J No. 19 Arif El-Naga

The present study deals with the preparation and microscopic investigations for 56 ditch samples (cuttings), provided from J No. 19 Arif El-Naga. These samples represent the interval from depth 10 to 901 m.

In the following, a short account is given for the results obtained for each of the provided samples.

- Sample depth 10m

Residue : With rat

: With rather common presence of planktonic forams as:

Globotruncana aegyptiaca Nakkady, G. arca (Cushman),
G. rosetta (Carsey), G. stuarti (de Lapparent),

Rugoglobigerina macrocephala (Bronn.), some benthic

forams as: Neofladellina sp., ITextualria sp., also with

presence of valves of ostracoda.

- Sample, depth 20m

Residue

With the same previously mentioned foraminiferal assemblage, but less in abundance.

- Sample depth 40m

Residue

: With some pyrite, chert fragments; almost nonfossiliferous except for some micro-organic debris.

- Sample, depth 50m

Residue

With some gypsum debris, non-fossiliferous except for some shell fragments.

- Sample, depth 70m

Residue

: With some shell fragments, chert debris, no free forams.

- Sample, depth 90m

Residue

With some shell remains, rare ostracoda: Bairdia sp.,

absence of free forams.

- Sample, depth 110m

Residue

With rare chert fragments, absence of index microfossils.

- Sample, depth 120m

Residue : Highly crystalline calcareous residue, absence of free

micro-fossils.

- Sample, depth 130m

Residue : Highly calcareous, with some valves of ostracoda.

- Sample, depth 140m

Residue : With some shell remains, some valves of ostracoda, chert

fragments.

- Sample, depth 150m

Residue: With presence of rare benthic forams: Textualria sp.

- Sample, depth 160m

Residue : With presence of some shell fragments, some valves of

ostracoda.

- Sample, depth 170m

Residue : With chert, pyrite fragments, some valves of ostracoda,

rare shell remains.

- Sample, depth 180m

Residue : With pyrite fragments, valves of ostracoda.

- Sample, depth 190m

Residue : sandy with pyrite fragments, some valves of ostracoda,

some shell remains, dwarfed gastropoda.

- Sample, depth 200m

Residue : With pyrite remains, no free forams.

- Sample, depth 210m

Residue : Quartzitic, with presence of shell fragments, pyrite and

chert remains, rare valves of ostracoda, some reworked

forams.

- Sample . depth 220m

Residue

Quartzitic, with shell remains, some valves of ostracoda.

- Sample, depth 230m

Residue

With pyrite fragments, some valves of ostracoda, rare

reworked planktic forams.

- Sample depth 240m

Residue

: With Hedbergellasp., Heterohelix sp., Globotruncana sp.,

valves of ostracoda: Planileberis sp., some other micro-

organic remains, pyrite fragments.

- Sample, depth 260m

Residue

: Some shell fragments, chert and pyrite remains, rare

benthic forams: Textularia sp., some valves of ostracoda.

- Sample, depth 280m

Residue : With presence of some ostracoda : Cytherella cf., C.

austinensis Alex., Cythereis cf., C. rawashensis Van den

Bold, pyrite fragments.

- Sample, depth 300m

Residue

With rare reworked ostraoda, some pyrite remains.

- Sample, depth 310m

Residue

: With chert and pyrite debris, valves of ostracoda :

Cytherella sp., Cythereis sp.

- Sample, depth 320m

Residue

: With rare ostracoda, Cythereis sp., rare pyrite fragments.

- Sample , depth 330m

Residue

: With rare ostracoda, Paracypris sp., no other free

microfossils.

- Sample, depth 340m

Residue

: With pyrite fragments, rare ostracoda, Cytherella sp., no

other free microfossils.

- Sample, depth 358m

Residue

: Non-fossiliferous.

- Sample, depth 360m

Residue

: With rare arenaceous forams, Pseudocyclammina sp., and

some other reworked tests.

- Sample, depth 370m

Residue

Calcareous, dolomitic, with some chert fragments, some

pyrite remains, devoid of free microfossils.

- Sample, depth 390m

Residue

: Dolomitic limestone with some pyrite fragments, devoid

of index microfossils.

- Sample, depth 408m

Residue

Calcareous dolomitic, with some chert fragments, rare

macro-invertebrate shell remains, echinoid spines, no

inde forams.

- Sample, depth 430m

Residue

: Calcareous, quartizitic, with some chert, pyrite

fragmetns, rare valves of ostracoda: Planileberis sp.,

rare planktic forams: Hedbergella sp.

Age

Cenomanian or late Turonian

- Sample, depth 450m

Residue

Calcareous, with presence of some reworked planktics,

rare ostracoda, Cytherella sp.

- Sample, depth 468m

Residue

Dolomitic, with some chert fragments, rare pyrite

remains, devoid of index free microfossils.

- Sample , depth 480m

Residue

: Calcareous with some valves of ostracoda, Bythocypris

sp., Metacytheropteron berbericum (Bassoullet and

Damotte), Paracypris sp., Dolocytherida atlasica Bass. and

Dam., small gastopoda.

- Sample, depth 495m

Residue

Calcareous, with some pyrite fragments, valves of ostracoda, Cytherella ovata (Roemer), Dolocytherida atlasica Bassoullet and Damotte.

- Sample, depth 510m

Residue

Dolomitic, with pyrite fragments, valves of ostracoda, Bairdia sp., Metacytheropteron berbericum (Bassoullet & Damotte), Cytherella sp., some small gastropoda, some other shell remains.

- Sample, depth 520m

Residue

Calcareous, with pyrite fragments, some valves of ostracoda, *Paracypris* so.

- Sample, depth 530m

Residue

Dolomitic, with some pyrite fragments, and some shell remains.

- Sample, depth 540m

Residue

Sandy, glauconitic, with calcareous and pytite fragments, some small gastropoda, some arenaceous forams, *Pseudocyclammina* sp.

- Sample , depth 552m

Residue

Glauconitic, quartzitic, with some shell fragments, chert

remains, pyrite debris.

Age

This horizon probably belongs to Early Cenomanian.

- Sample, depth 715m

Residue

Sandy with iron oxides, pyrite and chert remains.

Age

Lower Jurassic may be assigned starting from this sample and the following samples until depth, 901m, as matched by the study presented by Allam & Khalil (1988).

- Sample, depth 780m

Residue

Quartzitic, with some pyrite fragments, devoid of index micro-organic remains.

- Sample, depth 790m

Residue : Quartzitic, with presence of some holothuroid ? pyritic

remains.

- Sample, depth 805m

Residue : Shaley, silicified, with some gypsum and pyrite

fragments, absence of index microfossils.

- Sample, depth 815m

Residue : Shaley, highly pyritic, sandy, non-fossiliferous.

- Sample, depth 830m

Residue : Shaley, quartzitic, with some small gastopoda, some chert

debris.

- Sample, depth 838m

Residue : Shaley, pyritic, with chert fragments, slightly sandy,

non-fossiliferous.

- Sample, depth 845m

Residue : Shaley, quartzitic with pyrite and other various rock

fragments, non-fossiliferous.

- Sample, depth 855m

Residue : Shaley, quartzitic, chert, pyrite and various rock

fragments, slightly sandy, with some macro-

invertebrate remains and small gastropoda.

- Sample, depth 867m

Residue : Sandy, chert fragments, iron stained rock fragments.

- Sample, depth 874m

Residue : Sandy, rare echinoid remains, some pyrite fragments.

- Sample, depth 885m

Residue: Sandy, with chert and pyrite fragments, non-

fossiliferous.

- Sample, depth 895m

Residue

Sandy, carbonaceous with some pyrite fragments, non-

fossiliferous.

- Sample, depth 901m

Residue

Carbonacocous, quartzitic, with some pyrite fragments

non-fossiliferous.

The best possible figured determination for these stages could be summarized as follows:

from 10 - 240m Maastrichtian - Santonian 240 - 430m Coniacian - Turonian

430 - 552m Cenomanian

552 - 715m Lower Cretaccous

715 - 901m Lower Jurassic

TECHNICAL REPORT

III

GRAIN SIZE ANALYSIS OF LOWER CRETACEOUS

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1 INTRODUCTION

The Lower Cretaceous formation outcrops in south Sinai covering considerable areas overlain Palaeozoic rocks. The formation extends east and west on the scarp face of El Tih Plateau and are overlain by Cenomanian limestone. It consists mainly of quartzose sandstone of different grain size, due to the contental facies. This formation is about 200 to 300 meter thick and gently dips to north. The Lower Cretaceous formation is overlain by Upper Cretaceous and Eocene sediments at the El Teh and Egma Plateau.

The Lower sandstone occasionally appears in certain areas in north Sinai due to the tectonic movements. Some outcrops of Lower Cretaceous are observed at many domes and along fault structures.

Although some test wells were sunk to the Lower Cretaceous aquifer to determine the physical properties, the number of the test wells is limited considering the extension of the Lower Cretaceous over the study area (Section 7-3-3, Technical Report I).

In order to draw a general feature of continuity, homogeneity and change in facies of the sandstone of the Lower Cretaceous, detailed description of geologic columns were undertaken at 11 sites, and the rock samples of these sandstones were obtained for grain size analysis. The distribution of the grain size is a one of clues to estimate the permeability of the strata.

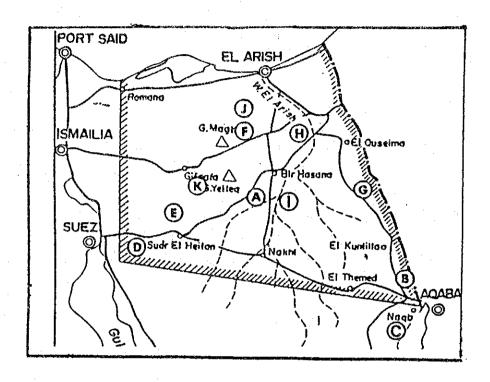
It is intended to evaluate hydrogeological properties of the Lower Cretaceous aquifer by the comparison of the results of aquifer test and grain size analysis.

2 SAMPLING SITES

The location of the outcrops of the Lower Cretaceous in the study area is listed below;

Location	Number of Sampling Sites
Maghara (G. Maghara, G. Mafruth)	2
Yelleq (G. Falig)	1 .
Halal	1
Kherim	. 1 .
Minshera	1
Giddi	1
Raha	. 1
Arif El Naga	1 .
Naqb (East to Wade Watir, G. Alada)	2
Total	11

According to the results of the detailed geological field investigation of these outcrops, eleven sampling sites are selected. The outcrops at Raha and Giddi are narrow and compact so that these samples are discarded for the grain size analysis. Detailed lithological columns are recorded. Location of these outcrops is shown in Fig 2-1.



A: G. Minshera
B: G. Alada
C: East To Wadi Watir
D: G. Raha
E: G. Giddy
F: G. Maghara
G: Arif El Naga
H: G. Halal
I: G. Kherim
J: G. Mafruth
K: G. Falig

FIG 2-1 SAMPLING SITES

3 GEOLOGICAL DESCRIPTION OF SAMPLING SITES

3-1 Introduction

Although detailed geological descriptions are given in the Chapter 6, Geology of the Main Report, the geological spatial conditions are summarized in the following part of this section.

3-2 Gebel Minshera

Gebel Minshera is formed as an clongated dome structure with trend in a N80°E direction disrupted by the fault at the northern side. The sandstone of the Lower Cretaceous is observed in 300 m thick, overlaying the rocks of the Jurassic land overlain by the limestone of the Upper Cretaceous. The Jurassic consists of limestone, sandstone and shale which are observed in the center of the dome structure.

3-3 Gebel Alada

Gebel Alada is located at the northern side of the Ragalet El-Naam Fault. In this area, the Lower and the Upper Cretaceous are gently tilting toward NW direction. The outcrop of about 100 meter thick Lower Cretaceous is observed, however, the lower limit is unidentifiable.

3-4 East to Wadi Watir

This site is located at about 10 km south from the Naqb Air Port where a gently undulating plateau on the Upper Cretaceous is steeply incised toward the Gulf of Aqaba. The sandstones of the Lower and the Upper Cretaceous are gently tilting toward NW to W direction unconformably underlain by the Precambrian rocks.

3-5 Gebel Raha

This is a dome structure located in the south west of Sadr El Heitan. Different formations varying from the Jurassic to the Tertiary are observed, however, the thickness of the Lower Cretaceous is only 40 m in the outcrop since the outcrop is dissected by many faults.

3-6 Gebel Giddi

This site is located in the graben between Gebel El Heitan and Gebel Hamra at 20 km from Sadr El-Heitan to the northwest. The strata gently tilt toward the east to north east direction and formations from the Lower Cretaceous to the Tertiary are observed, although the Lower Cretaceous encounters only the top 15 m at the outcrop.

3-7 Gebel Maghara

This site is located at the southern fringe of the dome structure 3 km west from the outlet of the Wadi Hama at the Gebel Maghara.

The thickest Jurassic is observed in the center of the dome under the outcrops of the Lower Cretaceous and limestone of the Upper Cretaceous and Eocene. However, the boundary between the Jurassic and the Lower Cretaceous is covered by the sand dunes and the Quaternary deposits. The Lower Cretaceous is observed in 180 m thick at this site.

3-8 Gebel Arif El Naga

This site is located on the inner wall of the dome structure. The Triassic and the Jurassic are observed in the core. The Lower and the Upper Cretaceous outcrops are observed in the inner wall of the dome. Although the boundary between the Lower Cretaceous and the Jurassic is covered by the Quaternary deposits, a 300 m thick outcrop of the Lower Cretaceous is exposed.

3-9 Gebel Halal

This site is located in the dome structure of the Gebel Halal which is also a large dome structure as the Gebel Maghara. The central part of the dome is heavily eroded and the Lower Cretaceous is exposed. The thickness of the Lower Cretaceous is estimated at more than 600 m. The boundary with the Jurassic is under the deposits of debris.

3-10 Gebel Kherim

This site is located in the dome structure 6 km from Hasana to the southeast. The central part of the dome is heavily eroded and the Lower

Cretaceous is exposed. On the croded wall of the dome, the limestone of the Upper Cretaceous is observed overlying the Lower Cretaceous. The thickness of the Lower Cretaceous in the outcrop is 250 m. The bottom is covered by the debris.

3-11 Gebel Mafruth

This site is located on the inner cliff of the northern side of the dome. On this cliff, the Lower Cretaceous and the Upper Cretaceous are observed gently tilting toward the north. The thickness of the Lower Cretaceous is over 245 m.

3-12 Gebel Falig

This site is located in the dome structure in the northwest of the Gebel Yelleq. In the core of the dome, about 30 m thick Lower Cretaceous is exposed and overlain by the limestone of the Upper Cretaceous. The bottom of the Lower Cretaceous is below the ground surface.

4 GRAIN SIZE ANALYSIS

4-1 Introduction

Prior to the collection of the rock samples, detailed litho-stratigraphic columns are recorded at each sampling site (see Attachment). It is empirically known that the grain size distribution generally correlate with the permeability of the stratum, so that 20% value of the accumulation curve of the grain size distribution (D_{20}) is obtained to estimate the permeability of each sampled section. Finally, above mentioned litho-stratigraphic columns are evaluated their nature as an aquifer by interpreting by the grain size distribution and estimated permeability.

4-2 Analysis

4-2-1 Samples

Prior to sampling rocks, the route map is constructed and the true thickness is estimated referring to the dip and strike. Rock samples are collected in each 2 to 3 m intervals of the true thickness. A total of 1,400 rock samples are collected at 720 sampling points in 11 sites including some duplicate samples;

Table 4-1 Samples and Sampling Sites

Site number	Site name	Thickness observed	Number of sampling point
Α	Gebel Minshera	327 m	102
В	Gebel Alada	116 m	. 58
С	Easet to Wadi Watir	192 m	62
D	Gebel Raha	42 m	22
Е	Gebel Giddi	14 m	6
F	Gebel Maghara	178 m	57
G	Gebel Arif El Naga	290 m	106
Н	Gebel Halal	665 m	114
I	Gebel Kherim	239 m	114
J _.	Gebel Mafruth	245 m	68
K	Gebel Falig	30 m	11

The sieve analysis is undertaken at the laboratory of the Suez Canal University in order for determination the grain size distribution.

Table 4-2 Classification of Grain Size

over 4 mm : Gravel

4 - 2 mm : Granute

2 - 1 mm : Very Coarse Sand

1 - 0.5 mm : Coarse Sand 0.5 - 0.25 mm : Medium Sand

0.5 - 0.25 mm : Medium Sand 0.25 - 0.125 mm : Fine Sand

0.125 - 0.063 mm : Very Fine Sand

under 0.063 mm : Clay and Silt

Based on the obtained D_{20} , the permeability of each sample is estimated according to the table shown below:

Table 4-3
Correlation of D₂₀ with Permeability

		T		1	
D ₂₀ (mm)	k (cm/sec)	Classification	D ₂₀ (mm)	k (cm/sec)	Classification
0.005	3.00E-06	clay	0.18	6.85E-03	
0.01	1.05E-05		0.20	8.90E-03	fine sand
0.02	4.00E-05	silt	0.25	1.40E-02	
0.03	8,50E-05		0.30	2.20E-02	
0.04	1.75E-04		0.35	3.20E-02	
0.05	2.80E-04		0.40	4.50E-02	
0.06	4.60E-04		0.45	5.80E-02	medium sand
0.07	6.50E-04	very fine	0.50	7.50E-02	
0.08	9.00E-04	sand	0.60	1.10E-01	
0.09	1.40E-03		0.70	1.60E-01	
0.10	1.75E-03		0.80	2.15E-01	coarse sand
0.12	2.60E-03		0.90	2.80E-01	
0.14	3.80E-03	fine sand	1.00	3.60E-01	
0.16	5.10E-03		2.00	1.80E+00	fine gravel

K : permeability coefficient (cm/sec)

D20: 20% value of accumulation curve of grain size distribution (mm)

4-2-2 Litho-stratigraphic Column

The geological columns were recorded on the site when samples were collected, and were interpreted with the results of the sieve analysis to complete the litho-stratigraphic column of each site (Attachment).

Description items given to the litho-stratigraphic column are:

- 1) Thickness of each bed
- 2) Lithology
- 3) Grain size description
- 4) Passing D₂₀
- 5) Permeability

5 GRAIN SIZE DISTRIBUTION

According to the results of the analysis, the general feature of the grain size distribution of the sandstone of the Lower Cretaceous is summarized as described below:

1) Gebel Minshera(Column-A) (Page III-21)

- * The sandstone of the Lower Cretaceous consists of quartz sand intercalated with limestone. Sandstone facies in 80 m thickness appears at the base of the Cenomanian.
- * Thin shale layer less than 10 m thickn is observed at some places in the upper part of the Lower Cretaceous.
- * The sandstone consists mainly of medium sand and the matrix hardly contains silt and clay.
- * Cross-bedding is commonly observed.
- * Very coarse sand and granule are predominating from 180 m to 327 m from the top of the Lower Cretaceous.
- * Clay in the matrix tends to be accompanied by very fine and fine sand rather than coarse sand.

2) Gebel Alada(Column-B) (Page III-25)

- * The intercalation of limestone and sandstone is observed at the base of the Cenomenian of the Upper Cretaceous. The thickness is less than 10 m which is much thiner than that observed at Gebel Minshera.
- * The sandstone consists of predominating medium and fine sands.
- * Relatively thick silt is observed at the top 20 m, however silt is hardly contained in the lower part of the top 20 m.

- * Shale is rarely observed.
- * A 10 m thick fine sand bed encounters between 40 m and 50 m from the top.
- * Cross bedding is commonly observed in the sandstone of the Lower Cretaceous.

3) Gebel Al Mostadul(Column-C) (Page III-27)

- * No intercalation of the limestone and sandstone is observed at the base of the Cenomanian of the Upper Cretaceous.
- * Down to 10 m from the top, medium to coarse sand predominate intercalating with occasional granule and gravel. The portion of silt and clay increases from the depth of 120 m toward the lower part. Cross beddings are also commonly observed in this part.
- * Granule and gravel predominate at 180 m from the top.
- * The Lower Cretaceous unconformably overlays the Precambrian rocks.

