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Program and abstracts

Edited by Philippe STEEMANS & Philippe GERRIENNE

A meeting of the NFSR Working Group:
"Micropaléontologie végétale et Palynologie (MVP)"

Palaeobiogeology, Palaeobotany, Palaeopalynology
University of Liège
December, 2016

Program

09h30-10h00 - Welcome coffee

10h00-10h40 – **Vivi VAJDA:** Keynote - The Chicxulub impact – a perfect astrobiological laboratory.

10h40-11h00 – **Marie Catherine SFORNA, M. DAYE, P. PHILIPPOT, M. A. VAN ZUILEN, E. GÉRARD, A. SOMOGYI, K. MEDJOUBI, F. JAMME, C. DUPRAZ, O. BRAISSANT, C. GLUNK & P. T. VISSCHER -**Patterns of metal distribution in hypersaline microbialites: Implications for the fossil record.

11h00-11h20 - **Camille FRANÇOIS, Blaise KABAMBA BALUDIKAY, Jean-Louis BIRCK, Daniel BAUDET, Jean-Yves STORME, Jean-Louis PAQUETTE, Michel FIALIN, Vinciane DEBAILLE & Emmanuelle J. JAVAUX -** Several dating approaches of a sedimentary sequence: application to the Mbuji-Mayi Supergroup (Proterozoic, DRCongo) to constrain the diversification of early eukaryotes in Central Africa.

11h20-11h40 – **Corentin LORON & Emmanuelle J. JAVAUX -** Diversity and paleobiology of Proterozoic organic-walled microfossils.

11h40-12h00 - **Yohan CORNET & Emmanuelle J. JAVAUX -** Microanalyzes of remarkable microfossils of the Late Mesoproterozoic–Early Neoproterozoic

12h00-12h10 – **Vivi VAJDA -** Ordovician land plant spores of Sweden

12h10-12h30 – **Philippe STEEMANS, Pierre BREUER, Saïd AL-HAJRI, Alain LE HÉRISSÉ, Florentin PARIS, Jacques VERNIERS & C.H. WELLMAN -** Biostratigraphy of the JLMD-EW8 borehole and palaeogeographic interpretation

12h30-14h00 – Lunch (Sandwiches)

14h00-14h20 – **Philippe GERRIENNE, Oive TINN, Gerard J. M. VERSTEEGH, Borja CASCALES-MIÑANA, Kalle KIRSIMÄE, Leho AINSAAR, Viirika MASTIK, Tõnu PANI, Thomas SERVAIS, Philippe STEEMANS & Tõnu MEIDLA** - The "graptolite hypothesis" or how to turn a palaeobotanical evidence into a scientific puzzle.

14h20-14h40 – **Gonzalo RIAL, Borja CASCALES-MIÑANA, Philippe GERRIENNE & Philippe STEEMANS** - New evidence from the Devonian dispersed spore record of the Iberian Peninsula: implications in our conception of the Rheic Ocean.

14h40-15h00 – **Borja CASCALES-MIÑANA & PHILIPPE GERRIENNE** - A Rhynie Chert plant out of the Rhynie Chert

15h00-15h20 – **Cyrille PRESTIANNI, Julien DENAYER, Bernard MOTTEQUIN & Eddy POTY** - The latest Devonian plants from Belgium: a bright new world before a major crisis?

15h20 – 15h40 – Coffee break.

15h40 – 16h00 **- Julien DENAYER, Cyrille PRESTIANNI, MARKUS ARETZ & Edouard POTY -** Statements and new agreements for the redefinition of the Devonian-Carboniferous Boundary: a summary of the International Workshop of the joined SDS/SCCS Task group (Septembre 2016)

16h00-16h20 **– Maurice STREEL** - A new DCB in the deep facies of Sauerland (RFA) near Stockum

16h20-16h40 – **Thomas SERVAIS** - The absence of a late Palaeozoic 'phytoplankton blackout' and the need of picopalaeontology

16h40-17h00 **- Emile ROCHE, Chantal KABONYI & Charles NTAGANDA** - Evolution paléoenvironnementale dans la Région des Collines et sur la Dorsale du Rwanda au cours des trois derniers millénaires

17h00 …. Farewell Coffee

Poster - **Kamyar KAMRAN, Mona COURT-PICON, Philippe GERRIENNE & Maurice STREEL** - Misten peat Bog: High resolution palynological record

A Rhynie Chert plant out of the Rhynie Chert

Borja CASCALES-MIÑANA[1,*]& Philippe GERRIENNE[2]

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In this communication, we present a new and quite striking Gondwanan early compression fossil that is extremely similar to the key permineralized fossil plant *Aglaophyton* from the Rhynie Chert on the Laurussian continent. Plant remains come from the shallow-water marine deposits of the Lower Devonian Nogueras (Lochkovian-Pragian) Formation of the Iberian Peninsula. This finding is highly significant because prior to this the Rhynie Chert plants were thought to be endemic and characteristic of a particular hydrothermal setting. So, we show for the first time that a key element of the Rhynie Chert flora had a much more widely distribution, which has real implications for understanding the broader relevance of the Rhynie Chert to contemporary early plant floras. In addition, this finding suggests that at least one Rhynie Chert plant was not only restricted to hydrothermal environments only.

Acknowledgements: We are grateful to the Government of Aragón region (Spain) for permissions to conduct fieldworks. This study has been supported by a Marie Curie COFUND Postdoctoral Fellowship (University of Liege, grant number: 600405). PG is a F.R.S.-FNRS Senior Research Associates.

