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Stratigraphic palynology of Devonian boreholes from northern Saudi Arabia.

[Palynologie stratigraphique de sondages dans le Dévonien du nord de l'Arabie Saoudite]

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Key Words: Biostratigraphy; Devonian; miospores; Saudi Arabia

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Mots-Clefs : Biostratigraphie ; Dévonien ; miospores ; Arabie Saoudite

Introduction

This extended abstract describes well-preserved palynomorph assemblages recovered from Devonian strata in five shallow boreholes in the northern part of Saudi Arabia (Fig. 1). These fully cored holes overlap stratigraphically to form a 1,640 ft composite section spanning the upper Tawil, Jauf and lower Jubah formations (Fig. 2). Only the Jauf and lower Jubah, represented by 188 samples taken over a 1,300 ft stratigraphic interval, are addressed here as the sandy Tawil lithologies are unsuitable for palynological analysis. The 900 feet of alternating of siliciclastic and carbonate units, that together comprise the five members of the Jauf Formation, were sampled comprehensively. However, the Jubah Formation, like the Tawil Formation, is mostly sandstone and is productive palynologically at only two levels separated by a 300 ft barren interval. The age of the sampled succession is assessed using index species from the established Euramerican Devonian palynozonations of RICHARDSON & MCGREGOR (1986) and STREEL *et alii* (1987), and is shown to span the late Early and Middle Devonian.

Stratigraphic palynology

Miospores dominate the palynological assemblages of most samples. Trilete spores are abundant, whereas monolet spores and cryptospores are less common. At certain levels within the Hammamiyat and Murayr members of the upper Jauf Formation, leiospheres and acritarchs predominate. A specific leiosphaerid typifies the D3B palynozonal event that occurs in both northern and eastern Saudi Arabia (AL-HAJRI *et alii*, 1999). Moreover, within these assemblages there are other algal palynomorphs and perhaps a dinoflagellate-like cyst of uncertain affinity (? *Arpylorus* sp.). However, other specimen of this form must be found before a reliable determination can be made. Undescribed chitinozoans also occur at one level.

Figure 2 depicts the palynostratigraphy of the Jauf-Jubah succession. The oldest productive samples are from the Sha'iba Member of the Jauf Formation in the BAQA-2 borehole. These assemblages include the trilete spores *Verrucosisporites polygonalis*, *Dictyotriletes emsiensis*, *D. subgranifer* and *Brochotriletes foveolatus* (Fig. 3) and therefore can be referred to the west European Su Interval Zone of STREEL *et alii* (1987). On that

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basis they are assigned a late Pragian age.

Monolete spores (Fig. 3) occur in the upper part of the Sha'iba Member in BAQA-2 and range to the top of the Jauf Formation. The overlying Qasr and Subbat members present in the BAQA-1 borehole also contain trilete spores such as *Emphanisporites schultzei*, *Synorisporites papillensis* and *Knoxisporites riondae* (Fig. 3). As the upper limit of the

ranges of these species is confined to the Emsian an early to middle Emsian age is proposed for the upper Sha'iba-Qasr-Subbat interval. Hence, the upper Sha'iba monolete spores are among the oldest known since the only other Early Devonian records found are from the early Emsian of Antarctica (KEMP, 1972) and late Emsian of Russia (ARKHANGELSKAYA, 1985).