4) Gebel Raha (Column-D) (Page III-29)

- * The sandstone consists of fine sand and coarse sand. The former predominates in the column. No interbed of thin shale is observed.
- * Samples of this site was so solid that no grain size analysis by the sieve test was carried out. Therefore, the porosity was measured by comparing the specific gravities in moist and dry samples;

Table 4-4 Porosity of Rock Samples

Sample number	Porosity (%)
D1	3.28
D3	13.38
D5	9.09
D7	10.22
D8	13.73
D9	10.62
D10	7.53
D11	16.57
D13	8.21
D15	14.75
D16	17.16

5) Gebel Giddi (Column-E) (Page III-30)

Sandstone consists of fine sand with occasional coarse sand. This bed was consolidated so that the porosity was measured instead of the sieve analysis;

Table 4-5 Porosity of Rock Sample

Sample number	porosity (%)
E 1	5.72
E3	4.48
E6	7.77

6) Gebel Maghara(Column-F) (Page III-31)

- * A intercalation of shale and sandstone is observed at the top 110 m. The sandstone in this alternation consists of fine sand and smaller particles.
- * The proportion of the sandstone in the alternation increases more than that in the above layer. The sand increases in size to coarse to medium sand.
- * Cross bedding is commonly observed through the column. Sand larger than 1mm diameter is hardly observed.

7) Gebel Arif El Naga(Column-G) (III-33)

- * A intercalation of sandstone and limestone is observed at the base of the Cenomanian.
- * In general, fine sandstone predominates over the Lower Cretaceous. Shale are observed between 140 m and 180 m from the top of the Lower Cretaceous.
- * Cross bedding is commonly observed.
- * Matrix composed of silt and clay is observed in the fine to medium sand rather than coarse sand.

- 8) Gebel Halal (Column-H) (Page III-36)
 - * A more than 600 m thick Lower Cretaceous is identified at this site. Intercalation of limestone and sandstone is observed at the base of the Cenomenian.
 - * Medium to fine sands predominate with frequent shale of less than 5 m thick in the upper 140 m from the top.
 - * A thick shale encounters between 145 m and 255 m from the top partly covered by the Quaternary. Further down most of the part is covered by the Quaternary deposit, however where it is exposed frequently shale is observed.
 - * Matrix of silt and clay is observed in the calcareous sandstone.
- 9) Gebel Kherim(Column-1) (Page III-43)
 - * Medium to coarse sands are predominating over the profile and shale less than 10 m thick appears at 80 m and 95 m from the top.
 - * Shale encounters occasionally in the upper 105 m from the top, however no shale appears further below.
 - * All samples contain coarse sands more than 1 mm of grain size to a certain extent.

10) Gebel Mafruth(Column-J) (Page III-46)

- * The outcrop of the Lower Cretaceous is recognized down to 250 m from the top, however the bottom is unidentifiable. Medium and coarse sands predominate over the section and matrix hardly contains silt.
- * Intercalation of sandsstone and limestone is observed at the base of the Upper Cretaceous.
- * Shale appears at the upper part in 30 m thick and occasionally a thin shale with less than 10 thickness encounters in the lower part of the outcrop and also limestone encounters. The maximum thickness of the limestone reaches 10 m.
- * Granule and gravel are commonly observed in the coarse sand.

11) Gebel Falig(Column-K) (Page III-49)

- * The Lower Cretaceous is identified for 30 m below the base of the Cenomenian, the rest is covered by the Quaternary deposits.
- * The sandstone consists of very fine to fine sands and consolidated with silt and clay matrix. Sands with more than 1mm diameter is hardly observed.

6 EVALUATION OF SANDSTONE AQUIFER OF LOWER CRETACEOUS

6-1 Geological Characteristics of Sandstone of the Lower Cretaceous

Based on the above analysis, a general feature of the sandstone of the Lower Cretaceous is observed.

In general, the sandstone consists of predominating medium to coarse sands of which grain size is between 0.25 mm and 1.0 mm. Crossbeds are often observed in the sandstone especially in the fine sandstones.

The whole sequence of the Lower Cretaceous is recognized at five sites; Gebel Minshera, Arif El Naga, Kherim, Maghara and Mafruth. The thickness of the Lower Cretaceous at these sites varies from 200 m to 300 m. However, the thickness of the Lower Cretaceous is more than 600 m only at Gebel Halal.

At Gebel Halal a thick shale bed is observed at the middle to lower part of the section, however the interbedded shale in the sandstone is observed only occasionally and their thickness rarely reaches 10 m.

In the south of Naqb area siltstone or claystone are occasionally interbedded in the sandstone instead of shale.

The continuity of the stratigraphic sequence among these sampling sites is not proofed, however a general feature of the Lower Cretaceous is summarized that the sandstone is predominating throughout this formation with occasional interbeds of lenticular shale and the size of the sand granule varies even in a single bed. However, this sandstone is porous to a certain extent.

The medium to coarse sands predominating in the sandstone hardly contain matrix and even very fine to fine sands contain matrix only to a certain extent.

6-2 Hydrogeological Characteristics of Sandstone of Lower Cretaceous

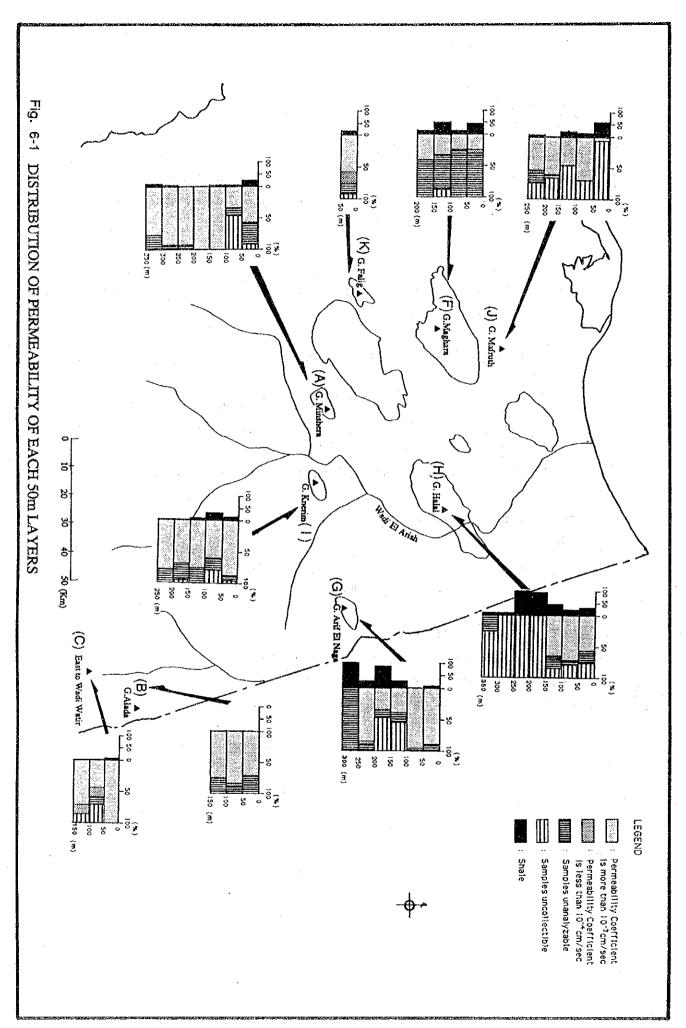
Majority of the estimated permeability coefficients by the grain size analysis is in a range between 10^{-2} cm/sec and 10^{-3} cm/sec which is recognized as a favorable property of the aquifer from a hydrogeological point of view.

Each sample is collected in 2 to 3 m intervals so that the estimated permeabilities are classified in the following criteria by each 50 m thickness of the sequence;

- 1) The layer of which permeability coefficient is more than 10⁻³ cm/sec,
- 2) The layer of which permeability is less than 10⁻³ cm/sec,
- 3) The layer of which sample is not collected because it is so hard and
- 4) The layer of which facies is shale or covered by debris.

The percentage of the total thickness of the above classified layers in each 50 m thick column at each sampling site is shown in Fig 6-1. The percentage of the thickness of shale in each 50 m thick column is also shown on the left side of the diagram.

The top 100 m to 150 m bed at Halal and Arif El-Naga consists of highly permeable sandstone. The section lower than 150 m from the top is occupied by impermeable shale at Halal and there is an another permeable bed between 200 m and 250 m from the top at Arif El-Naga.



There is impermeable bed at the top 50 m at Mafruth, however almost 50 % of the section consists of permeable sandstone. The permeable sandstone consists only 20 to 40 % of the section and shale occupies greater part of the section at Maghara. These two sites may represent the lithological sequence in the northern part of the study area.

Although the observed thickness of the geological sequence is only 50 m at Falig, most of the geologic column sequence is occupied by the permeable sandstone at Falig, Minshera and Kherim distributing in the central part of the study area. The shale appears in the upper part of the section at these site, however it is a kind of a thin lenticular type.

In the southeastern area of the study area at Alada and East to Wadi Watir the shale is hardly observed and almost of whole section is occupied by the permeable sandstone.

In conclusion, it would be summarized that the Lower Cretaceous sandstone consists mainly of a thick sequence of medium to coarse quartzose sandstone, sandy clay interbedded with shale and clay beds in study area. In the northern area thick shale beds appears in a part of the formation. In the central area the sandstone sequence is observed through the whole section interbedded with thin shale, however these are lenticular, discontinuous. In Naqb, the southeastern corner of the study area, the Lower Cretaceous sandstone consists of pure sandstone.

ATTACHMENT

LITHO-STRATIGRAPHIC COLUMNS

				PARTICLE SIZE	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		
	THICK-	LITHOLOGY	SAMPLING		PASSING D 20	PERME AB-	
	NESS	Limotogi	NO.		×10 ⁻¹ 5 4 3 2 1	ILITY	KS
_	(m)					(cm/sec)	
					i.		
1	:		<u> </u>				
							·
-	:						
			<u> </u>				
			[
			VOV 00	1 11			
아	1.5	58 75 55 57 1 WEST (2.54)	ДОЧ			<u> </u>	L.Brown
	3,		- A 03	1 1			Brown
	2		— 486 na				
	3		—A87 °°			1.40x10 ⁻²	}
아	2.5		-A88 ee	\rangle		4.50x10 ⁻²	
	3		_A89 ººº				L Brown
	2.5		-A90 aa			2.20x10 ⁻²	
0	2.5		—A91 ^{□□}			6.85x10 ⁻³	
\mathbb{I}	2.5		_A92		,	·1.40x10 ⁻²	
-			-AJZ				
	8						Red
0 -		The second secon	A93 [□] .				
			A 94 ^{□□}			8.90x10 ⁻³	White
1			_A 95 ™			i	
	14		-A 96 00		· /	3.80x10 ⁻³	L.Gray
0		Talis Talis alignatus alignatus filosofii Talis Talis Alignatus al			(6.85x10 ⁻³	L.Brown
			—А 9 7 ^{го}		<i>)</i>	5.10x10 ⁻³	White
	1		A98 ™	1	, /	2.20x10 ⁻²	LBrown
	3		—A 99 □			,	Red
아			—д 100 □	1	1	3.80x10 ⁻³	R White
Ĺ	9.5		— A 101 ºº]	5.10x10 ⁻³	White
			— A 102 пп			6.85x10 ⁻³	1771110
0 -				,			
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+				· ·			
] .			*			-1
아					:		
+		•			!		
			1.		•		
)-		<u> </u>	L		1.5	GEND	
11/	500				_		nd, Granule, Gra
					b) 0.25mm ~ 0.5mm	: Medium sa	•
1	THO-	- STRATIGRAF	PHIC CO	LUMN-A	c) 0.125mm ~ 0.25mm	: Fine sand	
`		* [·	d) 0.063mm = 0.125mm	: Very five	sand
	AT:	G. MINSHE	-RA		e) less than 0.063mm	: SIIt, shale	e, clay
1		•		· ·			

				PARTICLE SIZE		. :	
	THICK-	LITHOLOGY	SAMPLING	DISTRIBUTION	PASSING D 20	PERMEAB-	
	NESS	LITHOLOGI	NO.	000	X10°' 5 4 3 2 1	ILITY	KS
) -	(m)			000	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	(cm/sec)	
1	2						D.Gray
-	-						
	7		— A1 ^в		• •		
)-	2		— A2°	/ \ \\	·		L Blue
	i.5		— A3°.	<i>!</i>	i i	6.85×10 ⁻³	
-	4	X	A4°°	$\langle \langle \langle \rangle \rangle$)	5.10x10 ⁻³	
			A5 °		. (8.90x10 ⁻³	L Gray
) -	5.5		A6°		}	8,90x10 ⁻³	·
	3		A7 °			4.50x10 ⁻²	
	·	<u> </u>	A8°			3.80x10 ⁻³	L.Brown
	3		— до	1			
0 -	2.5 		— Λ9 [□] ,		/	2.60x10 ⁻³	
	5.5		д10 еп	1		1.40x10 ⁻²	White
			— д11 A83 — д12 A83	1 1		1.40x10 ⁻²	Red
o -	1.5	*************	- !			3.20x10 ⁻²	
	6		_ ∆13°			8.90x10 ⁻³	L . Red
+	<u> </u>		Д14 °			8.90x10 ⁻³	
	5		— д15 °□	\ \ \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	/	1.40x10 ⁻²	
아			_ д16 °			8.90x10 ⁻³	L. Brown
	6		Δ17 °			1	
1		**************************************	<u>4</u> 18°°			1.40×10 ⁻²	
	j		A19 º º			8.90x10 ⁻³	
아	<u> </u>		1	7 1		3.20x10 ⁻²	
			A20°			5.80x10 ⁻²	Brown
			A 21 ª º			1.40x10 ⁻²	
0-		: ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' ' '	_∆22°	{	1)	8.90x10 ⁻³	
Ĭ			∆23°			1.40×10 ⁻²	
ļ.	31.5		A 24°			2.20x10 ⁻²	While
	-		— A 25∘		\	3.20x10 ⁻²	
0-			_A26°			8.90x10 ⁻³	L Brown
			д27 о		\ .	6.85×10 ⁻³	White
ŀ			— A28°				: :
	3		_ A29°	11		1.40x10 ⁻²	
0 -	2.5		— A 30 0 0			3.20x10 ⁻²	
	3	2.7% (10.00 1/3)	i		. \	2.20x10 ⁻²	<u> </u>
	4,5		_ Д 31 00		}	8.90x10 ⁻³	
	cont,		д 32 °	<u> </u>	1	1.40×10 ⁻²	<u> </u>
	·			•	LEG	END	
\mathbb{P}^{V}	500	the second					Granule, Grave
					, 	: i fedium sand	i
		•			c) 0.125mm - 0.25mm	: Fine sand	• * .
				· ·	d) 0.063mm - 0.125mm	: Very five sa	100
1					e) less than 0.063mm	: Silt, shale,	clay

	*(1)		CANDUNC	PARTICLE SIZE	DACCING DOC	PERMEAB-	DEMAR-
	THICK- NESS	LITHOLOGY	SAMPLING NO.	DISTRIBUTION	×10 ⁻¹	PERMEAU~	KEMAK- KS
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	3.5		— д 34°			.5.10x10 ⁻³	While
	3		— д 35°			1.40x10 ⁻²	R. White
-	1.5		A 36 °		\	8.90x10 ⁻³	L.Gray
			<u> — д</u> 37°) .	8.90x10 ⁻³	Danua
	13.5		— д 38°	$ \rangle$		2.20x10 ⁻²	Brown
		· · · · >	— д 39°			3.80x10 ⁻³	i
-			A 40 °			8.90x10 ⁻³	
	1.5		A41 °			-	
	4		д42°			3.20x10 ⁻²	
		等交流	A 43 °			1.75×10 ⁻³	White
	9	7.	Д44 °°			1.40x10 ⁻²	
-	₹		Δ 45°			5.10x10 ⁻³	
		4			\ .	5.10x10 ⁻³	
-	- 4	シニン	1 4 → 0.03			3.80×10 ⁻³	1. 1
	2	i ž			/	1.40×10 ⁻³	Drowo
-	9	ン・・・・ン	A 40) > '	\ \ \ \ \ \	5.10x10 ⁻³	Brown
		ン・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・	_ д 49 ° п		<i>\</i>	2.60x10 ⁻³	White
			— A 50 °			1.40x10 ⁻²	
			A 51: °		/	1.40x10 ⁻²	
	10.5		д 52 °		(3.20x10 ⁻²	Gray
-			— A53 оо			2.20x10 ⁻²	i
			- A54 ""		, /	1.40x10 ⁻²	
-	. 4		— A'55 🕫				White
			A56 °°			8.90x10 ⁻³	Brown
-	6.5		A57 00	/ /	/	8.90x10 ⁻³	
	2	2.00	_ A58 ***			,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Gray
			A59 °°			8.90×10 ⁻³	R.White
-	6.5		A60 PD		\	8.90x10 ⁻³	
			— A61 00			Į	Brown
-						6.85x10 ⁻³	White
	- 11	7	A62		/ '	8.90x10 ⁻³	Brown
-			— A63	1) > 1		2.20x10 ⁻²	
			— Д64			8.90x10 ⁻³	Red
	5	7	— A65			8.90x10 ⁻³	Brown
_	con(-A66	/		3.80x10 ⁻³	Red
1					LE	GEND	
i	500				a) more than 0.5mm	: Coarse san	d, Granule, Gra
1	_ITHO -	- STRATIGRAI	PHIC CO	DLUMN-A		: fledlum sar	าฮ์
		O NACHIOLIET	ο Λ		c) 0.125mm - 0.25mm	: Fine sand	
	AT:	G.MINSHER	ξ Α		d) 0.063mm ~ 0.125mm	: Very five s 333 : Slit, shale,	
				and the state of t			
	03 JV.	- 150 (52×36)		III - 22			

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	THICK- NESS	LITHOLOGY	SAMPLING NO.	PARTICLE SIZE DISTRIBUTION	PASSING D 20 ×10 ⁻¹ 5 4 3 2 1	PERMEAB- ILITY (cm/sec)	REMAR-
280	1		-A67"		\		L.Brown
1	4,5		А 68°° Д 69°°			6.85x10 ⁻³	White
290	- 7.5	\mathcal{S}	A 7,0 00	$\langle \rangle$		3.20x10 ⁻² 1.40x10 ⁻²	L Brown
			_A71			6.85x10 ⁻³	White
	9,5		_A72 00 _	7	1 (1	2.20x10 ⁻²	L.Brown
300	_ 3.5	7	—∆74 °°			1.40x10 ⁻² 2.20x10 ⁻²	-
-	6		—A 75 00				L Red
310	1		—А 76 ^{во} —А 77 ^{во}			1.75x10 ⁻³	- White
			—А78 ^{пв}			1.75x10 °	L.Brown
700	13		A 79°°			8.90×10 ⁻³	L Red
320	-		A 80°°	$\langle Z \rangle$		3.20×10 ⁻² 1.40×10 ⁻²	
-	2	*************	_A82 nn			2.20x10 ⁻²	L Brown
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350					·		-
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380-							
1	/500					END : Coarse sand	, Granule, Gravel
	LITHO -	STRATIGRAP	PHIC CO	DLUMN-A	b) 0.25mm ~ 0.5mm (: fledium sand	1 · .
		G.MINSH			d) 0.063mm - 0.125mm	: Fine Sand : Very five Sa	nd .
,	AI:	HCMIM. O	LIVA		e) less than 0063mm	: Sill, shale,	clay
	_ 4 1.	15D (52×36)		187 G.O			

