

## PALAEOZOIC PALYNOLOGY OF THE ARABIAN PLATE AND ADJACENT AREAS

A joint Saudi Aramco/CIMP (Commission Internationale de Microflore du Paléozoïque) project to study the Palaeozoic palynostratigraphy of Saudi Arabia was initiated in 1990. In late 1992, a session was dedicated to Saudi Arabian palynology during the 8th International Palynological Congress (Aix-en-Provence, September 6–12, 1992). The related papers were published in a 1995 special issue of *Review of Palaeobotany and Palynology* edited by B. Owens, H. Al-Tayyar, J.G.L.A. Van der Eem and S. Al-Hajri. In 1998 a CIMP workshop was held in Pisa, Italy, and the papers were published in GeoArabia Special Publication I entitled *Stratigraphic Palynology of the Palaeozoic of Saudi Arabia* edited by S. Al-Hajri and B. Owens (2000).

The third of the series of studies, covering the palynostratigraphy of the Palaeozoic in the Middle East and North Africa, was recently published in the *Revue de micropaléontologie* (January-March 2007, Volume 50, Issue 1) by Elsevier. The special section *Palaeozoic Palynology of the Arabian Plate and Adjacent Areas* was edited by F. Paris, B. Owens and M.A. Miller. The abstracts of the third special publication are reprinted here.

**Le Hérisse, A., M. Al-Ruwaili, M. Miller and M. Vecoli 2007. Environmental changes reflected by palynomorphs in the early Middle Ordovician Hanadir Member of the Qasim Formation, Saudi Arabia. In, F. Paris, B. Owens and M.A. Miller (Eds.), Palaeozoic Palynology of the Arabian Plate and Adjacent Areas. *Revue de micropaléontologie*, v. 50, no. 1, p. 3-16. Elsevier.**

Core samples from the Qasim-801 (QSIM-801) water well in the Qasim region of central Saudi Arabia were investigated palynologically. The interval studied contains the transgressive succession from the Sajir Member of the Saq Formation to the Hanadir Member of the Qasim Formation, and yields well-preserved and abundant cryptospores, microphytoplankton (acritarchs and chlorophycean algae), and chitinozoans, indicative of a Darriwilian (Llanvirn) age. The lowermost portion of the cored interval from the upper Sajir Member consists of fine-grained sandstones deposited in tidal flat, and shallow-marine settings. It is characterized by abundant and diverse cryptospores (permanent tetrads, dyads, monads), cuticle-like phytoclasts, and a low diversity assemblage of marine palynomorphs. The upper part of the cored interval from the Hanadir Member is composed of hemipelagic to pelagic, organic-rich, graptolitic shales, and micaceous shales, of middle- to outer-shelf depositional settings, which yield abundant marine palynomorphs (acritarchs and chitinozoans). Cryptospore-bearing horizons are interspersed in the succession. Changes in the

composition of palynomorph assemblages reflect higher frequency environmental changes within an overall transgressive succession. Four new acritarch species are described in open nomenclature, *Tyrannus* sp. A, *Clypeolus* sp. A, *?Pulvinosphaeridium* sp. A and *?Tinacula* sp. A.

**Miller, M.A. and M.H. Al-Ruwaili 2007. Preliminary palynological investigation of Saudi Arabian Upper Ordovician glacial sediments. In, F. Paris, B. Owens and M.A. Miller (Eds.), Palaeozoic Palynology of the Arabian Plate and Adjacent Areas. *Revue de micropaléontologie*, v. 50, no. 1, p. 17-26. Elsevier.**

An Ordovician stratigraphically admixed palynomorph assemblage that contains palynomorphs eroded from Middle through Upper Ordovician strata characterizes the Hawban Member (restricted) of the Sarah Formation in central Saudi Arabia. This distinctive assemblage, combined with detailed sedimentology, helps identify the presence of Hirnantian Gondwanan glacial sediments on the Arabian Plate. Similar Ordovician admixed assemblages have been recognized from Upper Ordovician glacial sediments elsewhere along the Gondwanan margin. Within Saudi Arabia the composition of reworked assemblages depends upon the stratigraphic succession exposed to glacial erosion. *Sylvanidium? hawbanense*, which is one of the acritarchs found in glacial sediments, is newly described from Arabian Upper Ordovician strata.

