9

The Jurassic in Syria: an overview. Lithostratigraphic and biostratigraphic correlations with adjacent areas

Mikhail MOUTY

Department of Geology, Damascus University, Damascus, Syria

ABSTRACT

The carbonated Jurassic sediments in Syria and the adjacent areas are generally dominated by limestones, dolomitic limestones and restricted marly intercalations, precipitated in shallow marine environments. Since the Jurassic marine onset, transgressions covered the entire region of Syria with the exception of two NE-SW elongated uplifts in the E-SE (Hamad Uplift) and in the N-NE of the country (Aleppo-Mardin High). Before the end of the Middle Jurassic (early Bathonian), the sea regressed from the interior of Syria northwards, moving the Tethyan Ocean shore line westward to the Levantine zone. There, subsidence continued and the Jurassic sediments are locally thicker than 1300 m (Mount Hermon, Galilee). Before the end of the Upper Jurassic (late Kimmeridgian), the sea further regressed from the last submerged areas. Consequently, the entire Syrian platform remained emerged until the Cretaceous transgression initiated in the Barremian-Aptian time. As elsewhere in the Levant, volcanic activity characterises locally the beginning and the end of the Jurassic serie in Syria.

RÉSUMÉ

Le Jurassique de Syrie : une vue d'ensemble. Corrélations lithostratigraphiques et biostratigraphiques avec les régions avoisinantes.

Les sédiments carbonatés du Jurassique de Syrie et des régions adjacentes sont généralement dominés par des calcaires, des calcaires dolomitiques et de façon moindre par des intercalations de marnes, déposés dans des environnements marins peu profonds. Depuis le début du régime marin au Jurassique, les transgressions couvrent l'ensemble de la Syrie à l'exception de deux zones surélevées allongées, de direction NE-SW, dans l'est-sud est (zone surélevée de Hamad) et dans le nord-nord est du pays (zone surélevée d'Aleppo-Mardin). Avant la fin du Jurassique moyen (Bathonien inférieur), la mer régresse de l'intérieur de la Syrie vers le nord, déplaçant la ligne de rivage de la Téthys vers l'Ouest, vers la zone Levantine. Là, la subsidence continue et les sédiments jurassiques, localement, ont une épaisseur supérieure à 1300 m (Mont Hermon, Galilée). Avant la fin du Jurassique supérieur (Kimméridgien supérieur), la mer se retire des dernières zones submergées. En conséquence, la totalité de la plate-forme syrienne reste émergée jusqu'à la transgression du Crétacé, débutant au Barrémien-Aptien. Comme ailleurs dans le Levant, l'activité volcanique caractérise localement le début et la fin du Jurassique.

MOUTY, M., 2000.— The Jurassic in Syria: an overview. Lithostratigraphic and biostratigraphic correlations with adjacent areas. *In*: S. CRASQUIN-SOLEAU & É. BARRIER (eds), Peri-Tethys Memoir 5: New data on Peri-Tethyan sedimentary basins. *Mém. Mus. natn. Hist. nat.*, **182** : 159-168. Paris ISBN : 2-85653-524-0.

PDF created with pdfFactory trial version www.pdffactory.com

INTRODUCTION

Jurassic strata crop out in the main chains in Syria: the Anti-Lebanon Chain, the Coastal Chain (Jibal As-Sahilyeh), the Kurd Dagh Chain and the Palmyrides Chain (Fig. 1). A large number of boreholes penetrating the Jurassic in different areas, and the sections measured in the Jurassic outcrops give an important insight on its development in Syria.

The earliest works on the Jurassic of Syria date from the 19th century (LARTET, 1869; FRAAS, 1877; NOETLING, 1887). Several important studies have described the Jurassic sequences in Syria (VAUTRIN, 1934; DUBERTRET, 1949-1975; PONIKAROV, 1966; MOUTY, 1976, 1978).

The recent lithological and palaeontological studies conducted on several formations, units and biozones within the Jurassic series (MOUTY, 1997a, b; FOURCADE & MOUTY, 1995; FOURCADE *et al.*, 1997) gave precise correlations between different Jurassic sections in Syria and in the neighbouring countries, allowing an accurate palaeogeographic reconstruction of the Syrian platform during the Jurassic.

The aim of the present paper is to correlate Jurassic formations in Syria and other neighbouring countries on lithological and palaeontological basis.