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	1		56	PARTICLE SIZE			_	
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Ť			B1					
	8		B3		\	3.8x10 ⁻³	l.Brown	
ŀ					}	1.75×10 ⁻³		
10		シー・・・・・ソ	— B5	$\langle \cdot \cdot \cdot \cdot \rangle$		3.8x10 ⁻³	Purple	_
107-	B			> _>>	·			İ
					7		L.uray	.
	-			$Z = Z \setminus I$		6.85×10 ⁻³	Purple	
	3		·- В10		Į.	2.20x10 ⁻²	 	i
20				//		1.75x10 ⁻³		
•	6,5						L.Gray	ĺ
f	1				1			
	4	No. 346		. , ,	•	2.6x10 ⁻³	Red L Grav	ł
30		 	— B16			_a	[010)	i
]		— B.17	1		1.40x10 ⁻³		İ
F	10	<i>>.</i> ::::::::::::::::::::::::::::::::::::				8.90x10	L.Purple	-
		数据的思想		/		8.90x10 ⁻³		
40-		*:::::::::::::::::::::::::::::::::::::				8.90x10 ⁻³		-
4	2			1			L.Red	ſ
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50-					:			· -
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	5		— В29			8.90x10 ⁻³	L. G. Q)	ĺ
60-				((<i>)</i>	6.85x10 ⁻³	I Brown	
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L						8.90x10 ⁻³		-
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/0				/		1.40x10 ⁻²	L'GL9A	
		シーン・シー				6.85x10 -3	GCAY	~
			— в 39		·		L'reals	Į
0.1	1.5		— в 4С			1.40x10 ⁻²		-
OUF	0 - (m) 3 3 3 4 3 2 1 (cm/sec)							
		<i>ジ</i> ン・・・・・ン・		///		3.20x10 ⁻²		-
ŀ	7						u. 47	
	8	l Ceau						
90	8	וניטוע).						
	6.5				7	1.40x10 ⁻³	Purole	
.						5.10x10 ⁻³	Gray	
	2					3.20X10 -	Yellow	
100	<u> </u>							
1/	/500				•		5.7	,
L.		CTDATICDAD	יוור רח	LIMN-B		LV.X.36		'el
	LHMU -	SIRALIGRAF	THE CO	LUITH D	b) 0.25mm ~ 0.5mm	: Hedlum sar	nd	
	ΑТ.	$C = A \perp A \perp D A$	•		c) 0.125mm = 0.25mm	: Fine sand		ļ
	AI:	G. ALADA	•		d) 0.053mm ~ 0.125mm	: Very five s	and	Ì
	Sample : I	Indisturbed Fx 2	2 Total 116		e) less than 0.063mm	: Silt, shale,	, clay	
l				the second secon				

	THICK- NESS	LITHOLOGY	SAMPLING NO.	PARTICLE SIZE DISTRIBUTION	PASSING D 20 ×10 ⁻¹ 5 4 3 2 1	PERMEAB- ILITY (cm/sec)	KS
00-	(m) 6 7		B51 - B52 - B53 - B54 - B55			2.20x10 ⁻² 8.90x10 ⁻³ 2.20x10 ⁻² 2.20x10 ⁻²	Purple L.Gray D.Gray L.Red
110-	2 2		— B56 — B57 B58		•	1.40x10 ⁻²	White L.Gray White
20-							
		* • .					
130 -	and an in the second						
140-							
- 150 -							
160-		•					
170-							
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			:				
90-			,				
00-	/ 500		<u> </u>			EGEND : Coarse sa	nd, Granule, Gravel
	_ITHO	STRATIGRAP	ніс сс	DLUMN-B	b) 0.25mm - 0.5mm c) 0.125mm - 0.25mm d) 0.063mm - 0.125mm	: Medium sa	กd สลกับ
	AT:	G.ALADA			e) iesa than 0.063mm	: SIII, shale	, clay

ſ	**************************************		-				
	THICK-	LITHOLOGY	SAMPLING N O.	PARTICLE SIZE DISTRIBUTION	×10 ⁻¹	PERMEAB- ILITY	REMAR- KS
40	(m)				5 4 3 2 1	(cm/sec)	
10	- 9		C1 C2 C3 C4			2.20x10 ⁻² 6.85x10 ⁻³ 8.90x10 ⁻³ 1.40x10 ⁻²	L.Brown
50	- 3		- C5 - C6 - C7			6.85x10 ⁻³ 1.40x10 ⁻² 7.50x10 ⁻²	White Purple
	3.5		- C8 C9			1.40x10 ⁻² 2.20x10 ⁻²	L,Brown
60	_ 4	1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	C10 C11	\geq	5	3.20x10 ⁻² 1.40x10 ⁻²	
	6 0. 5 -	· · · · · · · · · · · · · · · · · · ·	C 12 C 13 C 14			4.50x10 ⁻² 2.20x10 ⁻²	Red
70	- 0.5 - 1 1		Č15 C16			2.20x10 ⁻² 8.90x10 ⁻³ 8.90x10 ⁻³	L.Brown
	3	00 00 00 00 00 00 00 00 00 00 00 00 00	C 17 C 18 C 19			8.90x10 ⁻³ 3.20x10 ⁻²	
80	_ 4	200,000,000	— С20 — С21	\geq		2.20x10 ⁻² 2.20x10 ⁻² 8.90x10 ⁻³	L.Brown
	- 8	2000 2000 700 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	— C 22 — C 23 — C 24		\	2.20x10 ⁻² 1.40x10 ⁻² 1.40x10 ⁻²	2,0
90	O.5 3.5		— С 25 — С 26		5	2.20x10 ⁻² 5.1x10 ⁻³	
	0.5 1.5		— C 27 — C 28 — C 29			8.90x10 ⁻³ ,1.40x10 ⁻² 2.20x10 ⁻²	<u> </u>
100	_ 8		— C 30 — C 31			8.90x10 ⁻³ : 8.90x10 ⁻³ :	White
	2		— C 32 — C 33			1.40x10 ⁻² 2.20x10 ⁻²	
110	16	Missing by					
	-	Fault					
120			<u>C34</u>	// / /	\	9.00x10 ⁻⁴	C. Yellow
	2		C34 C35 C36 C37			1.40x10 ⁻³	∠Purplr L,Brown
130	2 2 2		C38 C39	K_{i}	}	9.00x10 ⁻⁴ 9.00x10 ⁻⁴	C, Yellow
	_ 14	/	C40 C41 C42		\	1.75x10 ⁻³ 2.80x10 ⁻⁴	/Purple
140	cont2		C43		. 150	1.75x10 ⁻³	ll
	1/500	CIDATIONA	nuic of	N LINANI C	a) more than 0.5mm		f, Granule, Gravel
.	LITHO	- STRATIGRAI	THIC CC	JEUMN ~ C	c) 0.125mm ~ 0.25mm	: Fine sand	
		G.AL-MOST			d) 0.063mm ~ 0.125mm	: Very five s	
	And in case of the last of the	Indisturbed C ×2	Total 124	-			

							1	A
	THICK- NESS	L ITHOLOGY	SAMPLING NO.	PARTICLE SIZE DISTRIBUTION •••	PASSING D 20	ILITY	REMAR- KS	
10	(m) cont1 14		— C44 — C45 — C46	> \	5 4 3 2 1	4.60×10 ⁻⁴ 4.60×10 ⁻⁴	C.Yellow /Purple	_
50 -	3		C48 C48 C49			6.50x10 ⁻⁴ 3.8x10 ⁻³ 1.75x10 ⁻³ 1.75x10 ⁻³	L'BLOMU	_
-	9	Missing						
50-	<u> </u>		— C50 — C51 — C52 — C53			1.75x10 ⁻³ 5.1x10 ⁻³ 2.6x10 ⁻³	white	_
70-	2 2		— C 54 — C 55 — C 56	1		2.6x10 ⁻³ 5.1x10 ⁻³ 5.1x10 ⁻³ 3.8x10 ⁻³	L.Brown C Yellow	:-
_	0.5 1.5		C57 C58 C59 C60			8.90x10 ⁻³	L.Brown	=
30 -	4		— C 62	711		$\begin{array}{c} 2.6 \times 10 \\ 1.10 \times 10^{-1} \\ 7.50 \times 10^{-2} \end{array}$	Red -	
3O-		:						. -
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-		·						-
•								-
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_								-
Ì	500 	- STRATIGRAF	DUIC CC		a) more than 0.5mm b) 0.25mm - 0.5mm	: Hedium sand	l, Granute, Gravel	1
		G. AL-MOS		COPIN C	c) 0.125mm - 0.25mm (d) 0.063mm ~ 0.125mm (e) tess than 0.063mm	: Fine sand : Very five sand : Silt, shale,	:	•

	THICK-		SAMPLING	PARTICLE SIZE DISTRIBUTION	PASSING D 20	DEDME VD ~	DEMAR-
	NESS (m)	LITHOLOGY	NO.	O'S THOUTON	X10 ⁻¹	ILITY (cm/sec)	KS
)-	3.5		D1 D2 D3				L.Brown
	2		— D4 — D5		·		Brown
)-	2		— D6 — D7				Purple
	4		— D8 — D9				Brown
, -	4		— D10 — D11 — D12	·			L.Brown
-	2		— D13 — D14				Brown
, -			— D15 — D16 — D17				L.Brown
-)6.5 !		— D18 — D19 — D20				Brown
-			D21 D22	·			
		·		:			
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-							
					LEG	END	
•	00. .TUO	STRATIGRAP	יוור רח		a) more than 0.5mm b) 0.25mm - 0.5mm	: Coarse sand,	
L			me co		c) 0.125mm - 0.25mm	: Fine sand	
		G . RAHA Undisturbed , D×1		and the second second	6) 0.063mm - 0.125mm	: Very five sar	

0	THICK- NESS (m)	LITHOLOGY	SAMPLING NO.	PARTICLE SIZE DISTRIBUTION	PASSING D20 ×10 ⁻ 5 4 3 2 1	PERMEAB- ILITY (cm/sec)	REMAR-
	6.5		— E1 — E2 — E3 — E4		·		L. Brown
0 -	2	1	— E5 — E6	:			
0 -		Quaternary Deposit					
0							
-		·		·	. '		
) -							
)-					·		
					·		
) }-	·						
-				,	:		
)-					:		
)-							
1							:
1/1	500	<u></u>	.			GEND	·
1		STRATIGRAP	HIC CO) more than 0.5mm (: Coarse sand,	Granule, Gravel
		G. GIDDI		c) 0.125mm ~ 0.25mm) 0.063mm ~ 0.125mm	: Fine sand	nd
Car		ndisturbed E×2	Total 12) less than 0.063mm		

				PARTICLE SIZE]
	THICK-	LITHOLOGY	SAMPLING			PASSING D20	PERME AB-	1
	NESS	Limotour	NO.			×10 ⁻¹ 5 4 3 2 1	ILITY (cm/sec)	KS
0-	(m)		F1			5 4 3 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	3.00×10 ⁻⁶	L.Brown
			F 2				3.00x10	Gray
ŀ.	2		F3					Brown
	4	X	G _{F4}	1				Gray
10-	3	7	∸F5					Brown
	3		- F6			•	1.40x10 ⁻³	L Brown
	2	0.00	— F 7					Red
20 -	2.5		F8					Brown
	2		— F9			. , .	2.60×10 ⁻³	White
T.	1		F10			[5.10x10 ⁻³	L.Brown
30-	5.5		F11			1.	6.85×10 ⁻³	C.D(0),,,
	1 3		— F 12					Y.Brown
-	2.5		— F13					Red
	1.5 0.5		-G =5F14					t.Gray
40 -	3 1.5		– F15		1			Y Brown Brown
	2		— F16					[: <u>-</u>]
			— F17					L Brown /Red
50-	8		F18					/L.Gray
	3		— F 19					
-:		1	−F20					Brown
60	4.5		— F 21			,	3.80×10 ⁻³	
60-	4		F22				3.00.12	L.Gray
-	2.5		-G _{F23}					C. Yellow
•	0.5		-G _{F24}			•		Brown
70-	2	1	F 25			·		Brown
]]	7	F26 ¢			,	1.75×10 ⁻³	
	1-1-		-F27 ₽			• /	.5.10×10 ⁻³	White
80-	2.5 1.5		F 28			·	1	Gray/Rea
O.V	2	Le estado	— F 29					
- }	4		- F30					Red
	4.5		-F31				3.80x10 ⁻³	L.Gray
90 -	1.5		−F32			·	3.80X10 °	2.4.0)
	3.5		—F33		-			G.Gray
	5.5		F34					Brown
00-	cont.		1 34	· · ·			<u> </u>	[
•	500	G:Gypsum	. 4				SEHD	
1		- STRATIGRAI	эніс со	NIIMN-F		nore than 0.5mm 0.25mm = 0.5mm		Granule, Gravel
	•			JEDINI I.		0.125mm = 0.25mm	: Medium sand	ı
	AT:	G. MAGHARA	Ź	•		0.063mm - 0.125mm	: Very five said	nd
	C	Company Carl Co.	ാ 'സപ്പ ദർ	c	e) (ess than 0.063mm	: Silt, shale, c	
	Sample:	Undisturbed Fx	ا المالان ک	O .			**************************************	

	,		COAL TO MINERAL COME ON MICHAEL SHAWN SHAWN SHAWN SHAWN SHAWN SHAWN SHAWN SHAWN SHAWN SHAWN SHAWN SHAWN SHAWN S								***************************************	
		1			PARTIC						DE D	
		THICK-	LITHOLOGY	SAMPLING	DIST	RIBUTIO	N	PASSI	NG D 20	PERMEAB-		
		NESS		NO.	• • •			5 4	3 2 1	(cm/sec)	KS	
100		(m) ont,1		— F 35		+ +	'''	L			Brown Red	-
		2		−G	/	1 \	\					
	- -	2	L	— F 36	/ .	1 '	1 /				Brown	
		5	Carlos Contractor Contractor (1)	F 37 °	í		\ \			3	G.Gray	_
110	_		Missing by	— r 3/			` `]		•	3.80x10 ⁻³		
	.		Quaternary Deposit								:	-
							·					
120	_	3		— F 38							Brown	-
'`- ` `		2	F. Comment	— F 39							R. Brown	
	-			F40						4.50x10 ⁻²	Gray	-
İ		10.5		—F41					>	2.20x10 ⁻²	Brown	
130	-			−F42						2.20x10 ⁻²	Purple	
		-		— F43						5.10x10 ⁻³	Ceau	
		4.5		F44							Gray	
140	_	1.5	<u> </u>	F45							<u>R</u> ēd Gray/Red	-
, , ,	-	2		F46		٠.					i	
	- [2.5		F 47							Red	
		2.5		F48							R. Brown	
150	-	3		F49				· · ·			Brown	_
		2 1.5		F50	•					5.10x10 ⁻³		
	- [F51			: []		· \	5.10x10 ⁻³	L.Brown	
					-		•			5.10x10		_
160	-	15.5		F 52							Purple	
- 1				−F53			. #			6.85x10 ⁻³	<u> </u>	
ĺ				F54			μ,			6.85x10 ⁻³	L Brown	
170	_	1.5		— F 55				* - *			Red	-
			L- 1	F56								
ļ	-	6.5		F57							D Brown	-
				−F58							ļ	
180	-											-
				:								
											ļ.	
190												-
190											. :	
	_											
						,						
200	L L		G : Gypsum	<u> </u>	<u></u> _			<u></u>			J.,	, _
	1/5	00	a caypaun	•	:			a) more than		EGEND	d Gradula Co	u a 1
.					<u> </u>	are e		b) 0.25mm		: Coarse san	d, Granule, Gra	**1
	L	THO -	– STRATIGRAF	PHIC CO)LUM1	4 — F		c) 0.125mm		Fine sand		
			C NACHADA	\			•	d) 0.063mm		· Very five	sand .	
		A1:	G. MAGHARA	4				e) less than	0.063mm	: SIII, shale		
			- 15D (52×36)			A. A. Carrier and				APP THE Serie Schiller rise or being and color as well as		

THICK- NO. PASSING D.20 PERMEAB- REMAR- REM		-			PARTICLE SIZE]
NESS LINUTED NO.		THICK-	LITHOLOGY	SAMPLING		PASSING D 20	PERMEAB-	REMAR-	
Brown Brow		NÉSS	LITHULUGY	NO.		×10 ⁻¹		KS	l
Brown G.Gray G.Gray G.Gray Brown G.Gray Brown Y.Brown S. 10x10 ⁻³ Red 6. 89x10 ⁻³ 8. 90x10 ⁻³ Red 6. 89x10 ⁻³ 7. 10x10 ⁻³ 8. 90x10 ⁻³ 9. 90x10 ⁻³ 8. 90x10 ⁻³ 8. 90x10 ⁻³ 9. 90x10 ⁻³ 8. 90x10 ⁻³ 8. 90x10 ⁻³ 9. 90x10 ⁻³ 8. 90x10 ⁻³ 9. 90x10 ⁻³ 9. 90x10 ⁻³ 9. 90x10 ⁻³ 1. 15x10 ⁻³	0					5 4 3 2 1	(cm/sec)		
Brown G. Gray Brown G. Gray Brown G. Gray Brown Y. Brown Y. Brown S. 90x10 ⁻³ Red A 90x10	Ĭ ļ	0.60.6	,1,1,1,1,1,1,1	(s) .					
G.Gray 6.3 6.3 7. Brown 8. 90x10 ⁻³ 9. 90x10 ⁻³ 8. 90x10 ⁻³ 9.	-							Brown	
G3		3.7							
- 2.2	0 [2						G.Gray	
- 2.2		6.3				·			
4								BLOWII	l
Section Sect		2.2							
38	가	4		63 64				Y.Brown	١
Section Sect		1 1							
9		4.2							l
Solution Solution		22							l
38	1							Brown	I
S		: 9							١
S		Ì					21		l
08	-	70		G 5		1			l
S	1 1			G <u>G</u>	(/)	\			l
Solution	\vdash	5			l			∨ Brown	ĺ
1.4		i i		G9		/	8.90x10 ⁻³	L.Purple	l
1.4	-	2.5	1					Brown	l
3.8	-	T		_G12		,	'5:10x10 ⁻³	P Grav	l
3.8			×	G13			8.90x10 ⁻³		
Solution		20			\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \		. C.LOILLO		ľ
Section Sect				G16					İ
Solution	- 1		0.000	G1/ G18			0 00010-2		ľ
4				G19		>	5.10x10 ⁻³	R.Brown	١
G22 G23 G24 G24 G25 G25 G26 G26 G27 G27 G28 G29 G31 G31 G32 G33 G34 G35 G35 G34 G35 G35 G34 G35	\vdash	2			7 7 111	(8.90x10 ⁻³	D: ak	
4.4		4 [G22	> >		2.20x10 ⁻²		l
1.6 G25 G25 G26 G26 G27 G28 G29 G30 G31 G32 G33 G34 G35 G34 G35 G35 G34 G35		4.4		G23					
4			×	G25			2.20x10 ⁻²		l
4		1		-G26			1.40×10 ^{~3}		
6.4	$\lfloor \ \ \rfloor$	ŀ	7	−G27 −G28				1	l
G30 G31 G32 G33 G34 G35 G34 G35 G34 G35 G34 G35 G35 G34 G35		4	200000000	−G29			8.90x10 ⁻³	∕Pin k	
1.75×10 ⁻³ 8.90×10 ⁻³ 1.40×10 ⁻³ 1.40×10 ⁻³ 8.90×10 ⁻³ 1.40×10 ⁻³ 8.90×10 ⁻³ 1.40×10 + 1	C.4		G30		• }		Duzolo		
1 2.5 3.4 40×10 ⁻³ 8.90×10 ⁻³ 1.40×10 ⁻³ 8.90×10 ⁻³ 1.40×10 ⁻³ 8.90×10 ⁻³ 1.500 LEGEND 1.500 LITHO - STRATIGRAPHIC COLUMN-G b) 0.25mm ~ 0.5mm c) 0.125mm ~ 0.5mm tledium sand c) 0.125mm ~ 0.25mm representation of the sand c) 0.125mm ~ 0.125mm very five sand very five sand c) 0.63mm ~ 0.125mm very five sand c) 0.63mm ~ 0.125mm very five sand c) 0.65mm c) 0.125mm c) 0.125		6.4		G32	/ //	\	1.75x10 ⁻³	•	
1/500 LITHO - STRATIGRAPHIC COLUMN-G AT: ARAIF EL NAGA LEGEND a) more than 0.5mm b) 0.25mm ~ 0.5mm c) 0.125mm ~ 0.5mm c) 0.125mm ~ 0.25mm c) 0.125mm ~ 0.125mm c) 0.125mm	 			G33					
LEGEND 1/500 LITHO - STRATIGRAPHIC COLUMN-G AT: ARAIF EL NAGA LEGEND a) more than 0.5mm b) 0.25mm ~ 0.5mm c) 0.125mm ~ 0.25mm c) 0.125mm ~ 0.25mm c) 0.063mm ~ 0.125mm c) very tive sand		. Z.5 1					8.90x10 ⁻³	L.Purple	
1/500 LITHO - STRATIGRAPHIC COLUMN-G AT: ARAIF EL NAGA a) more than 0.5mm b) 0.25mm ~ 0.5mm c) 0.125mm ~ 0.25mm c) 0.125mm ~ 0.25mm d) 0.063mm ~ 0.125mm c) very tive sand	┝┕	<u> </u>	<u> </u>					•	
LITHO - STRATIGRAPHIC COLUMN-G b) 0.25mm ~ 0.5mm c) 0.125mm ~ 0.25mm c) 0.125mm ~ 0.25mm d) 0.063mm ~ 0.125mm : Very tive sand	1/5	00						Geanula Grava	,1
AT: ARAIF EL NAGA c) 0.125mm ~ 0.25mm d) 0.063mm ~ 0.125mm every five sand			- STRATIGRAF	PHIC CO)LUMN-G	1325	9. 8	OF BITCLE, GEAVE	1.
AT : ARAIF EL NAGA d) 0.063mm ~ 0.125mm [13] : Very tive sand						L			
at the thin postern First cut and also		AT:	ARAIF EL N	I AGA				sd	
					2) less than 0.063mm			

