Palynological analysis of some core samples from the Northwestern edge of Sirt basin

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Palynological analysis of some core samples from the well T/2D/79/79 which penetrates the Memoniat Formation and the Tanezzuft Formation in the northwestern edge of the Sirt Basin indicates the presence of two distinguished assemblages. These were compared with similar assemblages described from other parts of Libya.

Shale deposits from the lower part of this horizon contain well preserved species of acritharch, *Baltisphaeridium longispinosus delicatum, Baltisphaeridium. aliquigranulum, Veryhaqchium irroratum* and *Villosacapsula steosapelliula*. Comparison of this assemblage with those studied by Hill and Molyneux (1988) and Grignani et al. (1991) indicate that this level of the Memoniat Formation belongs to the Ashgillian.

Sample from the upper part of the studied horizon are composed of graptolitic shales and contain distinguished species of acritarchs, such as *Ammonidium microladium, Cymbosphaeridium pillaris, Leiofusa estrecha, Leiosphaeridia wenlockia* and *Micrhystridium stellatum*, and a small association of chitinozoa composed of *Cingulochitina cingulata, Sphaerochitina longicollis* and *Conochitina convexa*. The spore association is more diversified and contains *Ambitosporites ambitus, A. avitus, Synorisporites verrucatus*.

Comparison of this assemblage with the assemblages described by Al-ameri (1983) and Tekbali and Wood (1991) attributes this level of the Tanezzuft Formation to the Wenlockian-Ludlovian.

Because the studied borehole is located between the Sirt and Ghadamis basins, it can offer paleogeographic and paleoenvironmental parameters, which can be used in the correlation of oil and water reservoirs.

Poster session g4

UPPER PALAEOZOIC PALYNOLOGY / CIMP SIMPOSIUM

The spores of Upper Devonian plants and the dispersed spore morphones

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This investigation is based on the studying of in situ mega- and microspores extracted from Tanaitis furcihasta Krassilov, Rask.et Istch. Sporangium which is intermediate between the progymnospermous order of Aneurophytales and Archaeopteridales, spores from dispersed sporangia of the Late Devonian pteridophytes with an emphasis on their variation and dispersal miospores picked out during bulk maceration of the rock matrix around Tanaitis from the Lower Frasnian deposits (Lower Upper Devonian) of Pavlovsk in the upper reaches of the Don River (Russia).

In modern palynology, classification of dispersed sporomorphs is based on the formal system of Naumova (1953), as well as on the congregational system of Potonie and Kremp (1954; Potonie, 1956, 1958). Both these systems deal with single organ parataxa unrelated to whole plant taxa (eutaxa). However, classification of dispersed sporomorphs takes into account the variability in similar morphotypes in the eutaxa, as well as preservation and morphological variation in each sample. By this criteria parataxa are made comparable with respective eutaxa. However, only in situ records of spores, classified as parataxa, give evidence of their taxonomic affinities in the system of eutaxa.

The importance of this and similar studies of in situ spores cannot be over-emphasized.

This paper describes the wide variety of spores present in numerous sporangia of Tanaitis and in situ spores from dispersed sporangia of the Late Devonian pteridophytes with an emphasis on their variation. The spores are easily identifiable in dispersed spore assemblages because of their distinctive sculpture. Dispersed spores, many identical to those found in situ, were investigated from Lower Frasnian strata and are considered to belong to one morphospecies. Within this species we describe several informal variants referred to numbered types and subtypes. This sequence of assemblages of types we regard as a single species morphon. A morphon has been defined as a group of palynological united by continuous variation of morphological characteristics. As from taxa and taxonomic levels are subjective, we are extending the morphon concept to include groups of informal units at any taxonomic level that are interconnected by continuous variation. Within the morphon of Tanaitis spores, and spores inferred to belong to this plant genus, the morphographic ranges and proportions of types vary through geological time. At a particular geological horizon, the pattern of types and subtypes constitutes a palynodeme, which may be unique in its range of variation.

The morphographic variation is mainly between the spores of different sporangia of Tanaitis and dispersed sporangia. Spores from an individual sporangium commonly belong to a single type.

In situ spores show a number of basic features in common, but the variation is considerable and affects all three sculptural areas: distal, equatorial and curvatural. The central body is visible on some specimens. The descriptions are based entirely on in situ spores, but when possible, dispersed spores from the rock matrix are included for comparison.

Tanaitis furcihasta is heterosporous and has yielded megaspores similar to the spore species Contagisporites optivus (Tschibr.) Owens 1971 and microspores similar to spore species Geminospora rugosa (Naumova) Obuch., G.micromanifesta (Naumova) Archang.1985.

