# GEOLOGY OF THE DAHR-el-BAIDAR AREA

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## ABSTRACT

The Dahr-el-Baidar area situated in Central Lebanon comprises the northern plunge of the Jabal Barouk and the depression between this mountain and Jabal Knisse. This depression is the Dahr-el-Baidar pass through which the Beirut-Damascus road runs.

The stratigraphic sequence encountered includes Upper Jurassic, Lower and Middle Cretaceous strata together with some Quaternary soils in the Beka'a.

Tectonically the major part of the area is occupied by the Dahr-el-Baidar graben separated by E-W trending faults from Jabal Knisse in the north and from Jabal Barouk in the South.

The Upper Jurassic is formed by the gray compact Kesrouane limestones; the uppermost horizons (of Bhannes, Bikfaya and Salima) are missing in the area investigated, having been eroded in late Jurassic times. This erosion period points to the first gentle uplift of the Lebanon range, accompanied in neighboring areas by volcanism and faulting.

The Lower Cretaceous comprises the Basal Cretaceous sandstones and the Aptian, while the Middle Cretaceous is represented by the Albian and the lowermost Cenomanian dolomitic limestones.

The Cretaceous sandstones, of fluviatile-deltaic origin, are overlain by transgressive lower Aptian strata, both formations being thinner here than farther west. This can most probably be explained by assuming that during the Lower Cretaceous the Dahr-el-Baidar and

~~and~~ Jabal Barouk were already relatively elevated areas, pointing possibly to the existence of an embryonic horst during this period. With the deposition of the "Falaise de Jezzine", 50 m of compact limestone at the base of the Upper Aptian, deeper water and more stable marine conditions prevailed, followed by another regression.

With the Albian, the Middle Cretaceous transgression set in, depositing compact limestones alternating with marls followed by the thick monotonous Cenomanian sequence.

Numerous faults are present in the area investigated. The main one, the Yammouneh fault (trending NNE-SSW with a throw of some 3000 m), separates the Barouk horst and the Dahr-el-Baidar area from the Beka'a graben. Further, there are two important approximately E-W trending faults; the Wadi-ed-Delem fault with a throw of 60 m in the north, and Kab-Elias fault with a throw of more than 100 m in the south.

The Yammouneh fault is of considerable importance, as it forms the northern extension of the Jordan fault; it does not seem to show any evidence of large scale horizontal movements.

Aquifers and aquicludes are found in the Jurassic cavernous limestones, in the Lower Cretaceous with its numerous springs, and in the Middle Cretaceous with its massive limestones and interbedded marls.

# INTRODUCTION

## Location

The Dahr-el-Baidar area in the Central Lebanon lies just to the west of Kab-Elias and south of Jabal-el-Knisse. The area of the map is 24 $km^2$ limited by the grid lines 204-208 N and 152-158 E. Refer to Plate 1.

## Previous work

The area has been mapped by Dubertret, on a scale of 1:50,000 (Zahle sheet) and has been published together with a "Note explicative" in 1953.

## Morphology

The area is part of the Lebanon range. Altitudes along this range reach up to 3088 meters above sea level at Kornet as Souda in the north, while in the south the highest elevation is about 1853 meters at Jabal Niha. The Dahr-el-Baidar area is between 870 and 1700 meters in elevation. The main valley in the area is Wadi-ed-Delem which is wide in the west, but towards the east where it runs through the Jurassic limestones it has cut quite a steep gorge. In general the valleys in areas covered by Lower Cretaceous formations are relatively wide.

## Accessibility

The Dahr-el-Baidar col is the main passage linking the Beka'a with the coastal region; the Beirut-Damascus highway runs through the area. In the area itself, most of the parts are accessible by jeep except the rugged Jurassic terrain which has to be reached by foot.

Climate

Lebanon has a Mediterranean climate characterised by long dry summers and short mild humid winters. In winter, there are clear differences between temperatures along the coast and those on the mountains; where they vary between -5°C and 10°C, and snow falls above the 1000 meters elevation. Along the coast temperatures rarely drop below 8°C. In the Beka'a winter temperatures drop below 0°C in January and February, while summer temperatures rise above 30°C, the climate of the Beka'a is semicontinental.

Average rainfall is about 800 mm concentrated in the short winter between the months of November and April. Rainfall increases from the coast to the mountain due to higher elevations and decreases in the Beka'a which lies in the rainshadow of the Lebanon.

Objective of Work

The surveying and studying of Dahr-el-Baidar area was undertaken to produce a detailed geological map on a scale of 1:20,000 with accurate boundaries between the different rock units and detailed mapping of the faulting of the area. This was done with the aid of the new detailed excellent topographic map of Lebanon, on a scale of 1:20,000, (Chtoura sheet) and with aerial photographs.

# INDEX MAP
# CENTRAL LEBANON

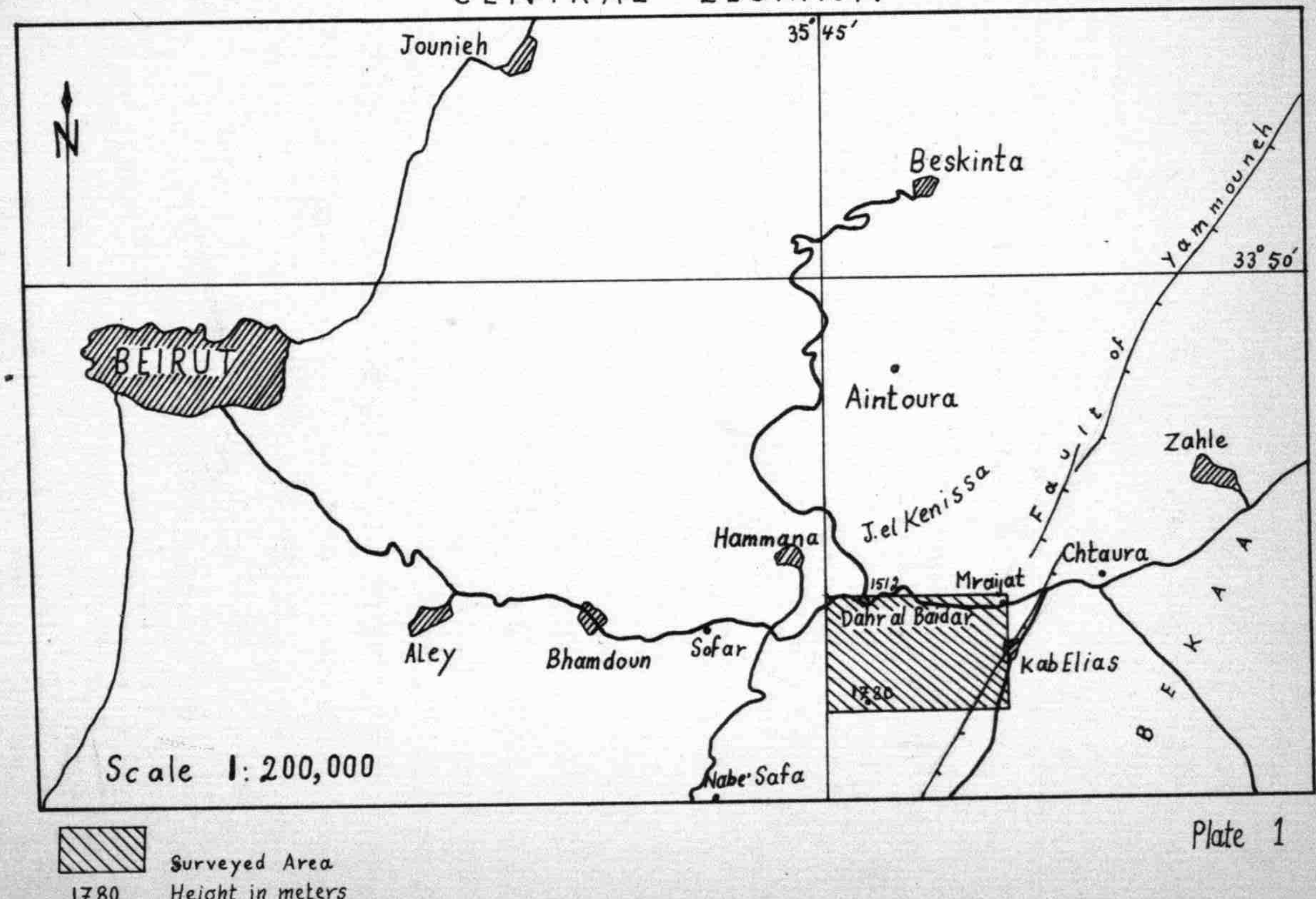



Plate 1

# STRATIGRAPHY

In the Dahr-el- Baidar area Upper Jurassic to Middle Cretaceous formations are exposed as well as some Quaternary.

## Outcrops in the Area

The stratigraphic sections which have been studied in Dahr-el-Baidar area are not continuous, due to the fact that this area has been an agricultural one in the past; many terraces were built, but now the fields are deserted and terraces have fallen down; also scree and rockfall have contributed to hide the outcrops. This applies particularly to the Basal Cretaceous sandstones and the Aptian; the Albian forms a dip slope making it impossible to establish a continuous stratigraphic section of this stage.

## Upper Jurassic

The Jurassic limestones and dolomites are massive, hard, compact of a bluish-gray color. In the Dahr-el-Baidar area, the Upper Jurassic is exposed in Wadi-ed-Delem and to the south. In this area 200-300 meters of the Upper Jurassic are eroded and the Basal Cretaceous sandstones lie disconformably over the Kesrouane Limestone. The Salima Limestone, the falaise de Bikfaya, the Bhannes level and even the top of the Kesrouane Limestone are eroded. Dubertret (1953 p. 24) already pointed to this erosion on the eastern part of the horst.

The succession of the Upper Jurassic from top to bottom in Central Lebanon according to Dubertret (1953) is as follows:

5-Salima Limestone, 20-150 m, bluish, oolitic limestones and marls.

4-Falaise de Bikfaya, 80 m, gray limestone with flint nodules, corals stromatopores and gastropods.

3-Bhannes Volcanic level, 20-50 m, brown marl with thin limestone beds and interstratified basalts and ash

2-1 Kesrouane Limestone, fine limestones and marls 50 m, with abundant globulous Stromatopores digitiformis, corals, Nerinea and Actaeonellis at the top, underlain by 400-500 m, gray massive limestone poor in fauna.

In view of the general importance of the late Jurassic erosion period, a special study was made of the distribution of the Salima Limestone. For this purpose an isopach map has been prepared of this formation, compiled partly from own observation and partly from thicknesses obtained from literature or taken from Dubertret's 1:50,000 geological maps of Lebanon.

In Central Lebanon, the Salima Limestone is not found everywhere; the isopach map, plate 2 shows the greatest thickness around the village of Salima, and thinning of the limestone towards the west and disappearance due to erosion towards the east. While in some places the whole of the Upper Jurassic sequence is present, at others it is partly eroded; this is due to differential faulting or to a pattern of basins and swells which preserved the sequence in sheltered areas and eroded it in exposed ones. Along the western flexure of Mount Lebanon, it is debated whether there exists a real disconformity between the Salima Limestone and the Basal Cretaceous sandstones. During the end of the Upper Jurassic, the embryonic horst was under shallow water, and the thinning of the Salima limestone might be due to submarine erosion.

Cretaceous

General

Following the regression at the end of the Jurassic, Basal Cretaceous sandstones were deposited in a deltaic fluviatile environment. These sandstones are in turn overlain by transgressive shallow marine sediments of the Aptian. Continued transgression and deeper marine conditions brought the deposition of the Middle Cretaceous massive limestones.

The Cretaceous of Lebanon is generally divided as follows:

1. Lower Cretaceous, 200-500 meters, represented by the Basal sandstones and the Aptian consisting mainly of shallow marine sediments.
2. Middle Cretaceous, 700-1000 meters, Albian, Cenomanian and Turonian with marls and massive limestones.
3. Upper Cretaceous or Senonian, 110-600 meters consist of chalky marls with Globigerina. (Dubertret 1953).

Basal Cretaceous Sandstones, $C_1$

In the Dahr-el-Baidar area the thickness of the Basal sandstones is about 60 meters. The main outcrops are found on the southern side of Wadi-ed-Delem; as described below, they are mainly of hematitic coarse to fine cross-bedded sandstones. At Haidara, east of Dahr-el-Baidar, the sandstones show yellowish colors with fine lignite beds 1-5 cm thick.

Stratigraphic Section of the Basal Cretaceous Sandstones

at Dahr-el-Baidar Area - Wadi-ed-Delem

Refer to Plate 3

| Unit Number | Type of Rock | Thickness in meters | Description |
|---|---|---|---|
| Base of Lower Aptian | | | |
| - | Covered | 10 | - |
| 4 | Sandstone | 5.0 | Hard, massive, hematitic fine to coarse grained, cross bedded with no calcareous material. |
| - | Covered | 37 | - |
| 3 | Sandstone | 8.0 | Massive, clayey, coarse, grained, friable, hematitic with brownish and white sand grains. |
| Jurassic | | | |
| 2 | Limestone | 2.0 | Yellow brownish, hard, porcellanous jointed. |
| 1 | Limestone | 2.0 | Bluish gray, hard massive porcellanous jointed, non-fossiliferous. |

Detailed studies by Kana'an (1966) and Wakim (1968) have shown that quartz sandstones dominate this formation in Lebanon, often with hematite as a cementing material. The sandstones show rapid changes in color both vertically and laterally, with yellow, brown, red and violet colors occuring in definite beds of short lateral extent. Argillaceous sandstones which are fine silty sands with clay as a matrix are the second most prominent rock type. Clay and shales, often rich in carbonaceous material are of limited occurrence. Lignites are thinly bedded, black colored and of limited lateral extent. Rare limestones and marls occur in several localities in Lebanon. (Kana'an 1966. p. 22) "In the Jezzine area a sandy fossiliferous limestone bed 50 cm in thickness occurs in the middle of the section. In Adloun No. 1 well a sequence of limestones was encountered". Heybroek (1942 plate 6) also encountered an oolitic Limestone bed 1.5 meters thick, 17 meters from the base of the Basal Cretaceous sandstones in the Nahr-ed-Damour section, (Fig. 1).

The presence of limestones and marls in the Basal Cretaceous sandstones in some localities especially in the western part of the Lebanon range, might indicate that the change from Upper Jurassic to the Basal Cretaceous was gradual with no real disconformity.

## Environment of Deposition

It is believed that the Basal Cretaceous sandstones were deposited on a peneplained surface. According to Kana'an (1966 p. 73) "Local downwarping gave rise to an undulating but peneplained surfaces by the advent of the "Basal Cretaceous". The peneplanation does not apply everywhere, since volcanism, faulting and erosion contributed to the formation of the irregular Jurassic relief. This relief has been smoothed out by the rapid deposition of the sands which kept pace with the subsidence of the Lebanon.

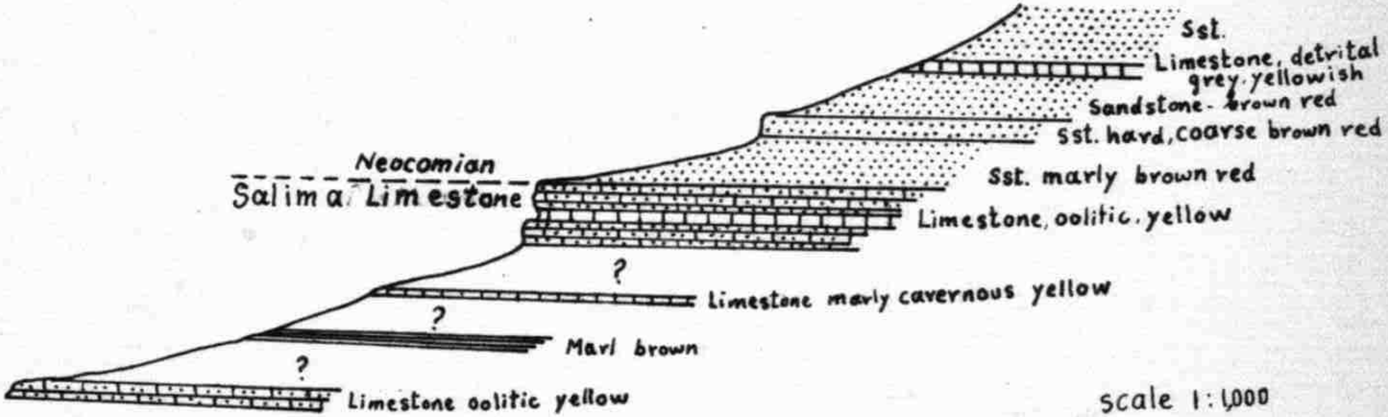



FIG. 1 - Stratigraphic section through the Salima Limestones and Neocomian (Basal Cretaceous Sandstones) showing a limestone bed in the sandstones, at Nahr Damour valley. F. Heybroek (1942 Planche 6).

## Aptian $C_2$

General

The Lower Aptian is marked by shallow marine sediments, rich in fossils. The base of the Aptian generally consists of pisolites, followed by oolitic and detrital limestones alternating with marls and sands; these shallow marine deposits are succeeded by a conspicuous gray limestone formation 60 meters thick forming a prominent escarpment all over Lebanon called the "Falaise de Jezzine" (Dubertret 1955). The Falaise de Jezzine together with the neritic limestones, marls and sandstones above it, are of Upper Aptian age, while the strata below the escarpment, are Lower Aptian.

## Lower Aptian C2a

In Dahr-el-Baidar area, the Lower Aptian is about 100 meters thick. The formation outcrops on both sides of Wadi-ed-Delem; to the north it is in faulted contact with the Upper Jurassic. It outcrops also in Wadi-ed-Dabbour, Wadi Ain-ej-Jaouz and Wadi-el-Hiri, where it is also in faulted contact with the Jurassic.