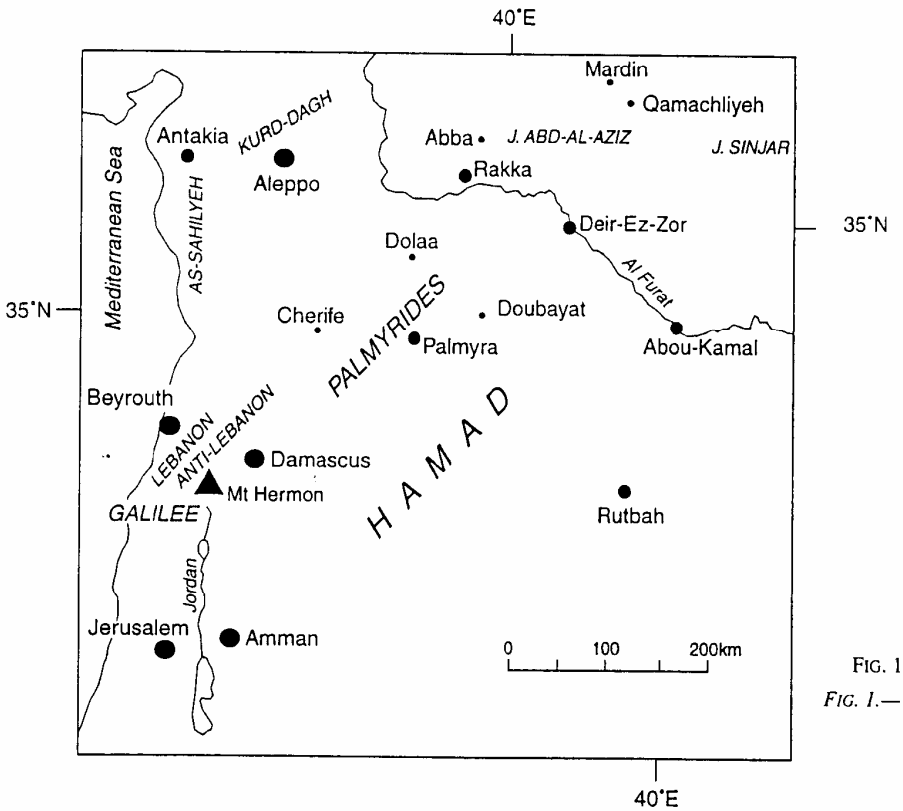


FIG. 1.— Location map.

FIG. 1.— Carte de localisation.

PDF created with pdfFactory trial version www.pdffactory.com

STRATIGRAPHY (Fig. 2)

EARLY JURASSIC (LIASSIC)

The Early Jurassic in Mount Hermon (Anti-Lebanon) is represented by the Aarne Formation (MOUTY, work in progress). It is essentially composed of numerous thin beds of multicoloured (black, yellow,...) argillaceous marls with thin beds of limestones which predominate in the upper part of the formation. A 50 m thick volcanic layer (spilite) is interbedded within this formation. Some limestone beds in the upper part of the formation contain *Pseudocyclammina liasica* Hottinger Foraminifera which is characteristic of the late Liassic (Pliensbachian-Toarcian).

The thickness of this formation in the type section (Mount Hermon) reaches 150 m. It overlies intercalations of black argillaceous marls and black thin bedded limestones (Rime Formation, DUBERTRET, 1960) with *Aulotortus sinuosus* (Weynschenk) which characterises the Late Triassic (Norian-Rhaetian).

The Aarne Formation is correlated in Lebanon with the lower part of "niveau 2" of Wadi Nahr Ibrahim (RENOUARD, 1951) which is composed of limestones, dolomitic limestones with rare marl intercalations and overlies a 300 m thick of dolomites and dolomitic limestones ("niveau 1") with probable Triassic Nodosaridae (NOUJEIM-CLARK & MOUTY, work in progress).

The Early Jurassic in the Palmyrides Chain is represented by the lower part (Unit A) of Satih Formation (MOUTY, 1997a), which is composed of thin beds of limestones and dolomitic limestones with some marl intercalations containing Liassic Foraminifera (*Mayncina termieri* Hottinger) in its upper part.

In the boreholes drilled in central, north and northeast Syria, the Early Jurassic is represented by limestones in the upper part of the Dolaa Group (DUBERTRET & DANIEL, 1962, according to DUBERTET, 1963).

The Early Jurassic in the Coastal Chain (Jibal As-Sahilyeh) is represented by Treize Formation (MOUTY, 1997b) which is composed of thin beds of light yellow marls, marly limestones and limestones. Fossils found in this formation are Brachiopoda, *Liospiriferina undulata* (Seguenza), and Foraminifera, *Pseudocyclammina liasica* Hottinger which indicate a Pliensbachian-Toarcian age. The thickness of this formation in its type locality reaches 40 meters. It underlies a thick serie of dolomites and dolomitic limestones (200-300 m) with Late Triassic Foraminifera: (*Galeanelia* aff. *laticarinata* Al Shaibani, *Gsollbergella spiriloculiformis* (Oroveczne-Scbeffer).

In the Kurd Dagh Chain, the Early Jurassic is represented by thick beds of micritic and pelbiomicritic limestones (the lower part of the Dodo Formation: "*Lithiotis* Limestone") (MOUTY, work in progress), with big, undulated and plated Pelecypoda: *Lithiotis* sp., which characterises the basal beds of the Jurassic in Iran (KENT *et al.*, 1951).

The numerous boreholes, which penetrated the Jurassic series, are located in the interior of Syria. The Early Jurassic encountered in these boreholes is undifferentiated in the upper part of Dolaa Group (DUBERTRET & DANIEL, 1962, according to DUBERTRET, 1963), and consisting in limestones underlying evaporates with some intercalations of thin beds of marls and marly limestones containing Late Triassic microfossils (BASH IMAM & SIGAL, 1985).

In this respect, it is very important to mention that the entire Jurassic serie is missing on the Aleppo-Mardin High (PONIKAROV, 1966; KAMMAR, 1994) and on the Hamad Uplift (MOUTY & AL MALEH, 1983; MOUTY, 1997a).

The Early Jurassic formations or units in Syria are correlated with the Ubaid Formation (DUNNINGTON, 1954, according to DUBERTRET, 1959) in west Iraq (Rutbah area) which is composed of limestones, dolomitic limestones and rare marl intercalations containing Liassic Foraminifera (DUNNINGTON, 1954 cited *in* DUBERTRET, 1959). They are correlated, in the northwestern Iraq, with the

PDF created with pdfFactory trial version www.pdffactory.com

lower part of the Sargelu Formation which is composed in its type locality of "thin bedded black, bituminous limestones, and black laminated shales" containing Liassic fauna at the base (BELLEN cited *in* DUBERTRET, 1959). They are also correlative with the upper part of the "Grès à plantes de Subeihi" (WETZEL & MORTON, 1959) in the northwest Jordan (Wadi Nahr Az-Zarqua).

