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Original article

Two new Middle Devonian megaspores from Saudi Arabia

Deux nouvelles mégaspores du Dévonien moyen d'Arabie Saoudite

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Abstract

Two new megaspore species, *Biharisporites jubahensis* and *Verrucisporites yabrinensis*, are described from the Middle Devonian Jubah Formation of south central Saudi Arabia. Miospore-based biostratigraphy indicates that the age of the megaspore-bearing interval is no older than the early Givetian *Geminospora lemurata* Interval Zone, and not younger than Givetian. The presence of similar species in both Arctic Canada and Saudi Arabia suggests that the megaspore-producing plants achieved wide distribution in the Middle Devonian.

Résumé

Deux nouvelles espèces de mégaspores, *Biharisporites jubahensis* et *Verrucisporites yabrinensis*, découvertes dans la partie méridionale du centre de l'Arabie Saoudite sont décrites dans la Formation Jubah, d'âge Dévonien moyen. D'après la biostratigraphie des miospores, le niveau contenant les mégaspores n'est pas plus ancien que la Zone d'Intervalle à *Geminospora lemurata* du Givétien inférieur et pas plus récent que le Givétien. La présence d'espèces similaires dans l'Arctique canadien et en Arabie Saoudite suggère que les plantes à mégaspores s'étaient déjà largement répandues au Dévonien moyen.

Keywords: Saudi Arabia; Middle Devonian; Megaspores; Taxonomy

Mots clés : Arabie Saoudite ; Dévonien moyen ; Mégaspores ; Taxonomie

1. Introduction

Specimens of morphologically complex megaspores, described here, are the first of this type to be recovered from the Devonian of Saudi Arabia. They occur with moderately diverse, but thermally darkened, miospores that indicate a Middle Devonian (Givetian) age for the assemblage, and suggest that they are from strata equivalent to the Jubah Formation (Miller et al., 2004). Their discovery was fortuitous in that they were only observed during non-routine sample preparation for scanning electron microscopy, (SEM). The megaspores were recovered from the conventional core of the Jubah Formation, penetrated by exploration drilling south of the Ghawar oilfield, Eastern Province, Saudi Arabia (Fig. 1).

2. Material and method

The megaspore-bearing samples are from a conventionally cored siliciclastic succession that contains common dispersed megascopic carbonaceous plant fragments and occurs above a prominent paleosol. The palynomorphs recovered were well preserved despite the elevated thermal maturity exhibited. To examine the mostly opaque spores, residues processed from core samples were not oxidized and prepared for SEM observation.

The samples were treated with hydrochloric acid followed by hydrofluoric acid. The organic residues were then sieved using a 20 μm nylon screen. The residues were examined using a stereoscopic binocular microscope to check the quality of the

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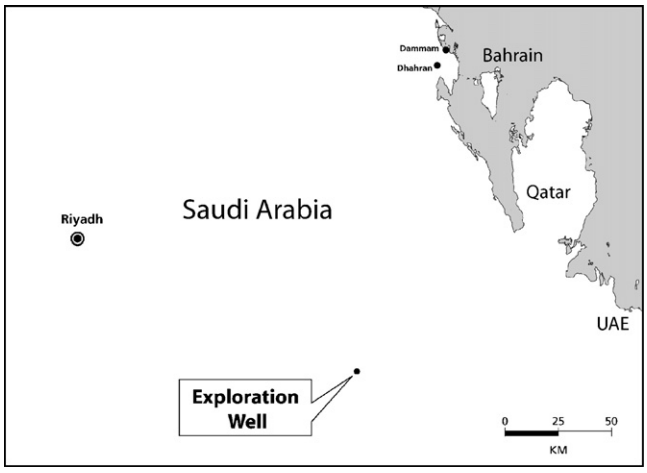

Fig. 1. Map showing the location of the exploration well from which the megaspores were recovered.
Fig. 1. Carte montrant la position du puits d'exploration ayant livré les mégaspores.

preparation and their suitability for SEM study. During this examination comparatively large grains were observed. These were individually picked using a micropipette in the manner described by Miller (1996) for chitinozoans. For SEM observation, specimens were mounted on circular glass cover slips attached to SEM stubs with aluminium foil as described by Paris (1978), and then coated with gold. SEM images were captured digitally using a Philips XL-30 SEM. Although these samples were previously processed using standard palynological methods, complete megaspores were not recovered. Fragments of the reticulum of *Verrucisporites yabrinensis* nov. sp. were observed in the strew mount preparations but their origin was unknown.

Various reagents were tried in attempts to oxidize the picked megaspore specimens. In the first attempt cold nitric acid was applied for 1.5 h with no noticeable affect. Room temperature Schultze's solution was then used. The specimens became translucent and orange in color after approximately 15 min. The specimens were neutralized with distilled water and mounted on glass slides. Following the oxidation procedure the specimens that were orange in color darkened to brown. Fracturing of the spores was noticeable prior to their internment in mounting media (polyvinyl alcohol and Petroexpoxy®). Oxidation times exceeding 15 min using Schulze's solution were avoided because of concerns of excessive fracturing of the spore wall.