The base of the Lower Aptian is marked by a sandy calcareous bed of pisolites. Although the sequence at Wadi-ed-Delem is poorly exposed, the presence of sands and silty clays at the top indicates very shallow marine conditions.

## Stratigraphic Section of the Lower Aptian at the

### Dahr-el-Baidar Area - Wadi-ed-Delem

Refer to Plate 4

| Unit Number | Type of Rock | Thickness in meters | Description |
|---|---|---|---|
| Base of Falaise de Jezzine | | | |
| - | Covered | 5.0 | - |
| 22 | Sandy clay | 5.0 | Grayish green, massive, sticky, with very fine sand. |
| 21 | Sandstone | 1.0 | Red brown, fine to coarse grains. |
| 20 | Sandy clay | 5.0 | Grayish green, massive, sticky with very fine sand. |
| - | Covered | 15 | - |
| 19 | Sandy limestone | 1.5 | Hard, bedded, yellow brownish, jointed, with red brown surfaces and shell fragments. |
| 18 | Sandstone | 0.5 | Yellowish brown, coarse grained relatively hard. |
| 17 | Sandstone | 4.0 | White coarse to fine grains, massive, friable. |
| 16 | Sandstone | 2.0 | Yellowish brown, friable, medium grained with grayish bands of clay. |
| - | Covered | 29.5 | - |
| 15 | Marl | 1.5 | Whitish gray with large pisolites at the base. |
| - | Covered | 4.0 | - |
| 14 | Clay | 3.0 | Grayish green, sticky, sandy with fine grains, slightly laminated. |
| 13 | Sandstone | 1.0 | Brown red, hard hematitic with fine to coarse grained. |

| Unit Number | Type of Rock | Thickness in meters | Description |
|---|---|---|---|
| 12 | Clay | 2.0 | Greenish, fine, friable with no lamination. |
| 11 | Sandstone | 1.5 | Brown red, hard, limy coarse grained at the surface. |
| 10 | Clay | 0.5 | Greenish, soft, fine laminated. |
| 9 | Limestone | 1.6 | Hard, grayish, coarse texture. |
| 8 | Clay | 1.6 | Grayish green, fine friable, soft sticky, massive with no lamination. |
| 7 | Marl | 1.5 | Clayey, greenish, fine, soft when wet. |
| - | Covered | 5.0 | - |
| 6 | Limestone | 0.5 | Nodular, white marly, joints with hematitic surfaces. |
| 5 | Pisolitic Marl | 0.9 | Gray whitish, soft, high percent of calcareous material with pisolites. |
| 4 | Pisolitic Limestone | 0.65 | Nodular, white, marly, jointed with hematitic surfaces, pisolites 1-2 cm in diameter. |
| 3 | Pisolitic Marl | 1.0 | Gray whitish, soft, high percent of calcareous material with pisolites. |
| 2 | Limestone | 1.0 | Hard, yellowish white, jointed, coarse texture with red brown surfaces. |
| - | Covered | 2.0 | - |
| 1 | Sandy limestone with pisolites | 2.0 | Compact, hard, brownish, pisolites of variable size 1-3 cm in diameter. |

The Foraminifera identified by Mr. N. Aker in the Lower Aptian at Wadi-ed-Dabbour (grid location 15202074) and Wadi-ed-Delem (15802064) are:

*Choffatella decipiens* Schlum-index fossil for the Lower Aptian.

*Tritaxia pyramidata* Reuss.

*Ammobaculites* sp.

*Ammodiscus* sp.

*Cyclammina* sp.

*Dentelina* sp.

*Eggerella* sp.

*Eponides* sp.

*Eoguttulina* sp.

*Gaudryina* sp.

*Lenticulina* sp.

*Lingulina* sp.

*Quinqueloculina* sp.

*Sigmoilina* sp.

*Textularia* sp.

*Trochamminoides* sp.

Ostracods, microscopic gastropods, and echinoid spines are abundant; of the fossil flora, *Prochara* was identified.

The base of the Aptian in Lebanon is marked in several places by a level of calcareous pisolites the size of nuts, (Dubertret 1951). Heybroek (1942) identified this pisolitic level with the base of the Aptian at Kfer Niss; but at Abieh where the pisolites are lacking, by the presence of a fossiliferous clay bed with Perna orientalis, Perna tetragona and Alectryonia alicula. Above the pisolites, sandstones, marls and clays with echinoids and pelecypods, alternate with limestones, marls, oolitic limestones and sandy limestones. A common type fossil of the Lower Aptian is Heteraster oblongus.

The thickness of the Lower Aptian in Lebanon varies between 50 and 170 meters; in general it diminishes towards the eastern part of the horst. This fact is explained by the transgression of the Cretaceous sea on an inclined surface. (Dubertret 1951 p. 26) Refer to fig. 2 here.

Upper Aptian $C_2b_1$, $C_2b_2$

The thickness of the Upper Aptian in Dahr-el-Baidar area is between 90 and 100 meters. This formation covers a large area north and west of Wadi-ed-Delem. At its base the Upper Aptian betrays fully marine conditions in the massive limestones forming "Falaise de Jezzine"; this escarpment is a marker formation and is distinguished by its grayish massive jointed beds and the presence of brown-red limestone with Orbitolina lenticularis at the top and Heteraster oblongus near the base. Above the Falaise de Jezzine clays and brown red sandstones alternate, while marls and limestones with Orbitolina overlie the clays and sandstones. The Upper Aptian ends with the deposition of a massive bed of ferruginous oolites. This bed can be seen at an outcrop near the entrance of the tunnel at Dahr-el-Baidar col, where they are overlain by the Albian limestones and marls just above the road. These ferruginous oolites which outcrop to the surface at Dahr Jouret Qamar have been exploited in 1960, but one year later work was discontinued.

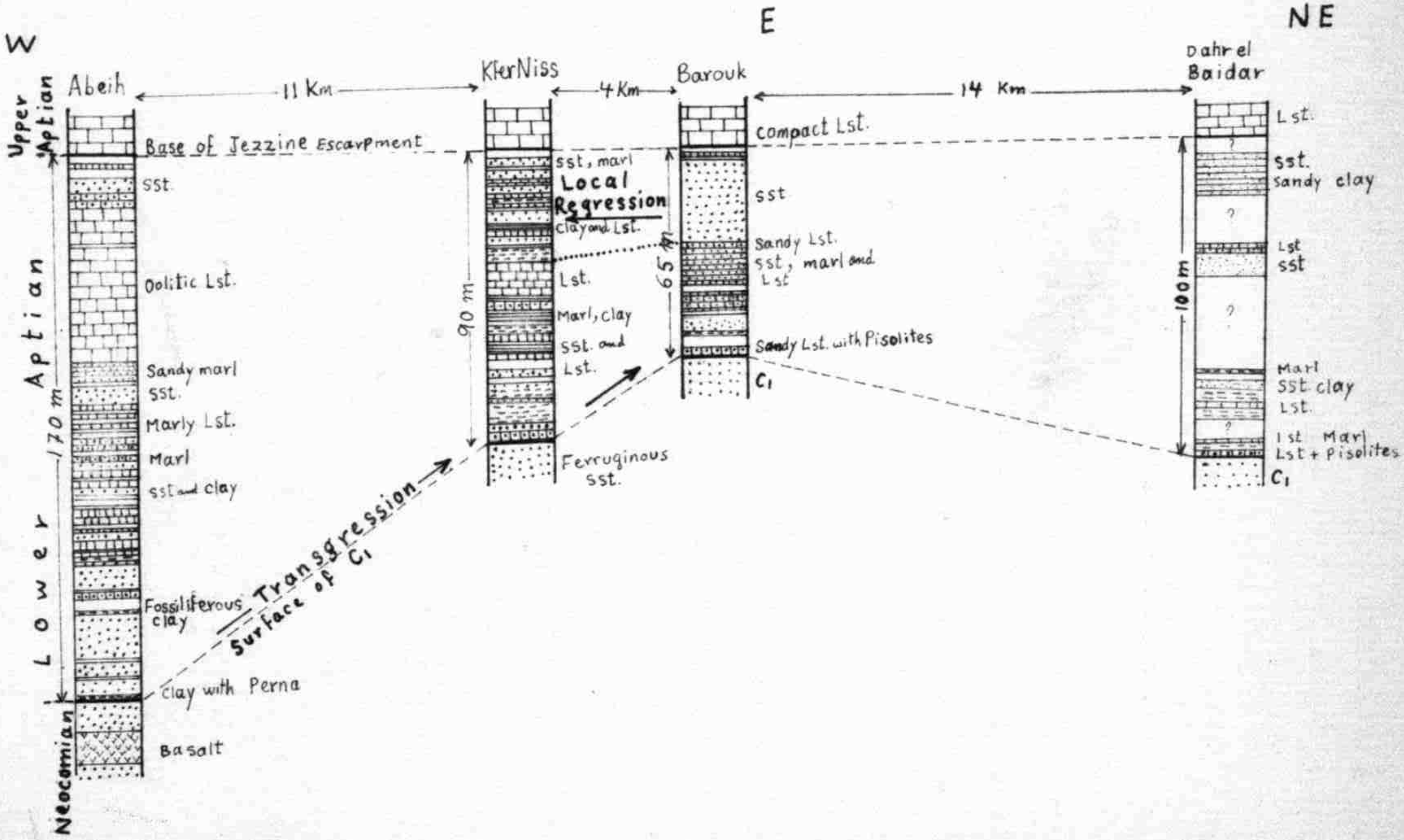



FIG. 2 – *Stratigraphic correlation of the Lower Aptian, showing generally increasing thickness towards the west with deeper marine conditions which might indicate that the embryonic horst was in existance in the Lower Cretaceous.*
*Abeih, Kfer Niss and Barouk sections, after F. Heybroek (1942).* Scale, 1:200

Stratigraphic Section of the Falaise de Jezzine at

the Dahr el Baidar Area - Ain-ech-Cheikh

Refer to Plate 5

| Unit Number | Type of Rock | Thickness in meters | Description |
|---|---|---|---|
| Top of the Falaise de Jezzine | | | |
| 8 | Limestone with Orbitolina | 2.0 | Red brown, coarse, full of Orbitolina |
| 7 | Limestone | 21.0 | Hard, massive, yellowish gray, coarse texture, jointed, cavernous with numerous calcite veins. |
| 6 | Limestone | 20.0 | Hard, massive, bedded 1-5 meters jointed, yellowish gray with calcite veins. |
| 5 | Brecciated Limestone | 1.0 | Brecciated Limestone alternating with hard thinly bedded lst. 1-5 cm thick coarse texture with grayish color. |
| 4 | Limestone | 1.0 | Hard, gray, jointed, coarse texture. |
| 3 | Marl | 0.4 | Greenish gray with brecciated limestone thinly bedded 1-2 cm thick. |
| 2 | Limestone | 1.0 | Hard, brownish gray, jointed, coarse texture. |
| 1 | Marl | 1.0 | Greenish gray with brecciated limestones coarse texture with moulds of pelecypods. |
| - | Covered | 3.0 | - |
| Top of Lower Aptian | | | |

Stratigraphic Section of the Upper Aptian at the

Dahr-el-Baidar Area - Dahr-el-Baidar Col

Refer to Plate 6

| Unit Number | Type of Rock | Thickness in meters | Description |
|---|---|---|---|
| Base of Albian | | | |
| 16 | Ferruginous oolites | 9.0 | Dark red brown, oolites in a matrix of clay, ferruginous nodules with shell fragments. |
| - | Covered | 2.0 | - |
| 15 | Limestone | 0.35 | Hard, bluish, with brownish yellow surface coarse texture with shell fragments. |
| 14 | Marl | 0.7 | Grayish, high percent of calcareous material no lamination, coarse texture. |
| 13 | Marl | 0.5 | Yellowish greenish, soft, coarse lamination. |
| 12 | Limestone | 0.5 | Hard, bluish, jointed with white brownish surface. |
| 11 | Marl | 0.2 | Greenish, soft, high percent of calcareous material. |
| 10 | Limestone | 0.45 | Hard brownish, shelly, coarse texture. |
| 9 | Marl | 2.0 | Grayish white, fine, soft. |
| - | Covered | 2.0 | - |
| 8 | Sandstone | 1.0 | Violet, friable, coarse sand. |
| 7 | Limestone | 0.35 | Hard brownish, shelly with calcite veins. |
| 6 | Marl | 1.7 | Grayish, fine, limy, soft. |
| - | Covered= | 2.0 | - |
| 5 | Limestone | 0.8 | Brownish, hard coarse texture, jointed, sandy. |
| 4 | Clay | 1.0 | Bluish, fine sticky, laminated, hard when dry. |

| Unit Number | Type of Rock | Thickness in meters | Description |
|---|---|---|---|
| 3 | Sandstone | 2.0 | Red brown, coarse to fine grained friable. |
| 2 | Sandstone | 5.0 | Massive, yellowish white, friable, coarse. |
| — | Covered | 3.0 | — |
| 1 | Limestone | 1.0 | Nodular, marly, white with numerous moulds of pelecypods. |
| - | Covered | 4.0 | - |

Top of Falaise de Jezzine

The Foraminifera identified by Mr. N. Aker in the Upper Aptian, NW of Ain Douba (grid location 15462079) are:

Cyclammina sp.

Haplophragmoides sp.

Hyperamminoides sp.

Lenticulina sp.

Reofax sp.

Microscopic gastropods were recognised also.

## Albian $C_3$

The Albian in the Dahr-el-Baidar area is about 60 meters thick. It outcrops in three areas, Dahr-el-Baidar col, Dahr Ain-el-Hajal and north of Wadi-ed-Delem. It consists of alternating marls and limestone beds which range in thickness between 10 cm and 6 meters; Ostrea shells, Orbitolina, as well as gastropod and pelecypod moulds are found in these beds especially at the bottom of the sequence. Abed of fine chocolate clay is found near the middle of the section.

Stratigraphic Section of the Albian Dahr-el-Baidar

Area - Mreijat

Refer to Plate 7

| Unit Number | Type of Rock | Thickness in meters | Description |
|---|---|---|---|
| Cenomanian | | | |
| 30 | Dolomitic Limestone | - | Massive, hard, jointed grayish shiny, coarse texture with calcite veins. |

| Unit Number | Type of Rock | Thickness in meters | Description |
|---|---|---|---|
| Top of Albian | | | |
| 29 | Marl | 2.0 | Yellowish, soft, friable, massive with high percent of calcareous material. |
| 28 | Limestone | 0.2 | Hard, yellowish jointed with shell fragments. |
| 27 | Marl | 0.1 | Greenish with brecciated limestone. |
| 26 | Limestone | 0.45 | Grayish brownish, jointed, coarse texture with calcite veins and shell. fragments. |
| - | Covered | 3.0 | - |
| 25 | Limestone | 0.6 | Grayish, hard, jointed with fine veins of calcite. |
| 24 | Limestone | 2.0 | Massive, brecciated, gray, jointed coarse, with shell fragments. |
| - | Covered | 2.0 | - |
| 23 | Brecciated Limestone | 0.9 | Brecciated, marly dark yellowish joints with brownish yellow surfaces. |
| 22 | Limestone | 2.0 | Grayish with reddish brown joint surfaces, brecciated with intercalations of thin marl. |
| 21 | Marl | 0.2 | Grayish, limy, coarse, friable. |
| 20 | Limestone | 1.4 | Grayish with reddish brown joint surfaces brecciated with intercalations of thin marl and thin calcite surface. |
| 19 | Marl | 0.1 | Yellowish, thin lamination, soft limy. |
| 18 | Limestone | 6.6 | Hard, massive yellowish with brown patches coarse texture, lateral and vertical joints. |
| - | Covered | 2.0 | - |
| 17 | Marl | 2.0 | Greenish gray, argilaceous, soft friable no lamination. |
| 16 | Limestone | 0.4 | Hard, yellowish, coarse texture shelly with brown patches. |

| Unit Number | Type of Rock | Thickness in meters | Description |
|---|---|---|---|
| 15 | Chocolate clay | 1.6 | Chocolate color, massive, fine lamination, flaky, friable and crumbles easily. |
| 14 | Limestone | 0.7 | Hard yellowish brownish, coarse with hematitic surfaces. |
| 13 | Clay | 1.2 | Massive brown greenish, marly friable, laminated. |
| 12 | Limestone | 2.5 | Yellowish green, hard, massive jointed, coarse. |
| 11 | Marl | 1.0 | Greenish, soft, clayey, friable with no lamination. |
| - | Covered | 15.0 | - |
| 10 | Limestone | 1.0 | Yellowish brown, hard, jointed coarse texture with moulds of pelecypods. |
| 9 | Nodular Marl | 0.6 | Greenish, limy, soft with nodules of limestone. |
| 8 | Limestone | 0.75 | Yellowish brown, hard, jointed, coarse with moulds of pelecypods. |
| 7 | Marl | 0.3 | Greenish, soft, friable with moulds of pelecypods. |
| 6 | Limestone | 0.5 | Brecciated, yellowish brown, jointed coarse. |
| 5 | Marl | 1.0 | Greenish, laminated, with moulds of pelecypods. |
| 4 | Limestone | 0.5 | Yellowish greenish, brecciated, shelly with moulds of pelecypods and gastropods. |
| 3 | Marl | 0.4 | Greenish, soft, clayey, no lamination with Ostrea. |
| 2 | Limestone | 0.75 | Yellowish, coarse, jointed, joints with red brown surface. |
| 1 | Marl | 0.5 | Greenish, clayey, friable, soft with moulds of pelecypods. |
| - | Covered | 3.0 | - |

Top of Upper Aptian

Foraminifera identified by Mr. N. Aker in the Albian near Ain-Bou-Ghizlane (15672079) and Mreijat (15772078) are:

Flabellamina alexanderi

Ammobaculites albiensis

Haplophragmium sp.

Eponides sp.

Hyperamminoides sp.