Microanalyzes of remarkable microfossils of the Late Mesoproterozoic–Early Neoproterozoic

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The Late Mesoproterozoic–Early Neoproterozoic is an important period to investigate the diversification of early eukaryotes (Knoll *et al.,* 2006). Following the first appearance of red algae in the Late Mesoproterozoic, other (morphological or molecular) fossils of crown groups are recorded during the Early Neoproterozoic, including green algae, sponges, amoebozoa and possibly fungi. Other microfossils also includes unambiguous eukaryotes, including several distinctive forms for that time period, such as the acritarchs (~820–720 Ma) *Cerebrosphaera buickii,* (1100-720 Ma) *Trachyhystrichosphaera aimika, T. botula*, and the multicellular eukaryotic *problematicum* taxon (1100–?720 Ma) *Jacutianema solubila*. To further characterize the taxonomy of these microfossils and to test hypotheses about their possible relationships to crown groups, we combine analyzes of their morphology, wall ultrastructure and microchemistry, using optical microscopy, Scanning and Transmission Electron microscopy, and Raman and FTIR microspectroscopy respectively.

Cerebrosphaera populations from the Svanbergfjellet formation, Spitsbergen, and from the Kanpa Formation, Officer Basin, Australia, include organic vesicles with dark and robust walls ornamented by cerebroid folds (Butterfield *et al.,* 1994). Our study shows the occurrence of complex tri or bi-layered wall ultrastructures, confirming the eukaryotic nature of these microfossils, and a highly aromatic composition (Cornet *et al.,* in preparation). The genus

Trachyhystrichosphaera includes various species characterized by the presence of a variable number of hollow heteromorphic processes (Butterfield *et al.,* 1994). Preliminary infrared microspectroscopy analyzes performed on two species, *T. aimika* and *T. botula,* from the 1.1 Ga Taoudeni Basin, Mauritania, and from the ~1.1 - 0.8 Ga Mbuji-Mayi Supergroup, RDC, indicate a strong aliphatic and carbonyl composition of the wall biopolymer, with some differences linked to thermal maturity between the two locations. Transmission electron microscopy is performed to characterize the wall ultrastructure of these two species. Morphometric analyzes are also ongoing to constrain the large morphological diversity of processes of these acanthomorphic acritarchs. Various morphotypes of the species

Jacutianema solubila from the Svanbergfjellet Formation, Spitsbergen and from the Taoudeni Basin, Mauritania, are also characterized with infrared and Raman microspectroscopy as well as with transmission electronic microscopy, permitting to test a previous hypothesis proposing that *Jacutianema* represents part of the life cycle of a Vaucherian alga (Butterfield, 2005).

Deciphering the identity of these distinctive microfossils will improve our understanding of the timing and pattern of eukaryote stem and crown group diversification in the mid-Proterozoic, prior to large "snowball Earth" glaciations and during time of changing ocean chemistry.

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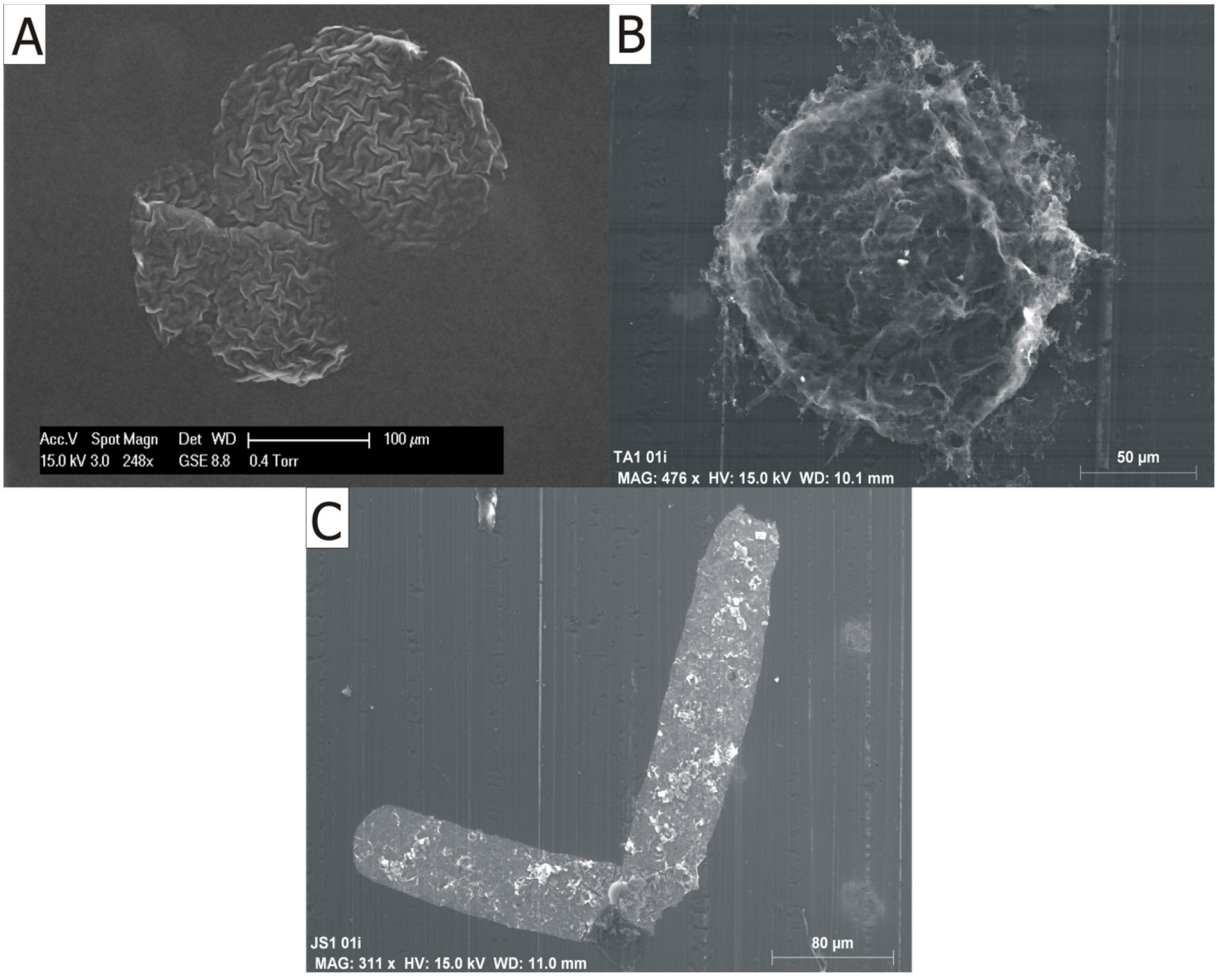

