



Estonian Journal of
Earth Sciences
2023, 72, 1, 62–65

<https://doi.org/10.3176/earth.2023.61>

www.eap.ee/earthsciences
Estonian Academy Publishers

SHORT COMMUNICATION

Received 31 March 2023
Accepted 17 May 2023
Available online 14 June 2023

Keywords:

graptolites, conodonts, Ordovician,
Sandbian, Precordillera, Argentina

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Citation:

Lopez, F. E., Ortega, G., Albanesi, G. L. and
Banchig, A. L. 2023. New contributions to
the Ordovician biostratigraphy of the
Western Precordillera, Argentina. *Estonian
Journal of Earth Sciences*, 72(1), 62–65.
<https://doi.org/10.3176/earth.2023.61>



New contributions to the Ordovician biostratigraphy of the Western Precordillera, Argentina

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ABSTRACT

Upper Ordovician graptolites and conodonts are recorded from the Yerba Loca Formation in two sections, in the El Toro and Las Viudas creeks, from the El Tigre Range in the Western Precordillera of San Juan Province, Argentina. A collection of graptolites from the late Sandbian *Climacograptus bicornis* Zone and conodonts on bedding plane surfaces corresponding to the *Amorphognathus tvaerensis* Zone are presented. Graptolites apparently corresponding to the early Sandbian *Nemagraptus gracilis* Zone have also been recorded. The fossils determined allow for regional and global correlations, revealing sections suitable for future integrated studies on deep marine environments that are poorly known in the Argentine Precordillera.

Introduction

The Western Precordillera, located in the west of Argentina, has vast outcrops of siliciclastic, carbonate, and igneous rocks of Ordovician age, distributed throughout its ranges. Furthermore, the tectono-magmatic cycles that occurred in the western part of Gondwana have caused pervasive low-grade metamorphism, and the associated tectonic features make biostratigraphic studies complicated.

Several Ordovician formations have been described in the Western Precordillera with two lithological features: olistostromic mélanges, such as the Los Sombreros Formation, and turbiditic or hemipelagic deposits, such as the Alcaparrosa, Cabeceras, Cortaderas, Portezuelo del Tontal, and Yerba Loca formations.

The Yerba Loca Formation, studied herein, is composed of conglomerates, sandstones, black and gray shales, carbonates, and Ordovician intrusive-extrusive basic igneous rocks. Its main studied sections are located in the Yerba Loca, Negra, La Tranca, and El Tigre ranges (Fig. 1). The fossil content is bare, mostly composed of graptolites, conodonts, brachiopods, arthropods, and traces. Graptolites referable to the early Darriwilian *Levisograptus austrodentatus* or probably *L. dentatus* zones, and conodonts from the *Yangtzeplacognathus crassus* and *Eoplacognathus pseudoplanus* zones of middle Darriwilian age were found in the Yerba Loca Range (Albanesi et al. 2022). In the Negra Range, the early Sandbian *Nemagraptus gracilis* Zone was recorded (Blasco and Ramos 1976), and in the El Tigre Range, the late Sandbian *Climacograptus bicornis* Zone and early Katian graptolites were identified (Ortega et al. 1991; Caballé et al. 1993; Brussa 1995). Recently, Lopez et al. (2022) extended the range of the *C. bicornis* Zone to the El Toro Creek, El Tigre Range, mentioning an assemblage composed of the eponymous species, *Hallograptus* sp., *Dicellograptus* sp., and *Dicranograptus* sp. Accordingly, the biostratigraphic records constrain the age of the Yerba Loca Formation between the early Darriwilian and the late Sandbian–early Katian.

This study introduces one new Ordovician fossiliferous section for the Western Precordillera and expands the knowledge of a recently discovered section, i.e. Las Viudas and El Toro creeks, respectively, both located in the El Tigre Range in the Western Precordillera. Graptolites of the *Climacograptus bicornis* Zone

