STUDY OF GEOCHEMICAL PARAMETERS AND RESERVOIR PROPERTIES OF MIOCENE SEDIMENTS OF PART OF CHITTAGONG HILL TRACTS, E. PAKISTAN

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The petrographic study of rock samples from Upper Bhuban, Boka Bil and Tipam formations of Miocene age from Dakhin Nila, Olah Taung, Sitakund and Semutang areas and a few core samples from Jaldi wells drilled by Oil and Gas Development Corporation in Chittagong Hill Tracts, East Pakistan was undertaken with a view to evaluate the source and reservoir rocks of these areas. The study included the determination of paragenetic association of minerals, heavy mineral content, determination of effective porosity and hydraulic factor, grain size analysis and the determination of permeability. The data thus obtained shows that sediments of Upper Bhuban and Boka Bil formations from Dakhin Nila and Olah Taung, Upper Bhuban formation from Jaldi and Sitakund and Tipam formation from Semutang area may be considered as potential source rocks as revealed by extremely reducing potential (Eh from −0.27 to −0.3) during their deposition. Rocks of Boka Bil formation from Jaldi and Sitakund areas are also interesting from the point of view of source rocks as they have been deposited in weakly alkaline reducing condition. These rocks are reservoir of average to large capacity (9-20.5%) and by their permeability, rocks of Upper Bhuban formation correspond to medium to high permeability, those of Boka Bil formation correspond to negligible permeability and of Tipam formation correspond to poor to high permeability.

Introduction

This paper describes the results of petrographic study of rock samples collected by various geological parties of Oil and Gas Development Corporation during field seasons 1962–63 and 1963–64, from Dakhin Nila, Olah Taung, Sitakund and Semutang areas and a few core samples from Jaldi GIB-1 and Well-1 drilled by OGDC in Chittagong Hill Tracts, East Pakistan. The area under investigation lies in the south-east of East Pakistan, between the eastern coast of Bay of Bengal and the chain of mountains of Arakan-Yoma (Fig. 1). The investigations were carried out with a view to evaluate the source and reservoir rock properties of Miocene sediments in the area described above.

To study the geochemical parameters and reservoir properties of rocks the following investigations were carried out: (i) determination of paragenetic association of minerals, (ii) heavy mineral content, (iii) determination of effective porosity and hydraulic factor, and (iv) granulometric analysis and the determination of permeability.

Geochemical Parameters of Rocks

1. *Determination of Paragenetic Association of Minerals.*—Determination of paragenetic association of minerals of 40 rock and core samples from Upper Bhuban, Boka Bil and Tipam formations of Miocene age were carried out. The microscopic study of thin sections from these samples was conducted both in transmitted and reflected light under polarising microscope. Rocks of Upper Bhuban

