Ordovician to Lower Silurian palynomorphs from the Sierras subandinas (Subandean ranges), northwestern Argentina: a preliminary report.

[Carnets de Géologie / Notebooks on Geology - Memoir 2005/02, Abstract 09 (CG2005_A02/09)]

Claudia Viviana RUBINSTEIN

Key Words: Ordovician; Silurian; palynomorphs; biostratigraphy; palaeogeography; palaeoenvironment


Mots-Clefs : Ordovicien ; Silurien ; palynomorphes ; biostratigraphie ; paléogéographie ; paléoenvironnement

Introduction

Ordovician clastic sediments of the Central Andean Basin, northwestern Argentina, were deposited in a proto-Andean foreland basin on the western margin of Gondwana (ASTINI, 2003; ASTINI & MARENGO, 2003). The Sierras Subandinas (Subandean Ranges) represent the outermost exposures of this Ordovician basin, where proximal environmental settings and their related palynological content are currently being analysed. These platform facies are exposed in the Eastern Cordillera, where palynological knowledge has increased remarkably in recent years (RUBINSTEIN & TORO, 2001; RUBINSTEIN, 2003). On the other hand palynological information on the deep marine facies exposed in the Puna is still meager and involves only the Ordovician-Silurian boundary (RUBINSTEIN & VACCARI, 2004) (Pl. 1).

The outermost portion of the foreland basin, the Sierras Subandinas, is characterized by alternating shallow-marine deltaic systems and estuarine environments, which indicate repeated changes in the coast line caused by fluctuations in relative sea-level (ASTINI & MARENGO, 2003) (Pl. 1). These authors undertook a detailed study of sequence stratigraphy in the Ordovician-earliest Silurian rocks of this region. However, determination of their age is difficult because of the scarcity in some units of biostratigraphically useful fossils.

Ordovician and earliest Silurian rocks are well exposed along the Río Capillas, in the Sierra de Zapla, Jujuy Province (Fig. 1). The lowest unit is the Zanjón Formation, considered as middle-late Arenig. It is followed in succession by the Labrador Formation with its two sub-units, the late Arenig Laja Morada Member and the early-middle Llanvirn Lagunañillas Member; the Capillas Formation, of late Llanvirn-basal Caradoc age; the Centinela Formation, considered to be not older than late Caradoc, and the Zapla Formation of Hirnantian age. The uppermost Ordovician is overlain by the Silurian Lipeón Formation that initiates a separate supercycle (ASTINI & MARENGO, 2003; ASTINI et alii, 2003).

This work analyses the succession of palynological assemblages throughout the Ordovician and lower Silurian, and attempts to determine the biostratigraphic control of the units, their palaeogeographic affinities, and the palaeoenvironmental changes related to recurrent fluctuations in sea level.

Palynological results

All units involved in this study yielded palynomorph assemblages that include acritarchs and related marine forms, chitinozoans and cryptospores (Pl. 1). Their abundance, diversity and preservation range widely in accordance with stratigraphic level and sedimentary facies.

Detailed descriptions and illustrations of the palynological assemblages from all units discussed herein are currently in progress.

The Zanjón Formation is characterized by repeated tidal parasequences that shallow-upward into heterolithic and muddy intervals. It yielded a rich acritarch assemblage containing Striatotheca principalis parva BURMANN 1970, Arbusculidium filamentosum (VAVRDOVÁ) VAVRDOVÁ 1972 emend. FATKA et BROCKE 1999, Aureotesta clathrata var. simplex (CRAMER et alii) emend BROCKE et alii 1998, Cymatiogalea...
Figure 1: Location map of the study area, in the Sierras Subandinas, north-west Argentina. Ordovician and Lower Silurian stratigraphy of the Sierra de Zapla, recognized sequences, lithologies and sea-level curve from ASTINI & MARANGO, 2003.