Ostracods and microscopic gastropods are abundant.

The Albian facies represents deeper marine conditions. The typical "Cardium" marker bed (Dubertret 1953) forms the base of the Albian. The Albian is characterised by the presence of Heteraster delgadoi, Knemiceras sp. Engonoceras sp. and Ostrea flabellata, (Dubertret 1951).

Cenomanian $C_4$

The Cenomanian which is mainly made up of compact limestone and dolomitic limestone is seen north of Wadi-ed-Delem; only its base occurs in the area investigated.

In Lebanon the Cenomanian attains a thickness of more than 600 meters; during this period, stable, fully marine conditions prevailed all over Lebanon.

The base of the Cenomanian is placed arbitrarily at the first occurrence of Eoradiolites and dolomitic limestones. Typical fossils of the Cenomanian are: Orbitolina concava, Exogyra flabellata, Alectryonia carinata, Acanthoceras sp., Eoradiolites lyratus, and Nerinea schiosensis. (Dubertret 1953).

Turonian, Senonian, Tertiary

The Turonian, Senonian and Tertiary deposits are missing in the Dahr-el-Baidar area, but the geologic history can be reconstructed from literature.

Turonian $C_5$

The Turonian limestones are between 150-300 meters thick. The lithology consists of compact limestones, marly limestones and oolitic limestones with Hippurites and ammonites. During the Turonian shallowing and reef growth took place with emergence in some parts.

Senonian $C_6$

The Senonian chalky marls are characterised by Globotruncana sp., and Heterohelicidae sp. The change from Senonian to Eocene is marked by a discontinuity; its thickness varies between 110 and 600 meters.

Nummulitique

The Nummulitique which is the Lower Tertiary in Lebanon consist of the Eocene and Oligocene.

Eocene

The Eocene consists mainly of reeflike limestones and marls with the characteristic Nummulites deposited in shallow waters.

In the area of Zahle the Lower and Middle Eocene are present, while in the north of Lebanon Lower Eocene is in part missing and no upper Eocene or Oligocene have been identified. In the Nummulitique a large part of Lebanon was exposed and so the Eocene was not deposited everywhere.

Neogene

Marine Miocene is found in parts of the coastal area and consists of limestones and marly **limestones** which lie unconformably over the Cretaceous, (Fig. 3). This shows that the flexure already existed at the western edge of the Lebanon horst, when the Miocene was deposited at its foot. The marine Miocene at Nahr-el-Kelb is affected by an E-W trending fault at Dbaye, bringing the Miocene in fault contact with the Cretaceous and Jurassic. This clearly shows that the last movement of this fault is of Post-Miocene age.

In the Beka'a lacustrine Miocene and Pliocene gravels and conglomerates lie unconformably upon the Middle Eocene. The conglomerates reach their maximum development at Zahle.

Quaternary

In the Quaternary, alluvial deposits and calcareous gravels spread over the Beka'a covering the older formations. These deposits came from the Lebanon and Anti-Lebanon by the torrential rivers. The thickness of these deposits is unknown.

Along the coast marine Quaternary occurs on the raised beaches at different levels up to 100 meters above sea level. The marine Quaternary consist of conglomerates with rounded pebbles embedded sometimes in sands. In the area of Beirut torrential rivers from the mountain deposited a thick layer of dark red sands with conglomerates.

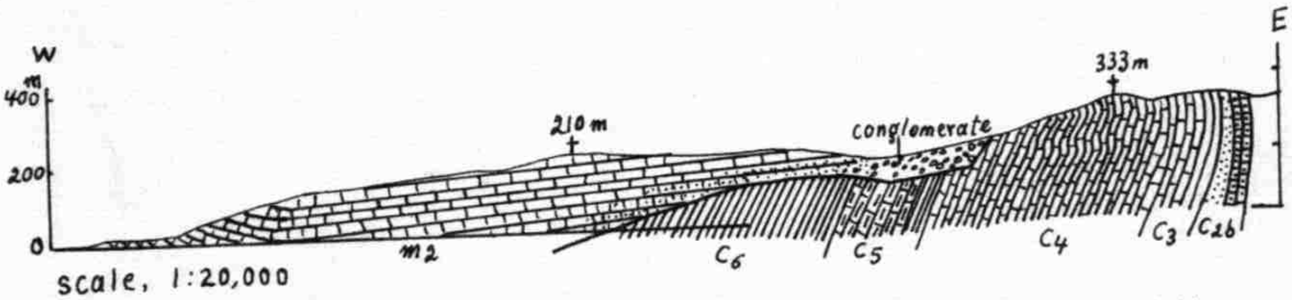



Fig. 3 Unconformity between the steep dipping Cretaceous strata and the Miocene limestones at Nahr el Kelb showing that the flexure is older than Miocene. (After Dubertret 1955.)

## TECTONICS

The Dahr-el-Baidar area is a graben lying between Jabal Knisse to the north and Jabal Barouk to the south. The fault of Yammouneh, which runs through the eastern side of the area, separating the Dahr-el-Baidar area from the Beka'a has a throw of about 3000 meters. Apart from the Yammouneh fault, there are two main faults parallel to each other running E-W and then curving in a SW direction.

The one to the north is the Wadi-ed-Delem fault, which has a downthrow of 50 meters in the west, while in the east it is difficult to determine the amount of throw, because of the erosion of the Jurassic limestones. North of Wadi-ed-Delem fault, there are two parallel faults striking NNW-SSE. The estimated displacement of these faults is more than 60 meters, as the Basal Cretaceous sandstones are missing and the Lower Aptian is in contact with the Jurassic limestones. These two faults are joined by smaller ones causing several fault blocks.

The one to the south, the Kab-Elias fault, separates in the eastern part of the area the Jurassic limestones from the Cretaceous. Since the Jurassic limestones are eroded, it is difficult to determine the structural displacement; however the height of the fault scarp is more than 100 meters; towards the west the throw is not more than 70 meters. South of the Kab-Elias fault we find another E-W trending fault which brings the Lower Aptian in contact with the Jurassic. Another fault, the Wadi-el-Biyada fault striking NWW-SEE occurs south of the Kab-Elias fault. Between Wadi-el-Biyada and Wadi-ed-Delem faults, a series of step faults with downthrows towards the north is found; the total displacement between these two major faults is therefore more than 400 meters.

Efforts were made to find out whether there is difference in age between the main NNE-SSW trending Yammouneh fault and the generally E-W trending secondary faults. However, no conclusions could be reached in this respect. The youngest strata being Cenomanian and these strata also being affected by faulting, we can only conclude that the age of the youngest fault movement is post Cenomanian.

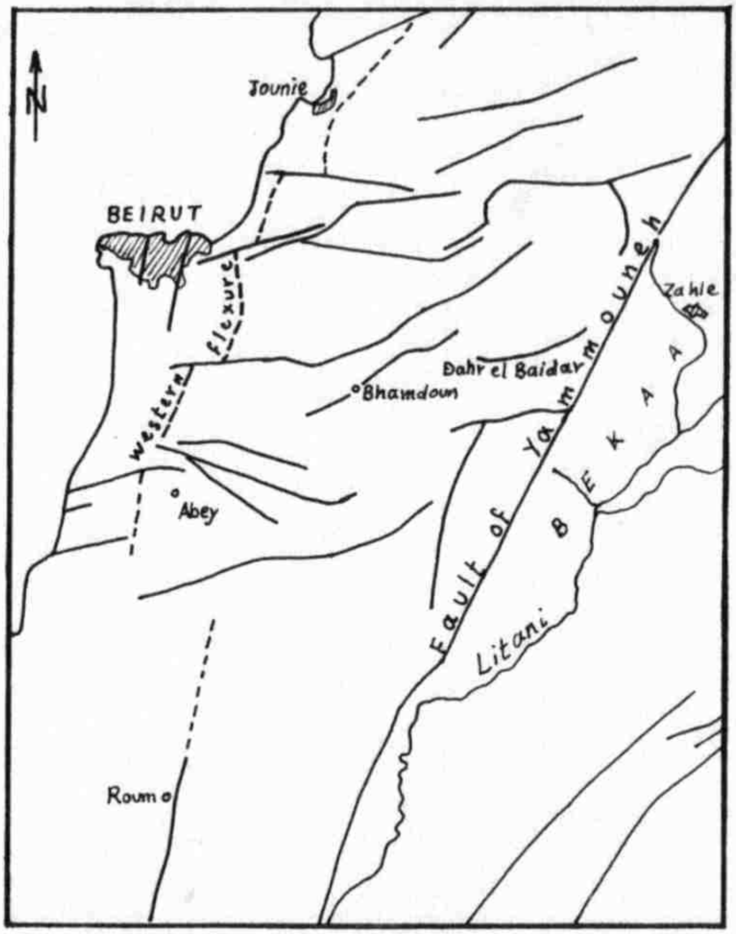
## General Tectonics

Lebanon is a horst bordered to the west by a flexure, and to the east by the fault of Yammouneh, oriented NNE-SSW. The Beka'a, which is a graben is bordered to the west by this Yammouneh fault, and to the east by the Hasbaya fault and the western flexure of the Anti Lebanon, which is also a horst.

Apart from the Yammouneh fault, secondary faults which strike SW-NE in the south and E-W in the north of the Lebanon do not cross the Yammouneh fault, which might indicate that the secondary and the major faults are not of the same age.

Heybroek (1942) considers Mount Lebanon and Anti Lebanon as two horsts separated by the graben of the Beka'a. Dubertret (1967) believes that the horsts were formed due to vertical forces, along the large generally N-S trending faults.

As the first uplift of the Lebanon occurred at the end of the Jurassic, the fault of Yammouneh might have developed at that time. It is however, not at all certain that this fault showed already any appreciable dislocation at that time. The Yammouneh fault may also have been reactivated at the end of the Cenomanian, although pertinent data to prove this are lacking. According to Dubertret (1967 p. 13) the genesis of the chain of massifs and depressions on the eastern border




Scale, 1:500,000

Plate 8. NE-SW en echelon Faults in Central Lebanon. (after Dubertret. 1951)

marked effects in Syria and even in Turkey. Such effects appear to be lacking ... The detailed mapping of the Beka'a of Lebanon by Dubertret has shown a downthrow of 2000 meters on the Serrhaya fault and of 4000 meters on the Yammouneh fault, but his detailed mapping has failed to reveal any large horizontal movements on these two dominant faults."

Dubertret, who developed his own idea about transcurrent movement along the Dead Sea Rift in 1932, enlarged on it in 1967, believes that sliding of the Palestine-Sinai block towards the south might have taken place along the Roum-Jordan fault as follows:

1. Sliding of the Sinai - Palestine block to the south 160 km along the Roum-Jordan fault.
2. A rotation of the African block $6.4^{\circ}$ clockwise relative to the Arabian block, around a center situated in the Ionian Sea.

Dubertret admits that the Cretaceous cover over the extension of the fault of Roum does not present any horizontal displacement. R Wetzel and M. Morton (1959)* have shown that during the Cretaceous, Palestine and Transjordan had already been clearly differentiated, that between these two regions a contrast of relief already existed resembling that of today. Dubertret (1967 p. 13) concluded that the sliding along the Roum-Jordan fault might have taken place at the end

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* In Dubertret 1967 p. 13.

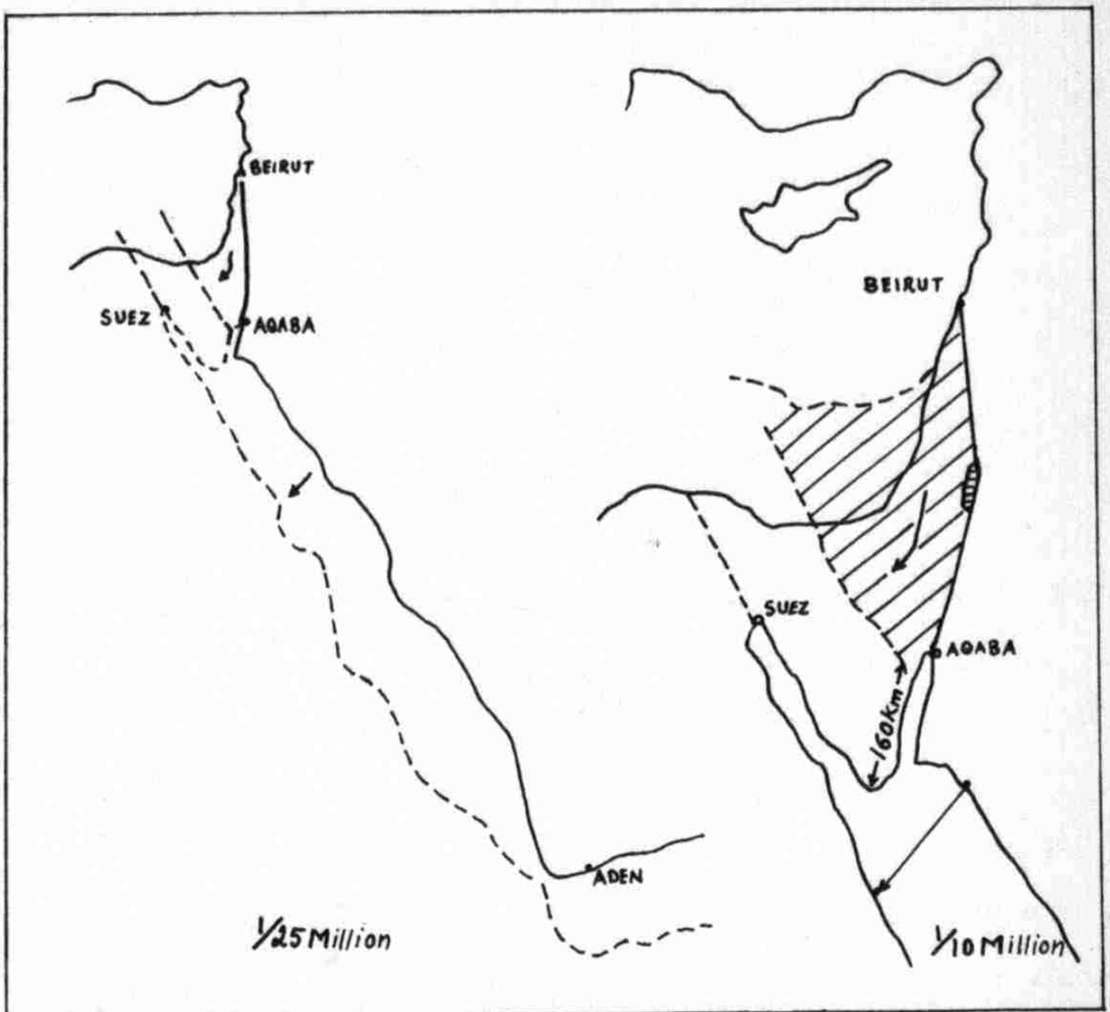


FIG. 4-Horizontal movement of the Sinai-Palestine block southwards 160 Km. along Roum-Dead Sea fault. Dubertret (1967).

of Jurassic, as the Cretaceous and Cenozoic formations do not show any traces of horizontal displacement.

Zak and Freund (1966) presented evidence from vertical areal photographs, showing straight faults cutting alluvial fans, that recent sinistral strike-slip dislocation of about 600 meters along the Dead Sea Rift has taken place along straight lines, from the Gulf of Aqaba to the Sea of Galilee. Of the 600 meters movement 150 meters is younger than 20,000 years.

Discussion

Since Dubertret (1967) believes that the Yammouneh fault and the major faults in the area are ancient, and that they have been reactivated during the Cretaceous and the Cenozoic, the fault of Roum should show some horizontal dislocation due to the recent movements mentioned above. The fault of Roum changes into a flexure in the neighborhood of Nahr al Aouali, and even dies out further north. The fault of Yammouneh on the other hand is clearly a major fault along which rejuvinations might have taken place and along which horizontal movements are possible.

The general trend of NE-SW secondary faults which are arranged en-echelon in Lebanon, might possibly be explained by compression caused by horizontal movement along the Yammouneh. This "compression" might be caused by the change from the N-S trending Jordan fault to the NNE-SSW trending Yammouneh fault.

Since there are no signs of any large horizontal displacement along the Yammouneh and Roum faults, serious doubt can therefore be raised whether any large scale horizontal movements have taken place at all along the Dead Sea Rift. It seems that the facts on which these displacements are based, could also be interpreted in a different way. It is possible however to have small/strike slip movements of several hundred meters showing clearly in one area while further away, these effects diminish and become unrecognisable.

Strike-slip faults have been recognised in many areas in the world, they seem to be the general case rather than the exception. It is worthwhile to look for evidence of small scale horizontal displacement along the fault of Yammouneh and the other meridional faults in Lebanon.

## GEOLOGICAL HISTORY OF LEBANON

The Upper Jurassic is marked by gentle uplift accompanied by quite important volcanic eruptions. The appearance of the first relief led to erosion of 200-300 meters of the uppermost Jurassic in the Dahr-el-Baidar area. From the presence at Mazra'at Beni Sa'ab (W of Hadeth el Joubbe) of undisturbed Lower Cretaceous sediments above a fault in the Upper Jurassic (Wetzel and Dubertret, 1951; see Fig. 4 here), it can be concluded that faulting had already started in late Jurassic times. In Central Lebanon the preservation of the Upper Jurassic sequence in some places and its erosion nearby might be due to this faulting.

The Basal Cretaceous sandstones were deposited on an irregular Jurassic surface. The Aptian facies becomes increasingly marine although neritic deposits predominated. The fact that the transgression of the Cretaceous sea was on an inclined surface, together with marked facies and thickness differences in the Lower Cretaceous seem to point to the existence of an embryonic submarine horst during that period.

Volcanic activity persisted during the "Basal Cretaceous", the Upper Aptian and the Lower Albian. According to Kutayneh (1967 p. 4) the Lower Cretaceous volcanics mark a reactivation of the same centers which supplied the Upper Jurassic ones in the neighborhood of the Qartaba vents.