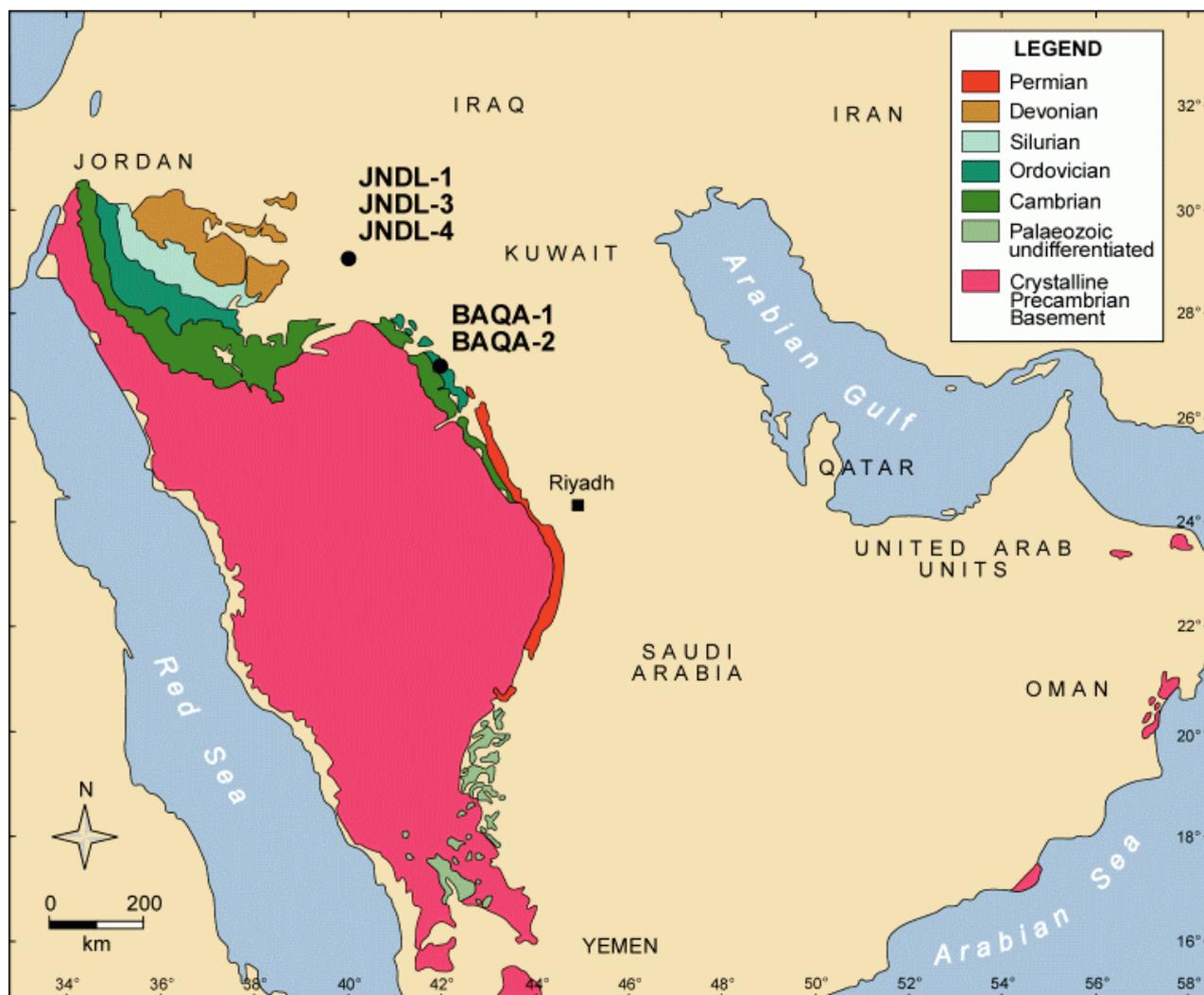


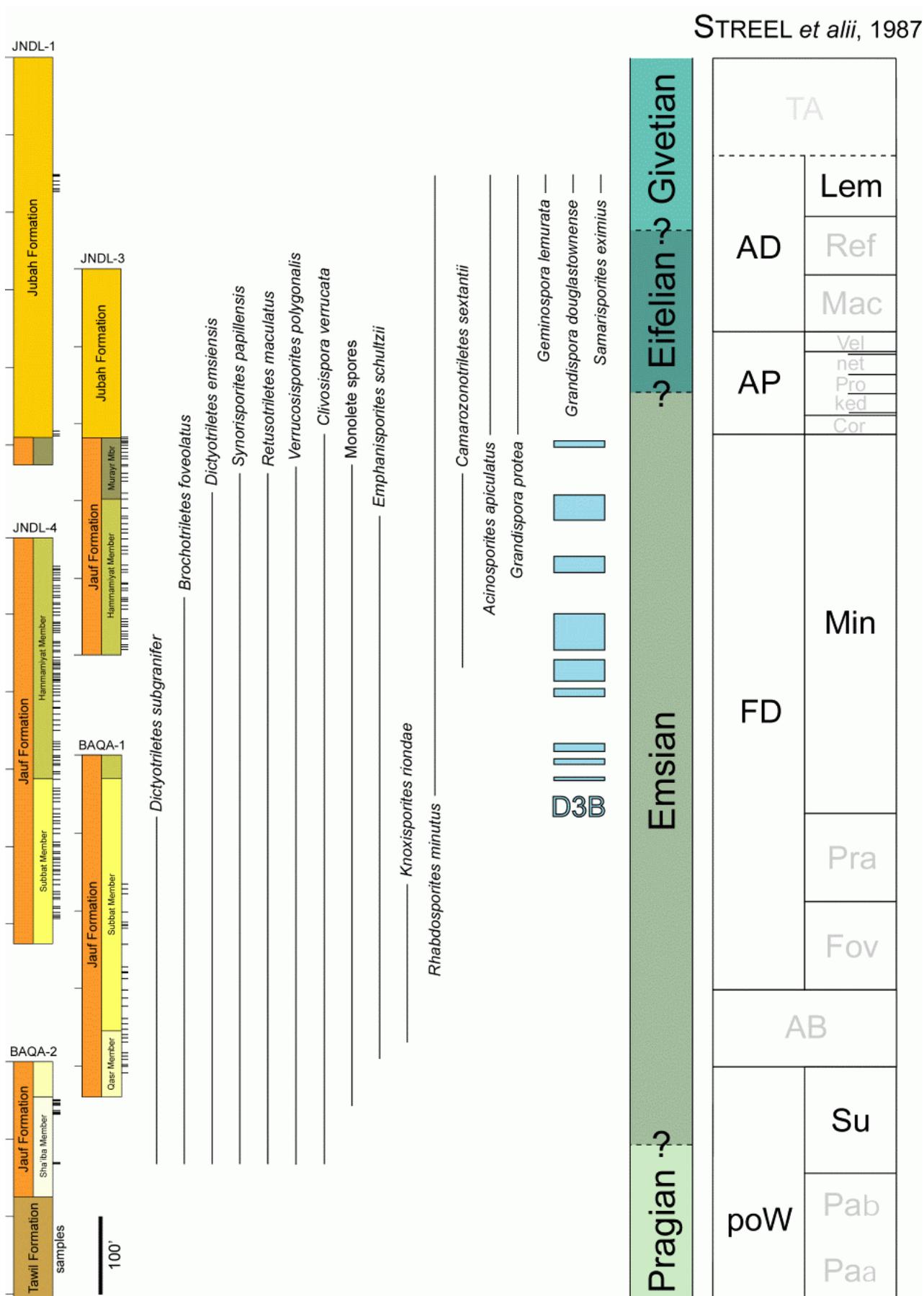
Figure 1: Map showing Palaeozoic outcrops in northern parts of the Arabian Peninsula and the location of studied boreholes.