A: *Cerebrosphaera buickii. B: Trachyhystrichosphaera aimika.* C: *Jacutianema solubila*

Statements and new agreements for the redefinition on the Devonian-Carboniferous Boundary : a summary of the International Workshop of the joined SDS/SCCS Task group (Septembre 2016)

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The present DCB based on the *praesulcata–sulcata* conodont evolutionary sequence is the perfect example not to be followed as it is not easily recognized and correlated throughout environments. However, because of repeated difficulties encountered in the recognition of the conodont taxa, the doubts on their phylogenetic relationships, and their scarcity/lack in shallow-water facies, their use was disappointing for the recognition of the boundary. For all these reasons, it was necessary to select a new criterion for the definition of the boundary.

The Hangenberg extinction event(s) should constitute an opportunity rather than an impediment. Therefore, we recall that the use of biostratigraphy is not mandatory and that other criterion though biostratigraphically constraint can be used. The Hangenberg extinctions developed in two main stages: the first is linked to a rise of the sea level and the development of the Hangenberg Black Shale (HBS) and the second to a "sudden" drop of the sea level and the Hangenberg Sandstone (HSS).

The HBS event is variously developed in thickness and in duration, and sometimes not marked lithologically as is the case on shallow platforms. This local absence has often been interpreted as a stratigraphic gap. It is however more likely that the anoxic facies, corresponding to a high sea-level event, never spread or only exceptionally into shallow-water environments (e.g. the Namur–Dinant Basin, where carbonate facies rich in benthic fossils continued to develop). Consequently, the extinctions linked to the HBS event are local – even if they can affect wide areas and whole basins – and diachronous. On the contrary, the sea-level drop corresponding to the following HSS event, is easily recognizable and traceable everywhere, both in shallow and deep water facies. It caused a major extinction even in the areas which did not suffer previously from the HBS, and was responsible for the final demise of the so-called late Devonian faunas. The HSS occurs sharply in the stratigraphic record and does not correspond to the long sea-level fall of a third-order sequence boundary, but probably to a short out-of-sequence event. Its position is easy to constrain by the use of guide taxa among conodonts, foraminifers, corals, brachiopods, spores and others.

The international workshop on the DCB, joined by the ICCS and SDS Task Group, held in Montpellier in Septembre 2016 resulted in a vote on a new criterium after several days of discussion. The elected criterium agreed by a vast majority of the task group members refers to a physical marker bracketed by biostratigraphical marker: the end of the HSS sea-level drop superimposed by the FAD of the conodont *Protognathodus kockeli* in lineage from *Pr. collinsoni*. This criterium has the advantage to be traceable through environment and to be close to the historical definition of the boundary. The next step will be the selection a new stratotype and the ratification the decision in the forthcoming years.

Several dating approaches of a sedimentary sequence: Application to the Mbuji-Mayi Supergroup (Proterozoic, DRCongo) to constrain the diversification of early eukaryotes in Central Africa

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The Mbuji-Mayi Supergroup, DRC, is located between the Archean-Paleoproterozoic Kasai Craton and the Mesoproterozoic Kibaran Belt. This sedimentary sequence is unaffected by regional metamorphism and preserves a large diversity of well-preserved microfossils, evidencing the evolution of complex life (early eukaryotes) for the first time in Meso-Neoproterozoic record of Central Africa (Baludikay et al., 2016). A total of 49 taxa belonging to 27 genera were identified, comprising 11 species of unambiguous eukaryotes, 10 species of possible eukaryotes or prokaryotes and 28 species of probable bacteria.

The lithostratigraphy consists of two distinct successions:
- BII Group: an unconstrained upper carbonate sequence intercalated with shales. Basaltic lavas overlying the Mbuji-Mayi Supergroup were dated around 950 Ma (Cahen, 1974; Cahen et al., 1984)
- BI Group: a lower siliciclastic sequence poorly constrained (ca. 1174 Ma to ca. 1055 Ma (Cahen, 1954; Cahen, 1974; Delpomdor et al., 2013; Holmes & Cahen, 1955; Raucq, 1957;) unconformably overlying the ca. 2.82-2.56 Ga granitoid Dibaya Complex (Cahen, 1972; Delhal et al., 1976; Holmes, A., & Cahen, L. 1955).

The diagenesis of BI Group was dated by LA-ICP-MS and Electron MicroProbe (on xenotimes, monazites and zircons) between 1030 and 1065 Ma (François et al., 2016a; François et al. 2016b). Nevertheless, no diagenetic minerals were found in the BII Group which contains the more diverse fossiliferous levels.