Fully marine conditions prevailed during the Albian and Cenomanian. During the Turonian shallowing caused by local uplift occured,

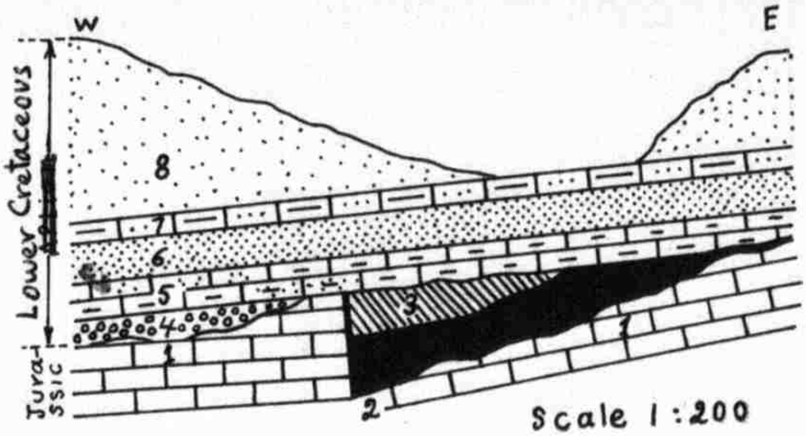


Fig 4 - Mazraat Beni Saab.

Section showing undisturbed ~~Aptian~~ Lower Cretaceous overlying faulted Jurassic.

1 - Compact Limestone, gray with Lovcenipora.

2 - Basalt, 5 meters.

3 - Lignite and ~~cinerites~~ ash, 3 meters.

4 - Conglomerate, sand, 0.5 meters.

5 - Marly Limestone with Lamellibranchs and Nerinea, 1.0 m.

6 - Fine sand, partly argillaceous, 1.0 m.

7 - Marly and sandy Lst. with Foraminifera and Nerinea, 0.6 m.

8 - Sand, 26 meters.

After R. Wetzel and L. Dubertret 1951 P. 22

limestones and marls were deposited during the Turonian, while chalk is the dominant rock in the Senonian. The end of the Cretaceous is marked by uplift and erosion, there is a marked unconformity between the Senonian and the Tertiary.

The emergence of Mount Lebanon began slowly in the Turonian, and in the Middle Eocene, Mount Lebanon and Anti Lebanon had already emerged to some extent and the Beka'a had begun down dropping. The deposition of the Nummulites gizehensis limestones with their reeflike facies in the southern Beka'a give evidence of a continuous subsiding movement during the Middle Eocene. (Sabbagh 1961)

The present topography of Lebanon was formed in the Neogene; the flexure at the western edge of the Lebanon horst was existing when the Miocene limestones were deposited at its foot. Lacustrine Miocene-Pliocene marls and conglomerates were deposited in the Beka'a by torrential streams eroding the uplifted blocks on either side.

Basaltic flows occur in the Miocene and Pliocene in the Homs area, while volcanism persisted in the Hauran into the Quaternary.

During the Quaternary raised beaches up to 100 meter level were formed. Alluvium and conglomerates were deposited on these terraces along the coast. In the Beka'a alluvium has covered part of the Eocene and Miocene formations while some crests were left like islands among the alluvium.

## HYDROGEOLOGY

### Precipitation and Infiltration

Groundwater is the most valuable natural resource of Lebanon. Precipitation is sufficient, but it is confined to the mild winter season, when little water is needed. In summer rainfall is nearly nil from May to October. Water which infiltrates into the porous rocks is thereby stored and delivered as springs which continue flowing during the dry season. Precipitation occurs mainly as rain, but above 1500 meters elevation snow accumulates for sometimes. Since rainfall comes down in heavy showers, most of it runs off along the steep slopes, while snow which accumulates on the peaks of Mount Lebanon until summer is the main source of infiltration and recharge of aquifers.

As the result of confinement of rainfall to the short winter season, Lebanon shows to a large extent the influence of topography and structure in the development of its river systems. Due to the presence of the Jurassic and Middle Cretaceous limestone aquifers at the top of Mount Lebanon, there occur many springs at an altitude of 900 to 1500 meters above sea level; these springs keep the rivers flowing during the dry summer. Refer to Figs. 6 and 7.

### Springs in Dahr-el-Baidar Area

The large springs in Dahr-el-Baidar area with a magnitude of several cubic feet per second during summer are: Ras el Ain, Ain Douba, Ain ech Cheikh and Ain el Hamra. Ras el Ain spring which issues from the Jurassic limestones is also connected with a fault bringing the lower Aptian in contact with the Jurassic. The other springs are in the Lower

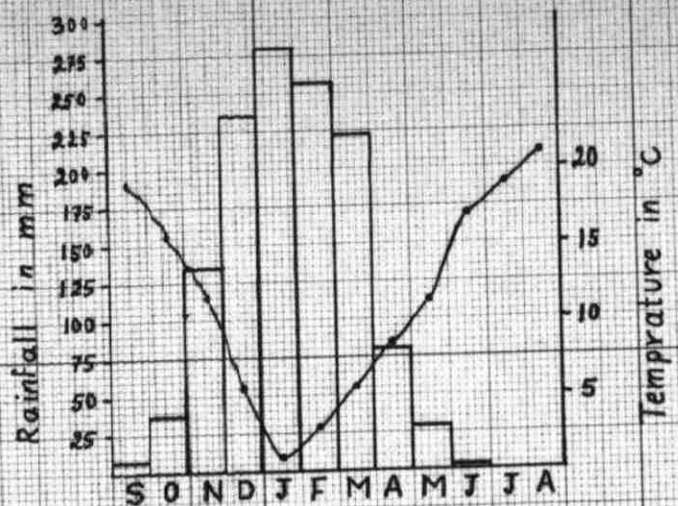


Fig. 6 Average Monthly Temprature and Rainfall at Dahr al Baidar

Source: Atlas Climatique Du Liban, 1967


Fig 7 Wadi ed Delem Monthly Water Flow

Kab Elias Station

Source : Annuaire Hydrometrique 61-65, Republique Libanaise, Office National Du Litani, Service Irrigation.

LEBANON

AVERAGE ANNUAL TEMPERATURE °C

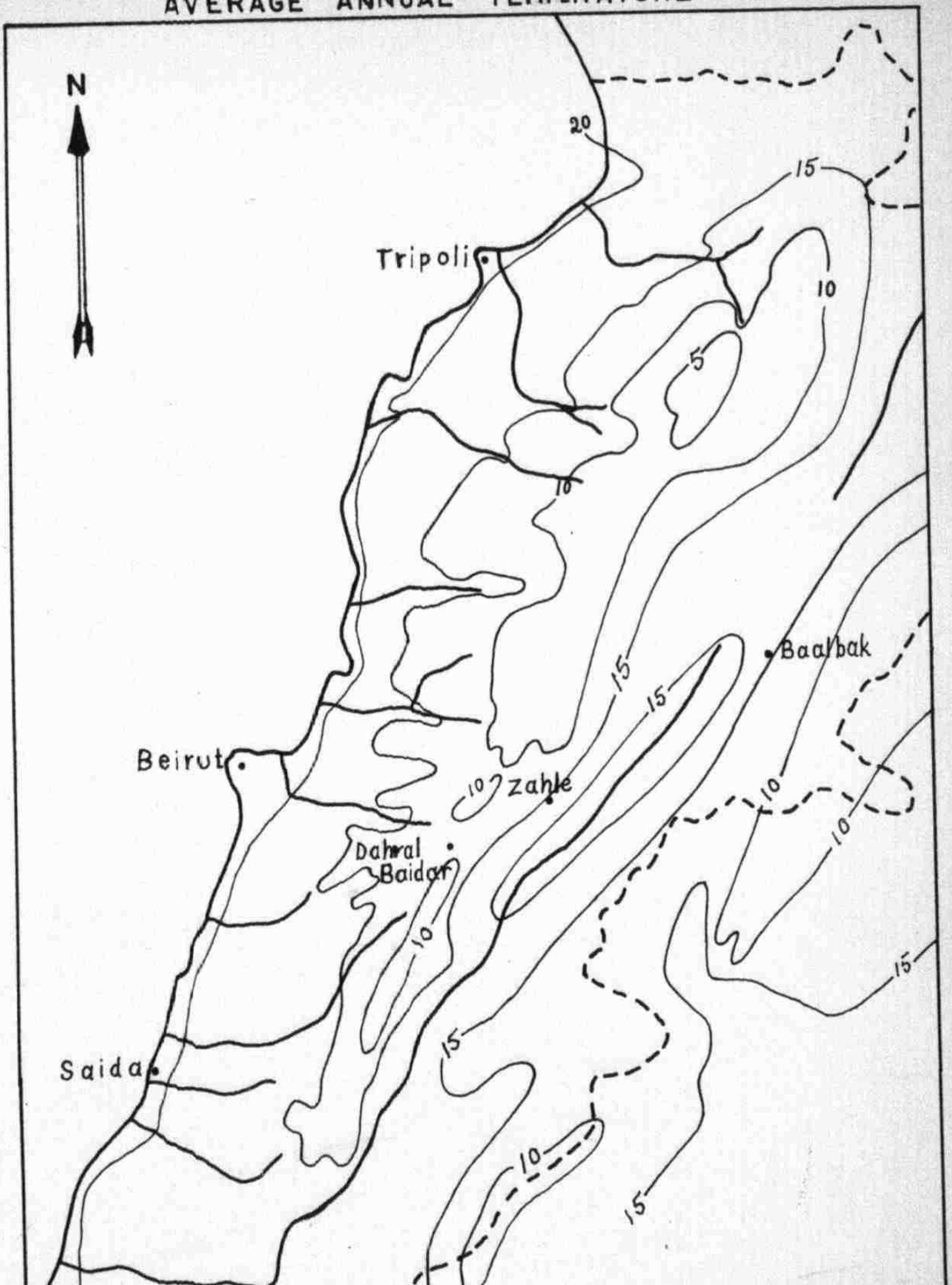


Plate 11. Source: Atlas Climatique Du Liban, Republique Libanaise Ministere des Travaux Publics et des Transports, Beirut, 1967.

LEBANON

AVERAGE ANNUAL PRECIPITATION in mm

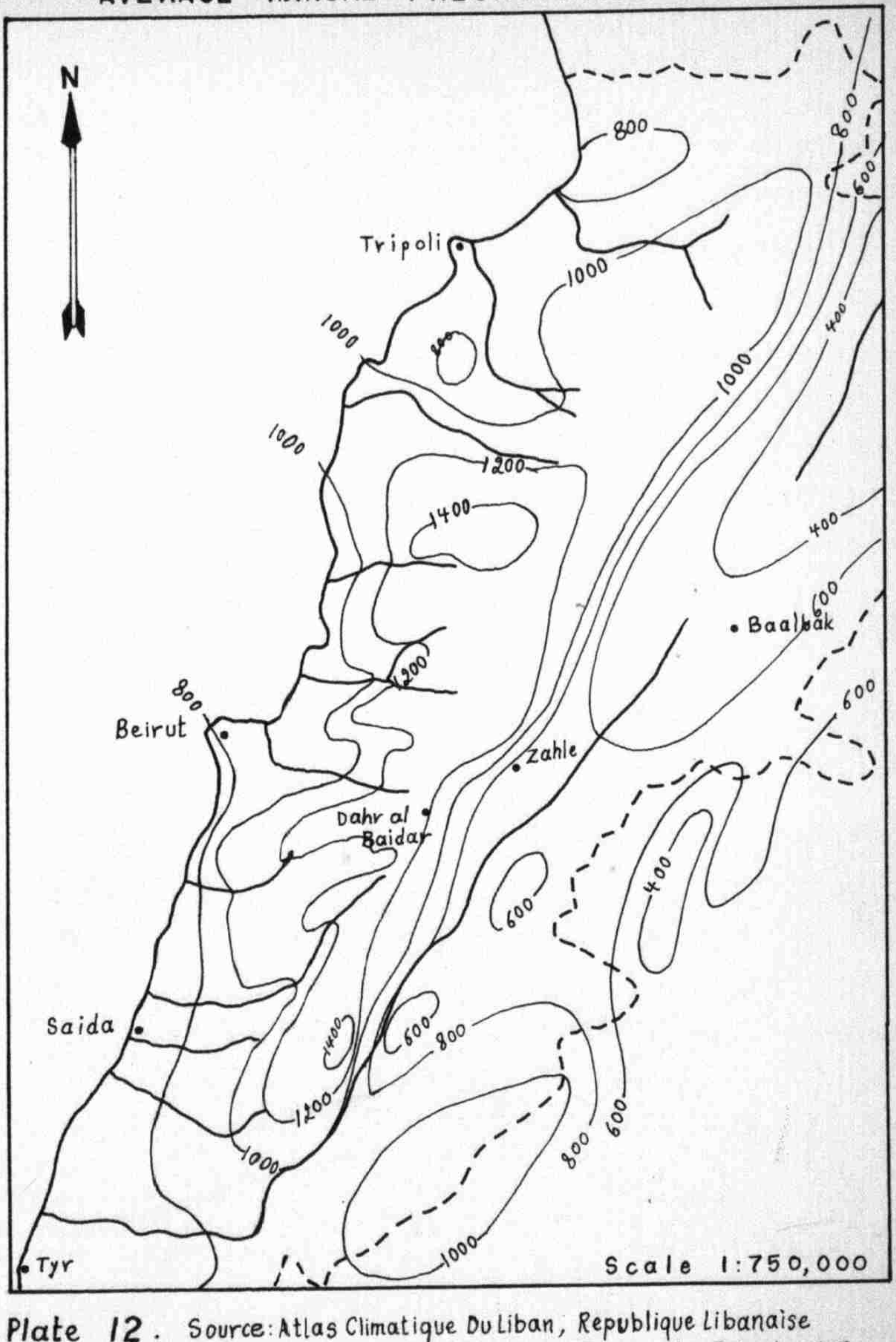


Plate 12. Source: Atlas Climatique Du Liban, Republique Libanaise Ministere des Travaux Publics et des Transports, Beirut, 1967.

Aptian formation but directly below the Falaise de Jezzine which is an important limestone aquifer contributing to the rise of these springs.

In the area two ways have been devised to utilise the waters of the Aptian aquifers; first by digging tunnels in the sands above the contact between the sands and marls or clays, and so water is collected over the impermeable layer. Another way isto dig shafts 10-15 meters deep and 2-3 meters in diameter; in these shafts water seeps in from the sands and collects at the bottom. In the first case there is an apparent seepage, and to increase the seepage of water, the digging of the tunnel increases the surface area, and more water could be collected. Fig. 8. The advantage in this case is that a little amount of labor is needed to dig the tunnel. The recharge of the aquifer is rather slow and the springs are affected by fluctuations in rainfall. While the second case, although expensive, gives a larger amount of water. The aquifers are recharged directly Fig. 9 B since these shafts are dug in the bed of the valley, river waters fill the shaft. In summer the water seeps out and collects at the bottom.

In general the infiltration of water in Dahr-el-Baidar is through:

1. The many faults and joints which act as channels for the movement of water.
2. Karst topography.
3. Outcrop of the aquifers at the surface.

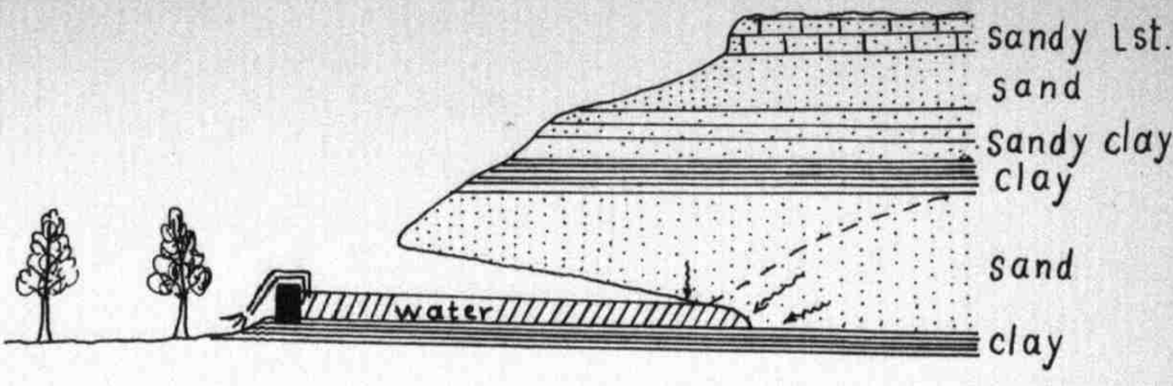


Fig. 8 _ Tunnelling the Aptian sands to increase the output of water seepage.