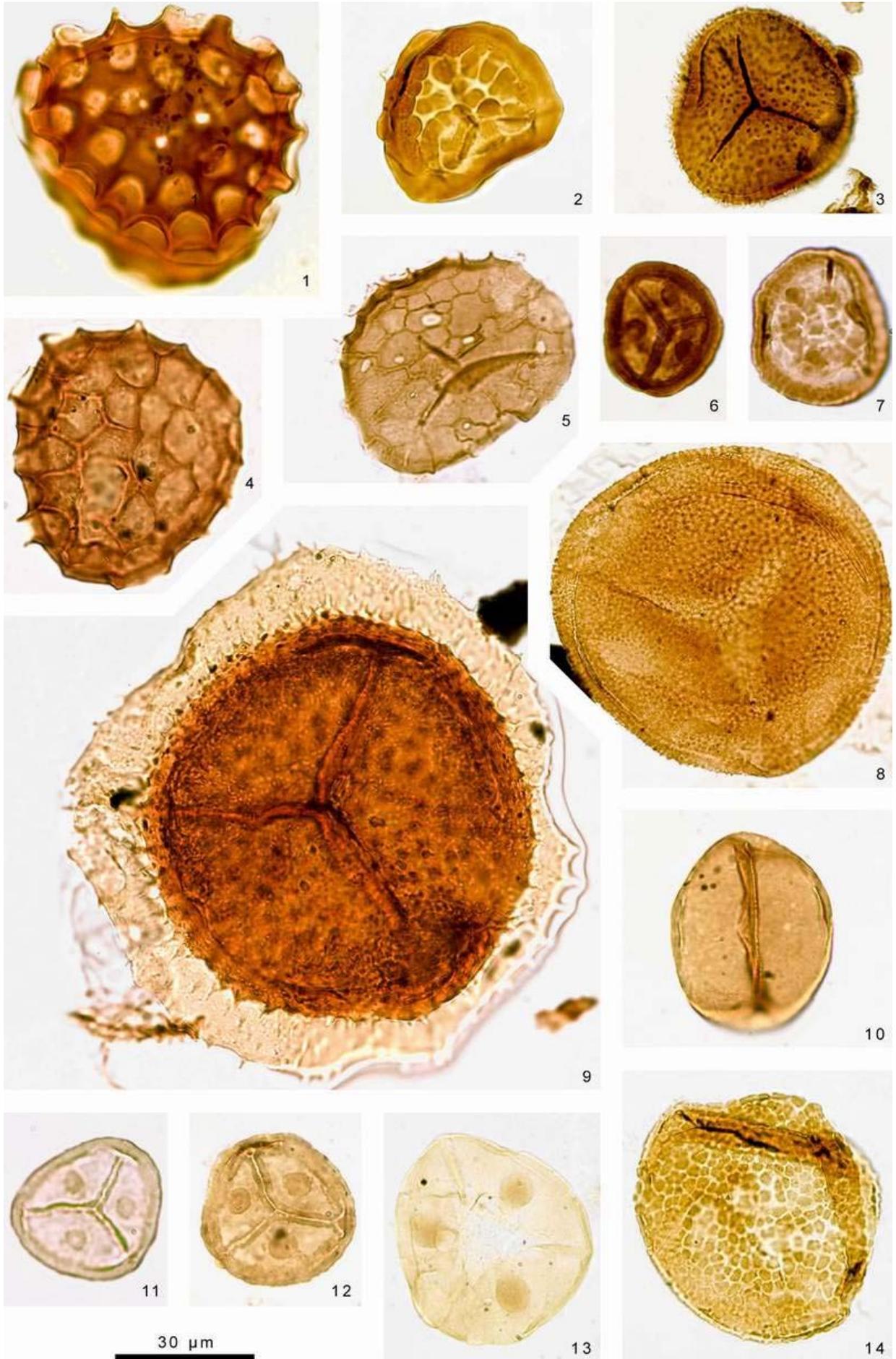
The pseudosaccate miospore *Rhabdosporites minutus* occurs first in the upper Subbat Member of JNDL-4. Its occurrence marks the base of the Interval Zone Min of Opeel Zone FD (STREEL *et alii*, 1987). The same levels contain *V. polygonalis* and *Clivosispora verrucata* (Fig. 3) species that become extinct before the Emsian/Eifelian boundary. *Camarozonotriletes sextantii* (Fig. 3) makes its first inception in the overlying Hammamiyat Member of JNDL-4.

