

Well 7-11-2X

Microlog Run No. & Date _____

A. Commercial Producer

725.3

Depth Temp. of R_m R_{mc} R_{mf}
Ωm Ωm Ωm

Field CD

Electric Log Run No. & Date _____

B. Drill steam test hydrocarbon

L-10

Company PHILLIPS

Bit Size 8 1/2"

C. Hydrocarbon shows in cores or cuttings

BH 210° .032 .082 0.0185

Block 7-11

Interpreted By E.A. AL-KASIM

D. Drill steam test H₂O

E. No hydrocarbon shows in cores or cuttings

| Interval Investigated | Cen Ray | Φ _N | F | SP | R _w | R _o | R _{LL} | R _u | R _{xo} | R _{xo} /R _{LL} | R _{xo} /R _u | R _{xo} /R _e | R _e | R _e /R _o | | | | | | | | | | n=2 | n=1.8 | | | |
|-----------------------|---------|----------------|-----|------------------------|----------------|----------------|-----------------|----------------|-----------------|----------------------------------|---------------------------------|---------------------------------|----------------|--------------------------------|------|---|---|---|---|---|---|---|---|----------------|----------------|------|------|--|
| | | | | | | | | | | | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | S _w | S _w | | | |
| 9189 - 91 | | 2 | .28 | 10.7 | | .05 | .536 | 1.1 | 1.0 | .33 | .30 | .33 | .15 | 2.2 | 4.1 | | | | | | | | | | | .49 | .46 | |
| 91 - 92 | | 2 | .32 | 9 | | .05 | .45 | 1.2 | 1.40 | .35 | .29 | .25 | .19 | 1.84 | 4.1 | | | | | | | | | | | .49 | .46 | |
| 92 - 96 sh | | 3 | .27 | 11.5 | | .05 | .575 | 0.9 | .8 | .37 | .412 | .415 | .20 | 1.85 | 3.2 | | | | | | | | | | | .560 | .525 | |
| 96 - 9801 | | 5 | .27 | 11.5 | | .05 | .575 | 1.3 | 1.0 | .39 | .3 | .39 | .14 | 2.8 | 4.86 | | | | | | | | | | | .46 | .42 | |
| 9801 - 9814 sh | | 1 | .30 | 9.5 | | .05 | .475 | 1.3 | 1.0 | .33 | .253 | .33 | .12 | 2.7 | 5.7 | | | | | | | | | | | .42 | .38 | |
| 14 - 28 | | 14 | .31 | ^{35.0} 8.0 | | | .40 | 2.4 | 1.6 | .54 | .225 | .34 | .10 | 5.4 | 13.5 | | | | | | | | | | | .275 | .24 | |
| 28 - 31 sl | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 31 - 36 v.sh | | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9912 - 9918 sl | | 7 | .22 | 16.5 | | | .83 | 1.9 | 1.6 | .75 | .395 | .47 | .17 | 4.4 | 5.3 | | | | | | | | | | | .44 | .40 | |
| 9932 - 38 | | 6 | .18 | 24 | | | 1.2 | 1.75 | 1.9 | 1.07 | .61 | .56 | .6 | 1.9 | 156 | | | | | | | | | | | .80 | .78 | |
| 38 - 40 sh | | 2 | .22 | 16.5 | | | .83 | 2.1 | 2.0 | 1.07 | .51 | .535 | .6 | 2.1 | 2.5 | | | | | | | | | | | .64 | .60 | |
| 40 - 44 | | 4 | .19 | 22 | | | 1.1 | 2.0 | 1.44 | 1.07 | .535 | .84 | N.I | 2.0 | 1.82 | | | | | | | | | | | .75 | .72 | |
| 50 - 61 s.sl | | 11 | .20 | 20 | | | 1.0 | 3.5 | 4.38 | 1.39 | .4 | .324 | .3 | 4.65 | 4.65 | | | | | | | | | | | .46 | .43 | |
| 61 - 63 sh | | 2 | .30 | 9.5 | | | .475 | 2.7 | 2.5 | 1.39 | .515 | .555 | N.I | 2.7 | 5.7 | | | | | | | | | | | .42 | .38 | |
| 63 - 68 | | 5 | .22 | 16.5 | | | .83 | 2.8 | 2.85 | 1.39 | .495 | .49 | .5 | 2.8 | 3.4 | | | | | | | | | | | .54 | .51 | |
| 68 - 71 sh | | 3 | .27 | 11.5 | | | .575 | 3.0 | 2.5 | 1.39 | .415 | .56 | N.I | 3.0 | 5.2 | | | | | | | | | | | .44 | .40 | |
| 71 - 77 | | 6 | .22 | 16.5 | | | .83 | 3.0 | 3.0 | 1.12 | .374 | .374 | .20 | 3.74 | 4.5 | | | | | | | | | | | .47 | .43 | |
| 77 - 81 sh | | 4 | .26 | 12.0 | | | .60 | 3.5 | 2.8 | .64 | .182 | .23 | .10 | 6.4 | 10.7 | | | | | | | | | | | .31 | .27 | |
| 81 - 93 | | 12 | .20 | 20 | | | 1.0 | 4.2 | 4.2 | .62 | .148 | .148 | .09 | 6.9 | 6.9 | | | | | | | | | | | .38 | .34 | |
| 93 - 95 sh | | 2 | .23 | 15 | | | .75 | 4.1 | 4.0 | .64 | .136 | .16 | .08 | 8.0 | 10.6 | | | | | | | | | | | .31 | .27 | |
| 95 - 99 sh | | 4 | .18 | 22 | | | 1.1 | 3.4 | 3.5 | 1.07 | .315 | .306 | .175 | 6.1 | 5.5 | | | | | | | | | | | .43 | .39 | |
| 9999 - 10003 | | 4 | .20 | 20 | | | 1.0 | 4.7 | 5.0 | .65 | .138 | .13 | .09 | 7.2 | 7.2 | | | | | | | | | | | .37 | .33 | |

SUMMARY OF THE STRATIGRAPHY
OF THE PHILLIPS WELL 7/11-1X

QUATERNARY

PLEISTOCENE 15908 1650

Fine grained sands and conglomerates interbedded with clays.

TERTIARY

a) PLIOCENE

U.Pliocene 1680- 2010

Grey and greyish brown clays. Pyrite is present in most samples increasing towards the bottom where it is joined by little limonite.

L. Pliocene 2090- 2450

Dark grey clays, only very slightly pyritic.

b) MIOCENE

U.Miocene 2500- 2650

Dark grey clays are dominant, with a noticeable increase in pyrite. Traces of brownish silty ironstone.

M. Miocene 2700- 5100

Grey clays dominant to 3600, strongly pyritic. Rare thin layers of arg. 1st 3300-3610.

Below 3650 lt to medium grey shales, becoming abdt between 3880&4020. Reddish shales and siltstones present below 3880 often associated with reddish and red-brown ironstones. Pyrite present. Dolomite grey micro-Xaline often sucrose between 4920&5100.

L. Miocene 5120-5820

Greyish clays & shales w. occasional buff to brownish shales. Hard dense lt. grey sucrose dolomite common 5120-5280.

L. Miocene 5840-6500

Soft grey clays w. occasional beds of grey to bluish grey shales. Traces of brown dolomite.

c) OLIGOCENE 6560-8720

Dark grey and black clays intbd w. dark grey and black shales down to 7600. The shales are often locally strongly micaceous. Brown dolomitic and sideritic mudstones form occasional bands esp. above 7060. Thin brown silty dolomite 7580-7600. Traces of fine white to colourless angular grains of quartz 7000-7100 &

7320.

Shale increases at 7620. 7620-7880 consists of light and dark greyish brown shales. Dark grey shale is absent below 7880. The whole interval is essentially a uniform shale sequence with clays above 7080 and rare thin bands of limestone throughout.

d) EOCENE

U?-M?. Eocene 8740-9220

Essentially light and medium grey shales. Traces of green to greenish grey shales. Brown slightly dol. limestone 8800 and also as thin bands between 9060 and 9120.

e) ?L.Eocene ?Palaeocene 9240-9380

Shale dominant, light grey and greenish grey with some purple shale common at 9280. Traces of brownish silty limestone at 9300.

f) PALAEOCENE 9400-~~10060~~10060

Shales predominate down to 9520. Light grey to greenish grey with subordinate amounts of purplish shale. Cream to white limestone forms thin rare bands. Minor amount of fine angular quartz.

Sandstones appear at 9540, generally brownish to grey fine to very fine grained interbedded with greenish grey and grey shales

The lowest interval 9820-10060 is dominated by sandstone, fine to very fine with occasional medium subrounded grains. Shales are still present in this interval as thin layers interbedded with the sandstones. Toward the base below 10000 the sandstone becomes locally greyish and contains black carbonised plant fragments. Three core samples were received showing fine ~~xx~~ medium grey very argillaceous slightly silty sandstone associated with micaceous siltstone. The core sample from 9696 is entirely dark grey and greenish grey occasionally waxy shale.

Induction Log

Type 6 FF40. Therefore no skin correction required.

Borehole Correction

$$\left. \begin{aligned} R_m &= 0.38 \text{ } \Omega\text{-m at } 58^\circ \text{ F} \\ R_m &= 0.11 \text{ } \Omega\text{-m at } 210^\circ \text{ F} \end{aligned} \right\} \text{ salinity of mud} = 20,000 \text{ NaCl equiv.}$$

$$\text{Correction} = -5.1 \text{ mhos/m}$$

\therefore Negligible.

R_{ho} from MLL

$$R_{mc} = 0.81 \text{ } \Omega\text{-m at } 57^\circ \text{ F}$$

$$R_{mc} = 0.22 \text{ } \Omega\text{-m at } 210^\circ \text{ F}$$

$$t_{mc} = 0.55''$$

No invasion deduced from chart 15 using $\frac{R_{15}}{R_{16}}$ and

$\frac{R_{15}}{R_{14}}$ relationship.

R_w

Assuming salinity of 60,000 ppm

$$R_w \text{ at } 210^\circ \text{ F} = 0.044 \text{ } \Omega\text{-m}$$

0.86
0.044

$$R_{mf} = 0.22 \text{ at } 65^\circ \text{ F}$$

$$0.072 \text{ at } 210^\circ \text{ F}$$

$$SP_{max} = 14$$

Using chart D-1 $R_w = 0.050 \text{ } \Omega\text{-m}$.

Water salinity from chart B-2 = 50,000 ppm NaCl equiv.

Porosity

Both the sonic and neutron logs agree to a remarkable degree. The Schlumberger calibration of the neutron log was accepted ($\phi_{\text{sst}} = \phi_{\text{lst}} + 0.03$). For the sonic, a plot of shale porosity - dense bed ($35\% - 3\%$) was used.

It must be remembered that the porosity derived from the neutron or sonic log is greatly affected by gas and shaliness. No correction for these was attempted.

In the absence of core porosity, the neutron porosity was accepted for the calculations, especially as it seems to give good results which tie in with the test results.

As an attempt to assess the accuracy of the neutron, porosity was derived from the FDL, using chart B-11 and multiplying by 0.7 to correct for the presence of gas. The results of interpretations based on these porosities are given in Table 1.

It is obvious that the results obtained for S_{ws} are too high. As no water was recovered in the tests, the porosities from the FDL can not but be too pessimistic.

S_{g}

Chart D-3 was used to derive S_{g} from I . Two sets of figures are given, one for $n=2$ and the other for $n=1.8$. The latter figures were used for calculating the avg S_{ws} and S_{g} .

Well 7-11-IX Microlog Run No. & Date _____ A. Commercial Producer _____
 Field COD Electric Log Run No. & Date _____ B. Drill stem test hydrocarbon _____
 Company PHILLIPS Bit Size 12 1/4" C. Hydrocarbon shows in cores or cuttings _____ 210° 11 22 072
 Block 7-11 Interpreted By F.A. Al-Kadiri D. Drill stem test H₂O _____
 E. No hydrocarbon shows in cores or cuttings _____

| Interval Investigated | St. Snd | φ | F | SP | R _w | R _o | R _{IL} | R _{IL} /R _o | S _w | | | | | | | | | | n=2 | n=1.8 | | |
|-----------------------|---------|-----|------|----|----------------|----------------|-----------------|---------------------------------|----------------|----|----|----|----|----|----|----|----|----------------|----------------|-------|-----|-----|
| | | | | | | | | | .10 | .2 | .3 | .4 | .5 | .6 | .7 | .8 | .9 | S _w | S _w | | | |
| 9426 - 9430 | 4 | .27 | 11.6 | 9 | .056 | 0.5 | .9 | 1.8 | | | | | | | | | | | | | .75 | .72 |
| 30 - 34 | 4 | .30 | 9.6 | 10 | .054 | .52 | .8 | 1.54 | | | | | | | | | | | | | .80 | .78 |
| 38 - 43 | 5 | .30 | 9.6 | 12 | .051 | .49 | 1.2 | 2.45 | | | | | | | | | | | | | .64 | .61 |
| 48 - 50 | 2 | .29 | 10.0 | 11 | .053 | .53 | 2.0 | 3.76 | | | | | | | | | | | | | .52 | .48 |
| 50 - 53 | 3 | .34 | 7.6 | 11 | .053 | .41 | 2.5 | 6.1 | | | | | | | | | | | | | .41 | .37 |
| 53 - 56 | 3 | .29 | 10.0 | 11 | .053 | .53 | 1.6 | 3.0 | | | | | | | | | | | | | .58 | .55 |
| 56 - 61 | 5 | .25 | 13.3 | 11 | .053 | .70 | 1.5 | 2.15 | | | | | | | | | | | | | .68 | .65 |
| 61 - 64 | 3 | .30 | 9.5 | 10 | .054 | .51 | .9 | 1.76 | | | | | | | | | | | | | .78 | .76 |
| | | | | | | | | | | | | | | | | | | | | | | |
| | 29' | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |

Well 7-11-ZX
 Field COO
 County NORWAY
 State PHILLIPS PET CO.

Microlog No. & Date _____
 Electric Log Run No. & Date _____
 Bit Size 12 1/4"
 Interpreted By F.A. Al-Kalim

A. Commercial Producer _____
 B. Drill stem test Hydrocarbon _____
 C. Hydrocarbon shows in cores or cuttings _____
 D. Drill stem test H₂O _____
 E. No hydrocarbon shows in cores or cuttings _____

Depth _____ Temp. 210° F
 R_m .11 Ωm
 R_{mc} .22 Ωm
 R_{mf} .272 Ωm

| Interval Investigated | Feet Sand | Microlog | | | | | | | | | | Electric Log | | | | | Resistivity Index R _t /R _o | K=2 S _w | K=18 S _w |
|-----------------------|-----------|---------------------|-----------------|--------------------------------------|----------------------------------|-----------------------------------|----------------|---|----------------|-----|------|---------------------------------|----------------------------------|----------------|--------------------------------|----------------|---|-----------------------|------------------------|
| | | R _{1 1/2"} | R _{2"} | Φ _{SN} | | | R _o | φ | P _B | F | S.P. | ④ | | | R _t /R _o | | | | |
| | | | | R _{1 1/2"} /R _{mc} | R _{2"} /R _{mc} | R _{xos} /R _{mc} | | | | | | R _{xo} /R _o | R _{xos} /R _o | R _L | | R _W | | | |
| 9525-9528 | 3 | | | | .107 | .25 | .132 | 1 | 1.03 | .21 | 248 | 18 | 8 | 2.0 | .057 | 1.94 | .71 | .69 | |
| 33-38 | 5 | | | | .100 | .223 | .195 | | 1.08 | .20 | 230 | 20 | 10 | 8.0 | .054 | 7.4 | .37 | .33 | |
| 38-40 | 2 | | | | .80 | .157 | .195 | | 0.67 | .26 | 230 | 12 | 9 | 8.0 | .056 | 12 | .29 | .25 | |
| 40-44 | 4 | | | | .87 | .178 | .178 | | 0.97 | .21 | 235 | 18 | 10 | 11.0 | .054 | 11.3 | .30 | .26 | |
| 44-46 | 2 | | | | .87 | .178 | .178 | | 0.7 | .25 | 235 | 13 | 10 | 6.0 | .054 | 8.6 | .34 | .30 | |
| 46-52 | 6 | | | | .90 | .190 | .178 | | 0.97 | .21 | 235 | 18 | 10 | 7.5 | .054 | 7.7 | .36 | .32 | |
| 58-59 | 3 | | | | .87 | .178 | .213 | | 0.89 | .24 | 225 | 15 | 7 | 3.0 | .059 | 3.4 | .58 | .53 | |
| 66-72 | 6 | | | | .90 | .19 | .143 | | 0.89 | .22 | 245 | 16.5 | 10 | 7.3 | .054 | 8.2 | .35 | .31 | |
| 72-75 | 3 | | | | .92 | .195 | .195 | | 0.6 | .28 | 230 | 11 | 10 | 4.3 | .054 | 7.2 | .37 | .33 | |
| 75-83 | 8 | | | | .85 | .170 | .172 | | 1.16 | .19 | 237 | 22 | 11 | 12.0 | .053 | 11.3 | .30 | .26 | |
| 83-88 | 5 | | | | .90 | .19 | .178 | | 0.80 | .24 | 235 | 15 | 11 | 7.9 | .053 | 9.9 | .32 | .29 | |
| 88-90 | 2 | | | | .82 | .16 | .178 | | 1.30 | .18 | 235 | 24 | 10 | 9.6 | .054 | 7.4 | .37 | .33 | |
| 9602-9607 | 5 | | | | .85 | .17 | .23 | | 0.97 | .21 | 220 | 18 | 10 | 23.0 | .054 | 23.5 | .21 | .175 | |
| 9-12 | 3 | | | | .96 | .21 | .202 | | 0.84 | .24 | 228 | 15 | 9 | 3.7 | .056 | 4.4 | .48 | .44 | |
| 15-25 | 10 | | | | .88 | .18 | .195 | | 1.38 | .17 | 230 | 26.0 | 11 | 16.0 | .053 | 11.6 | .30 | .26 | |
| 25-29 | 4 | | | | .90 | .19 | .178 | | 0.95 | .21 | 235 | 18 | 11 | 7.0 | .053 | 7.4 | .37 | .32 | |
| 29-32 | 3 | | | | .88 | .18 | .153 | | 1.17 | .19 | 242 | 22 | 11 | 12.0 | .053 | 10.2 | .31 | .28 | |
| 32-36 | 4 | | | | .88 | .18 | .178 | | 0.89 | .22 | 235 | 16.5 | 10 | 7.0 | .054 | 7.9 | .35 | .31 | |
| 36-39 | 3 | | | | .91 | .192 | .16 | | 0.62 | .27 | 24 | 11.5 | 10 | 13.0 | .054 | 21.0 | .22 | .185 | |
| 42-44 | 2 | | | | .93 | .20 | .195 | | 0.73 | .25 | 230 | 13 | 9 | 4.7 | .056 | 6.4 | .40 | .36 | |
| 44-50 | 6 | | | | .93 | .20 | .14 | | 0.59 | .27 | 243 | 11.5 | 12 | 7.5 | .051 | 20.4 | .23 | .19 | |
| 50-53 | 7 | | | | .77 | .14 | .16 | | 0.77 | .23 | 24 | 15 | 12 | 10 | .051 | 13.0 | .27 | .24 | |
| 53-58 | 5 | | | | .94 | .20 | .195 | | 0.64 | .26 | 23 | 12.5 | 12 | 7.0 | .051 | 11.0 | .30 | .265 | |
| 58-61 | 3 | | | | 1.00 | .22 | .202 | | 0.63 | .26 | 228 | 12.5 | 13 | 9.4 | .050 | 14.9 | .26 | .225 | |
| 61-65 | 4 | | | | 1.00 | .22 | .18 | | 0.74 | .24 | 233 | 15.0 | 14 | 8.5 | .049 | 11.5 | .29 | .26 | |

