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Late Callovian Ammonites from the Tuwaiq Mountain Limestone of Saudi Arabia

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Abstract. The present study on the Upper Tuwaiq Mountain Limestone in central Saudi Arabia has led to the identification of an ammonite fauna consisting of; *Pachyceras (Pachyceras) lalandeanum* (d'Orbigny), *P. (P.) indicum* Spath, *P. (Pachyerymnoceras) jarri* (Douvillé), *Levanticeras sinaiensis* Lewy, *Peltoceras (Peltoceras)* cf. *trifidum* (Quenstedt) and *P. (P.) cf. pachygaster* Gill, Thierry & Tintant.

This ammonite fauna indicates a late Callovian age (*Athleta – Lamberti* zones) for the Upper Tuwaiq Mountain Limestones. *Pachyceras* and *Pachyerymnoceras* were known and recorded by different authors from the formation, but *Levanticeras* and *Peltoceras* are identified here from the formation for the first time. The *Peltoceras* fauna indicates the presence of the *Lamberti* zone and confirms a late Callovian age for the lower part of the Upper Tuwaiq Mountain Limstone.

Introduction

The succession of the Jurassic basin in central Saudi Arabia is divided into the early Jurassic Marrat Formation, the Middle Jurassic Dhruma Formation and Tuwaiq Mountain Limestone and the Upper Jurassic Hanifa Formation, Jubaila Limestone, Arab Formation and Hith Anhydrite.

The reference lithostratigraphic column (1020 m thick) for the Jurassic of Saudi Arabia is located in the median region of the basin, around the latitude of Al-Riyadh where the most developed marine facies are encountered.

The stratigraphic assignations of the Jurassic series are based primarily on the ammonite fauna in the median part of the basin, where Bramkamp and Steineke (in Arkell [1]), Powers *et al.* [2] and subsequently Powers [3] defined the lithologic divisions, which are still broadly valid to day.

Geology Setting

The lithostratigraphy of the Tuwaiq Mountain Limestone has been described by Bramkamp and Steineke (in Arkell [1]), Steineke *et al.* [4], Powers *et al.* [2] and Powers [3]. According to Powers *et al.* [2], the Tuwaiq Mountain Limestone is named after Jabal Tuwaiq, the specatacular, nearly parallel sequence of west-facing scarps developed in the jurassic rocks of central Arabia. The Tuwaiq Mountain Limestone itself forms the largest and most persistent of these escarpments and, as such, constitutes the backbone of Jabal Tuwaiq. It has been mapped from lat. 17 30 N to lat 27 30 N, a distance of more than 1200 km (see location map. Text-Fig. 1). The thickness of the Tuwaiq Mountain Limestone reaches a maximum of between 200 m and 215 m in the Darb al Hijaz (type locality) to Wadi Nisah (lat. 24 15 N) area. The formation thins uniformly away from this region to the north and to the south, where it becomes 45-60 m thick at its northern and southern extremities.

Vaslet *et al.* [5] have defined three lithosedimentologic units (T1 to T3) in the Tuwaiq Mountain Limestone that can be recognized over the greater part of the Jurassic Basin. These units have been redefined by Manivit *et al.* [6] in a new reference section at Khashm al Qaddiyah near Al Riyadh (lat. 24 31 N.) where the formation is 184 m thick. Unit T1, 32 m thick in the reference section and throughout the median region, comprises series of fine -grained, fairly clayey limestone intercalated with beds of brown calcarenite and white bioturbated nodular limestone. Unit T2, 56 m thick in the reference section, comprises a monotonous assemblage of fine-grained or bioclastic limestone, relatively bioturbated and clayey, containing isolated corals. Unit T3, 95 m thick in the reference section, consists of very extensive bioclastic limestone and calcarenite and is rich in silicified corals and stromatoporoids. It locally gives rise to reef forms with bioherms in the median part of the basin.