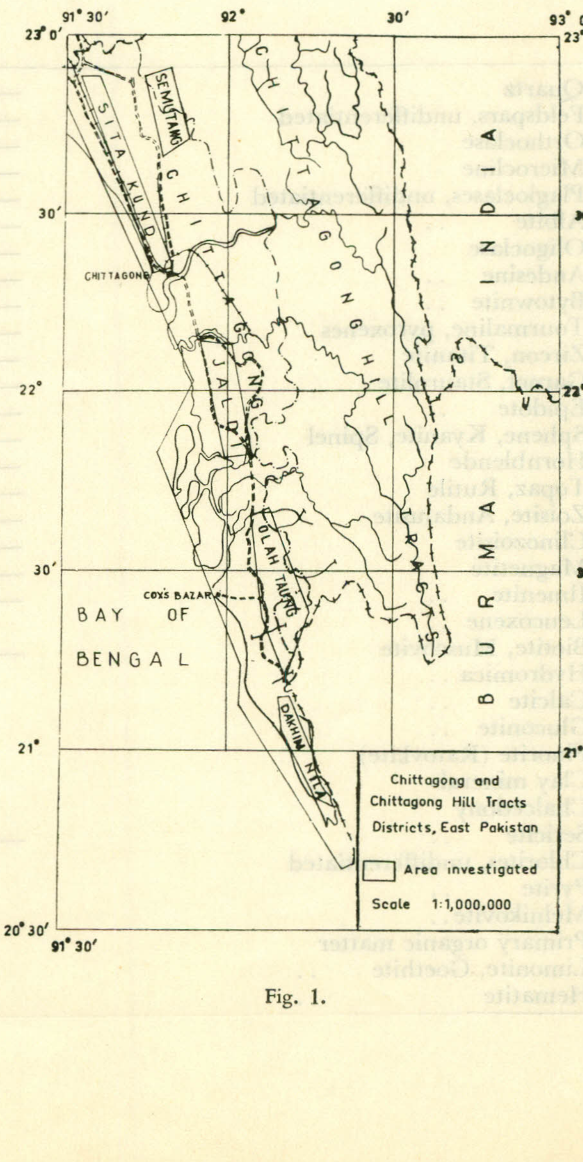

Fig. 1.

and Boka Bil formations are generally very fine to medium grained polymictic sandstones, siltstones and sandy shales with clayey and chloritic cement. Sometimes quartz grains are corroded by poikilitic calcite cement. Rocks of Tipam formation are medium to fine grained sandstones sandy shales and silty sandstones with cement consisting of chlorite, clay minerals, hydromica and occasionally calcite.

The minerals observed in thin sections of the samples are given in Table 1. They can be classified as follows:

(a) *Terrigenic Minerals.*—The clastic grains, even those larger than 0.5 mm are as a rule, poorly rounded (exceptions are small pebbles). The grains are generally quartz, orthoclase, acid, medium and basic plagioclases and microcline. Basic plagioclases are predominant. The sandstones contain pyroxenes (both orthorhombic and monoclinic). Hornblende is present only as chloritized fragments. The rocks usually included muscovite or hydromuscovite and sometimes hydrobiotite with tourmaline, andalusite, epidote, ilmenite, magnetite and leucoxene as accessory minerals.

TABLE 1.—PARAGENETIC ASSOCIATION OF MINERALS OF MIOCENE SEDIMENTS.

Minerals and fragments of rocks	Genetic groups			
		Authigenic		
	Terrigenic	Syngenetic	Epigenetic	
			Supergenetic	Hypergenetic
Quartz	——			
Feldspars, undifferentiated	——			
Orthoclase	——			
Microcline	——			
Plagioclases, undifferentiated	——			
Albite	——			
Oligoclase	——			
Andesine	——			
Bytownite	——			
Tourmaline, pyroxenes	——			
Zircon, Titanite	——			
Garnet, Staurolite	——			
Epidote	——			
Sphene, Kyanite, Spinel	——			
Hornblende	——			
Topaz, Rutile	——			
Zoisite, Andalusite	——			
Clinozoisite	——			
Magnetite	——			
Ilmenite	——			
Leucoxene		....	....	....
Biotite, Muscovite	——			
Hydromica		——	——	
Calcite		——	....	
Gluconite		——		
Fluorite (Ratovkite)			——	
Clay minerals		——	....	
Chalcedony		——		
Sericite	——			
Chlorites, undifferentiated		——	——	
Pyrite		....		——
Melnikovite		——		
Primary organic matter		——		
Limonite, Goethite		....		——
Hematite			——	

(b) *Authigenic Minerals*.—Syngenetic Group: This group includes chlorite, glauconite, clay minerals, hydromica, chalacedony, and primary organic matter. The pelitomorphic texture of calcite and kidney shape, metacolloidal or micro-aggregate texture of glauconite are the characteristics of this group. Primary organic matter is closely associated with pelitomorphic calcite.

Supergenetic Group: This group includes fluorite, recrystallised calcite and in some cases enlarged chlorite, clay minerals and hydromica. Corrosion of quartz by calcite is the characteristic of this group.

Hypergenetic Group: This group includes pyrite, limonite and goethite. These minerals form pseudomorphs after pyrite or thin coatings on other minerals.

From the paragenetic association of authigenic minerals the following geochemical parameters of sediments can be established as shown in Table 2. This study was based on the sedimentary chemical

TABLE 2.—THEORETICAL GEOCHEMICAL PARAMETERS OF MIOCENE SEDIMENTS.