**Breuer, P., A. Al-Ghazi, M. Al-Ruwaili, K.T. Higgs, P. Steemans and C.H. Wellman 2007. Early to Middle Devonian miospores from northern Saudi Arabia. In, F. Paris, B. Owens and M.A. Miller (Eds.), Palaeozoic Palynology of the Arabian Plate and Adjacent Areas. Revue de micropaléontologie, v. 50, no. 1, p. 27-57. Elsevier.**

Well-preserved palynomorph assemblages were recovered from the Devonian Jauf and Jubah formations in five shallow boreholes in the northern part of Saudi Arabia. These fully cored boreholes overlap stratigraphically to form a 1,640 ft composite sequence. Miospores dominate the palynological assemblages of most samples. The assemblages are mainly composed of trilete spores but also contain cryptospores and monolete spores. One new genus, sixteen new species and two new varieties of miospores are described from the studied assemblages: *Artemopyra inconspicua* nov. sp., *Artemopyra recticosta* nov. sp., *Camarozonotriletes filatoffii* nov. sp., *Camarozonotriletes rugulosus* nov. sp., *Cymbohilates baqaensis* nov. sp., *Cymbohilates comptulus* nov. sp., *Cymbohilates heteroverrucosus* nov. sp., *Cymbosporites asymmetricus* nov. sp., *Dibolisporites pilatus* nov. sp., *Dictyotriletes biornatus* nov. sp., *Gneudnaspora divellomedia* (Chibrikova) Balme, 1988 var. *divellomedia*, *Gneudnaspora divellomedia* (Chibrikova) Balme, 1988 var. minor nov. var., *Latosporites ovalis* nov. sp., *Scylaspora costulosa* nov. sp., *Squamispora arabica* nov. gen. and sp., *Stellatispora multicostata* nov. sp., *Zonotriletes armillatus* nov. sp. and *Zonotriletes simplicissimus* nov. sp. Their stratigraphic distribution is compared to the well-established Devonian West European zonation of Streeel et al. (1987) (M. Streeel, K.T. Higgs, S. Loboziak, W. Riegel, P. Steemans 1987). Spore stratigraphy and correlation with faunas and floras in the type marine Devonian of the Ardenne-Rhenish region (Review of Palaeobotany and Palynology, v. 50, p. 211-219). A late Pragian-Givetian age is suggested for this sequence. No characteristic Eifelian taxa are recorded, but this could be explained by a gap in palyniferous samples.

**Al-Ghazi, A. 2007. New evidence for the Early Devonian age of the Jauf Formation in northern Saudi Arabia. In, F. Paris, B. Owens and M.A. Miller (Eds.), Palaeozoic Palynology of the Arabian Plate and Adjacent Areas. Revue de micropaléontologie, v. 50, no. 1, p. 59-72. Elsevier.**

Well-preserved Early Devonian continental and sparse marine palynomorph assemblages recovered from an exploration borehole located in northern Saudi Arabia are reported here and add to the understanding of Arabian Devonian stratigraphy. The units examined are the conventionally cored lower Murayr, upper Hammamiyat and Sha'iba members of the Jauf Formation. A comparison with data sets from elsewhere in the Arabian Plate suggests

that the units examined are Emsian in age. The age of the Murayr and Hammamiyat boundary interval is revised, based on the occurrence of *Dibolisporites eifeliensis* in northern Saudi Arabia, and placed in the *Rhabdosporites minutus* (Min) Interval Zone of the *Emphanisporites foveolatus-Verrucosisorites dubia* (FD) Opper Zone. A new miospore, *Apiculiretusispora densa* with distinctive inter-radial thickenings, is described.