The Early Jurassic volcanic serie, which outcrops in the Mount Hermon, reaches its maximum thickness in the Galilee to the west and southwest where it is represented by Asher volcanic Formation (GARFUNKEL & DERIN, 1985). The dolerite flow in the Abba borehole, 54 km NE by N of Raqqa (DANIEL cited *in* DUBERTRET, 1963) and the volcanic flow in the SE of Turkey (ALTINLI, 1966) are about of the same age.

<table>
<tr><td>Locality / Age</td><td>Galilee</td><td>Hermon</td><td>Lebanon</td><td>Coastal Chain J. As Sahilyeh</td><td>Kurd Dagh</td><td>Palmyrides</td><td>West Iraq</td><td>Jordan</td></tr>
<tr><td>Aptian - Cenomanian</td><td>Tayasir</td><td>Grès de base</td><td>Grès de base</td><td>Bab Janneh</td><td>Grès de base</td><td>Palmyra</td><td>Rutbah</td><td>Hathira</td></tr>
<tr><td>Tithonian</td><td>absent</td><td>absent</td><td>absent</td><td>absent</td><td rowspan="4">absent</td><td rowspan="4">absent</td><td rowspan="4">absent</td><td rowspan="4">absent</td></tr>
<tr><td>Kimmeridgian</td><td rowspan="2">Haifa Bay</td><td>Batroun</td><td>Salima</td><td rowspan="2">Nasirah</td></tr>
<tr><td>Oxfordian</td><td>Bloudane</td><td>Bikfaya</td></tr>
<tr><td>Callovian</td><td rowspan="6">Haifa</td><td>Majdal Chams</td><td>Bhanness</td><td>Wadi Al Ouyoun</td></tr>
<tr><td>Bathonian</td><td>Hermon</td><td>Kesrouane</td><td rowspan="2">Machta</td><td rowspan="2">Dodo
Lithotis limestones</td><td>C</td><td rowspan="2">Satih</td><td>C</td><td rowspan="2">Muhaiwir</td><td rowspan="2">Huni</td></tr>
<tr><td>Bajocian</td><td>Bqassem</td><td>niveau 4a
niveau 3</td><td>B</td><td>B</td></tr>
<tr><td>Aalenian</td><td rowspan="2">Kalaat Jandal</td><td rowspan="3">niveau 2</td><td rowspan="2">Ouyoun</td><td rowspan="3">A</td><td rowspan="3">A</td><td rowspan="3">Ubaid</td><td rowspan="3">Subeihi</td></tr>
<tr><td>Toarcian</td><td rowspan="3">Aarne</td></tr>
<tr><td>Pliensbachian</td><td rowspan="2">Asher</td><td rowspan="2">Treize</td></tr>
<tr><td>Lower Triassic</td></tr>
<tr><td>Norian-Rhaetian</td><td>Mohilla</td><td>Rime</td><td>niveau 1</td><td>Jweikhate</td><td>Smalek</td><td>Hayan</td><td>Zor Hauran</td><td>Zarqa</td></tr>
</table>

FIG. 2.— Correlation of the Jurassic formations in Syria and neighbouring countries.

FIG. 2.— Corrélations des formations jurassiques en Syrie et dans les régions avoisinantes.

MIDDLE JURASSIC (DOGGER)

The Middle Jurassic is the thickest serie of this stage in Syria. It is represented by many formations and units, especially along the coasts of the Eastern Mediterranean, from the Coastal Chains in Syria, all the way down to northern Sinai (Egypt).

The Kalaat Jandal Formation in the Mount Hermon was first defined by DUBERTRET (1960), as "Calcaire de Kalaat Jandal". It was modified recently (MOUTY, work in progress) by the separation of its lower part (Aarne Formation), due to the fact that it is lithologically different. It is essentially composed, in its type section, of medium to thick beds of micritic and pelbiomicritic limestones which are partly dolomitised. Its facies indicates a shallow marine environment of low energy. Its thickness is approximately 400 m.

The formation yields relatively abundant fossils, mainly Foraminifera. The most important ones are: *Timidonella sarda* Bassoullet, *Haurania deserta* Henson, *Amijiella amiji* (Henson). These fossils indicate an Aalenian-Bajocian age.

This formation is correlated with the Ouyoun Formation in the Coastal Chain in the NW Syria

PDF created with pdfFactory trial version www.pdffactory.com

(MOUTY, 1997b) which is composed of thick beds of limestones, dolomites, and dolomitic limestones containing *Timidonella sarda* Bassoullet, *Haurania deserta* Henson, *Amijiella amiji* (Henson). It is correlated with the B unit of Dodo Formation (MOUTY *et al.*, work in progress) in the Kurd Dagh, which consists in micritic and pelbiomicritic limestones containing *Timidonella sarda* Bassoullet, and with the B unit of Satih Formation in the Palmyrides Chain (MOUTY, 1997a) which consists in massive dolomicritic limestone containing *Haurania deserta* Henson and *Amijiella amiji* (Henson).