Geminospora-type microspores were also found in the dispersed sporangia, containing numerous microspores singly and in tetrads. Most of megaspores from dispersed sporangia are assignable to the morphological genera Biharisporites.

Such information could, if better understood in an evolutionary context, vastly increase our knowledge of the evolution, distribution and habitats of Devonian land floras. Dispersed spore records greatly exceed those of their parent plants, and the key to this treasure chest of data is the study of in situ spores: studies of the diversity of in situ spores and how they change in time may give clues to evolutionary pathways of dispersed spores and their parent plants which neither plants nor spores alone can give.

Chitinozoan response to the Frasnian/Famennian biotic crisis in the Holy Cross Mountains (Kielce region), Poland

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Organic-walled microfossils (chitinozoans, tasmanaceans and scolecodonts) were investigated in the Frasnian/Famennian boundary interval comprising rhytmic calcareous-marly sequences at Plucki and Kowala sections located in the Kielce region of the Holy Cross Mountains (HCM; Małopolska Massif) in southern Poland (Racki et al. 2002).

The abundant Chitinozoan occurrence in the basal bed of the Kellwasser interval coincides with a short-term transgressive pulse in the linguiformis conodont Zone. This very rich abundance of the chitinozoans has been correlated with the fluctuation of the other palynomorphs (Filipiak 2002), conodonts (Dzik 2002, Racki et al. 2002), ostracods (Casier et al. 2002; Olempska 2002), and brachiopods (Baliński 2002) present in the same beds of investigated sections, as well as with sedimentological and environmental factors. The upper part of the Frasnian beds in both sections, corresponding to the Upper Kellwasser Crisis level and correlated with short-term regressive pulse, contains only few chitinozoans (*Angochitina, Cingulochitina, Fungochitina* and *Sphaerochitina*), but other palynomorphs, particularly spherical prasinophycean green algae and scolecodonts are common in the same beds.

Palynological results from HCM sections are similar to those of previous records of the F-F boundary beds at La Serre, Montagne Noire, Southern France (Paris et al. 1996), but the chitinozoan response to the Kellwasser bio-event in Poland appears earlier than in France. The frequency distribution of chitinozoans recovered from Frasnian/Famennian sediments in the Holy Cross Mountains is discussed with a particular

attention to the consequence of the Frasnian-Famennian extinction events (e.g., Schindler 1993, McGhee 1996, Walliser 1996).

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Devonian-Carboniferous acritarchs from central part of Badajoz Province (Ossa-Morena Zone, SW Spain)

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The palynological content of the Robledillo section in the area of Los Santos de Maimona (Ossa-Morena Zone, SW Spain) has been analyzed in order to obtain new biostratigraphic data. A detailed stratigraphical analysis of this section allows us to differentiate four lithostratigraphic units in the rank of formations:
Lower detritic unit: The lower part consists of alternations of fine sandstones, calcareous siltstones and limestones. The upper part is characterized by a higher proportion of sandstone levels, the absence of limestones and, towards the top, the appearance of pyroclastic levels with abundant plant remains (*Lepidodendron* and *Stigmaria*).

Volcanosedimentary unit: This unit consists mainly of volcanosedimentary material, including pyroclastic levels, dacitic and andesitic rocks, volcanic breccias, mudstones, sandstones, marls and limestones. It contains abundant macrofossils, which include colonial corals, brachiopods, gastropods and trilobites. **Carbonate unit**: This unit consists of rhythmic alternations of limestones and calcareous mudstones. **Upper detritic unit**: This unit consists mainly of mudstones.

The lower detritic unit shows high diversity and abundance of acritarchs in the lower part, some of which are characteristic of the middle and upper Devonian. The following genera have been recognized: *Baltisphaeridium, Comasphaeridium, Cymatiosphaera, Duvernaysphaera?, Elektoriskos?, Gorgonisphaeridium, Leiofusa?, Leiosphaeridia, Lophosphaeridium, Micrhystridium, Multiplicisphaeridium, Pterospermella, Solisphaeridium, Stellinium, Unellium?, Veryhachium.* Acritarch diversity drops drastically with the appearance of first pyroclastic levels.

The upper three units show a continuous acritarch record of low species diversity. The recovered acritarchs species are not age diagnostic, but previously reported fossils, including foraminiferans and corals (RODRÍGUEZ *et al.* 1992), indicate a Visean age for these sediments.