THE MINISTRY OF INDUSTRY-OIL SECTION

WELL No. 7/11-1
SHEET No. 1 of 2

Data furnished by licensee:

| | | | | |
|---|---|----|----|----|
| 1 | 5 | 9 | 13 | 17 |
| 2 | 6 | 10 | 14 | 18 |
| 3 | 7 | 11 | 15 | 19 |
| 4 | 8 | 12 | 16 | 20 |

WELL LOGGING WORK SHEET

Geologist: *ag* Date: 26/2-70 RTKB (MSL): _____ ft Sea Bed (MSL): _____ ft
from 9589 ft to 9644 ft

| BED BOUNDARIES DEPTH BELOW (MSL) | STRATIGRAPHIC DIV. | | | NAME OF ROCK | POROSITY AND PERMEABILITY | COLOUR | TEXTURE | HARDNESS AND CEMENTATION | ACCESSORY MINERALS | FOSSILS | STRATIFICATION AND SEDIMENTARY STRUCTURES | TECTONIC STRUCTURES | HYDRO-CARBON AND CARBON'S INDICATIONS | INTERPRETATION | | |
|----------------------------------|--------------------|-----------|-------------|-----------------------|---------------------------|-------------------------|--|-------------------------------------|--|---------------|--|----------------------------------|---------------------------------------|----------------|------------------------|--------|
| | TIME UNIT | ROCK UNIT | PALAEO UNIT | | | | | | | | | | | SAMPLES USED | FACIES | RATING |
| 3 9589 | | | | m sandy siltst. | (P) (Perm) | dk Gy vgt. | Grains: >80% Qtz >90% Occ. plag. & mica. (Srt) sub. ang. low sph. Matrix: Dolomite (?) | hd. - 3 cmb. Frac. Brk. HCl ÷ | Glauc. } Min. amount Rutil } Pyrite - Infreq. but widespr. | None obs. | (=) - slightly bedded S - Stamp str. (conv. lamin.) Dist. microbed. ind. by the cryst. | | O - streaks of carb. matter in T.S. | Shallow PRB | | |
| 4 9590 | | | | - siltst. | (P) (Perm) | brn. Gy w/ dk str. | Grains: >80% Qtz >95% a. srt, - srt., sub. rnd, - sub. ang. mod. - low sph. Matrix: Dolomite (?) | hd. - 3 cmb. Frac. Brk. HCl ÷ | Pyrite. Spread all over the rock. as tiny spots Glauc. - Min. am. | None obs. | (=) S - x bd. | | None obs. | B. | T.S. is not very good. | |
| 5 9607.5 | | | | - siltst. | (P) (Perm) | Gy. dull. | Grains: >95% Qtz >90% Occ. mica & plag. (Srt), sub. ang - sub. rnd. Matrix: Dolomite. It seems like a dolomitization reworks the rock. | hd. - 3 cmb. Frac. Brk. HCl ÷ | Glauc. - Min. amount Pyrite - Infreq. | None obs. | (=) No app. bed. | Fract. zones | O in fract. | PRB | | |
| 6 9618.5 | | | | - silty sst. (turbid) | P Perm | brn-rd Gy w/ dk. fragm. | Grains: >95% Qtz >95% Occ. mica & plag. & calcite v dol. (Srt), sub. rnd - rnd, mod - low sph. Matrix: Dolomite. Dolomitization | hd. - 3 cmb. Frac. Brk. HCl ÷ | Glauc. - Min. amount Pyrite - Infreq. | Fest fragm. ? | (=) Turbid. | Slicken side on the large fragm. | None obs. | B. | | |
| 7 9644 | | | | crs. Sandst. | (P) (Perm) | lt Gy dull. | Grains: >95% Qtz >95% Occ. mica & plag. (Srt), sub. rnd - rnd, low - mod sph. Matrix: Dolomite | hd. 3 cmb. Frac. Brk. HCl ÷ | Pyrite - Infreq. | None obs. | (=) S - (=) | | O? Small dark spots in the T.S. | PRB | | |

Cont.

THE MINISTRY OF INDUSTRY-OIL SECTION

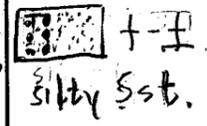
WELL No. 7/11-1
SHEET No. 2 of 2

Data furnished by licensee:

| | | | | |
|---|---|----|----|----|
| 1 | 5 | 9 | 13 | 17 |
| 2 | 6 | 10 | 14 | 18 |
| 3 | 7 | 11 | 15 | 19 |
| 4 | 8 | 12 | 16 | 20 |

WELL LOGGING WORK SHEET

Geologist: ayz Date: 2/2-70 RTKB (MSL): _____ ft Sea Bed (MSL): _____ ft
from 9689 ft to 9701 ft

| BED BOUNDARIES DEPTH BELOW (MSL) | STRATI- GRAPHIC DIV. | | | NAME OF ROCK | POROSITY AND PERMEABILITY | COLOUR | TEXTURE | HARDNESS AND CEMENT- ATION | ACCESSORY MINERALS | FOSSILS | STRATI- FICATION AND SEDIMENTARY STRUCTURES | TECTONIC STRUCTURES | HYDRO- CARBON AND CARBON'S INDICATIONS | INTERPRETATION | | |
|--|----------------------------|-----------|-------------|--|------------------------------|----------------------|--|-------------------------------------|-----------------------------|-----------|---|-------------------------|--|----------------|--------|---|
| | TIME UNIT | ROCK UNIT | PALAEO UNIT | | | | | | | | | | | SAMPLES USED | FACIES | RATING |
| 9689 | | | |  silty sst. | (P) (Perm) | lt Gy. dull. | Grains: >98% Qtz >80% Dol. (?) 10% Srt (and) low-mod sph. No matrix. Dolomitiz. seems to be going on. | hd. -3 cmb. Frac. Brk. | Glaucon. - Scab. grains. | None obs. | | Frac. w/ slickenside | None obs. | | B | Add slide from 9695 indicates increasing amount of matrix downwards |
| 9701a | | | |  f-m. | (P) (Perm) | lt. Gy dull. | Grains: >75% Qtz >95% Srt, sub.rnd., mod.sph., Matrix: Dol. (?) Clay (?) Occ. Mica Dol. | hd. cmb. Frac. Brk. | Glaucon. - Scab. grains. | None obs. | | Frac. | None obs. | | B | a & b are |
| 9701b | | | |  f-m. | P Perm | gn-dk Gy. dull | Qtz. Flaggy. | brct. hkl. Frac. Brk. | | None obs. | Bedding. Prob. eroded by tect. mov. | Frac. w/ slickenside | None obs. | | B | Interm. |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

10

2

8

Well 7-11-1X Microlog No. & Date A. Commercial producer Depth Temp. R_m R_{mc} R_{mt}
 Field C.O.D. Electric Log Run No. & Date B. Drill steam test hydrocarbon °F Ω_m Ω_m Ω_m
 Company PHILLIPS Bit Size 1 1/4" C. Hydrocarbon shows in cores or cuttings 210° .11 .22 .472
 Block 7-11 Interpreted By F.A. AL-KASIM D. Drill steam test H₂O
 E. No hydrocarbon shows in cores or cuttings

| Interval Investigated | ft. Sed | ① φ _N | ② F | ③ SP | ④ R _w | ⑤ R _o 4x2 | R _L | φ _s | R ₁₁ / R _o | S _g | | | | | | | | | | S _w | n=2 | n=18 | | | |
|-----------------------|---------|---------------------|--------|---------|---------------------|----------------------------|----------------|----------------|-------------------------------------|----------------|----|----|----|----|----|----|----|----|--|----------------|-----|------|--|------|-----|
| | | | | | | | | | | .10 | .2 | .3 | .4 | .5 | .6 | .7 | .8 | .9 | | | | | | | |
| 9665 - 75 | 10 | .22 | 17 | 15 | .0475 | .81 | 16 | 19/26 | 19.8 | | | | | | | | | | | | | | | .225 | .19 |
| 75 - 79 | 4 | .23 | 15.3 | 14 | .049 | .75 | 8.5 | .18 | 11.3 | | | | | | | | | | | | | | | .30 | .26 |
| 79 - 82 | 3 | .18 | 24 | 12 | .051 | 1.22 | 11.0 | .17 | 9.0 | | | | | | | | | | | | | | | .33 | .30 |
| 82 - 84 | 2 | .29 | 10 | 12 | .051 | .51 | 5.5 | .235 | 10.8 | | | | | | | | | | | | | | | .30 | .27 |
| 84 - 86 | 2 | .23 | 15.3 | 11 | .053 | .81 | 6.5 | .19 | 8.05 | | | | | | | | | | | | | | | .35 | .31 |
| 86 - 89 | 3 | .26 | 12.3 | 11 | .053 | .65 | 9.2 | .17 | 12.6 | | | | | | | | | | | | | | | .28 | .25 |
| 89 - 91 | 2 | .37 | 6.5 | 10 | .054 | .35 | 6.0 | .215 | 17.2 | | | | | | | | | | | | | | | .24 | .21 |
| 91 - 99 | 8 | .24 | 14 | 10 | .054 | .81 | 4.0 | .195 | 4.95 | | | | | | | | | | | | | | | .45 | .41 |
| 9699 - 9703 | 4 | .27 | 11.3 | 9 | .056 | .63 | 4.5 | .21 | 6.40 | | | | | | | | | | | | | | | .40 | .36 |
| 9706 - 9712 | 7 | .19 | 22 | 6 | .061 | 1.34 | 4.4 | .18 | 3.30 | | | | | | | | | | | | | | | .55 | .52 |
| 9768 - 73 | 5 | .21 | 18 | 11 | .053 | .95 | 4.0 | | 4.65 | | | | | | | | | | | | | | | .47 | .43 |
| 73 - 76 | 3 | .23 | 15.3 | 11 | .053 | .81 | 4.7 | | 5.8 | | | | | | | | | | | | | | | .42 | .38 |
| 82 - 87 | 5 | .19 | 22 | 13 | .050 | 1.10 | 4.6 | | 4.2 | | | | | | | | | | | | | | | .49 | .45 |
| 87 - 91 | 4 | .21 | 18 | 13 | .050 | .90 | 4.2 | | 4.65 | | | | | | | | | | | | | | | .47 | .43 |
| 91 - 94 | 3 | .22 | 17.0 | 13 | .050 | .85 | 5.2 | | 6.1 | | | | | | | | | | | | | | | .41 | .37 |
| 98 - 9801 | 3 | .23 | 15.3 | 10 | .054 | .83 | 4.1 | | 4.95 | | | | | | | | | | | | | | | .45 | .41 |
| 9802 - 9806 | 4 | .24 | 14.0 | 9 | .056 | .51 | 3.0 | | 5.9 | | | | | | | | | | | | | | | .41 | .38 |
| 12 - 16 | 4 | .22 | 17.0 | 14 | .049 | .83 | 2.0 | | 2.4 | | | | | | | | | | | | | | | .65 | .62 |
| 16 - 20 | 4 | .11 | 60 | 10 | .054 | 3.25 | 2.6 | | 0.8 | | | | | | | | | | | | | | | 1.0 | 1.0 |

TABLE 1

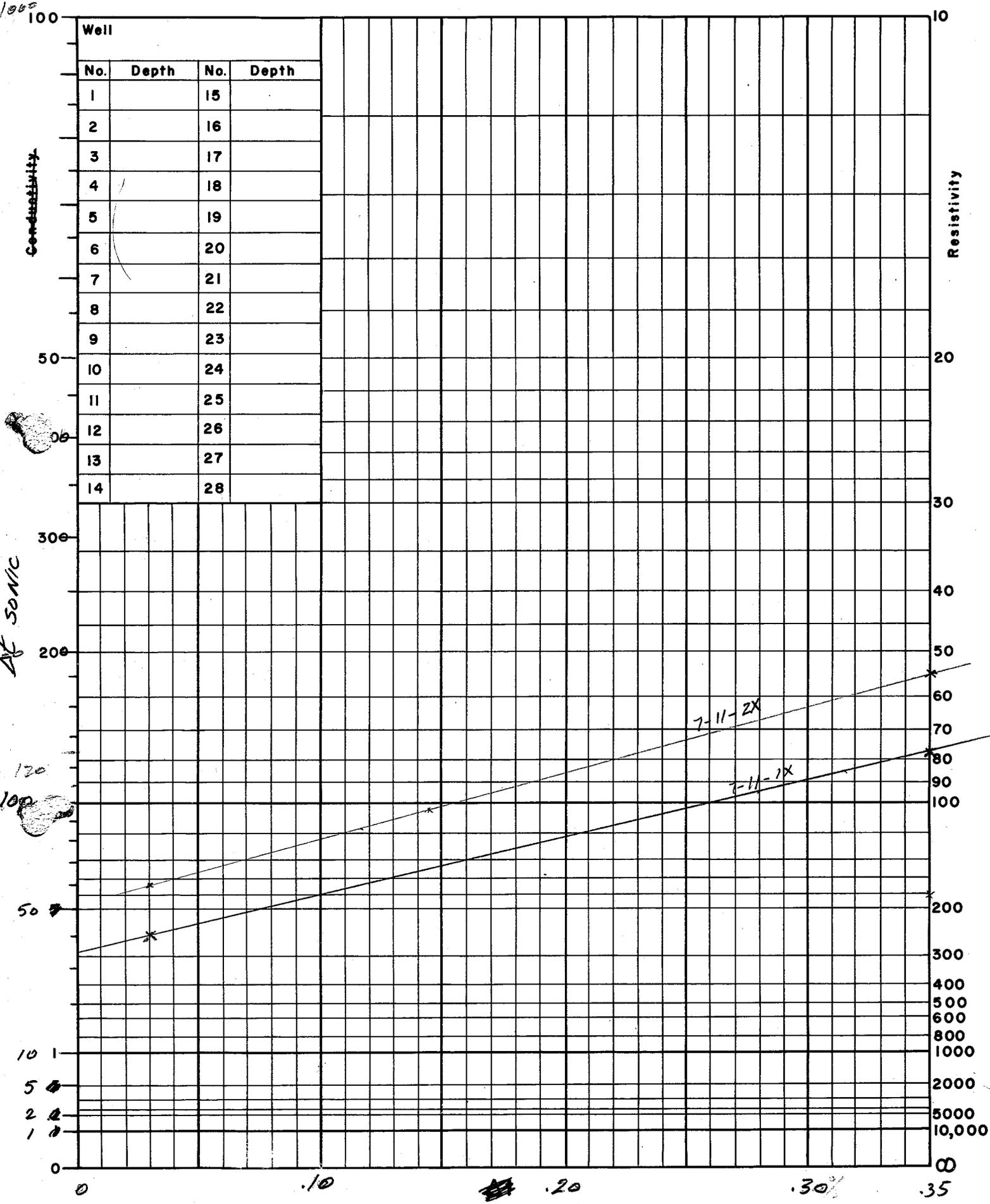
Well 7-11-1X Microlog in No. & Date _____ A. Commercial producer
 Field COD Electric Log Run No. & Date _____ B. Drill steam test hydrocarbon _____
 Company PHILLIPS Bit Size 1 1/4" C. Hydrocarbon shows in cores or cuttings _____
 Block 7-11 Interpreted By F.A.-AL-KASIM D. Drill steam test H₂O _____
 E. No hydrocarbon shows in cores or cuttings _____