The correlation of this formation with its rivals in the neighbouring countries bears some problems. It could be preliminarily correlated in age with the lower part of Haifa Formation (DERIN, 1974) in Galilee, with the upper part of "Niveau 2" in Lebanon (RENOUARD, 1951), with the limestones and marly sandstones of the Huni Formation in Wadi Az-Zarqa (WETZEL & MORTON, 1959), in the northwest Jordan, with the lower part of Muhaiwir Formation (WETZEL, 1951 cited *in* DUBERTRET, 1959) in the southwest Iraq, which contains *Haurania deserta* Henson, *Amijiella amiji* (Henson) and with the middle part of Sargelu Formation (WETZEL, 1951 cited *in* DUBERTRET, 1959) in the northwest Iraq, which contains abundant macrofossils (ammonites, Rhynchonellidae).

Bqassem Formation, in the Mount Hermon, overlies the Kalaat Jandal Formation. It was first defined by DUBERTRET (1960) as "Calcaire jaune de Bqassem". It is composed of limestones with marl intercalations, very thick in the lower part of the formation. It represents shallow marine environment sediments of relatively high energy. It overlies an important hard ground surface on the top of Kalaat Jandal Formation. Its thickness in its type locality is 150 m. According to VAUTRIN (1934) and DUBERTRET (1960), fossils are abundant. The formation fossil assemblage consists of *Rhynchonella hopkinsi* McCoy, *R. absoleta* Sowerby, *Terebratula superstes* Douville, *T. quillyensis* Bayle. The presence of characteristic Foraminifera, *Haurania deserta* Henson, *Amijiella amiji* (Henson), indicates an upper Bajocian-Bathonian age.

The formation has no proved correlation except the age with its rivals in the neighbouring countries. It could be correlated with the upper part (Unit C) of Satih Formation (MOUTY, 1997a) in the Palmyrides Chain which contains brachiopods, *Daghanirhynchia subversabilis* (Weik), and Foraminifera, *Haurania deserta* Henson, *Amijiella amiji* (Henson), with the lower part of Machta Formation (MOUTY, 1997b) in the Coastal Chain in the NW Syria, which consists in few metres of marl and limestone intercalations with a typical surface of emersion (palaeosoil surface). This surface is marked in the interior Syria, in the west of Iraq and in the northwest of Jordan, by an erosion surface, covered by clastic continental sediments of Early Cretaceous.

The Hermon Formation overlies the Bqassem Formation in Mount Hermon. It was first defined by DUBERTRET (1960) as "Calcaire de l'Hermon". It consists in thick beds of micritic, biomicritic and pelbiomicritic limestones. The depositional environment of this formation is neritic and normal saline, subject to long period of subsidence. Its thickness, in its type locality, is about 700m.

Fossils in the type locality are relatively frequent, consisting in lower part of *Paleopfenderina salernitana* (Sartoni & Crescenti), *P. trochoidea* (Smouth & Sugden), *Kilianina blancheti* Pfender, *Endersonella palastiniensis* (Henson), and in the upper part, are rich in *Steinekella steinekei* Redmond, *S. crusei* Redmond, *Praekurnubia crusei* Redmond, *Redmondoides lugeoni* (Septfontaine) with Dasycladacea: *Salpingoporella annulata* Carozzi, *Thaumatoporella parvovesiculifera* (Raineri).

Fossil assemblages mentioned above indicate a Bathonian-lower Callovian age.

The formation can be correlated with the upper part of the Haifa Formation in the Galilee area (DERIN, 1974). It is correlated with massive limestones of the Kesrouane Formation in Lebanon (DUBERTRET, 1960).

The Hermon Formation has no proper lithologic correlation with the Coastal Chain in the northwest Syria. It is correlated, essentially in age, with the upper part of the Machta formation, and the lower part of Wadi Al-Ouyoun formation (MOUTY, 1997b), since Machta Formation consisted in an alternation of thick lithological units of limestones and marls, that contain, from the base to the top, *Paleopfenderina trochoidea* (Smouth & Sugden), *P. salernitana* (Sartoni & Crescenti), *Kilianina blancheti* Pfender, which indicate a Bathonian age, and the lower part of Wadi Al-Ouyoun formation which contains *Steinekella steinekei* Redmond, *S. crusei* Redmond and which indicate a Callovian age.

The Hermon Formation is missing in the entire interior Syria, except for west Palmyrides Chain (Sherifeh area) which contains *Valvulinella jurasica* (Henson).

PDF created with pdfFactory trial version www.pdffactory.com

LATE JURASSIC (MALM)

The Majdal Chams Formation overlies the Hermon Formation in the southwest flank of Mount Hermon (Majdal Chains village). It was first defined by DUBERTRET (1960) as "Marnes gris-clair de Mejdel Chems" (in Hermon geological map). It is composed of argillaceous marls with limonitic concretions at the base and intercalations of thin beds of limestone and marl.

Fossils are abundant throughout, specially in ammonites and brachiopods. According to NOETLING (1887), VAUTRIN (1934), HAAS (1955), ARKELL (1956), DUBERTRET (1960), RAZVALYAEV (1966), CARIOU & HANTZPERGUE (1997), CARIOU *et al.* (1997), this fauna indicates an Oxfordian age.

The thickness of Majdal Chams Formation in its type locality is about 150-200 m. It decreases in thickness northwards. It drops to 50 m in Wadi Al-Karn, 40 km northeast of Mount Hermon: "Marne jaune de Wadi Al-Karn" (DUBERTRET, 1950), yielding abundant fossils: stromatopora, corals, echinoids, brachiopods (*Somalirhynchia africana* Uhlig, *Bihenithyris weiri* Muir-Wood) which indicate a middle Callovian age (*Erymnoceras* and *Pachyerymnoceras* horizon) (ALMÉRAS, personal communication).