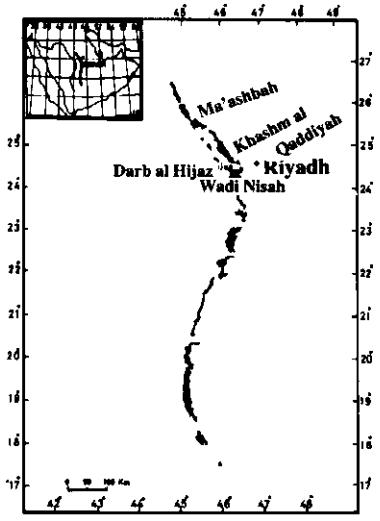
Previous dating of the Tuwaiq mountain limestone

The lower part of the Tuwaiq Mountain limestone was assigned to the Middle Callovian by Arkell [1] on the basis of the ammonites *Erymnoceras*, and later by Imlay [7] on the basis of the ammonites *Pachyceras cf. schloenbachi, Erymnoceras philbyi* and *Erymnoceras (Pachyerymnoceras) cf. E. (P.) jarri.* The upper part of the Tuwaiq Mountain Limestone contains two distinctive foraminifers, *Kurnubia wellingsi* (Henson) and *Steinekella steinekei* (Redmond), which were considered to be of Oxfordian age by Powers *et al.* [2]. Subsequently, Le Nindre *et al.* [8] assigned a Middle to Upper Callovian age to the Tuwaiq Mountain Limestone outcrops south of Riyadh, following their record of *Trocholina palatiniensis* (Henson) generally associated with *Kurnubia bramkampi* Redmond from the lower part of the formation, *Kurnubia cf. palastiniesis* (Henson) from the middle part, and *Steinekella steinekei* (Redmond) from the coral biostromal facies in the upper part. According to Vaslet *et al.* [5] and Manivit *et al.* [6], the upper part of the Tuwaiq Mountain Limes-

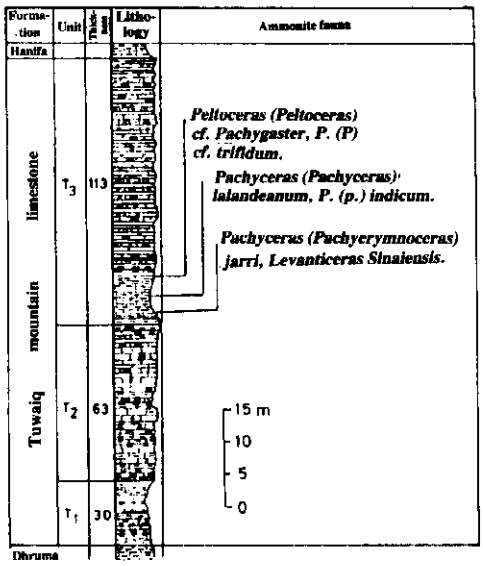
tone was assigned to a late Callovian age?; this was based on their finding of a single ammonite fragment which they attributed to the genus *Pachyerymnoceras* Breistroffer. Enay *et al.* [9] recorded the ammonites, *Pachyerymnoceras, Erymnoceras* and *"Prorsiceras" hatirae* (Lewy) from the Tuwaiq Mountain Limestone and they assigned an upper Middle Callovian age (*Coronatum* zone) to the formation. They stated that ammonites in unit T3 (Upper part of Tuwaiq Mountain Limestone) are too rare for a late Callovian age to be definitively rejected, at least in the upper part of this unit and that there can be no certainty as to the presence of late Callovian facies from unit T3.

Ammonite fauna

The present study of the outcrops of the Tuwaiq Mountain Limestone in central Saudi Arabia has led to the identification of an ammonite fauna from the lower part of unit T3 in the vicinity of Al Ma'ashbah village along the northern side of Wadi Hanifa (see Text Fig. 1 and Text Fig. 2). This ammonite fauna includes *Pachyceras (Pachyerymnoceras) jarri* Douvillé, *Pachyceras (Pachyceras) lalandeanum* (d'Orbigny), *Pachyceras (Pchyceras) indicum* Spath, *Levanticeras sinaiensis* Lewy, *Peltoceras (Peltoceras) cf. trifidum* (Quenstedt) and *Peltoceras (Peltoceras) Pachygaster*



Text-Fig. 1. Outcrops map of the Tuwaiq mountain limestone and localities.

