PALYNOZONATION OF THE PERMIAN OF BOLIVIA AND PERU

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The Cisuralian Vitiacua Formation in southern Bolivia is partially time-correlative with the upper Copacabana Formation from north- and western Bolivia and Peru. Palynological information here analyzed comes from Apillapampa, Yesera, Canaletas, Iglesiani and Angosto de Beu in Bolivia, and Cuzco in Perú. Also, new information from sections at Morochata and Via Molino (Bolivia), and Pongo de Mainique (Perú) is provided in this study. Forty-one selected Permian species recovered from at least two of the 13 sections analyzed support the palynozonation proposed herein. Long-ranging species (13 spores and 36 pollen grains and 8 microplankton), documented in most of the sections, and 56 species (20 spores, 32 pollen grains and 4 microplankton) found at single localities were not considered. Ten selected taxa appeared in the oldest *Vittatina* Zone (*VZ*), such as the Permian species *Vittatina costabilis, V. subsaccata, V. vittifera, Marsupipollenites striatus, Pakhapites fusus, Pakhapites ovatus,* and *Striatopodocarpites cancellatus*. This zone is found in the Copacabana Formation at Apillapampa, Via Molino, Angosto de Beu and Pongo de Mainique. The appearance of *Lueckisporites virkkiae* and other species of this genus supports the homonymous *Lv* Zone, which is subdivided in the *Lv* (*sensu stricto*) and the *Lv-Hamiapollenites karrooensis-Polypodiisporites mutabilis* (*Lv-Hk-Pm*) Subzones. The former is characterized by the appearance of 18 species such as *Lueckisporites nyakapendensis, Lunatisporites noviaulensis, Lunatisporites pellucidus, Pakhapites fasciolatus, Protohaploxypinus rugatus, Protohaploxypinus samoilovichii, Protohaploxypinus varius, Striatopodocarpites phaleratus, Striomonosaccites cicatricosus, Vittatina corrugata,* and *Weylandites* spp. The *Lv-Hk-Pm* Subzone is defined by the appearance of 13 species, with abundant monolete (e.g., *Polypodiisporites mutabilis, Reticuloidosporites warchianus, Thymospora rugulosa*) and trilete spores (*Lundbladispora braziliensis, Convolutispora uruguaiensis*) and few pollen grains (e.g., *Hamiapollenites karrooensis, Scheuringipollenites circularis*). Two assemblages of the Vitiacua Formation at Iglesiani are attributed to the *Lv* Zone. The *Lv* (*s.s.*) Subzone occurs in the Vitiacua Formation at Yesera, Canaletas, and two more sections at Canaletas and Narváez, and in the Copacabana Formation at Apillapampa and Via Molino. The *Lv-Hk-Pm* Subzone is documented in the Vitiacua Formation at West Yesera, and the Coal Member of the Copacabana Formation at Apillapampa, Morochata, Pongo de Mainique and Cuzco. The *Vittatina* (Asselian) and the *L. virkkiae* (late Asselian-?Guadalupian) Zones are similar in composition and correlated with the Brazilian *V. costabilis* (Asselian-mid Artinskian) and *L. virkkiae* (middle Artinskian-Wuachiapingian) Zones of Paraná Basin and the Argentinian *Pakhapites fusus-Vittatina subsaccata* (Asselian-Artinskian) and *Lueckisporites – Weylandites* (middle Artinskian-Wuachiapingian) Zones of western basins. [PIP CONICET 0305].

NEW FINDINGS OF THE *LUECKISPORITES VIRKKIAE* ZONE (LATE CISURALIAN-GUADALUPIAN) IN THE SERRA DO RIO DO RASTRO AND NEIGHBORING LOCALITIES (PARANÁ BASIN) IN SANTA CATARINA, BRAZIL