				PARTICLE SIZE			_
	THICK-	LITHOLOGY	SAMPLING	DISTRIBUTION	PASSING D 20		
	NESS	Emologi	NO.	• • •	×10 ⁻¹ 5 4 3 2 1	ILITY (cm/sec)	KS
)-	1.8		G36			1.40x10 ⁻²	L.Brown
	6.7		— G 37 G 38			3.80×10^{-3} 2.60×10^{-3}	L.Gray
	1,00		- G39	$\rangle > \rangle$		8.90x10 ⁻³	
)	3.5		G40: G41	$\langle \langle \langle \langle \langle \rangle \rangle \rangle \rangle$	 	3.80×10^{-3} 6.85×10^{-3}	White /Pink
	2	<u> </u>	G42			6.85×10^{-3}	, , , , , ,
	28	y	G43 G44			2.66x10 ⁻³ 2.20x10 ⁻²	L Purple
	32		- G45	1 /1		6.85×10 ⁻³	C-21
)	2 -		G46 G47			3	Gray Black
-	05 - 3.5		G48			2.60x10 ⁻³ 8.90x10 ⁻³	Red
	1 1 1 1 1		— G49 G50	1		6.85x10 ⁻³	
)	4	<u> </u>	G51		1	$\begin{array}{c} 2.60 \times 10^{-3} \\ 3.80 \times 10^{-3} \end{array}$	L Ole
	4.9		G52 G53			3.80x10 ⁻³	L Purple
Γ			G54			4.60x10 ⁻³ 6.85x10 ⁻³	
) _	3.2		- G55 G56			5.10x10 ⁻³	Pink
1	14.		G57	//		2.20x10 ⁻² 3.80x10 ⁻³	Gray
-	1.6		G58			8.90x10 ⁻³	Purple
	2.4		G59		`	1.40×10 ⁻²	rulpie
)				·			
	16	Missing by					
		Quaternary Deposit					
) -		_					
			G60	:			
ŀ	1.6 3.2		— G61 — G62	/ \ \	/	6.85x10 ⁻³ 3.80x10 ⁻³	White
	1		— G63			3.80×10^{-3}	Purple
	2.2	<u> </u>	G64 G65			8.90x10 ⁻³	Brown
	3		— G66			1.40x10 ⁻²	Pink
	4		— G67 — G68			1,40×10 ⁻²	Brown
)-						1.40X10 "	
							Red
ľ	31.8						
) -	cont.						
1		Missing by					
F		Quaternary Deposit					
		-					
						Fain	,
1/	′ 500				_	GEND : Coarse sand	1, Granule, Grav
	LITUA	CTDATIONA		OLHMNI—C	b) 0.25mm - 0.5mm	tledium san	
	LHHO.	- STRATIGRAI	THIC CO	OLUMN-G	c) 0.125mm = 0.25mm	: Fine sand	
	λТ.	ARAIF EL NA	4GA		d) 0.063mm = 0.125mm	: Very five s	
1	AI.	CHARLE LL IV	·UC1		e) less than 0.063mm	📆 : Silt, shale,	clay

:	THE RESERVE THE PROPERTY OF TH		nanggalipagnipagnipagnipagnipagnipagnipagnipagn				N-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1	,
	THICK- NESS	LITHOLOGY	SAMPLING NO.	PARTICLE SIZE DISTRIBUTION		PERMEAB- ILITY (cm/sec)	REMAR- KS	
200			:					
210	0.17		G69 G70			2.20x10 ⁻²	Red Black/Re Black Brown	
220	4		G71				Red	_
230	1.5 3 2 - 1.2 - 0.8	\$ 0.0 50 f	G72 G73 G74 G75 G76			5.10x10 ⁻³ 3.80x10 ⁻³ 3.80x10 ⁻³ 2.20x10 ⁻²	Black L.Brown Purple Black	
240	83		G77 G78 G80 G81			8.90x10 ⁻³ 2.60x10 ⁻³ 8.90x10 ⁻³ 3.80x10 ⁻³ 1.40x10 ⁻³	L.Purple	-
250	- 1 2 0.3 ^{1.4} 1.8 - 1.5	9 2 2 2	G82 G83 G84 G85	22		5.10x10 ⁻³ 3.80x10 ⁻³ 2.60x10 ⁻³ 8.90x10 ⁻³	White ∕Black	
:	6	6 26 6 0 6 0 6 0 0 4 0 6 6 0 0 0 0 0 0 0 0				1.40×10 ⁻² 2.20×10 ⁻² 1.75×10 ⁻³ 9.00×10 ⁻⁴ 1.40×10 ⁻²	L.Brow∩ White	
260	- 3.4 2.4 - 2.5 - 1.2	200000000000000000000000000000000000000	G91 G92 G93 G94			5.10x10 ⁻³ 8.90x10 ⁻³ 2.20x10 ⁻² 1.40x10 ⁻²	/Red Purple Red	-
270	1/W*W*G		G95 G96 G97 G98	•	•	6.85x10 ⁻³	L.Purple Yellow /Aurple	-
280	08		— G99 G100 G102	/ / //	\	8.90x10 ⁻³ 5.10x10 ⁻³ 5.10x10 ⁻³	/ Red L.Pürplē Furple	-
290	5.5	· · · · · · · · · · · · · · · · · · ·	— G103 G104 G105 G106			1.40x10 ⁻² 1.40x10 ⁻² 2.20x10 ⁻²	L_Purple Red	-
							,	-
300	1/500 LITHO	– STRATIGRAI	PHIC CO		LEGI a) more than 0.5mm b) 0.25mm - 0.5mm		Granule, Grave	_
-	ΑТ	: ARAIF EL N			c) 0.125mm ~ 0.25mm d) 0.063mm ~ 0.125mm e) less than 0.063mm	: Fine sand : Very five sand : Silt, shale, c	nd	

10	\$	THICK- NESS	LITHOLOGY	SAMPLING NO.	PARTICLE SIZE DISTRIBUTION	PASSING D 20 ×10 ⁻¹ 5 4 3 2 1	PERMEAB- ILITY (cm/sec)	REMAR- KS	
10	0-				/ A A A A A A A A A A A A A A A A A A A	<u> </u>		Brown	_
1.8	-	33	ション・ジ	— НЗ Н4			6.85x10 ⁻³ 1.40x10 ⁻²	Pink	
20 26 26 27 28 28 28 28 28 28 28	10-	1.8		— н6 — н7			2.6x10 ⁻³ 1.75x10 ⁻³	L,Brown	-
30	20-	2.6	7 11	— н9 — н10		1	1.40x10 ⁻³		-
30 16.9 17.0 17	-								
40 - 16.9 16.9 16.9 16.9 16.9 16.9 16.9 16.9	30-								
50 - 25 1	40-	2							<u>-</u>
60 - 25 1		16.9	I () () () () () () () () () (
25 1	50-	·	I.	•					
70- 80- 32 1.4 1.7 1.7 1.7 1.7 1.7 1.7 1.7 1.7 1.7 1.7	60-				·				_
90 - 1/500 LITHO - STRATIGRAPHIC COLUMN - H AT: G. HALAL S.1x10 ⁻³ 6.85x10 ⁻³ 6.85x10 ⁻³ 5.1x10 ⁻³ Red 1/500 LITHO - STRATIGRAPHIC COLUMN - H AT: G. HALAL C) 0.125mm - 0.125mm C) 1/25mm C) 1/25mm - 0.125mm C) 1/25mm -	7 0-	25		,					-
90 - 1/500 LITHO - STRATIGRAPHIC COLUMN - H AT: G. HALAL S.1x10 ⁻³ 6.85x10 ⁻³ 6.85x10 ⁻³ 5.1x10 ⁻³ Red 1/500 LITHO - STRATIGRAPHIC COLUMN - H AT: G. HALAL C) 0.125mm - 0.125mm C) 1/25mm C) 1/25mm - 0.125mm C) 1/25mm -	ŀ								-
90 - 8.9	80-			1147				a V mane a	-
1.1 1.4 3.1	90-	e.8·		— Н13 — Н14 — Н15			6.85x10 ⁻³ 6.85x10 ⁻³	White	
LEGEND 1/500 LITHO - STRATIGRAPHIC COLUMN - H AT: G. HALAL LEGEND a) more than 0.5mm b) 0.25mm - 0.5mm c) 0.125mm - 0.25mm c) 0.125mm - 0.25mm g: Fine sand c) 0.063mm - 0.125mm g: Very five sand e) less than 0.063mm g: SIII, shale, clay	100	1.4		— н17		•		Re₫	
LITHO - STRATIGRAPHIC COLUMN - H b) 0.25mm - 0.5mm c) 0.125mm - 0.25mm AT: G. HALAL d) 0.063mm - 0.125mm e) less than 0.063mm EEEE : SIII, shale, clay	1/			:				Granule, Grave	el
e) less than 0.063mm [777] : Slit. shale, clay				PHIC CO		b) 0.25mm - 0.5mm	: Hedlum sand		
Sample: Undisturbed Hx2 Total 36				u O Taraf		P-111-			

					gagan and a committee of a committee		1	1
		:		PARTICLE SIZE	DACCHIC DAG	DEDNÁCIA D	DEMAR-	
	THICK-	LITHOLOGY	SAMPLING	DISTRIBUTION	PASSING D20 ×10 ⁻¹	ILITY	KS	
	NESS		ÑO.		5 4 3 2 1	(cm/sec)		
100	0.40.9	2	H19				L Brown	
	26		н20		·		Red/Purt	∦e j
ļ	0.40.9	7 - 7/2 17 - 7 - 7 - 7 - 7 - 7 - 7 - 7 - 7 - 7 -	. 1120				L.Brown	
110								-
	0.7 44		Н21 Н22	LLI	1	3.8×10 ⁻³ 6.85×10 ⁻³	Purple_ Pink	
	- 3,6 - 7,5		- H23			5.80×10 ⁻²	L.Brown	
	2.9	Ž	H24 H25		7	8.90x10 ⁻³ 8.90x10 ⁻³	L.Purple L.Brown	
120	3.2		н 26			8.90×10^{-3}	Pink	
•	3.1		⊹- Н27 Н28		•	2.6x10 ⁻³	i ,Gray	
·	1.6 1.5		Н29	1	,	8.90x10 ⁻³		
130	- 1.5 - 0.6	3	— н <i>3</i> 0 н31			1.40x10 ⁻²	L.Brown	-
	5.3		H32		` <u>`</u>	1.40x10 ⁻² 6.85x10 ⁻³	L. Urple	
	-		- Н <i>3</i> 3 Н <i>3</i> 4		./	8.90x10 ⁻³	1.3rown	
	4.8		Н35	\ \ \!		1.40x10 ⁻² 2.20x10 ⁻²	Purple	
140	3.2		— нзс				L.Brown	1 1
	-0,6		Н37	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	. ,	6.85x10 ⁻³	Red	
İ	2.5	Zanazaran Zanazaran Zanazaran Zanazaran Zanazaran Zanazaran Zanazaran Zanazaran Zanazaran Zanazaran Zanazaran Z	— нз8		Į.	8.90x10 ⁻³	Brown	
150	- 2		Н,39	1	1	8.90x10 ⁻³	L.Purple	-
İ	1.4				\		Brown	
Ì	1.9		- н40 - н41		<i>)</i>	5.1x10 ⁻³ 1.40x10 ⁻²	L.Brown	
100	3		-– н42		·	`	Purple /White	
160	2.9		н43		· >	1.40×10^{-2} 5.1×10^{-3}	Purple	
	.		н44 н45		f l	8.90x10 ⁻³	White	
		×	н46	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	1	8.90x10 ⁻³ 8.90x10 ⁻³		
170	_ 13.6	X	н47 : н48			6.85x10 ⁻³	L.Brown	
ĺ		×	Н49			3.20x10 ⁻² 1.40x10 ⁻²	Purple	
ı	79.4	//::////// I	— H50	, II	V	8.90x10 ⁻³	T Brown	
180	3.1 - 0.9		- H51 H52				Black/Red White	_
100	1.4_ 2		_G		\	2,20x10 ⁻²	White Red /Yellow	
Į.	0.6 ^{1.4}		· Н53 - Н54)	6.85×10 ⁻³	White	-
J	2.8	,	– H55	/ II	l	8.90x10 ⁻³ 6.85x10 ⁻³	Cr€am	
190			— H56				Black	
	5.3		-		i		/Red	
	2	y	– H57	•	•	1.75x10 ⁻³	White	
200	1.9 2.6 cont.						Y. Brown	
	1/500				LEGE	ND .		
- 1		CTDATIONAD	ilio co	· ·) more than 0.5mm	-	Granule, Gravel	•
	LHHU -	STRATIGRAP	HIC CO		0.25mm - 0.5mm	: Medium sand		İ
	Δ Τ • 0	G. HALAL			1 0.125mm ~ 0.25mm 1 0.063mm ~ 0.125mm	: Fine sand		.
1			F 1 - 1 - 0 0 0) less than 0.063mm] : Very five sand		
L		indisturbed Hx2	10tal 228		E. C. S.			

THICK-NESS LITHOLOGY SAMPLING DISTRIBUTION NO. PASSING D20 PERMEABA-REMAR NO. No					PARTICLE SIZE				:	1
NESS CHROUGH NO		THICK-	LITUOLOGY	SAMPLING			PASSING D2		REMAR-	
200 H58 H59		3	LTHOLOGY	NO.	9 9 9		X10 ⁻ 5 4 3 2 1		KS	
16.6	200-		400000000000000000000000000000000000000						White	
210 - 16.6				— H58 — H59				3.8x10 ⁻³ 1.40x10 ⁻²		
210 — 16.6	ľ			<u></u> — н60 · ·				8.90×10 ⁻³		
H65	210-	16.6	· · · · · · · · · · · · · · · · · · ·	н62		(}	5.1×10^{-3}	Cream	-
H65		<u>.</u>				•)		8.90×10^{-3}		
220 - 6.1				H65			}	5.1×10^{-3} 5.1×10^{-3}		
230 - 4.9 1.8	220	2.0		₩ H67			•			
230 - 4.9 1.8		6.1		H69					Cream	
250 - 3.1 1.8				H70.			•	4.60×10 ⁻⁴		
240 - 3.1 1.9	230-	1		<u> </u>					G.Gray	1
240 - 1.9			ቀ ቆ ቀ ቆ ቀ							
250 - 97.1 270 - 97.1 280 - 97.1 280 - 97.1 280 - 97.1 280 - 97.1 280 - 97.1 280 - 97.1 280 - 97.1 280 - 97.1 280 - 97.1 280 - 97.1 280 - 97.1 280 - 97.1 280 - 97.1 280 - 97.1 290 - 97.1 200 -			<u>ት</u> ቀ ቀ ቀ ቀ ቀ						G.Brown	
250 - 97.1 Gord Garay 270 - 97.1 Gord Garay 280 - 97.1 Garay 280 - 97.1 Garay 280 - 97.1 Garay 290 - 97.1 Garay 290 - 97.1 Garay 30	240-		A CONTROL OF THE CONT	-G						-
270 - 97.1 CONI. 270 - G.G. G.G. G.G. G.G. G.G. G.G. G.G. G										
270 - 97.1 CONI. 270 - G.G. G.G. G.G. G.G. G.G. G.G. G.G. G								·		
260 - 97.1 G.G. Cont. 270 - Gypsun Included 280 - Gypsun Included 290 - STRATIGRAPHIC COLUMN - H AT:G. HALAL GGray /White Gypsun Included AT:G. HALAL LEGENO 3) more than 0.5mm D) 0.25mm - 0.5mm C) 0.125mm - 0.5mm C) 0.125mm - 0.25mm Gypsun Included 1/500 LITHO - STRATIGRAPHIC COLUMN - H AT:G. HALAL 1/500 G.Gravie, Granule, Gr	250									-
270 - Cont. 280 - G 290 - Cont. 290 - Con				-u						
270 - Cont. 280 - G 290 - Cont. 290 - Con						•	-			
280 - Gypsun 290 - John Gypsun 1/500 LITHO - STRATIGRAPHIC COLUMN - H AT: G: HALAL AT: G: HALAL JWhite AT: G: HALAL JWhite Approximation (Simmon) LEGEND JOSTON (Simmon) JOSTON (Simm	260	97.1							GGray	-
280 290 1/500 LITHO - STRATIGRAPHIC COLUMN - H AT: G: HALAL Gypsun Included Included AT: G: HALAL Included		cont.							/White	
Gypsun Included 290 1/500 LITHO - STRATIGRAPHIC COLUMN-H AT: G. HALAL Gypsun Included LEGEND 3) more than 0.5mm 6) 0.25mm - 0.5mm 7: Fine sand 10.063mm - 0.125mm 1: Every five sand 1: Very five sand 1: Very five sand 1: Very five sand 200-25mm 200-25					A THE STATE OF THE					
290 - 1/500 LITHO - STRATIGRAPHIC COLUMN - H AT: G: HALAL Included LEGEND LEGEND 1 Coarse sand, Granule, Gra 1 0.125mm - 0.5mm 1 : Fine sand 1 0.063mm - 0.125mm 2 : Very five sand	270						·			
290 1/500 LITHO - STRATIGRAPHIC COLUMN-H AT: G: HALAL LEGEND 3) more than 0.5mm 1/500 1/500 LITHO - STRATIGRAPHIC COLUMN-H 3) more than 0.5mm 4) 0.25mm - 0.5mm 5) Hedlum sand 6) 0.125mm - 0.25mm 7) Fine sand 1/500 1/50				·						
290 LEGEND 1/500 LITHO - STRATIGRAPHIC COLUMN-H AT: G: HALAL LEGEND 3) more than 0.5mm 1: Coarse sand, Granule, G				ļ			,		II KIGG-1	
LEGEND 1/500 LITHO - STRATIGRAPHIC COLUMN-H b) 0.25rnm - 0.5mm c) 0.125mm - 0.5mm filedium sand c) 0.125mm - 0.25mm s Fine sand d) 0.063mm - 0.125mm very five sand	280 -		1	-G						
LEGEND 1/500 LITHO - STRATIGRAPHIC COLUMN-H b) 0.25 mm - 0.5 mm c) 0.125 mm - 0.25 mm file and c) 0.125 mm - 0.125 mm very five sand c) 0.063 mm - 0.125 mm very five sand	ŀ						•			
LEGEND 1/500 LITHO - STRATIGRAPHIC COLUMN-H b) 0.25 mm - 0.5 mm c) 0.125 mm - 0.25 mm file sand c) 0.125 mm - 0.125 mm c) 0.063 mm - 0.125 mm very five sand	200			[•	ļ		
1/500 LITHO - STRATIGRAPHIC COLUMN-H AT: G: HALAL LEGEND a) more than 0.5mm b) 0.25mm - 0.5mm c) 0.125mm - 0.25mm d) 0.063mm - 0.125mm : Very five sand	230									
1/500 LITHO - STRATIGRAPHIC COLUMN-H AT: G: HALAL LEGEND a) more than 0.5mm b) 0.25mm - 0.5mm c) 0.125mm - 0.25mm d) 0.063mm - 0.125mm : Very five sand	ŀ									-
1/500 LITHO - STRATIGRAPHIC COLUMN-H AT: G: HALAL LEGEND a) more than 0.5mm b) 0.25mm - 0.5mm c) 0.125mm - 0.25mm d) 0.063mm - 0.125mm : Very five sand	300]
LITHO - STRATIGRAPHIC COLUMN-H b) 0.25mm - 0.5mm c) 0.125mm - 0.25mm AT:G: HALAL d) 0.063mm - 0.125mm : Very five sand		′500					u	GEND		
AT:G. HALAL c) 0.125mm ~ 0.25mm if line sand d) 0.063mm ~ 0.125mm i. Very five sand			- CTDATICDAD	אוור כר	M 11MM 11					:1
				THE CC	COMIN TO			~~~		İ
· · · · · · · · · · · · · · · · · · ·		AT:	G- HALAL				d) 0.063mm = 0.125mm		nd	·
e) less than 0.063mm : Silt, shale, clay						-	e) less than 0.063mm	: Slit, shale,	clay	