The upper part of the Majdal Chams Formation is partly correlated in age with the upper part of Wadi Al-Ouyoun Formation (MOUTY, 1997b) in the Coastal Chain, in the northwest Syria, which yields Foraminifera, *Steinekella steinekei* Redmond, *S. crusei* Redmond, and brachiopods, *Bihenithyris* sp., *Kutchirhynchia indica* (d'Orbigny), indicating a middle Callovian age.

A 30 m thick remarkable volcanic horizon termed "Niveau volcanic de Bhanness" (DUBERTRET, 1950) occurs in Lebanon.

The Late Jurassic is represented in the Levantine coastal chains. Above the Majdal Chams Formation follows the Bloudane Formation (MOUTY, work in progress) which is the "Calcaire à *Balanocidaris glandifera*" (VAUTRIN, 1934). It consists in massive limestones presenting a very distinctive 15-25 m high cliff. It yields relative abundant fossils, mainly echinoids (*Balanocidaris glandifera* Munster) and Foraminifera. The most important Foraminifera is *Levantinella egyptiensis* (Fourcade, Mouty & Teherani) which indicates an Oxfordian age (Levantinella egyptiensis biozone). The alga *Clypeina jurassica* Favre characterises this formation.

The depositional environment of the formation is clearly neritic.

It is followed by the "calcaires jaunes supérieurs". This formation is correlated with the "Falaise de Bikfaya" (DUBERTRET, 1949, 1950) which forms in the Lebanon a high cliff (80 m) of massive limestone. The absence of micropalaeontological analysis makes difficult a precise correlation. It is probably equivalent to the Haifa Bay Formation.

Nevertheless, the Bloudane Formation is correlated in age with the lower part of Nasirah Formation (MOUTY, 1997b) in the Coastal Chain, in northwest Syria, which consists in pelbiomicritic limestone with *Levantinella egyptiensis* (Fourcade, Mouty & Teherani) and *Alveosepta jaccardi* (Schrodt). It is also correlative with the Haifa micrite levels containing *Levantinella egyptiensis* (Fourcade, Mouty & Teherani) in the Galilee (PICARD & HIRSCH, 1987).

The Late Jurassic is represented in the Anti-Lebanon by the Batroun Formation or "Calcaire jaune de Batroun" (DUBERTRET, 1950) which is composed of light yellow micritic, pelbiomicritic and oolitic limestones with abundant marl intercalations. In the SW flank of Mount Hermon, near Hadar village, two 20 cm thick basalt beds are present at the top of upper part of the formation.

The thickness of this formation in the Anti-Lebanon is about 20-40 m.

Fossils in the Hermon area are, according to VAUTRIN (1934): *Terebratula subsella* Leym., *Pyguropsis noetlingi* De Loriol. Near the Batroun locality (Rawda), SW of Zebdani plain, the fossils are abundant: *Alveosepta jaccardi* (Schrodt), *Kurnubia palastiniensis* Henson, *Alveosepta (Iberina) prealusitanica* (Maync). The presence of the latter species characterises the Kimmeridgian in this region.

The formation is correlated with the Calcaire de Salima (DUBERTRET, 1950) in Lebanon which is

PDF created with pdfFactory trial version www.pdffactory.com

composed of light yellow oolithic and clastic limestones (150 m thick) locally interbedded by some volcanic levels.

The formation is correlated in age with the upper part of Nasirah Formation (MOUTY, 1997b) in the Coastal Chain in the northwest Syria, which yields *Alveosepta jaccardi* (Schrodt), *A. (Iberina) prealusitanica* (Maync) and *Kurnubia palastiniensis* Henson.

It is also correlated with the Haifa Bay Formation in Galilee which contains *Alveosepta (Iberina) prealusitanica* (Maync) (MAYNC, 1966).

The Late Jurassic is missing in the entire interior Syria, except for the Sherifeh area (W of Palmyrides Chain), which was submerged during that time: its sediments contain *Levantinella egyptiensis* (Fourcade, Mouty & Teherani) (HENSON, 1948).

It is also missing in west Iraq (BUDAY, 1980) and in Jordan (WETZEL & MORTON, 1959).

The Late Jurassic is restrictively present along the coastal chains of the East Mediterranean: Jabal Akraa, Coastal Chain (Jibal As-Sahilyeh), Lebanon Chain, Anti-Lebanon Chain and Galilee (Coastal Basin).

The Tithonian is missing in Syria and probably in the neighbouring areas due to an important hiatus which reaches the end of Neocomian.

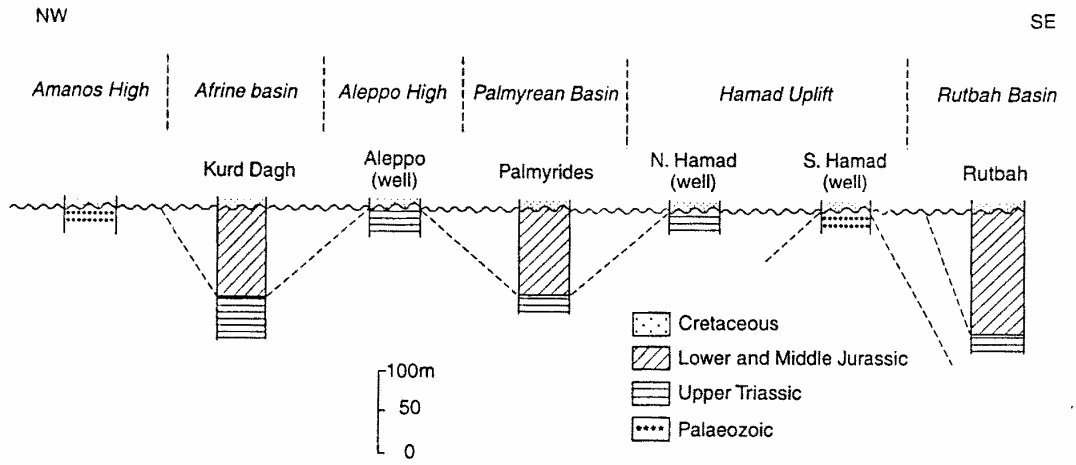


FIG. 3.— Correlation between sections from Amanos High to Rutbah Basin (NW-SE).