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New palynological data are documented from some deposits of the Passa Dois Group (Irati, Serra Alta, Teresina and Rio do Rasto formations), in Santa Catarina, Brazil. The well constrained Irati Formation (basis of the Passa Dois Group) is akin to the late Artinskian by different paleontological (including palynology) and radiometric data. Although, the overlying units are palynological poorly known, comprising few citations of pollen grains with no illustrations or description, mainly due to the rarity of these occurrences, as well as their poor preservation. A comprehensive sampling has been done from the Serra Alta, Terezina and Rio do Rastro formations in the Serra do Rio do Rastro and neighboring region in Santa Catarina State, revealing new records with biostratigraphic significance. The Serra Alta Formation is transitionally deposited over the Irati Formation and well exposed at the Point 9 of the classic White´s Column in the way to the top of the Serra do Rio do Rastro. Currently there is a mining development of slabs from a thick section (ca. 30 meters) composed of mudstones, shales, siltstones and sandstones. Eleven of the twenty two samples collected yielded fairly well preserved palynomorphs. The whole assemblage is dominated by pollen grains and subordinated spores and *Botryococcus*. Diagnostic species of the *Lv* Zone in the Paraná Basin were recorded (e.g. *Corisaccites alutas*, *Guttulapollenites hannonicus*, *Klausipollenites schaubergerii*, *Lueckisporites virkkiae*, *Lueckisporites* spp., *Marsupipollenites striatus*, *Staurosaccites* spp., *Vittatina* spp., *Weylandites lucifer*, and the spores *Convolutispora uruguaiensis*, *Polypodiisporites mutabilis* and *Reticuloidosporites warchianus*). Other sections exposed in the Urubici region, stratigraphically below the Botucatu Formation were also sampled (Corvo Branco Hill and Sete Quedras localities, both in Urubici Municipality). From the first locality, the palynoassociation is well preserved and dominated by pollen grains (e.g., *Corisaccites alutas*, *Lueckisporites virkkiae*, *Lueckisporites* spp., *Lunatisporites variesectus*, *Protohaploxypinus varius*, *P. limpidus*, *Scheurigipollenites ovatus*, *Staurosaccites* spp., *Vittatina* spp., *Weylandites lucifer*), and subordinated spores (*Convolutispora uruguaiensis*, *Polypodiisporites secoensis*, *Lophotriletes* cf. *parryensis*) and *Botryococcus*. Scarce and poor preserverd palynomorphs were retrieved from four samples from Sete Quedas at Urubici. These new records are very similar to the Serra Alta Formation association, and are assigned to the *Lueckisporites virkkiae* Zone. [CNPq Project 402873/2012-2].

DEVONIAN FLORA SUCCESSION IN GONDWANA: STATE OF ART IN SOUTH AMERICA

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The Devonian paleobotanical record in South America has recently been described in Argentina, Bolivia, Brazil, Chile, Colombia, Falkland Islands, Uruguay and Venezuela. This study aims to describe a pattern of floristic succession observed in the Devonian strata bearing primitive land plants mainly in Argentina, Bolivia and Brazil from Lochkovian to Frasnian deposits dated with palynomorphs. In the early Devonian (Lochkovian) the paleofloras are composed of bryophytes (*Hostinella* sp.), psilophytes and cooksonioids (including *Cooksonia paranenses*, *C. hemispherica* and *Aberlemnia caledonica*), recorded in Argentina (Villavicencio and Talacasto Fms.), Bolivia (Santa Rosa Fm.), Brazil (Furnas Fm.) and Uruguay (Cerrezuelo Fm.). These assemblages comprising herbaceous plants, simple organization, naked stems (leafless) and terminal sporangia, are named herein *Cooksonia*-like Flora (Embryobiota). This flora is associated to the *Dictyotriletes emsiensis* (Ems) Zone Grahn from Brazil (Lochkovian-Emsian). From the Middle-to-Late Devonian (Eifelian to Frasnian), herbaceous lycopsids (*Haplostigma* sp. and *Haskinsia* sp.) became dominant and especially during the Eifelian/Givetian interval, *Haplostigma* is widely documented in the South American floras. These plants, with a more complex organization, are recorded in Argentina (Chinguillos Gr.; Lolén, Punta Negra, Los Monos and Pescado Fms.), Bolivia (Huamapampa, Los Monos and Iquiri Fms.), Brazil (São Domingos Fm.), Chile (El Toco Fm.) and Venezuela (Campo Chico Fm.). The latter are grouped herein in the *Haplostigma* Flora. Its age is akin to *Grandispora permulta* (Per) and *Geminospora lemurata-Chelinospora* ex *Gr. ligurata* (LLi) Zones Melo and Loboziak from Brazil. It is noteworthy that the genus *Haplostigma* is also recorded in South Africa, Antarctica and Australia from a later interval, i.viz. Givetian to Famennian. The interval between the *Cooksonia*-like and *Haplostigma* floras is mainly hidden, due to marine transgression occurred during the Pragian/Emsian interval. The predominance of marine facies during Late Early Devonian is also attested by the domain of paleomicroplankton (i.e., acritarchs, quitinozoans) in palynological assemblages and great abundance and diversity of marine invertebrates of Malvinokaffric Realm. [CNPq 141979/2011-9, PQ309211/2013-1, 150239/2011-4, 401796/2010-8, 479774/2011-0, 402873/2012-2, and CONICET PIP 0305 (2011-2013)].

