Libyan Arab Republic

Kufra and Sarir Authority

Jalu - Tazerbo Project: Phase 2

APPENDIX 4

T(Q1-65)

SITE REPORT

Hydrogeological Department
Institute of Geological Sciences
Exhibition Road, London SW7 2DE
1974

The Institute of Geological Sciences was formed by the incorporation of the Geological Survey of Great Britain and the Museum of Practical Geology with Overseas Geological Surveys and is a constituent body of the Natural Environment Research Council.

Printed in England for the Institute of Geological Sciences
by North London Offset Services Limited

IGS 1056 50 6/74

CONTENTS

TABLES

FIGURES

Jalu--Tazerbo Project: Phase 2

Appendix 4: T(Q1-65) Site Report

1. Location: 27 54' 39" North, 21 00' 21" East

2. Ground elevation: 532 feet above mean sea level at oil exploration well site, Q1-65

3. Site plan and elevations: Figure 1 and Table 1

TABLE I

Ground and casing top elevations (in feet above mean sea level) at T (Q1-65)

Location	Ground Elevation	Casing Top
Q1-65	532	---
WW North	535.1	536.9
WW South	534.4	536.4
T(Q1-65)A	534.1	536.5

4. Existing Water Wells: BP Exploration Co. (Libya) Ltd water well records show three water wells to have been drilled on this site (Table II).

TABLE II

BP Exploration Co. (Libya) Ltd water well records

1	2	3
243	576	528-576
244	596	542-596
245	586	538-586

Columns:

1. Well number
2. Total depth in feet on completion
3. Perforated interval in feet bgl

NB Only two wells could be found at the site and were designated North and South (Table III)

TABLE III

Static water level data in water wells at Q1-65 in June 1973

WW South	258.2	278.2
WW North	258.8	278.1
T(Q1-65) A	257.8	278.7

Columns:

1. Well location
2. SWL in feet below casing top
3. SWL in feet amsl

5. Geophysical logs: The following logs are available on file but not enclosed with this report

(a) Schlumberger logs of Q1-65:

1. Final lithological log from 200 to 10,848' below rotary table (brt)

2. IES from 150 to 2730 feet below rotary table

3. Sonic log from 150 to 2730 feet below rotary table

(b) BP Co. mud log from surface to 4000 feet

(c) IGS gamma-ray log from surface to 978 feet bgl

6. Drilling and completion:

(a) T(Q1-65) was drilled by rotary rig using Quiktrol mud to a depth of 1250 feet bgl and was finally abandoned at this depth leaving the bit, five drill collars and a considerable length of drill pipe in the hole. Abandonment was a consequence of hole collapse following upon loss of circulation.

(b) T(Q1-65)A was drilled using Quiktrol mud to 2365 feet bgl and was completed with a combination string of slotted and blank 6 3/8 inch casing. The slotted sections numbering seven in all, were wrapped with wire mesh to prevent sand entrance. The hole was lithologically sampled from 280 feet to total depth.

7. Lithology and stratigraphy: A summary of stratigraphic data is shown in Table IV, and a graphical log in Figure 2.

TABLE IV
Stratigraphic data at T(Q1-65)

	1	2
Ground elevation at Q1-65	---	532
Static water level	257	275
Base of Calanscio Formation	201	331
" " LMM (Zone a)	386	146
" " " (Zone b)	465	67
" " " (Zone c)	656	124
" " " (Zone d)	870	462
" " " (Zone e)	1264	732
Base of Oligocene (Zone a)	1770	1238
" " " (Zone b)	2266	1754

Columns:

1. Depths in feet below general ground level
2. Elevation in feet above or below mean sea level

The base of the Oligocene which overlies the Upper Eocene is picked out on the BP Final lithological log but no other sub-divisions are shown. These latter are mainly defined in relation to boundaries more apparent elsewhere in the Phase 2 Area but significant changes do occur also at this particular site which serve to differentiate them. The top of the Oligocene is based on a sonic change which has been traced over a large part of the Phase 2 Area and may indicate increased compaction in the Oligocene as compared with the Lower and Middle Miocene Formations above.