granulata VAVROVÁ 1966, Cymatiogalea messaoudensis JARDINÉ et alii 1974 var. messaoudensis autonym, Rhopaliophora palmata (COMBAZ et PENIGUEL) PLAYFORD et MARTIN 1984, Dactylofusa velifera COCCIO forma brevis ALBANI 1989, Eisenackidium orientalis RUBINSTEIN in RUBINSTEIN et alii, 1999, Coryphidium sp., and Vogtiandia sp. This assemblage can be correlated with acritarchs of the Acoite Formation in the Cordillera Oriental. Consequently, its age is not younger than middle Arenig, although stratigraphic correlation suggests that it includes the late Arenig.

The lower subdivision of the Labrado Formation, the Laja Morada Member, records exposure during a lowering of relative sea level indicated by subaerial features and a gradual change toward purple-red colours near the top. Consequently, the only palynomorphs present are leiospheres and other prasinophycean algae such as Cymatosphaera, all devoid of...
stratigraphic value. The upper Lagunillas Member, representing restricted estuarine facies, yielded a poorly diversified assemblage with some acritarchs such as \textit{Aremoricanium simplex} \textit{Loeblich} & \textit{McCadam} 1971, in addition to leiospheres.

Transition to the open marine deposits of the Capilla Formation is indicated by a maximum flooding surface. This formation yielded a rich and well-preserved acritarch assemblage containing such taxa as \textit{Arbusculidium filamentosum}, \textit{Striatotheca} spp., \textit{Arkonia} sp., \textit{Dactylofusa} cf. \textit{D. striatogranulata} \textit{Jardine et alii} 1974, \textit{Erianthecia pollicipes} \textit{Cramer} et \textit{Diez} 1977, \textit{Liliosphaeridium} cf. \textit{L. intermedium} (\textit{Eisenack}) \textit{Playford et alii} 1995 and \textit{Leprotolypa} \textit{evelixa} \textit{Colbath} 1979. It also contains cryptospores of the morphon \textit{Dyadospora murusattenuata} \textit{Strother} et \textit{Traverse} 1979 \textit{sensu Steemans et alii} 1996, and \textit{Sphaerasaccus glabellus} \textit{Steemans et alii} 2000. The latest record of \textit{Arbusculidium filamentosum}, independently dated, is probably lowermost Llanvirn. But other less well age-constrained records of its occurrence attain the Llanvirn and may reach the Caradoc strata (\textit{Tongiorgi et alii}, 2003). The genus \textit{Striatotheca} may also extend up to the Caradoc (\textit{Vecoli} & \textit{Le Hérisse}, 2004). The genus \textit{Arkonia}, and the species \textit{Erianthecia pollicipes} and \textit{Liliosphaeridium} cf. \textit{L. intermedium} were recorded from Llanvirn strata (\textit{Tongiorgi et alii}, 2003; \textit{Vecoli} & \textit{Le Hérisse}, 2004) and \textit{Dactylofusa} \textit{striatogranulata}, previously known only in the Ashgill has recently been found in the middle Arenig (uppermost Lower Ordovician) of Argentina (\textit{Achab et alii}, in press). Furthermore, \textit{Leprotolypa} \textit{evelixa} is unknown below the base of the Caradoc (\textit{Vecoli} & \textit{Le Hérisse}, 2004). Although there is some dispersion in the stratigraphic ranges of the acritarch species, a late Llanvirn-earliest Caradoc age assignment for the Capilla Formation based on the presence of \textit{Sacabambaspis janvieri} (Vertebrata), roughly agrees with the age inferred from the palynomorph assemblages.

The Centinela Formation contains mainly leiospheres, pre-cryptospores and simple acanthomorph acritarchs, and testifies to a possible progradation of localized deltaic complexes. At its upper limit a regional unconformity correlated with a major eustatic fall in sea-level caused by the Hirnantian glaciation separates the Centinela Formation from the uppermost Ordovician Zapla Formation.