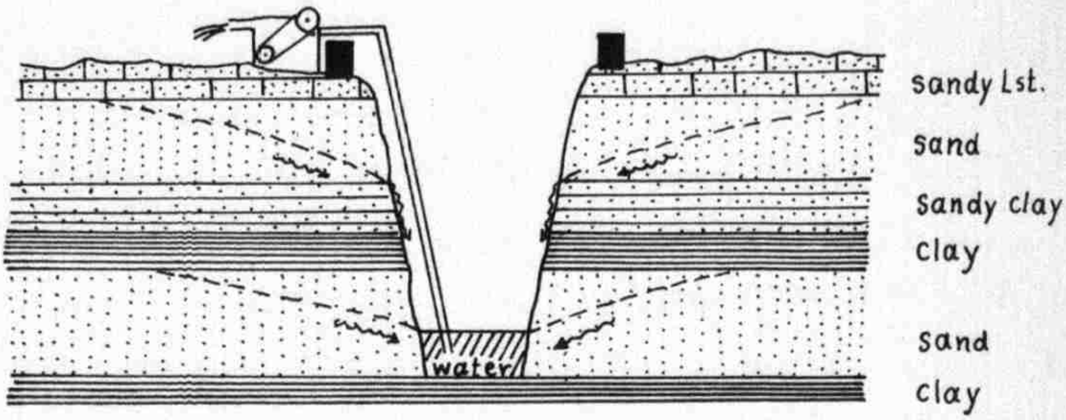


Fig. 9 A _ Summer

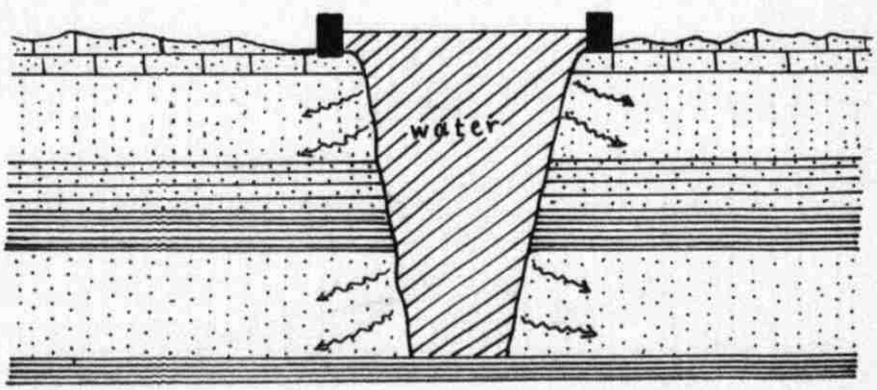


Fig. 9 B _ Winter

A. Welldug in Aptian sands to collect water seeping from the sands.

B. The sand aquifers are recharged through direct filling of the well from rainwater during winter.

Aquifers and Aquicludes in Lebanon

The massive permeable and cavernous limestones of the Jurassic, Middle Cretaceous and Middle Eocene are the main aquifers from which large springs issue. According to Sabbagh (1961) the exposed areas of these limestones are as follows:

| | |
|---|---|
| Jurassic limestones | 1,500 km$^2$ |
| Middle Cretaceous Limestone | 5,200 km$^2$ |
| Middle Eocene Limestone | 200 km$^2$ |
| | 6,900 km$^2$ |

The karstic limestone reservoirs occupy about 3/4 of the area of Lebanon. Several important springs arise from these aquifers like Jeita and Kadisha from Jurassic limestones. Many streams also are supplied from springs arising from Middle Cretaceous limestones, like Fnaideq, Afka and Akoura.

Jurassic Limestones

The Jurassic is composed predominantly of limestones; they are fractured by bedding, and jointing planes which act as channels for the movement of water, and at the same time these channels are enlarged by percolating waters. At the surface the karstic topography favors high infiltration. In the Dahr-el-Baidar area this is manifested by the presence of dolinas.

Lower Cretaceous

The Lower Cretaceous formations are represented by the "Basal Sandstones" and the Aptian; these contain numerous aquifers and aquicludes and give rise to small but numerous springs, plate 14. In Dahr-el-Baidar area, these springs provide water for the apple orchards, and the flocks of goats which graze the area during summer.

Middle Cretaceous

The Middle Cretaceous, represented by Albian, Cenomanian and Turonian massive limestones cover a large area in Lebanon. Large amounts of water from rainfall and thawing snow infiltrate through these limestones due to jointing and fissuring; the presence of marls interbedded in these limestones give rise to many springs at the plane of contact.

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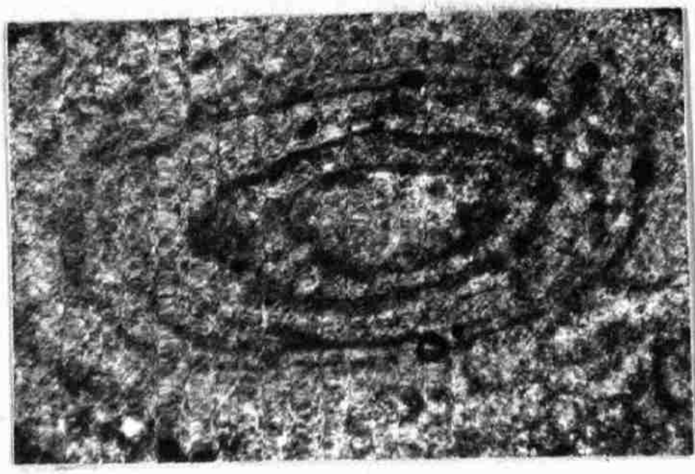


Photo. 1 - Core of a pisolite showing concentric rings, base of lower Aptian, Wadi-ed-delem x525.

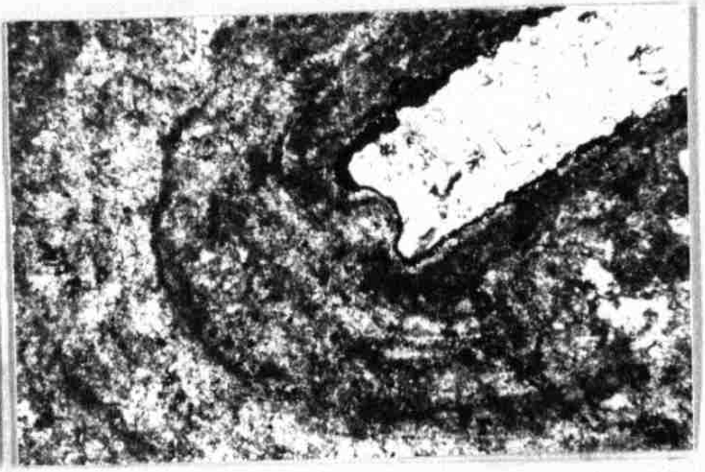


Photo. 2 - Part of a shell fragment showing growth layers around it in a pisolite 5 cm in diameter. lower Aptian, Wadi-ed-Delem. x 25.

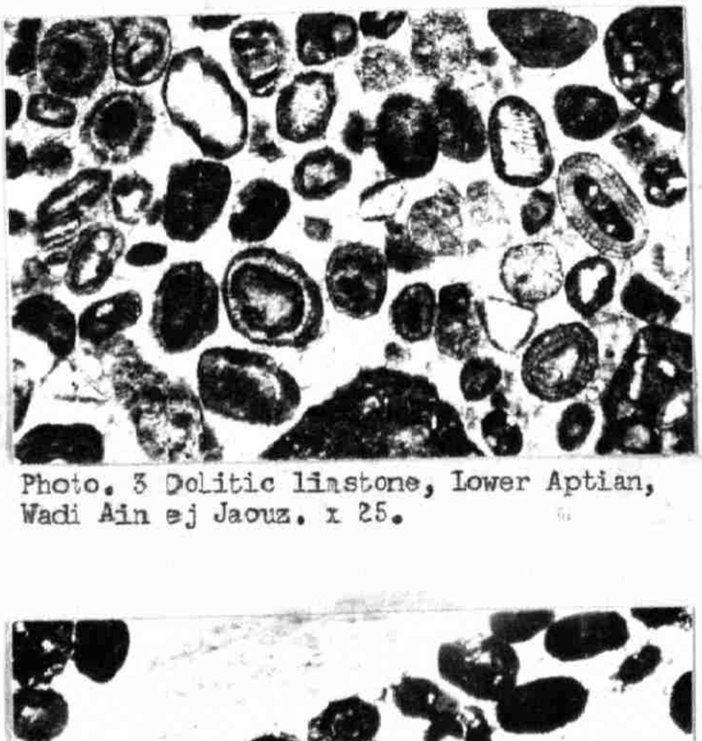


Photo. 3 Oolitic limstone, Lower Aptian, Wadi Ain ej Jaouz. x 25.

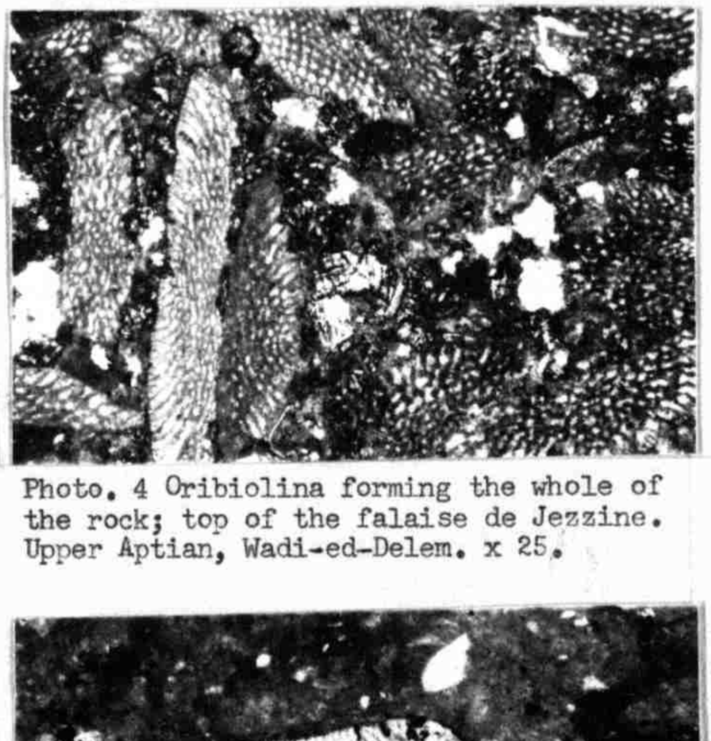


Photo. 4 Oribiolina forming the whole of the rock; top of the falaise de Jezzine. Upper Aptian, Wadi-ed-Delem. x 25.

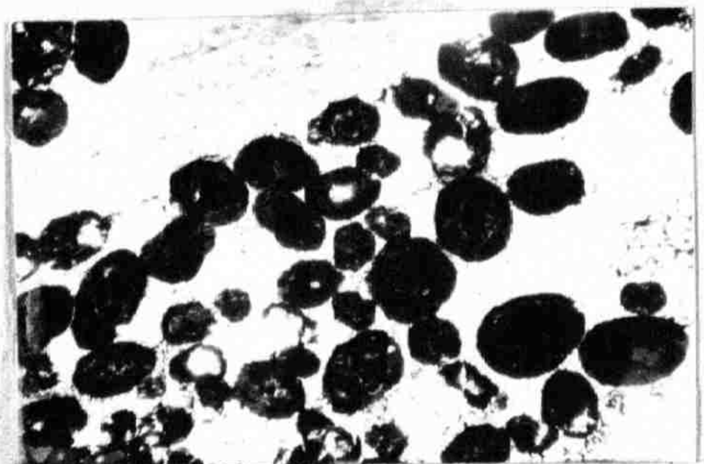


Photo. 5 - Ferruginous oolites in a clay matrix, top of Upper Aptain, Dahr el Baidar col. x 25.

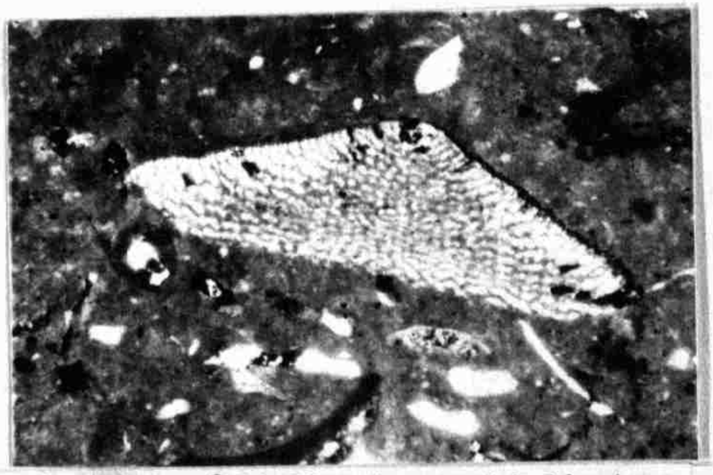


Photo. 6 - Orbtolina in grayish limstone Albian, Mraijat. x 25.

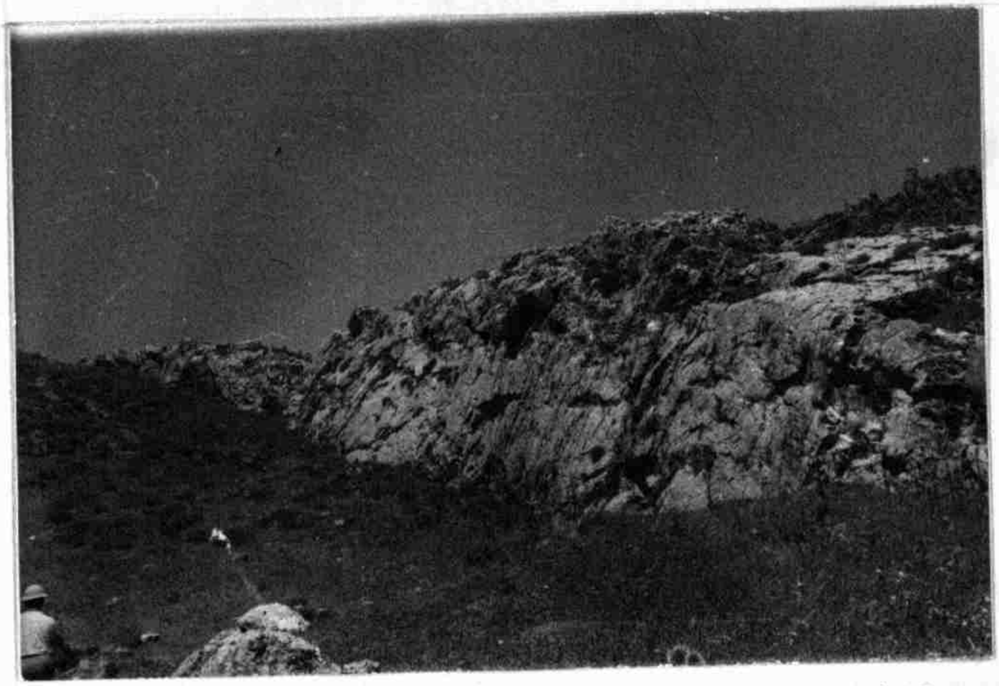


Photo. 7 - Fault Scarp along Wadi-ed-Delem fault with Jurassic limstones forming the foot wall while Basal Cretaceous sandstones represent the hanging wall.

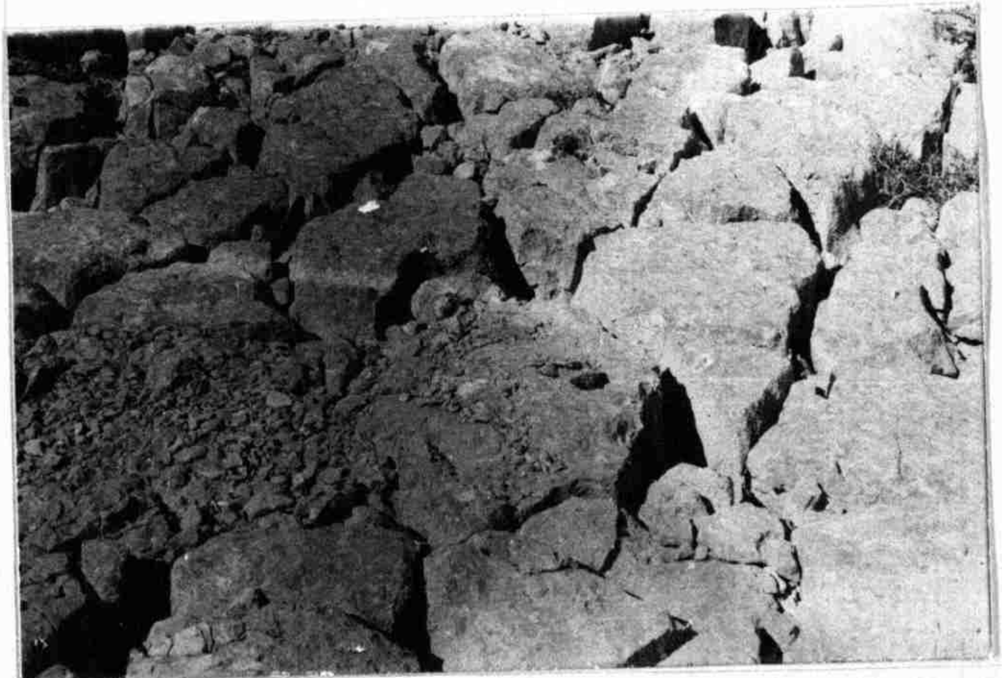


Photo. 8 - Jointing and fracturing of Upper Jurassic limstones in Ain el Marj south of Dahr-el-Baidar col.

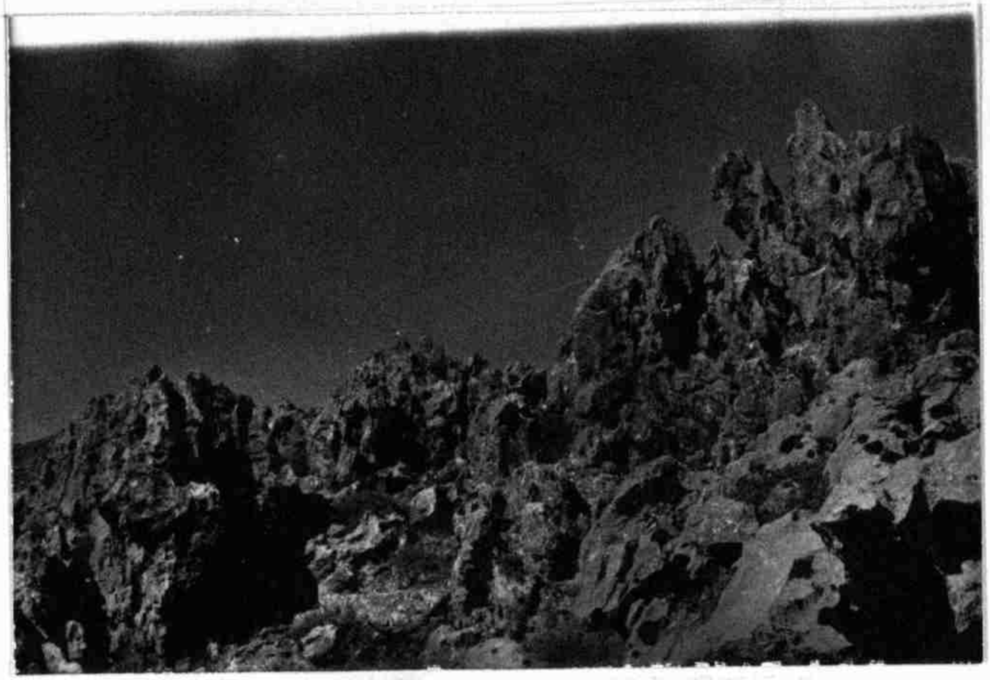


Photo. 9 Badly weathered cavernous limstones of the Upper Jurassic, Wadi-ed-Delem.