**Marshall, J., M.A. Miller, J. Filatoff and K. Al-Shahab 2007. Two new Middle Devonian megaspores from Saudi Arabia. In, F. Paris, B. Owens and M.A. Miller (Eds.), Palaeozoic Palynology of the Arabian Plate and Adjacent Areas. Revue de micropaléontologie, v. 50, no. 1, p. 73-80. Elsevier.**

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.

**Paris, F., A. Le Hérisse, O. Monod, H. Kozlu, J.-F. Ghienne, W.T. Dean, M. Vecoli and Y. Günay 2007. Ordovician chitinozoans and acritarchs from southern and southeastern Turkey. In, F. Paris, B. Owens and M.A. Miller (Eds.), Palaeozoic Palynology of the Arabian Plate and Adjacent Areas. Revue de micropaléontologie, v. 50, no. 1, p. 81-107. Elsevier.**

Revision of the lithostratigraphy of Ordovician deposits in southern and southeastern Turkey led to a re-evaluation of the age assignments of formations identified in the subsurface and at outcrop. Previous datings were based on macrofauna (mainly trilobites and graptolites). The present paper focuses exclusively on organic-walled microfossils (chitinozoans and acritarchs), which provide numerous chronostratigraphical improvements, especially in successions barren or poor in macrofossils. Close to 200 samples were collected in the Taurus chain (i.e. from Kemer, Seydisehir, Ovacik, Kozan, to Sariz regions in southern Turkey) and in the Border Folds (Mardin and Hakkari regions), usually regarded as part of the Arabian Plate in palaeogeographical reconstructions. Many samples are productive and yield chitinozoans and/or acritarchs of extremely variable preservation, depending on their geographical and geological location. In the Taurus chain, the material is "coalified" and frequently fragmented, whereas in the Border Folds, maturation of the organic matter is much lower and preservation of

the microfossils is good to excellent. Several Ordovician chitinozoan biozones (northern Gondwana zonation) as well as diagnostic acritarch assemblages are identified in southern and southeastern Turkey. These Ordovician formations are assigned here to the new global stages of the Ordovician chronostratigraphical scale. The Seydisehir (upper part), Sobova, and Kilgen Lake (lower part) formations are referred to the Darriwilian. The Kilgen Lake (upper part), Sort Tepe, and Bedinan formations are attributed to the Sandbian and to the Katian, and the Halevikdere Formation (glacio-marine part) is assigned to the Hirnantian. Reworking of Early Ordovician acritarchs is documented in pre-glacial and in glacial Late Ordovician deposits. They indicate that active erosive processes occurred during the Middle and Late Ordovician sedimentation. The organic-walled microfossils recorded in the Ordovician of south and southeastern Turkey belong to the northern Gondwana realm. Interestingly however, some Baltoscandian influences are noted in the Border Folds during early Late Ordovician.

**Kermandji, A.M.H. 2007. Silurian-Devonian miospores from the western and central Algeria. In, F. Paris, B. Owens and M.A. Miller (Eds.), Palaeozoic Palynology of the Arabian Plate and Adjacent Areas. Revue de micropaléontologie, v. 50, no. 1, p. 109-128. Elsevier.**