Sample No.	Locality	Formation	Limit of values	
			pH	Eh
L-1	Olahtaung	Boka Bil	7.0 to 8.5	−0.27 to −0.3
L-3	,,	,,	7.9 to 8.5	
L-6	,,	,,		
L-7	,,	,,		
L-8	,,	,,		
L-12	,,	Upper Bhuban	7.0 to 7.9	
L-16	Dakhin Nila	Boka Bil		
L-17	,,	,,		−0.15 to −0.25
L-18	,,	,,		−0.15 to −0.25
L-19	,,	,,	7.9 to 8.5	−0.27 to −0.3
L-21	,,	,,	7.0 ot 7.9	−0.15 to −0.25
L-22	,,	,,		
L-23	,,	Upper Bhuban	Less than 7.0	
L-24	,,	,,	7.9 to 8.5	−0.27 to −0.3
L-25	,,	,,		
L-26	,,	,,		
L-27	,,	,,		
L-28	,,	,,	7.0 to 8.5	−0.15 to −0.25
L-29	,,	,,	7.0 to 7.9	−0.27 to −0.3
L-30	,,	,,		
L-31	,,	,,		
L-32	,,	,,	7.0 to 8.5	
L-34	Sitakund	Boka Bil	7.9 to 8.5	
L-35	,,	,,	7.0 to 7.9	−0.15 to −0.25
L-36	,,	,,		
L-37	,,	,,		
L-38	,,	U. Bhuban		−0.27 to −0.3
L-39	,,	,,		−0.27 to −0.3
L-41	Semutang	Tipam	Less than 7.0	+0.0 to −0.1
L-42	,,	,,	7.0 to 7.9	−0.27 to −0.3
L-43	,,	,,		−0.27 to −0.3
L-44	Jaldi GIB-1	Boka Bil	More than 6.0	+0.0 to −0.1
L-45	,,	,,		
L-53	,,	,,		
L-54	,,	,,		
L-48	Jaldi Well-1	,,		
L-49	,,	,,		
L-50	,,	U. Bhuban	7.0 to 8.5	−0.27 to −0.3
L-51	,,	,,		
L-52	,,	,,		

end member association in their relations to environmental limitations imposed by selected Eh and pH values, according to Krumbein and Garrels.[1]

(i) Association stable at Eh from +0.0 to –0.1; pH less than 7.0 (limonite, hematite, small quantities of silica and chlorite).

(ii) Association stable at Eh from –0.15 to –0.25; pH from 7.0 to 8.5 (mainly calcite, chlorite, occasionally glauconite with organic matter).

(iii) Association stable at Eh from –0.27 to –0.3; pH from 7.9 to 8.5 (calcite, glauconite silica, sulphides and organic matter).

(iv) Association stable at Eh from –0.27 to –0.3; pH 7.0 to 7.9 (silica, sulphides and organic matter).

2. *Heavy Mineral Analysis.*—Nineteen rock and core samples were selected for heavy minerals analysis. The fractions (0.25–0.1 mm) obtained from granulometric analysis were dispersed in heavy liquid to separate heavy minerals. The heavy liquid chosen was bromoform with specific gravity 2.7. The percentage of heavy minerals is generally low ranging from 0.002 to 1.0. The minerals were examined under microscope using immersion liquid with refractive indices 1.605 as mounting medium. In other cases liquids of different refractive indices were used to determine refractive indices of individual minerals. The results are presented in Table 3, showing the frequencies of individual minerals. The mineral frequencies have been computed according to Grams, Hayman and Majeed (1933) as can be seen from accompanying Table. Here are the frequency number 1, 2......8^-, 8,8^+ which denote ½ to 100%. '5' denotes 7–13%, 6^+ denotes 23.27% while 6 represents 18–22%. Similarly 8^+gives 90–100%, 8 denotes 75–89% and 8^-, 60–74%. 7 denotes 35–44% while use of positive and negative indices have made it possible to give other divisions viz. 45–49% and 28–34% respectively.