To better constrain the age of this BII Group and the age of organic-walled microfossils in the Meso-Neoproterozoic interval, we perform Re-Os datings (Laboratoire de Géochimie des enveloppes externes, IPGP, Paris, France) on fossiliferous shales with the method developed by Birck et al. (1997).

We also plan to re-evaluate the age of basaltic lavas overlying the Mbuji-Mayi Supergroup (previously

dated around 950 Ma [2, 3] with Ar-Ar technique (Laboratoire G-Time, ULB, Bruxelles, Belgium & Centre & Dept of Applied Geology, Curtin University, Perth, Australia) to constrain the end of deposition of this Supergroup.

This project is supported by the Belspo IAP PLANET TOPERS, the ERC Stg ELITE project, and 2 STSMs from the EU COST ORIGINS network.

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The "graptolite hypothesis" or how to turn a palaeobotanical evidence into a scientific conundrum

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The present contribution is dedicated to the description and the interpretation of well-preserved fossils from the Early Silurian Kalana Lagerstätte in Estonia (Baltica palaeocontinent). The fossils are found in a sedimentary succession comprising exclusively shallow marine to lagoonal carbonates. They have first been interpreted as a land plant, more precisely an early polysporangiophyte – to make it simple, a precursor of vascular plants. According to us, the plant demonstrated clear adaptation to terrestrial life: anchoring structures, epidermal outgrowths, presumable cuticle, and pitted, elongated, possibly conducting cells. All of those characters were well described and illustrated. The complex morphology of this Early Silurian plant and its large size were said to contrast markedly with the habit of all other Silurian basal polysporangiophytes.

Even though some uncertainties remain, it now turns out that this "early polysporangiophyte" could be a graptolite. Most characters that fitted so well with a land plant interpretation fit equally well – to be completely honest, even better - with a graptolite interpretation. In this talk, we analyse the two interpretations in detail, and evaluate the pros and cons of the plant vs. graptolite identification. We also review other graptolites that have been mistakenly interpreted as plants – and vice versa.

Misten peat Bog: High resolution palynological record

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Pollen analysis is carried out on 01B drilling (Belarus cores) obtained from Misten peat bog in the Hautes-Fagnes plateau, from Holocene of eastern Belgium. Samples with known volume and weight were treated with HCl, submitted to KOH and acetolised. The isolated pollen and spore grains were then mounted in glycerin and counted up to a minimum of 300 (mean: 353) arboreal pollen grains excluding herbaceous pollens, bryophyte and fern spores. Pollen grains and spores were identifies using keys (Ciampolini et al., 1981; Erdtman, 1954; Fægri, 1975; Kremp, 1968; McAndrews et al., 1973; Moore et al.,1978; Pokrovskaia, 1958 and Reille, 1992). Countings were taken for 352 samples at 1.5 centimeter intervals. Pollen percentages are plotted against depth and age and furthermore the number of grains is calculated for gram of dry sediment, gram of wet sediment, square centimeter of wet sediment (pollen concentration) and finally per square centimeter per year (pollen influx). Percentage, concentration and influx-diagrams are drowning using TILIA and TILIA GRAPH (Grimm, 1990).

The studied section begins at the depth of 753, 5 cm (7250±110 BP) in the Atlantic period and continues to the depth of 270 cm (2781±145 PB) in the early Subatlantic period. In this span of time, the tree pollen percentages were high (94-100%) suggesting highly closed forest conditions-mainly consisted of trees such as *Alnus glutinosa*, *Corylus avellana*, *Quercus* and *Fagus sylvatica* accompanied by *Calluna vulgaris* and other ericaceous dwarf shrubs. Four zones could be distinguished in the studied section including Atlantic A, Atlantic B, Subboreal and Subatlantic. In the Atlantic A/Atlantic B zone-boundary, located at the depth of 600 cm (5950±128 BP) the percentage of *Tilia* pollen exceeds that of *Ulmus*. The *Ulmus* decline in the Atlantic/Subboreal boundary at the depth of 450 cm (4569±73 BP) could be interpreted as human impact on the landscape (Troels-Smith, 1960; Iversen, 1973; Peglar, 1993; Peglar et al, 1993, Hannon, 2000). *Fagus sylvatica* appears in considerable proportion just from the beginning of Subboreal and shows a sharp increase at the start of Subatlantic period (3588±110BP).