The high acritarch diversity and the presence of species characteristic of the Devonian (*Micrhystridium stellatum, Multiplicisphaeridium ramispinosum, Pterospermella capitana, Uncinisphaera lappa, Veryhachium downei, Veryhachium roscidum*) in the lower detritic unit contradict the current stratigraphical and depositional model, which invokes emergence (or non-deposition) of the study area during the Devonian (COLMENERO *et al.*, 2002). The new data presented here indicate that the sediments of the lower part of the section were deposited during the Devonian, and suggest that the Devonian-Carboniferous boundary in the Ossa-Morena Zone coincides with the first appearance of volcanoclastic rocks, as previously suggested by VALENZUELA *et al.* (1990). This data is in accordance with recent palynological data in the Iberian Pyrite Belt (MORENO *et al.*, 2003).

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Palynostratigraphy of the Phyllite-Quartzite Group in the easternmost sector of the Iberian Pyrite Belt, SW Spain.

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This work summarises the palynological analysis carried out in the lower part of the Phyllite-Quartzite Group of the Iberian Pyrite Belt (IPB). The IPB, located in the south-western corner of the Iberian Peninsula, represents one of the world's major metallogenetic provinces, including sulphide deposits as well-known as Riotinto, Tharsis, Aljustrel or Neves-Corvo. Its stratigraphic sequence is constituted by both volcanic and sedimentary rocks of Devonian and Carboniferous age, which traditionally have been subdivided into three main stratigraphical units: the Devonian pre-volcanic sedimentary rocks (PQ Group); a complex sequence of volcanic, sedimentary and volcanoclastic rocks, where the ore bodies cited above are emplaced (Volcano-Sedimentary Complex); and the post-volcanic upper Visean to Westphalian Culm facies deposits (Culm Group).

The paleontological record of the IPB is poor. Most of the age data are provided by goniatites, generally associated with diagenetic concretions included into shaly levels, and by the sparse amount of conodonts included into the equally sparse carbonate lenses scattered throughout the region. During the last time, Palynology has turned into one of the most efficient biostratigraphic tool in the region.

The studied unit, PQ Group, represents the base of the outcropping series of the IPB. Most of stratigraphical record of the PQ is constituted by a monotonous detrital sequence of shales with quartzites and quartzwackes as subordinated litologies. At the top, this unit contains a complex mixture of conglomerates, sandstones, carbonate lenses and shale levels.

Samples were taken from the easternmost area of the IPB, where the oldest rocks of the PQ Group outcrop due to the combined effect of 1) Variscan tectonic, 2) post-Terciary Iberian Plateau tilt and, 3) erosive processes –denudation-. Twenty three shaly samples were collected, of which 11 yielded well preserved to moderately well preserved palynomorphs. Most of the samples contain mainly trilete miospores and, in a second

order, organic-walled microphytoplancton (both acritarchs and prasinophyte phycomata). The miospore assemblage contains taxa representative of the Middle to Upper Devonian. The species biostratigraphically most relevant are *Chelinospora concinna, Cristatisporites triangulatus, Geminospora lemurata, Retusotriletes rugulatus, Aneurospora greggsii* and *Verrucosisporites scurrus*. These taxa define a stratigraphical range comprising the Biozones *optivus-triangulatus* and *ovalis-bulliferus*, which implies an upper Givetian-lower Famennian age, the oldest age established in the IPB.

Concerning the marine microflora, the most noticeable feature is the record of different taxa of prasinophyte phycomata assignable to the genus *Maranhites* such *M. mosesii, M. brasiliensis* and *M. britoii*, indicatives of a higher vertical stratigraphic range comprising Middle and Upper Devonian age. The acritarch content includes sparse specimens of *Gorgonisphaeridium* spp. erratically recorded.

Evidence from the palynological assemblage suggests a shallow marine environment close to mainland consistent with the interpretation provided by previous sedimentological studies.

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New data on the palynostratigraphy of the Carboniferous succession of Variscan externides (SW Poland)

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The monotonous Carboniferous turbidite succession of Varicsan externides, occurring under the Foresudetic Monocline, was studied palynologically. These studies provided new and interesting palynostratigraphical data. Miospores were obtained from rock samples from 10 boreholes. Majoryty of the studied rocks haven't had a palaeontological documentation until now. Thermal maturity of the organic matter was various and represented all stages - from mature to metamorphosed. The precision of the stratigraphical conclusions was limited by the general poor preservation of miospores.