The palynomorph assemblages of the Zapla glacial horizon are dominated by marine elements such as \textit{Villosacapsula} sp., subordinate acanthomorph acritarchs (\textit{Polygonion}, \textit{Michrystridium}, \textit{Multiplicisphaeridium}) and leiospheres, but also contain terrestrial cryptospores (mainly tetrads). Stratigraphically, the Zapla Formation is dated latest Ordovician, probably corresponding to the Hirnantian Glaciation. However, chitinozoans indicate an Aeronian s.l. to early Telychian age (\textit{Grahn} \& \textit{Gutiérrez}, 2001). Acritarch assemblages are meager and not well preserved so they do not provide accurate stratigraphic control. In addition, transgressive-regressive events frequently caused reworking of fossils. Nevertheless, it should be noted that no typical Silurian forms were found among acritarchs or cryptospores. Further investigations, particularly on chitinozoans from the levels under discussion, may shed some light on this controversy.

The Lipeón Formation initiates a new supercycle with the deposition of oolitic ironstones during the transgression that followed the Hirnantian glaciation. These Silurian deposits correspond to a series of high-frequency sea-level fluctuations. In the area studied the lowermost levels of the Lipeón Formation have yielded abundant, diverse and well-preserved palynomorphs. The assemblage is dominated by acritarchs and prasinophyte algae, but also contains cryptospores and chitinozoans. Acritarch species include \textit{Domasia trispinosa} \textit{Downie} 1960, \textit{Domasia elongata} \textit{Downie} 1960, \textit{Dactylofusa estilis} \textit{Cramer} et \textit{Diez} 1972, \textit{Dactylofusa maranhensis} \textit{Brito} et \textit{Santos} 1965, \textit{Beromia rexradii} \textit{Wood} 1996, \textit{Baiomeniscus camurus} \textit{Loeblich} 1970, \textit{Carminella maplewoodensis} \textit{Cramer} 1968, \textit{Eupokifusosa striatifera} (\textit{Cramer}) \textit{Cramer} 1970, among others. Cryptospores are represented by tetrads and also \textit{Imperfectotritiletes vavrdovae} (\textit{Richardson}) \textit{Steemans et alii} 2000 and \textit{Laevolancis chibrikovae} \textit{Steemans et alii} 2000. The acritarch assemblages are meager and with those described by \textit{Bultynck} \& \textit{Martin} (1982) from the lower part of the unit, dated late Llandovery-early Wenlock, and also has species in common with acritarch assemblages from the Vargas Peña Formation, in Paraguay (\textit{Wood} \& \textit{Miller}, 1997). The palynomorphs of the Lipeón Formation have particularly strong affinities with the assemblage of the Tianguá Formation, in the Brazilian Paranaiba Basin (Le \textit{Hérisse et alii}, 2001). In the Subandebean Ranges, the lower part of this unit was referred to the early Llandovery (\textit{Parakidograptus acuminatus- Atavograptus atavus} graptolite biozones) by \textit{Rickards et alii} (2002). On the other hand, in the Río Capillas section, chitinozoans indicate a late Telychian age for the lower part of this formation (\textit{Grahn} \& \textit{Gutiérrez}, 2001). Nevertheless, the acritarch assemblage of the Lipeón Formation suggests an age probably near the Aeronian/Telychian boundary and not older than late Aeronian (\textit{Rubinstein} \& \textit{Toro}, in press).
The palynological slides are housed in the Paleopalynological Slide Collection of the Unit of Paleopalynology, IANIGLA, CRICYT, Mendoza. Specimen locations are referred to using England Finder coordinates.

