Sedimentary Geology 296 (2013) 103–121

Contents lists available at ScienceDirect

Sedimentary Geology

journal homepage: www.elsevier.com/locate/sedgeo

Sedimentology and palaeontology of the Upper Jurassic Puesto Almada Member (Cañadón Asfalto Formation, Fossati sub-basin), Patagonia Argentina: Palaeoenvironmental and climatic significance ☆

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ARTICLE INFO

Article history:
Received 9 May 2013
Received in revised form 20 August 2013
Accepted 21 August 2013
Available online 28 August 2013

Editor: B. Jones

Keywords:
Facies
Palaeontology
Palaeoclimatology
Upper Jurassic
Cañadón Asfalto Formation
Patagonia

ABSTRACT

Six facies associations are described for the Puesto Almada Member at the Cerro Bandera locality (Fossati sub-basin). They correspond to lacustrine, palustrine, and pedogenic deposits (limestones); and subordinated alluvial fan, fluvial, aeolian, and pyroclastic deposits. The lacustrine–palustrine depositional setting consisted of carbonate alkaline shallow lakes surrounded by flooded areas in a low-lying topography. The facies associations constitute four shallowing upward successions defined by local exposure surfaces: 1) a Lacustrine–Palustrine-pedogenic facies association with a 'conchostracan'–ostracod association; 2) a Palustrine facies association representing a wetland subenvironment, and yielding 'conchostracans', body remains of insects, fish scales, ichnofossils, and palynomorphs (cheirolepidiacean species and ferns growing around water bodies, and other gymnosperms in more elevated areas); 3) an Alluvial fan facies association indicating the source of sediment supply; and 4) a Lacustrine facies association representing a second wetland episode, and yielding 'conchostracans', insect ichnofossils, and a palynoflora mainly consisting of planktonic green algae associated with hygrophile elements. The invertebrate fossil assemblage found contains the first record of fossil insect bodies (Insecta-Hemiptera and Coleoptera) for the Cañadón Asfalto Formation. The succession reflects a mainly climatic control over sedimentation. The sedimentary features of the Puesto Almada Member are in accordance with an arid climatic scenario across the Upper Jurassic, and they reflect a strong seasonality with periods of higher humidity represented by wetlands and lacustrine sediments.

1. Introduction

The Jurassic basins of Patagonia are associated with intense volcanism and plutonism, which was the result of subduction at the western margin. In the Middle Jurassic, magmatic activity became particularly intense in Patagonia as well as in several other areas of Gondwana (Spalletti and Franzese, 2007). The Cañadón Asfalto Basin was characterized by a great diversity of environments, represented mainly by lakes, rivers, ponds, and wetlands, which suffered dry and wet intervals and which were affected by magmatic activity (Lizuain and Silva Nieto, 1996; Cabaleri and Armella, 1999; Cabaleri et al., 2010a; Gallego et al., 2011).

The sedimentological study of carbonate deposits is relevant since these deposits contain high resolution information about climatic conditions at the time of deposition (Platt and Wright, 1992). The Cañadón Asfalto Formation in the Fossati sub-basin, possesses thick limestone beds that allow such studies. The limestones of the lower member of this formation, the Las Chacritas Member, were recently studied by Cabaleri and Benavente (2013). The sedimentary features revealed an intermediate climate (arid to sub-humid conditions) and suggested that minor sedimentary changes were caused by variations in the exposure index of the Las Chacritas wetland directly determined by climatic conditions. The upper member of the unit, the Puesto Almada Member, has also numerous limestone beds that have not yet been studied and that could provide valuable information about the dynamics of the sedimentary system that could be extrapolated to the other sub-basins of the Cañadón Asfalto Basin. Therefore our objective in this paper is to complete the palaeoenvironmental framework, based on sedimentological, mineralogical, and palaeontological data, at the time of deposition of the upper section of the Cañadón Asfalto Formation (i.e., the Puesto Almada Member), outcropping at the Cerro Bandera locality (Fig. 1). With the information provided by the aforementioned proxies, the palaeogeographic setting, and other relevant reports, we aim

☆ In memory of Dr. Sara Ballent (1950–2011).
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http://dx.doi.org/10.1016/j.sedgeo.2013.08.011