Circular coverslips with SEM types were removed from the stubs, inverted, and attached to glass slides with Petroexpoxy®. All specimens selected for typification are indicated by circles on the cover slips, identified by England Finder Coordinates and housed in the Natural History Museum, Cromwell Road, London, UK under the designation PM FM. The remaining SEM stubs are retained in the collections of Saudi Aramco, Geological Technical Services Division, Dhahran, Saudi Arabia.

3. Age

The age of the megaspore-bearing sample is based on miospores and the zonation of Streel et al. (1987). Species identified in the upper part of the core include: *Aneurospora goensis*, *Auroraspora micromanifesta*, *Emphanisporites mcgregorii*, *E. rotatus*, *Geminospora?lemurata*, *G. punctata*, *Retusotriletes rugulatus*, *Rhabdosporites langii*, *R. minutus*, *R. parvulus*, *Samarisporites concinnus*, *Verruciretusispora magnifica*, *V. pallida*, *Verrucosisporites scurrus*, and *V.* cf. *uncatus*. *Samarisporites triangulatus* suggests that the upper part of the core is no older than the middle Givetian *S. triangulatus-Ancyrospora ancyrea* Oppel Zone. *Geminospora?lemurata*, *Verruciretusispora magnifica*, and *V. pallida* also suggest it is no older than the underlying Givetian *G. lemurata* Interval Zone of the *Acinosporites acanthomammillatus - Densosporites devonicus* Oppel Zone of Streel et al. (1987). The presence of *Auroraspora micromanifesta* and *Rhabdosporites minutus* suggest the samples are no younger than Givetian. The prominent occurrences of *Geminospora* spp. and *Verruciretusispora* (al. *Cymbosporites*) spp. in the assemblages conform to the D2 Palynozone of Al-Hajri et al. (1999: Fig. 2) associated with the lower part of the Jubah Formation.

The sample with the megaspores is rich in the *Geminospora* miospores whereas the sample from a bed approximately six feet deeper is dominated by the *Verruciretusispora* species.

Plate 1. **Figs. 1–2**. Holotype of *Verrucisporites yabrinensis* nov. sp., transmitted light, 1, ×150, NHM PM FM 1870. 2. Enlargement of sculpture of the holotype of *V. yabrinensis* nov. sp. showing sculpture formed by coalescing verrucae to form a reticulum with conspicuous lumina, transmitted light, ×240. **Fig. 3**. Paratype of *Verrucisporites yabrinensis* nov. sp., transmitted light, ×150 NHM PM FM 1871. **Fig. 4**. SEM image of a laterally compressed *V. yabrinensis* nov. sp., ×150. Note the prominent curvaturae, the reticulate sculpture, and labra accompanying the trilete mark. Three microspores are adhering to the proximal contact area. **Figs. 5–6**. A specimen of *V. yabrinensis* nov. sp. with a scabrate to rugulate proximal surface. Note that the labra accompanying the suturae are incomplete, 5, ×150. 6. Enlargement of Fig. 5 showing the scabrate exine structure that normally underlies the smooth proximal face, ×305. **Figs. 7–9**. A specimen of *V. yabrinensis* nov. sp. where the exine sculpture has partially spalled off to reveal a basal layer, 7, ×150. 8. Close up of Fig. 7 showing verrucate sculpture on the normally laevigate contact area, ×760. 9. Close up of the sculpture of Fig. 7 showing the coalescence of verrucae to a reticulum. Note the apical coni on the top of most verrucae, ×1520. **Fig. 10**. A specimen of *V. yabrinensis* nov. sp. with a reticulate sculpture on what appears to be the proximal surface. Beneath this reticulate layer a split trilete suture can be identified. The solid layer behind this is interpreted as the inner distal surface, ×150. **Fig. 11**. A specimen of *V. yabrinensis* nov. sp. with a well-defined reticulate sculpture, a laevigate proximal surface, and well-defined curvaturae. This specimen was used to draw Fig. 2A, which shows the variation in the verrucate sculpture, ×150.

Planche 1. **Figs. 1–2**. Holotype de *Verrucisporites yabrinensis* nov. sp., en lumière transmise, 1, ×150, NHM PM FM 1870. 2. Détail de la sculpture de l'holotype de *V. yabrinensis* nov. sp. montrant que cette sculpture résulte de la coalescence de verrues formant un réticule avec des lumières marquées en microscopie optique, ×240. **Fig. 3**. Paratype de *Verrucisporites yabrinensis* nov. sp., lumière transmise, ×150 NHM PM FM 1871. **Fig. 4**. Cliché au MEB d'un exemplaire de *V. yabrinensis* nov. sp. compressé latéralement, ×150. Noter les curvatures saillantes, l'ornementation réticulée et les lèvres accompagnant la marque trilète. Trois miospores sont fixées sur la zone de contact proximale. **Figs. 5–6**. Spécimen de *V. yabrinensis* nov. sp. avec une surface proximale scabrate à ruguler. A noter que les lèvres accompagnant les sutures sont incomplètes, 5, ×150. 6. Détail de la Fig. 5 montrant la structure rugulée de l'exine qui, normalement, se place sous la