THICK- NESS	LITHOLOGY	SAMPLING NO.		SIZE ION 		D 20 ×10 ⁻¹	PERMEAB- ILITY (cm/sec)	REMAR KS
	The state of the s							
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	The state of the							G,G ray
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	A CONTROL OF THE PROPERTY OF T							
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59.7	Missing by							
22:1	Quaternary Deposit				,	•		
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				:				
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45.6	24 Z Z W	н71						D' ~ fr
10, 2 cont.		— H72						Pink
/500					a) more than 0.5m		END : Coarse sand	l, Granule, Gr
	- STRATIGRA	PHIC CO	H-NMUJC		b) 0.25mm ~ 0.5m c) 0.125mm ~ 0.25t	m [: Hedium san	
AT:	G . HALAL				d) 0.063mm ~ 0.12	5mm .	: Very five s	
					e) less than 0.063	mm E	SIII, shale,	clay

	THICK-	[]			ยบเย	}	SIZE									1
		LITUOLOGY	SAMPLING	ś	RTICL)ISTR				РΔ	SSI	NG	D 2			REMAR-	
	NESS	LITHOLOGY	N O.						5	4	3	×10 2 1	1	iTY :m/sec)	KS	
00-			— H 73 — H 74 — H 75	8 0 8			1	•	Ĭ	i	<u> </u>		100	/5 6 6/	White Purple D. Red	
110-	2.7 0. 6 _{0.9.}	The state of the s	– H76			1 1 1 1 1									G.Gray Pink	
						1 1 1	1 1 1	}								
20-	365			1		1	1								G.Gray /White	
30 -		Missing by Quaternary Deposit		7 - 7 - 7		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1 1 1 1								7 Willie	
<u>-</u>						1 1			٠.							
40-					•	[] 		11							·	
50-	3.5		— н 77 н 78 н 79		/	-							6.	.90x10 ⁻³ .85x10 ⁻³ .85x10 ⁻³	L.Gray L.Brown L.Purple	1
60-	10.1 -0.9 -3.6	у У У	— н80 - н81 — н82 — н83 — н84 — н85 — н86			/ /	> >		:			<i>}</i> >	3. 8 8 8	.8x10 ⁻³ .90x10 ⁻³ .90x10 ⁻³ .90x10 ⁻³ .40x10 ⁻² .50x10 ⁻²	Pink L.Brown Purple Pink	
70-	3.2 1.9		— H87 — H88 — H89			4							1		Red	
80-	12.2					8-90	×10-3								G.Gray	
	2.9		— н90						ı						Brown	-
190-	42.8 cont.	Missing by														
00	:				<u> </u>	····]								
- 1	500								a) mo	ore tha	ın ().'	5mm	LEGEN		d, Granule, Gra	ivel
1	LITHO	- STRATIGRA	PHIC CO	OLU	MN	- -	l		.b) 0.2 c) 0.1	25mm 125mm				: Medium sai	ndi .	
	ΑТ	:G.HALAL								63mm	a - 0.	125 _{mm}		: Fine sand : Very five s		

500	THICK- NESS	LITHOLOGY	SAMPLING N O.	PARTICLE SIZE DISTRIBUTION		PERMEAB- ILITY (cm/sec)	REMAR- KS
500			,				-
510	30	Quaternary Deposit					
520-							-
							G.Gray
530	1.8 2 2.4		н91 н92		•	2.6×10 ⁻³ 9.00×10 ⁻⁴	L'Purple White White White Brown Purple
540	1.6 2.2		— H93 — H94			8.90×10 ⁻³ 1.75×10 ⁻³	Red
550-	5.8 0.8 1.8		— н95 — н96 — н97			9.00×10 ⁻⁴ 5.1×10 ⁻³ 5.1×10 ⁻³	/Black _Porple Y.White L.Brown
			— н98	\	\	2.6x10 ⁻³	
560		Missing by					
570	44.6	Quaternary Deposit					
580	-						
590						2	Red
	19.2 cont.		— н99		•	8.90×10 ⁻³	Red White GGray
600	/500				a) more than 0.5mm	EGEND Coarse s	and, Granule, Gravel
		- STRATIGRA: G. HALAL	PHIC C	OLUMN-H	 b) 0.25mm ~ 0.5mm c) 0.125mm ~ 0.25mm d) 0.063mm ~ 0.125mm 	: Hedlum s : Fine sand	l
		-15D (52×36)	BANGUNG TERRETOR A MERITAN TO THE STREET OF THE STREET OF THE STREET OF THE STREET OF THE STREET OF THE STREET	n was a support of the state of	e) less than 0.063mm	: SIIt, sha	le, clay

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	THICK-	LITHOLOGY	SAMPLING	PARTICLE SIZE DISTRIBUTION	PASSING D 20	PERMEAB-	
	NESS	LITHOLOGI	NO.		×10 ⁻¹ 5 4 3 2 1	ILITY (cm/sec)	KS
600-	T THE PARTY SERVICE AND ADDRESS OF THE PARTY SERVICES.	1 (1 (1 (1 (1 (1 (1 (1 (1 (1 (1 (1 (1 (1		/ / /			
-			:				G.Gray
610							_
	0.6	→	— H 100		1	3.8x10 ⁻³ 3.8x10 ⁻³	Brown
Ī	0.7		— H 101 — H 102			6.85x10 ⁻³	L,Brown Brown
620	6.7		1407			6.85x10 ⁻³ i	
.		<u> </u>	— H103 — H104			3.8x10 ⁻³ 3.8x10 ⁻³	Pink .
630-			— Н105			\$14To	-
000		Missing by	-	•			
	24.4	Quaternary Deposit					
640-							_
ŀ			H106 H107		•	6.85x10 ⁻³ 8.90x10 ⁻³	Purple
650-	2.6		H108 — H109	/		1.40x10 ⁻² 2.20x10 ⁻²	₩ĥYe -
	7	Y Y	Н 110 Н 111			6.85x10 ⁻³ 3.20x10 ⁻²	G.Brown Pink
	3,2	× ×	— Н 112 — Н 113		>	8.90x10 ⁻³ 2.20x10 ⁻²	L Brown
ee0-	1.4	The state of the s	— Н 114			6.85×10 ⁻³	Ригріе -
ŀ					٠.		
670 -						}	-
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680					·	:	
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690							-
Ì						·	
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700	L	l .,			LEC	END	<u></u> <u>.</u>
[1]	/500	. CTDATICDA	DUIC C			: Coarse sand	, Granule, Gravel
		- STRATIGRA	rnic C	JEOI III II	c) 0.125mm = 0.25mm	: Fine sand	.
	ΑT	:G.HALAL			d) 0.063mm ~ 0.125mm () e) less than 0.063mm ()	: Very five sa	

F	CARPER CONTRACTOR CONTRACTOR	erryg skiem h <u>is bested Norsell yn yn de his heffer yn d</u> en gen gel hennes (Ch. 10) (de		nacidades programas de la composiçõe de programa de la composição de la co				
k		1		PARTICLE SIZE				
	THICK-		SAMPLING	DISTRIBUTION	PASSING D 20	PERME AB-	REMAR-	
	NESS	LITHOLOGY	NO.		×10 ⁻¹	ILITY	KS	
	146.55	•	""		5 4 3 2 1	(cm/sec)		
0		#1024000 A156 (405)	- 11	The state of the s		5.80x10 ⁻²	Brown	
}	3	12112	12			3.20x10 ⁻²	1. : 1	
- -	. 4					1.40x10 ⁻²	Red	1
•	1 1		13	\ /////////////////////////////////////	. \	8.90x10 ⁻³	PinkRed Furple	
10	_ 1-7:2-		4		. /		L-Rurple "	-
''	11-6		15 16	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \		8.90×10 ⁻³ 2.20×10 ⁻²	Pink	
	•		- 17		<i>\</i>	2.20x10 2.20x10 ⁻²		-
I	10.6		18		\ \ \ \	8.90×10 ⁻³	L.Brown	
1	10.0		19			2.20x10 ⁻³	L.DOW!	4
20	-	44.44.7	I 10			3.20x10 ⁻²		
1	2	I	111.			8.90x10 ⁻³	Purple]
ŀ	2.5	1	- 112			6.85x10 ⁻³ 3.20x10 ⁻³	Pink	
.	2.7	6.00000	113 114	2			Brown	:
30-	- 2.6	* * * * * * * * * * * * * * * * * * * *	i15			3.20x10 ⁻³	Purple	
ŀ	1.8		116			7.50x10 ⁻³	Pink Red	
- 1	0.61.2		117	> \	/	3.80x10 ⁻³ 8.90x10 ⁻³		1
	1.	<u> </u>	<u>i 18</u>			8.90×10 ⁻³	/Purple Pink	
40	0.60A	\$1111111111111111111111111111111111111	119 120		/	1.40×10 ⁻²	LBcown	\mathcal{A}
,	⁹⁶ 1.6 1.6		— 120 — 121		1	1.40x10 ⁻²		ĺ
		**************************************	i 22	1		1.40x10 ⁻²	L.Brown	4
	4.4		— I 23			3.20x10 ⁻²	D.Gray	
	1.4		<u> </u>			· ·	Orange.	
50	3,3		— 1 25 — 1 26				White	
	2,2		1 20		ļ .	8.90x10 ⁻³	Purple	
-	·		i 28		. /	8.90×10 ⁻³	1	1
.	7.7		129		}	6.85x10 ⁻³	L.Brown	-
60-	_		− I 30			2.20x10 ⁻²		=
- 1	2	010000000000000000000000000000000000000	- I 31			1.10x10 ⁻¹	Red	
L	5.4		1 32			1.40x10 ⁻²	/ Pink	-
	٦٠٦	27.5	- 1 33 - 1 34			1	1	ł
70	1.2		- 135			1.40×10 ⁻²	Red	_
70	_		- 136			2.20x10 ⁻²	PBrown	
	11.7		- 137			1.40x10 -2	1 (
1	· ''''		_ 138)	1.40x10 ⁻²	/L.Brown	
ł			139	\rightarrow	l /	2.20x10 ⁻²		ļ
8C-	-		140		'	2.20×10 ⁻²		
	4.1		ĺ				Red	
ŀ			— I41					٦
1	3.6	T	-142				Purple	
90	- 2		143	1		4.50x10 ⁻²	Red	
	4	· · · · · · · · · · · · · · · · · · ·	-144			8,90x10 ⁻³	L.Brown	Ì
-			145			.3.80x10 ⁻³		
	4.8						Red	
100					<u> </u>	<u> </u>		
					LE	GEND		
. [1	1/500						d, Granule, Gravel	,
		- STRATIGRAI	рије се	DLUMN-I		: Medium sar		ļ
	LITTU	SINALIGNAL	THE C	ACOLITA I	c) 0.125mm - 0.25mm			
-	ΛТ	C KHEDIM	•		**************************************	: Fine sand		
	A1 3	G KHERIM	•	•	d) 0.063mm = 0.125mm	: Very five s		
: 1	Samol	e:Undisturbed (x 2 Total 3	00	e) less than 0.063mm	्रीति : Silt, shale,	, clay	
L		-15D (52×36)						1

				L DATION C. AMP.		T T	1	7
	THICK-		SAMPLING	PARTICLE SIZE DISTRIBUTION	PASSING D20	PERMEAB-	REMAR-	.[].
	THICK- NESS	LITHOLOGY	NO.	o o o i i i i i i i i i i i i i i i i i	×10 ⁻¹	ILITY	KS	
	IVESS			0 0 0	5 4 3 2 1	(cm/sec)		
100			146	- 3rd		3.20x10 ⁻²	F'Browu	
1	2		47 48			6.85x10 ⁻³	Purple L.Purple	
	2.6 1.6	Z	149		\ \ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\	1.75×10 ⁻³	_Purple	
110	2.2	2 × × × × Z	I 50		/	5.10x10 ⁻³	,	-
	10.8	The state of the s	I 51 I 52			2.20x10 ⁻²		
	6		153		>	5.10×10^{-3}	White	
	1.2 1.3		[54 [55]		-/	8.90x10 ⁻³		
.120	_		- I 56		·		Purple	
	8.3		— 57 58		.	6.85x10 ⁻³ 6.85x10 ⁻³	114	
		2	1 59		. /	1.40×10 ⁻²	White	
130	2	I	160 161		<i>></i>	8.90x10 ⁻³ 2.20x10 ⁻²	Pi.White	$\mid \cdot \mid$
100			162		\ \frac{1}{2}	8.90x10 ⁻³		
1		E 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	163 164	\ (/	1.40x10 ⁻² 2.20x10 ⁻²	_	
	13.6	I	165			8.90x10 ⁻³	L.Orange	
140	-	I	- 166			2.20x10 ⁻²	/ White	
		T. C. C. C. C. C. C. C. C. C. C. C. C. C.	167 168			3.20x10 ⁻²		
Ī	5.4		169 .	• ••	•	2.20x10 ⁻²		
150			70 71			6.85x10 ⁻³	D.Gray] _]
150	5,8	and the factor of the factor	`''		;		Orange	
-	J		172					-
	2.6		173 174			2.20x10 ⁻²	Brown	
160	4.3		1 /4 75			8.90x10 ⁻³	L.Brown	
Ì	1.3	I	76 77	:			White	
Ī			78		7	8.90x10 ⁻³ 6.85x10 ⁻³		1
170	12.6		79			4.50x10 ⁻²		
"	ł		180 181			3.20x10 ⁻² 2.20x10 ⁻²	Cream	
-			182					
İ		IV	183 184		/ /	1.40×10 ⁻² 1.40×10 ⁻²		
180	- 4.6		185			TITONIO		-
	2.8		186 187				L.Brown	,
İ			188			2.20x10 ⁻²		1
190	15.2	**************************************	189 190			2.60x10 ⁻³ , 4.50x10 ⁻³		
150	15.4		<u> </u>			8.90x10 ⁻³		
}			192 193			3.20x10 ⁻² 8.90x10 ⁻³	White	
	ļ		— 193 194 195		7	8.90x10 ⁻³ 2.20x10 ⁻²	053000	
200	_	1 * 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1351			· · · · · · · · · · · · · · · · · · ·	Orange	1 1
-	1/500	•				GEND	,	
		- STRATIGRAI	סטור כי	JLUMN-1	a) more than 0.5mm	: Coarse san	d, Granule, Gra nd	vel
.	LITTIO	JINAHUNAI	THC C	JEUTHN 1	c) 0 125mm ~ 0.25mm	: Fine sand		
	ДΤ	G KHERIM			d) 0.063mm = 0.125mm	: Very five s	and	-
					e) less than 006Jmm -	: SIIt, shale,	clay	
Ł		-15D (52×36)	LINESCO DANS MINESCO DE LA CONTRACTORIO	nging (ng malapangan naning pamina dan dan dan mendan dan mengan benggupakan pandan pangangan pangang pangang	The second secon	·		أحيين

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210 -		L.	— 1 98 — 1 99 — 1 100 — 1 101			1.40x10 ⁻² 2.20x10 ⁻² 7.50x10 ⁻² 2.20x10 ⁻²	Cream /Orange
<u>.</u> 			— 102 103 104		>	2.20x10 ⁻² 1.40x10 ⁻²	
220-	,		105 106 107 108			4.50×10 ⁻² 1.40×10 ⁻² 2.20×10 ⁻² 2.20×10 ⁻²	Red Pink
230-		I I.	109 110 111 112	<u> </u>	-1	2.20x10 ⁻² 2.20x10 ⁻²	Brown Red
240		I	(113 (114		•	8.9x10 ⁻³	Brown
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250-							
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270-							_
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290-							
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:		- STRATIGRA : G . KHERIM	РНІС С	OLUMN-I	a) more than 0,5mm	: Coarse sand : Hedlum sand : Fine sand : Very five s	and