Depth _____ Temp. _____ R_m _____ R_{mc} _____ R_{mf} _____
 °F _____ Ωm _____ Ωm _____ Ωm _____
 210°F 11 22 22

This interpretation is obviously invalid. FDL is too low, resulting in very high Sw values which are disproven by test results which showed no water out on the gas.

| Interval Investigated | L | P _B | φ _{FDL} | F _{M=1.85} | R _w | ① | | R _{XOS} | SP | R _{XOS} /R _o | ② R _o | ③ | | k=1.8 | S _{w1} |
|-----------------------|----|----------------|------------------|---------------------|----------------|----------------|----------------|------------------|----|----------------------------------|------------------|--------------------------------|--------------------------------|-------|-----------------|
| | | | | | | R _o | R _L | | | | | R _L /R _o | R _L /R _o | | |
| 9525 - 9528 | 3 | 2.48 | .07 | 136 | .057 | 7.75 | 2.0 | 14 | 8 | 1.3 | 10.8 | <.5 | | | |
| 33 - 38 | 5 | 2.30 | .15 | 34 | .054 | 1.84 | 8.0 | 2.8 | 10 | 1.3 | 2.15 | <.5 | | | |
| 38 - 40 | 2 | 2.30 | .15 | 34 | .056 | 1.9 | 8.0 | 2.8 | 9 | 1.25 | 2.25 | 4.2 | 3.55 | | 0.41 |
| 40 - 44 | 4 | 2.35 | .13 | 43 | .054 | 2.33 | 11.0 | 3.6 | 10 | 1.3 | 2.76 | 4.72 | 4.0 | | 0.42 |
| 44 - 46 | 2 | 2.35 | .13 | 43 | .054 | 2.33 | 6.0 | 3.6 | 10 | 1.3 | 2.76 | 2.28 | 2.17 | | 0.62 |
| 46 - 52 | 6 | 2.35 | .13 | 43 | .054 | 2.33 | 7.5 | 3.6 | 10 | 1.3 | 2.76 | 3.2 | | | 0.53 |
| 56 - 59 | 3 | 2.25 | .17 | 27 | .059 | 1.59 | 3.0 | 2.2 | 7 | 1.2 | 1.84 | 1.89 | | | |
| 66 - 72 | 6 | 2.45 | .09 | 86 | .054 | 4.64 | 7.3 | 8.0 | 10 | 1.3 | 6.16 | 1.58 | | | |
| 72 - 75 | 3 | 2.30 | .15 | 34 | .054 | 1.84 | 4.3 | 2.8 | 10 | 1.3 | 2.15 | 2.34 | | | |
| 75 - 83 | 8 | 2.37 | .12 | 52 | .053 | 2.75 | 12.0 | 4.4 | 11 | 1.4 | 3.15 | 4.4 | | | |
| 83 - 88 | 5 | 2.35 | .13 | 43 | .053 | 2.28 | 7.9 | 3.6 | 11 | 1.4 | 2.56 | 3.46 | | | |
| 88 - 90 | 2 | 2.35 | .13 | 43 | .054 | 2.32 | 9.6 | 3.6 | 10 | 1.3 | 2.76 | 4.14 | | | |
| 9602 - 9607 | 5 | 2.20 | .19 | 22 | .054 | 1.19 | 23.0 | 1.65 | 10 | 1.3 | 1.27 | 19.3 | | | |
| 9 - 12 | 3 | 2.28 | .16 | 30 | .056 | 1.70 | 3.7 | 2.40 | 9 | 1.25 | 1.92 | 2.17 | | | |
| 15 - 25 | 10 | 2.30 | .15 | 34 | .053 | 1.80 | 16.0 | 2.8 | 11 | 1.4 | 2.0 | 8.9 | 8.0 | | 0.26 |
| 25 - 29 | 4 | 2.35 | .13 | 43 | .053 | 2.28 | 7.0 | 3.6 | 11 | 1.4 | 2.56 | 3.08 | | | |
| 29 - 32 | 3 | 2.42 | .10 | 72 | .053 | 3.82 | 12.0 | 6.5 | 11 | 1.4 | 4.65 | 3.15 | | | |
| 32 - 36 | 4 | 2.35 | .13 | 43 | .054 | 2.32 | 7.0 | 3.6 | 10 | 1.3 | 2.77 | 3.00 | | | |
| 36 - 39 | 3 | 2.40 | .12 | 52 | .054 | 2.80 | 13.0 | 4.4 | 10 | 1.3 | 3.4 | 4.65 | | | |
| 42 - 44 | 2 | 2.30 | .15 | 34 | .056 | 1.90 | 4.7 | 2.8 | 9 | 1.25 | 2.25 | 2.47 | | | |
| 44 - 50 | 5 | 2.43 | .10 | 72 | .051 | 3.67 | 7.5 | 6.5 | 12 | 1.42 | 4.58 | 2.04 | | | |
| 50 - 53 | 3 | 2.40 | .12 | 52 | .051 | 2.65 | 10 | 4.4 | 12 | 1.42 | 3.10 | 3.76 | | | |
| 53 - 58 | 5 | 2.30 | .15 | 34 | .051 | 1.74 | 7.0 | 2.8 | 12 | 1.42 | 1.98 | 4.0 | | | |
| 58 - 61 | 3 | 2.28 | .16 | 30 | .050 | 1.53 | 9.4 | 2.40 | 13 | 1.45 | 1.66 | 6.15 | | | |
| 61 - 65 | 4 | 2.40 | .12 | 52 | .049 | 2.55 | 8.5 | 4.40 | 14 | 1.50 | 2.94 | 3.35 | | | |