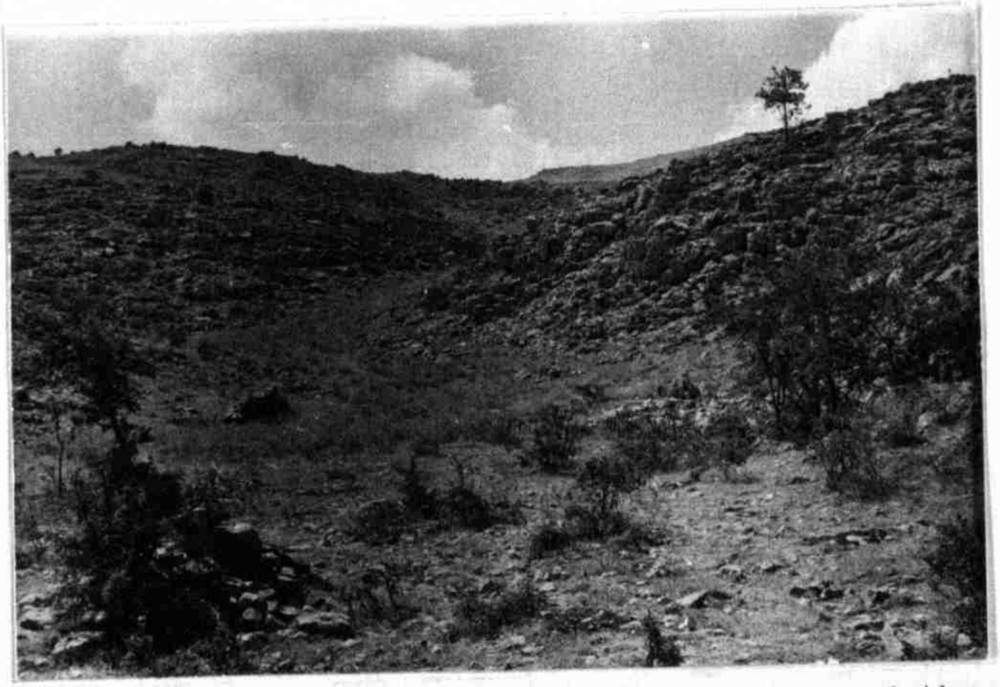


Photo. 10 - A dolina with a poor soil cover and vegetation in karstic limestones of the Upper Jurassic in Ain el Marj.

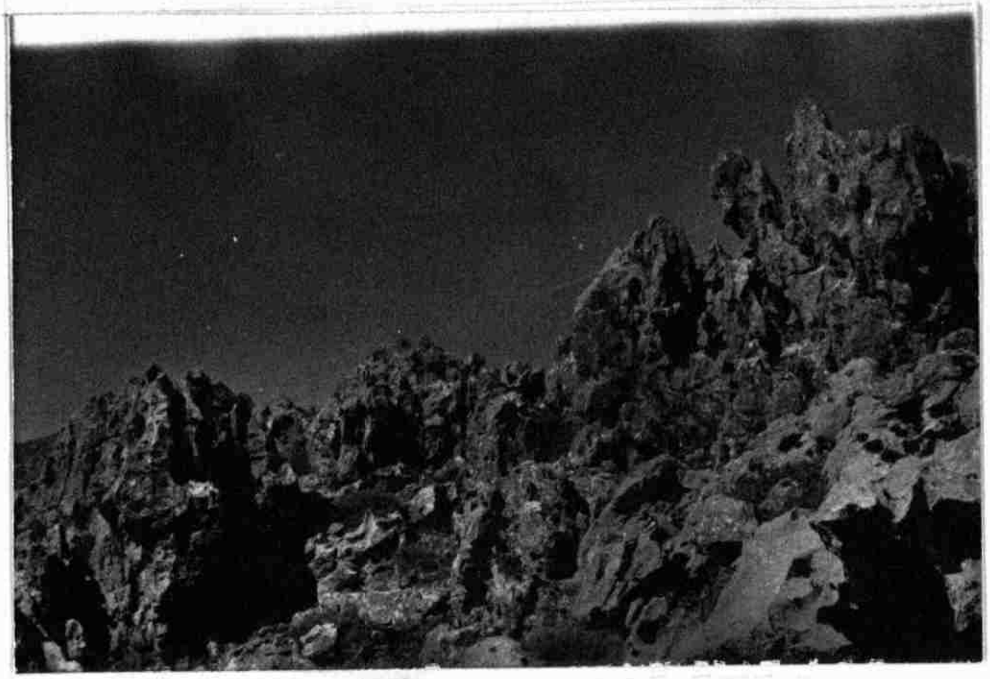


Photo. 9 Badly weathered cavernous limstones of the Upper Jurassic, Wadi-ed-Delem.

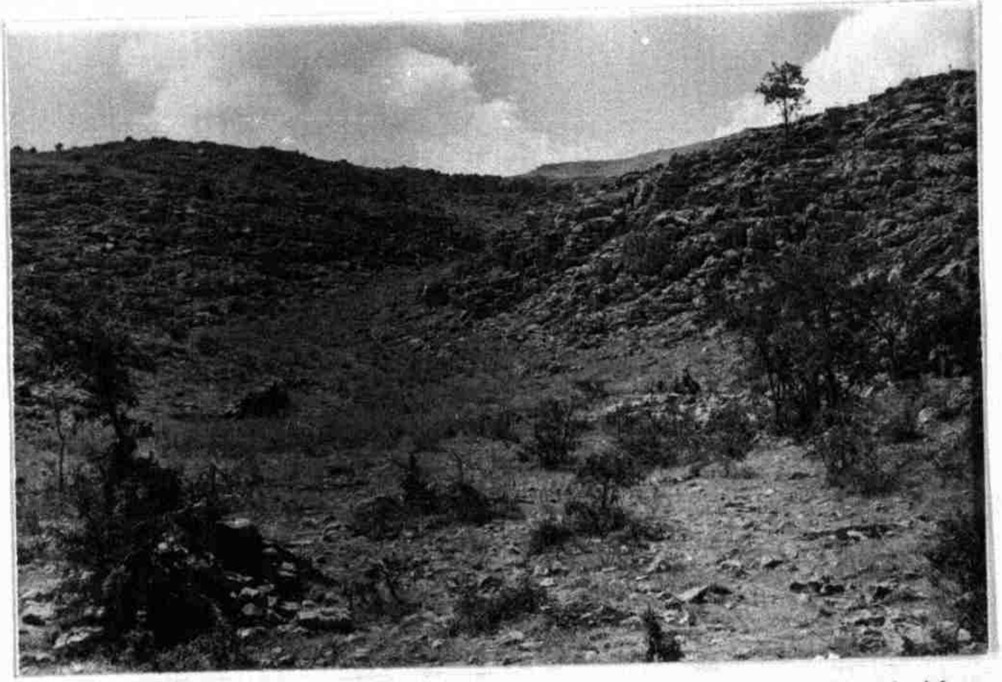


Photo. 10 - A dolina with a poor soil cover and vegetation in karstic limestones of the Upper Jurassic in Ain el Marj.

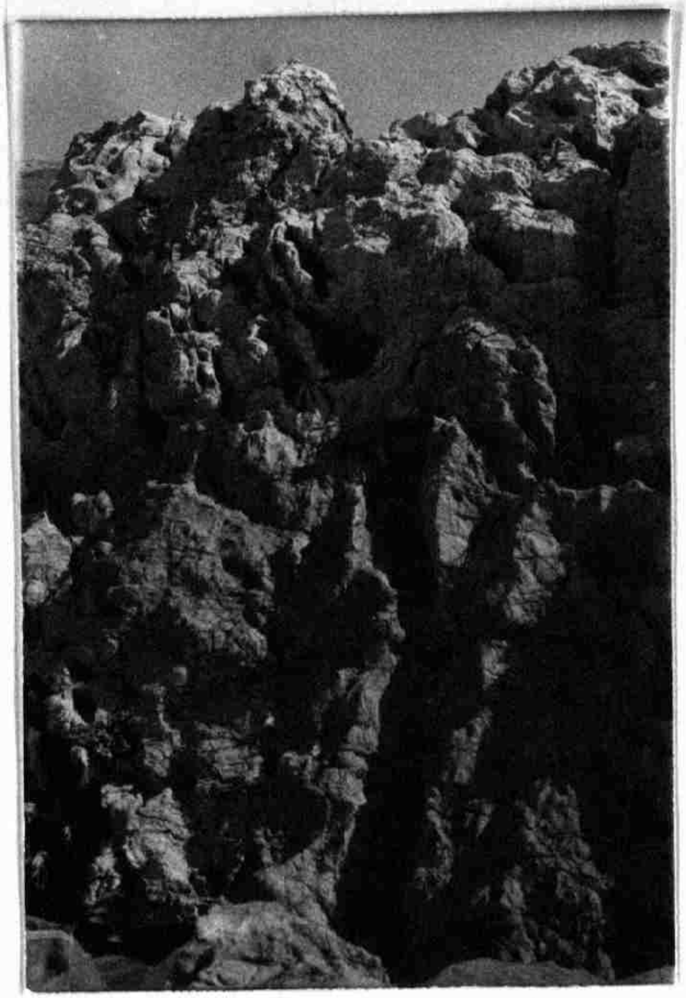


Photo. 11- Massive, cavernous, jointed limestones with numerous calcite veins in the falaise de Jezzine, northern side of Wadi-ed-Delem.

Photo. 12 - Parallel vertical jointing in the massive limestones of the falasie de Jezzine. West of Wadi-ed-Delem.

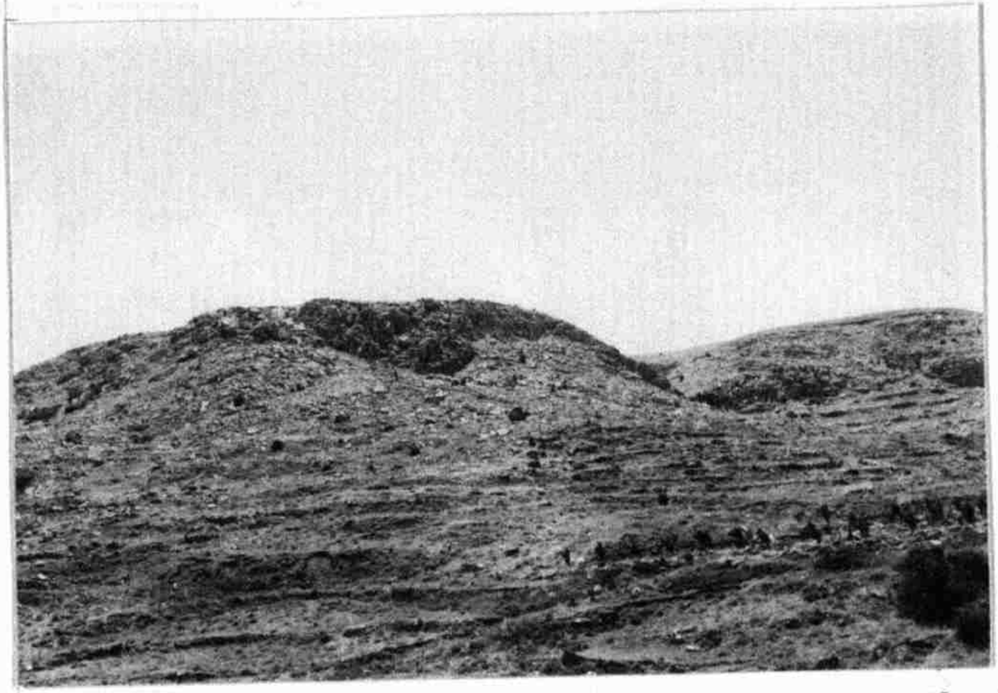


Photo. 13 - Scree and rock fall from the falaise de Jezzine covering part of the cliff and lower Aptian, southern side of Wadi-ad-Delem.

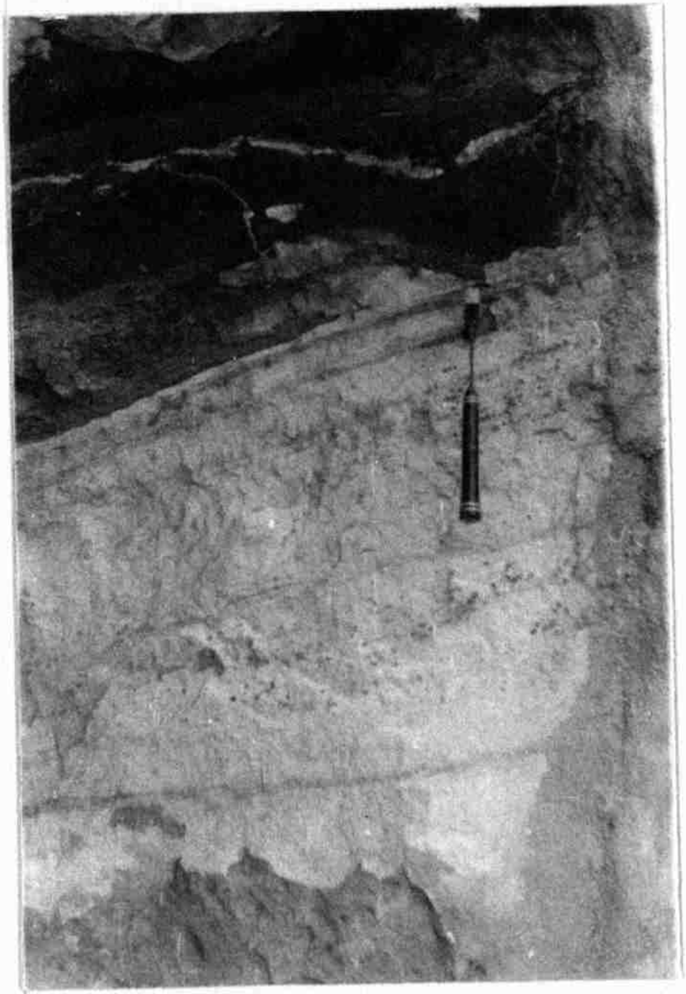


Photo. 14 - Brown red and white sandstones of the Upper Aptian showing grayish thin bands of sands. Dahr-el-Baidar col.

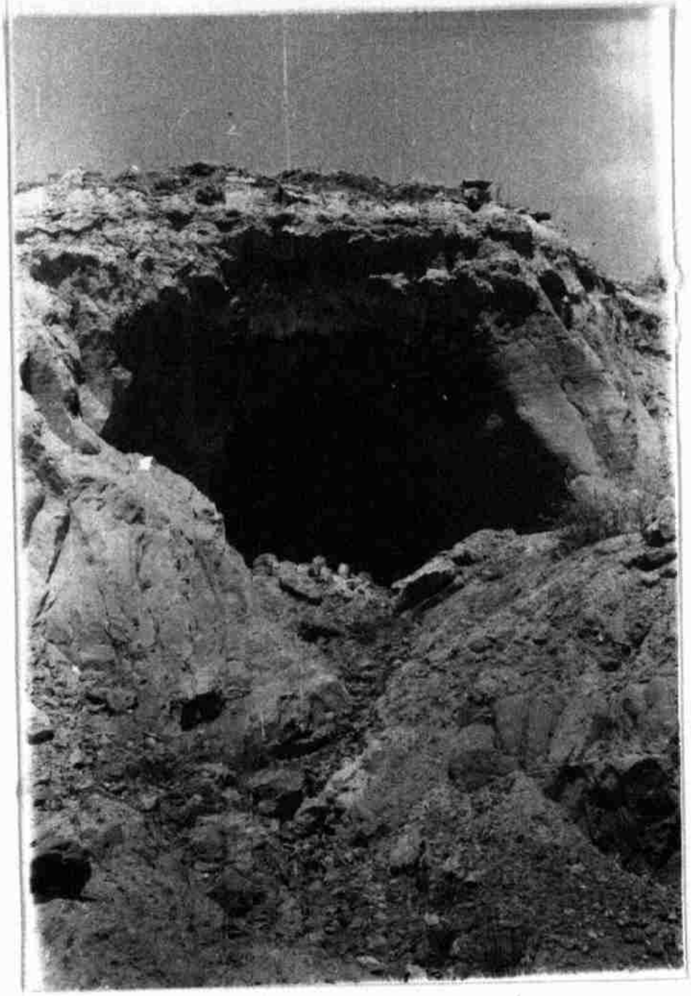


Photo. 15.- Quarrying the Upper Aptian sandstones for use in construction. Dahr-el-Baidar col.