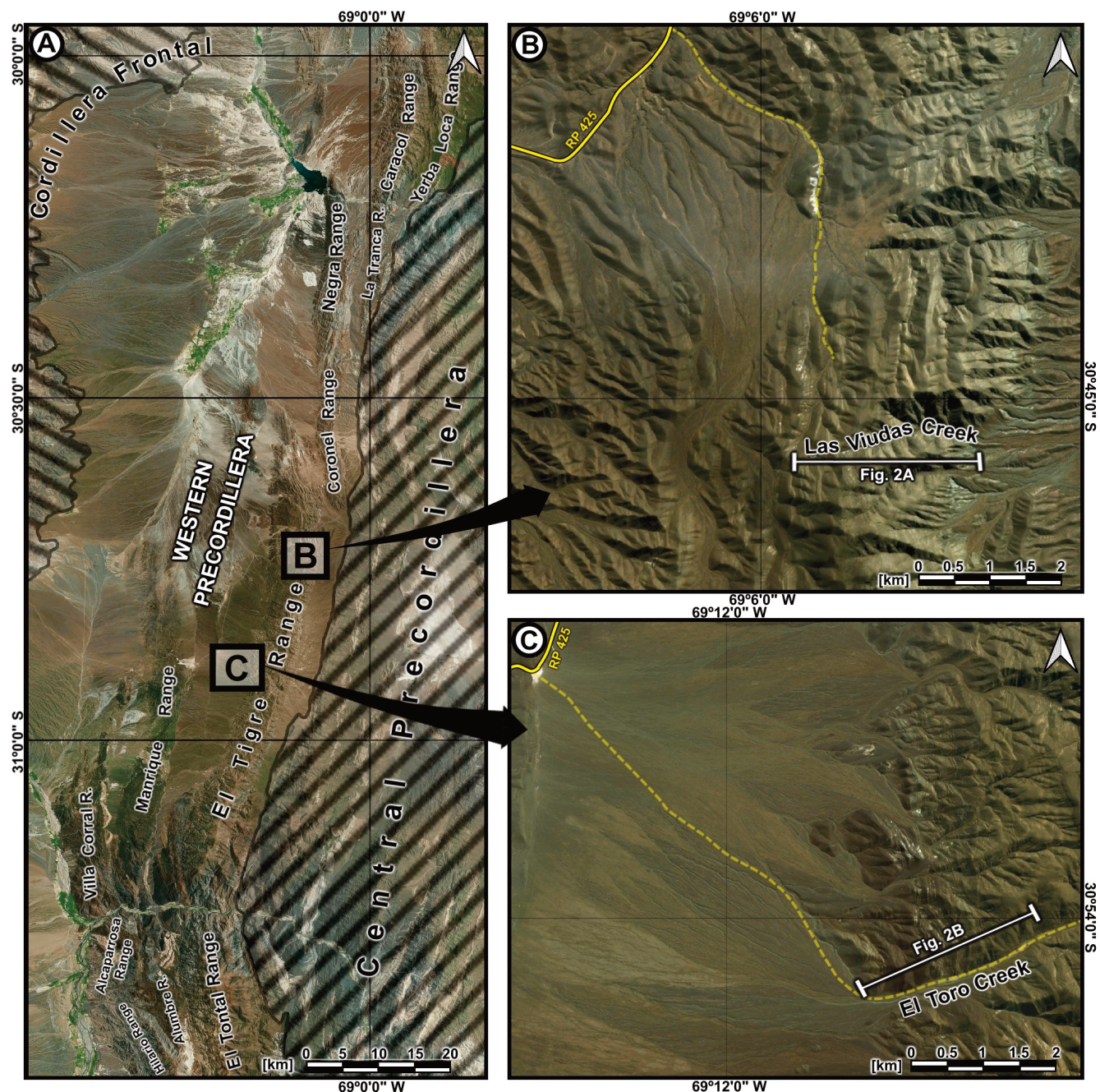


Fig. 1. **A** – location map showing the principal ranges of the Western Precordillera of San Juan; **B** – detailed map of the Las Viudas Creek section, northern area of the El Tigre Range; **C** – closer view of the El Toro Creek section, central part of the El Tigre Range.

and conodonts on bedding planes corresponding to the *Amorphognathus tvaerensis* Zone indicate a late Sandbian age. Furthermore, graptolites provisionally referred to as the *Nemagraptus gracilis* Zone (Lower Sandbian) are reported. These new sections show great potential to increase the paleontological and biostratigraphic knowledge of a critical time and place to untangle the complex geological history of the western margin of Gondwana.

Materials and methods

The graptolite samples were collected from the Las Viudas and El Toro creeks, from sandstones, gray and black shales, and present a poor to moderate preservation. Conodont elements and possible brachiopod specimens were recorded from bedding planes. All material is housed in the

Repositorio-INGEO Emiliano P. Aparicio, FCEF, Universidad Nacional de San Juan, under the acronym INGEO-PI-1988–2001.

Results and discussion

El Tigre Range sections. The first section, referred to as the Las Viudas Creek, is located on the eastern slope of the range, 30°45'21"S and 69°05'25"W, 4 km south of RP 425 (Fig. 1B). This outcrop is characterized by a west-dipping 969 m thick stratigraphic succession, with faulted base and top, composed mainly of thick beds of sandstones, gray shales, siltstones, and occasional conglomerates and calcarenite beds. Several basic Ordovician igneous bodies, sills and pillows were found across the section, which thermally affected the surrounding strata and fossil preservation. Only a few

Azules, Las Vacas and Sierra de La Invernada formations (Central Precordillera; Ortega and Brussa 1990; Ortega et al. 2007a; Ortega et al. 2008), the Empozada Formation (South Precordillera; Ortega et al. 2007b), the Pavón Formation (San Rafael Block; Cuerda and Cingolani 1998), and the Las Lagunitas Formation (Cordillera Frontal; Tiky et al. 2009). Globally, a number of sections from Scandinavia, Great Britain, North America, Australasia, and China can be confidently correlated.

Conclusions

New biostratigraphic studies are presented after surveys carried out in the El Toro and Las Viudas creeks, from the El Tigre Range, Western Precordillera of San Juan Province, Argentina. Graptolites of the *Climacograptus bicornis* Zone and conodonts on bedding plane surfaces corresponding to the *Amorphognathus tvaerensis* Zone were collected, indicating a late Sandbian age for the bearer strata. Graptolites possibly referable to the early Sandbian *Nemagraptus gracilis* Zone have also been recorded. These two sections reveal important paleontological and biostratigraphic potential for the study of the Upper Ordovician in poorly known deep marine environments from the Western Precordillera of Argentina.

Acknowledgments

The CONICET, the FCEfyN-UNSJ and the CIGEA, FCEfyN-UNC, provided institutional support for this research. J. M. Drovandi, O. Conde, and G. Molina assisted in the field work. This study was partly funded by PIP 2021–2023 (11220200100298CO) CONICET. The authors would like to thank Petr Kraft and Olle Hints for their review and help in improving the text. The publication costs of this article were partially covered by the Estonian Academy of Sciences.

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