The age of Rock Units B1 and B2 of the middle Silurian-Lower Devonian of Sahara (Algeria) is assessed and confirmed as late Homeric to ?earliest Lochkovian on the basis of moderately well-preserved miospore assemblages. The data upon which this age assessment is provided by recent palynological studies in the Cantabrian Mountains (NW Spain), the type Wenlock area, Shropshire (England), south and south-west Wales, the Midland Valley of Scotland and the Ghadames Basin, Libya. Quantitative study shows that cryptospores decrease in number and variety upwards, laevigate miospores are prevalent and the representatives of the rugulate, crassitate genus *Scylaspora* are dominant. The occurrence and range of these species as well as other miospore taxa recorded during this study provide the basis for recognizing three miospore assemblage and one interval biozones, namely *Scylaspora vetusta*–*Scylaspora kozlica*, *Chelinospora sanpetrensis*–*Cymbosporites triangulatus*, *Chelinospora hemiesferica* and *Scylaspora radiata*–*Apiculiretusispora synoria*. Of these biozones, two assemblage biozones are proposed as new. Core samples of Rock Unit B1 from borehole NGS-1 of the Triassic Province contain the oldest two miospore assemblage biozones. Rock Unit B2 from the boreholes GMD-2, ISS-1 (Tidikelt Plateau) and NGS-1 (Triassic Province) comprise the youngest two miospore biozones. The assemblage and interval biozones allow inter-regional correlation with latest Middle Silurian to probably earliest Devonian strata. The inadequacy of coverage of core samples result in the absence of critical palynological evidence, to determine

the exact position of the base of the Ludlow, Pridoli and Lochkovian. Comparison with the zonal and sub-zonal divisions of Mid-Palaeozoic sequences from other parts of the world shows crucial differences in the distribution of the spore flora within Gondwanan and Euramerican regions during Pridoli and early Lochkovian. Six new miospore species namely *Retusotriletes delicatus* nov. sp., *Scylaspora cymba* nov. sp., *S. distincta* nov. sp., *S. radiata* nov. sp., *S. undulata* nov. sp. and *Cymbosporites triangulatus* nov. sp. are described. Three more possibly new miospore forms are described and illustrated but not specifically named.

**Ghavidel-syooki, M. and B. Owens 2007. Palynostratigraphy and palaeogeography of the Padeha, Khoshyeilagh, and Mobarak formations in the eastern Alborz Range (Kopet-Dagh region), northeastern Iran. In, F. Paris, B. Owens and M.A. Miller (Eds.), Palaeozoic Palynology of the Arabian Plate and Adjacent Areas. Revue de micropaléontologie, v. 50, no. 1, p. 129-144. Elsevier.**

A total of 113 surface samples collected from the Padeha, Khoshyeilagh, and Mobarak formations of Kuh-e-Ozum, northeast of Jajarm town, were processed for palynomorphs, in order to determine age relationships. Well-preserved and abundant palynomorphs dominated by organic-walled, marine microphytoplankton (acritarchs and prasinophyte phycmata), miospores and subordinate chitinozoans, and scolecodonts were recovered. Seven species of prasinophyte phycmata (four genera), 19 acritarch species (14 genera), one species of chitinozoa, and 26 miospore species (19 genera) were recorded and assigned to eight local Assemblage Zones. Assemblage Zones I–IV occur in the Padeha Formation and suggest an early Late Devonian (Frasnian) age whilst assemblages zones V–VII are present in the Khoshyeilagh Formation and indicate Late Devonian (Famennian) ages. Assemblage zone VIII, which occurs in the basal part of Mobarak Formation, suggests a Lower Mississippian (Tournaisian) age for this formation. Many of the palynomorph groups encountered are closely comparable with coeval assemblages recorded from Western Australia, southwest Ireland, England, Turkey, Saudi Arabia, North Africa, and South America, indicating the close relationship of the Iranian Platform to other parts of the northern Gondwana Domain during the time interval represented by these strata. The presence of marine palynomorphs (acritarchs/prasinophyte phycmata, chitinozoans, and scolecodonts), and shelly macrofauna (brachiopods, gastropods, and corals) in Member c of the Padeha Formation (as well as the Khoshyeilagh and Mobarak formations), together with associated miospores, indicate an open marine (moderately nearshore) depositional environment for the Upper Devonian and Lower Carboniferous deposits in northeastern Alborz Range (Kopet-Dagh region) of Iran.