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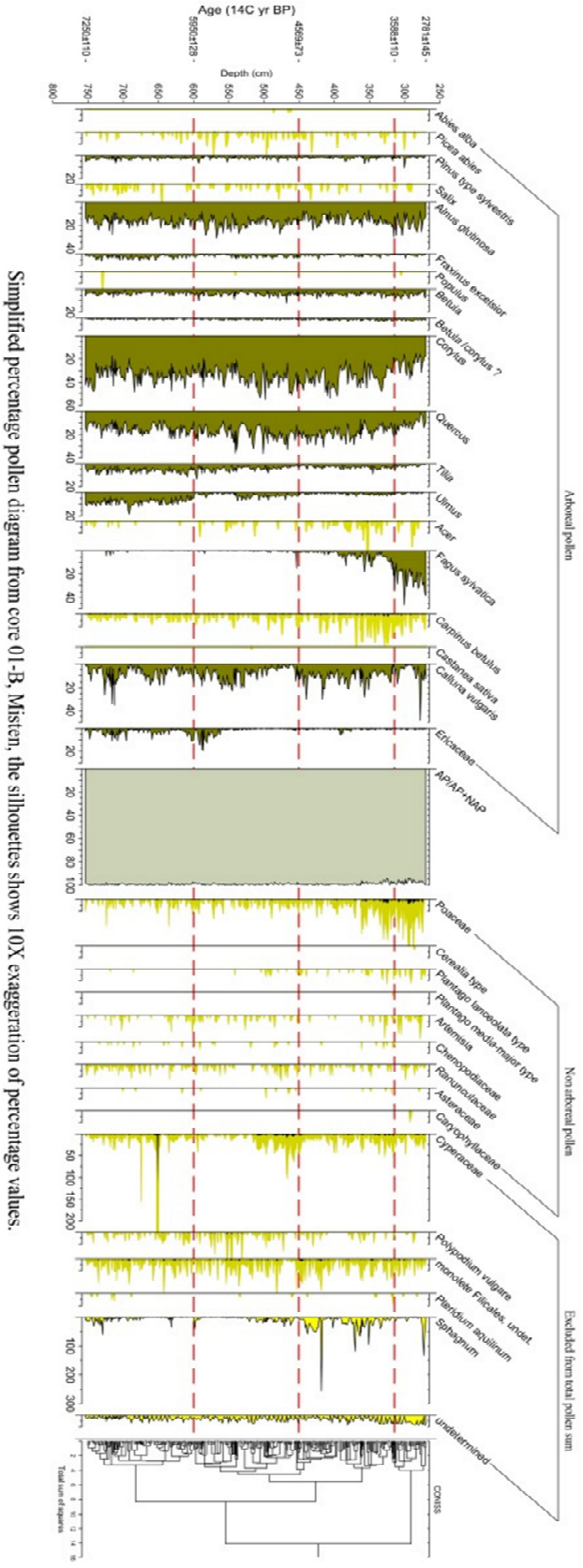

Simplified percentage pollen diagram from core 01-B, Misten, the silhouettes shows 10X exaggeration of percentage values.

Diversity and paleobiology of Proterozoic organic-walled microfossils from Arctic Canada

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The Mesoproterozoic-Neoproterozoic transition is increasingly recognized as a key interval in both planetary and eukaryotic evolution. Changes in the Precambrian Earth and biosphere are reflected in the diversification and evolution of organic-walled microfossils, a group of microfossils including acritarchs, filamentous and multicellular microorganisms. This PhD project focuses on characterizing the diversity and paleobiology of those organisms in several Late Mesoproterozoic and Early Neoproterozoic successions of Arctic Canada. Preliminary analyzes reveal abundant microfossils, comprising prokaryotes, eukaryotes and other microfossils that cannot be assigned taxonomically at this point. The methodology includes a combination of different microscopic and microchemical methods, such as optical microscopy, SEM, TEM, RAMAN and FT Infra-red microspectroscopy, and fieldwork.

This PhD project is part of the ERC Stg ELITE project "Early life Traces and Evolution, and implications for Astrobiology" (E Javaux, PI) and part of a collaboration with the multidisciplinary and international Agouron project "Eukaryote evolution in the Proterozoic of Arctic Canada" (G Halverson, PI; R Rainbird, H Turner, T Schulski, J Brocks, N Butterfield, C Hallman, E Javaux, co-I).

The latest Devonian plants from Belgium: a bright new world before a major crisis ?

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To date, the known plant fossil record of the Famennian in Belgium is only represented by the so-called Evieux flora. This flora is composed by a moderately diversified assemblage dominated by one species of *Archaeopteris* and the fern *Rhacophyton*. It further contain several spermatophyte taxa such as *Moresnetia*, *Dorinnotheca* or *Condrusia* as well as less common herbaceous taxa such as *Eviostachya* and *Sphenopteris flaccida*. The Evieux flora is thought to represent a monospecific *Archaeopteris* forest that evolved in relatively dry conditions.

In the course of an ongoing project aiming at better characterizing the Devonian/Carboniferous boundary in Belgium, several field explorations were done. A new fossil plant locality was located in the Trooz quarry. Interestingly, these fossiliferous beds have been dated palynologically and attributed to the LL biozone corresponding to the latest Famennian. Here we will present the preliminary results of this exploration and place them in the broader context of the Devonian/Carboniferous boundary.

The assemblage in Trooz is composed by *Archaeopteris/Callixylon* wood together with a new wood taxa that has been related to the spermatophytes and called *Dameria*. In addition, the impression of what could be interpreted as a lycophyte trunk as also been collected. Several leafy remains have also been collected. Finally, we notice the presence of several spermatophytes already present in the Evieux flora as well as the newly described *Thorezia vezerensis*. This assemblage thus differs from the classical Evieux flora by at least three taxa. One of the most notable one is the wood taxa *Dameria* which bears strong Carboniferous affinities. With the description of this assemblage we probably echo the *Lepidophyta* palynozone that is characteristic of the latest Famennian deposits worldwide.

The latest Famennian deposits are characterized by strong climate changes with the advent of more humid conditions. This very likely explains the rise of new plant assemblages. It furthermore highlight the ongoing diversification of seed plants (*Dameria*, *Thorezia vezerensis*) announcing the Tournaisian. This however puts into question the extent of the Hangenberg event on the continents.