LAND PLANT ASSEMBLAGE TAPHOFACIES IN MIDDLE DEVONIAN OF PARANÁ BASIN, SOUTHERN BRAZIL

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Taphonomic and sedimentological analysis of outcrops containing land plant remains have enabled the paleoenvironmental interpretation of depositional systems and the establishment of sedimentological contexts in which taphofloras were preserved. The overwhelming majority of studies on fossil plant taphonomy addresses primarily deposits of fully terrestrial or transitional deposits, being few studies of them carried out in fully marine environments. This study aims to describe the taphonomic signatures and sedimentological characteristics of fossiliferous assemblages bearing herbaceous early land plants (e.g. *Haplostigma*, *Palaeostigma*, *Spongiophyton* and plant debris) preserved in marine (shoreface to offshore) within Ponta Grossa and São Domingos formations, in Paraná Basin, southern Brazil. Ten outcrops within three surface stratigraphical sections located at Tibagi County, in the Paraná state, were described. The taphonomic analysis included the relationship between the plant material and sediment, the arrangement of the axes within beds (parallel or perpendicular to the bedding), degree of packing of the assemblages (concentrated or dispersed), orientation and fragmentation degrees of plant remains. Six different lithofacies, conglomeratic sandstone (SS-gr), coarse to medium sandstone (SS-hcs), fine-grained sandstone (SS-f), coarse to medium sandy siltstone (SL-hcs), fine-grained siltstone (SL-p) and mudstones (SH) indicatives of most proximal to distal depositional systems and three allochthonous plant remains assemblages [Plant Axe Assemblage (PAA), Plant Fragment Assemblage (PFA) and Plant Debris Assemblage (PDA)] were identified. PAAs preserved within SS-f facies were deposited mainly in upper to middle shoreface settings under low energy context. PFAs preserved within SS-hcs to SL-p facies were deposited mainly in shoreface to transitional offshore settings in moderate and high-energy contexts. Finally, PDAs preserved within SS-f to SH facies were deposited mainly in shoreface to offshore settings under low and high-energy contexts. This early land plants grew the wetlands near shorelines and were transported during storms associated with Highstand deposits or rise in the sediment inputs caused by flood events basinwards. [CNPq 141979/2011-9; PQ309211/2013-1; 150239/2011-4; 401796/2010-8; 479774/2011-0].