FIG. 3.— Corrélations entre les coupes depuis la surrélévation d'Amanos jusqu'au Bassin de Rutbah (NW-SE).

CONCLUSION

The palaeogeographic development during the Early and Middle Jurassic in Syria is controlled by two ENE-SW oriented huge uplift zones:

Hamad Uplift (MOUTY & AL MALEH, 1983; MOUTY, 1997a), Aleppo-Mardin high (PONIKAROV, 1966; KAMMAR, 1994) and Amanos High (LOVELOK, 1984) within the Syrian platform, separated by intracratonic rifted zones: the Rutbah basin (SW Iraq), the Palmyrid basin, the Afrine basin; and bordered in the west by the western margin of a N-E oriented rift zone (the Coastal basin) which represent the oldest manifestation of the Levant Fault-Zone (Dead Sea Fault) well developed at Late Tertiary (MOUTY, work in progress) (Figs 3 and 5).

These structures were the result of the Gondwana breakup, reflected by the opening of the Tethyan Ocean at the end of Upper Triassic.

PDF created with pdfFactory trial version www.pdffactory.com

The palaeogeographic development during the Early Jurassic is characterised by progressive transgression started just before the end of Late Triassic (MOUTY, 1997a) onto the Syrian platform, that did not submerge the huge uplifted zones. The evaporitic sediments precipitated under lagoonal conditions during the Triassic were replaced by marine sediments. The volcanic rocks within the Early Jurassic sediments (Mount Hermon, Galilee, Dolaa well) indicate the activity of these rifted zones at that time.

These marine conditions were continued during the Dogger, represented by frankly marine sedimentation, mostly neritic calcareous-micritic, pelitic or arenaceous sedimentation. The west marginal rift zone (Levantine basin) differs from the other basins, especially in its southern part (Lebanon, Anti-Lebanon and Galilee) which was being of more expressive mobility and subsidence (VAUTRIN, 1934; RENOUARD, 1951; DUBERTRET, 1966; PICARD & HIRSCH, 1987; HIRSCH & PICARD, 1988).

The Dogger sedimentation locally ended by an emergent phase. Before the end of the Dogger, at the base of the Bathonian, a regressive phase marks the end of the marine cycle on the entire interior Syrian platform.

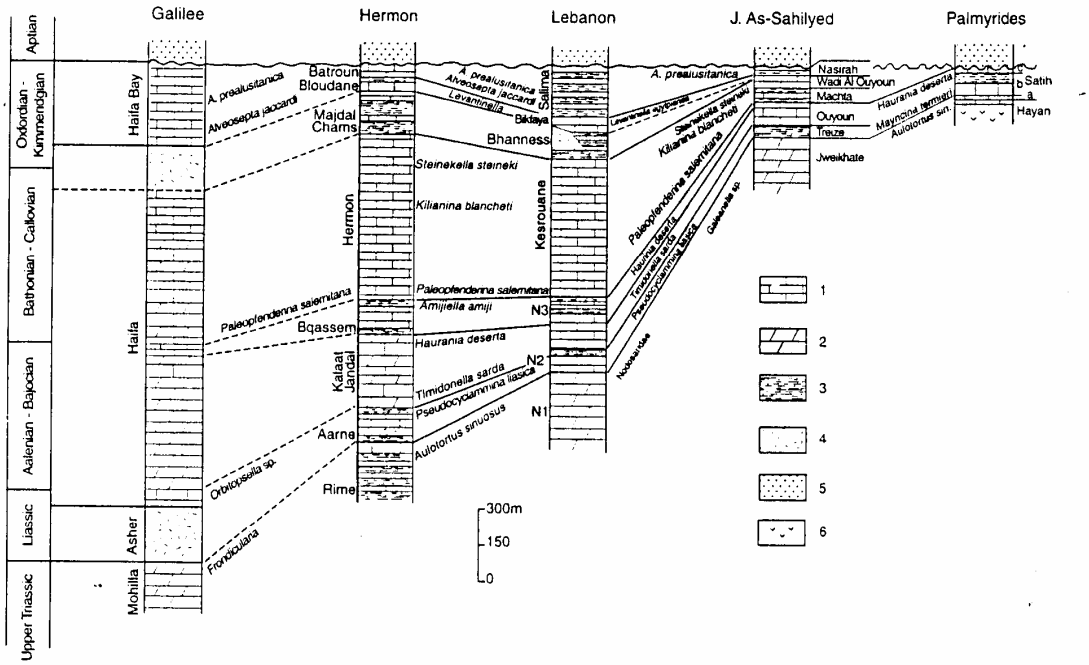


FIG. 4.— Stratigraphic sections of East Mediterranean Chains. **1**, limestones; **2**, dolomites; **3**, marls; **4**, basalts; **5**, sandstones; **6**, gypsum.

FIG. 4.— Corrélations stratigraphiques des Chaînes est-méditerranéennes. 1, calcaires ; 2, dolomies ; 3, marnes ; 4, basaltes ; 5, grès ; 6, gypse.