The LMM which intervenes between the Calanscio Formation of Post-Middle Miocene age and the Oligocene, contains a significant clay percentage although considerably less so than in the central Phase 2 Area. The relations are apparent in the cross-section A-A' in the main Report. The Calanscio Formation consists of sand, sandy limestone and some dolomite, and the base is selected at the top of the first prominent clay horizon. The water table at this site occurs below the base of the Calanscio Formation.

Samples from 10 feet intervals, except for those with a significant clay or carbonate content, were sieve analysed. A summary of the data is shown in Table V and some average values in Table VI.

The bulk of the Post-Eocene sequence consists of fine to medium uniform sands with clays occurring most significantly in Zones 'b' and 'd' of the LMM and Zone 'b' of the Oligocene. The associated sands in the clayey zones are commonly finer grained than in the other horizons. Sandstones and sandy carbonates are of limited occurrence. The sandstones recorded in Zone 'b' of the Oligocene could well be fine sands as indicated by the sieve analysis data.

The Post-Eocene sequence at Q1-65 is apparently unfossiliferous and the only significant recorded features having some bearing on the depositional environment are the single references to occurrences of lignite and of glauconite, both occurring in Zone 'b' of the Oligocene. The sieve analysis data show distinctive variations between the different zones but with one possible exception, no regular trends occur within the zones. The possible exception is Zone 'c' of the LMM where the D50 sizes show a fairly regular decrease upwards. Cross plots of the standard deviation against skewness and mean size have been produced, samples from each zone being grouped together. The plots for Zone 'e' of the LMM are shown in Figure 3 which also show the boundary lines separating environments according to Moiola and Weiser, 1968. The bulk of the samples fall into the fluviatile field apart from three occurrences within Zones 'd' and 'e' of the LMM for which beach sands are indicated. The feature is consistent with the characteristics of the Lower and Middle Miocene which becomes predominantly marine in the north-central Phase 2 Area. A 3-ft core was obtained from the 10-foot interval between 1100 and 1110 feet below ground level. The core consisted of poorly consolidated, rather clayey yellow brown sand with some streaks of grey clay. Petrographic studies carried out by the Petrological Department of the IGS gave the following information.

"CORE-SAMPLE OF OLIGOCENE SANDSTONE FROM BH T(Q1-65) EB, CENTRAL CYRENAICA, LIBYA. LAT 27 54' 39"N. LONG 21 00' 21"E. Depth between 1100 and 1110 feet below ground level.

Registered number F7791

Introduction

The following report is the result of analysis of the more coherent portion of the sample submitted, taken from the interior of the core in order to avoid contamination.

Grain size analyses, of the sand grade fraction by dry sieving and the silt and clay using the Sartorius sedimentation balance, are by C.W. Wheatley. G.E. Strong determined the statistical parameters from these results.

Petrography

The rock is a very poorly sorted soft silty sand with sand: silt: clay proportions of 60.4: 29.1: 10.5 respectively.

In colour the material is dark yellowish orange (Geol. Soc. Am. Color Chart 1972, number 10 YR 6/6) with irregular clay rich bands of moderate reddish brown (10R 4/6) and moderate greenish yellow (10Y 7/4).

The thin-section, number F7791, shows the rock to be composed of grains of quartz, a little feldspar and chert dispersed in a silty clay, iron-stained matrix. Among the clastic grains quartz predominates and is of metamorphic type with abundant inclusions, the feldspar is represented by both microcline and plagioclase in unaltered fragments. Modal analysis of the clastic grains gives the following proportions:

Quartz	94%
Feldspar	3%
Chert	2%
Others (limonite etc)	1%

It is noticeable that the shape of the clasts varies with size. The grains larger than about 0.5mm are well rounded and the smaller are angular to subrounded. Some slight modification of the shapes due to secondary growth on the quartz has occurred.

Matrix and cement

X-ray diffraction examination (Chart DX 1225) of the silt-clay fraction shows this to be composed predominantly of kaolinite and clay mica with approximately 10% quartz and a little feldspar.

Secondary mobilization of quartz has been noted above and some of the same material recorded on the XRD chart probably represents silica cement as well as finely clastic material. Significant amounts of amorphous iron are present.

The cement therefore appears to a mixture of clay, silica and iron hydroxides.

No carbonates are present.

Grain-size distribution

The attached chart shows the size distribution in ϕ units.

G.E. Strong has determined the following statistical parameters following Folk's (1957) usage.