[A CONTRACTOR OF THE PARTY AND ADDRESS OF THE P			PARTICLE SIZE			
	THICK-	LITHOLOGY	SAMPLING NO.	I :	PASSING D20	PERMEAB- ILITY	REMAR- KS
	NESS		IN O.		5 4 3 2 1	(cm/sec)	
0 -	2 - 1,5 - 2					5.10x10 ⁻³	Brown/Blac Brown GGray
10	2		J1 J2		/	6.85x10 ⁻³	L Brown Brown
20	29.3		. :				G.Gray /Red Gypsum Included
30							
40	2.2		·				Brown
50-	9		: :				Y.Brown Brown
eo -	4 0.5	7	— J3 — J4		>	4.50x10 ⁻² 4.50x10 ⁻²	Purple White Y.White
70	12.8	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	- J5 - J6 - J7 - J8 - J9			5.80x10 ⁻² 7.50x10 ⁻² 3.20x10 ⁻² 4.50x10 ⁻² 8.90x10 ⁻³	Red White Brown
80-	3.5 2 1.7 1.8		— J10 — J11 J12 G J13	>_//		2.20×10 ⁻² 2.20×10 ⁻² 6.85×10 ⁻³	G.Gray L.Brown Cream Red Pink
90-	8.8	7, 10, 20, 20, 20, 20, 20, 20, 20, 20, 20, 2	— J14 — J15 — J16 — J17 — J18			2.60×10 ⁻³ 2.20×10 ⁻² 3.20×10 ⁻² 4.50×10 ⁻² 1.40×10 ⁻² 5.80×10 ⁻²	Purple White
00-	2.6 5.6 cont.	······································	J19 J20	1		5.80x10 ⁻² 5.80x10 ⁻² 2.20x10 ⁻²	Red/Black Pink
1/	′ 500				_	EGEND : Coarse san	d, Granule, Gravel
	THO -	STRATIGRAP	HIC CO	L LIANAL _		: Medium sac	
	AT:	G. MAFRUT	{		c) 0.125mm ~ 0.25mm d) 0.063mm ~ 0.125mm	: Fine sand	sand
	Sample:	Undisturbed J.x	2 Total 139	ŝ	e) less than 0.063mm	: Silt, shale	, clay
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				PARTICLE SIZE	·		
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			J 22 J 23			6.85x10 ⁻³	White
Ī	8	.0,0.000000000 0 0 0 0 0 0 0 0 0 0 0 0 0	1 24	> 7		.4.50x10 ⁻² 2.20x10 ⁻²	/Purple
0-		7	— J 25			4.50x10 ⁻²	4.0
Υ .			_ J 26		•	5.10x10 ⁻³	GGray Brown
1	3	ž.,''' / '''''	— J 27)	5.10x10 ⁻³	Purple
	7	0,0 4 04 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	J 28 J 29			1.40x10 ⁻²	Cream
0-	'	00.000	— J 30		. (1.40×10^{-2} 8.90×10^{-3}	or Cerm
1	2		— J 31		\	6.85x10 ⁻³	Pink
- -	1 2		- J32			5.10x10 ⁻³	Cream
	2		J.J.L	•		3.10X10	Y.Brown
0-	1 .						Y.Gray
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~	5.4	X	- J 33	1 11	,	1.40x10 ⁻²	L.Gray
	2		— J 34		, '	1.40×10 ⁻²	G.Gray
	3.4		J 35 J 36	• •	•	2.20x10 ⁻²	White
0-	0,7		— 3 36 — J 37				_Brown_
	-		J38	/ /		1.40x10 ⁻² 8.90x10 ⁻³	Pink
-	3.1		— J 39		·	0.90X10	L.Brown
	2.2						B.Bl ack
O-	7						Brown
	ĺ		V	1 //	/	3.20x10 ⁻²	
		3.	J41 J42			3.20x10 ⁻² 1.40x10 ⁻²	
			J43			2.20x10 ⁻²	
아	12	7: : : : : : : : : : : : : : : : : : :	J44		7	6.85x10 ⁻³	
			— J45 — J46		/ /	8.90x10 ⁻³ 1.40x10 ⁻³	Cream
	Q.7		— J47	/ \ /	. [1.40x10 ⁻³	OFCOUL
아	.3.		— J48 — J49	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \		8.90x10 ⁻³	
		,00000000	— J50			8.90x10 ⁻³ 3.20x10 ⁻²	Ì
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	i karan da		1 ·	•	d) 0.063mm ~ 0.125mm	: Very five s	andi ,
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	THICK- NESS	LITHOLOGY	SAMPLING N O.	PARTICLE SIZE DISTRIBUTION	PASSING D 20 ×10 ⁻¹ 5 4 3 2 1	PERMEAB- ILITY (cm/sec)	REMAR- KS RBrown
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20	10.2	4.0000 900 00 00 00 00 00 00 00 00 00 00 0	J53 J54 J55 J56 J57 J58			1.40×10 ⁻² 2 8.90×10 ⁻³ 2.20×10 ⁻² 2.20×10 ⁻² 1.40×10 ⁻² 6.85×10 ⁻³	White Cream White
230-	5 1 2 2.4 3.6		— J59 — J60 — J61 — J62 J63 — J64 — J65			2.20x10 ⁻² 6.85x10 ⁻³ 1.75x10 ⁻³ 4.50x10 ⁻² 3.00x10 ⁻⁵	Cream Eurple Cream White Y.Brown
250-	2.6 1.2 1.2		J66 J67 J68	/		6.85×10 ⁻³ 2.60×10 ⁻³ 1.75×10 ⁻³	White Brown
260-							
270-							
80-							
90-							
		STRATIGRAP G MAFRUTH		LUMN-J		GEND : Coarse san : Fledlum san : Fine sand : Very five s	rand

1 [7			PARTICLE SIZE]		
	HICK-		SAMPLING		PASSING D20	PERMEAB-	REMAR-
	VESS	LITHOLOGY	NO.	••• • • • • • • • • • • • • • • • • • •	-10-1	ILITY	KS
	(m)			• • •	5 4 3 2 1	(cm/sec)	
아	2			\ \\\\			Brown
	3				Į.		{
			- K1				G.Gray Brown
10-	6		K2 K3	11 / 11	\	5.10×10^{-3} 2.60×10^{-3}	White
'' -	·		K4			1.75×10 ⁻⁴	l
	5	Y	— K5			1.75x10 ⁻⁴	L.Purple
		isandi turni di sama (ili sama) Bulia	— K6 — K7			2.20x10 ⁻² 1.40x10 ⁻³	White R.B. ack White Red
20- [2		– K8		•	i e	Red
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-		night and the state of the first	— қ 9		\	3,80x10 ⁻³	White
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	IUO	STRAHURAFI	TIC COL	-OFFIX 1X	c) 0.125mm ~ 0.25mm	: Medium sar	iu
	۸Τ٠٢	YELLEQ			d) 0.063mm = 0.125mm	: Very five s	and
1							
1		:Undisturbed K	x 2 Total 2	22	e) less than 0.063mm	: Silt, shale,	

TECHNICAL REPORT IV COMPOSITE COLUMN

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1. INTRODUCTION

In order for preparation of a hydrogeological map reliable geological columns and borehole profiles are inevitable to determine lithology and stratigraphy of the objective area. The borehole profiles prudently analyzed by interpretation of geological logging data and slime conditions are major sources of the hydrogeological information.

However, most of water well profiles do not have age determination and lithological descriptions sometimes do not correspond to the logging data. Also these data collected on some geological columns and profiles of some petroleum wells were not detailed enough to refer to correlate with. As the result it was difficult to identify rocks in which horizon form the aquifer.

For this reason, much of efforts were made to produce detailed geological maps at many key areas and to record detailed geological columns in the second phase study (Geological Map, Porttolio).

At the same time, additional detailed reliable petroleum well data were obtained in cooperation with RIWR.

These geological columns and detailed petroleum well data enabled us to reanalyze lithology and stratigraphy of existing well data for determination of the composite columns.

The hydrogeolosical structure, the basis of the hydrogeological maps, is figured out by detailed analysis of these composite columns together with results of the geophygical investigation (Section 6-3, Main Report).

2. AVAILABLE DATA

A total of 311 of geological columns and lithological profiles were obtained from various sources.

Available Data of the Pre-Quaternary Sections are listed as below:

Type of data	Number of data collected	No. of revised profiles	1 -	ging ata		escription Available
			R	γ	Age	Lithology
1) Geological Column						are en
JICA Study	13	13	0	0	13	13
Other sources	29	29	0	0_	29	29
2) Springs	1.7	0	0	0	0	0
3) Petroleum Wells	63	3 7	0_	0	3.7	37
4) Water Well						
JICA	7	7	7	7	7	7
UNICEF	15	10	3	7	1	7
RIWR	73	4.5	15	36	19	39
Others	94	8	0	0	5	-
Total	311	149	2.5_	50	111	140

Note: R: Resistivity logging

γ: Gamma ray logging

3. DETERMINATION OF COMPOSITE COLUMNS

Based on a detailed analysis, 149 composite columns were determined out of 311 data collected. The remaining 162 data consist of springs (17), Petroleum wells out side of the North Sinal (26), wells drilled by UNICEF (5) RIWR wells cited in SDS (28) and dug wells (86) which have no geological description except these of petroleum wells. The composite columns (146) consist of the following groups:

3-1 Field Observation of Outcrops

(1) JICA column (13 columns)

Detailed geological columns were described at 13 sites of outcrops during the second phase study. For detailed age determination, the geological column at Minsherah collected by (Farag and Shata), 1954 and results of micro fossil analysis obtained through cooperation with RIWR were also referred.

(2) Other sources (29 columns)

These are geological columns mainly cited in SDS. Descriptions of geology is rather approximate. However, the lithofacies and their thickness at the Lower Cretaceous, at Wadi Giddi and the one in the southern part of Maghara may require confirmation so that these parts are deleted from the data.

3-2 Well Logs

(1) Petroleum Wells (37 columns)

These columns are treated as reliable both in lithology and age.

(2) Water Wells (70 columns)

Most of these well data are accompanied by gamma ray logging, however resistivity curves are recorded either incompletely or improperly in many cases. Problems of there data are;

- a) Lithology dose not correspond to logging curves,
- b) Description of lithology is missing,
- c) Ages are not determined and
- d) Logging curves are incomplete.

Completion of lithological descriptions are undertaken. Detailed interpretation of the data is made comparing the description of lithology with the logging data, however, these which do not have complete description of lithology or are mistakenly described, are revised according to the logging data available.

In our experience in analysis of interrelationship between lithology of core samples and logging data of wells of Mesozoic and Paleozoic, it is found that the value of resistivity corresponds to the lithology. In many cases a certain relationship among resistivities of different rocks is found. In general the magnitude of resistivity values has significant influence of the water quality in the aquifers, however, the resistivity of shales indicates a relatively low resistivity value within a certain limited range.

Empirically it is known that taking the value of resistivity of shale as an unit value, a certain multiplied value of the unit value corresponds to the resistivity value of the other type of rock with in the complex in the vicinity. Of course the value of resistivity of the rock varies depending on its solidity and contents of minerals so that the unit value of the resistivity of the shale has to be determined in each complex and locality.

Taking the above in mind a detailed analysis has been made in comparison of the lithological profiles and with of lodgings at the test hole of Minsherah, Gifgafa, Halal, Naqb and Wadi Sheira referring to occurrence of the lithological sequences of 13 geological columns collected by the study team.

The conclusion of the above analysis is summarized as shown below;

- Identification of lithology in sandstone and shale group in the Cenomanian of the Upper Cretaceous and in the Lower Cretaceous.
 - a) When the low value of the resistivity of the shale is assumed as one unit (it is preferable to take the short normal):
 - * 1.0 ~ 2.0 times of the unit corresponds to the resistivity of the shale.
 - * 2.0 ~ 3.0 times of the unit corresponds to the alternation of shale and sandstone or sandstone with high content of mud or shale.
 - * The resistivity indicating more the 4.0 times of the unit corresponds to the sandstone.

- b) When the low value of the gamma ray of the sandstone is assumed as one unit:
 - * $1.0 \sim 1.5$ times of the unit corresponds to that of sandstone.
 - * 1.5 ~ 3.0 times of the unit corresponds to that of the intermediate type of rocks between shale and sandstone.
 - * More then 3.0 times of the unit indicate that of shale. It must be mooted that the gamma ray often shows at nominally high value indifferent to the lithology so that it is easily misleading.
- 2) Identification of lithology in the limestone and shale group of Cenomanion and others in Upper Cretaceous.
 - a) When the low value of the resistivity of shale is taken as one unit:
 - * $1.0 \sim 2.0$ times of the unit corresponds to that of shale. .
 - * 2.0 ~ 4.0 times of the unit corresponds to that of marl
 - * More than 4.0 times of the unit corresponds that of limestone.
 - b) When the low value of the gamma ray of limestone is one unit:
 - * $1.0 \sim 1.5$ times of the unit corresponds to that of limestone. .
 - * 1.5 ~ 2.0 times of the unit corresponds to that of limestone with high content of mud.
 - * 2.0 ~ 3.0 times of the unit corresponds to that of marl
 - * More then 3.0 times of the unit corresponds that of shale.

However, dolomite usually indicates high gamma ray value so that the occurrence of dolomite shall be carefully interpreted through the detected resistivity values and geological columns in the vicinity. Also attention has to be paied to chalk.

In this manner, 50 water well profiles out of 70 were carefully interpreted referring to the relevant data.

Thus lithological descriptions of 70 borehole data have been finalized and further analyzed to determine ages. The geological columns obtained by field observation in the second stage of the study and a publication of Farag & Shata (1954) were referred for this purpose,

Major item of revision for composite columns are summarized in the Attachment 1.

The finalized composite columns are shown in the Attachment-2.

ATTACHMENT - 1

MAJOR ITEM OF REVISION

Well Name	Major Item of Revision
Darag No.1	 Considering the resistivity value the muddy sandstone in the Lower Cretaceous is revised as the sandstone. The lithology is undifferentiated between 782m - 800m.
Nakhi 1	 * The lower Cretaceous between 1,118m - 1,414m is revised as the Jurassic. * The lithology is revised between 683m - 1,143m according to the resistivity log.
Nakhl 2	 Lithology is revised according to the resistivity log. Shale between 736m - 870m could be dolomite. The aquifer is assumed at the layer between 940m and 1,073m. The static water level is assumed to be at ASL 190m in -
El Themed	 stead of GL-190m. Lithology is revised according to logging results and the ages are determined.
Bir Guraid	* Lithology and ages are determined.
Naqb 3	* Lithology is revised and age determination is made.
Naqb 2	* Lithology was analized according to the log data and age was determined. The low value of gamma ray log of the pre-cambrian may indicate that it could be the metamorphic rocks rather than acidic igneous rocks.
Bir El Abd	* The boundary between the Miocene and the Pliocene is determined. There is a possibility that the Miocene between 192m to 306m might be the Pliocene.
No.69	* The Quaternary is specified.
Wadi Umm Zroub	
No.70 Wadi Maleiz Well No. 1	Partly the lithology is revised and the ages are determined.
Pl Gifgafa	* The age determination is made.
Gebel Amrar	* The Upper Senonian might be read as the Lower Senonian.
Gebel Halal	* The same as Gebel Libni above.
Gebel Arf	* The Upper Cretaceous appears to be Upper Senonian. The Location shall be confirmed.

Talet El Badan	* The Upper Cretaceous appears to be the Upper Senonian. The location shall be confirmed.			
Gifgafa	There are many questions: Is there dolomite in the Turonian?; Is the Senonian is only in this thickness? and is there shale in the Paleocene?			
Abu Ghazala 1	The location shall be confirmed.			
No. 49				
El Arish Well No. 14	The lithology is revised and ages are determined.			
(Bir Hasana Well No. 15)				
No. 50				
El Arish Well No. 15	The lithology is revised and ages are determined.			
No. 57A				
El Arish Well No. 19	Ages are revised referring to the geological column and			
(Gebel Menshera Well)	also the lithology was revised.			
	There is a possibility that microfossils collected from 49 -			
	50m and 100 - 103m might drop from the upper part.			
No. 62	The age determination is made.			
El Bruk No. 2				
No. 61	The age is determined.			
El Bruk No. 1				
No. 65	The age is revised referring to the geological column.			
El Menshera 2				
No. 66	The age is revised referring to the geological column.			
Umm Gholam No. 1				
No. 67	The age is determined.			
El Resha No. 1				
No. 94	The lithology shall be confirmed.			
El Hasana	Ages are determined.			
No. P18	The alternation of shale and sandstone between 860m and			
Egyptian Army Hasana	1,060m is revised as sandstone.			
	The ages are determined.			
Gebel Kherim	The thickness of the Turonian is identified to be 70m thick,			
	however, this column indicates 200m thick.			
Gebel Umm Mafruth	The Lower Cretaceous between 500m and 745m is revised as			
· .	the Cenomanian.			
Maghara El Maaza	The Lower Cretaceous between 667m and 900m is revised as			
	the Cenomanian.			

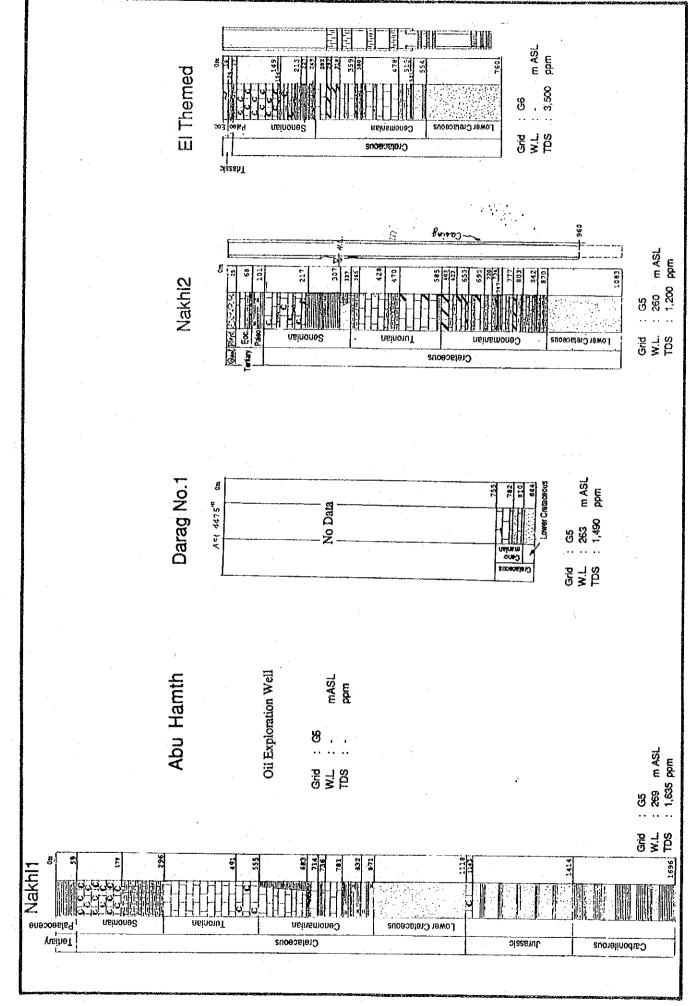
No. 8	The age was determined.
Coal mine	
No. 47B	The basement of the Quaternary is assumed at 150m from
El Arish Well No. 12	the ground surface.
No. 51B	The lithology is revised as well as the boundary of the age.
El Arish Well No. 16	
No. 52A	Ages are determined, however, the part between 50m and
El Arish Well No. 17A	92m is subject to confirmation whether it is a part of the
	Quaternary or the Jurassic.
No. 53A	Ages are determined.
El Arish Well No. 18	
No. 54A	Ages are determined.
El Fath Well No. 4	
No. 55	The lighology is revised and ages are determined.
El Massaid Well No. 4	
No. WX2	The age is determined.
Coal Mine	
El Hemma	The age is determined. The part between 16m and 64m
·	might be the Paleocenc.
Risan Aneiza	The part between 400m and 630m is revised as the
	Cenomanian. Sandstone between 630m and 886m is subject
	to confirmation.
No. 63A	Ages are determined, however further confirmation is
Gebel Libni No. 1	required.
No. 41	Ages are determined.
El Arish Well No. 6	rigos are determined.
No. 42	The lithology is determined according to the logging data
El Arish well No. 7	and ages are determined.
No. 45	According to the logging data marks between 2m - 15m, 32m
El Arish Well No. 10	- 54m and 114m - 132m are revised as shale. The part
	between 150m and 290m is revised as the Eocene.
No. 60	Ages are determined.
Gebel Halal Well No. 1	
No. 64	Ages are determined and the lithology is revised referring
Libni No. 4	to the lithology of No. 63A.
Baghdad No. 1	The lighology and ages are determined.