Table 3 shows that samples are rich in transparent heavy minerals. These include pyroxenes, biotite, muscovite, garnet, chloritoid with minor amounts of tourmaline, staurolite, epidote, zircon and titanite. The opaque heavy minerals include magnetite, ilmenite, pyrite and leucoxene. Some samples are predominantly rich in minerals like muscovite, (L-14, L-19, L-32, L-40, and L-45), biotite (L-31, L-43, L-44 and L-45) and some have relatively high amount of garnet (1-2, L-7, and L-15).

Discussion.—It will be seen from Table 2 that rocks from Upper Bhuban and Boka Bil formations from Dakhin Nila, Olah Taung and Sitakund and Tipam formation from Semutang area revealed mostly stable alkaline reducing facies (pH more than 6.0; Eh from –0.15 to –0.3). Alkaline facies with extremely reducing potential (Eh from –0.27 to –0.3) is the characteristic of Upper Bhuban and Boka Bil formations of Dakhin Nila and Olah Taung areas, respectively. Similiar facies are also noticed in the rocks of Upper Bhuban formation of Jaldi (Core samples from Jaldi Well-1) and Sitakund areas. Rocks of Boka Bil formation from Jaldi GIB-1 and Well-1 revealed unstable oxidation-reduction potential. Stable facies with negative Eh values having alkaline or weakly alkaline conditions are the pre-requisite for the formation of source rocks.[2] From drilling in Jaldi structure, it has been established that gas is present almost in all the penetrated section (Boka Bil and Bhuban formations).

According to heavy minerals content the association of authigenic minerals assemblage (pyrite and chlorite) observed in rocks of Upper Bhuban and Boka Bil formations from Olah Taung and Dakhin Nila and Tipam formation from Semutang area indicate that these rocks were deposited in stable alkaline reducing environment.

The association of authigenic mineral assemblage observed in rocks of Boka Bil formation of Sitakund and Jaldi areas also indicate that the environment of deposition were stable alkaline reducing.

Reservoir Properties of Rocks

1. *Determination of Effective Porosity and Hydraulic Factor.*—Determination of effective porosity and hydraulic factor of 11 rocks and core samples have been studied by impregnation method.[3]

The samples were impregnated with dyed Canada Balsam at a temperature of 180–200°C and constant pressure of 0.9 atmosphere. The photographs of polished surface and/or thin sections of impregnated samples were computed to determine effective porosity and hydraulic factor according to following formulae:

$$P_e = \frac{S_1 \times 100}{S_2}$$

Where P_e=effective porosity; S_1=area of the effective pores; S_2=area of the rock surface.

$$F = \frac{L}{El.K.}$$

TABLE 3.—MINERAL FREQUENCIES IN MIOCENE SEDIMENTS.