RESISTIVITY VELOCITY LOG - WEST TEXAS TYPE



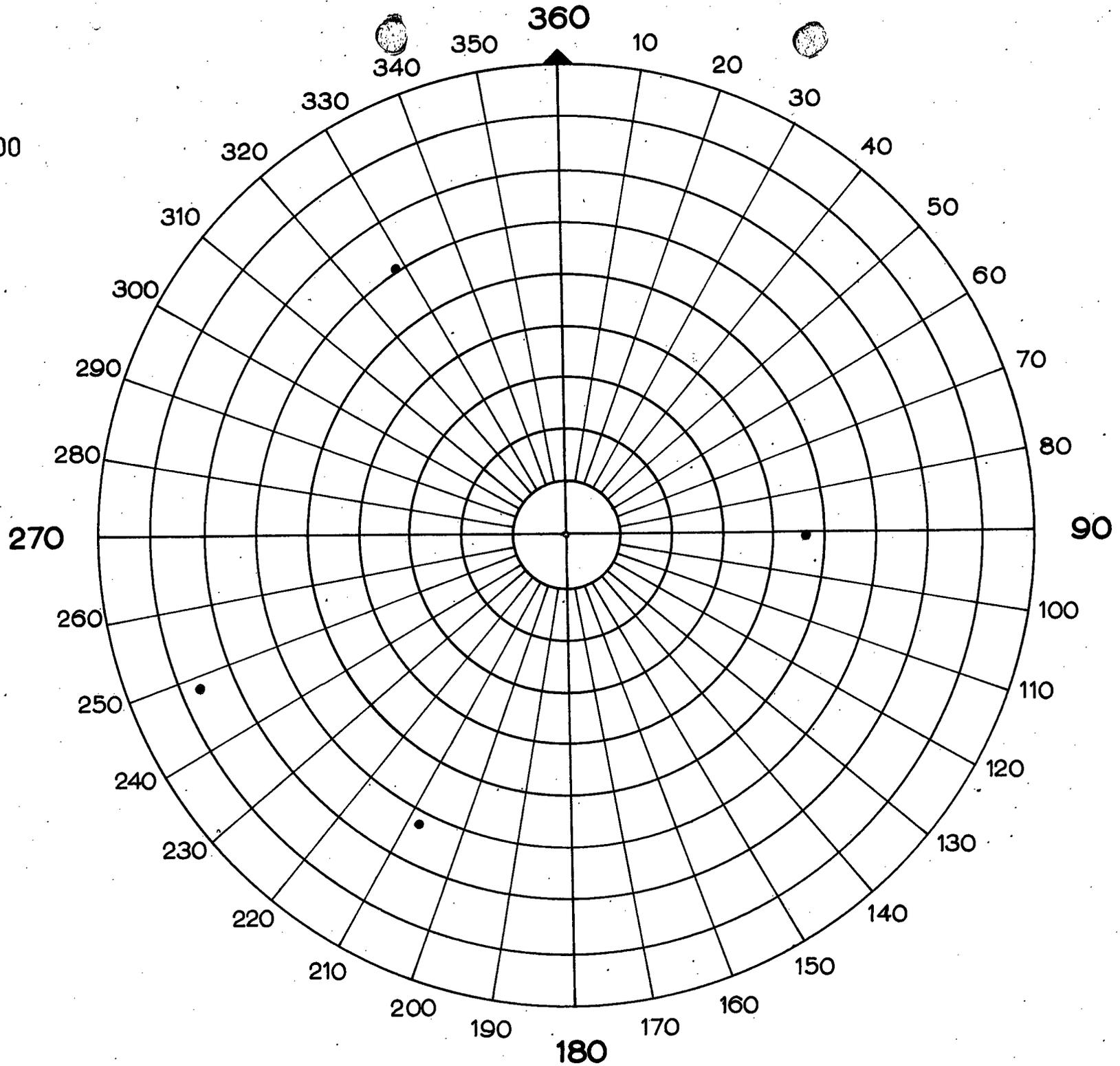
Porosity

Phillips

7/11-1X

6445 6500

• = A

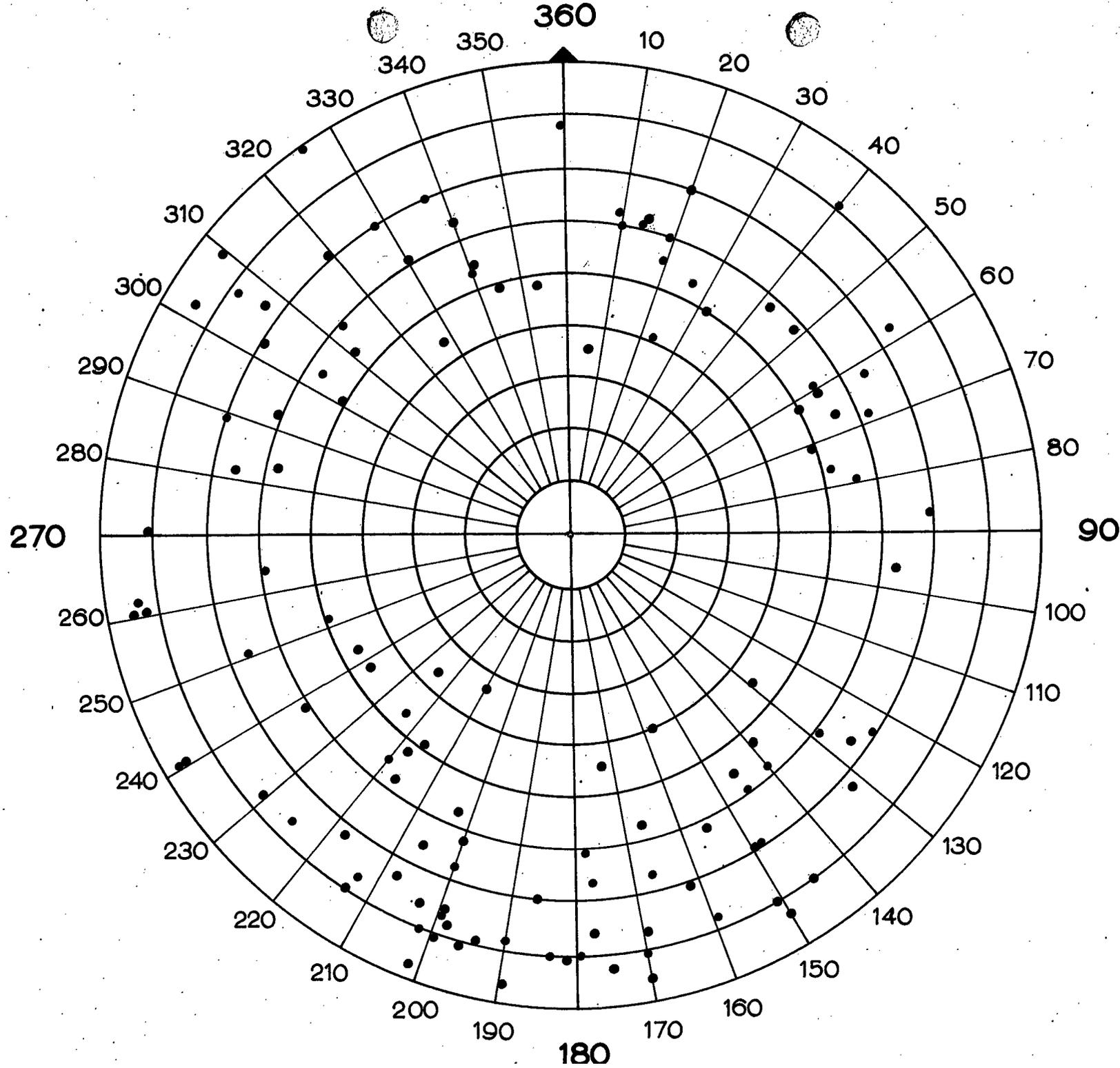


Phillips

7/11-1X

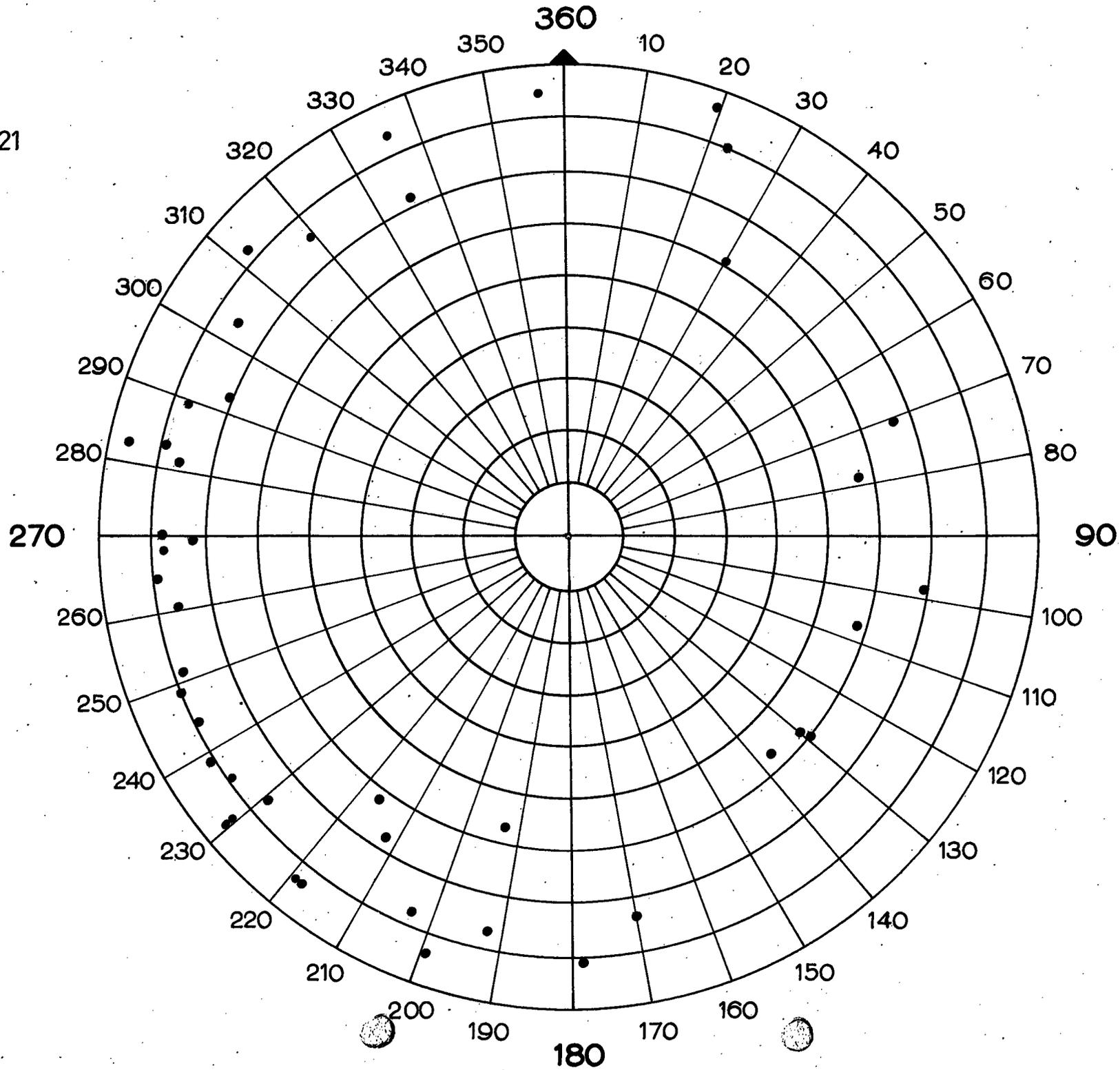
6500 8723

- = A
- = B



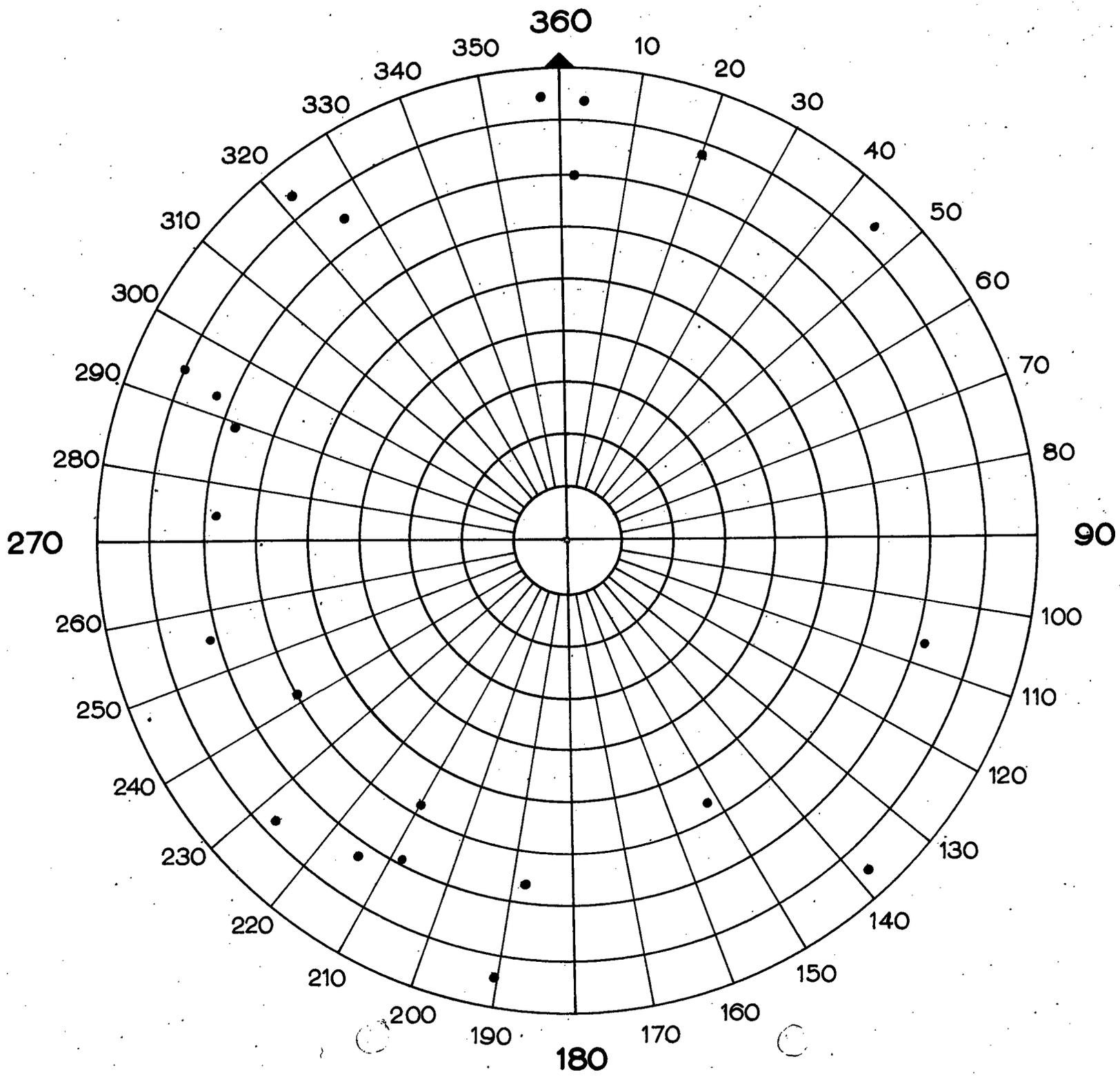
Phillips
7/11-1X
8723 - 9221

- = A
- = B



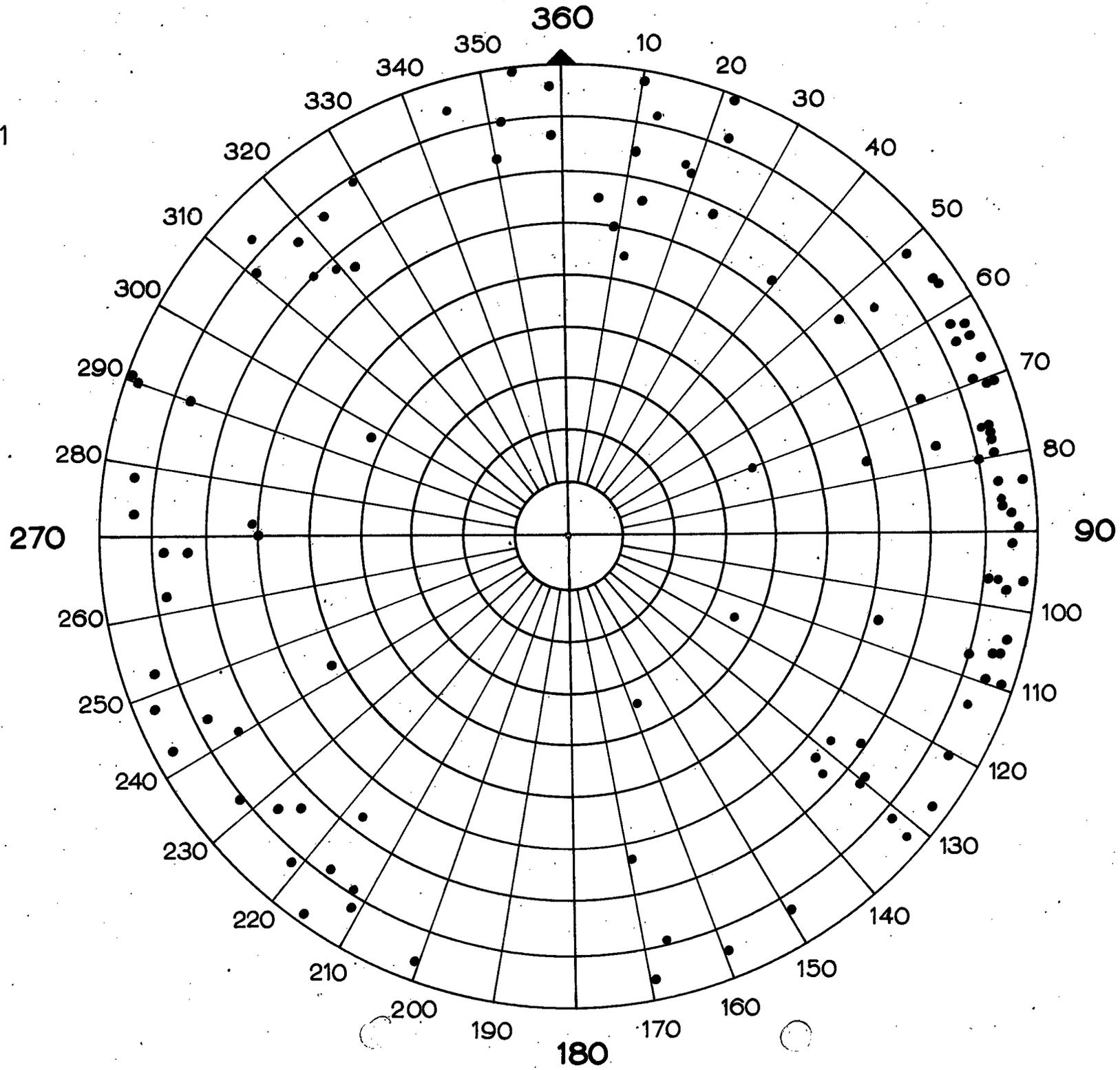
Phillips
7/11-1X
9221-9381

• = A
• = B



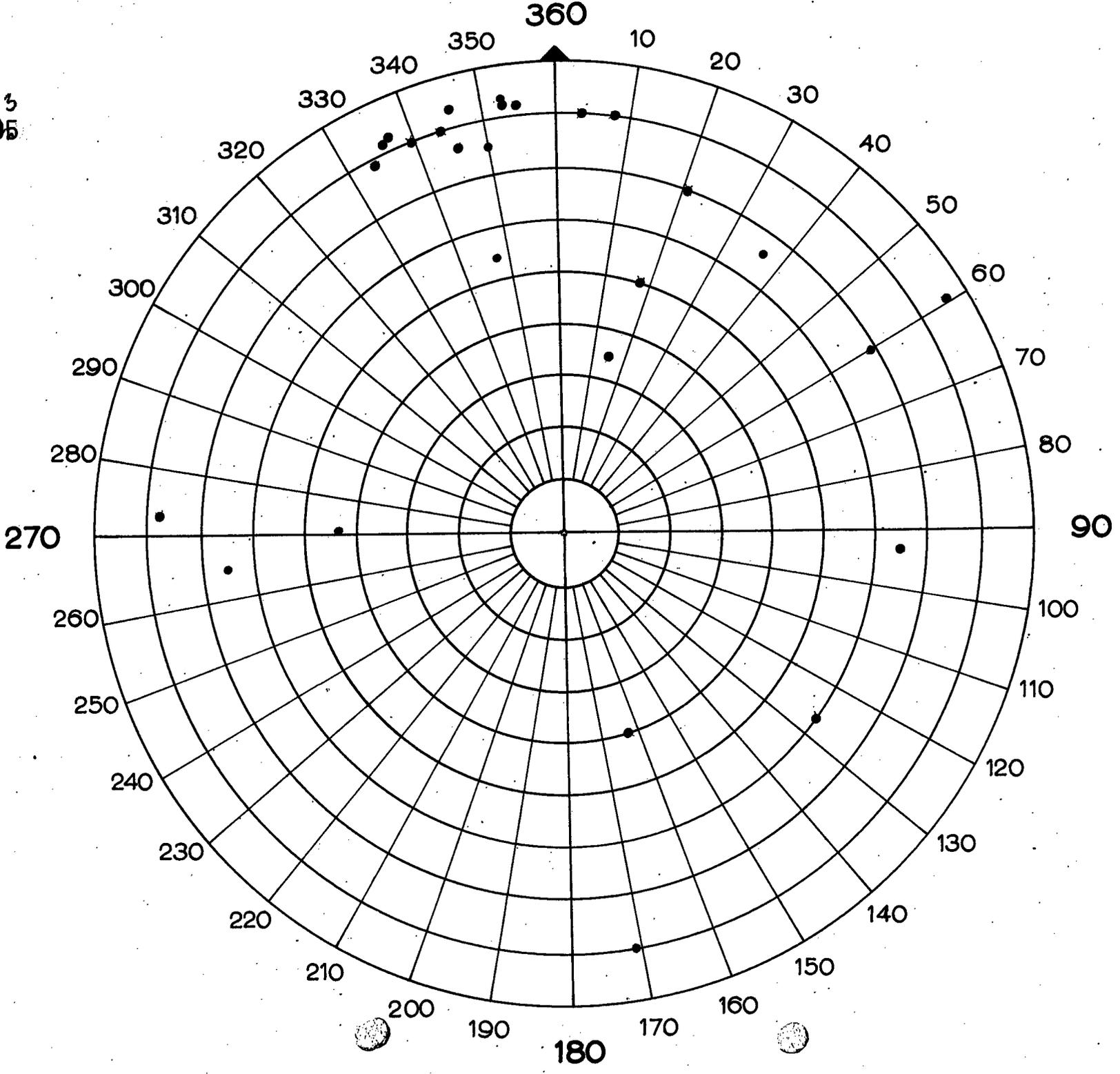
Phillips
7/11-1X
9381-10061

• = A
• = B



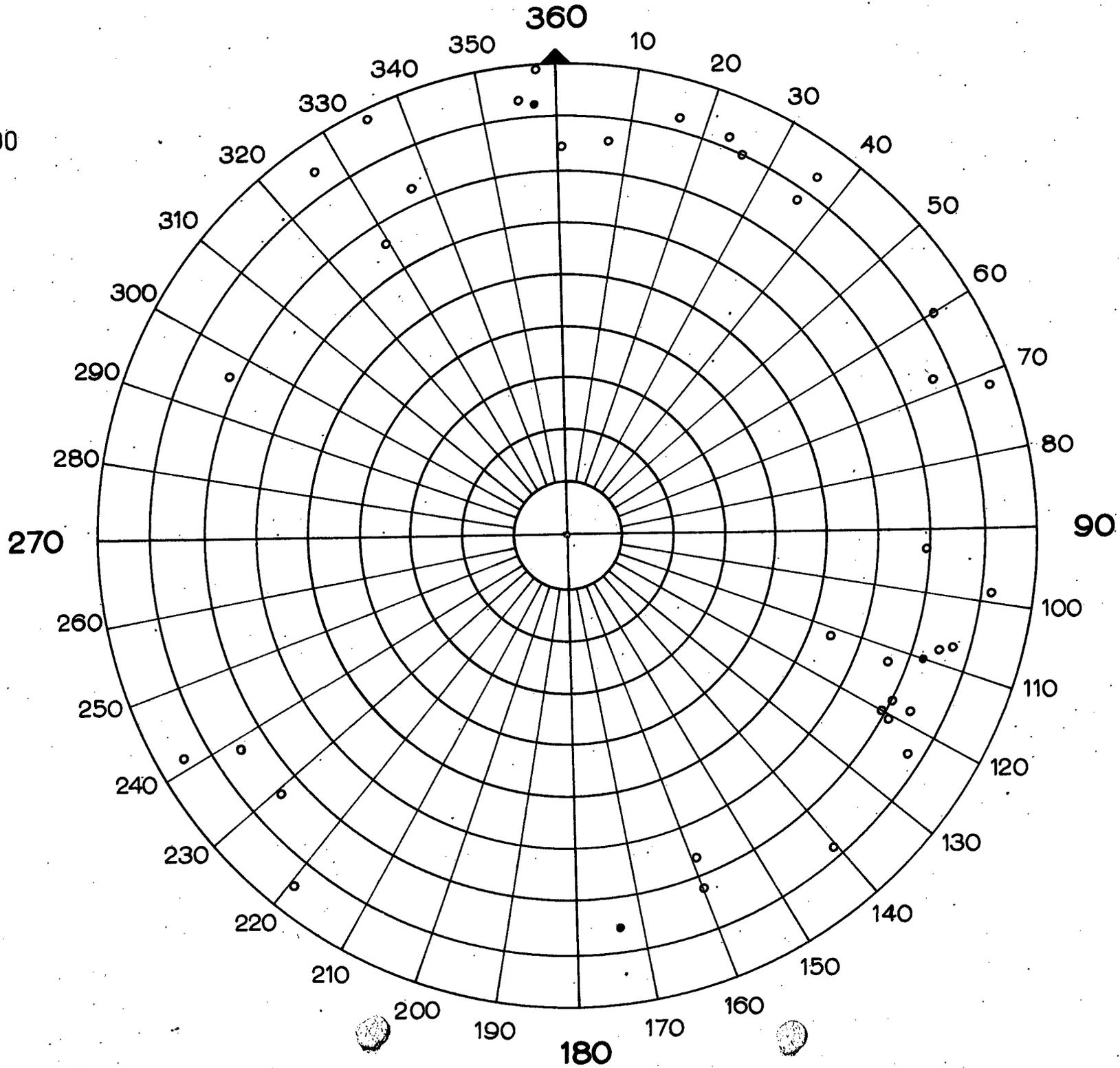
Phillips
7/11-1X
10061-10395

• = A
• = B



Phillips
7/11-1X
10395-12200

• = 2
○ = 3

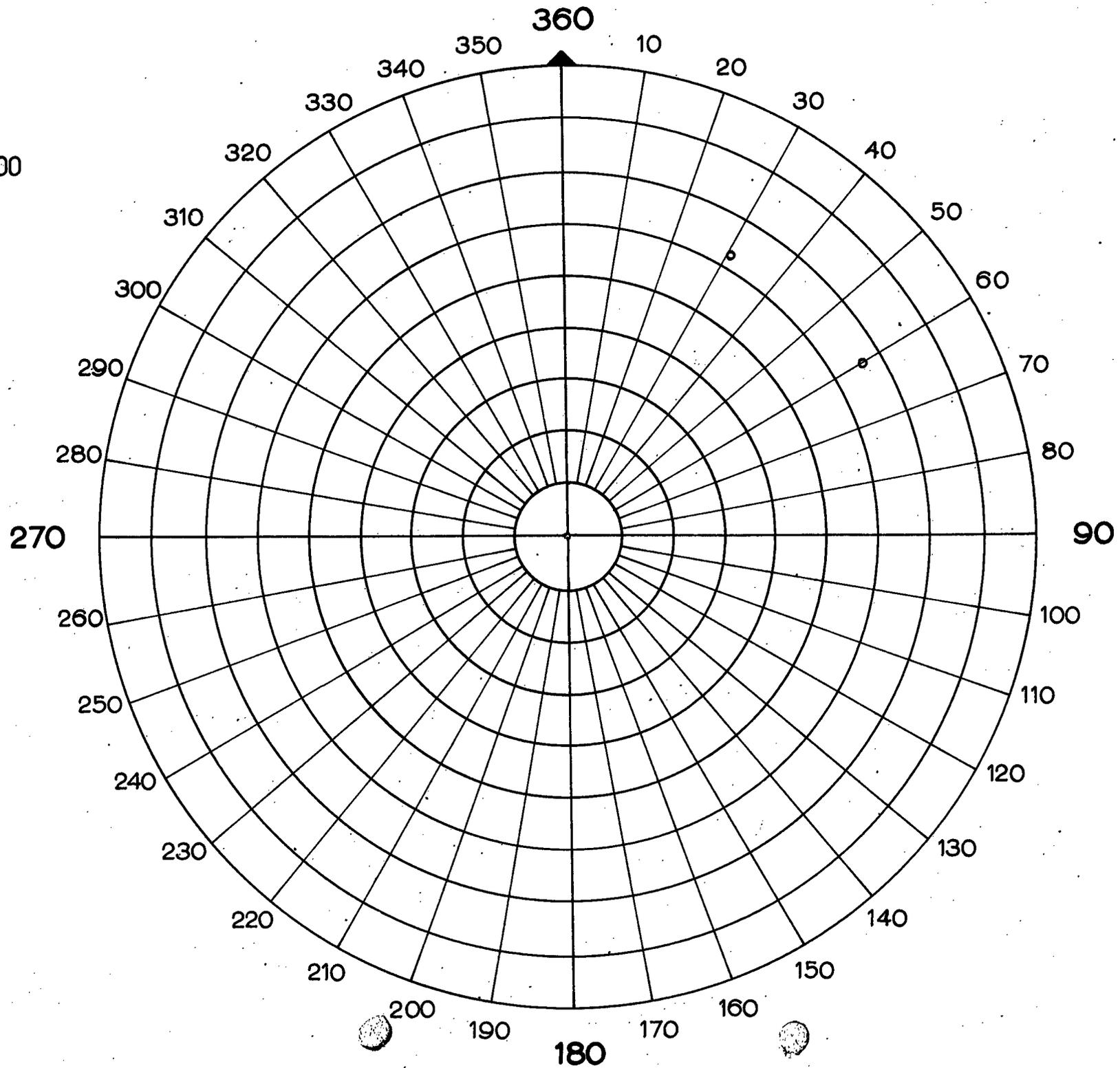


Phillips

7/11-1X

12300-13000

○ = 3



| | | | |
|----------------------------------|----------------|-------------|--------------------------|
| Pleistocene | 1590' - 1650' | | } Quaternary Tertiary |
| Upper Pliocene | 1680 - 2060' | | |
| Lower - " - | 2090' - 2450' | | |
| Upper Miocene | 2500 - 2650' | | |
| Middle - " - | 2700 - 5200' | | |
| Lower - " - | 5120' - 5820' | Burdigalian | |
| - " - " - | 5840 - 6500' | Aquitanian | |
| Oligocene | 6560 - 8720 | | |
| Upper? Middle? | | | |
| Eocene | 8740' - 9220' | | |
| Lower Eocene? } Palaeocene? } | 9240' - 9380' | | |
| Palaeocene | 9400 - 10060' | | |
| Lower - " - | 10070 - 10388' | | |

| | |
|-----------------------|----------------|
| Upper Cretaceous | 10390 - 12264 |
| Cretaceous - Frasnian | 12270 - 12460' |
| Upper Permian | 12480 - 13000' |

OK 2/9/68

Core Analysis Data

Porosity.

Permeability.

Relative permeability

Capillary pressure curves. (S_w weighted avg), Residual Gas saturation.

Wettability

Formation water analysis

Cementation factor (m)

Saturation exponent (n)

Res. Temp.

Structural & Reservoir Description

Structure Contour map on top and bottom of Pay.

Isopach of Net Pay.

Seismic profiles

Testing data

Initial Res. Pres. Down point (P_b). BHFP. WHFP.

WHCIP. BHCIP. Orifice size. Separator Temp & pres.

Pressure gradient in borehole.

Draw down test data if any were taken.

Drive mechanism. Viscosity of rock not determined.

Gas compressibility

Rock compressibility? Water compressibility.

Conformance factor.

Gas analysis. Hydrocarbon components. Liquid

analysis. Flash analysis. Carbon isotope.

Blow down pressure.

Reservoir Temperature

Taking DST-5

GPM in well stream of C_3+ = 4.665 say 4.7 avg.

Liquid recovered = $\frac{\text{Gas displaced} \times \text{GPM at cycling pressure} \times \text{Plant Rec}}{42}$

assume plant Recovery = .90

$$= \frac{80 \times 3.6 \times 10^9 \times 4.70 \times .9}{42} = \frac{12.1824 \times 10^9}{42}$$

$$= \underline{290,000,000} \text{ bbls}$$

Gas Council estimates Reserves of

| | | |
|---------------|---|-----------------------|
| West Sale | } | $25,000 \times 10^9$ |
| Soman | | |
| Hewlett | } | $= 25 \times 10^{12}$ |
| Indefatigable | | |

EXPECTED LIQUID RECOVERIES
BY CYCLING.

The average stock tank liquid to well stream = 72.78 bbls/MMSCF
Avg 70 bbl/MMSCF

Original Gas in place = 3,600,000 MMSCF

Recoverable gas assuming 80% recovery = 2,800,000 MMSCF

Liquid recovery by cycling = $2,800,000 \times 70$
 $= 196,000,000$ bbls
Avg = 200,000,000 bbls

THIS FIGURE IS MAXIMUM

Since

- 1) It is assumed that gas recovery is 80% ?!
- 2) Conformance and efficiency factors are 1.0
- 3) Average liquid to well stream ratios stays 70 bbls/MMSCF
- 4) Plant recovery is assumed not higher than equipment used in test ?! This makes to minimize the figure.

CONDENSATE LOSS DUE TO PRESSURE

DEPLETION

Area under curve = 585 revolutions.

$$4 \text{ of } 16 \text{ cm}^2 = 180 \quad 4$$

$$16 \text{ cm}^2 = 2000 \times 4 = 8,000$$

$$\begin{aligned} \text{Area under curve} &= \frac{585}{180} \times 8,000 = \frac{4,680,000}{180} \\ &= 26,000 \end{aligned}$$

$$\frac{26,000}{5576} = 4.663\% \text{ condensate will be left in reservoir due to } \text{depletion by pressure depletion.}$$

Say 5%

$$\text{i.e. } \frac{.05}{180} \times 3600 \times 10^9 = 180 \times 10^9 \text{ cu. ft.}$$

$$\left(\frac{PV}{ZT}\right)_{103} = \left(\frac{PV}{ZT}\right)_{\text{standard}}$$

$$\frac{P_s V_s}{Z_s T_s} = \frac{P_R V_R}{Z_R T_R}$$

$$V_s = \frac{P_i V_i \times Z_s T_s}{P_s Z_i T_R}$$

$$= \frac{P_i V_i}{Z_i T_R} \frac{Z_s T_s}{P_s} = \frac{520}{14.65}$$

GAS RESERVES

$$\text{Area of } 20 \text{ cm}^2 = 0.213 \text{ mvs.}$$

$$\text{" " } 1 \text{ cm}^2 = \frac{0.213}{20} = 0.01065 \text{ mvs.}$$

$$\text{Each cm} = 200 \text{ acres} \times 100 \text{ ft} = 20,000 \text{ acres. ft}$$

$$\text{Area between curves} = 3.615 \text{ mvs}$$

$$= \frac{3.615}{0.01065} = 339.5 \text{ sq cm}$$

$$\text{Area between curves} = 339.5 \times 10,000 = 3,395,000$$

$$= 2 \times 3.395 \times 10^6 \text{ acres. ft}$$

Percent sand