Median	= 3.1 ϕ
Graphic mean M_2	= 4.6 ϕ
Inclusive Graphic Standard Deviation $_I$	= 3.0 Very poorly sorted
Inclusive Graphic Skewness SK_1	= 0.73 Very positively skewed
Inclusive Graphic Kurtosis K_G	= 0.94 Mesokurtic
(Transformed Kurtosis K_G	= 0.49)

Reference

Folk, R.L., & Ward, W.C. 1957. Brazos River Bar: a study in the significance of grain size parameters. J. Sed. Pet. 27 pp. 3-26"

8. Aquifer analysis: This is based on sieve and log analysis data combined with the results of testing of the individual screened sections by air lift and casing packers. Since the sands appear to be largely unconsolidated, sieve analysis data may provide a fair indication of the permeability. The correlation between permeability and grain size variations is discussed in detail in the Final Report on the Phase 1 Area (Wright el al, 1974). Permeability appears moderate in zones 'a', 'c', and 'e' of the LMM and zone 'a' of the Oligocene but lower elsewhere. The method of analysis cannot account for the presence of clay and the calculated values tend to be higher than the true values. It is worthwhile noting that zone 'b' of the Oligocene which includes appreciable amounts of fine sand or sandstone in the graphic log also shows fine sand in the sieve analysis. The feature may indicate that the sands are also unconsolidated and that the low porosity relates mainly to fine grain size. It is also significant that no production could be obtained from the screened section within this interval.

Water samples were obtained from each screened section of the hole and chemically analysed. Details of the analyses are included in the Phase 2 Report. An in-casing packer system was used in preference to an in-hole packer on account of the likelihood of hole collapse in these unconsolidated formations. The packer used was a straddle packer which extended across the screened interval and was set mechanically. Air lifting was carried out with an air line set inside an inner casing. It was assumed that production would be mainly limited to the screened section since demudding and development had mainly been concentrated on these sections. Drawdowns were calculated on the basis of the change in pressure during air lifting.

Details of the testing are shown in Table VII. It is significant to note that no production could be obtained from level 6 which is within the fine sand or sandstone of Zone 'b' of the Oligocene and level 7 which is within sandy carbonates of the Upper Eocene. The testing did incidentically show the efficiency of the packer system across which no significant leakage can have occurred despite a head differential of over 600 feet of water. The result gives increased confidence of the validity of the other data. Static water levels appear to be uniform throughout the Post-Eocene sequence, but possibly a foot higher below interval 3 which between 1680 and 1710 feet bgl. This represents the only information on hydraulic head values in the Oligocene in the Phase 2 Area. Specific electrical conductance values are in the range 2000 - 2700 micromhos at 25° C increasing downwards. The figures can be compared with the shallow company wells set in LMM Zone (a) which produce water of 2500 micromhos/cm. Water appears to be fresh therefore down into the Zone (a) of the Oligocene and confirms the indications of the S. P. electrical log.

TABLE V

Summary of sieve analysis data

(i) Calanscio Formation (Post Middle Miocene): 0 - 201 feet bgl

No Samples

(ii) Zone 'a', Lower and Middle Miocene (LMM): 201 - 386 feet bgl

Depth Interval (feet bgl)	D50 (microns)	D40/D90	K[1] (US galls/d/ft^2)
280 290	490	2.67	410
290 310	Clayey		---
310 320	235	2.04	245
320 330	150	2.23	140
330 340	290	2.83	235
340 350	370	2.16	340
350 360	No Sample		---
360 370	315	1.89	290
370 380	390	2.23	385
380 390	265	2.46	195

Zone 'b', LMM: 386 - 465 feet bgl

Depth Interval (feet bgl)	D50 (microns)	D40/D90	K[1] (US galls/d/ft^2)
390 400	240	2.14	195
400 410	Sandy Clay		---
410 420	195	1.72	192
420 430	185	1.82	165
430 440	190	1.78	172
440 450	190	1.78	182
450 460	225	2.00	215
460 470	215	2.00	185

