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Research paper

Palynology and palynofacies analysis of a Silurian (Llandovery–Wenlock) marine succession from the Precordillera of western Argentina: Palaeobiogeographical and palaeoenvironmental significance

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ABSTRACT

A comprehensive survey of the marine and terrestrial palynomorphs from the La Chilca Formation, exposed in the Central Precordillera of San Juan, Argentina, is presented. Twenty-four samples from the Quebrada Ancha section were analysed. Marine phytoplankton predominated in the entire stratigraphic unit while the contribution of terrestrial palynomorphs was much less. Acritarchs and chlorophytes represent a highly diversified assemblage, including stratigraphically relevant taxa such as *Domasia trispinosa*, *Tylotopalla caelamenicutis*, *Tylotopalla digitifera*, *Crassiangulina variacornuta*, *Stellinium rabians* and *Percultisphaera* cf. *stiphrospinata*. Terrestrial palynomorphs are exclusively represented by six cryptospore species; namely *Gneudnaspora divellomedia*, *Pseudodyadospora laevigata*, *Rugosphaera cerebra*, *Tetrahedraletes medinensis*, cf. *Imperfectotriletes vavdovae* and *Velatitetras retimembrana*. Comparisons with coeval phytoplankton assemblages from Gondwana and other palaeoplates such as Laurentia, Baltica and Avalonia show strong similarities, suggesting a cosmopolitan distribution pattern during the Llandovery and Wenlock. The first palynofacies analysis for the early Silurian of Argentina was performed. Depositional environments based on palynofacies match with those previously suggested based on sedimentological data. Two main palynofacies associations are recognised. Association B occurs in the lower part of the La Chilca Formation and is mostly composed of amorphous organic matter (AOM) representative of low energy inner shelf environments. Association A is recognised in the upper part of the formation, where sandstone beds become more frequent, and is characterised by a greater amount of possible palynomorph remains (PPR), indicating a proximal platform to shoreface environment. Three excursions of Total Organic Carbon (TOC) were identified in the section, probably as a result of sea level rise episodes that produced anoxic conditions and preservation of organic matter.

1. Introduction

During the Late Ordovician, the oldest of the 'Big Five' Mass Extinction Events occurred due to a major glaciation. However, marine plankton displayed a noteworthy behaviour. That is, several chitinozoan and phytoplankton taxa survived, and a turnover instead of extinction has been recognised. Several genera and species of organic-walled phytoplankton disappeared and new morphologically innovative taxa emerged during the latest Ordovician–Early Silurian, thus evidencing the turnover (Paris et al., 2000; Vecoli, 2008; Delabroye and Vecoli, 2010; Le Hérissé et al., 2015 and references therein).

The Silurian global events form part of a succession of ocean–atmosphere–biosphere changes that took place from the Late Ordovician to the Early Devonian (Calner, 2008). Consequently, rapid and important changes in oceanic conditions and in the global carbon cycle are reflected in the Silurian marine biodiversity crises. These events affected several fossil groups such as graptolites, conodonts, chitinozoans and acritarchs (Bergström, 1990; Calner, 2008). During the Llandovery and Wenlock, these crises were identified by fluctuations in the diversity and abundance of phytoplankton, particularly documented in Baltica and Laurentia (e.g., Gelsthorpe, 2004; Strother, 2008; Lehnert et al., 2010).

Two palaeophytoprovinces are recognised for the Late Ordovician: the Baltic/Laurentian and the Gondwana provinces. This provincialism has been interpreted mainly as a result of sea level changes of the Rheic Ocean during pre-glacial, glacial and post-glacial events (Delabroye et al., 2011a). However, in the Llandovery and Wenlock, local environmental factors such as the distance to the shoreline, could have had more influence on acritarch distribution than the oceanic circulation and palaeogeographical location (Le Hérissé and Gourvennec, 1995; Delabroye et al., 2011a; Molyneux et al., 2013).

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The miospore assemblages are globally very similar from the Hirnantian to the Aeronian, and there is no evidence of a decrease in diversity during the latest Ordovician glaciation. Nevertheless, during the Aeronian and Telychian a decline in diversity has been observed, reaching a minimum, probably due to adverse environmental conditions for land plants related to the post-glacial global marine transgression (Steemans et al., 2010). Later, just before the Late Wenlock, land plants underwent a major recovery and during the Devonian the diversification and spread of vegetation allowed the definitive colonisation of land by plants (Morris and Edwards, 2014).