El Girai	Ages are determined.
No. 58	The lighology and ages are determined.
El Rawafa 1	
No. P16	The lithology is revised and ages are determined.
El Amro	
No. 76A	The lithology and the age are determined.
Wadi El Amro No. 2	
No. 76B	Ages are determined.
Wadi El Amro No. 1	
No. 78	The lithology and ages are determined.
Wadi El Husseiny	
No. 79	The lithology and ages are determined.
El Merterah	
No. 80A	Neither the lithology nor the age are differentiated due to
El Quseima	poor quality of the data.
No. 81	The same as No. 80A.
El Gouderate, No. 82 El	
Gorour	
No. 82	The same as No. 80A.
El Gorour	
No. 83	The lithology and ages are determined referring the result
El Mewaleh Well No. 1	of fossil analysis, however the thickness of the Paleocene
	appears to be too thick.
No. 84	The lithology and ages are determined.
El Ghifi	
No. 85	The lithology and ages are determined.
Abu Raty	
El Monbateh Well No. 2	Logging data are required to analyze.
El Barth (B)	The kurkar between 0m and 24m described as the Recent is
	revised as the Pleistocene.
El Khabra	Ages are revised.
No. 55:	Ages are determined, however, no analysis of the lithology
Lehfein Well No.2	is made due to incomplete logging data.
El Goura	The Pliocene between 60m and 84m is revised.
Well No. 1	

The lithology is revised however, the location shall be
confirmed.
The lithology is partly revised and ages are determined.
The lithology and ages are revised.
The part between 0m and 16m is revised as the Pleistocene.
The lithology is revised and ages are determined.
The second secon

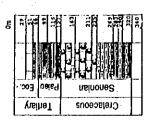
ATTACHMENT - 2

COMPOSITE COLUMNS



mASL ppm Naqb 2 Grid :: Refer Technical Report I mASL ppm JNo.15 Naqb Grid . H3 W.L . . . TDS . . . Seira Well 2 (Shira Well 1) Grid W.L. Lower Cretaceous m ASL ppm Sheira Well 1 Grid H3 W.L.: 420 TDS : 1,575 mASL ppm Bir Guraid Grid : GS W.L. : · TDS : · Ctelaceous

Naqb 3



Quaternary

South Shohat

Katib

Bir El Abd

Kuntilla

mASL ppm Oil Exploration Well Grid : J6 W.L : -TDS : -

Tertiary

Grid W.L TDS

Grid : H4 W.L. : 290 m ASL TDS : 35,000~40,000 ppm

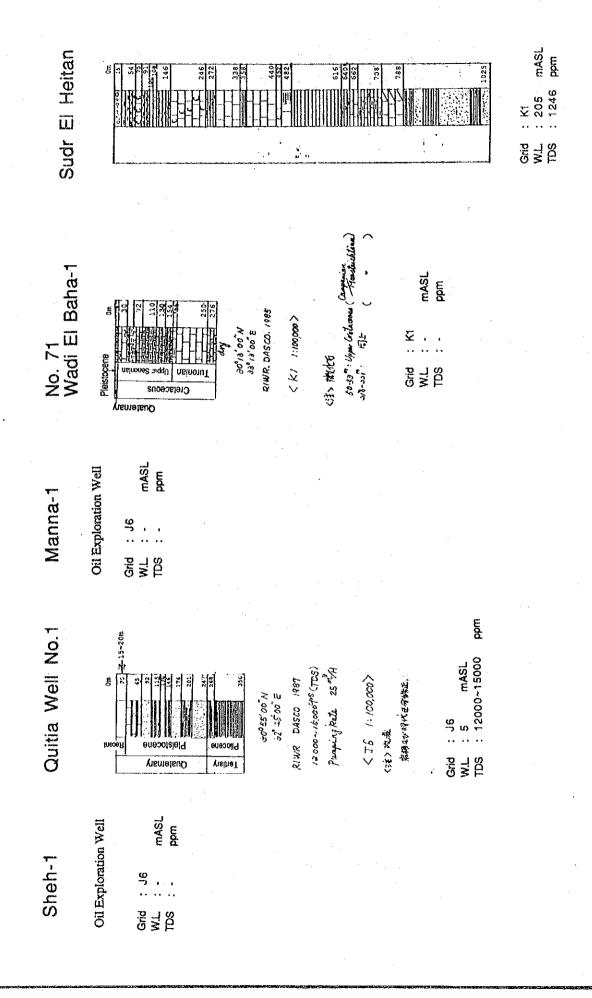
mASL ppm

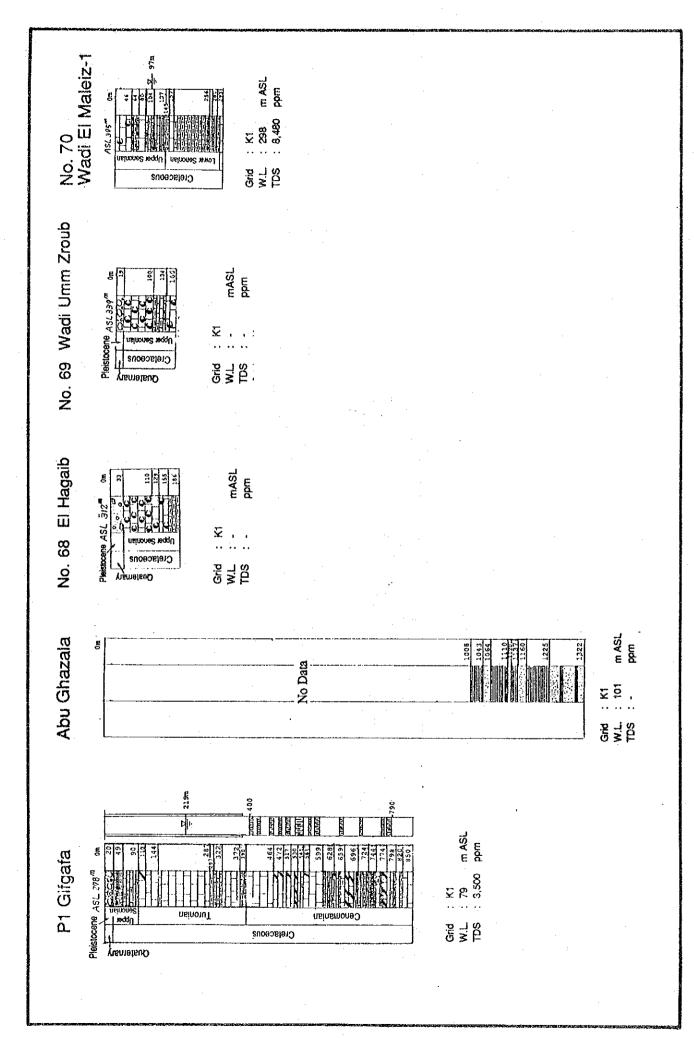
mASL ppm

Grid W.L. TDS

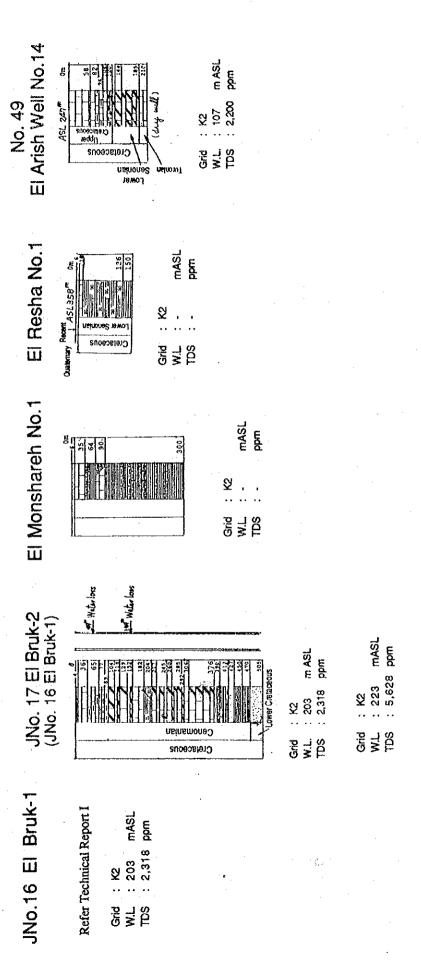
Cretaceous

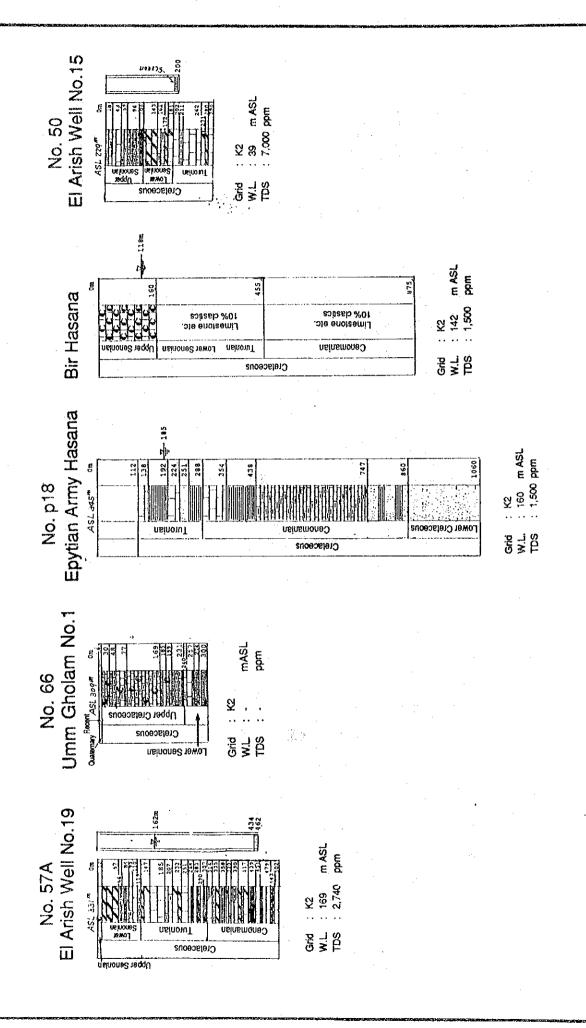
mASL ppm ž... Grid W.L TDS

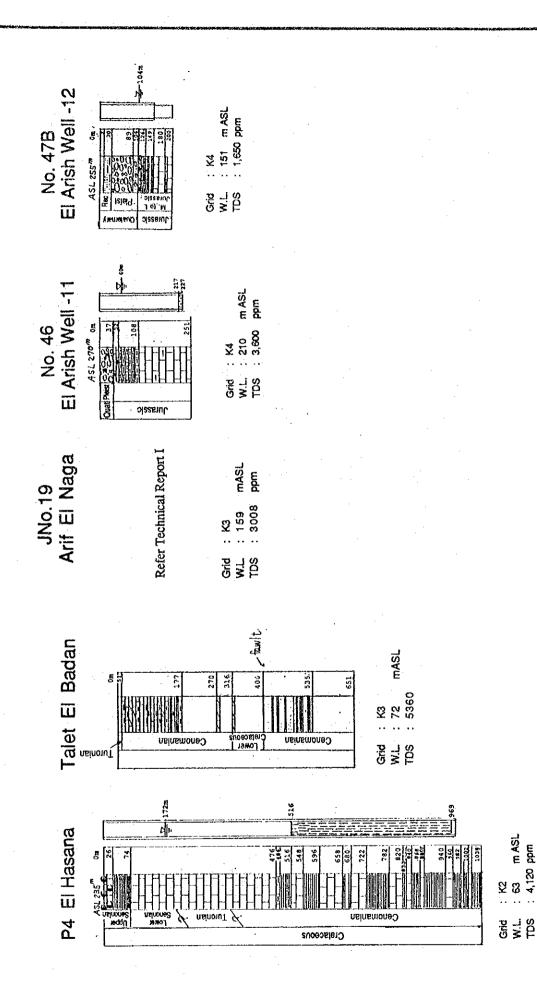


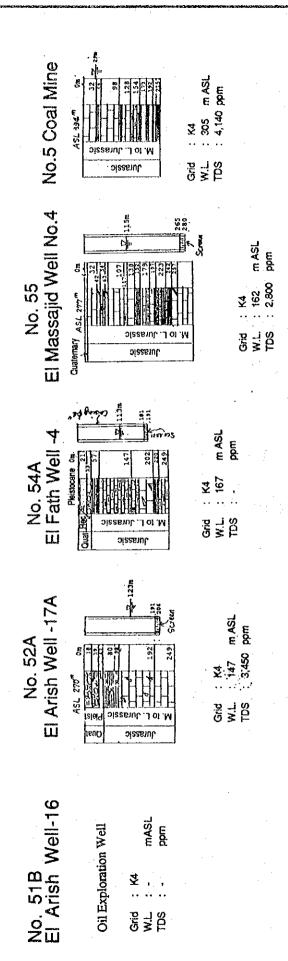


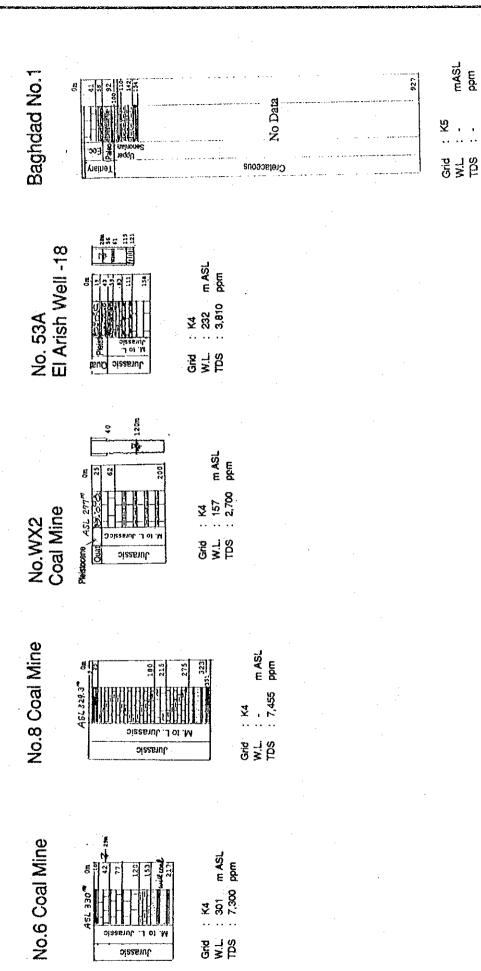
JNo.12 Minsherah Refer Technical Report I Grid W.L TDS Grid TDS No. 65 El Menshera2 mASL ppm Grid W.L TDS No. 62 El Bruk No.2 mASL ppm 월 . . . Grid TDS mASL ppm No. 61 El Bruk No.1 Grid W.L TDS Refer Technical Report I mASL ppm JNo.13 Falig Grid : K1 W.L : 67 TDS : .