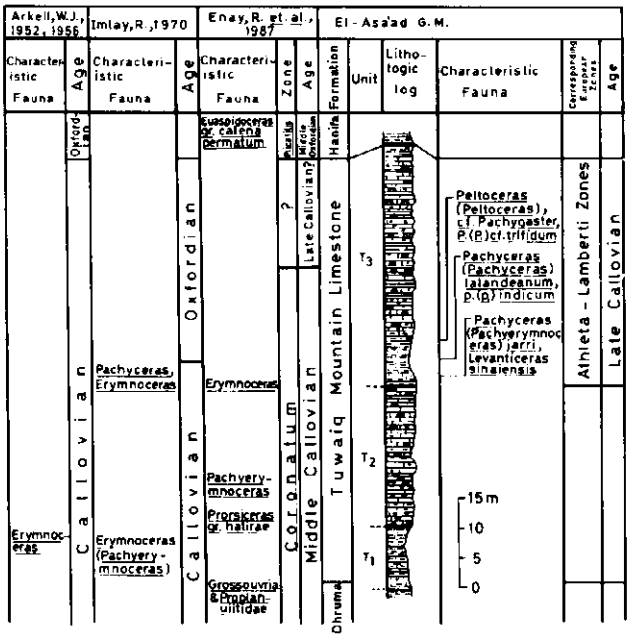


Text-Fig. 2. Stratigraphical section of the Tuwaiq mountain limestone at Al-Ma'ashbah area.

Gill, Thierry and Tintant. (See plates 1-4). All the figured specimens are deposited in the collection of the Department of Geology, King Saud University, Riyadh, Saudi Arabia and they are prefixed by KSU. G. Am.

Although *Pachyceras* and *Pachyerymnoceras* fauna are well known from the Tuwaiq Mountain Limestone and have been recorded by different authors from the formation in central Saudi Arabia (see Fig. 3), the *Levanticeras* and *Peltoceras* are identified here from the Tuwaiq Mountain Limestone for the first time.

Pachyceras (Pachyceras) lalandeanum (d'Orbigny) appears in Europe in the upper part of the *Athleta* zone and is most abundant in the *Lamberti* zone, both zones of late Callovian age (Charpy and Thierry [10]). It appears in northern Sinai, Egypt (Gebel Maghara and Gebel Minshera) in the top of the Zohar Formation *(Athleta - Lamberti* zones), Lewy [11] and in the extreme summit of the *Athleta* zone at Hamakhtesh Hagadol (Hathira), Negev, southern Palestine (Gill *et al.* [12]. Douvillé, H. [13], identified some fragments as *Pachyceras cf. Pachyceras lalandei* (d'Orbigny) from Gebel Maghara, Sinai. These fragments have been attributed by Charpy and Thierry [10] to microconchs of *Pachyceras lalandeanum* (d'Orbigny).



Text-Fig. 3. Age of the Tuwaiq mountain limestone in central Saudi Arabia based on ammonites and comparison with previous works.

Pachyceras (Pachyceras) *indicum* Spath was recorded by Spath [14] from the *Athleta* beds (Divesian Upper Callovian) at the localities of Ler and Fakirwadi, Cutch, India. Spath [14] considered this Indian species as equivalent to the European *Pachyceras (Pachyceras) lalandeanum* (d'Orbigny).

Pachyceras (Pachyerymnoceras) jarri (Douvillé) appears in Europe in the *Lamberti* zone (Charpy and Thierry [10]). Lewy [11], recorded it from the top of the Zohar Formation *(Athleta - Lamberti* zones) at Gebel Maghara, Northern Sinai, Egypt. Gill *et al.* [12], recorded it from the top of the Middle Callovian *(Coronatum*

zone) up to the Late Callovian (*Athleta* zone) at the locality of Hamakhtesh Hagadol (Hathira), Negev, southern Palestine.

Levanticeras sinaiensis Lewy was recorded by Lewy [11] from the upper prt of the Zohar Formation (*Athleta - Lamberti* zones) at Gebel Minshera, northern Sinai, Egypt.