Results of the palynostratigraphical studies indicate that two rock successions of different age occur in the studied profiles. The older one is of Viséan? and/or Early Namurian age and was recorded in all of the boreholes. Age of the rock samples with poor preserved miospore assamblages was interpreted as Viséan-Namurian. Rich and well preserved miospore associations with *Kraeuselisporites ornatus, K. echinatus, Crassispora kosankei, C. maculosa, Rotaspora spp., Savitrisporites nux, Grandispora spinosa, Schulzospora spp., Secarisporites remotus, Spinozonotriletes uncatus* and *Bellispores nitidus* from three boreholes allowed to limit their age to Namurian A. In profiles Siciny IG 1 and Marcinki IG 1 the younger rock succession was recorded. Presence of taxa *Torispora secutis, Microreticulatisporites nobilis, Triqutrites sculptilis, Vestispora laevigata and V. costata* indicate on its Westphalian C age. In the latter rocks reworked miospores of Viséan-Namurian age were recorded. The duplication of stratigraphic intervals in these two profiles and no evidence of the Upper Namurian and Lower Westphalian rocks in the studied boreholes indicates an important role of thrust tectonics in that area.

Palaeoenvironmental evolution of the Itararé Subgroup at Itaporanga (Upper Carboniferous, Paraná Basin), São Paulo State, Brazil, based on paleontologic and palynofacies data

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New palynological data are presented from the Itararé Subgroup, which is related to the Permocarboniferous Gondwana glacial event in the Brazilian Paraná Basin and includes marine and continental strata. This study is based on four fertile core levels from the IG-01 borehole at Itaporanga, São Paulo State, northeastern basin. The section analysed corresponds to the middle-upper part of the Itararé Subgroup and revealed rich palynological assemblages. Thirty species of spores, seventeen monosaccate pollen grains (one species striate), six bisaccate pollen grains (two species striated), one praecolpate pollen grain species and other, colpate were identified from a total of fifty-eight miospore species. Paleophytoplankton species like *Deusilites tenuistriatus* Gutiérrez, Césari and Archangelsky, *Botryococcus braunii* Kützing and *Brazilea scissa* (Balme and Hennelly) Foster have also been recognised. Seven species of spores and one of pollen grain are recorded for the first time in the Brazilian Paraná Basin: *Retusotriletes anfractus* Menéndez and Azcuy, *Cyclogranisporites firmus* Jones and Truswell, *Apiculatasporites parviapiculatus* Azcuy, *Dibolisporites disfacies* Jones and Truswell, *Convolutispora muriornata* Menéndez, *Cristatisporites stellatus* (Azcuy) Gutiérrez and Limarino, *Kraeuselisporites volkheimerii* Azcuy and *Circumplicatipollis plicatus* Ottone and Azcuy. Taxonomic results, including a new species of spore and a new genus combination were presented by Di Pasquo *et al.* (2003a; 2003b).

Taking into account previous paleontological information from this well related to marine bivalves and brachiopods, palynological composition, botanical affinities, palynofacies characters, and lithology, an evolution of the palaeoenvironment / paleoclimatic conditions of depocentre is proposed. A first stage reflecting estuarine conditions is registered at the 76 m level. A second one linked with restricted coastal lagoon and dry-wet temperate seasonally climate features, corresponds to the 54 m level. The last episode interpreted as a low energy and normal salinity shelf setting is recognized at the 37 m and 36,5 m levels. Therefore, a relative sea-level rise upward the upper section of the Itararé Subgroup is recognised. This transgressive event may correlate with the retreat of glaciers during an interglacial period.

Marine invertebrates comprise species distributed from the Late Carboniferous to the Early Permian in Brazil and correlated Gondwana basins, preventing their use in correlation and as biostratigraphical markers. Besides, they have been found in low diversity. The palynological assemblages are attributed to the Late Carboniferous *Crucisaccites monoletus* Interval Zone (Souza, 2000; Souza & Marques-Toigo, 2001), in which spores and monosaccate pollen grains are dominant.

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On the fine morphology of *Plicatipollenites malabarensis* (Potonié & Sah) Foster 1975

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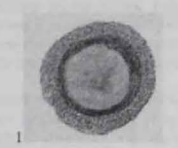
The trilete monosaccate pollen taxon, *Plicatipollenites malabarensis* is characterized by radial symmetry, a prominent trilete mark and a continuous endexinal fold encircling the pollen corpus. Pollen grains of the taxon from the Early Permian of the Arabian Peninsula were studied using light microscopy (LM, Fig. 1), scanning electron microscopy (SEM), and transmission electron microscopy (TEM). A "crochet-like" sculpture is visible on the both sides of the corpus in SEM (Fig. 2, 3). On TEM ultramicrographs this sculpture is distinguishable as a thin undulated ectexinal layer. The dark area around the proximal trilete mark (LM) is caused by a slight thickening of the endexine in that area, though the ectexine does not change in thickness or morphology

in this region. The reticulate ornament of the saccus, as shown in LM, is formed by superficial folds visible with SEM (Fig. 2) and inner ectexinal partitions (TEM).