Zone 'c', LMM: 465 - 656 feet bgl

Depth Interval (feet bgl)	D50 (microns)	D40/D90	K[1] (US galls/d/ft^2)
470 480	240	1.95	238
480 490	240	2.20	220
490 500	260	1.11	245
500 510	222	2.06	205
510 520	220	2.09	212
520 530	315	2.03	270
530 540	330	2.12	180
540 550	207	2.38	165
550 560	270	2.50	235
560 570	270	2.07	275
570 580	270	1.76	295
580 590	275	2.67	205
590 600	360	1.94	560
600 610	390	2.34	345
610 620	540	2.81	400
620 630	530	3.53	285
630 640	377	2.00	340
640 650	360	2.05	370
650 660	310	1.73	340

Zone 'd', LMM: 656 - 870 feet bgl

Depth Interval (feet bgl)	D50 (microns)	D40/D90	K[1] (US galls/d/ft^2)
660 670	295	1.94	310
670 680	245	2.45	200
680 690	290	2.00	290
690 700	260	2.35	215
700 760	Sandy Clay		---
760 770	167	1.99	145
770 780	230	1.69	235
780 790	240	1.82	285
790 800	257	1.79	290
800 810	258	1.90	300
810 820	335	2.36	390
820 830	275	2.57	215
830 840	185	2.16	165
840 850	213	1.98	185
850 860	260	2.77	205
860 870	290	2.37	250

Zone 'e', LMM: 870 - 1264 feet bgl

Depth Interval (feet bgl)	D50 (microns)	D40/D90	K[1] (US galls/d/ft^2)
870 880	295	2.44	250
880 890	303	2.34	250
890 900	230	3.12	180
900 910	263	2.59	205
910 920	280	2.51	195
920 930	278	2.62	220
930 940	255	2.64	200
940 950	265	2.45	230
950 960	285	2.46	245
960 970	230	2.60	160
970 980	255	2.36	188
980 1000	Sandy Clay		---
1000 1010	245	2.03	240
1010 1020	250	2.07	230
1020 1030	240	1.85	250
1030 1040	355	2.08	430
1040 1050	290	1.88	320
1050 1060	155	2.71	140
1060 1070	285	2.00	280
1070 1080	230	2.04	180
1080 1090	230	2.21	180
1090 1100	175	1.81	145
1100 1110	No Sample	----	---
1110 1120	270	2.44	228
1120 1130	215	1.81	190
1130 1140	295	2.34	260
1140 1150	290	1.67	390
1150 1160	450	1.60	760
1160 1170	285	2.03	290
1170 1180	430	1.57	720

1 K: permeability in US galls/day/ft^2 calculated on a cross plot of standard deviation and D50

Depth Interval (feet bgl)		D50 (microns)	D40/D90	K[1] (US galls/d/ft^2)
1180	1190	430	1.61	710
1190	1200	365	1.83	560
1200	1210	210	2.95	165
1210	1220	280	2.52	---
1220	1230	200	2.68	150
1230	1240	175	3.55	115
1240	1250	No Sample	----	---
1250	1260	303	3.82	205
1260	1270	450	2.25	410

(iii) Zone 'a', Oligocene: 1264 - 1770 feet bgl

1270	1280	540	3.24	305
1280	1290	480	5.82	155
1290	1300	410	4.95	215
1300	1310	540	2.48	540
1310	1320	290	2.41	225
1320	1360	Sandy Clay Calc		
1360	1370	378	2.33	350
1370	1380	400	2.42	370
1380	1390	435	2.38	520
1390	1400	415	2.12	435
1400	1420	Sandy Clay		---
1420	1430	445	2.02	470
1430	1440	440	2.51	400
1440	1450	220	2.41	170
1450	1460	350	2.50	300
1460	1470	390	2.22	410
1470	1480	290	4.30	185
1480	1490	Silt		---
1490	1500	420	3.09	335
1500	1550	Sandy Silt		---
1550	1500	203	2.86	155
1560	1570	320	3.02	250
1570	1580	No Sample		---
1580	1590	544	3.27	390
1590	1600	360	2.86	240
1600	1610	313	3.52	230
1610	1620	340	2.59	270
1620	1630	223	2.64	175
1630	1640	258	2.68	185
1640	1650	182	2.95	132
1650	1660	190	4.16	122
1660	1700	No Sample		---
1700	1710	195	2.79	148
1710	1720	180	2.68	135
1720	1730	185	2.55	145
1730	1740	200	2.35	162
1740	1750	335	3.52	232
1750	1760	370	2.62	325
1760	1770	330	2.75	275

