang Shale occur as source rock and also entered gas window then it's expected shale gas potential may be evaluated as below.

The amount of generated hydrocarbon = Shale mass xTOC change x HI change (Jarvie,2005).

The present TOC in outcrop sample of MCR-2 is 4.23% which is assumed to be equal to sub surface sample. The Tmax of MCR-2 is 486 which is equivalent to 1.588 vro (Jarvie,2005) suggesting it to be in wet gas maturity but for shale gas the Disang Shale must be in dry gas generating maturity over 2,0 vro. Expecting 2 vro at present, the original TOC is 17. 24%(swapan,2015). Therefore TOC change = 13.01%. MCR-2 shows present S2=3.56. If present subsurface shale also have same S2 then present HI= 84 . The original S2 = 160.31 and original HI=930 (Jarvie et al,2005)

Mass of $1ft^3$ shale =70792.11648g (using shale density 2.5g/cc)

Therefore amount of generated hydrocarbon in $1ft^3$ shale = 70792.12 x13.01 x846 =779170637mg =779170.637g. The maturity of 2vro indicate maturity remained 70% for oil generation 30% maturity remained for gas generation. Therefore of the total generation 545419.45g per 1 ft^3 shale was generated oil and 233751.19 g per 1 ft^3 shale was generated gas. Generated oil is 7.7g and generated gas is 3.3g per gm of the shale. The generated oil volume is 9.625cc which is 401 times the pore volume suggesting appreciable primary migration and 0.048cc =0.0384g remained stored for gas conversion.

The stored oil has around 0.03456g carbon of which 0.01728g can be converted to gas 0.01728x100/76.43g =0.02261g = 31.84cc. Therefore the total generated gas is 3.32261g=4679cc which is 194958 times the pore

volume suggesting possible primary migration. The stored gas shall be 2253 times the pore volume =54.072cc 0r 0.03839g per gm of subsurface Disang shale. Thick 3km Disang Shale if extends 2km length and 1km width then the volume 6km^3 shale =6 x 10^{15}cc =15 x10^{15}g. The amount of stored shale gas potential =811.08 x 10^{15} cc =811.08 x10^9m^3 .= 811 billion m^3 of gas potential equivalent to 575.87 million tonnes **.**

Possible Calculation of Shale Gas potential if Disang Shale had trapped migratory hydrocarbon.

The surface samples of Disang Shale show contaminated with migratory hydrocarbons and also reacted with environment. For the possibility of shale gas the subsurface shale also assumed to have stored migratory oil which has not been suffered any reaction. Because the pore volume of shale is 0.024cc per gm of shale the amount of trapped oil can be 0.048cc assuming the primary migration failed at twice the pore volume(Jarvie,2005).This assumption is made because no subsurface character of Disang Shale is known for which assumption is made based on proved Barnett Shale of USA. Once then Disang Shale move to gas window then the stored oil shall be converted to gas. The mass of stored oil is 0.0384g of which amount of carbon mass is 0.03456g. The amount of carbon mass which shall be converted to gas is 0.01728g. Therefore the amount of generated gas is 0.01728x100/76.43= 0.02261g per gm of shale which is 31.845cc equal to 1326.875 times the pore volume which is not exceeding 2253 times of pore volume suggesting no possible primary migration. Therefore the stored gas shall be 0.02261g per gm of shale.

6 km^3 shale has mass of 15x10^{15}g may have 15x0.02261x10^{15}g = 339.15x10^{12} g gas = 339.15 million tones of gas.

II. CONCLUSIONS

It is therefore concluded that if Disang Shale remained in the subsurface same as MCR-2 as source rock of 4.23% TOC with 84HI and the shale moved to gas window maturation and its primary migration of oil assumed to take place when exceeded double the pore volume then the assessment of its shale gas potential is 54.072cc per gm of the shale, Also in the thickest 3km shale if the thickest area cover around 2sq.km then the potential is 575.87 million tonnes of gas.

Further if Disang Shale is not source but contaminated with migratory hydrocarbon in the subsurface and ultimately move to gas window then the assessment of shale gas potential is 31.845cc per gm of shale and around the thickest areas it amounts to 339.15 million tones.

For future exploration of shale gas in Disang Shale it is essential to find its subsurface location and find if it is matured to gas window or not. Thereafter its shale gas resources whether by source rock or by migratory oil are to be confirmed. Further the calculated amounts are based on assumed parameters for which it may not be exactly equal but if potential really exist and shale character is not much variable from Barnett Shale then the calculated amounts will be closer.

REFERENCES

[1]. A.B.Dasgupta, A.K.Biswas, 2008, "Geology of Assam" Report published through Geological Society of India in Bangalore

[2]. Jarvie Daniel M, Brenda L, Claxton Floyd BO Henk and John T Breyer, 2001, "Oil and Shale gas from Barnett Shale, FT. Worth Basin, Texas." AAPG National Convention, June 3-6, 2001, AAPG Bulletin,v85, no13, page-100.

[3]. Jarvie Daniel M, Ronald J Hill & Richard M Pollastro, 2005, "Unconventional Energy Resources in the Southern Mid-Continent " 2004 symposium, Oklahoma geological Survey circular, 110 , pp 37-50.

[4]. swapan kumar Bhattacharya, 2015, "Geochemical Limitations of Shale Gas Resource Assessment." IOSR Journal of Applied Chemistry, V-8, Issue-8, pp65-69.

International Journal of Engineering Research and Applications (IJERA) is **UGC approved** Journal with Sl. No. 4525, Journal no. 47088. Indexed in Cross Ref, Index Copernicus (ICV 80.82), NASA, Ads, Researcher Id Thomson Reuters, DOAJ.

Swapan Kumar Bhattacharya Assessment of Shale Gas Potential in Disang Shale of Upper Assam Basin." International Journal of Engineering Research and Applications (IJERA) , vol. 7, no. 11, 2017, pp. 30-33.