TEM demonstrates that the saccus is hollow with ectexinal partitions, many of which are radially oriented. This taxon was previously described as protosaccate (Foster, 1979); although most of these partitions reach the underlying layer, the protosaccate appearance might be due to compression. The endexine is prominent and homogeneous; at the region of the fold (where there is less compression) several lamellas are visible.

Of great interest is comparison between this material and the ultrastructure of monosaccate pollen grains of *Cordaitina* Samoilovich from the Permian of Angaraland (Zavialova et al., 2002). Both taxa show a very similar sculpture of the corpus surface. They are also similar in the thick, apparently homogeneous but ontogenetically lamellate endexine, and in the thickening of the endexine which is present around the proximal trilete mark. This similarity is important since the genera *Plicatipollenites* Lele 1964 (and *Cannanoropollis* Potonié & Sah 1960) are generally used by taxonomists in the Gondwana palaeophytogeographic province, while in Angaraland and the Euramerican province *Cordaitina* is used. Attempts have been made to compare the ultrastructure of *Cordaitina* and taxa such as *Plicatipollenites* and *Cannanoropollis* using SEM, TEM and LM (e.g. Powis 1979) but we consider that these comparisons were inconclusive. This preliminary report, which is part of a larger project, will attempt a more detailed comparison.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Palynostratigraphy of Givetian deposits in the Volgograd Povolzhye region, Russia

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The Givetian stage is characterized by persistent lithology, fauna and miospore complexes. It is mainly composed of terrigenous deposits and is dismembered to form three horizons: Vorobievian, Ardatovian and Moullinian. *Geminospora extensa* zone in the Russian platform corresponds to the Givetian stage. Three subzones corresponding to these horizons are allocated within zone Geminospora extensa. The lower zone boundary is one of the most precise in the total of the Devonian section.

The lower subzone *Cymbosporites magnificus-Hymenozonotriletes tichonovitschi* corresponds to the Vorobievian horizon. The lower boundary of Vorobievian horizon is determined by the change of Chernoyarian horizon argillites with sandstones and aleurolites containing Vorobievian complex of miospores, brachyopods and ostracods. Spore complex of this subzone is represented by the following species: *Cymbosporites magnificus, Hymenozonotriletes tichonovitschi, Geminospora micromanifesta, G.extensa, G.tuberculata, Archaeozonotriletes timanicus, A.gravis, Lanatisporites bislimbatus, Camarozonotriletes minutus*, etc. *H tichonovitschi* species-index is vanishing in this zone. Except for species listed before, there are traced spores passing from the Eifelian deposits: *Rhabdosporites langii, Grandispora velata, Densosporites devonicus, Cirratriradites monogrammos*, and also forms of wider vertical expansion: *Stenozonotriletes formosus, Lophozonotriletes scurrus, L.grandis*, etc.

The spore complex of this subzone is almost similar to spore complexes from Vorobievian deposits of the central and east regions in Russian platform (Raskatova, 1969; Tchibrikova, 1977; Arkhangelskaya, 1985; Avkhimovich et al., 1993; Rodionova et al., 1995).

The middle subzone *Vallatisporites celeber-Grandispora violabila* corresponds to the Ardatovian horizon. Species passing from the underlying subzone are mainly distributed in this subzone with *Vallatisporites celeber, Cirratriradites monogrammos, C.punctomonogrammos* vanishing here. The quantity and the variety of *Geminospora* genus are still increasing. Prevailing are: *Geminospora vulgata, G.tuberculata, G.decora, G. micromanifesta, Chelinospora concinna*. Constantly are present *Geminospora extensa, Lophozonotriletes scurrus, L. grandis*. *V.celeber-G.violabila* spore complex is almost similar to palynocomplexes determined in the Ardatovian horizon of Russian platform (Raskatova, 1969; Tchibrikova, 1977; Arkhangelskaya, 1985; M.Raskatova, 1990; Avkhimovich et all, 1993; Rodionova et al., 1995). Besides, two lower subzones of the Givetian stage may be compared to *Geminospora lemurata - Cymbosporites magnificus* zone in the Western Europe (Richardson and McGregor, 1986).