Zone 'b', Oligocene: 1770 - 2266 feet bgl

Depth Interval (feet bgl)		D50 (microns)	D40/D90	K[1] (US galls/d/ft^2)
1770	1780	255	2.11	235
1780	1790	300	1.96	332
1790	1800	350	2.23	348
1800	1810	420	2.64	340
1810	1820	275	2.13	200
1820	1830	245	2.24	200
1830	1840	255	2.24	215
1840	1850	230	2.08	190
1850	1900	Fine Sand-Silt		
1900	1910	185	2.18	142
1910	1940	Silt-Clay		
1940	1950	180	2.80	118
1950	1960	200	2.65	140
1960	1970	285	2.83	203
1970	1980	215	2.77	158
1980	1990	235	2.39	182
1990	2000	205	2.72	155
2000	2010	150	2.90	113
2010	2020	135	2.87	108
2020	2030	150	2.50	125
2030	2040	160	2.80	125
2040	2050	145	2.92	115
2050	2060	175	2.86	128
2060	2070	220	2.00	185
2070	2080	200	2.25	162
2080	2090	195	2.20	158
2090	2100	170	2.78	130
2100	2110	175	2.70	128
2110	2120	230	2.75	162
2120	2130	175	2.71	132
2130	2140	175	2.38	138
2140	2150	195	2.68	152
2150	2160	190	3.07	145
2160	2170	185	2.87	140
2170	2180	175	2.67	138
2180	2190	185	2.87	140
2190	2200	185	3.68	139
2200	2210	190	2.99	142
2210	2220	170	3.14	130
2220	2230	195	2.20	158
2230	2240	205	2.55	155
2240	2250	145	3.24	120
2250	2260	145	3.21	122
2260	2270	150	3.60	118

1 K: permeability in US galls/day/ft^2 calculated on a cross plot of standard deviation and D50

TABLE VI

Summarised average values of data in Table V

Interval	Thickness (feet)	Average D50 (microns)	Average K US gpd/ft^2
LMM Zone 'a'	185	313	280
" Zone 'b'	79	205	187
" Zone 'c'	191	329	283
" Zone 'd'	214	253	245
" Zone 'e'	394	279	274
Oligocene Zone 'a'	506	338	271
" Zone 'b'	496	201	163

TABLE VII

Test pumping on T(Q1-65)A

1	2	3	4	5	6	7	8	Remarks
1-7	None	495	38	69	2200	(x = 8) 252.6	------	2 hour test
7 947-997	880-1002	495	18	166	2100	(x = 20) 252.40	252.39	4 hour test
6 1094-1124	1066-1196	495	35	92	2160	(x = 59) 252.34	252.33	4 hour test
5 1312-1342	1257-1385	495	30	148	2200	(x = 45) 252.44	252.39	4 hour test
4 1461-1491	1391-1522	495	22	164	2450	(x = 45) 252.4	252.31	4 hour test
3 1680-1710	1652-1785	495	16	176	2700	(x = 67) 251.42	251.41	4 hour test
2 2012-2042	1978-2109	865	--	---	----	------	------	No production
1 2271-2301	2236-2315	679	--	---	----	------	------	No production

Columns:

1. Screen setting interval in feet below ground level

2. Packer setting showing straddle limits

3. Depth of airline setting within inner casing attached to packer

4. Yield in US gpm

5. Drawdown calculated from airline pressure differentials

6. Conductivity of discharge in micromhos/cm at 25°C

7. Rest water level inside interior casing at x min after pumping stopped. NB 252.4 correspond to 257' + in relation to present casing level