Miospore abundance and species diversity are low in the Hammamiyat Member of the

JNDL-3 section, so no palynozonal boundaries can be defined. The Murayr Member in JNDL-3 is more productive and seems to be of late Emsian age, based on the extinction of *C. sextantii*, *V. polygonalis* and *Retusotriletes maculatus* (Fig. 3) in the upper part of this unit.

The miospore assemblages show a marked increase in diversity, as well as a change in composition, in the lower part of the Jubah Formation as found in the JNDL-1 borehole. This characteristic allowed early workers (HEMER





◀ **Figure 3:** Photomicrographs of miospores from the studied boreholes.

1. *Brochotriletes foveolatus*. Borehole BAQA-1, sample & slide 169.1', EFC K39-40.
2. *Clivosispora verrucata*. Borehole JNDL-4, sample & slide 87.2', EFC F34/1.
3. *Camarozonotriletes sextantii*. Borehole JNDL-4, sample & slide 75.0', EFC Q-R29.
4. *Dictyotriletes emsiensis*. Borehole BAQA-2, sample & slide 56.0', EFC X46.
5. *Dictyotriletes subgranifer*. Borehole BAQA-1, sample & slide 366.9', EFC G28.
6. *Knoxisporites riondae*. Borehole BAQA-1, sample & slide 285.5', EFC R48/3.
7. *Knoxisporites riondae*. Borehole BAQA-1, sample & slide 366.9', EFC K27/1.
8. *Geminospira lemurata*. Borehole JNDL-1, sample 172.7', slide 60845, EFC G31.
9. *Samarisporites eximius*. Borehole JNDL-1, sample & slide 167.8', EFC O34/2.
10. Monolete spores. Borehole BAQA-2, sample & slide 56.0', EFC S27.
11. *Synorisporites papillensis*. Borehole BAQA-1, sample & slide 222.5', EFC W51/3.
12. *Synorisporites papillensis*. Borehole BAQA-2, sample & slide 50.2, EFC R26.
13. *Retusotriletes maculatus*. Borehole BAQA-1, sample & slide 395.2', EFC W49.
14. *Verrucosisporites polygonalis*. Borehole JNDL-4, sample & slide 87.2', EFC F38/2.

& NYGREEN, 1967) to recognize a Devonian (Givetian-Frasnian) section (now termed Jubah Formation) younger than the marine, lower Middle and Lower Devonian Jauf Formation known up to that time. Simple trilete spores like *Retusotriletes* and *Apiculiretusispora* are much less abundant in the lower part of the Jubah Formation than in the underlying succession, and more complexly structured and ornamented species such as *Acinosporites apiculatus* and *Grandispora protea* appear for the first time. They characterize the AP Opper Zone of STREEL *et alii* (1987) and in the sequences of western Europe appear just prior to the Emsian/Eifelian boundary. As *C. verrucata* is still present in the lower part of the Jubah Formation that portion of the formation may be of latest Emsian age.

The distinctive camerate spores *Geminospira lemurata*, *Grandispora protea*, *G. douglstownense* and the zonate miospore *Samarisporites eximius* (Fig. 3) occur in the upper part of JNDL-1. The first occurrence of *G. lemurata* defines the base of the Lem Interval Zone of STREEL *et alii* (1987) within their AD Opper Zone and for this reason the upper part of the JNDL-1 succession is dated Givetian. Similar assemblages have been described from the Jubah Formation in well TRBH-1, approximately 150 km north of the BAQA boreholes (LOBOZIAK & STREEL, 1995), and from borehole S-462 located some 100 km north of the JNDL boreholes (LOBOZIAK, 2000).