$$\begin{aligned} \text{Pore Volume} &= \frac{8,712}{43,560} \times 20 \times .75 \times 3.395 \times 10^6 \times 0.22 \\ &= 6,534 \times 3.395 \times 10^6 \times 0.22 \\ &= 22,183 \times 10^6 \times 0.22 \\ &= \frac{22,183 \times 10^9 \times 0.22}{2} = 2 \times 4.88 \times 10^9 \text{ cu. ft} \end{aligned}$$

$$\text{Gas reserves} = \frac{P_i \times \text{Por. Vol}}{Z_i R T_R} \times 379.4$$

$$\begin{aligned} &= \frac{5705 \times 4.88 \times 10^9}{1.054 \times 10.73 \times (460 + 235)} \times 379.4 \\ &= \frac{2,7840 \times 10^9}{11.31 \times 695} \times 379.4 \end{aligned}$$

$$= \frac{1.056 \times 10^7 \times 10^9}{7.860} = \frac{11343 \times 10^9}{7.860} \text{ cu. ft}$$

$$2686 \times 10^9$$

Area under curve = 1160 hrs

$$\frac{1.160}{.01065} = 2 \times 108.92 \text{ cm}^2$$

$$108.92 \times 20,000 = 2 \times 1089200 = 2 \times 1.0892 \times 10^6 \text{ acres-ft}$$

$$\begin{aligned} \text{Porc Vol} &= 43,560 \times 2 \times 1.0892 \times 10^6 \times \frac{.15}{.2 \times .75} \\ &= 2 \times 7.116.8 \times 10^6 = 2 \times 7.1168 \times 10^9 \text{ cu. ft} \end{aligned}$$

$$\begin{aligned} \text{Gas reserves} &= \frac{P_i \times \text{Porc Vol}}{z_i R T_R} \quad 379.4 \\ &= \frac{5705 \times 7.1168 \times 10^9 \times 379.4 \times 2}{1.054 \times 10.73 \times 695} \\ &= \frac{1.5404 \times 10^{16} \times 2}{7860} = 2 \times 1960 \times 10^9 \text{ cu. ft} \end{aligned}$$

$$= 2 \times 1.96 \times 10^{12}$$

$$= 1960 \text{ MM MSCF}$$

$$3920 \times 10^9 \text{ SCF}$$

$$\text{Area under curve} = 1142 \text{ revs}$$

$$\frac{1.142}{1.065} \times 200,000,000 = 1.0723 \times 2 \times 10^6 = 2.1446 \times 10^6$$

$$\begin{aligned} \text{Por Vol} &= 43,560 \times 2.1446 \times 10^6 \times \frac{0.15}{0.2 \times 0.75} \\ &= 0.3217 \times 43,560 \times 10^6 \\ &= 14,012.8 \times 10^6 = 14,013 \times 10^9 \end{aligned}$$

$$\begin{aligned} \text{Gas reserves} &= \frac{P_i \times \text{Por Vol}}{Z_i R T_R} \times 379.4 \\ &= \frac{5705 \times 14,013 \times 10^9 \times 379.4}{1,054 \times 10,73 \times 695} \\ &= \frac{79944 \times 10^9 \times 379.4}{11,309 \times 695} \\ &= \frac{30,331 \times 10^{15}}{7860} = \underline{\underline{3859 \times 10^9 \text{ SCF}}} \end{aligned}$$

Area under curve = 1052 revolutions.

$$\frac{1.052}{1.065} \times 2,000,000 = 1.9756 \times 10^6$$

$$\begin{aligned} \text{Por vol} &= 43,560 \times 1.9756 \times 10^6 \times 0.2 \times 0.75 \\ &= 65,34 \times 1.9756 \times 10^6 \\ &= 12,909 \times 10^9 \end{aligned}$$

say 13×10^9 cc. ft

$$\text{Gas Reserves} = \frac{P_i \times \text{Por Vol} \times 379.4}{Z_i R T_R}$$

$$= \frac{5705 \times 13 \times 10^9 \times 379.4}{1.054 \times 10.73 \times 695}$$

$$= \frac{28,138 \times 10^{12}}{7860} = \underline{\underline{3580 \times 10^9 \text{ SCF}}}$$

say $3600 \times 10^9 \text{ SCF}$

Taking the reservoir as a flat sheet whose area = 7800 acres = 31.6 sq. km.

$$\text{Rock Vol. of sand} = 7800 \times 250 = 1.95 \times 10^6 \text{ acres ft}$$

$$\begin{aligned} \text{Por vol} &= 43,560 \times 1.95 \times 10^6 \times 0.2 \times 0.75 \\ &= 0.2928 \times 43,560 \times 10^6 \\ &= 12,741 \times 10^6 \\ &= 12.74 \times 10^9 \end{aligned}$$

$$\begin{aligned} \text{Gas Reserves} &= \frac{5705 \times 12.74 \times 10^9}{1.054 \times 10.73 \times 695} \times 379.4 \\ &= \frac{27.58 \times 10^{15}}{7860} = \underline{\underline{3508 \times 10^9 \text{ SCF}}} \end{aligned}$$

$$\text{say } \underline{\underline{3500 \times 10^9 \text{ SCF}}}$$

Optimistic estimate based on the optimistic sand count of 2.8 = $\frac{280}{250} \times 3500 \times 10^9 = 3.92 \times 10^{12}$

$$\text{Recoverable} = \underline{\underline{3.14}}$$

1 km² = 247.1044 acres

| | <u>Area km²</u> | <u>Acres</u> | <u>Depth ft. bel. MSL</u> |
|-----------------|----------------------------|--------------------|---------------------------|
| 3.08 | 0.701 | 173.22 | 10.238 ✓ |
| 3.10 | 1.709 | 422.30 | 10.352 ✓ |
| 3.12 | 2.978 | 735.88 | 10.468 ✓ |
| 3.14 | 4.485 | 1108.26 | 10.584 ✓ |
| 3.16 | 6.438 | 1590.86 | 10.700 ✓ |
| 3.18 | 8.710 | 2152.28 | 10.817 ✓ |
| 3.20 | 11.300 | 2792.28 | 10.935 ✓ |
| 3.22 | 14.200 | 3508.88 | 11.053 ✓ |
| 3.24 | 18.100 | 4472.59 | 11.173 ✓ |

| | | | |
|-----------------|-----------------|-------------------|--------------------|
| 2.96 | 0.778 | 192.25 | 9.417 ✓ |
| 2.98 | 2.36 | 583.16 | 9.496 ✓ |
| 3.00 | 4.37 | 1079.83 | 9.577 ✓ |
| 3.02 | 6.15 | 1519.66 | 9.657 ✓ |
| 3.04 | 8.80 | 2174.48 | 9.737 ✓ |
| 3.06 | 11.30 | 2792.23 | 9.818 ✓ |
| 3.08 | 14.60 | 3607.66 | 9.899 ✓ |
| 3.10 | 20.00 | 4942.00 | 9.980 ✓ |
| 3.12 | 31.60 | 7808.36 | 10.062 ✓ |

GREEN

3.04

3.06

$$\begin{array}{r} \textcircled{1} \quad 3855 \\ \underline{3479} \\ 376 \end{array}$$

376

$$\begin{array}{r} \textcircled{1} \quad 5102 \\ \underline{4619} \\ 483 \end{array}$$

483

$$\begin{array}{r} \textcircled{2} \quad 4230 \\ \underline{3855} \\ 375 \end{array}$$

375

$$\begin{array}{r} \textcircled{2} \quad 5585 \\ \underline{5102} \\ 483 \end{array}$$

483

$$\begin{array}{r} \textcircled{3} \quad 4606 \\ \underline{4230} \\ 376 \end{array}$$