8. RWL at x + 15 min after pumping stopped

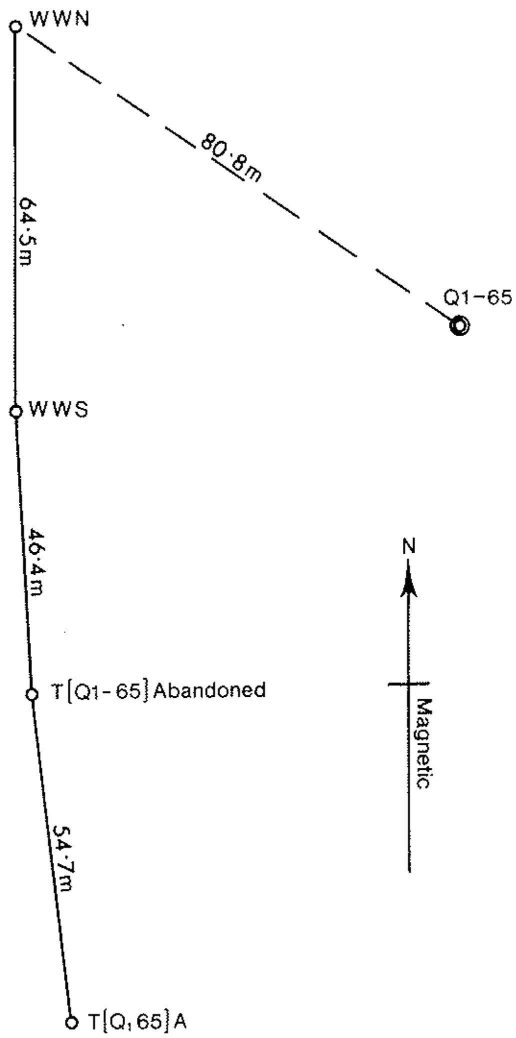


Figure 1. Site plan : T(Q1-65)