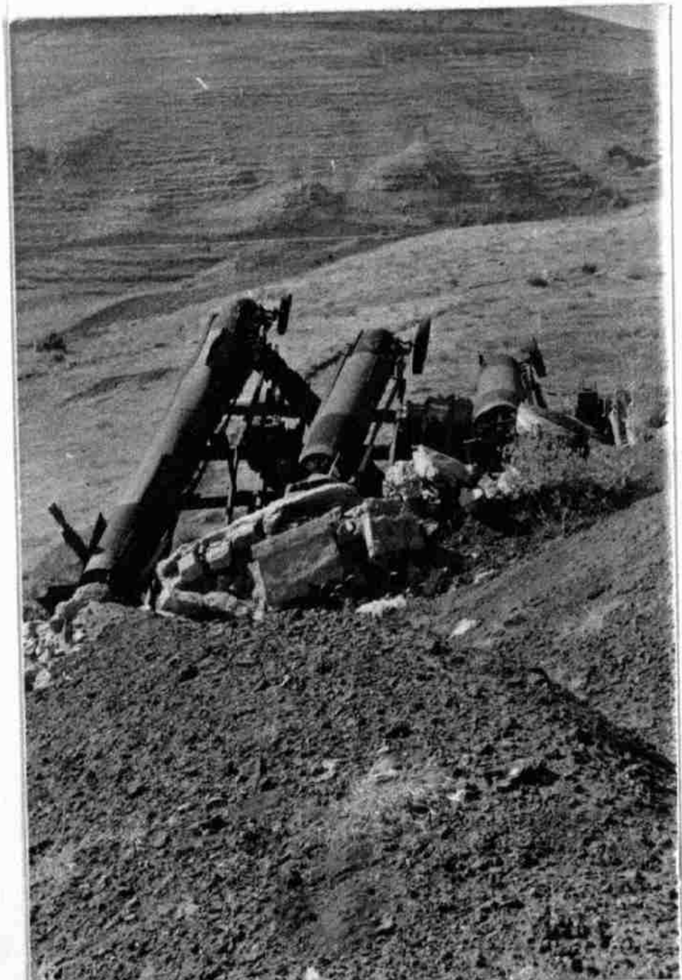


Photo. 16 - In the foreground are the ferruginous oolites of the Upper Aptian which were exloited in 1960, today this is what is left of the project at Dahr Joret Qamar.

Photo. 17 - Ras el Ain Spr ing issuing from the Jurassic limestones in Wadi-ed-Delem.

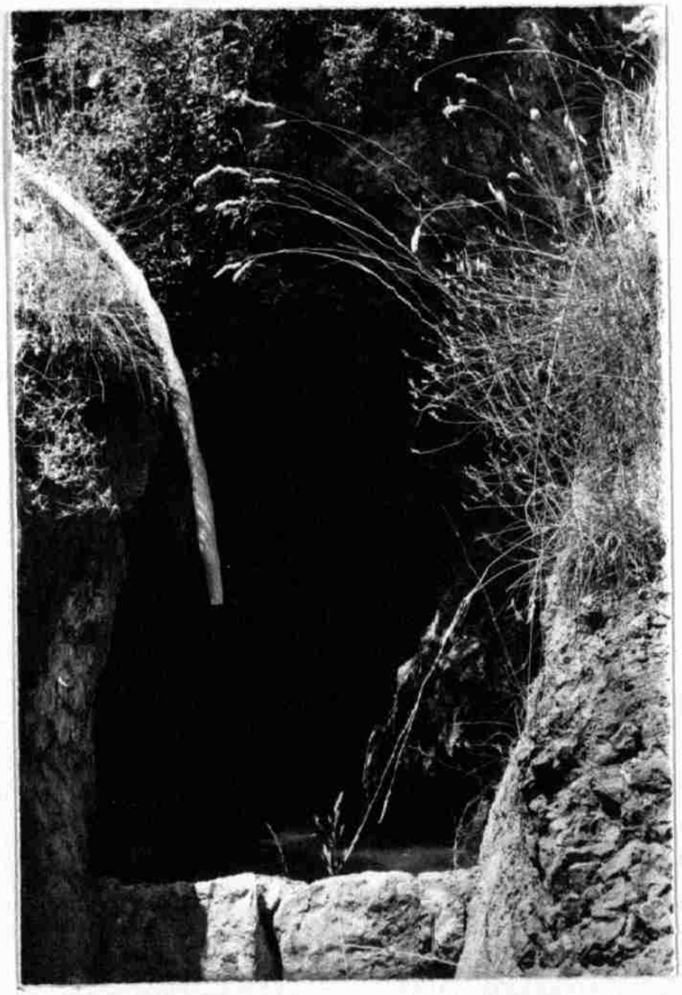
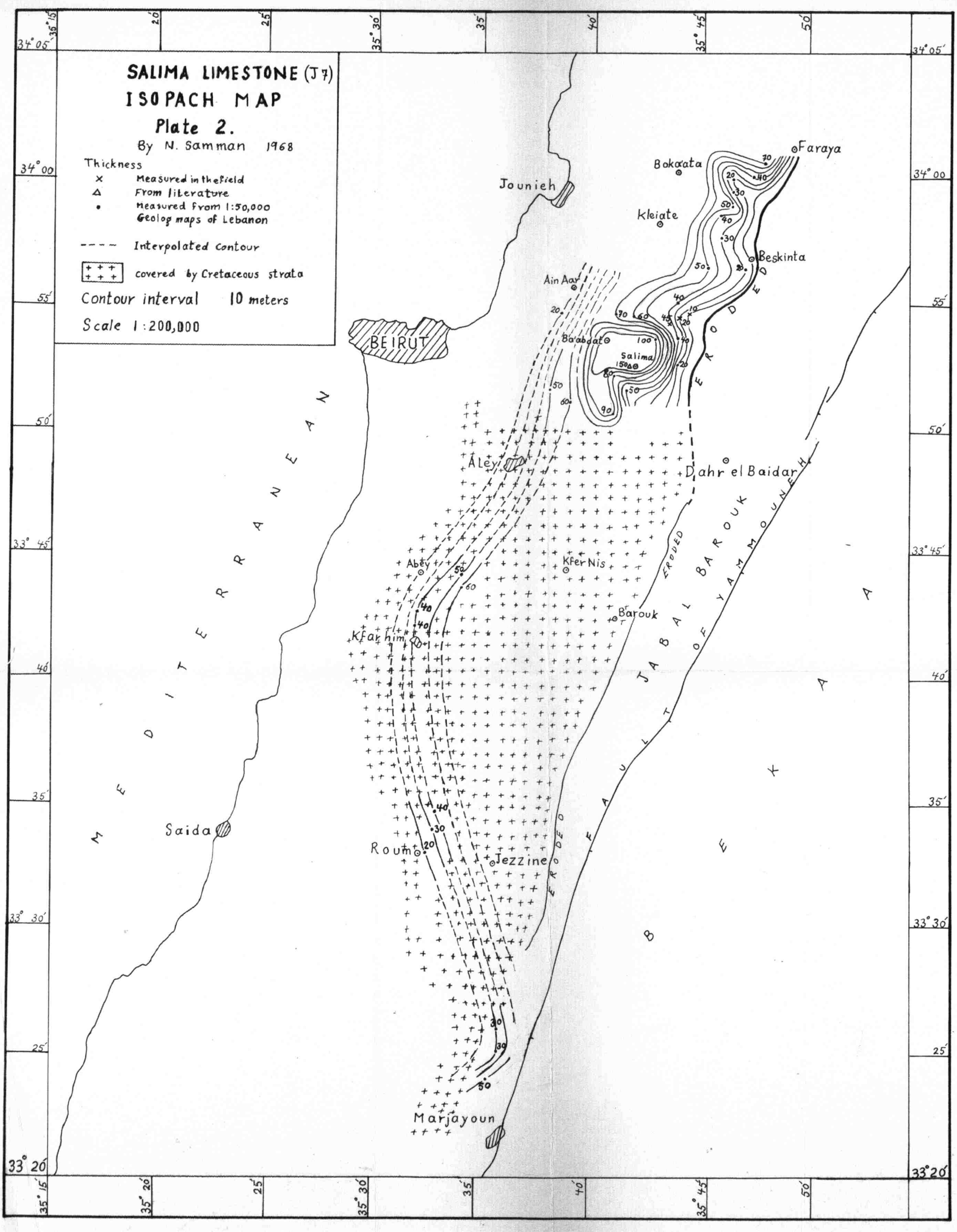


Photo. 18 - Tunnelling in the lower Aptian sandstones to increase the seepage of water in Wadi Ain ej Jaouz.


SALIMA LIMESTONE (J7)
ISOPACH MAP
Plate 2.
By N. Samman 1968
Thickness
× Measured in the field
Δ From literature
• Measured from 1:50,000 Geolog maps of Lebanon
---- Interpolated contour
covered by Cretaceous strata
Contour interval 10 meters
Scale 1:200,000
MEDITERRANEAN
BEIRUT
Jounieh
Bokaata
Faraya
Kleiate
Beskinta
Ain Aar
Ba'abdat
Salima
ERODED
Aley
Dahr el Baidar
JABAL BAROUK
FAULT OF YAMMOUNEH
Abey
Kfer Nis
Barouk
Kfarhim
BEKAA
Saida
Roum
Jezzine
Marjayoun
34° 05′
34° 00′
55′
50′
33° 45′
40′
35′
33° 30′
25′
33° 20′
35° 15′
20′
25′
35° 30′
35′
40′
35° 45′
50′

STRATIGRAPHIC SECTION

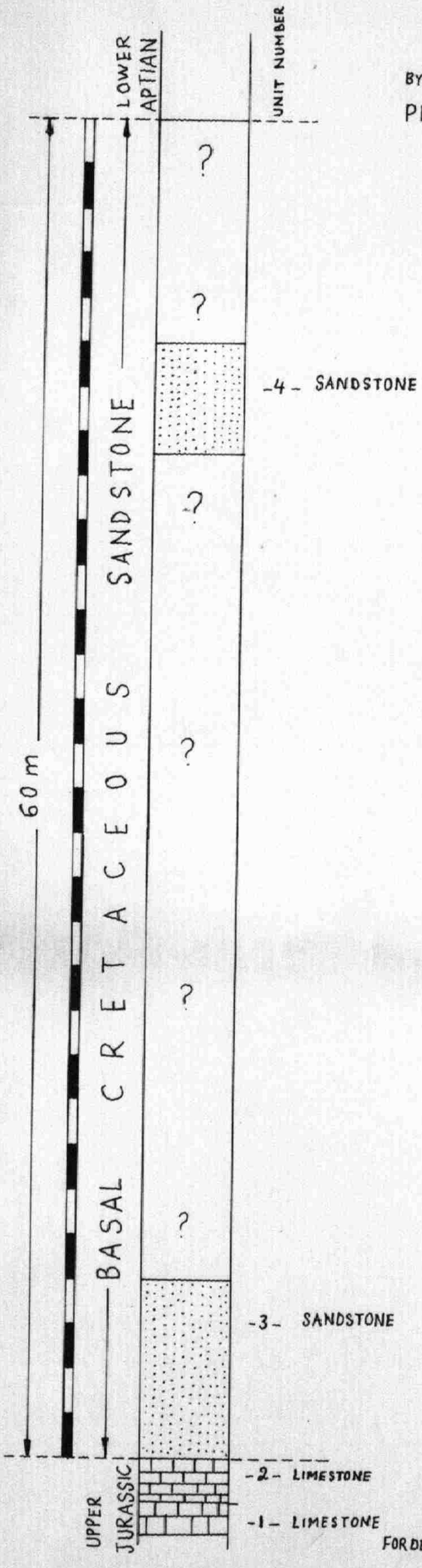
BASAL CRETACEOUS SANDSTONE – DAHR EL BAIDAR AREA

WADI ED DELEM

LOCALITY 1

BY N. SAMMAN

PLATE. 3




FOR DETAILED DESCRIPTION REFER TO STRATIGRAPHY

Scale, 1:200

STRATIGRAPHIC SECTION

LOWER APTIAN - DAHR EL BAIDAR AREA

WADI ED DELEM

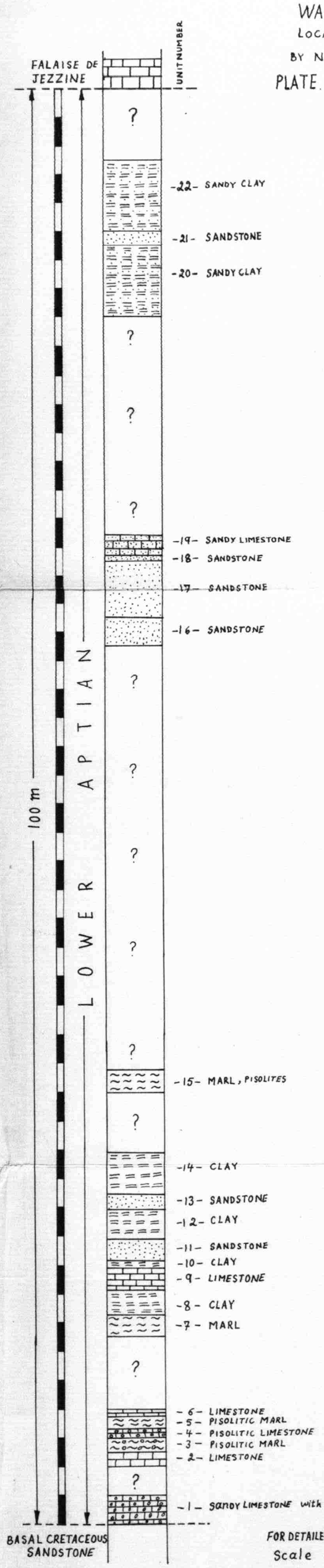
LOCALITY 2A, 2B

BY N. SAMMAN

PLATE 4

2A 20 - 22

2B 1 - 19




FOR DETAILED DESCRIPTION REFER TO STRATIGRAPHY

Scale 1:200

STRATIGRAPHIC SECTION

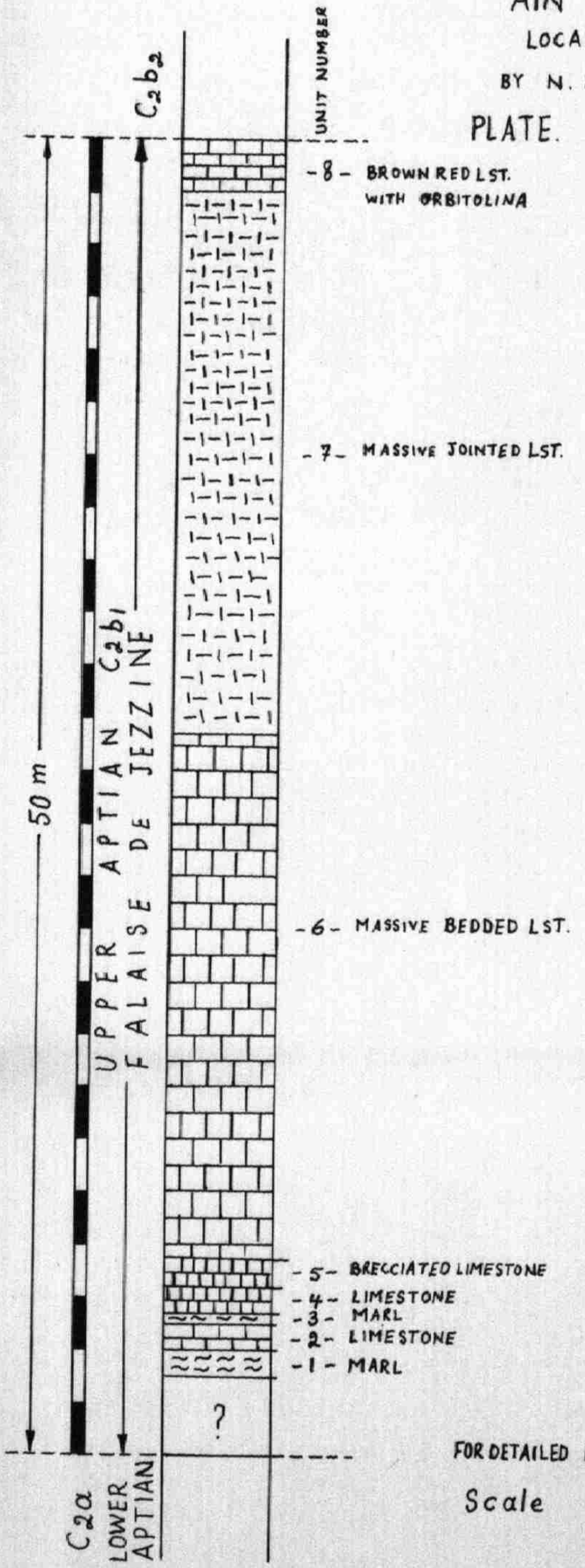
FALAISE DE JEZZINE - DAHR ELBAIDAR AREA

AIN ECH CHEIKH

LOCALITY 3

BY N. SAMMAN

PLATE. 5




FOR DETAILED DESCRIPTION REFER TO STRATIGRAPHY

Scale 1:200

STRATIGRAPHIC SECTION

UPPER APTIAN - DAHR EL BAIDAR AREA

DAHR AL BAIDAR COL

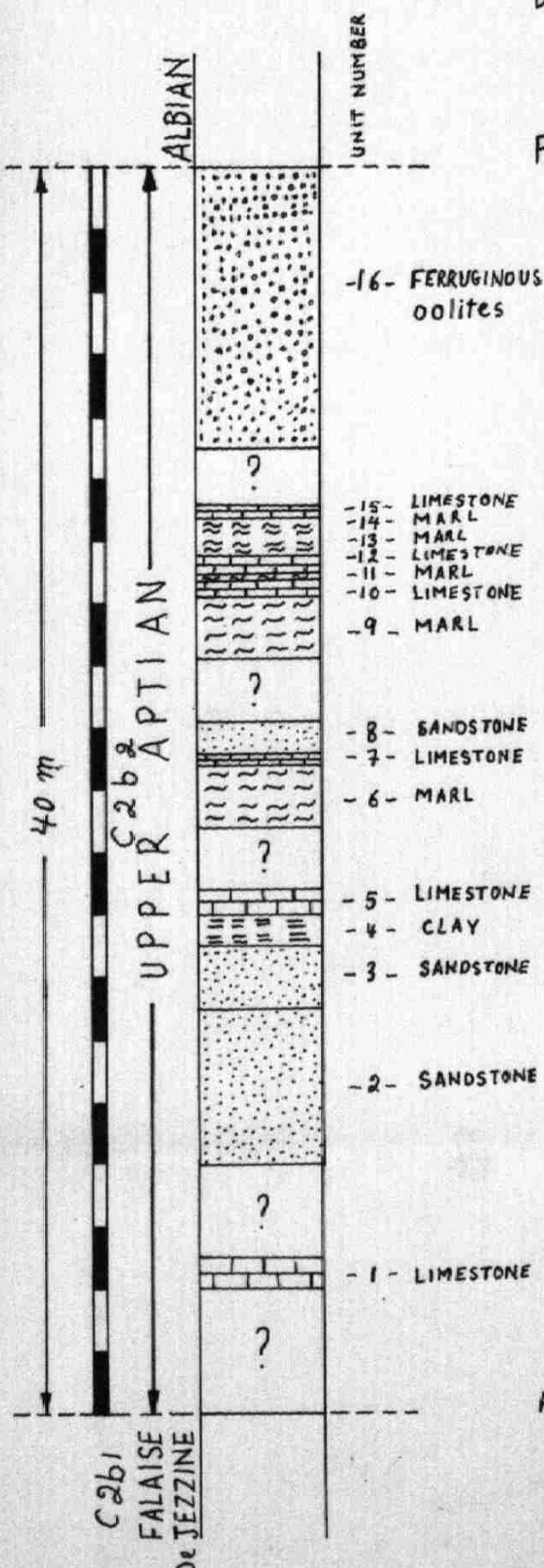
LOCALITY 4 A, 4 B

BY N. SAMMAN

PLATE 6.

