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Lower Darriwilian radiolarians from the Argentine Precordillera☆

Radiolaires du Darriwilien inférieur de la Précordillère argentine

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Abstract

The first radiolarians discovered in the Ordovician of the Argentinian Precordillera are reported. The material is associated with conodonts indicating the upper part of the *Lenodus variabilis* Biozone (Lower Darriwilian, Da1-2). The low diversity radiolarian fauna shows similarities with Middle Ordovician radiolarians from the Akzhal Mountains of Kazakhstan. However, a close comparison is difficult due to the poor preservation of the material, in which internal structures of the radiolarian tests are not preserved.

Résumé

Nous décrivons ici les premières radiolaires découvertes dans l'Ordovicien de la Précordillère argentine. Ce matériel est associé à des conodontes caractéristiques de la partie supérieure de la biozone à *Lenodus variabilis* (Darriwilien inférieur, Da1-2). La faible diversité de la faune de radiolaire la rapproche de celles de l'Ordovicien moyen des monts d'Akzhal, au Kazakhstan. Cependant, une comparaison précise est difficile du fait de la mauvaise préservation du matériel, pour lequel les structures internes des radiolaires ne sont pas conservées.

Keywords: Ordovician; Darriwilian; Radiolaria; South America; Argentina; Precordillera

Mots clés : Ordovicien ; Darriwilien ; Radiolaire ; Amérique du Sud ; Argentine ; Précordillère

1. Introduction

Ordovician radiolarians have not previously been described from South America and their discovery in conodont samples from the Argentine Precordillera was quite a surprise (Voldman et al., 2008). In general, Palaeozoic radiolarians are more frequently mentioned in recent literature, but they have long been neglected (Maletz, 2007a). Ruedemann and Wilson (1936) described Ordovician radiolarians from thin sections of Normanskill Formation cherts, but provided very poor illustrations. Stürmer (1951, 1952, 1966) recorded abundant and well-preserved radiolarians from Silurian cherts of Germany and provided excellent photographs of polished rock surfaces showing the delicate radiolarian structures in great detail. It was, however, the successful chemical isolation of radiolarians from limestones and cherts that boosted the research on Palaeozoic radiolarians. Fortey and Holdsworth (1971) documented what was then the oldest known radiolarian fauna recovered from limestones. The material from the Middle Ordovician of Spitsbergen is excellently preserved with fine details still visible, even though the material is recrystalized (Maletz and Bruton, 2005, 2007). The renewed interest in radiolarians from the Palaeozoic can be shown to provide an important tool for biostratigraphic purposes when studied in detail (Noble and Aitchison, 1995, 2000; Maletz, 2007a; Danelian and Popov, 2003). A number of radiolarian assemblages can be differentiated in the Ordovician, but biostratigraphic ranges of these faunas have not yet been documented (Maletz, 2007a). Several clearly distinct faunas

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with no biostratigraphic overlap of any faunal elements are differentiated and ranges have been established only from a few sections in western Newfoundland, crossing the Cambrian–Ordovician boundary (Won and Iams, 2002; Won et al., 2005). Nothing is known about biogeographic differentiation of radiolarian faunas. Thus, every new record adds important information to the knowledge on Palaeozoic radiolarian faunas and their usefulness.

2. Geological context

The Argentine Precordillera represents an eroded fold-and-thrust belt, mostly composed of Cambrian to Carboniferous strata, located in the foothills of the Andes, between 28 and 33° S (Ramos, 1988). There is a general agreement about the exotic nature of the lower Palaeozoic Precordillera to Gondwana. However, the debate continues over the original geographic position of the block or the timing of its rifting and collision (see recent reviews in Thomas and Astini, 2003; Ramos, 2004; Finney, 2007).

The Yerba Loca Formation (Furque, 1963) is a Darriwilian to Sandbian siliciclastic unit that crops out in the northern and central parts of the Western Precordillera, in the Yerba Loca, La Tranca, and El Tigre ranges. The strongly deformed unit is characterized by distal turbidites and hemipelagites, deposited in deep ocean basin to slope environments (Astini, 2003), and accompanied by subordinated concordant to subconcordant mafic to ultramafic rocks. Furque (1983) suggested a minimum thickness of 1500 m, based on lithostratigraphic correlations of sandstones, claystones, calcarenites and sparce conglomerates; although, the base and top are not well defined as yet.