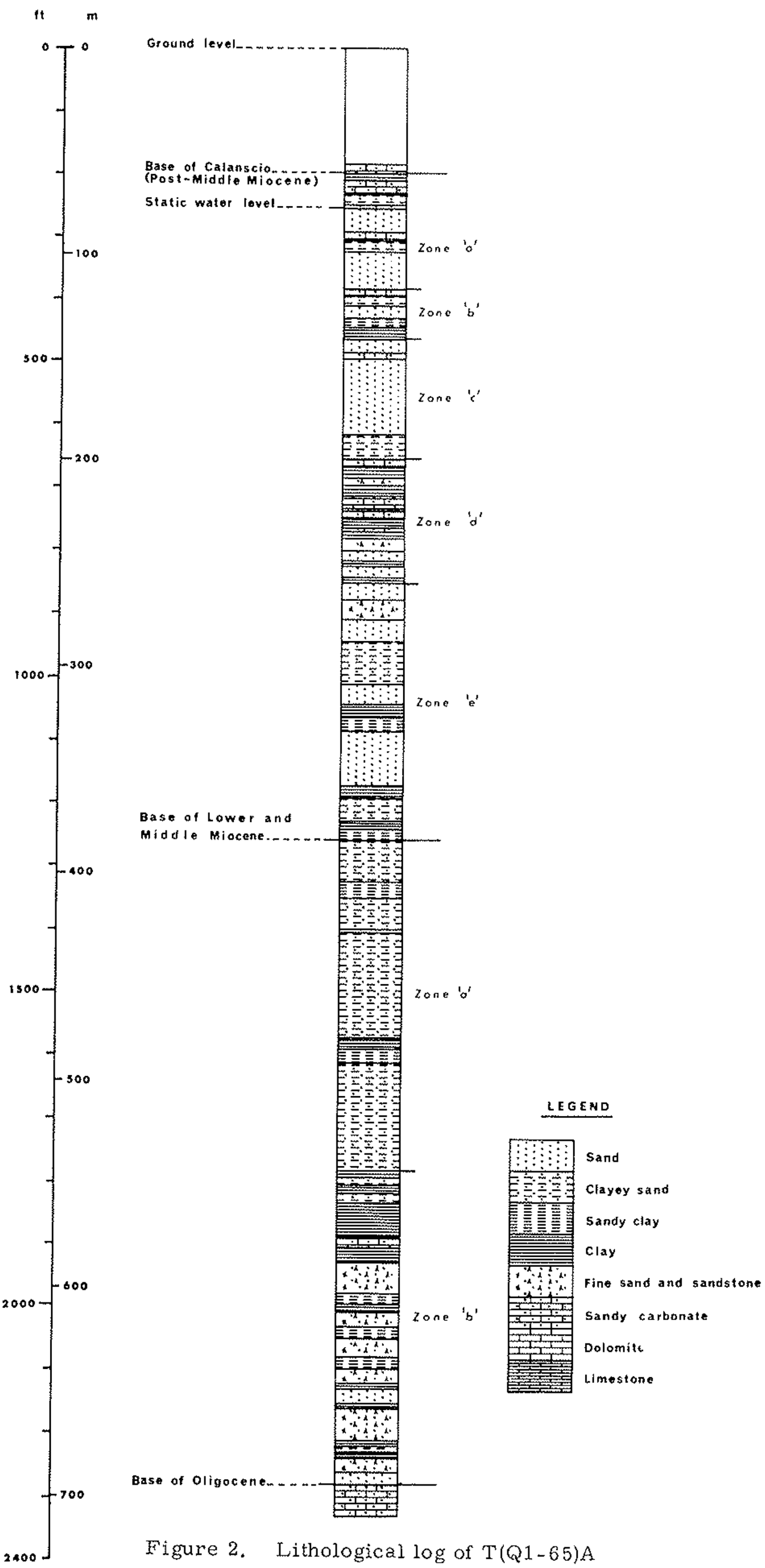
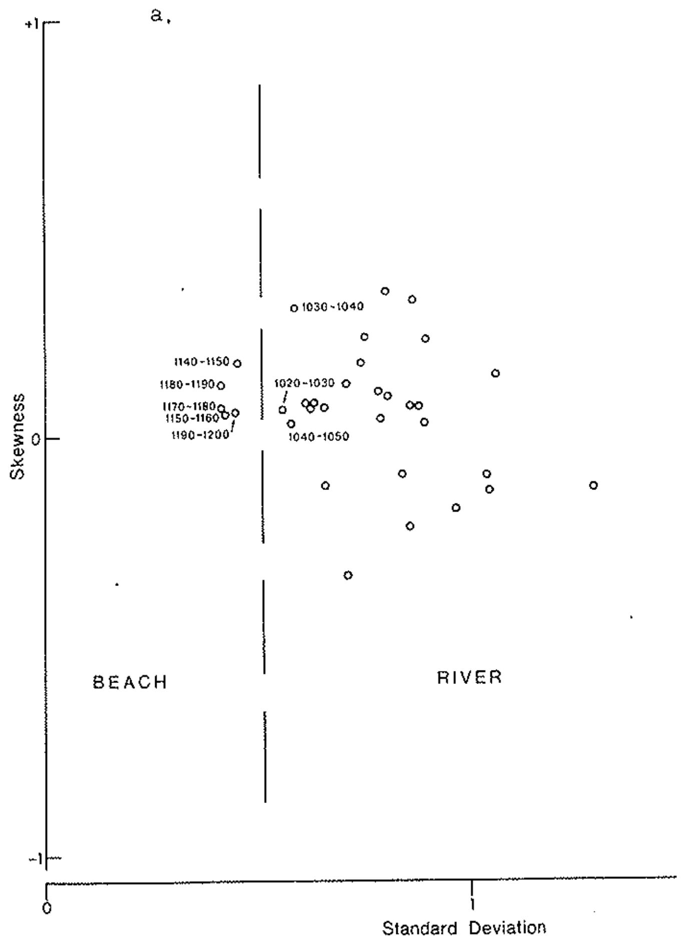
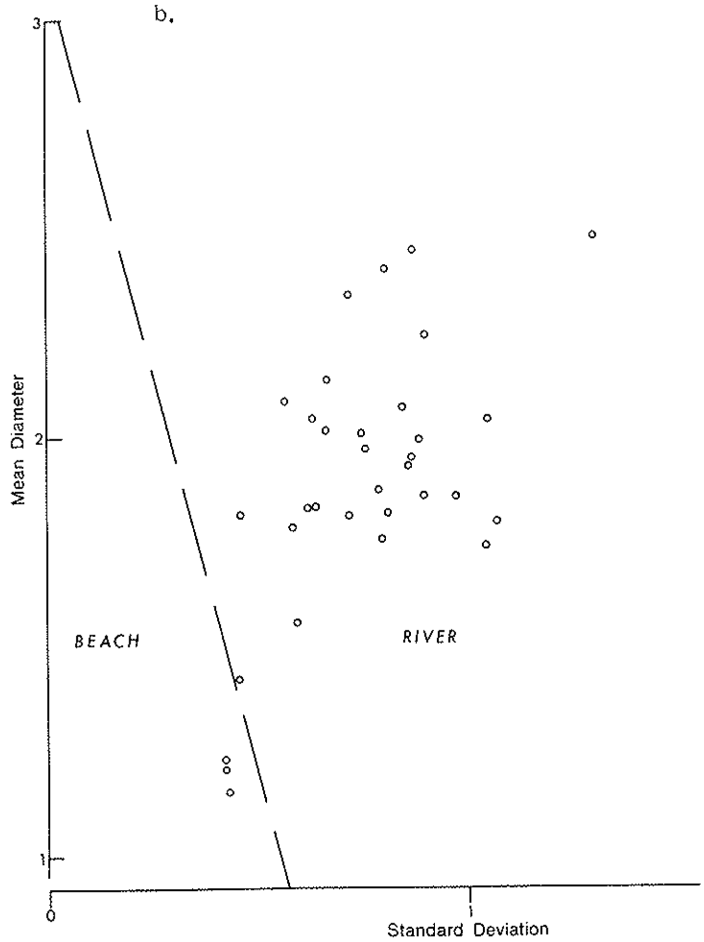