4 A, 6 - 16

4 B, 1 - 5




FOR DETAILED DESCRIPTION REFER TO STRATIGRAPHY

Scale 1:200

# STRATIGRAPHIC SECTION

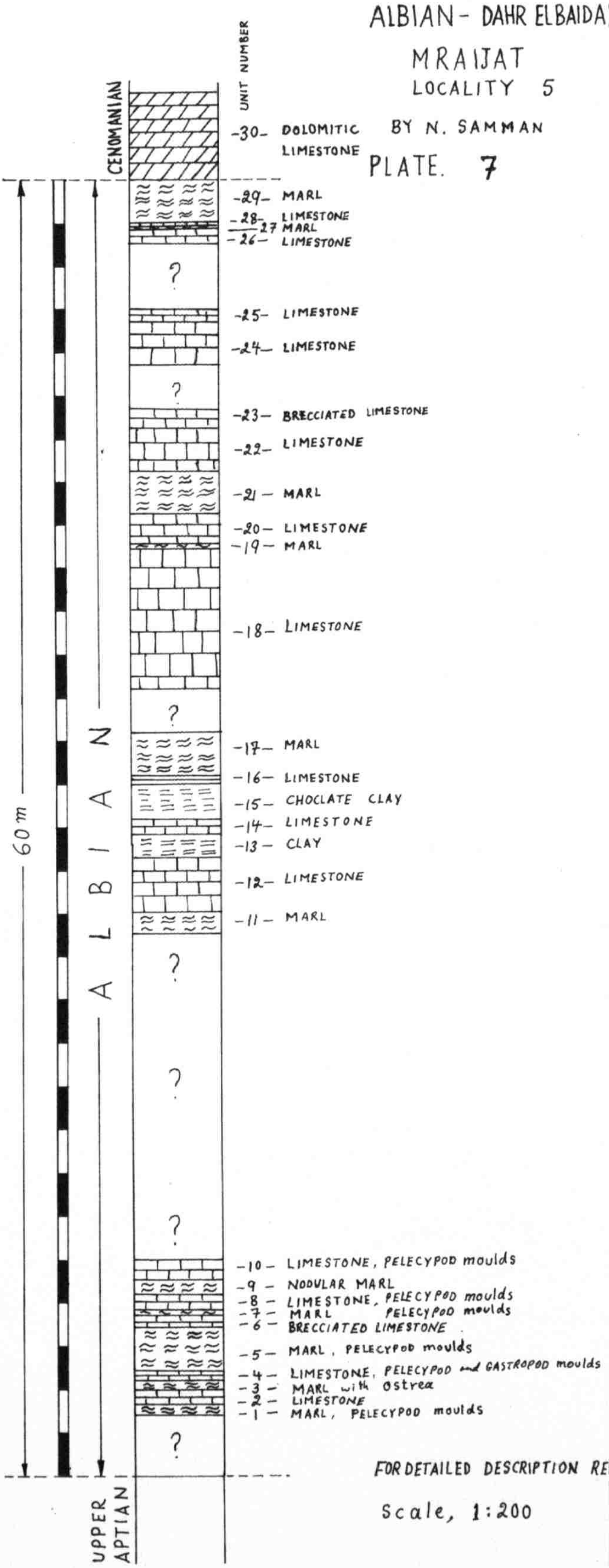
## ALBIAN - DAHR ELBAIDAR AREA

### MRAIJAT

LOCALITY 5

BY N. SAMMAN

PLATE. 7




FOR DETAILED DESCRIPTION REFER TO STRATIGRAPHY

Scale, 1:200

Plate 9

# GEOLOGICAL MAP OF DAHR EL BAIDAR AREA

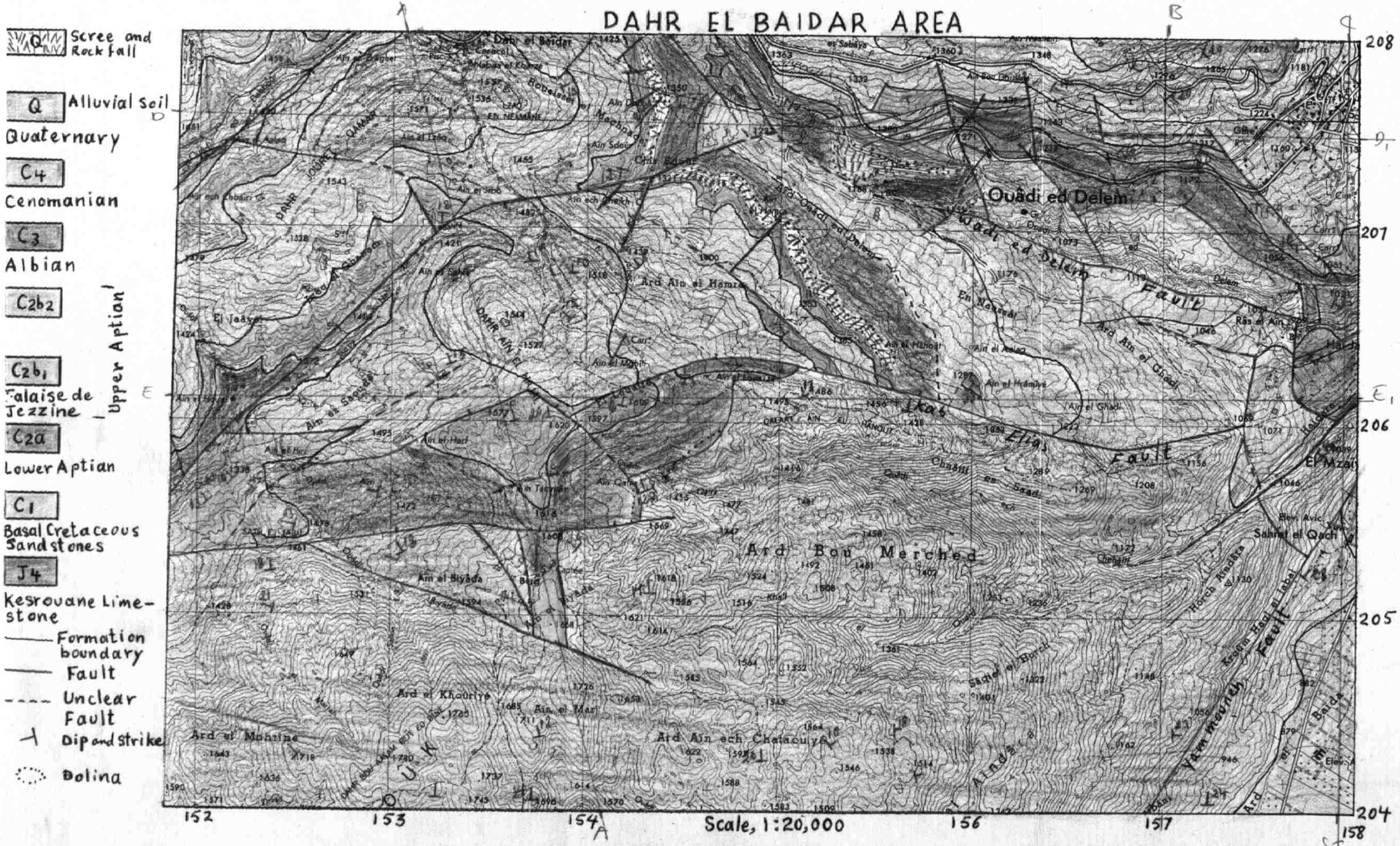


Plate 13

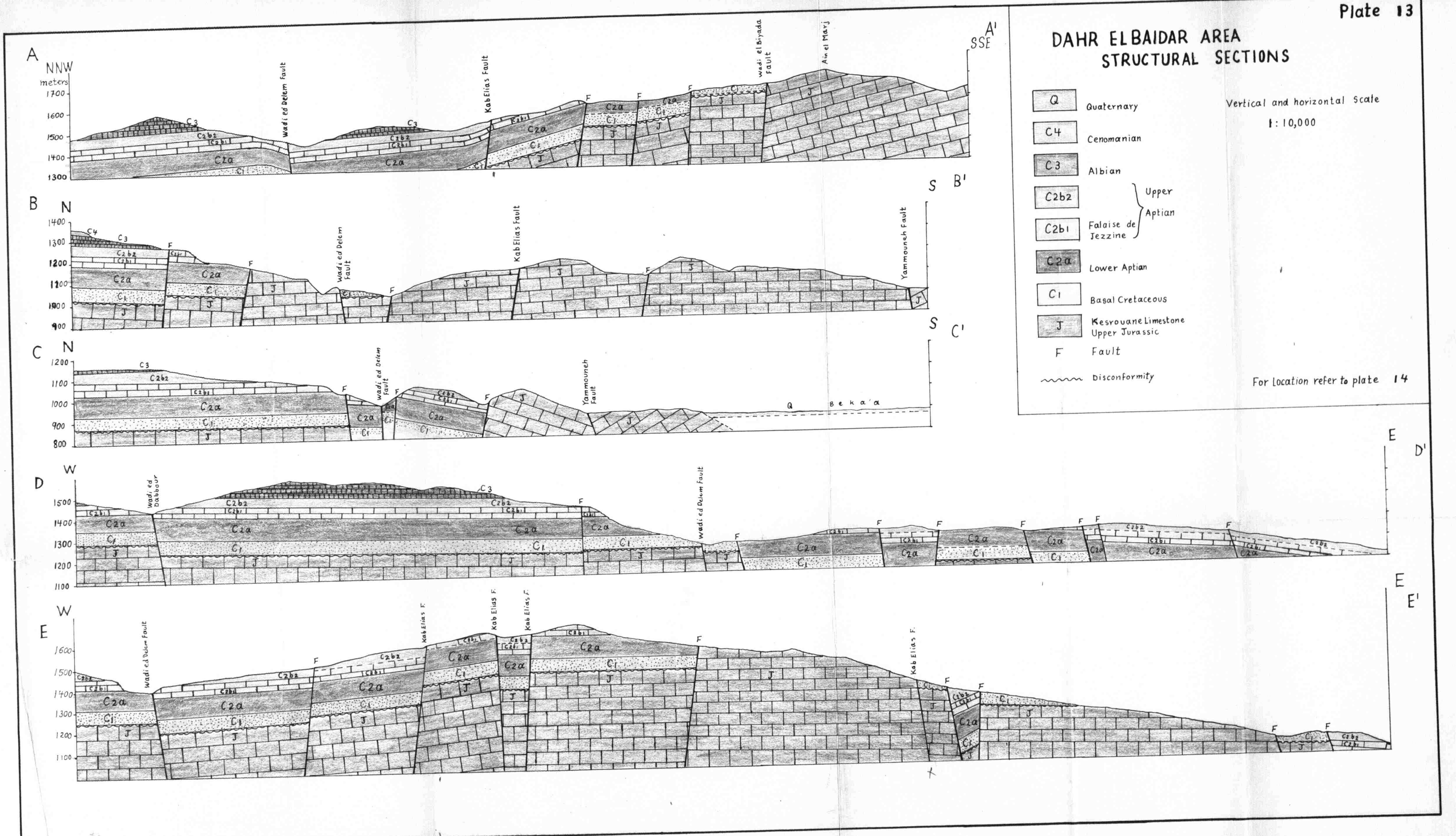
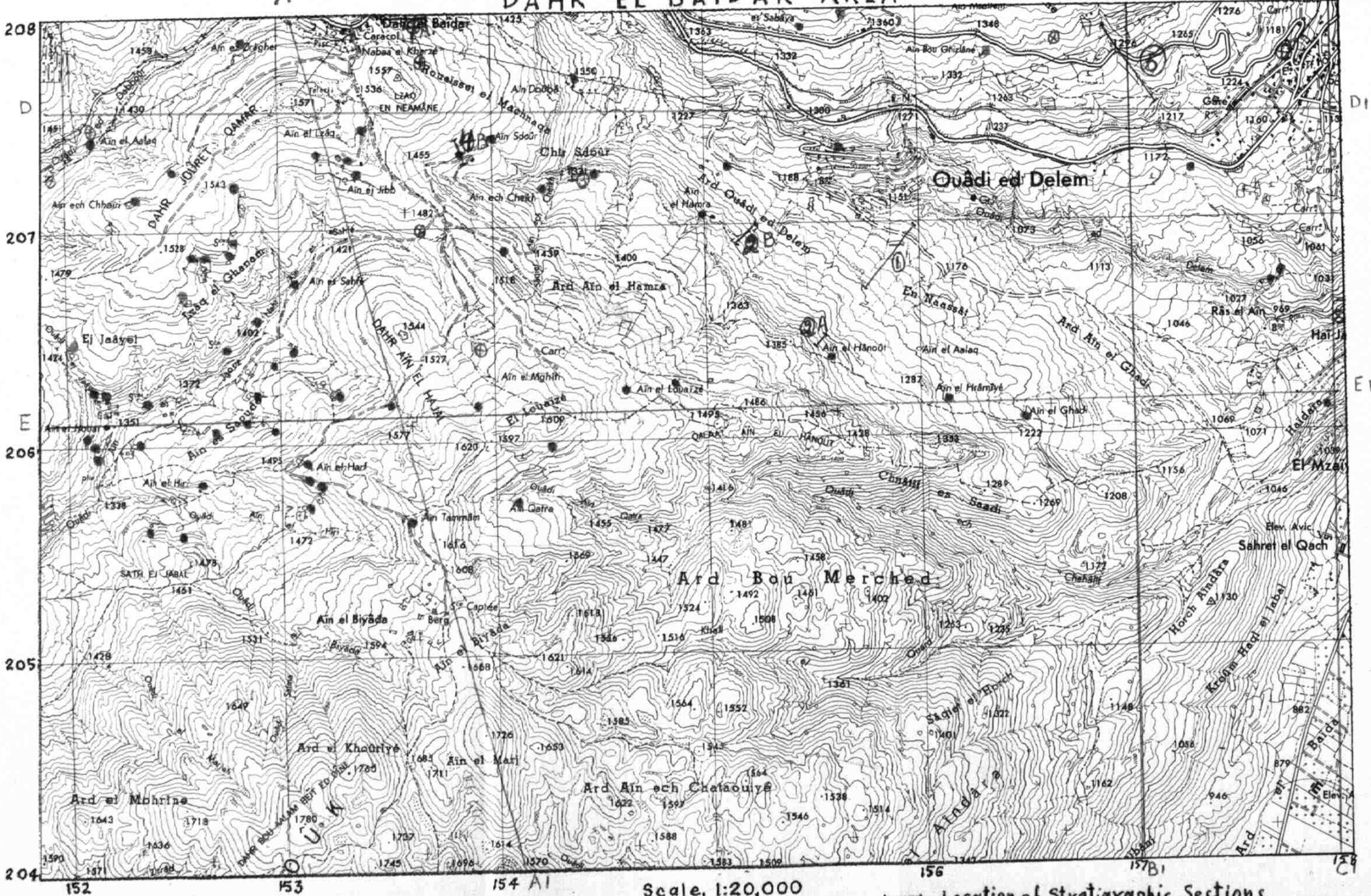

DAHR ELBAIDAR AREA
STRUCTURAL SECTIONS
Vertical and horizontal Scale
1:10,000
Q Quaternary
C4 Cenomanian
C3 Albian
C2b2 Upper Aptian
C2b1 Falaise de Jezzine
C2a Lower Aptian
C1 Basal Cretaceous
J Kesrouane Limestone Upper Jurassic
F Fault
Disconformity
For location refer to plate 14
A NNW
A' SSE
meters
Wadi ed Delem Fault
Kab Elias Fault
Wadi el Biyada Fault
Ain el Marj
B N
B' S
Yammouneh Fault
C N
C' S
Beka'a
D W
D' E
Wadi ed Dabbour
E W
E' E
Kab Elias F.

Plate 14

# INDEX MAP OF DAHR EL BAIDAR AREA




Scale, 1:20,000

- ● Springs
- ⊗ Fossil Localities
- Location of Stratigraphic Sections
- Location of Structural sections