First records of fossils from the Yerba Loca Formation correspond to Volkheimer (1962), who mentioned the appearance of *Climacograptus* sp. in the western flank of the Alto de Mayo Mountain. Later, Blasco and Ramos (1976) documented graptolites, indicative of the *Nemagraptus gracilis* Zone (Sandbian) from outcrops of the Yerba Loca Formation at the Cuesta del Viento locality. Subsequently, Ortega et al. (1991) extended the temporal range of this stratigraphic unit from mid Darriwilian to lower Sandbian (early Llanvirn to late Caradoc in the British timescale) through the record of specimens from the *Paraglossograptus tentaculatus* and *Nemagraptus gracilis* zones, respectively. At Ancaucha creek, the Yerba Loca Formation overlies in apparent conformity the Los Sombreros Formation, a lower Darriwilian olistostromal unit (Albanesi et al., 1995). The Yerba Loca Formation is one of the main stratigraphic units of the clastic wedge in the Western Precordillera and correlates with several Ordovician siliciclastic formations in the Precordillera (e.g., Sierra de la Invernada, Portezuelo del Tontal).

The study area involves two fossiliferous localities within the Yerba Loca Formation: the Puerta de Ancaucha (S30°6′20″, W68°52′34″) and El Salto (S30°5′41″, W68°53′37″). It is located in the foothills of the Alto de Mayo Mountain, on the eastern border of the Western Precordillera, *ca.* 20 km northwest of Jáchal City, San Juan Province (Fig. 1).

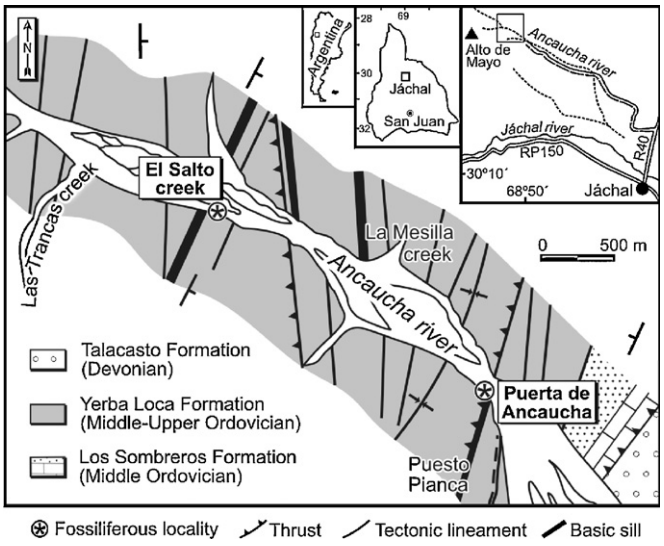

Fig. 1. Location map of the study area showing the radiolarian localities.

3. Conodont biostratigraphy

The radiolarians of the present study were recovered from the same samples of the Yerba Loca Formation that yielded conodonts, which are the objective of a major project on paleothermometry (Voldman et al., 2008). The samples come from two sections, Puerta de Ancaucha (sample P10) and El Salto (sample A17) (Fig. 1). The age of recorded radiolarians is constrained by the conodont biostratigraphy resulting from 44 calcarenite samples that produced *ca.* 1300 conodont elements, representing about 50 conodont species (Albanesi et al., 2006). These microfossils are housed in the Museo de Paleontología, Universidad Nacional de Córdoba, under repository code CORD-MP.

Most representative conodont species, which have been illustrated in a previous work (Voldman et al., 2008), represent a diverse fauna that characterizes the *Paroistodus horridus* Subzone of the *Lenodus variabilis* Zone, following the biostratigraphic scheme developed for the Argentine Precordillera (Albanesi et al., 1998). In this scheme, the *L. variabilis* Zone correlates with the *Holmograptus lentus* and *Nicholsonograptus fasciculatus* graptolite zones, which represents the middle Darriwilian in the Baltoscandian biostratigraphy (Webby et al., 2004). The conodont biozonation for this region, as proposed by Löfgren (2003, 2004), includes the *Yangtzeplacognathus crassus* and *Eoplacognathus pseudoplanus* zones for this interval, which correlates with the upper part of the *L. variabilis* Zone and the *Eoplacognathus pseudoplanus/Dzikodus tablepointensis* zones of the Precordillera in the recent review for the Ordovician conodont biostratigraphy provided by Albanesi (2007) (Fig. 2). The *Histiodella holodentata* Zone of the North American midcontinent and Newfoundland (Harris et al., 1979; Stouge, 1984; Chen et al., 2006) and the *Dzikodus tablepointensis* Zone of the Yangtze Platform, in south-central China (Zhang, 1998) are other well-documented correlative units. Diverse formations of the Argentine Precordillera include this biostratigraphic interval as documented by the conodont records in different parts of the