The La Chilca Formation, represented by extensive outcrops in the well-known Precordillera Basin, western margin of Gondwana, spans from the Ordovician/Silurian boundary to the early Wenlock. Apart from undergoing the global events of this time period, the formation was also influenced by particular geodynamic environmental conditions in a foreland basin. In this context, the La Chilca Formation provides key information to evaluate how major global events and local palaeogeographic or palaeoenvironmental factors influence the distribution of marine phytoplankton and the radiation of land plants at their first terrestrialisation steps. Moreover, knowledge on Silurian marine phytoplankton is still incomplete and scattered, lacking palynological studies on complete and continuous sequences from many regions and palaeocontinents and, particularly, from South America. Such scarcity of data inhibits precise global palaeogeographical and palaeoenvironmental interpretations.

The La Chilca Formation (Cuerda, 1965), from the Central Precordillera of Argentina has been extensively studied in the last fifty years; however fossil records were sparse, and mainly concentrated

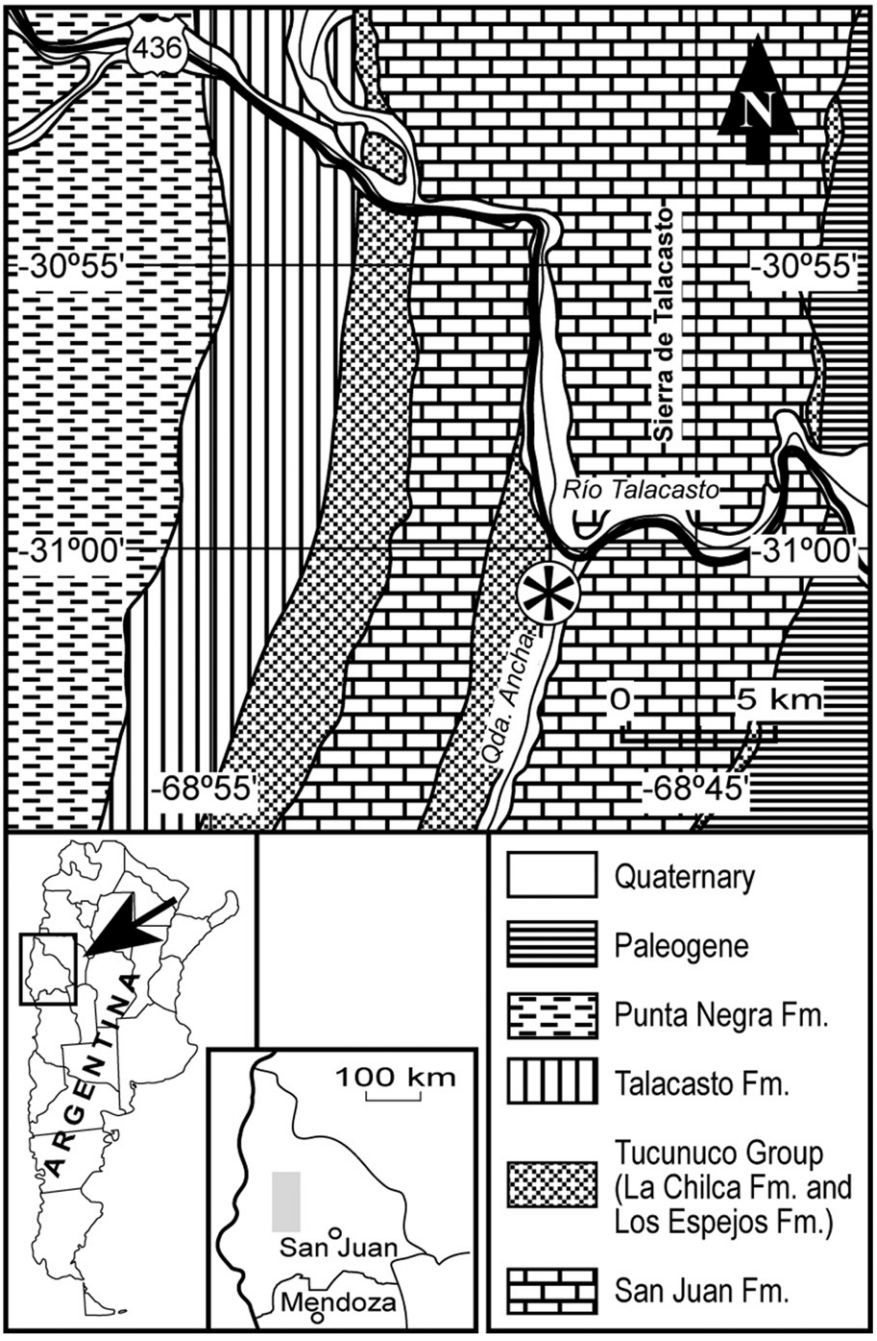

Fig. 1. Geologic map of the southern outcrops of the La Chilca Formation, and location of the Quebrada Ancha study section. (Modified from Ferrero, 2006 and Rustán, 2011.)