Minerals	L-2 Boka Bil	L-4 Boka Bil	L-5 Boka Bil	L-7 Boka Bil	L-9 Boka Bil	L-13 U. Bhuban	L-14 U. Bhuban	L-15 U. Bhuban	L-19 Boka Bil	L-22 Boka Bil	L-31 U. Bhuban	L-32 U. Bhuban	L-35 Boka Bil	L-40 U. Bhuban	L-43 Tipam	L-44 Boka Bil	L-45 Boka Bil	L-46 Tipam	L-47 Tipam
Pyroxene Ortho	3	4	3	3	3	1	1	2	2	3	4	2	3	3	2	2	2	2	3
Clino	5	5	5	6⁻	5	6⁻	4	5	5	5	5	4	5	5		5	4	5	7⁻
Idocrase	3	6⁻		3	2	3		1*							3				
Hornblende	4	3	3	2	3	2		2	5	1	2				2				4
Actinolite	3		3	3		3	1								3	2	1	2	3
Biotite	1	3	3	2	1	2	6⁻	3	5	5	7	3		3	6+	6+	6	2	2
Garnet	6⁻	4	5	6⁻	1*	4	4	6+	4	4	4		6⁻		4	1	3	5	5
Chlorite	4		4	3	1	4	5	5	4	4	5	5	4	3	5	5	5	4	4
Staurolite	2	1	3	4	5	3	2	4	2	3	4	4	1	3	3	2	1	1	1
Chloritoid						1	4	5	5	4	5				5	3		4	5
Tourmaline	3	4	2	3	2		3	3			1*	1*	3	1*	1*	2	1	1*	1*
Epidote	5	3	4	5	1	3	3	3	3		4		3	1*		3	2	5	3
Muscovite	2	3	2	3		4	7⁻	4	6	6⁻	5	8⁻	5	6	4	7	6+	2	2
Kyanite	1*	1*	1		1		1		2	1*	1*								1
Rutile	2	1	1*			3		2	1*		4		1			1	1*	3	
Titanite		2			2	2												4	1
Zircon	4	4	1*	2			1*	1*		1			1		1*	1		1	1
Tremolite					2													1	1
Andalusite	1*		1*		3			2		1		1	1	3				3	
Glauconite								1*	3				2					4	
Zoisite		1*				1*													
Ilmenite	4	4	4	4	3	4	2	4	4	3	4	3	3	4	4	4	4		3
Limonite	2		3	3	4		2	3	4			3	4	6⁻		3		2	5
Hematite	2	3		3			3	3			2		2	5	1			5	
Pyrite	2	1	1	1*	2	1	2	2	2	1*	1*	2	3	1*	3	1	1	2	2
Marcasite			1*	1									3	3	1*			2	4
Magnetite	4	4	5	4	3	4	3	5	5	3	4		4	3	4	4	5	3	5
Leuxcoxene	5	4	3	4	4	3	4	4	5	4	3	5	4	5	4	2	4	4	4
Rock fragments						5													

Frequency	Approximate percentage
8+	90—100
8	75—89
8⁻	60—70
7+	45—59
7	35—44
7⁻	28—34
6+	23—27
6	18—22
6⁻	13—17
5	7—13
4	4— 6
3	2— 3
2	1— 2
1	½— 1
1*	1 grain only

Table for mineral frequency according to Gram; Hayman and Majeed (1933).

Where F=hydraulic factor; El=sum of perimeter of pore projection in 100 cm^2; L=perimeter of circle, which is equivalent to the sum of projection areas of effective pores; K=coefficient of projection enlargement.

Results obtained from the analysis are given in Table 4 which shows that rocks have medium to good effective porosity (9–20.5%) and low hydraulic factor (0.0017 to 0.0034). Effective porosity and hydraulic factor of these rocks are characterised by classes D to A and group 3 respectively.[3]

2. *Granulometric Analysis and the Determination of Permeability.*—In all 18 rock samples were selected for granulometric analysis. The selected samples were acid-washed to remove carbonate matter (predominantly $CaCO_3$). The residue was again dispersed in water in 25-cm high jars and was allowed to settle down. In about 20 min the finest sand and silt-sized particles settled down and the suspended clay-sized particles were then decanted off. After repeated decantations to ensure complete removal of clay matter, the samples were passed through various screens of different size openings (1.0, 0.25 and 0.1 mm) to obtain aleuritic and psammitic fractions. The results are given in Table 5.

As seen from Table 5 all the rocks are rich in psammitic fractions except sample Nos. L-18, L-22, L-31, L-40 and L-41 which are preponder-

TABLE 4.—RESERVOIR PROPERTIES OF MIOCENE SEDIMENTS.

Sample No.	Locality	Formation	Lithology	Effective porosity%	Hydraulic factor
L-2	Olah Taung	Boka Bil	Silty sandstone	13	0.0027
L-9	,,	U. Bhuban	,,	18	0.0030
L-10	,,	,,	,,	9	0.0019
L-20	Dakhin Nila	Boka Bil	,,	14.5	0.0017
L-31	,,	U. Bhuban	,,	12	0.0023
L-32	,,	,,	,,	20.5	0.0028
L-45	Jaldi GIB-1	Boka Bil	Silty shale	12	0.0024
L-53	,,	,,	Silty sandstone	9	0.0025
L-54	,,	,,	,,	15	0.0020
L-48	Jaldi Well-1	,,	Silty shale	10	0.0034
L-49	,,	,,	Silty clayey sandstone	15	0.0027

TABLE 5.—RESULTS OF GRANULOMETRIC ANALYSIS AND PERMEABILITY OF MIOCENE SEDIMENTS.