The upper subzone *Cristatisporites triangulatus-Corystisporites serratus* corresponds to the Moullinian horizon. The typical spore complex of this subzone consists of *Cristatisporites triangulatus, Perotrilites spinosus, Corystisporites serratus, Geminospora vulgata, G.micromanifesta, G.rugosa., Cymbosporites magnificus, Densosporites cassiformis, D.cassiformis var. clarus*. Two last species are actually absent in the underlying Ardatovian deposits. *Archaeozonotriletes variabilis, Azonomonoletes costatus, Cristatisporites inusitatus*, etc. are much less in their number. The upper subzone part is also characterized by the presence of *Ancyrospora incisa* and *A.fidus*. Besides, small transition spores of *Acanthotriletes, Diatomozonotriletes, Retusotriletes* species are also met here. This spore complex is compared with palynocomplex of the Moullinian horizon in the Volga-Urals region and the Russian platform (Tchibrikova, 1962, 1977; Raskatova, 1969; Arkhangelskaya, 1974; Avkhimovich et al., 1993; Rodionova et al., 1995; etc.) as well as in the lower part of zones *Contagisporites optivus-Cristatisporites triangulatus* in the Western Europe (Richardson and McGregor, 1986).

Judging by lithology, the Givetian stage upper boundary is determined by the change of the Moullian argillites with sandstones of the Pashiyaian horizon (*Ancyrospora incisa-Geminospora micromanifesta* subzone). Judging by palynological data, *G. extensa* zone upper boundary is less distinct than the lower one. The change of dominants in the spore complexes is mainly seen here at the species level. In the upper part of the Moullian horizon, alongside with the Givetian forms, there are seen species that are widely distributed in the overlying Pashiyian horizon of the Frasnian stage. They are mainly represented by *Geminospora micromanifesta, G.rugosa, Spelaeotriletes krestovnikovii, Ancyrospora incisa, A. fidus., Perotrilites spinosus, Reticulatisporites retiformis*, etc. On the whole, *Geminospora extensa* zone in the Volgograd Povolzhye is to a definite degree similar to the upper part of the triangulatus-ancyrea (TA) zone and the lower part of a triangulatus-concinna (TC_0) zone in the Western Europe (Loboziak, Streel, 1981; Loboziak, 1983; Streel et al., 1987).

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Occurrence of palynofossils in the Lower Gondwana sediments exposed in and around Singrimari, West Garo Hill district, Meghalaya and Dhubri district, Assam, India

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The occurrence of Lower Gondwana Palynofossils assemblage has been recorded from the sediments of Singrimari area of Meghalaya and Dhubri district of Assam. The recorded palyno assemblage includes genera like verticipollenites, gnetaceaepollenites, dentatispora, alisporites, divarisaccus, parasaccites cyclogranisporites, etc. The Palynofossils assemblage shows similarity with the palynological assemblages of Lower Gondwana Formations of other parts of India. This assemblage mostly represents the Karharbari and Barakar Formations of Upper Carboniferous to Lower Permian age. The palynofacies is found to be humic and terrestrial under braided nature of environmental set-up.

Applied multivariate statistics to a phylogenetic evolution within a trilete miospore population

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In the 'La Gileppe' outcrop (Eastern Belgium), Lower Devonian miospore assemblages include, among other taxa, five varieties of trilete spores belonging to the genus *Emphanisporites*. These five varieties show a continuous variation of their morphological characteristics. The morphological similarity between these varieties related to the evolution of morphological features allows to define the *Emphanisporites micrornatus* Morphon. A statistical evaluation of this population highlights the interdependence of almost all morphological parameters. Although, sorting and reworking may disturb the evolutionary signal, this study proves the increase in size of ornamental and structural characters over several million years. The biometric changes and the progressive replacement of ancient morphotypes by younger ones indicate that a temporal link exists between these different varieties. Two phylogenetic hypotheses for the *E. micrornatus* Morphon are suggested. This morphological evolution is so far observed on the Eastern Old Red Sandstone Continent only, defining a palaeophytogeographic *micrornatus-zavallatus* Province.

Devonian in situ spores: morphology, evolution and stratigraphy

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The finds of Devonian spores in situ are very rare but they give the very essential information for early history plants reconstruction. Spores of Early Devonian plants are studied most well. They are known at small number in Middle and Late Devonian deposits. Of about 200 Devonian plants have a descriptions of the spores from sporangia now.

The analysis spores in situ has allowed to single out their basic morphological types corresponding to various phylogenetic lines of plants (Telnova, Meyer-Melikyan, 2002). At allocation of these types of spores both morphological features of a sporoderm surface and its ultra thin structure in section were used.