Peltoceras (Peltoceras) cf. trifidum (Quenstedt) was recorded by Lewy [11] from the upper part of the Tsia Member of the upper Zohar Formation (*Athleta - Lamberti* zones) at Makhtesh (Hatira), southern Palestine.

Peltoceras (Peltoceras) cf. pachygaster Gill, Thierry and Tintant was identified by Gill *et al.* [12] from the upper part of the *Athleta* zone at Hamakhtesh Hagadol (Hathira), southern Palestine.

Discussion

The Tuwaiq Moutain Limestone in central Arabia has been dated as Middle Callovian by Arkell [1] and bylmlay [7]; as Oxfordian by Powers *et al.* [2]; as middle-late Callovian by Le Nindre *et al.* [8] and as upper middle-late Callovian ? (*Coronatum* zone) byt Enay *et al.* [9]. The upper part of the Tuwaiq Mountain Limestone (T3) was assigned to a late Callovian age? by Vaslet *et al.* [5] and byManivit *et al.* [6].

The present finding of *Pachyerymnoceras* and *Levanticeras* ammonite fauna from argillaceous limestone at the base of unit T3 together with the presence of *Pachyceras* and *Peltoceras* from the top of this argillaceous limestone indicate a late Callovian age (*Athleta - Lamberti* zones) for the basal part of the Upper Tuwaiq Mountain Limestone (T3). (See Fig. 3).

Because of the absence of typical *Cardioceratine* ammonites from the upper part of the Tuwaiq Mountain Limestone (T3), the distinction between the two European bizones (*Athleta* zone and *Lamberti* zone) is not possible in central Arabia; therefore, the lower part of the Upper Tuwaiq Mountain Limestone is assigned here to the combined *Atheleta* Lamberti Zones (late Callovian).

A characteristic feature of the present ammonite species from the Upper Tuwaiq Mountain Limestone is that they were not equally distributed through the basin of the Upper Tuwaiq Mountain Limestone sea. They are much more limited in extent (only at the vicinity of Ma'ashbah village). Such a limited distribution in central Arabia was reported by Enay *et al.* [9] for the ammonite fauna from the Dhruma Formation and from the Tuwaiq Mountain Limestone. This limited distribution of jurassic ammonite fauna in central Arabia could be related to Palaeobiogeography and Palaeonvironmental conditions of a very shallow platform. Changes of Paleoenvironmental condi-

tions on a very shallow platform are responsible for a limited distribtion of the Jurassic Arabian fauna as a whole.

Acknowledgement. I am grateful to Professor R. Enay, Dr. A. Prieur and the staff of the Department des Sciences de la Terre de l'université Claud Bernard-Lyon who gave me access to comparative material kept under their care and allowed me use of their research facilities. Thanks are to Dr. D. Vaslet from the B.R.G.M. - Jeddah - for his assistance in field work. Special thanks are to King Saud University, Riyadh for financial support.

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Explanation of Plates, Figures and Tables

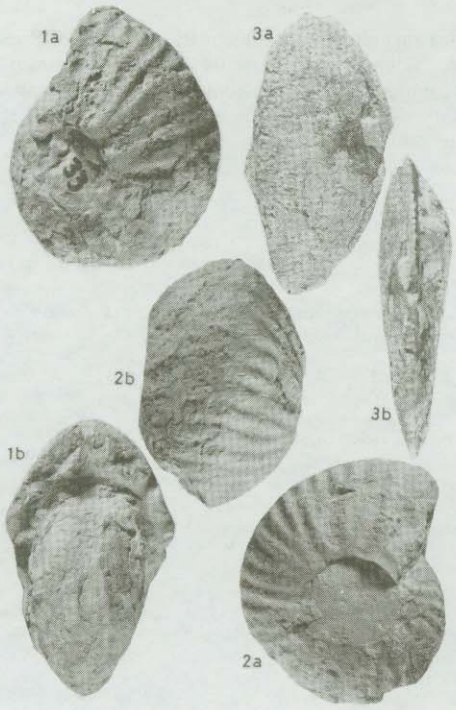

Plate 1.