The regressive phase began at the base of the Bathonian. The Jurassic sea withdrew from the interior rifted basins to the Tethyan Ocean in the north and to the East Mediterranean basin in the west forming an embayement in the Sherifeh area. This basin on the western margin of the Syrian platform continues to subsidise, especially in its southern part (Lebanon, Anti-Lebanon and Galilee) until the end of Kimmeridgian (Fig. 4) where the latest regressive phase began, with some volcanic activity locally (Mount Hermon and Lebanon), and the entire Syrian platform became emerged during the Tithonian stage.

PDF created with pdfFactory trial version www.pdffactory.com

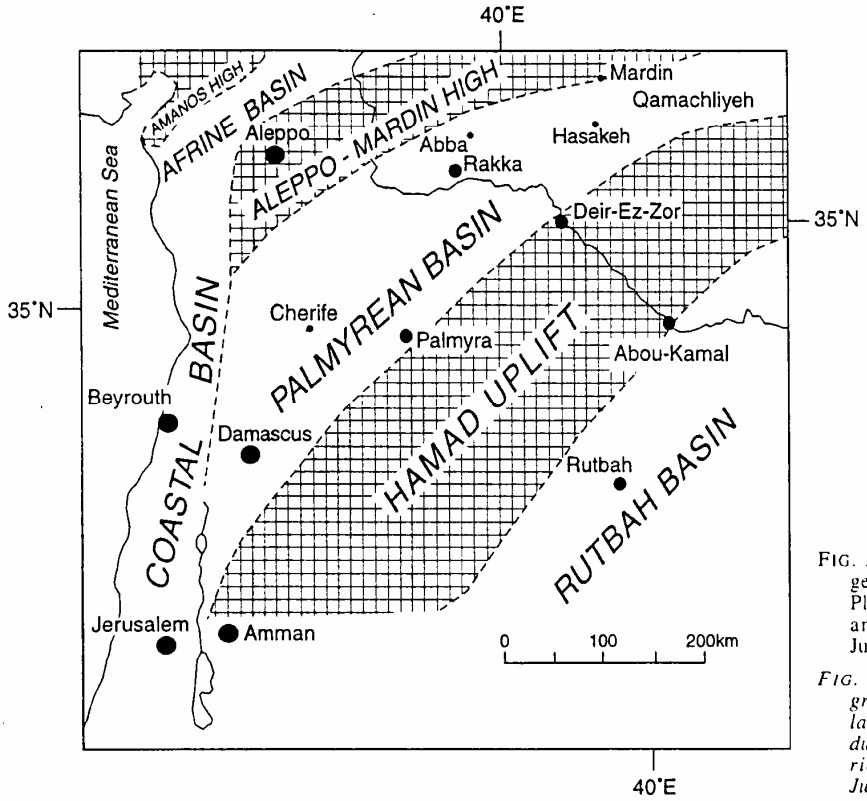


FIG. 5.— Schematic palaeogeographic map of Syrian Platform during the Early and the early Middle Jurassic.

FIG. 5.— Carte paléogéographique schématique de la plate-forme syrienne durant le Jurassique inférieur et le début du Jurassique moyen.

REFERENCES

ALTINLI, I.E., 1966.— Geology of eastern and southeastern Anatolia. *Bulletin of Mineral Exploration Institute, Foreign Edition, Ankara*, **60**: 36-76.

ARKELL, W.J., 1956.— *Jurassic Geology of the World*. Oliver & Boyd, London: 1-806.

BASH IMAM, I. & SIGAL, J., 1985.— Précisions nouvelles sur l'âge triasique et non jurassique de la majeure partie des formations évaporitiques des forages de l'Est syrien. *Revue de Paléobiologie*, **4** (1): 35-42.

BUDAY, T., 1980.— *The Regional Geology of Iraq*. Tome 1. State Organization for Minerals, Baghdad. 1-445.

CARIOU, É., BASSOULLET, J.-P., GROSSOWICZ, L., HIRSCH, F., 1997.— Le Callovo-Oxfordien du Sud Levant: données biostratigraphiques nouvelles (Ammonites, Foraminifères) endémisme et corrélations stratigraphiques. *In: De la biostratigraphie à la paleobiogéographie: réunion spécialisée APF-SG*. Lyon, Société géologique de France: 21.

CARIOU, É. & HANTZPERGUE, P., 1997.— Biostratigraphie du Jurassique ouest-européen et méditerranéen: zonations parallèles et distribution des invertébrés et microfossiles. *Elf Aquitaine Édition, Pau, Mémoire*, **17**: 1-440.

DERIN, B., 1974.— *The Jurassic of Central and Northern Israel*. Ph. D. Thesis, Hebrew University, Jerusalem, Israel: 1-70 (in Hebrew, English summary).

DUBERTRET, L., 1949.— *Carte géologique au 1: 200 000. Feuille de Tripoli. Notice explicative*. République libanaise, Ministère des Travaux publics, Beyrouth: 1-64.

DUBERTRET, L., 1950.— Sur le Jurassique du Liban et de l'Anti-Liban. *Comptes Rendus sommaires de la Société géologique de France*, **2**: 12-13.

DUBERTRET, L. (ed.), 1959.—*Lexique stratigraphique international*. 3: *Asie, Iraq*. CNRS, Paris, Fasc. 10a: 1-333.

DUBERTRET, L., 1960.— *Feuille Hermon, Notice explicative*. République libanaise, Ministère des Travaux publics, Beyrouth: 1-46.