Sample	Formation	Locality	Lithology	Mechanical contents						Permeability
				Pl <0.01		Al. 0.01-0.1		Ps 0.1 — 1 mm		
				g	%	g	%	g	%	
L-2	Boka Bil	Olah Taung	Silty Sst.	3.227	6.7	18.968	39.0	26.373	53.3	Poor
L-4	,,	,,	,,	1.876	3.0	8.309	19.5	32.988	77.5	Poor
L-5	,,	,,	,,	1.411	3.0	10.739	22.1	36.386	74.9	Medium
L-7	,,	,,	Clayey Silty Sst.	5.372	11.1	18.366	37.7	24.920	51.2	Poor
L-9	U. Bhuban	,,	Sandstone	1.020	2.5	4.204	9.6	38.237	87.9	Medium
L-13	,,	,,	Silty Sst.	0.207	0.5	9.156	18.9	38.989	80.6	High
L-14	,,	,,	,,	1.052	2.2	10.693	22.4	36.045	75.4	High
L-15	,,	,,	,,	2.798	5.7	11.323	22.7	35.668	71.6	Medium
L-19	Boka Bil	Dakhin Nila	Sandy Siltst.	0.947	2.1	24.807	54.4	19.844	43.5	—
L-22	,,	,,	,,	4.007	8.4	24.708	51.5	19.262	40.1	—
L-31	U. Bhuban	,,	,,	2.053	4.3	27.807	56.7	19.144	39.0	—
L-32	,,	,,	Silty Sst.	1.163	2.5	17.878	37.2	28.937	60.3	High
L-33	Boka Bil	Sitakund	,,	2.823	5.85	20.602	42.73	24.783	81.42	—
L-35	,,	,,	,,	2.150	6.1	10.977	31.4	21.890	62.5	Poor
L-40	U. Bhuban	,,	Sandy Siltst.	2.327	5.35	22.384	51.56	18.709	43.09	—
L-41	Tipam	Semutang	Clayey Siltst.	11.152	24.13	22.663	49.03	12.405	26.84	—
L-46	,,	,,	Clayey Silty Sst.	5.531	11.5	8.808	18.3	33.667	70.2	Poor
L-47	,,	,,	Silty Sst.	0.583	1.2	7.611	15.6	40.700	83.2	High

antly aleuritic with appreciable pelitic fractions. Rocks of Upper Bhuban formation from Dakhin Nila and Olah Taung areas are silty sandstones except samples Nos. L-31 and L-40 which are predominantly aleuritic and may be termed as sandy siltstones. Rocks of Boka Bil formation from Olah Taung and Sitakund areas are silty sandstones with appreciable amounts of clay. Rocks of Tipam formation from Semutang area are moderately sorted silty sandstones except sample No. L-41 which is poorly sorted sandy siltstone.

The data obtained from the granulometric analysis was then computed to determine permeability of rock samples using Fedorova's method.[4] This method is based on the relative quantities of silt, clay and sand-sized particles in a rock as well as the variation in mineralogical composition of clay minerals. Abundance of one mineral group, say, montmorillonite will inevitably be accompanied by a corresponding decrease in permeability whereas increase in the quantity of kaolinite or polymictic clay would not have any effect on the permeability.

Fedorova, obtained three curves (I, II and III) as shown in Fig. 2 computing the permeability as abscissa and percentage of clays and sands as ordinates. These curves, as mentioned above, indicate that permeability in sand depends on quantities of clay and aleuritic fraction as well as the mineralogical composition of clay minerals. In these curves, however, the decrease in permeability with the increase of aleuritic fraction has been taken into account.

Each of these curves is used for different silt/sand ratios. Curve I gives permeability of those rocks in which silt/sand ratio is less than 1, curve II when it is equal, and curve III, when silt/sand ratio is more than 1.