376

Average = 376

Average 483

$$\frac{376}{4.28} \times 100 = 8.80$$

$$\frac{483}{4.28} \times 100 = 11.30$$

8.56

3.08

3.10

$$\begin{array}{r} \textcircled{1} \quad 5893 \\ \underline{5266} \\ 627 \end{array} \quad 627$$

$$\begin{array}{r} \textcircled{1} \quad 9125 \\ \underline{8312} \\ 813 \end{array} \quad 813$$

$$\begin{array}{r} \textcircled{2} \quad 6517 \\ \underline{5893} \\ 624 \end{array} \quad 624$$

$$\begin{array}{r} \textcircled{2} \quad 9938 \\ \underline{9125} \\ 813 \end{array} \quad 813$$

$$\begin{array}{r} \textcircled{3} \quad 7143 \\ \underline{6517} \\ 626 \end{array} \quad 626$$

$$\begin{array}{r} \textcircled{1} \quad 0149 \\ \underline{0126} \\ 23 \end{array}$$

$$\begin{array}{r} \textcircled{4} \quad 7770 \\ \underline{7143} \\ 627 \end{array} \quad 627$$

$$\begin{array}{r} \textcircled{2} \quad 0143 \\ \underline{0149} \\ 24 \end{array}$$

$$\begin{array}{r} \textcircled{5} \quad 8393 \\ \underline{7770} \\ 623 \end{array} \quad 623$$

$$\begin{array}{r} \textcircled{3} \quad 0197 \\ \underline{0173} \\ 24 \end{array}$$

avg = 24

average = 625.4 or 626

avg = 813

$$\frac{6254 \cdot 100}{4.28} = 146$$

avg = 24

$$\text{avg} = \frac{18}{855}$$

$$\begin{array}{r} \textcircled{1} \quad 0010 \\ \underline{9991} \\ 19 \end{array}$$

$$\begin{array}{r} 0027 \\ \underline{0010} \\ 17 \end{array}$$

$$\begin{array}{r} 0045 \\ \underline{0027} \\ 18 \end{array}$$

$$\frac{855}{4.28} \times 100 = 20$$

3.12

$$\begin{array}{r} \textcircled{1} \quad 4219 \\ \quad 2867 \\ \hline \quad 1352 \end{array} \quad 1352$$

$$\begin{array}{r} \textcircled{2} \quad 5572 \\ \quad 4219 \\ \hline \quad 1353 \end{array} \quad 1353$$

$$\begin{array}{r} \textcircled{3} \quad 6922 \\ \quad 5572 \\ \hline \quad 1350 \end{array} \quad 1350$$

$$\text{avg} = 1352$$

$$\frac{1352}{4.28} \times 100 = 316$$

8.02

West Side

East Side

$$\begin{array}{r} \textcircled{1} \quad 2273 \\ \quad 2128 \\ \hline \quad 145 \end{array} \quad 145$$

$$\begin{array}{r} \textcircled{1} \quad 2988 \\ \quad 2866 \\ \hline \quad 122 \end{array} \quad 112$$

$$\begin{array}{r} \textcircled{2} \quad 2417 \\ \quad 2273 \\ \hline \quad 144 \end{array} \quad 144$$

$$\begin{array}{r} \textcircled{2} \quad 3106 \\ \quad 2988 \\ \hline \quad 118 \end{array} \quad 118$$

$$\begin{array}{r} \textcircled{3} \quad 2561 \\ \quad 2417 \\ \hline \quad 144 \end{array} \quad 144$$

$$\begin{array}{r} \textcircled{3} \quad 3228 \\ \quad 3106 \\ \hline \quad 122 \end{array} \quad 122$$

$$\begin{array}{r} \textcircled{4} \quad 2707 \\ \quad 2561 \\ \hline \quad 146 \end{array} \quad 146$$

$$\begin{array}{r} \textcircled{4} \quad 3346 \\ \quad 3228 \\ \hline \quad 118 \end{array} \quad 118$$

$$\begin{array}{r} \textcircled{5} \quad 2852 \\ \quad 2707 \\ \hline \quad 145 \end{array} \quad 145$$

$$\begin{array}{r} 5 \quad 3465 \\ \quad 3346 \\ \hline \quad 119 \end{array} \quad 119$$

$$\begin{array}{r} \text{Average} = 144.8 \\ \quad 118.0 \\ \hline \quad 262.8 \end{array}$$

$$\text{Average} = \underline{\underline{118}}$$

$$\frac{2628}{4.28} \times 100 = 6.15$$

292

West Side

East Side

$$\begin{array}{r} \textcircled{1} \quad 574 \\ 0523 \\ \hline 51 \end{array}$$

$$\begin{array}{r} \textcircled{1} \quad 0987 \\ 0935 \\ \hline 52 \end{array}$$

$$\begin{array}{r} \textcircled{2} \quad 0770 \\ 0672 \\ \hline 48 \end{array}$$

$$\begin{array}{r} \textcircled{2} \quad 1040 \\ 0987 \\ \hline 53 \end{array}$$

$$\begin{array}{r} \textcircled{3} \quad 0769 \\ 0720 \\ \hline 49 \end{array}$$

$$\begin{array}{r} \textcircled{3} \quad 1092 \\ 1040 \\ \hline 52 \end{array}$$

$$\begin{array}{r} \textcircled{4} \quad 0818 \\ 0769 \\ \hline 49 \end{array}$$

$$\begin{array}{r} \textcircled{4} \quad 1145 \\ 1092 \\ \hline 53 \end{array}$$

$$\begin{array}{r} \textcircled{5} \quad 0809 \\ 0818 \\ \hline 51 \end{array}$$

$$\begin{array}{r} \textcircled{5} \quad 1196 \\ 1145 \\ \hline 51 \end{array}$$

$$\begin{array}{r} \text{Average} \quad 49.4 \\ 52.0 \\ \hline 101.4 \end{array}$$

$$\text{Average} = 52$$

$$\frac{0.1014}{428} \times 100 = \underline{\underline{2.36}}$$

296

West Side

East Side

$$\begin{array}{r} \textcircled{1} \quad 0387 \\ \quad 0382 \\ \quad \quad 5 \end{array}$$

$$\begin{array}{r} \textcircled{1} \quad 481 \\ \quad 0456 \\ \quad \quad 25 \end{array} \quad 25$$

$$\begin{array}{r} \textcircled{2} \quad 0395 \\ \quad 0387 \\ \quad \quad 8 \end{array}$$

$$\begin{array}{r} \textcircled{2} \quad 505 \\ \quad 481 \\ \quad \quad 24 \end{array} \quad 24$$

$$\begin{array}{r} \textcircled{3} \quad 0402 \\ \quad 0395 \\ \quad \quad 7 \end{array}$$

$$\begin{array}{r} \textcircled{3} \quad 531 \\ \quad 505 \\ \quad \quad 26 \end{array} \quad 26$$

$$\begin{array}{r} \textcircled{4} \quad 0410 \\ \quad 0402 \\ \quad \quad 8 \end{array}$$

$$\begin{array}{r} \textcircled{4} \quad 555 \\ \quad 531 \\ \quad \quad 24 \end{array} \quad 24$$

$$\begin{array}{r} \textcircled{5} \quad 0418 \\ \quad 0410 \\ \quad \quad 8 \end{array}$$

$$\begin{array}{r} \textcircled{5} \quad 581 \\ \quad 555 \\ \quad \quad 26 \end{array} \quad 26$$

Average = 8

Average = 25

$$\frac{.008}{4.28} \times 100 = 0.187$$

$$\frac{0.583}{0.778}$$

$$\frac{.025}{4.28} \times 100 = 0.583$$

208

$$Q_0 = 100 \text{ km}^2$$
$$n_0 = 4280$$

YELLOW

West Side

East Side

$$\begin{array}{r} 4206 \\ 4196 \\ \hline 10 \end{array} \quad 10$$

$$\begin{array}{r} 4332 \\ 3310 \\ \hline 22 \end{array} \quad 22$$

$$\begin{array}{r} 4215 \\ 4206 \\ \hline 9 \end{array} \quad 9$$

$$\begin{array}{r} 1367 \\ 1346 \\ \hline 21 \end{array} \quad 21$$

$$\begin{array}{r} 4224 \\ 4215 \\ \hline 9 \end{array} \quad 9$$

$$\begin{array}{r} 1307 \\ 1286 \\ \hline 21 \end{array} \quad 21$$

$$\begin{array}{r} 4232 \\ 4224 \\ \hline 8 \end{array} \quad 8$$

$$\begin{array}{r} 1328 \\ 1307 \\ \hline 21 \end{array} \quad 21$$

$$\begin{array}{r} 4257 \\ 4248 \\ \hline 9 \end{array} \quad 9$$

$$\begin{array}{r} 1349 \\ 1328 \\ \hline 21 \end{array} \quad 21$$

Average = 9

Average = 21

$$Q = \frac{n}{n_0} \times Q_0$$

$$Q = \frac{.009}{4280} \times 100 = 0.210 \text{ km}^2$$

$$\frac{.021}{4280} \times 100 = 0.491 \text{ km}^2$$

$$\begin{array}{r} 0.210 \\ + 0.491 \\ \hline 0.701 \end{array} \text{ km}^2$$

3.100

West Side

$$\begin{array}{r} \textcircled{1} \quad 1566 \\ \quad 1534 \\ \hline \quad \quad 32 \end{array} \quad 32$$

$$\begin{array}{r} \textcircled{2} \quad 1436 \\ \quad 1406 \\ \hline \quad \quad 30 \end{array} \quad 30$$

$$\begin{array}{r} \textcircled{3} \quad 1470 \\ \quad 1436 \\ \hline \quad \quad 34 \end{array} \quad 34$$

$$\begin{array}{r} \textcircled{4} \quad 1504 \\ \quad 1470 \\ \hline \quad \quad 34 \end{array} \quad 34$$

$$\begin{array}{r} \textcircled{5} \quad 1534 \\ \quad 1504 \\ \hline \quad \quad 30 \end{array} \quad 30$$

Average = 32

East Side

$$\begin{array}{r} \textcircled{1} \quad 1604 \\ \quad 1565 \\ \hline \quad \quad 39 \end{array}$$

$$\begin{array}{r} \textcircled{2} \quad 1645 \\ \quad 1604 \\ \hline \quad \quad 41 \end{array}$$

$$\begin{array}{r} \textcircled{3} \quad 1686 \\ \quad 1645 \\ \hline \quad \quad 41 \end{array}$$

$$\begin{array}{r} \textcircled{4} \quad 1732 \\ \quad 1686 \\ \hline \quad \quad 46 \end{array}$$

$$\begin{array}{r} \textcircled{5} \quad 1773 \\ \quad 1735 \\ \hline \quad \quad 38 \end{array}$$

Average = 41

$$\frac{032}{4.280} \times 100 = 0.749 \text{ km}^2$$

$$\frac{041}{4.280} \times 100 = 0.96 \text{ km}^2$$

$$0.749 + 0.960 = \underline{1.709} \text{ km}^2$$

3.120

West Side

$$\begin{array}{r} \textcircled{1} \\ 2023 \\ \underline{1960} \\ 63 \end{array} \quad 63$$

$$\begin{array}{r} \textcircled{2} \\ 2086 \\ \underline{2023} \\ 63 \end{array} \quad 63$$

$$\begin{array}{r} \textcircled{3} \\ 2151 \\ \underline{2086} \\ 65 \end{array} \quad 65$$

$$\begin{array}{r} \textcircled{4} \\ 2215 \\ \underline{2151} \\ 64 \end{array} \quad 64$$

$$\begin{array}{r} \textcircled{5} \\ 2276 \\ \underline{2215} \\ 61 \end{array} \quad 61$$

Average = 63

$$\frac{.063 \times 100}{4.280} = 1.470$$

$$1.470 + 1.508 = \underline{2.978 \text{ km}^2}$$

East Side

$$\begin{array}{r} \textcircled{1} \\ 2017 \\ \underline{1955} \\ 62 \end{array} \quad 62$$

$$\begin{array}{r} \textcircled{2} \\ 2080 \\ \underline{2017} \\ 63 \end{array} \quad 63$$

$$\begin{array}{r} \textcircled{3} \\ 2146 \\ \underline{2080} \\ 66 \end{array} \quad 66$$

$$\begin{array}{r} \textcircled{4} \\ 3192 \\ \underline{3126} \\ 66 \end{array} \quad 66$$

$$\begin{array}{r} \textcircled{5} \\ 3257 \\ \underline{3192} \\ 65 \end{array} \quad 65$$

Average = 64.5

$$\frac{.0645}{4.280} = 1.508$$

3.14

$$\begin{array}{r} \textcircled{1} \quad 3355 \\ \underline{3257} \\ 98 \end{array}$$

98

$$\begin{array}{r} \textcircled{1} \quad 3857 \\ \underline{3764} \\ 93 \end{array}$$

93

$$\begin{array}{r} \textcircled{2} \quad 3455 \\ \underline{3355} \\ 100 \end{array}$$

100

$$\begin{array}{r} \textcircled{2} \quad 3665 \\ \underline{3573} \\ 92 \end{array}$$

92

$$\begin{array}{r} \textcircled{3} \quad 3554 \\ \underline{3455} \\ 99 \end{array}$$

99

$$\begin{array}{r} \textcircled{3} \quad 3860 \\ \underline{3763} \\ 97 \end{array}$$

97

$$\begin{array}{r} \textcircled{4} \quad 3653 \\ \underline{3554} \\ 99 \end{array}$$

99

$$\begin{array}{r} \textcircled{4} \quad 4045 \\ \underline{3953} \\ 92 \end{array}$$

92

$$\begin{array}{r} \textcircled{5} \quad 3752 \\ \underline{3653} \\ 99 \end{array}$$

99

$$\begin{array}{r} \textcircled{5} \quad 3953 \\ \underline{3860} \\ 93 \end{array}$$

93

Average = 99

Average =

93

$$\frac{.099}{4.280} \times 100 = 2.315 \text{ km}^2$$

$$\frac{.093}{4.280} \times 100 = 2.170$$

$$2.170 + 2.315 = \underline{4.485} \text{ km}^2$$

Yellow

3. No

West Side

East Side

$$\begin{array}{r} \textcircled{1} \quad 4246 \\ \quad 4104 \\ \hline \quad 142 \end{array}$$

$$\begin{array}{r} \textcircled{1} \quad 4983 \\ \quad 4854 \\ \hline \quad 129 \end{array}$$

$$\begin{array}{r} \textcircled{2} \quad 4392 \\ \quad 4246 \\ \hline \quad 146 \end{array}$$

$$\begin{array}{r} \textcircled{2} \quad 5115 \\ \quad 4923 \\ \hline \quad 132 \end{array}$$

$$\begin{array}{r} \textcircled{3} \quad 4535 \\ \quad 4392 \\ \hline \quad 143 \end{array}$$

$$\begin{array}{r} \textcircled{3} \quad 5249 \\ \quad 5115 \\ \hline \quad 134 \end{array}$$

$$\begin{array}{r} \textcircled{4} \quad 4681 \\ \quad 4535 \\ \hline \quad 146 \end{array}$$

$$\begin{array}{r} \textcircled{4} \quad 3590 \\ \quad 3460 \\ \hline \quad 130 \end{array}$$

$$\begin{array}{r} \textcircled{5} \quad 4825 \\ \quad 4681 \\ \hline \quad 144 \end{array}$$

$$\begin{array}{r} \textcircled{5} \quad 3853 \\ \quad 3720 \\ \hline \quad 133 \end{array}$$

Average = 144

Average = 132

$$\frac{.144}{4.280} \times 100 = 3.358$$

$$\frac{.132}{4.280} \times 100 = 3.080$$

$$3.080 + 3.358 = \underline{\underline{6.438}} \text{ km}^2$$

3.18

West Side

East Side

$$\begin{array}{r} \textcircled{1} \quad 3983 \\ \quad 3785 \\ \hline \quad 198 \end{array} \quad 198$$

$$\begin{array}{r} \textcircled{1} \quad 4984 \\ \quad 4810 \\ \hline \quad 174 \end{array} \quad 174$$

$$\begin{array}{r} \textcircled{2} \quad 4181 \\ \quad 3983 \\ \hline \quad 198 \end{array} \quad 198$$

$$\begin{array}{r} \textcircled{2} \quad 5156 \\ \quad 4984 \\ \hline \quad 173 \end{array} \quad 173$$

$$\begin{array}{r} \textcircled{3} \quad 4378 \\ \quad 4181 \\ \hline \quad 197 \end{array} \quad 197$$

$$\begin{array}{r} \textcircled{3} \quad 5331 \\ \quad 5156 \\ \hline \quad 175 \end{array} \quad 175$$

$$\begin{array}{r} \textcircled{4} \quad 4577 \\ \quad 4378 \\ \hline \quad 199 \end{array} \quad 199$$

$$\begin{array}{r} \textcircled{4} \quad 5504 \\ \quad 5331 \\ \hline \quad 173 \end{array} \quad 173$$

$$\begin{array}{r} \textcircled{5} \quad 4777 \\ \quad 4577 \\ \hline \quad 200 \end{array} \quad 200$$

$$\begin{array}{r} \textcircled{5} \quad 5678 \\ \quad 5504 \\ \hline \quad 174 \end{array} \quad 174$$

Average = 199

Average = 174

$$\frac{199}{4.280} \times 100 = 4.650$$

$$\frac{174}{4.280} \times 100 = 4.060$$

$$4.650 + 4.060 = \underline{\underline{8.710 \text{ km}^2}}$$

3.200

3.22

$$\begin{array}{r} \textcircled{1} \quad 6025 \\ \underline{5541} \\ 484 \end{array}$$

$$\begin{array}{r} \textcircled{1} \quad 9862 \\ \underline{9250} \\ 612 \end{array}$$

$$\begin{array}{r} \textcircled{2} \quad 6508 \\ \underline{6025} \\ 483 \end{array}$$

$$\begin{array}{r} \textcircled{2} \quad 0469 \\ \underline{9862} \\ 607 \end{array}$$

$$\begin{array}{r} \textcircled{3} \quad 6994 \\ \underline{6508} \\ 486 \end{array}$$

$$\begin{array}{r} \textcircled{3} \quad 0079 \\ \underline{0469} \\ 610 \end{array}$$

$$\begin{array}{r} \textcircled{4} \quad 8786 \\ \underline{8303} \\ 483 \end{array}$$

$$\begin{array}{r} \textcircled{4} \quad 1689 \\ \underline{1079} \\ 610 \end{array}$$

$$\begin{array}{r} \textcircled{5} \quad 9268 \\ \underline{8786} \\ 482 \end{array}$$

$$\begin{array}{r} \textcircled{5} \quad 2298 \\ \underline{1689} \\ 609 \end{array}$$

Average = 483.6

Average = 609.6
48

$$\frac{.4836}{4.280} \times 100 = 11.30$$

$$\frac{.609}{4.28} \times 100 = 14.20$$

~~14.20 + 11.30 = 25.50~~ ~~14.20~~

3.24

$$\begin{array}{r} \textcircled{1} \quad 3052 \\ \underline{2275} \\ 777 \end{array}$$

777

$$\begin{array}{r} \textcircled{2} \quad 3828 \\ \underline{3052} \\ 776 \end{array}$$

776

$$\begin{array}{r} \textcircled{3} \quad 4603 \\ \underline{3828} \\ 775 \end{array}$$

775

$$\begin{array}{r} \textcircled{4} \quad 5379 \\ \underline{4603} \\ 776 \end{array}$$

776

$$\begin{array}{r} \textcircled{5} \quad 6155 \\ \underline{5379} \\ 776 \end{array}$$

776

Average = 776

$$\frac{.776}{4.28} \times 100 = 18.1$$

Cod 1

.08
 .1
 60
 x
 80
 110
 8
 x 60

Depth of Palaeocene. 2.94 sec.
 Top of the chalk (U. Coek) 3.09 s
 Top of salt 3.33 s

1475
 1400
 9427
 8850
 5770
 4425
 1345

closure 600' ?!