Fig. 1. *Pachyceras (Pachyceras) lalandeanum* (d'Orbigny) KSU. G. Am. 20 from the basal part of the Upper Tuwaiq Mountain Limestone (T3), late Callovian, Ma'ashbah area.

1a. Lateral view of an inner whorl of a macroconch, XO.5

1b. Apertural view, XO.5

1c. Ventral view, XO.4

1d. *Pachyceras (Pachyceras) lalandeanum* (d'Orbigny), KSU. G. Am. 22, from the basal part of the Upper Tuwaiq Mountain Limestone (T3), late Callovian, Ma'ashbah area.

1d. Lateral view of a wholy septate fragment of an inner whorl of a macroconch, 0.4.

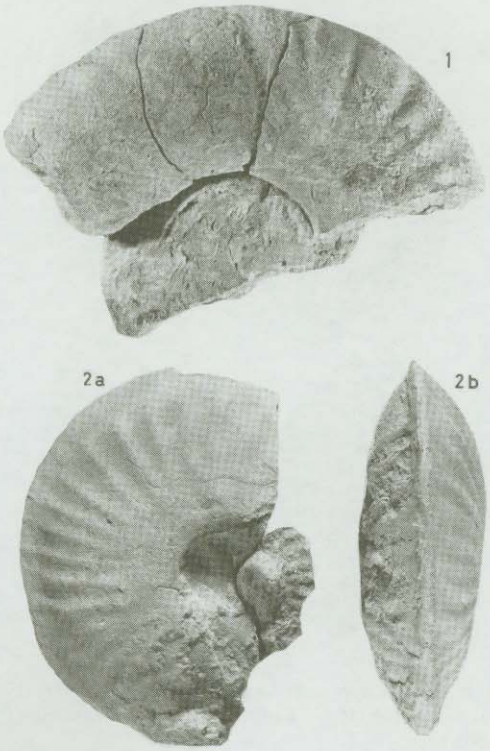

Plate 2

Fig. 1. *Pachyceras (Pachyceras) lalandeanum* (d'Orbigny), KSU. G. Am. 21, from the basal part of the Upper Tuwaiq Moutain Limestone (T3), late Callovian Ma'ashbah area,

1. Lateral view of inner whorls of a macroconch with fragments of the body chamber, × 0.4.

Fig. 2. *Pachyceras (Pachyceras) indicum* Spath, KSU G. Am. 25, from the basal part of the Upper Tuwaiq Mountain Limestone (T3), late Callovian, Ma'ashbah area.

2a. Lateral view of a macroconch showing the end of the phragmocone and the body chamber, × 0.7.

2.b Ventral view, × 0.7.

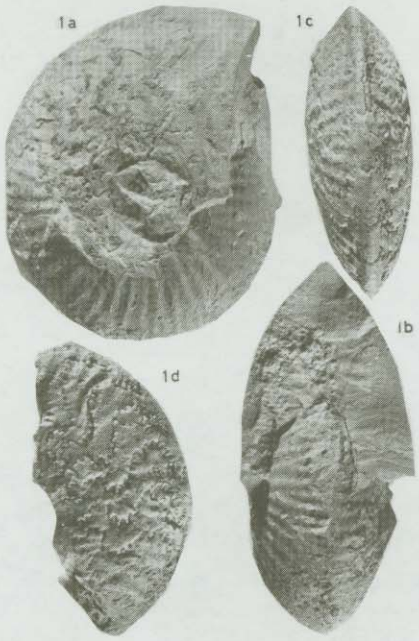

Plate 3

Fig. 1. *Pachyceras (Pachyerymnoceras) jarri* (Douvillé), KSU. G. Am. 30, from the basal part of the Upper Tuwaiq Mountain Limestone (T3), late Callovian, Ma'ashbah area.

1a. Lateral view of an almost complete specimen (microconch) with body chamber,

1b. Apertural view, X1.

Fig. 2. *Pachyceras (Pachyerymnoceras) jarri* (Douvillé), KSU. G. Am. 31, from the basal part of the Upper Tuwaiq Mountain Limestone (T3), late Callovian, Ma'ashbah area.