Figure 2. Lithological log of T(Q1-65)A





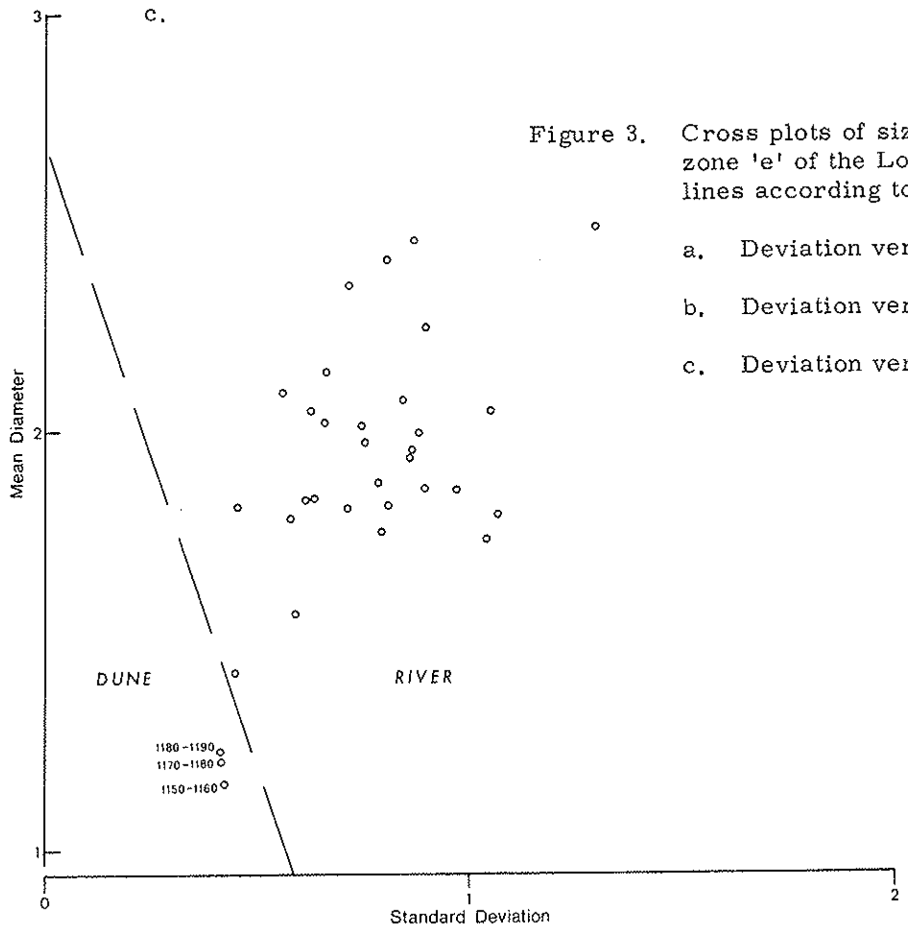


Figure 3. Cross plots of size analysis data of samples from zone 'e' of the Lower and Middle Miocene. Boundary lines according to Moiola and Weiser, 1968.

a. Deviation versus mean diameter

b. Deviation versus skewness

c. Deviation versus mean diameter