DUBERTRET, L. (ed.), 1963.—*Lexique stratigraphique international*. 3: *Asie, Syrie*. CNRS, Paris, Fasc. 10cl: 1-437.

DUBERTRET, L., 1966.— Liban, Syrie et bordure des pays voisins. *Notes et Mémoires sur le Moyen-Orient*, **8**: 251-358.

PDF created with pdfFactory trial version www.pdffactory.com

DUBERTRET, L., 1975.— Introduction à la carte géologique à 1/50 000 du Liban. *Notes et Mémoires sur le Moyen-Orient*, **13**: 345-403.

FOURCADE, E. & MOUTY, M., 1995.—Découverte d'un nouveau grand Foraminifère du Jurassique de la marge sud téthysienne: *Syriana khouryi* n.gen. n.sp. *Revue de Micropaléontologie*, **38** (3): 217-227.

FOURCADE, E., MOUTY, M. & TEHERANI, KH., 1997.— *Levantinella* nov. gen. et révision du genre *Mangashtia* Henson, grands Foraminifères du Jurassique et du Crétacé du Moyen-Orient. *Geobios, Lyon*, **30** (2): 179-192.

FRAAS, O., 1877.— Juraschichten am Hermon. Neues Jahrbuch fur Mineralogie, Geologie und Palaeontologie, **1**: 17-30.

GARFUNKEL, Z. & DERIN, B., 1985.— Permian-Early Mesozoic Tectonism and Continental margin formation in Israel and its implications for the history of the eastern Mediterranean. *Special Publications - Geological Society of London*, **17**: 187-201.

HAAS, O., 1955.— Revision of the Jurassic ammonite fauna of Mount Hermon, Syria. *Bulletin of the American Museum of Natural History*, **108**: 1-210.

HENSON, F.R.S., 1948.— *Larger Imperforate Foraminifera of South-Western Asia, Families Lituolidae, Orbitolinidae, Meandropsinidae*. British Museum, London: 1-127.

HIRSCH, F. & PICARD, L., 1988.— The Jurassic facies in the Levant. *Journal of Petroleum Geology*, **11** (3): 277-308.

KAMMAR, N., 1994.— *The Triassic and Jurassic in Aleppo Plateau*. M. Sc. Thesis, Damascus University, Damascus, Syria: 1-114 (in Arabic).

KENT, P.E., SLINGER, F.C. & THOMAS, A.N., 1951.— Stratigraphical exploration surveys in SW Persia. *In: Proceedings of the 3rd World Petroleum Congress, Section 1*. E. J. Brill, Leiden: 141-159.

LARTET, L., 1869.— *Essai sur la géologie de la Palestine*. Thèse, Faculté des Sciences de Paris, Paris, France, **316**: 1-229, 29 figs. Publiée également par Masson et Fils.

LOVELOK, P.E.R., 1984.— A Review of the tectonics of the Northern Middle East region. *Geological Magazine*, **121**: 577-587

MAYNC, W., 1966.— Microbiostratigraphy of the Jurassic of Israel. *Israel Geological Survey, Bulletin*, **40**: 1-56.

MOUTY, M., 1976.— Présence du Lias dans le Massif Alaouite, Syrie. *Comptes Rendus sommaires de la Société géologique de France*, 3: 104-105.

MOUTY, M., 1978.— Données nouvelles sur le Jurassique dans les Palmyrides. *Syrian Geological Magazine, Damas*, **2**: 20-22 (en arabe).

MOUTY, M., 1997a.— Le Jurassique de la Chaîne des Palmyrides (Syrie Centrale). *Bulletin de la Société géologique de France*, **168** (2): 181-186.

MOUTY, M., 1997b.— Le Jurassique de la Chaîne Côtière (Jibal As-Sahilyeh) de Syrie: essai de biozonation par grands foraminifères. *Comptes Rendus de l'Académie des Sciences, Paris*, **325**: 207-213.

MOUTY, M. & AL MALEH, A.KH., 1983.— *Geological Study of Palmyrides Chain (Syria)*. Ministry of Petroleum and Mineral Resources, Damascus: 1-257.

NOETLING, F., 1887.— *Der Jura am Hermon*. E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart: 1-46.

PICARD, L. & HIRSCH, F., 1987.— *The Jurassic Stratigraphy in Israel and the Adjacent Countries*. The Israel Academy of Sciences and Humanities, Jerusalem: 1-106.

PONIKAROV, V.P., 1966.— *Geological Map of Syria, Scale 1: 1 000 000*. Ministry of Petroleum and Mineral Resources, Damascus.

RAZVALYAEV, A.V., 1966.— *Explanatory Notes to the Geological Map of Syria, 1: 200 000*. Syrian Arab Report of the Ministry of Industry, Department of Geological and Mineral Research, Damacus: 1-122.

RENOUARD, G., 1951.— Sur la découverte du Jurassique inférieur (?) et du Jurassique moyen au Liban. *Comptes Rendus de l'Académie des Sciences, Paris*, **232**: 992-994.

VAUTRIN, H., 1934.— Contribution à l'étude de la série jurassique dans la chaîne de l'Anti-Liban et plus particulièrement dans l'Hermon (Syrie). *Comptes Rendus de l'Académie des Sciences, Paris*, **198**: 1438-1440.

WETZEL, R. & MORTON, D.M., 1959.— Contribution à la géologie de la Transjordanie. *Notes et Mémoires sur le Moyen-Orient*, **7**: 95-191.

PDF created with pdfFactory trial version www.pdffactory.com