2a. Lateral view of a microconch x1

2b. Ventral view of a microconch, x1

Fig. 3. *Levanticeras sinaiensis* Lewy, KSU. G. Am. 40, from the basal part of the Upper Tuwaiq Mountain Limestone (T3), late Callovian, Ma'ashbah area.

3a. Lateral view of a wholy septate half inner whorl, x1.

3b. Ventral view, x1.

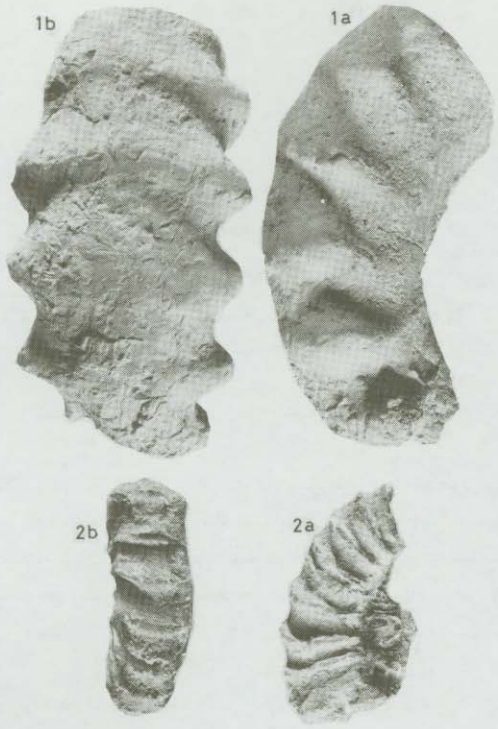

Plate 4

Fig. 1. *Peltoceras (Peltoceras) cf. pachygaster* Gill, Thierry & Tintant, KSU. G. Am. 36, from the lower part of the Upper Tuwaiq Mountain LImestone (T3), late Callovian, Ma'ashbah area.
1a. Lateral view of a fragment of body chamber of a large specimen, X 0.7.
1b. Ventral view, X 0.7.

Fig. 2. *Peltoceras (Peltoceras) cf. trifidum* (Quenstedt), KSU. G. Am. 35, from the lower part of the Upper Tuwaiq Mountain Limestone (T3), late Callovian, Ma'ashbah area.
2a. Lateral view of a fragment of an inner whorl, x1
2b. Ventral view, X1.

أمونيتات الكالوفي المتأخر من حجر جير طويق في المملكة العربية السعودية

غالب محمد الأسعد

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(استلم في ١٤١١/٧/١٩هـ؛ قبل للنشر في ١٤١٢/٨/٢٢هـ)

ملخص البحث. قادت الدراسة الحالية التي أجريت على جيولوجية حجر جير طويق العلوي إلى تعريف أحافير الأمونيتات التالية: باشيسيراس (باشيسيراس) لالاندينام (دي أوربيني)، باشيسيراس (باشيسيراس) انديكام سباث، باشيسيراس (باشيرمنوسيراس) جاراي (دوفيليبه) ليفانتيسيراس سينا أنسس ليفي، بلتوسيراس (بلتوسيراس) شبيه ترايفيدام (كونيسدت) وبلتوسيراس (بلتوسيراس) شبيه باكيجاستر جل، تيري وتنتان.

لقد أثبت وجود أحافير الأمونيتات هذه عمر الكالوفي المتأخر (نطاقي الثليتا ـ لامبرتي) لحجر جير طويق العلوي.

إنه وبالرغم من كون أحافير أجناس الأمونيتات باشيسيراس وباشيرمنوسيراس معروفة سابقًا من حجر طويق إلا أن أجناس الأمونيتات ليفانتيسيراس و بلتوسيراس قد عرفت من حجر طويق لأول مرة في هذه الدراسة.

يشير وجود أحافير جنس بلتوسيراس إلى تأكيد عمر الكالوفي المتأخر (نطاق لامبرتي) للجزء السفلي من حجر جير طويق في وسط المملكة العربية السعودية.