New evidence from the Devonian dispersed spore record of the Iberian Peninsula: implications in our conception of the Rheic Ocean

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The palynological fieldworks developed during the last 4 years in the Iberian Chains (NW Iberian Peninsula) have led to the discovery of important Devonian spore assemblages. This high spore diversity, together with the previous studies performed from the Cantabrian Mountains (N Iberian Peninsula) and the Pyrite Belt (SW Iberian Peninsula), represent a valuable source of information for studying the Devonian biodiversity of the Peninsula. This scenario plays a crucial role for a better understanding of the palaeogeographic position of the Iberian Peninsula and the dynamics of the Rheic Ocean. According to current reconstructions, the Iberian Peninsula was located in an intertropical position during the Early Devonian, having Gondwana affinities and being separated from Laurasia by the Rheic Ocean. It is therefore commonly accepted that, until its closure at the end of the Devonian, the Rheic Ocean represented a natural barrier between the land plant species. Recent works however reconsider the hypothesis of a large Rheic Ocean during the Early Devonian (see e.g. Dupret et al., 2011 and references therein), opening up the possibilities for new models. Miospores can be used to test several hypotheses such as e.g. an earlier closure of the Ocean that would have allowed the exchange of species between the Peninsula and Laurasia during the Early Devonian. This communication aims to reflect the current state of the studies carried out in the Iberian Chains and their possibilities to be used as key element for a better understanding of the spore dispersion during the Devonian.

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Evolution paléoenvironnementale dans la Région des Collines et sur la Dorsale du Rwanda au cours des trois derniers millénaires

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Dans le nord du Rwanda, sur la chaîne des volcans Virunga, des séquences sédimentaires tourbeuses ont archivé une évolution du milieu afro-montagnard se présentant comme suit :

- une progression continue de la forêt de montagne depuis la fin du Tardiglaciaire jusqu'à 7000-6000 ans BP ;
- une régression brutale de la forêt avec extension des savanes ca.4000 ans BP ; situation se prolongeant de façon irrégulière jusqu'à 2000 ans BP ;
- un regain forestier à partir de 2000 ans interrompu brièvement par une pulsation sèche ca.500 ans AD ;
- les premiers effets anthropiques sous 2000 m d'altitude au début du second millénaire AD.

Au sud, dans la Région des collines (ou Plateau central) et sur la crête Congo-Nil, l'évolution environnementale se présente différemment au cours des trois derniers millénaires.

Si, de 3000 ans à 1500 ans BP, l'évolution de la forêt ombrophile est assez semblable à celle occupant les pentes des volcans, au cours de la seconde moitié du premier millénaire AD, elle commence à subir un impact anthropique en lisières, se distinguant ainsi du milieu forestier septentrional.

Dans la région des collines, entre 1500 m et 1800 m d'altitude, la dégradation des savanes densément boisées s'amorce avant le début de notre ère ; mais c'est au cours des cinq premiers siècles qu'elle s'intensifie sous la pression de populations bantouphones du premier âge du fer ou Age du Fer Ancien (AFA). Originaires d'Afrique de l'Ouest, celles-ci pratiquaient l'agriculture, l'élevage et la fonte du fer ; cette dernière occupation contribuant principalement au déboisement intensif de la région.

La pulsation sèche de 500 AD aggravant la situation, le Plateau central du Rwanda connut un abandon relatif d'environ deux siècles avant que des populations sud-nilotiques du second âge du fer ou Age du fer récent (AFR) ne viennent s'y installer contribuant à leur tour à la déforestation.

Il faut toutefois attendre l'arrivée d'une seconde vague de sud-nilotiques au début du deuxième millénaire AD pour que l'impact anthropique commence à se marquer plus nettement sur la dorsale du Rwanda.

Patterns of metal distribution in hypersaline microbialites: Implications for the fossil record

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The use of metals as biosignatures in the fossil record requires understanding of the processes controlling the initial metal(loid) incorporation and diagenetic preservation in living microbialites. We report the distribution of metals and the organic fraction within the lithifying microbialite of the hypersaline Big Pond Lake (Bahamas). We show that the initial cation sorption at the surface of an active microbialite is governed by passive binding to the organic matrix, resulting in a homogeneous metal distribution. During early diagenesis, the metabolic activity in deeper microbialite layers slows down and the distribution of the metals becomes progressively heterogeneous, resulting from remobilization and concentration as metal(loid)-enriched sulfides, which are aligned with the lamination of the microbialite. The similarity of the metal(loid) distributions observed in the Big Pond microbialite to those observed in the Archean stromatolites of Tumbiana (2.72 Ga) provides to constraint the the evolution of the metal distribution through initial growth, early diagenesis, and fossilization of a microbialite.

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Palynology and palaeogeography of the JLMD-EW8 borehole from Saudi Arabia

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A distinctive, rich and diverse marginal marine palynological assemblage from the Tawil Formation occurs in several wells from northwestern and eastern Saudi Arabia. The composition of this assemblage strongly indicates a middle Přídolí age. The assemblage encountered contains abundant, miospores, chitinozoans, acritarchs, tasmanites, freshwater algae, scolecodonts, eurypterid cuticle and other organic remains. Many taxa from this assemblage are of taxonomic interest and useful for regional and intercontinental correlation. The palaeogeographic distribution of this assemblage is also discussed as acritarchs, chitinozoans and miospores encountered in the studied samples correlate well with similar assemblages from various Algerian, Libyan, and Ibero-armorican localities (i.e. Ibarmaghian regions). This corresponds to what is considered a transgressive mid-Přídolí event in the Algerian Sahara, with non-marine intervals bracketing this brief marine sea level rise. This event is likely to have extended into all of north Gondwana including Arabia.