Palynological events characterized by an

abundance of a monospecific leiosphaerid (Fig. 4.1-3) occur in the Hammamiyat and Murayr members of the Jauf Formation in JNDL-3 and JNDL-4. At some levels, this taxon constitutes almost the whole of the palynological assemblage. These leiosphaerid-rich, low-diversity assemblages can be related to Palynozon D3B defined by AL-HAJRI *et alii* (1999). Here, this subzone is not as a unique event but is represented by a series of pulses that span some 400 ft of section. In the current study, assemblages of this kind may also include a variety of large aquatic palynomorphs (Fig. 4) that can comprise 10-30% of an assemblage. Most are probably green algae and represent unnamed prasinophyte phycomata (LE HÉRISSE, pers. comm.). As recognized here, the D3B episode is restricted to the Min Interval Zone of western Europe and thus is middle to late Emsian in age.

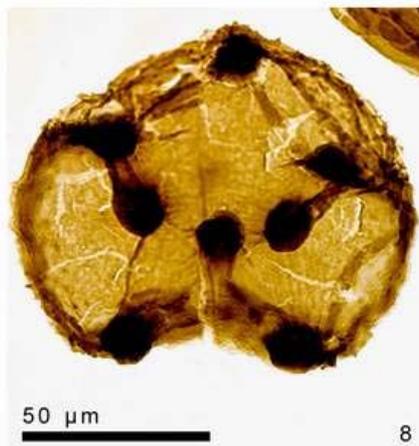
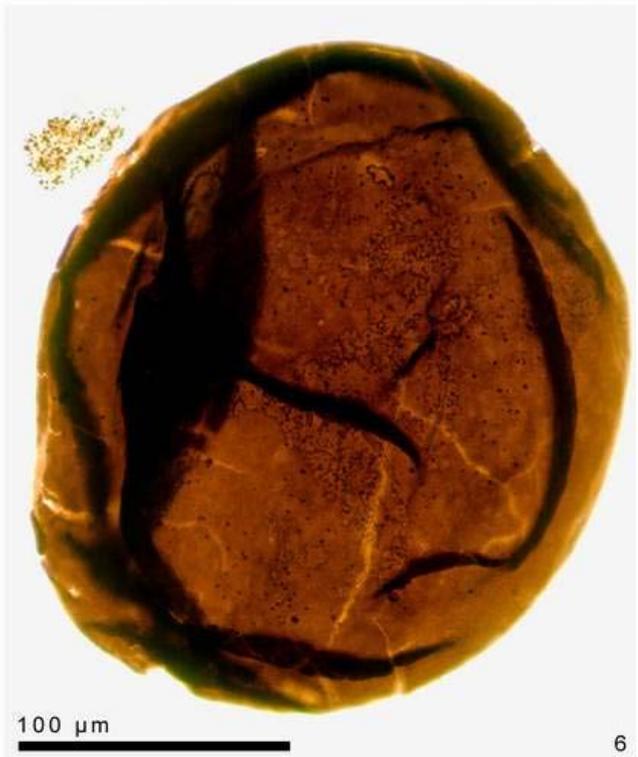
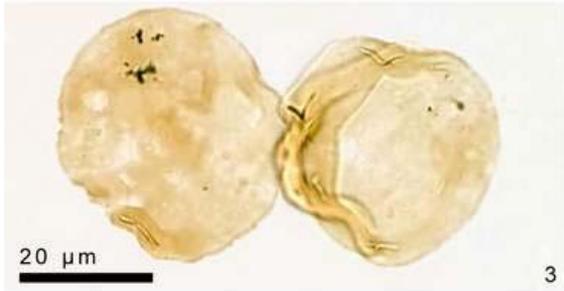
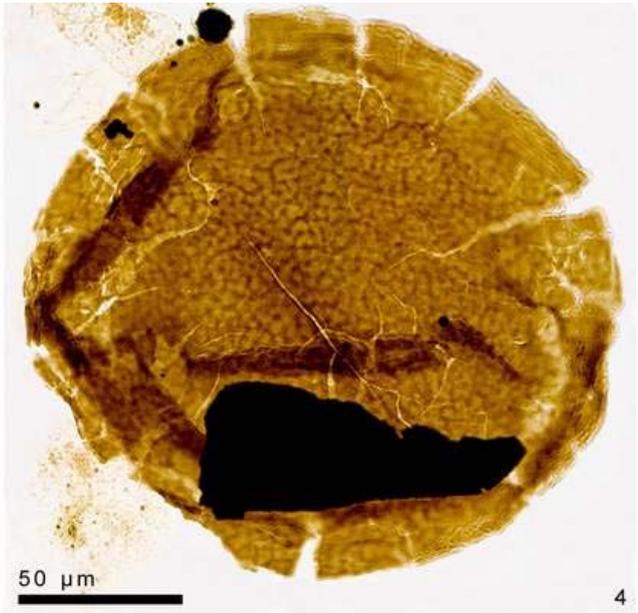
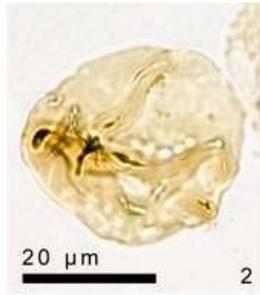
Conclusion