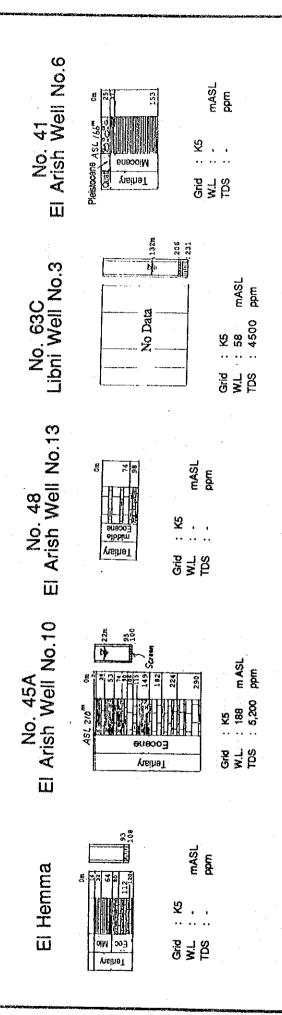


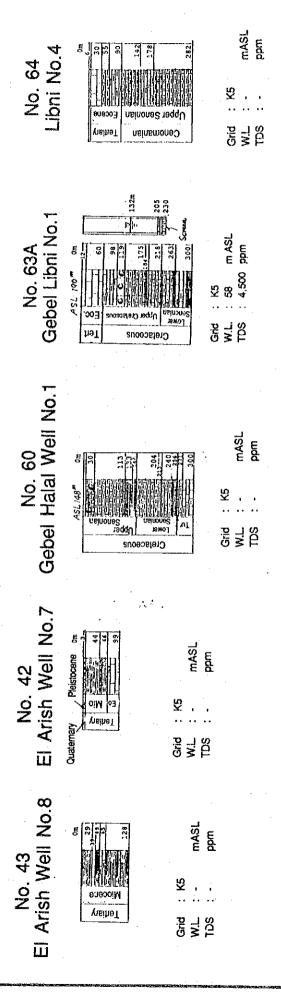


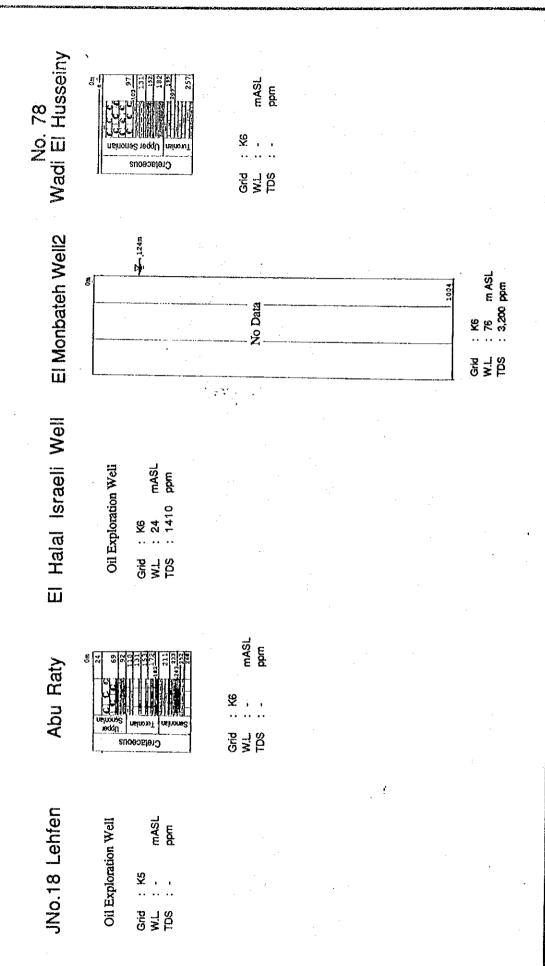


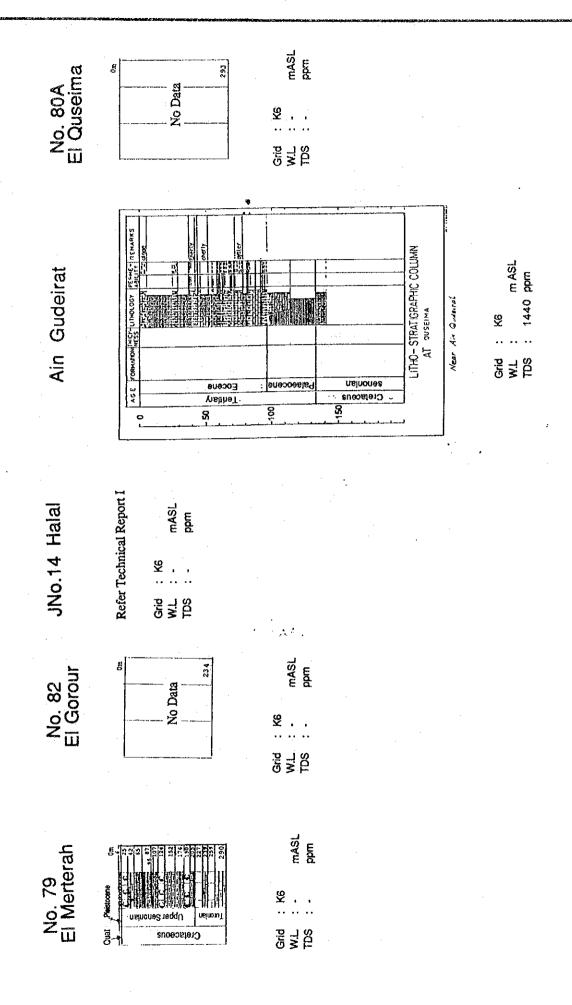


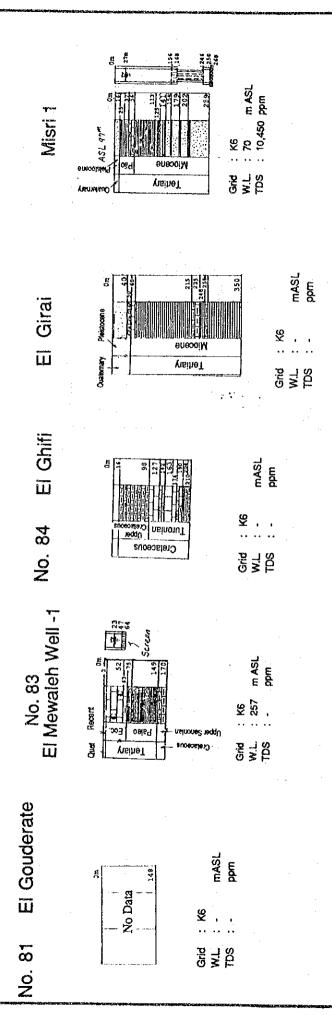


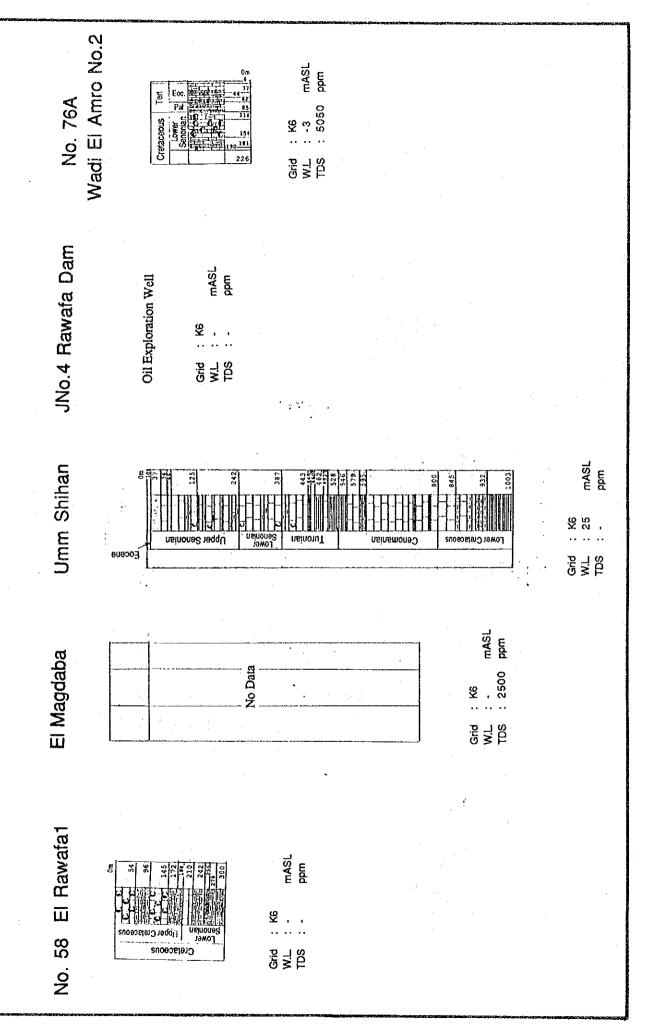


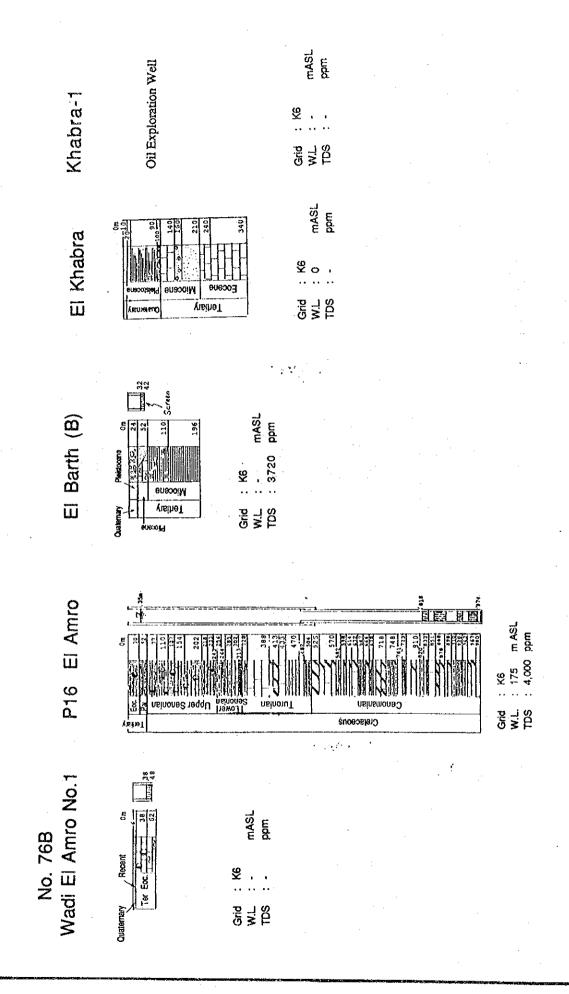












Pelusion	Oil Exploration Well	Grid : Of W.L : - mASL TDS : - ppm			
Rommana-1X Bougaz-1	Oil Exploration Well Oil Exploration Well	Grid : N3 MASL WL : - mASL WL : - ppm TDS : - ppm			
JNo.11 Barth Ro	Oil Exploration Well Oil	Grid : K6			
JNo.10 Barth	Oil Exploration Well	Grid : K6 W.L : 104 mASL TDS : 3,622 ppm			

Gofer-1

Slav-1

El Goura Well No.1

Oil Exploration Well

Oil Exploration Well

Terliary

mASL ppm

δ,...

Grid W.L TDS

mASL ppm

Grid GT TDS . . .

8 . . . Grid W.L. TDS

mASL ppm

No. 5-5 Lehfin Well No.2

Arish-1

Oil Expioration Well

Grid : O2 W.L : · TDS : ·

mASL ppm

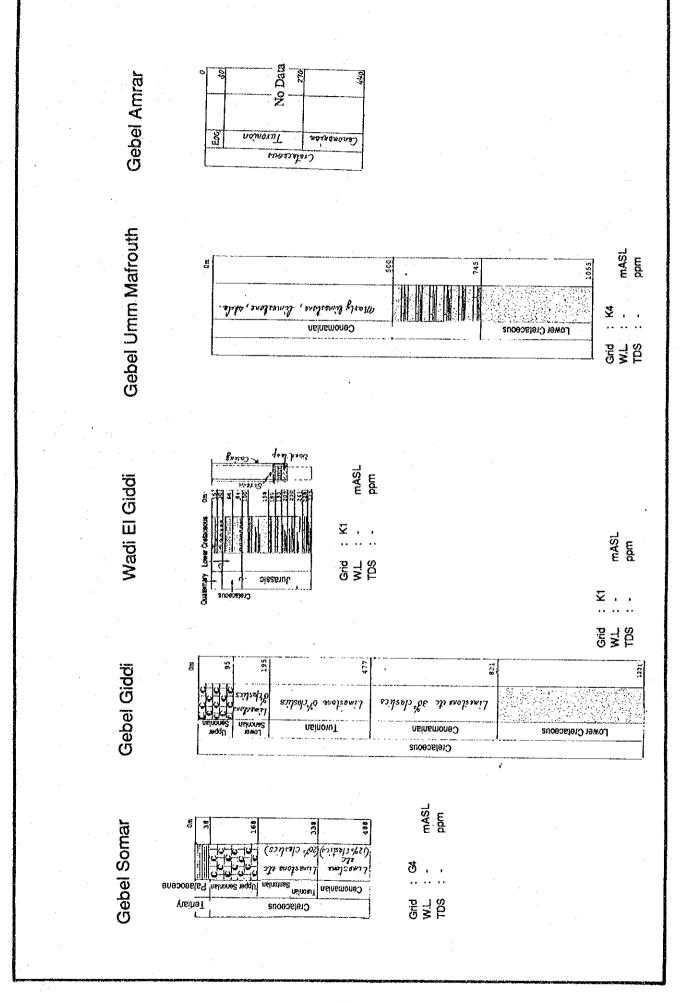
Tertiary

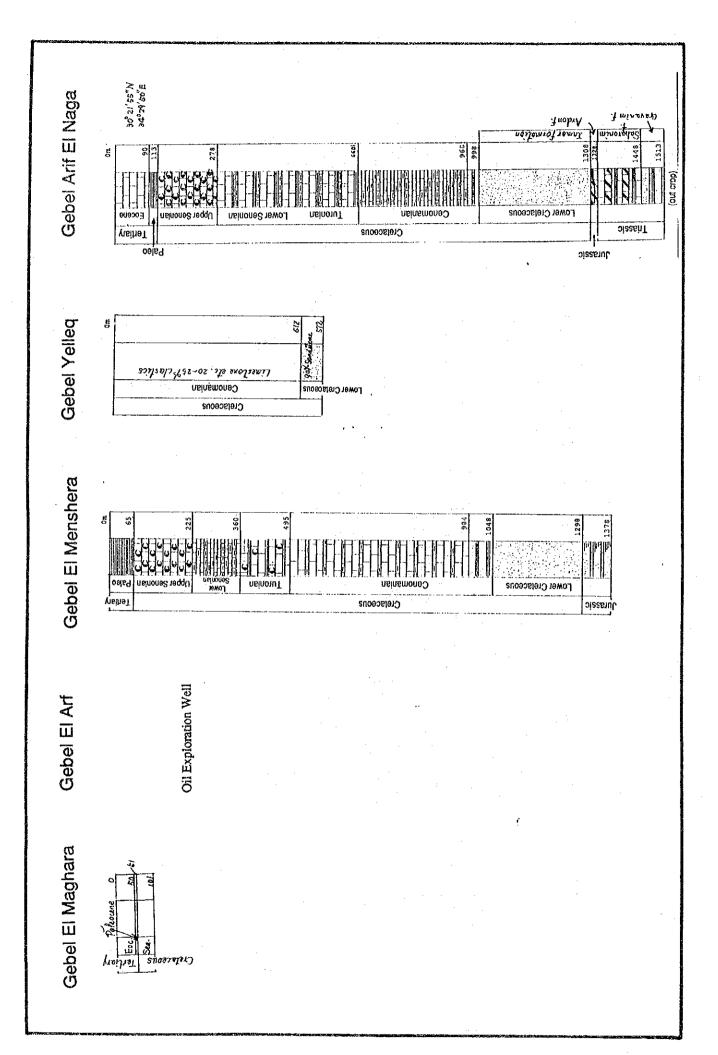
mASL ppm 8 . .

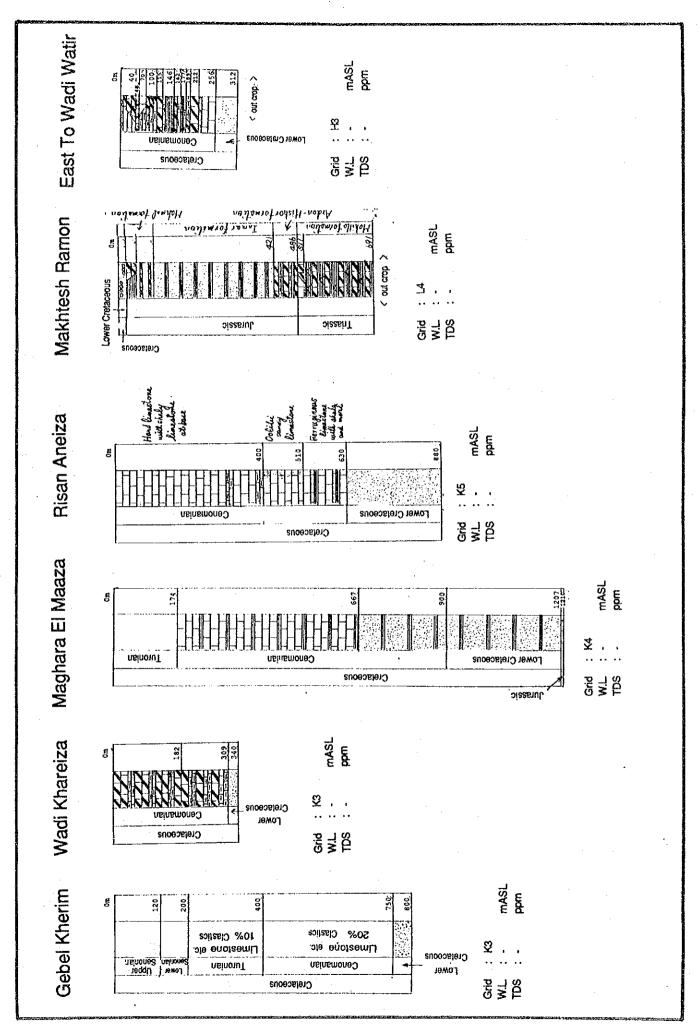
Grid W.L TDS

Haruvit-1	Oil Exploration Well	Grid : OB W.L : - mASL TDS : - ppm
JNo.5 El Kharoba	Refer Technical Report I	Grid : O3 W.L : 8.1 mASL TDS : 4,290 ppm
JNo.3 El Tawil	Refer Technical Report I	Grid : O2 W.L. : 3.0 mASL TDS : 5,562 ppm
JNo.2 El Tawil	Refer Technical Report I	Grid : O2 W.L : mASL TDS : ppm
JNo.1 El Medan	Refer Technical Report I	Grid : O2 W.L : mASL TDS : ppm

JNo.9 El Massora	Refer Technical Report i	Grid : 03 W.L : 0.7 mASL TDS : 3,470 ppm
JNo.8 El Massora	Refer Technical Report I	Grid : 03 W.L : 5.2 mASL TDS : 2,192 ppm
JNo.7 El Sheikh Zuwayed	Refer Technical Report I	Grid : 08 W.L. : 4.5 mASL TDS : 5560 ppm
JNo.6 El Sheikh Zuwayed	Refer Technical Report I	Grid : 03 W.L : 4.9 mASL TDS : 4,830 ppm







TECHNICAL REPORT

V

LANDFORM CLASSIFICATION

TABLE OF CONTENTS

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1 INTRODUCTION

Landsat image analysis was carried out for preparation of landform classification map of 1/250,000 scale. This analysis has been carried out in the phase-I stage of the study for the purpose of obtaining data required to comprehensively recognize the geomorphological feature of the study area.

The ground truth was carried out based on the results of landform classification obtained through the first stage study, in order for further detailed classification of the distribution of each landform unit.

2 SITE SURVEY

For North Sinai, monochrome aerial photographs in scale of 1/10,000 and 1/15,000 have been obtained and interpreted. In addition a 1/50,000 mosaic photographs have also been prepared based on these aerial photographs.

On the occasion of the site survey, landform classification was carried out using the aerial photographs, in addition to the Landsat images. Since these aerial photographs are extremely in large scale, the amount of information was considered to be too aboundant for this study. Therefore, site survey for this study was carried out based upon the Landsat image data, while improving the reliability of landform classification the aerial photographs were interpreted. Then, the final results were compiled into the landform classification map in scale of 1/250,000.

3 PREPARATION OF LANDFORM CLASSIFICATION MAP

In the first stage study, the landform in North Sinai was classified preliminarily into the following eleven items; Namely, 1) Mountain, 2) hilly upland, 3) Rock platform, 4) Diluvial upland, 5) Old fan, 6) Aluvial fan, 7) Wadi, 8) Sand dune, 9) Sand bar, 10) Lagoonal lowland, 11) Talus and 12) Coastal lowland. As a result of this site survey, the tableland and lowland were further subdivided, and the landform was classified into seventeen items in total. Thereby, the landform was summarized in a 1/250,000 scale map. The respective items of the landform classification are described below.

(1) Mountain (M)

The distribution of mountains has been dominated entirely by the The mountains consist of those ranging over geological structure. the so-called Syrian Arc and are distributed in a block form in the east-northeast and west-southeast directions. The distributed in a block form along the Syrian Arc have been formed Such mountains include the Gebel El due to tectonic movements. These mountains Magara, Gebel El Yelleg and Gebel El Halal. consisting mainly of limestone and other sedimentary rocks have also been formed on the east and west-south sides of the study area along the border with Israel. The elevations of the mountains range from several hundreds to 1,000 meters.

(2) Hilly upland (E)

Judging from the distribution of elevation, the hilly uplands are distributed widely in the intermediate zone between the mountain and desert zones. The base rocks of these hilly uplands consist of chalk and limestone of the Tertiary system with the elevation ranging from 200 - 300m to 500 - 700m at high places. In view of landform, the drainage system dominates where there are moderate ups and downs. Although small scale cuesta landform and erosional monadnock landform are distributed as a result of differential erosion.

(3) Plateau (PL)

The landform wherein a wide and flat area is formed on a summit surrounded by a steep ridge, is classified as plateau. The distribution of the plateau is comparatively limited. Regarding the causes of formation, the strata of chalk, limestone, etc. sedimented roughly horizontally are presumed to have been formed into plateau as a result of differential crosion.

(4) Terrace (TR1 and TR2)

In the study area, formation of clear terrace landforms are observed. The terrace landforms are formed particularly around Gebel El Maghara and Gebel El Yelleq, and also around the major tributaries upstream of the Wadi El Arish. Considering the fact that two stage terrace landform is observed in the study area, the landform in the land classification map is classified into higher terrace (TR1) and a lower Terrace (TR2). These terrace landforms are presumed to have been affected largely by variation in climatic conditions in the past. In other words, there existed a distinct period during which the sedimentation action played a major role, and another period during which the erosion action played a major role. Consequently, such landforms are considered to have been formed due to the change in environment in the Quaternary period.

Basically, the terraces are comprised chiefly of sand and gravel deposits. These deposits seem to be comparatively thin on the inland side.

(5) Fans (F1 and F2)

This fan landform has been formed due to the sedimentation action of rivers in mountainous areas. Under this study, the fan landform is divided into two types, F1 and F2. The fan F1 refers to the summit portion where the action of erosion has progressed to some extent in the past but is not subjected any erosion at present, while the fan F2 was not virtually been subjected to any erosion in the past but is subjected to considerable erosion at present.

Basically, such fans consist of sand and gravel. On the inland side, such fan sediments are presumed to be comparatively thin due to exposed conditions of bedrock. On the other hand, under the sand dune on the Mediterranean sea side, a fan is presumed to have been formed during the sea level reduction period (about 20,000 - 30,000 years ago), due to the fluctuation of the sea level associated with the change in climate during the Quaternary period.

(6) Pediment (P)

As a landform inherent to dry area, the pediment is a moderate mountain slope formed due to the action of erosion chiefly on the portion of pediment. Without any major river, only small scale drainage systems have developed on the slope of the pediment. The pediment is distributed as if surrounding the mountain of a pediment of hilly upland.

(7) Rock plain (RP)

The lowland with small ups and downs with mainly exposed rock is classified as a rock plain. Its distribution is comparatively limited and observed at the northeastern part of Hasane.

(8) Gravel plain (GP)

This plain is a lowland with small ups and downs where sand and gravels are mainly distributed on the ground surface, with small sand dune sediments. A part of the area is also presumed to have been affected by flash floods. This plain is considered to have been formed due to the sedimentation action in the past corresponding to the flow route of wadis. At some places, sand and gravels are quarried and supplied as aggregates for construction work.

(9) Talus (TL)

This is a landform formed due to sedimentation of collapsed materials under steep ridge by exposure of bedrock. The distribution of this talus landform is rather limited.

(10) Sand dune (SD)

The desert formed widely around the Suez Canal on the west side of the study area that extends towards the Mediterranean side is covered by this sand dune.

(11) Coastal sand dune (CSD)

The coastal sand dune is distributed along the coast from E1 Arish on the northeast side of the study area to Rafah. This area is entirely whitish according to the Landsat images, and is clearly different from the inland sand dune of the desert. The specific elevation of the coastal sand dune ranges from 20 to 30m and even to about 5km at places with a large width. As the rainfall is comparatively high (100 - 300mm per year) in the area from E1 Arish to Rafah, the rain stored in the coastal sand dune is utilized as groundwater source to the farmlands in this area.

(12) Coastal plain (CP)

This coastal plain has been formed on the Suez Bay side, located towards the west side of the study area.

(13) Lagoonal lowland (LL)

This coastal lowland lies along the Bardawil Lagoon of the coast towards the north side of the study area, and is surrounded by sand bar and inland sand dunes.

(14) Sand bar (SB)

An extremely long sand bar has been formed at the northern part of Sabkhet el Bardawil.

(15) WADI (W)

Tributaries of the Wadi E1 Arish system which include their respective floodplains. With the sediments mainly consisting of sand and gravel, localized groundwater is observed at times of floods. The width of the floodplain is extremely large. Although such sediments could generally be potential aquifers, the stratum is so thin with no significant potential for ground water development. A part of the Wadi sand and gravel sediments are also quarried as aggregates for construction work.

Legend

M	MOUNTAIN
Н	HILLY UPLAND
PL	PLATEAU
TR1	HIGHER TERRACE
TR2	LOWER TERRACE
F1	OLD FAN
F2	ALLUVIAL FAN
Р	PEDIMENT
RP	ROCK PLAIN
GP	GRAVEL PLAIN
TL	TALUS
SD	SAND DUNE
CSD	COASTAL SAND DUNE
СР	COASTAL PLAIN
LL	LAGOONAL LOWLAND
SB	SAND BAR
W	WADI