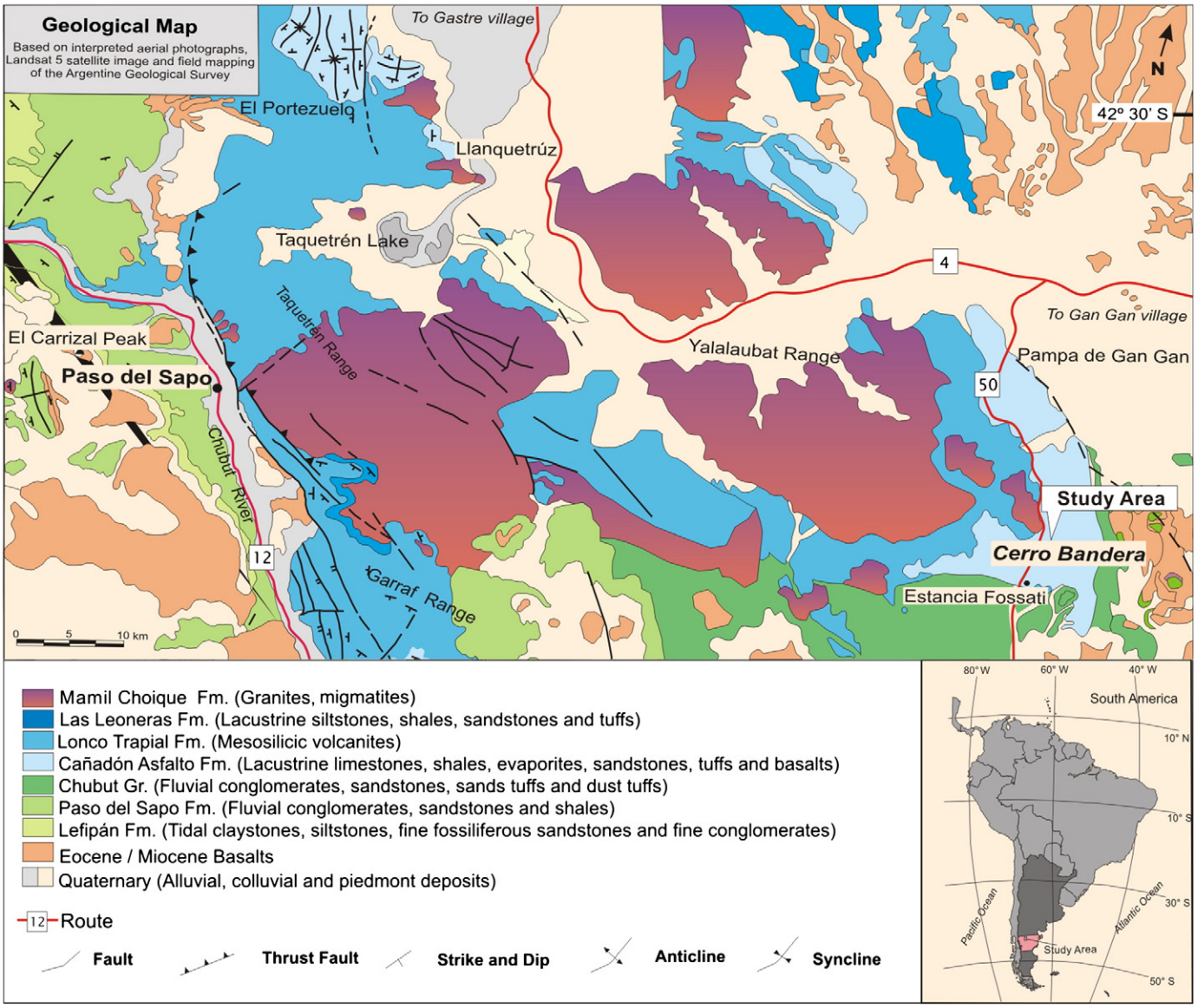

Fig. 1. Location and geological map of the Cerro Bandera locality in the Fossati sub-basin showing the outcropping units (Permian through Quaternary) modified from Cabaleri and Benavente (2013).

to contextualize the studied succession within the Late Jurassic palaeoclimatic conditions of southern South America.

2. Geological setting

A detailed geologic framework of the Cañadón Asfalto Basin is presented in Cabaleri et al. (2010a) and Cabaleri and Benavente (2013). Three sub-basins are recognized as part of the Cañadón Asfalto Basin: Cerro Cóndor (middle Chubut River area), El Portezuelo-Llanquetrúz (NW of Gastre village) (Figari et al., 1996), and Fossati (Pampa de Gan Gan) (Silva Nieto et al., 2007). Stratigraphic descriptions of the Cerro Cóndor and Fossati sub-basins are given by Cabaleri et al. (2006, 2008, 2010a, 2011).

The Fossati sub-basin occupies the north central region of the Cañadón Asfalto rift basin, formed by NW oriented faults (see Fig. 1 in Cabaleri and Benavente, 2013). The basement of the Fossati sub-basin is represented by the Mamil Choique Formation (Ravazzoli and Sesana, 1997), with a radiometric K/Ar age of 249.7 ± 5.3 Ma that corresponds to Permian–Triassic. This unit is unconformably covered by the Las Leoneras Formation (Pliensbachian age, 188.946 ± 0.096/0.13/0.24 Ma; Cúneo et al., 2013), which underlies the Lower–Middle Jurassic volcanites (K/Ar 173.1 ± 9.4 Ma; Silva Nieto, 2005) from the Lonco Trapial Formation (Lesta and Ferello, 1972), with an unconformity at the basal contact. The Lonco Trapial Formation is then unconformably overlain by the Cañadón Asfalto Formation, which is in turn separated from the continental deposits of the Chubut Group (Los Adobes and Cerro Barcino formations; Barremian–Santonian) by a low-angle unconformity. The Chubut Group (Lesta, 1968; Codignotto et al., 1979) was formed during a stage of tectonic stability (*sag* stage) (Ranalli et al., 2011). In the eastern area of the Cerro Bandera locality (Fig. 1), the Cañadón Asfalto Formation is covered by the Paso del Sapo (Campanian/Maastrichtian) and Lefipán formations (Lesta and Ferello, 1972). The Paleogene is represented by the Salamanca Formation and by the Eocene–Miocene basalts (Fig. 1).

The Cañadón Asfalto Formation (Stipanicic et al., 1968) is one of the most significant units of the basin. It is a thick sedimentary succession that includes lacustrine and fluvial systems, pyroclastic intercalations, and olivine-rich basalt flows at its base (Stipanicic et al., 1968; Nullo, 1983; Turner, 1983; Cabaleri et al., 2010a). The age of the complete volcano-sedimentary unit is Toarcian–Aalenian to Tithonian