A new DCB in the deep facies of Sauerland (RFA) near Stockum

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The locality of Stockum was visited by the former D/C Working Group on Tuesday, August 10th, 1982. The decision to place the DCB at the *praesulcata/sulcata* level had been taken during a Working Group meeting held in Washington (USA) in 1979. It was recommended to search for a section best displaying this evolution lineage, as well as exhibiting adequate representation among other zonally significant groups (See Paproth & Streel 1984).
Therefore, the Stockum sections, lacking the *praesulcata/sulcata* faunas, were no longer considered as a possible candidate for a DCB stratotype. However, since the publications of Alberti et al. (1974) and Clausen et al. (1994), the locality is known to exhibit a spectacular amount of various zonal fossil groups: ammonoids, trilobites, ostracodes and miospores and a very detailed *Protognathodus* conodont fauna. (See fig. enclosed)
The recent suggestion of Corradini et al. (2016), as well as the last recommendation of the new DCB Working Group meeting held in Montpellier (France) in September 2016, to place the DCB just after the Hangenberg Event, at the entry of *Pr. kockeli,* is easily met in the Stockum sections. Placing this limit on top of the last main Hangenberg Sandstone and Shale (HSS), below the Stockumer Limestone, would help, indicate an approximate position of the DCB even in sections where *Pr. kockeli* is poorly present; i.e. in the Dinant - Namur basin (Denayer et al. 2015)
Such new DCB would be close to the end of the so-called "LN Ubergang" microflora, the "*tener* effect" of Prestianni et al. (2016). Another advantage would be the close proximity of the former DCB and, therefore, the less disturbance of the existing continental and intercontinental correlation schemes, leaving for instance the glacial evidence entirely in the Devonian.

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Pleading for a new D/C Boundary in the historical German deep facies of Sauerland near Stockum

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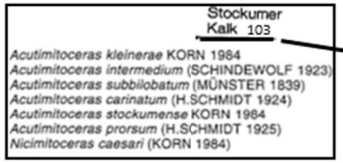
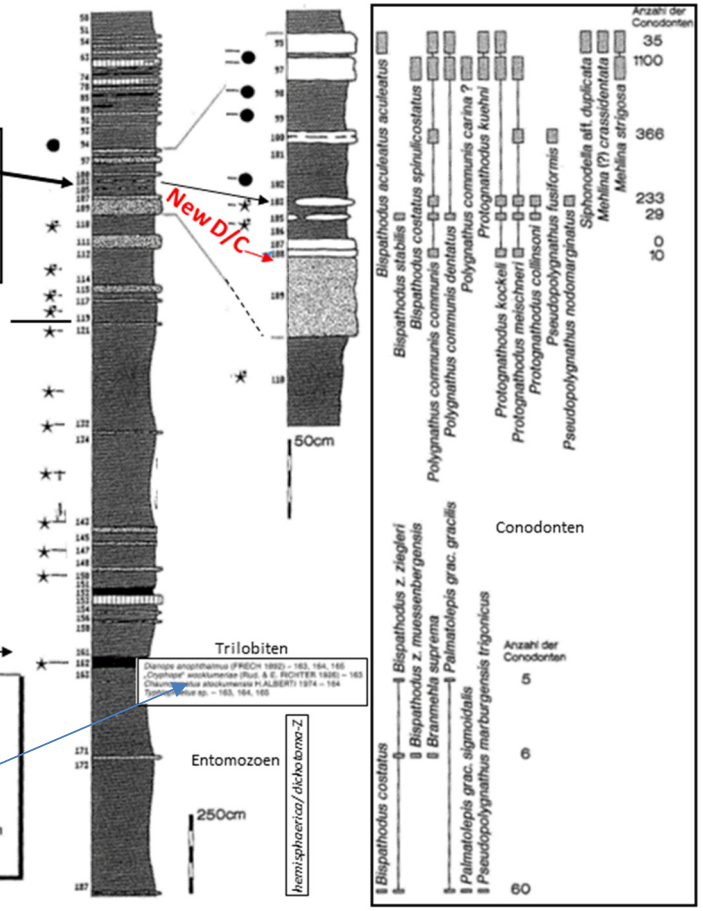
Die Devon/Karbon-Grenze bei Stockum (Rheinisches Schiefergebirge) 1994
Geol.Paläont.Westf. 29:71-95.

Claus-Dieter Clausen, Dieter Korn, Raimund Feist, Kerstin Leuschner, Helga Groos-Uffenorde, Friedrich Wilhelm Luppold, Dieter Stoppel, Kenneth Higgs & Maurice Streel*





A 28 m thick Devonian-Carboniferous boundary sequence of clay, siltstones and sandstones with intercalated carbonates has been exposed in a new trench at the Spitzer Kahlenberg near Stockum. The section has been examined because of its content of ammonoids, trilobites, ostracodes, conodonts and miospores as well as the microfacies of the carbonates.

The Devonian-Carboniferous boundary apparently lies above the Stockum Limestone in which ammonoids, trilobites and conodonts with Carboniferous affinities (but without typical Carboniferous index forms such as *Gattendorfia subinvoluta*, *Semiproetus* (*Macrobole*) *drewerensis* and *Siphonodella sulcata*) can be collected. The miospore boundary LN/VI is approximately at the Stockum Limestone.

In this section, for the first time, the Hangenberg Black Shale was discovered near Stockum, lying 15 m below the Stockum Limestone.