The following results were obtained according to the above mentioned calculations: (a) samples with high permeability (more than 1.5 darcy): L-13, L-14, L-32 and L-47. (b) samples with medium permeability (0.15–1.5 darcy): L-5, L-9 and L-15. (c) samples with poor permeability (less than 0.15 darcy): L-2, L-4, L-7, L-35 and L-46. (d) samples having no permeability (nil): L-19, L-22, L-31, L-33, L-40 and L-41.

Discussion.—The samples analysed for reservoir properties show that rocks have medium to good effective porosity (9–20.5%) and low hydraulic factor (Table 4. The permeability of these rocks varies from low to high (Table 5).

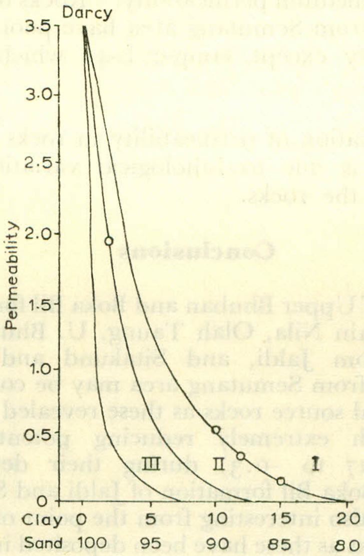

Fig. 2.— Permeability without considering the effect of cementation-By M.A. Fedorova (1954).

$$\underset{(g)}{\text{Sand}} + \underset{(g)}{\text{Clay}} = \Sigma g$$

$$\Sigma g = 100\%$$

$$\text{Sand (g)} = X\ \%$$

$$\text{i.e. } X = \frac{\text{Sand (g)}.\ 100}{g}$$

$$Y = \frac{\text{Clay (g)}.\ 100}{(g)}$$

$$\text{Curve I} \quad \frac{\text{Silt}}{\text{Sand}} < 1$$

$$\text{Curve II} \quad \frac{\text{Silt}}{\text{Sand}} \simeq 1$$

$$\text{Curve III} \quad \frac{\text{Silt}}{\text{Sand}} > 1$$

Table 4 shows that the hydraulic factor of rocks of Upper Bhuban and Boka Bil formations which depend on the pore characteristics of the rocks are very low despite medium to good effective porosity. This negligible hydraulic factor of rocks could be explained by the fact that the total volume of effective pores might be high but these pores may have irregular shape which would effect capilarity of the rock. Again, the cementing matter mostly clay, chlorite etc. might absorb the fluid which would also effect badly the reservoir characteristics.

Table 5 shows that rock of Upper Bhuban formation from Dakhin Nila and Olah Taung areas, mostly, have medium to high permeability except sample L-31 which is impermeable. Rocks of Boka Bil formation from Dakhin Nila, Olah Taung and Sitakund areas are generally poorly permeable to impermeable except sample L-5 which has medium permeability. Rocks of Tipam formation from Semutang area have poor to high permeability except sample L-41 which is impermeable.

The variation of permeability in rocks of same formation is due to lithological variations and sorting of the rocks.

Conclusions

Rocks of Upper Bhuban and Boka Bil formations from Dakhin Nila, Olah Taung, U. Bhuban formation from Jaldi, and Sitakund and Tipam formation from Semutang area may be considered as potential source rocks as these revealed alkaline facies with extremely reducing potential (Eh from −0.27 to −0.3) during their deposition. Rocks of Boka Bil formation of Jaldi and Sitakund areas are also interesting from the point of view of source rocks as these have been deposited in weakly alkaline reducing conditions.

According to volume of open pores (9–20.5%) rocks of Upper Bhuban formation from Dakhin Nila, Olah Taung areas are reservoir rocks of average to large capacity of classes D to A and have low hydraulic factor (0.0023–0.0030) which is characterised by complex pore structure (group 3) and by their permeability these rocks correspond to medium to high permeability. Rocks of Boka Bil formation from Dakhin Nila, Olah Taung, Sitakund and Jaldi areas are reservoir rocks of average capacity (classes D to C) and have low hydraulic factor and negligible permeability. Rocks of Tipam formation from Semutang area have poor to high permeability.

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