The spores from sporangia of most typical and importante species of Devonian plants from Timan are studied. The representatives of ferns and progymnospermes dominate in Late Devonian flora. The presence of endemic forms gives significant originality to Late Devonian phytocomplexes of Northern Timan. There is licopsids plant *Kossoviella timanica Petrosjan* among them. As a result of detailed studies of its spores it is established that ultra structural peculiarities of megaspores sporoderm of dyed and modern plants is in general similar.

Their sporoderm can consist of one or several layers, more often they have spongy ectexine and lamellar endexine and the degree of condensation of layers is various.

The microspores ultra structure is original in different phylogenetic lines of plants.

The most simple in the structure is homogeneous exine found out both at Devonian and at modern plants. The widely spread type of exine is the cellular structure, which, apparently, represents an initial type of ectexine. The internal sporoderm structure of each specie differs by a smaller rank of ultra structural attributes (density and sizes of cells etc.).

The study of a sporoderm internal structure of dispersed spores, most important for the purposes of stratigraphy, has allowed to establish their systematic connections and to make the conduction biostratigraphic partition of Upper Devonian deposits in the Timan-Pechora province more ground.

The analytical comparison of spores in situ speaks about that some species of spores can be indicators for concrete groups of Devonian plants. It allows (in view of given study ultra thin structure of sporoderm) to correlate dispersed spores with their producers. The new methodological approach in the decision stratigraphic questions

was used in substantiation of phitostratigraphic boundaries in Devonian (appropriate to the border of middle and top departments of Devonian in the Timan-Pechora province).

		Formation	Miospore zones
Late Devonian	Early Frasnian	Ust' Yarega	Cristatisporites deliquescens
Middle Devonian	Givetian	Timan	III Spelaeotriletes domanicus
			II Archaeoperisaccus verrucosus
			I Spelaeotriletes bellus
		Tchib'yu	Acanthotriletes bucerus
			Ancyrospora incisa - Spelaeotriletes krestovnikovii

Aspects of late Westphalian, Cantrabrian palynology of some coalfields in Europe and East Canada

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This paper provides a synthesis of the palynological evidence for the geographical variations in the composition of the coal forests during the late Westphalian and early Cantabrian age. The work is part of a mutidisciplinary research program within the framework of the NATO Science Program (2000-2002).

Using miospore data and the known correlations between miospore taxa and the parent plants, the palaeofloral assemblages have been reconstructed for the Dobrudzha Coal Basin (Bulgaria), the South Wales and Forest of Dean Coalfields (UK) and Sydney Coalfield (Canada) (figs 1-3). This present report summarises the biostratigraphical significance of the fossil spores and pollen from some of the coal seams and clastic material in the different basins, based partly on a reassessment of the palynological preparations made by Dr G. Dolby in Canada, Dr E. Spinner in UK and the senior author in Bulgaria. The results confirm the essential uniformity of the vegetation across the Variscan Foreland, with most of the slight observed differences being due to minor differences in elevation between the coalfields.

In the late Westphalian D, there is some evidence of a progressive increase in the lycophyte, backswamp vegetation, with a distinct "spike" in the *Lycospora* curve observable near the Westphalian - Stephanian boundary. We have been able to refine considerably the palynological biostratigraphy for the upper Westphalian D and lower Cantabrian. The stratigraphically lowest occurrence of the genus *Vesicaspora* coincides with the base of the zone of the macrofloral *Dicksonites plueckenetii* Subzone in the upper Westphalian D. The base of the Cantabrian Stage can be identified approximately with the increases in abundance of the species *Thymospora pseudothiessenii*. *Schopfites dimorphus* and *Cadiospora magna* and the first appearances of *Lundbladispora gigantea* and *Angulisporites splendidus*. In order to understand these changes in the general composition of the vegetation, they need to be examined in the context of the overall palynological spectra in areas such as the Forest of Dean Formation (Cleal, 1991) and South Wales. In addition to these taxa, the presence of abundant *Potonieisporites* (conifers), *Florinites* (cordaits) and *Endosporites* (lycopods) indicate that the vegetation was mainly that growing on the margins of lakes or on riverbanks. Taxa such as striate and non-striate

Monosaccate pollen and Bisaccate pollen, and the spore genera *Cadiospora, Angulisporites* and *Columinisporites* are practically absent from the Stephanian to Early Permiam of northwestern Eyrope, the Cantabrian Mountains and the Stephanian (*Potoniesporites* Zone of Hacquebard, 1997) of the Pictou Group, Canada.