EIFELIAN-GIVETIAN DIVERSITY TRENDS IN PALYNOFLORAS OF NORTHWESTERN ARGENTINA

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This study aims to elucidate diversity trends during the Middle Devonian in northwestern Argentina through the characterization of palynological events. A dataset of spore genera counts from two boreholes (San Antonio x-1, Santa Victoria x-1), ranging in age from the Eifelian to Givetian, was analyzed. Several measures of diversity were compiled and contrasted with the composition of the floras. The Simpson, Shannon-Wiener and standing diversity indices together with Pielou and Hurlburt's evenness measures were calculated. The standing diversity reaches its maximum during the Eifelian and rapidly decreases towards the Givetian. This tendency is also supported by the other computed parameters. The floras, during the Eifelian, are composed of apiculate, cavate and boldly sculptured spores represented mainly by the genera *Apiculiretusispora*, *Grandispora* and *Verrucosisporites* respectively. The decline in the evenness, towards the top of the sections, is shown when the *Verrucosisporites* genus outnumbers in the assemblages. The domination of these specimens is a pattern seen in other parts of Gondwana during the same time frame. The increment of this particular genus, associated with filicopsids, co-occurs with the inception of *Geminospora lemurata* and *Biharisporites parviornatus*. These species have a well-defined onset worldwide during the late Eifelian–early Givetian and are known to have affinities with archaeopteridaleans. Both, marine and continental elements, sustain a marginal depositional setting, with minor shoreline shifts for both assemblages during the Eifelian. By the early Givetian there is a significant increase of marine components. The diversity analysis and inferred palaeoenvironment support a change in the conditions, that show a stressed domain during the late Eifelian–early Givetian, which led to the predominance of few existing species and the establishment of new ones in the flora.

NEW TAXA AND COMPREHENSIVE OVERVIEW OF DEVONIAN PALYNOMORPHS FROM THE OXY-MOBIL PANDO X-1 CORE, MADRE DE DIOS BASIN, BOLIVIA

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Recently analyzed palynological mounts from the Pando X-1, in combination with previously published information, affirm an excellent stratigraphic hierarchy of tops and bases. This summary integrates spore, acritarch, prasinophyte, and chitinozoan data to create a new palynofacies and stratigraphic framework applicable to thick subsurface sections and possible unconventional (shale-gas) plays. The Pando core yielded a well preserved assemblage that ranges from the ?Silurian through Upper Devonian. The stratigraphic intervals assigned to the ?Silurian-Lower Devonian and Middle-Upper Devonian are the Tequeje and Tomachi formations, respectively. Another unit, the Upper Devonian-Lower Carboniferous Toregua, is a challenge to interpret because of the impact of recycled organic-walled microfossils related to glacial processes in the area during deposition. The Tequeje Formation assemblage ranges from ?Silurian to Lower Devonian, and contains several undescribed (?endemic) forms. The species from this stratigraphic unit include *Brochotriletes hudsonii, Retusotriletes maculatus, Leiofusa bernesgae, Onondagaella asymmetrica, Ozotobrachion furcillatus, Pterospermella circumstriata, Riculasphaera fissa, Schizocystia pilosa, S. saharica, Thysanoprobolus polykion, Cingulochitina serrata, Lagenochitina navicula, Margachitina catenaria, Pterochitina megavelata,* and *Urochitina* spp. Diagnostic species from the Tomachi Formation include *Camptozonotriletes caperatus, Clivosispora verrucata, Cristatisporites triangulatus, Geminospora lemurata, Verrucosisporites bulliferus, Ammonidium garrasioni, Duvernaysphaera angelae, Evittia sommeri, Horologinella horologia, Maranhites mosesii, Multisplicisphaeridium escobaides* (*Pyloferites pentagonalis*), *Tunisphaeridium tentaculaferum,* and *Umbellasphaeridium saharicum*. The assemblage includes new forms, some with morphologies uncommon in Devonian sections (e.g., an acritarch with a diacrodian-like process distribution). The Toregua Formation assemblage include abundant spore species, such as *Ancyrospora langii, Auroraspora macra, Chelinospora cocinna, Lophozonotriletes grumosus, L. lebedianensis, Retispora lepidophyta,* and *Tumulispora rarituberculata*. Also present are the acritarchs/prasinophytes *Maranhites* spp., *Puteoscortum polyankistrum,* and *Umbellasphaeridium* spp. Previous studies of this well have concentrated primarily on bases (first occurrence) and assemblage zones. The present study combines published information with new taxa and palynofacies insights reported here, and focuses on palynomorph tops (first downhole occurrence). This approach can be used when analyzing cuttings samples from Gondwanan exploration and production wells to constrain stratigraphic architecture.