This palynological study determines with great precision the age of the Jauf Formation in northern Saudi Arabia (late Pragian to late Emsian). The Pragian/Emsian boundary is very probably in the upper part of the Sha'iba Member while the Emsian/Eifelian boundary could be in the lower part of the Jubah Formation. However, taxa characteristic of the Eifelian are absent probably because of the 300 ft sample gap in the lower Jubah section of JNDL-1. The youngest samples from the Jubah Formation are Givetian in age.

The D3B interval in the JNDL boreholes comprises a series of marine pulses throughout the Hammamiyat and Murayr members of the upper Jauf Formation. Palynostratigraphically they equate with the FD Min western European zones of middle Emsian age. The 400 ft stratigraphic span of the D3B episode is much thicker than it is in eastern Saudi Arabia where it is represented normally by but a few tens of feet. Moreover, in the JNDL boreholes the assemblage is accompanied by many other marine palynomorphs that are rarely evident in the east.

Monolete spores appear in the upper Sha'iba Member and range to the top of the Jauf Formation. Their appearance in the earliest Emsian as reported here is among the oldest known global occurrences of this tracheophytic morphotype.

The stratigraphic palynology presented here is mainly based on species that are common to the established Euramerican zonations. A palynostratigraphic scheme grounded on species endemic to western Gondwana is under development (BREUER *et alii*, in preparation) and should lead to more refined Early and Middle Devonian correlations in the Arabian Peninsula.



◀ **Figure 4:** Photomicrographs of palynomorphs from the D3B interval.

1. *Leiosphaeridia* spp. Borehole JNDL-4, sample & slide 177.7', EFC J37.
2. *Leiosphaeridia* spp. Borehole JNDL-4, sample & slide 177.7', EFC P37/4.
3. *Leiosphaeridia* spp. Borehole JNDL-4, sample & slide 177.7', EFC D37/4.
4. *Prasinophyceae* sp. 1. Borehole JNDL-3, sample & slide 493.2', EFC O31/2.
5. ? *Arpylorus* sp. Borehole JNDL-4, sample & slide 221.8', EFC V45.
6. *Prasinophyceae* sp. 2. Borehole JNDL-4, sample & slide 221.8', EFC M33/3.
7. *Prasinophyceae* sp. 3. Borehole JNDL-4, sample & slide 221.8', EFC Q40.
8. *Prasinophyceae* sp. 3. Borehole JNDL-4, sample & slide 221.8', EFC K27/1.
9. *Prasinophyceae* sp. 2. Borehole JNDL-4, sample & slide 221.8', EFC P48/1.

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