2000 m/sec for Tertiary velocities.

64,64 ft/sec in Cod 1

65,25 ft/sec in Cod 2

5x = 8
 07
 95
 000
 8
 009

2.950

6400

* Porosity from Cores Information sent

25
 600
 56
 40

3.03
 2.95
 .08

3.03
 9786

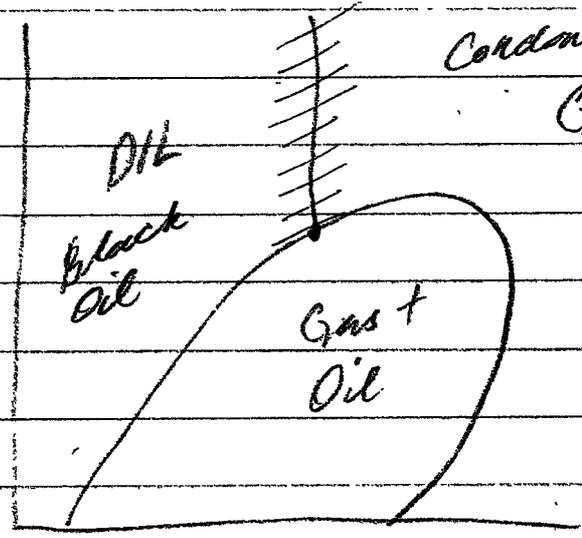
6459
 9786
 9090
 6960
 6060
 9000
 6464
 7575
 147
 14250
 13635
 615

2.95

1.475

650

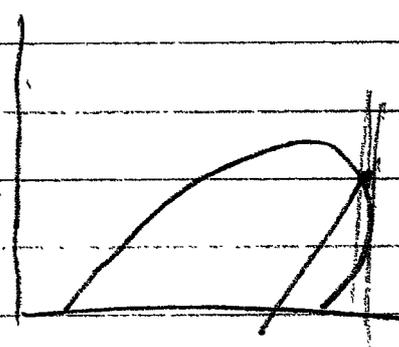
1 X 6500



Condensate

Gas

3.030



Gas

1.0

90 ft

90 ft

| | 7-11-1X | | 7-11-2X | |
|--------------------|---------|-----|---------|-------|
| Top of Palaeocene | 9427 | R&B | 9786 | 39 |
| 4' chalk | 10385 | | 10025' | |
| Gross thickness | 958' | | 1239' | |
| Net sand thickness | 230' | 24% | 280' | 22.6% |
| Net Pay | 4 | | | |

2.0

0-level in profiles is M.S.L.?

Do we subtract 2 ft from M.S.L. to sea bed?

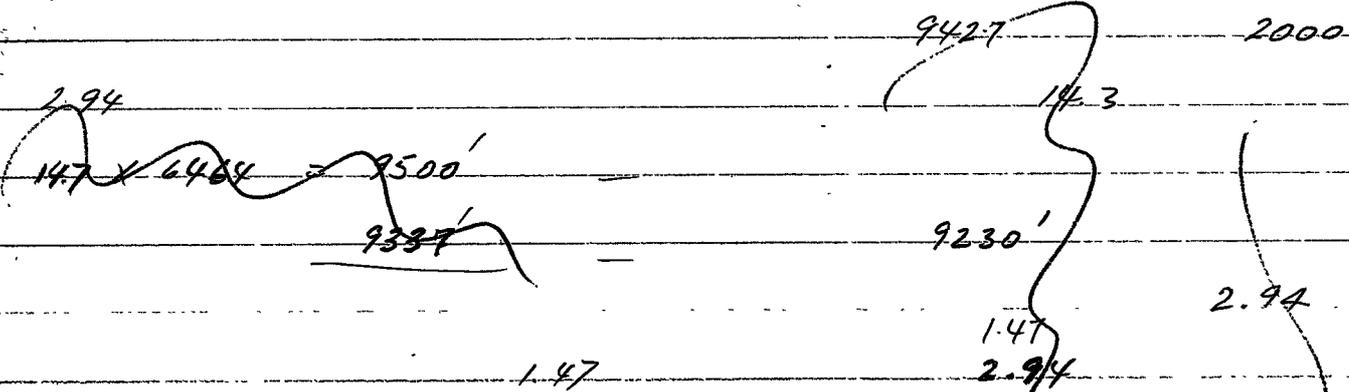
3.0 Porosity from 7-11-2X

- Shaly Neutron, sonic and ED give different results

- Are shales pure? which interval is pure shale?

- Deep invasion and thick mud cake. Was the well logged soon after it was drilled

VELOCITY SURVEY 7/11/1X



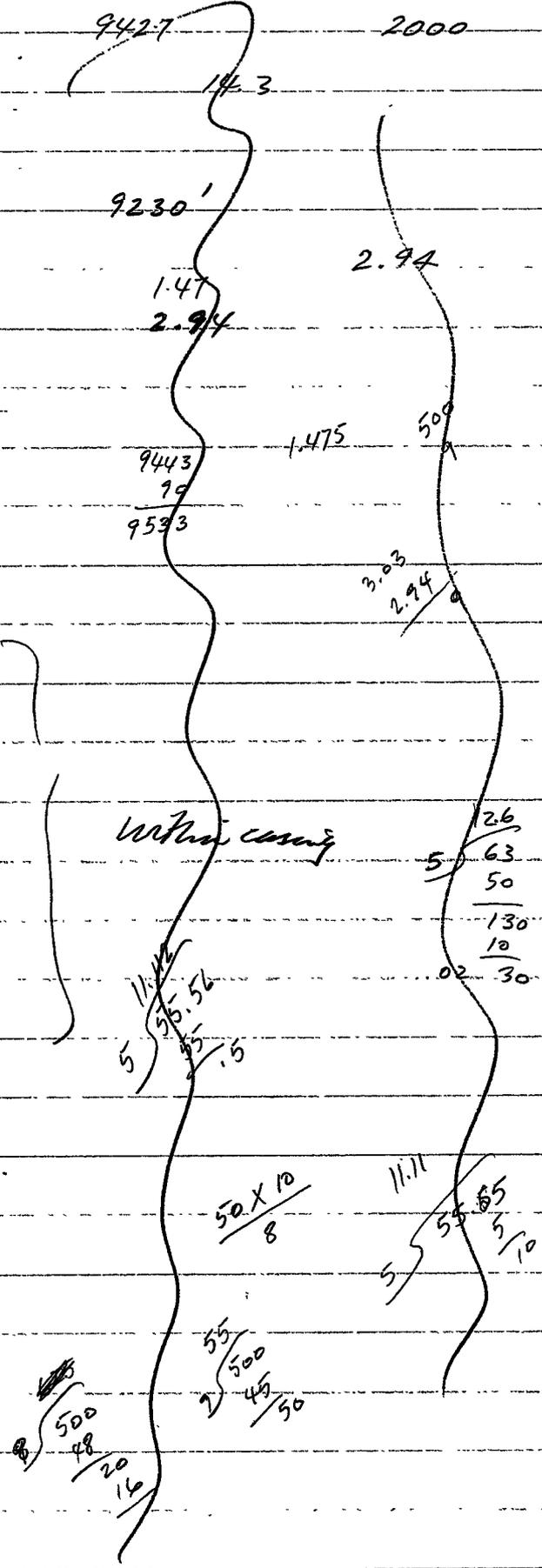
Velocity Survey CSD 1

11,250'

7/11/1X

| | |
|-------------|-------------|
| Sea Level | 1500 ft/sec |
| Ocean floor | 5820 ft/sec |
| 1505 (MSL) | 6350 |
| 2500 | 6820 |
| 3500 | 6210 |
| 4500 | 6300 |
| 5500 | 6500 |
| 6454 | 6680 |
| 7500 | 7060 |
| 8600 | 7510 |
| 9480 | 11,250 |
| 10255 | 14,140 |
| 10405 | 17,280 |
| 12320 | 15,450 |
| 13023 | |

within casing



500
48
20
16

$$\begin{array}{r} 1560 \overline{) 2500} \\ \underline{1560} \\ 940 \end{array}$$

Sea Level 0

| | | | | | |
|---------|------|-----------------------|---|-------------------|---------------|
| Sea Bed | 250 | 250 X 1500 | = | 375,000 | .1660 |
| | 1505 | 1255 X 5820 | = | 7,304,100 | .2150 |
| | 2500 | 995 X 6350 | = | 6,318,250 | .1565 |
| | 3500 | 1000 X 6620 | = | 6,620,000 | .1510 |
| | 4500 | 1000 X 6210 | = | 6,210,000 | .1610 |
| | 5500 | 1000 X 6300 | = | 6,300,000 | .1585 |
| | 6454 | 954 X 6500 | = | 6,201,000 | .1470 |
| | 7500 | 1046 X 6680 | = | 6,987,280 | .1565 |
| | 8600 | 1100 X 7060 | = | 7,766,000 | .1560 |
| | 9480 | 880 X 7510 | = | 6,608,800 | .1170 |
| | | | | <u>60,690,430</u> | <u>1.5885</u> |
| | | | | | 1.5845 |

3.03
1.515

1.47

9427

$$\begin{array}{r} 90 \\ \underline{9337} \end{array}$$

1.5845 X 948

1.65

6525

$$\begin{array}{r} 9337 \\ \underline{1.47} \end{array}$$

9500

9590

6525

$$\begin{array}{r} 1515 \times \\ \underline{6525} \\ 98,853.75 \end{array}$$

9400

3.3

1.65

10,766

$240 \times 1500 = 450,000$ 360,
 $1205 \times 5820 = 7,020,000$ 7,013,100
 $1000 \times 6350 = 6,350,000$ 6,
 $1000 \times 6620 = 6,620,000$
 $1000 \times 6210 = 6,210,000$
 $1000 \times 6300 = 6,300,000$
 $954 \times 6500 = 6,200,000$
 $1046 \times 6680 = 7,000,000$
 $1100 \times 7060 = 7,780,000$
 $880 \times 7510 = 6,610,000$
60,070,000

6402
1.47

9411
90
 9501

1.475
 6402

$64,02$
 $9480 \overline{) 60,690,430}$
 $56,880$
38104
 37920
18400

6413
 $1.47 \overline{) 9427}$
 8882
601
 588
190
 147
430

6410

TRAVEL TIME - DEPTH CONVERSION

1K 9427 - 90 = 9337' }
 2K 9786 - 90 = 9696 } Top Palaeocene

1K 10385 - 90 = 10295'
 11025 - 90 = 10935'

$$\begin{array}{r} 10295 \\ 9337 \\ \hline 0958 \end{array}$$

$9337 \div 1.47 = 6351 \text{ ft/acc}$
 $9696 \div 1.515 = \frac{6400}{49} \text{ ft/acc}$ } GREEN HORIZON

$10295 \div 1.545 = 6663.43 \text{ ft/acc}$
 $10935 \div 1.6 = \frac{6834}{17.1}$ } YELLOW HORIZON

1K 2.940 .09 49
 2K 3.030 .02 x $x = \frac{.02}{.09} \times 49 = 10.89$
 .09.0

 3.09 .11 171
 2K 3.20 .02 x $x = \frac{.02}{.11} \times 171 = 31.09$
 .11

For an increase of 0.02 in Δt , the avg $\Delta t/sec$ increases by 10.89

| Δt | avg $\Delta t/sec$ | | Depth $\Delta t - 1.3088$ | Depth metres |
|------------|--------------------|---|---------------------------|----------------------|
| 2.94 | 6351.70 X 1.47 | = | 9337 | 2845.9 |
| 2.96 | 6362.59 X 1.48 | = | 9417 | 2870.3 |
| 2.98 | 6373.48 X 1.49 | = | 9496 | 2894.4 |
| 3.00 | 6384.37 X 1.50 | = | 9576.5 | 2918.9 |
| 3.02 | 6395.26 X 1.51 | = | 9657 | 2943.5 |
| 3.04 | 6406.15 X 1.52 | = | 9737 | 2967.8 |
| 3.06 | 6417.04 X 1.53 | = | 9818 | 2992.5 |
| 3.08 | 6427.93 X 1.54 | = | 9899 | 3017.2 |
| 3.10 | 6438.82 X 1.55 | = | 9980 | 3041.9 |
| 3.12 | 6449.71 X 1.56 | = | 10062 | 3066.9 ¹³ |
| 3.14 | 6460.60 X 1.57 | = | 10143 | 3091.6 |
| 3.16 | 6471.49 X 1.58 | = | 10225 | 3116.6 |
| 3.18 | 6482.38 X 1.59 | = | 10307 | 3141.6 |
| 3.20 | 6493.27 X 1.60 | = | 10389 | 3166.6 |
| 3.22 | 6504.16 X 1.61 | = | 10472 | 3191.9 |

GREEN HORIZON

301

515
657
 1233
 96165

For an increase of 0.02 in Δt , $\Delta t/\text{sec}$ increase by 31.09

| ① Δt | ③ Avg $\Delta t/\text{sec}$ | ② | ④ Depth $\Delta t \times 3088$ | ⑤ Depth (meters) |
|-----------------|--------------------------------|------|-----------------------------------|-------------------------|
| 3.08 | 6647.885 X | 1.54 | = 10,238' | 3120.5 |
| 3.10 | 6678.975 X | 1.55 | = 10,352' | 3155.3 |
| 3.12 | 6710.065 X | 1.56 | = 10,467' | 3190 3209 |
| 3.14 | 6741.155 X | 1.57 | = 10,584' | 3226 |
| 3.16 | 6772.245 X | 1.58 | = 10,700' | 3261.4 |
| 3.18 | 6803.335 X | 1.59 | = 10,817' | 3297 |
| 3.20 | 6834.425 X | 1.60 | = 10,935' | 3333 |
| 3.22 | 6865.515 X | 1.61 | = 11,053' | 3369 |
| 3.24 | 6896.605 X | 1.62 | = 11,173' | 3405.5 |
| 3.26 | 6927.695 X | 1.63 | = 11,292' | 3441.8 |
| 3.28 | 6958.785 X | 1.64 | = 11,412' | 3478.4 |
| 3.30 | 6989.875 X | 1.65 | = 11,533 | 3515.3 |
| 3.32 | 7020.965 X | 1.66 | = 11,655 | 3552.4 |
| 3.34 | 7052.055 X | 1.67 | = 11,777 | 3589.6 |
| 3.36 | 7083.145 X | 1.68 | = 11,900 | 3627.1 |
| 3.38 | 7114.235 X | 1.69 | = 12,023 | 3664.6 |

YELLOW HORIZON

TOP OF CHALK

0
35
35

352
238
114
28
38
66

61
9
53
35

10352
535
10887
10447

116
58
29

56

OBSERVATION ON THE GEOLOGY OF THE NORTH
SEA AREA

P. HEYBROECK, U. HAANSTRA & D. A. ERDMAN (B.I.P.M.)

Seventh World Petroleum Congress Proceedings, Vol. 2, 1967
pp. 905 - 916

General

Based on seismic surveys with grids varying from
5x5 km to 25x25 (the latter being in the northernmost
regions).

Reflecting Horizons

1. Lowest reflecting horizon is the contact between the
Permian Zechstein ~~bed~~ rock salt and underlying older
rocks. (Rotliegendes)
2. Top of Zechstein rock salt.
3. Base of Upper Cretaceous.
4. " " " Tertiary.

Changing Structural Patterns

First pattern started in Permian and continued with
a gradually diminishing intensity of movement during
Triassic.

Second started in Mid. J. and remained
essentially the same until the end of L. Cret.

Third pattern started early Tertiary after a lull in U. Cret.

This is a simpler pattern unlike the older patterns.

The Permian-Triassic Zechstein Structural Pattern

Variscan orogeny subsided by U. Carb times. Period of denudation followed falling in 'basins' with Rotliegendes sed., largely continental including evaporites in localized basins.

Marine transgression deposited Zechstein. This started with the remarkably widespread and thickly developed Kuperschiefer which must have been laid down on a level plain. Zechstein deposits are mainly evaporitic rock salt, Anhydrite, dolomite and limestone, deposited in foci of subsidence separated by large swells or ridges where little or no deposition took place. The isopach picture of these evaporitic facies is now complicated by later halokinetic movements.

It can be safely assumed that areas of halokinetic movements ~~are~~ coincide with areas of greatest subsidence in the basin (overburden is sufficient).

The borders of the original Zechstein basin are not too far away from the limits of the present Zechstein sediments (i.e. although some were eroded, the erosion was not extensive). See map on pp 908.

Zechstein basin is present between Norway and Scotland. The northern limit is assumed, rather the basin is thought to go onto the open ocean to the north.

The Jurassic - Cretaceous Structural Pattern

The extensive removal of Tertiary sediments in late Kimmerian erosion and the intensive tectonic movements in some areas, make the structural picture difficult for Tertiary and Cretaceous times. Well control is required before the picture can be fully interpreted.

- Voigt summarized up the basins in Tertiary - Cretaceous times as
1. The Danish - Polish trough in Poland.
 2. Lower Saxony basin in W. Germany.
 3. The Pays-de-Bray basin in N. France.
 4. W. Wadden
 5. Hampshire

Recent marine exploration suggests

Broad Fourteen's Basin

Sole Pit

Dutch Offshore

English

Does not extend far into sea.