The stratigraphical significance of the *Protognathodus* fauna from Stockum (Devonian/Carboniferous Boundary, Rhenish Schiefergebirge) 1974 Newsl. Stratigr. 3,4: 263-276 H. Alberti, H. Groos-Uffenorde, M. Streel, H. Uffenorde, O.H. Walliser

The Stockum Limestone is the stratum typicum of the *Imitoceras* fauna described by H. SCHMIDT 1924 and of the *Protognathodus* fauna described by ZIEGLER 1969. New investigations have been made on the fossils from this limestone and from the sequences immediately above and below. *Gattendorfia subinvoluta* was not found in the Stockum Lime stone. This species possibly appears immediately af ter the deposition of the Stockum Limestone. On the other hand it is not possible to distinguish the conodont and trilobite fauna of this limestone from that of the stratum typicum of *Gattendorfia subinvoluta*. Therefore it would be more practicable to include the Stockum Limestone in the Lower Carbonif erous. The associated ostracodes and spores also support such a solution.

Dianops anophthalmus (FRECH 1892) – 163, 164, 165
„Cryphops" wocklumeriae (Rud. & E. RICHTER 1926) – 163
Chaunoproetus stockumensis H.ALBERTI 1974 – 164
Typhloproetus sp. – 163, 164, 165

The absence of a late Palaeozoic 'phytoplankton blackout' and the need of picopalaeontology

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Acritarchs, usually considered as being the resting cysts of various marine organic-walled phytoplankton in the early – middle Palaeozoic, become virtually extinct near the Devonian-Carboniferous boundary, whereas dinoflagellate cysts only appeared in the Triassic. The stratigraphical interval between the Carboniferous and early Triassic, i.e., the late Palaeozoic–Early Mesozoic, has therefore been considered by many authors to be a time period with a very low diversity of organic-walled phytoplankton, and the same period was even considered by some authors as corresponding to a 'Phytoplankton Blackout.'

It has been argued that the marine food web during this interval was related to the invasion of land by plants, suggesting that a reduced nutrient input to the ocean by runoff decreased the number of acritarchs and primary production in the marine realm.

However, the known Palaeozoic fossil record of the phytoplankton is incomplete to a high degree. It consists almost entirely on the organic-walled fraction, because calcareous and siliceous phytoplankton remain almost unrecorded. In addition, the fossil record solely provides information about the diversity of cysts, but not necessarily precise data of the number and quality of the cyst-producing phytoplanktonic organisms. Taking into consideration that only few modern phytoplankton taxa produce cysts, the absence of cysts in the fossil record does not necessarily imply the absence of phytoplankton. In contrast, the presence of planktotrophic larvae of marine invertebrate organisms indicates that phytoplankton must have been present in the late Palaeozoic oceans, and the marine trophic web did indeed not collapse in the Late Devonian. The presence and abundance of filter feeding and suspension feeding benthic organisms such as brachiopods, crinoids, sponges and corals also suggest sufficient primary production in the late Palaeozoic seas.

Another major problem in the fossil record of the organic-walled microphytoplankton is simply in the size fraction of the analysed material. Micropalaeontologists usually study only the larger fraction of the micropalaeontological material, i.e. larger than 20 µm. However, most of the phytoplankton during the Carboniferous and Permian (and of the entire Phanerozoic) is smaller than 20 µm. In addition, recent studies on modern phytoplankton indicate that the smaller fraction (the picophytoplankton) is by far the most diverse. This fraction remains largely unstudied by micropalaeontologists.

It can be concluded that (1) although the phytoplankton is largely absent from the fossil record in the late Palaeozoic and early Mesozoic, a 'phytoplankton blackout' is unrealistic ; and (2) micropalaeontologists should also analyse the smaller fraction in the fossil record, i.e., all organisms smaller than 20 µm

The Chicxulub impact – a perfect astrobiological laboratory

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Life on Earth was sharply disrupted 66 Ma ago as an asteroid hit the sea-floor in what is today Yucatan Peninsula, Mexico. Approximately 2 million km^3 of sedimentary rock were vapourized, ejected into the atmosphere and subsequently deposited globally as an ejecta apron and fallout layer.

The distribution of the vapourized target rock strongly influenced life on Earth at the close of the Mesozoic. The palynofloral changes around the Cretaceous-Paleogene (K-Pg) mass extinction event reveal the fine details of vegetation response to a global environmental crisis – induced by the asteroid impact. The Cretaceous-Paleogene (K–Pg) boundary clay, associated with the Chicxulub asteroid impact event, constitutes a unique global marker bed enabling comparison of the world-wide palynological signal spanning the mass-extinction event. The destabilization of terrestrial ecosystems is coincident with the K–Pg boundary markers, supporting a catastrophic event taking place over a very short duration.

High resolution palynological data from the Southern Hemisphere K-Pg sections are mainly known from South Island New Zealand (Vajda et al., 2001; Vajda & McLoughlin, 2004) whereas the most informative sections in the Northern Hemisphere occur in the northern Great Plains of the United States and central Canada (Vajda & Bercovici, 2015). The results from both hemispheres are consistent, revealing diverse latest Cretaceous assemblages of pollen and spores that are affected by a major diversity loss coincident with a fern spore spike in the basal Paleocene.

Proximal ejecta deposits occur in Belize and southern Mexico where the so called Albion Island spheroid bed is superimposed on the target rock (the Barton Creek Formation). The target rock comprises limestones rich in anhydrite and gypsum and the buried crater is marked by a ring of cenotes (sink holes) resulting from groundwater dissolution of limestone around the fractured crater rim. The cenotes are in many cases connected, forming cave systems and lakes. Lake Bacalar on Yucatan Peninsula is one of the few sites preserving fresh-water stromatolites. In conclusion, Yucatan Peninsula is an ideal locality for an astrobiological workshop where not only the geology and biology are accessible but the region also hosts a rich ancient cultural heritage in which astronomy played an important role.

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