These data have helped refine the stratigraphical correlation of the upper part of the Dobrudzha Coal Basin succession. The continental strata of the Gurkovo Formation is assigned to the *Thymospora* spp. Zone and sees the first regular occurrence of *Thymospora thiessenii* and *T. pseudothiessenii*. Dimitrova (1997) divided the Zone into two subzones at the level of the appearance of the genera *Candidispora, Polymorphisporites, Maculatasporites, Spackmanites, Cadiospora* and *Angulisporites*, and of the species *Spinosporites spinosus* and *S. exiguus*. Using miospore biostratigraphical data from western Europe (Cleal *et al.*, 2003) several of these taxa have been identified as being important indices for the Westphalian - Stephanian boundary, and this has allowed more precise stratigraphical correlations to be achieved for the Dobrudzha succession. The palynological associations are quite similar to those of the OT-ST palynozones of the uppermost Westphalian – lower Stephanian in the scheme of Clayton *et al.* (1997) and for parts of NW Spain (Coquel & Rodriguez, 1994). The Cantabrian part of the succession contains some of the best-preserved adpression floras with cuticles (Dimitrova & Uzunova, 1996) and pollen/spores.

There has been considerable confusion in the past over the positioning of the lower boundary of the Stephanian Series in non-marine sequences. The present study demonstrates the critical importance of palynological biostratigraphy for identifying this boundary.

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Poster session g5

PRE-JURASSIC PALYNOLOGY OF THE ARABIAN PLATE AND THE ADJACENT REGIONS (CIMP/SAUDI ARAMCO)

Detailed morphology of *Vallatisporites arcuatus* (Marques-Toigo) Archangelsky and Gamerro, 1979 from the Early Permian of Arabia

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The zonate spore taxon, *Vallatisporites arcuatus*, first described from the Carboniferous–Permian of Argentina is occasionally present in large numbers in Early Permian sediments of the Arabian Peninsula. The last uphole appearance of the taxon corresponds quite closely to the boundary between the glacigene Jawb Member (Juwayl Formation) and the postglacial Unayzah Formation. Detailed light microscope study has shown that it is strongly camerate, with a distinct intexinal body and a complex zona. The latter's inner part bears a line of minute proximal pits, and displays a well-developed cuniculus. In the Arabian specimens the cuniculus conforms exactly to Sullivan's (1964) definition in that it is positioned at the"..equator of the spore cavity.." and is interpreted to represent 'the space between the margin of the spore cavity and the inner surface of the equatorially expanded exoexine'. The row of pits was first noted by Hacquebard (1957) in *Vallatisporites*. Arabian specimens present a row of pits in the proximal exoexine of the zona. Some pits are open to the proximal surface, while others are wholly internal vacuoles. When the row is composed of closely spaced and large pits, the consequent increased transparency of the zona manifests a narrow 'light band', adjacent to the equatorial camera. The remainder of the zona is dominated by large distinctive oval or rectangular, radially elongate hollows or depressions delimited by distally protuberant arch-shaped or radial thickenings. These hollows or depressions are demonstrably not internal vacuoles. Most Arabian specimens of *V. arcuatus* possess distal galeae, spinae, coni and irregularly shaped (sometimes bifurcant) processes up to 10µm long and 1-2µm wide. The latter elements frequently fuse with the underside of the zona to form radial zonal struts. In the most heavily ornamented specimens, zonal struts are attached to the distally protuberant mid zonal thickening.

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Late Eifelian to earliest Givetian miospore assemblages from central northern Saudi Arabia

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Miospore assemblages from a cored section of shaley sandstones of the Hammamiyat Member, the uppermost part of the Jauf Formation in a borehole located in the central northern part of Saudi Arabia are documented. The full sequence in the borehole which is thought to represent one of the most complete Devonian sections in the northern part of the Kingdom has revealed the presence of well preserved Siegenian to Eifelian or even earliest Givetian miospores.

The composition of the assemblages from this cored interval includes representatives of *Calamospora* sp., *Retusotriletes* spp., *Dibolisporites echinaceus, D.* cf *gibberosus, Emphanisporites spinaeformis, Emphanisporites* sp., *Craspedispora ghadamisensis* and *Geminospora lemurata* and suggests correlation with at least part of the interval between the upper part of the Oppel Zone AD and the overlying Oppel Zone TA of the standard West European zonation of Streel et al. 1987.

Correlations will be suggested with data from the Ghawar Field of central Saudi Arabia (Al-Hajri et al., 1999) and other neighbouring areas.

A new Middle Devonian megaspore from Saudi Arabia

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A morphologically complex Middle Devonian megaspore was recovered from an exploration well located south of the Ghawar oil field, Eastern Province, Saudi Arabia. The palynomorph-bearing material is from a cored siliciclastic interval that contains abundant dispersed megascopic carbonaceous plant fragments and lies