Uplifted in late Cret. Eroded down to Tertiary.

Further north, a deep Mesozoic graben exists N-S between the Mid North Sea and Fyn - Grinstead highs. This coincides with the connection between the southern and Northern Zechstein basins, and forms part of the Cenozoic axis of maximum subsidence.

The Upper Cretaceous Period of Transition

The transgression which had been spreading gradually since late Jurassic, extended rapidly and widely in U. Cret. Monotonous and uniform chalk deposition took place everywhere. The base of U. Cret. is therefore shown to be largely parallel to the base of U. Tertiary.

except of course around salt structures. U. Cret. thickness varies from 300' to 600'.

The limits of U. Cret. go far beyond its present outcrops (e.g. in England). This is evidenced by small patches of U. Cret. in Scotland and N. Ireland, which escaped extensive Cenozoic erosion.

The ~~the~~ major part of the ~~the~~ North Sea (north of the Brabant and Rhenish massifs) was a scene of relative tect. tranquillity during U. Cret. times. A number of exceptions however exist. Voigt draws attention to basins of thick U. Cret. sed^s which are situated along the edge of the Jurassic-L. Cret. basins mentioned above which became inverted during late Cret. - early Tertiary times. He postulates a direct relationship between these bordering basins and adjoining uplifts and calls them compensatory troughs. Fig. 4 shows several such compensatory troughs bordering around the Sole Pit basin, ~~the~~ Broad Fourteen High (1300m) West Netherlands Uplift.

The Cenozoic Structural Pattern.

The base of Tertiary provides a prominent reflecting horizon. The influence of salt movement on thickness of Cenozoic is pronounced in some areas.

The axis of maximum subsidence corresponds roughly to the borderline between the Norwegian and British continental shelves and runs NW-SE but swings to NNE in the north and N-S in the south. The 200' isopach runs not parallel to the present coastlines of Britain and Norway. In the east and

south, the Cenozoic basin extends far inland covering the major part of Denmark, the NW German plains, the Netherlands and the London basin. This conformity to the present coastline classifies the North sea in its present configuration as a Cenozoic feature.

The relative independence of the Cenozoic structural pattern is striking. The effect of the late Cretaceous uplift is felt in only few cases and then only in early Tertiary.

The only structural feature as far recognised which has a bearing on previous (Mesozoic basin) features is the ^{southern} north-south basin which coincides in part with the Mesozoic basin.

Outline Geology of The Southern
North Sea Basin

P. E. Kent

Presidential address at York 10 Dec 1966

Yorkshire Geological Society Vol 36 part 1 1967

STRATIGRAPHY

Pleistocene and Recent

Extensive terminal moraine complex of boulder clay with igneous large boulders. Also locally outwash sand and gravel. The easternmost two thirds of the North Sea are covered by a thick wedge of Pleistocene and Recent deposits related to the large rivers of the mainland.

Tertiary

The Tertiary deposits thicken seaward attaining a maximum thickness halfway between Norway and Scotland. Eocene, Oligocene, Miocene and Pliocene are all represented in marine facies in the central parts of the basin.

Cretaceous

Chalk is quite extensive except that it is thin or absent in parts of Northern Netherlands waters where the Tertiary rests on Triassic in an area of early regional uplift. The greater part is white chalk, but ^{basal} Red chalk member is generally developed. Locally thin underlying developments

of clastic sediments which may be T. Cret (Aptian?) is very widely transgressive in North Sea. This evidently followed a major period of earth movement and erosion from end Jurassic to early Cret. This relationship suggests an origin for the ferruginous element of the Red Chalk and Lower Cretaceous rocks. Whether Mesozoic sediments occur in the marine arc is not yet known.

Jurassic

(U214)

Lower Cretaceous and Jurassic rocks distribution is not fully known on account of extensive erosion. They are known to have survived erosion in certain basins (See Fig-5.)

The Lias has been penetrated in several places. The thickness of the Lias seems to be maximum in the North Sea.

Trias

The uppermost member, the Rhaetic suffered widespread erosion. Where it is penetrated it consisted of a reddish marl upper member with marine ss and shale below. There is no indication of other Rhaetic members in North sea, and the open sea connection is still believed in the direction of south western England.

The Keuper marl is universally present over the southern North Sea, with few exceptions where T. Cret rests on lower beds. It is a salt bearing formation similar to hard facies on land but thicker.

The Muschelkalk is developed in British waters, an alternation of mudstones, dolomite, salt and gypsum. Whether there is a feather edge of the Muschelkalk on land in Britain is not at all decided.

The Bunter is well developed in North Sea. It is even more marly than in Yorkshire and contains thin evaporite beds including halite and Anhydrite. The English and German Bunter with continuous sst, and lenticular conglomerate beds should be regarded as atypical marginal facies. It grades downwards into the Permian; the contact is gradational and probably diachronous. It is a uniform formation with marked beds that can be traced all over its German waters.

Permian

The Zechstein (U. Perm.) is predominantly evaporitic. At the base a thin dark shale bed, 4' to 6' of ^{wide} Keuper-schiefer marks (uniform stagnant North sea, possibly very shallow land locked tideless sea, formed by transgression over plane surface. A basal sand member may be present. The Zechstein salt bodies have given rise to the halokinetic structures.

The Rotliegendes (L. Perm.) is more variable ranging from red marls and oilstones to with evaporites to pure sandstone with a quantity of well rounded sand grains.

STRUCTURE

a) The Pre-Permian Floor

It is likely that Coal Measures underlie the Perm in most of the North Sea (source rocks). It is also most likely that the Carboniferous shelf developed continue seaward (with some diversification) with a rigid floor beneath, and it may be further expected that a thick basinal Palaeozoic succession will be found out to sea beneath the mobile English salt basin.

b) The Permian Trias and later Beds

Within the pen shaped North Sea basin, there are irregularities caused a) by epirogenic effects (differential downwarping due to the salt basins and to the Tertiary and Quaternary wedge); and b) by post depositional halokinetical movement of Permian salt under load.

Three major Zechstein basinal areas

The German basin : ^{salt wall} ~~salt wall type~~ N-S

The English " : salt pillow

The Norwegian " : diapiric salt domes.

Salt movement began by Keuper Times and continued at least till Quaternary. Salt movement affects rocks of different ages indicating various phases. Super-imposed on the salt basins is the regional downwarping.

Information Required for Estimation of Original Gas in Place

1. Structure Contour maps on top and bottom of the Pay zone
2. Or: ~~Net~~ Net Pay isopach maps
3. Average porosity data. Logs. Core Analysis.
4. Average water saturation data
Capillary pressure curves for various k values.
to arrive at weighted average S_w .
Or S_w from logs.

Information Required for Calculation of Recoverable Reserve.

1. Conformance factor.
2. Residual gas saturation, from rel perm data.
3. Initial pressure.
4. Abandonment pressure.
5. Gas produced
6. Gas analysis.

Information Required for ~~Gas~~ G_n & G_p

1. Conformance factor
2. Residual gas saturation. (~~$1 - S_w$~~)
3. Initial pressure p_i
4. Pore volume. (cu ft)
5. Gas saturation ($1 - S_w$)
6. Thickness of reservoir.
7. Area of reservoir in acres.
8. Compressibility
9. Contour maps on top and bottom of structure.
 - a. Pay thickness (isopach) map
10. Capillary pressure curves for various k -values to arrive at ~~avg~~ S_w .

TRANSLATION FROM GREGERSEN & SORGENFREI
AND MEDD. DANSK GEOL. FOR.
VOLUME 12 - PART I, 1951.

PALEOGEOGRAPHIC SUMMARY.

During the arid period of the Zechstein there existed a well developed salt basin over most of Northern Jutland. In the border zone along the Fennoscandic bloc probably anhydritic and carbonatic evaporites were deposited, while in the central part of the basin the salt was precipitated.

During the Trias that is in Buntsandstein, Muschelkalk and Keuper time, continental sediments were likewise deposited over most of the area. Thereafter, in the Rhetian followed a more or less marine phase in northern Jutland which probably also extended over large areas of the Kattegat and periodically as far as Scania. In the latter area the limnic facies was nevertheless preponderant. In Liassic times true marine conditions appeared in the Northern Jutland. How far these marine conditions extended to the South can only be indicated with limited certainty. Parts of middle and southern Jutland as well as perhaps most of Fyn were probably emerged. On the other hand there seems to have existed at least periodically a sea connection via Sjælland - Scania to the Baltic area.

Large parts of Denmark have certainly been land areas during Dogger and Malm. However the sea transgressed once again in early Upper Jurassic over the Northern Jutland area of subsidence. It is also possible that at the same time a connection existed from here to the Jurassic areas of the East sea (Pommerania). This connection is indicated by faunistic evidence. These marine conditions in the Northern Jutland - Baltic areas appear to have lasted far into the Lower Cretaceous.

In the Upper Cretaceous occurred a very strong change of the geographical conditions. The marine sediments changed their character completely from terrigenous to almost exclusively limestone deposits and at the same time the sea transgressed practically over all of Denmark. Most certainly changes of climatological and other geographical factors have been the reason for this.

2. No gravity or magnetic.

1963. Phillips did seismic work in North Sea

1965. Joint surveys BRP Bureau Research & Petrol.

1965-66 Joint Survey.

Since then companies made their own surveys, refining structures.

Cod was off defined in reconnaissance form in 1964

1966 Phillips made detailed surveys on cod. Also some more in 1967.

These included other structures too in Phillips blocks.

Usually when a location is proposed, further lines of survey are made to get finer details.

3. No. 3 well on the S.E flank.

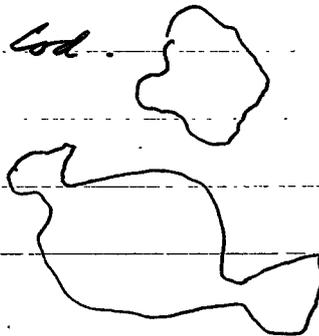
structural delineation.

Water Table?

Sand development.

A further well is thought of for next year to the north of structure.

Possibly another well on the small structure to the northeast of Cod.



4. No change.
5. Will suggest running 1:40 Microlog.
Sands were picked from logs, R.O.P and cuttings.
- Net Pay sands: 230 1X
 280 2X This figure was too high according to tests which showed no prodⁿ in the U & L sands.
- The new figure includes sands between 9933 and 10203.
- 6.
9. 3 cores in 1X
1 core in 2X + side-wall coring.
10. Cap. pres test are being made on the core from 2X. Many arrive in 3-weeks time.
11. ?
12. Isochorone Tests were made and are with the Ministry.
13. About 75% gas saturation.
Recovery 80%
14. Will be made on subsequent tests ?!
15. Already discussed.
16. Studies are underway.
18. No limits in present - 600' is the limit of the present floating platform.

Cod 3.

| | | |
|----------|-------|--------|
| To, Pal | 10140 | 10,000 |
| 4 shalle | 11270 | 11,400 |

Chub-1 7/8-1

Top of Pal 8000_{ft} - 8100

Pal ^{sand} / expected to be thinner.

apt. Top of chub 11300'

11300
8100

3200

14-24

21.0 ✓

20 ✓
~~21.5~~

17-23

2-1

250'

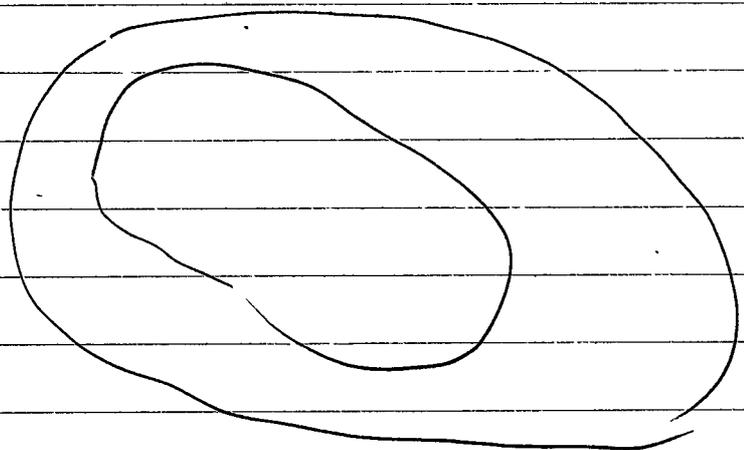
90 %

80 %

75 %

Cycling

100 %



1. No Carb was encountered in boreholes in Denmark
Rottinger conglomerate penetrated by Petrocord 17-4
But no sign of sandstone.
No knowledge of dolomite or list elements in the
Zechstein.

Triassic Little in Phillips wells. Red marls
silt and shales.

Jurassic: Jurassic - L. Cretaceous. mostly shales.
(Kimmeridgian) 374 ft in Phillips well.

U. Cretaceous. Chalk. approx 2000' Col 1
bottom N.R. 4 2
6400' 17-4

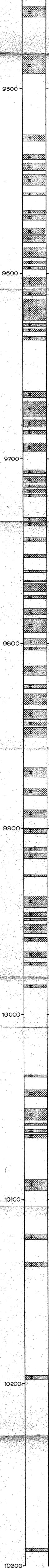
Generally in N. Sea 1,000' to 3,000'.
Thickness in Norway 1500-2000' which
may vary according to position on
structure eg on flanks of Col 2000-2600'

Tertiary: Oligocene sands may be present.
Possibly in Miocene - good reflective
horizon may indicate sand.
Also possibility of sands in Eocene.

Phillips Well 7-11- 1X

Sand Count

Scale: 1:200



9774

9936

725.1 7/11-1

LOGGING RAPPORT AV PALEOCEN
I PHILLIPS' BOREHULL 7/11-1

AV
ARNE LERVIK

TAUSHETSPLIKT

APRIL 1970

Generelle bemerkninger

Bergartene i Paleocen er begrenset av rene kalkstener i Maestrichtian og rene skifere i Eocen. Den samlede mektighet for lagpakken i dette området er 964'. Bergartene kan deles i to lighologiske enheter,

- 1: en eldre del som består av kalk - og sandstener, og
- 2: en yngre del av skifer, silt- og sandstener.

De to delene er klart avgrenset fra hverandre. Samlet kalles bergartsserien for COD-FORMATION.

Spesielle bemerkninger:

1:

Den eldste del av formasjonen består av en sedimentserie av vekselvis kalk- og sandstenslag. De finnes både som rene kalkstener og som rene sandstener, men også som sandstener med kalkstensmatriks. Lagenes tykkelse varierer fra tynne "streaks" til sammenhengende benker på noen cm. Variasjonen i enkelte deler er intens, og bare sjelden er det observert sammenhengende horisonter i størrelsesorden én meter eller mer.

Lithologi.

Den rene kalkstenen er en tett, hvit til "pinkish" hvit, chalky, mikrittisk bergart. Den inneholder flint. I enkelte horisonter (øvre Danien?) opptrer flinten i betydelige mengder.

Sandstenene har mer enn 80% kvarts. De er grain-supported (kornbåret) med fragmenter i størrelsene silt til grov sand. Formen er mest sub-angular, og sorteringen er dårlig. Matriks er antagelig silisium-sement. I kalksandstenene er matriks mikrittisk kalk.

I tillegg til disse to bergartstypene er det funnet noen få horisonter av grå skifer.

Samlet mektighet for denne eldste del av Paleocen er 306'.

2:

Den yngste lithologiske enheten er dominert av siltige og sandige sedimenter som veksler med grå skifer. Enkelte kalkstenslag forekommer, men finnes nå bare som spredte horisonter.

Også i denne del av lagserien er vekslingen mellom de enkelte bergartstypene stor. Skiferlagene er svært tynne, ofte bare "streaks". Siltsedimentene oppnår de største sammenhengende tykkelsene. De kan bli horisonter på noen meters mektighet. Sandstenene finnes både som "streaks" og som benker.

Lithologi.

Skiferne varierer fra lag til lag. Det er antydning til lagninger i "the cuttings" noe som fremkommer som bånding i bergarten. Det gir farver av forskjellig slag fra lyse grå og grønne lag til mørk brunlig grå. Som oftest er farven jevn, men enkelte av de lyse grå skiferne har mørke "spots" av pyritt. De fleste skiferne er "non-calcareous".

Også sandstenene varierer mye. Det er to typer som er mer vanlig enn de andre, én i den undre del av bergartsserien, og én i øvre. Den første av disse ligner sandstenen i eldste del av Paleocen, men er ikke fullt så grov. Den andre sandstenen finnes bare i de øvre 150' av serien. Den er svært glaukonittrik og glaukonitten utgjør 15-20% av materialet. Den får derved en grønnlig farvetone makroskopisk. De klastiske kornene virker svært jevnstore og ligger på grensen silt- "very fine sand". De er "sub-rounded" og har en viss sortering. De andre sandstenene finnes bare i små mengder.

Siltsedimentene er for en stor del bare en finere fraksjon av det materialet som har gitt sandstener. De er jevnt over mørkere i farven, et forhold som skyldes forskjell i matriks mellom sand og silt. Det er et gradvis skifte mot den yngre del av lagpakken til mere silt enn sand. Dette forhold var omvendt i den eldre del av lagserien. Bergartsserien er med andre ord ikke enhetlig utviklet. Men fra det ene ytterpunkt til

det andre er det en gradvis overgang noe som gjør det umulig å etablere en grense, og det er derfor serien i dette området betraktes som ett lithologisk ledd.

Denne yngste del av Paleocen har en mektighet på 658', og samlet når tidsepoken en tykkelse på 964'.