1- Eisenackidium orientalis RUBINSTEIN in RUBINSTEIN et alii, 1999. Zanjón Fm, 7999d, U33/1.
2- Cymatiogalea granulata VAVROVÁ 1966. Zanjón Fm, 7999d, K41/2.
3- Dactylofusa veilera COCCIO forma brevis ALBANI 1989. Zanjón Fm, 8000d, N3S/3.
4- Cymatiogalea messaoudensis JARDINÉ et alii 1974 var. messaoudensis. Zanjón Fm, 7999c, E34/0.
5- Striatotheca principalis parva BURMANN 1970. Zanjón Fm, 7S87i, A24/1.
6- Aureotesta clathrata var. simplex (CRAMER et alii) emend BROCKE et alii 1998. Zanjón Fm, 7999d, C37/2.

7- ?Aremoricanium simplex LOEBLICH et MCADAM 1971. Labrado Fm, Lagunilla Member, 7575a, M26/1.
8- Arkonia sp. Capillas Fm, 7589g, N38/0.
10- Ericanthia pollipes CRAMER et DIEZ 1977. Capillas Fm, 7589h, V40/2.
11- Leprotolypa eveska COLBATH 1979. Capillas Fm, 7588c, B22/1.
13- Sphaerasactus globellus STEEMANS et alii 2000. Capillas Fm, 7589h, P36/1.
14- Villosacapsula sp. Zapla Fm, 7590e, B23/0.
15- Tetrad 1. Zapla Fm, 7590d, W35/3.
16- Tetrad 2. Zapla Fm, 7583d, S28/0.
17- Carmiella maplewoodensis CRAMER 1968. Lipeón Fm, 7592d, W43/0.
18- Dactylofusa maranhensis BRITO et SANTOS 1996. Lipeón Fm, 7592e, W43/0.
19- Domasia elongata DOWNIE 1960. Lipeón Fm, 7582e, L33/2.
20- Dactylofusa estillis CRAMER et DIEZ 1972. Lipeón Fm, 7592g, P30/0.
21- Beromia rexroadii WOOD 1996. Lipeón Fm, 7582e, M27/0.
22- Baimenacis cameruni LOEBLICH 1970. Lipeón Fm, 7592g, Y38/0.
23- Laevolancis chibrikova STEEMANS et alii 2000. Lipeón Fm, 7592f, Y44/2.
24- Imperfectoritelles vavrdovaë (RICHARDSON) STEEMANS et alii 2000. Lipeón Fm, 7582e, F25/2.

Conclusions

Although still in a very preliminary stage, the analyses in this contribution provide biostratigraphic, palaeogeographic and palaeoenvironmental information about the palynomorph assemblages of the Central Andean Basin. They cover almost all of Ordovician, the Ordovician/Silurian transition and the Lower Silurian.

The acritarch assemblages of the Zanjón Formation provide the first age constraint for this unit. For the Capillas Formation, acritarch assemblages support the age suggested by other fossils. The palynomorph assemblages of the Zapla and Lipeóñon formations allow an independent age assessment.

From a palaeogeographic viewpoint, it is significant that acritarchs from the Zanjón Formation clearly show affinities to those of the peri-Gondwana province. Acritarchs of the lower Silurian also have Gondwanian affinities.

Palynological assemblages recovered from the seven depositional settings vary in diversity, composition and abundance, thus indicating the existence of a relationship between palynomorphs and local palaeoenvironments.

Acknowledgments

Financial support for this study was provided by the ANPCyT-CONICET (PICT 99 No 5387, PICT 2000 No 8920) and the CONICET. The author is grateful to J.H.G. MELO (PETROBRAS, Brazil) for reviewing the English version. C. WELLMAN (Sheffield, UK) and P. STEEMANS (Liège, Belgium) are thanked for their advice concerning miospores and A. LE HÉRISSE (Brest, France) for the review of the manuscript and useful suggestions. The author benefited from a NFSR post-doctoral grant at the University of Liège.

Bibliographic references


WOOD G.D. & MILLER M. (1997).- The stratigraphic and paleoecological importance of acritarchs, chitinozoans and spores from the Silurian Vargas Peña Shale, Paraguay.- 2nd European Meeting on the Palaeontology and Stratigraphy of South America (Heildelberg, September 2-4, 1997), Poster.