ELSEVIER

Journal of South American Earth Sciences 23 (2007) 304–320

Journal of
South American
Earth Sciences

www.elsevier.com/locate/jsames

Carbon and oxygen isotopes of Maastrichtian–Danian shallow marine carbonates: Yacoraite Formation, northwestern Argentina

Rosa Marquillas [a,*], Ignacio Sabino [b], Alcides Nobrega Sial [c], Cecilia del Papa [a], Valderez Ferreira [c], Stephen Matthews [d]

[a] *CONICET-Universidad Nacional de Salta, Buenos Aires 177, 4400 Salta, Argentina*
[b] *Universidad Nacional de Salta-CIUNSa, Buenos Aires 177, 4400 Salta, Argentina*
[c] *NEG–LABISE, Department of Geology, UFPE, C.P. 7852, Recife 50670-000, Brazil*
[d] *SERNAGEOMIN, CC 10465, Santiago, Chile*

Abstract

The Maastrichtian–Danian limestones of the Yacoraite Formation (northwestern Argentina) show carbon and oxygen isotopic values consistent with shallow marine conditions. The members of the formation respond to different sedimentary environments and are characterised by distinctive stable isotopes and geochemistry. The basal Amblayo Member is composed of high-energy dolomitic limestones and limestones with positive isotopic values (+2‰ $\delta^{13}C$, +2‰ $\delta^{18}O$). The top of the member reveals an isotopic shift of $\delta^{13}C$ (−5‰) and $\delta^{18}O$ (−10‰), probably related to a descent in the sea level. The sandy Güemes Member has isotopically negative (−2‰ $\delta^{13}C$, −1‰ $\delta^{18}O$) limestones, principally controlled by water mixing, decreased organic productivity, and compositional changes in the carbonates. The isotopically lighter limestones are calcitic, with a greater terrigenous contribution and different geochemical composition (high Si–Mn–Fe–Na, low Ca–Mg–Sr). These isotopic and lithological changes relate to the Cretaceous–Palaeogene transition. The Alemanía Member, composed of dolomitic limestones and pelites, represents a return to marine conditions and shows a gradual increase in isotopic values, reaching values similar to those of the Amblayo Member. The Juramento Member, composed of stromatolite limestones, shows isotopic variations that can be correlated with the two well-defined, shallowing-upward sequences of the member.

Keywords: C and O isotopes; Northwestern Argentina; Yacoraite Formation; Shallow marine carbonates; K–T boundary

Resumen

Las calizas maastrichtiano-danianas de la Formación Yacoraite del noroeste argentino revelan valores de isótopos estables coherentes con el ambiente marino somero predominante del depósito. Los miembros de la Formación, que responden a variaciones ambientales, quedan caracterizados por valores isotópicos y geoquímicos. El Miembro Amblayo basal está compuesto por calizas dolomíticas y calizas de alta energía con valores isotópicos positivos (+2‰ $\delta^{13}C$, +2‰ $\delta^{18}O$). En el techo del miembro se observa un salto isotópico del $\delta^{13}C$ (−5‰) y del $\delta^{18}O$ (−10‰) probablemente vinculado con un descenso del nivel del mar. El Miembro Güemes, arenoso, posee calizas con valores isotópicos negativos (−2‰ $\delta^{13}C$, −1‰ $\delta^{18}O$) controlados principalmente por mezcla de aguas, descenso en la productividad orgánica y cambios composicionales del carbonato. Las calizas isotópicamente más livianas son calcíticas, poseen mayor contenido de elementos terrígenos y composición geoquímica diferente (alto Si–Mn–Fe–Na, bajo Ca–Mg–Sr). Estos cambios estarían relacionados con la transición Cretácico-Paleógeno. El Miembro Alemanía, compuesto por calizas dolomíticas y pelitas, representa un regreso a las condiciones marinas y muestra un paulatino aumento isotópico hasta asemejarse a los valores del Miembro Amblayo. El Miembro

* Corresponding author. Address: CONICET, Buenos Aires 177, 4400 Salta, Argentina.
E-mail address: ramarq@unsa.edu.ar (R. Marquillas).

0895-9811/$ - see front matter
doi:10.1016/j.jsames.2007.02.009

Juramento, compuesto por calizas estromatolíticas, muestra variaciones isotópicas que serían correlacionables con los dos ciclos de somerización bien definidos del miembro.

Palabras Clave: Isótopos de C y O; Noroeste Argentino; Formación Yacoraite, Carbonatos marinos someros; Límite K–T

1. Introduction

The Yacoraite Formation (Maastrichtian–Danian) of the Salta basin represents a carbonate deposit widely distributed in northwestern Argentina (Fig. 1). Despite having been the subject of diverse reviews (e.g., Castaños et al., 1975; Marquillas, 1985; Gómez Omil et al., 1989; Salfity and Marquillas, 1994; Marquillas et al., 2005), isotopic studies of this formation are still scarce (Matthews et al., 1996; Sial et al., 2001). The present study offers a new oxygen and carbon isotope analysis of whole-rock samples from the Metán subbasin and compares it with those of the Sey and Tres Cruces subbasins (Fig. 1). The Yacoraite Formation displays different carbonate and clastic lithofacies resulting from environmental changes during its accumulation (Marquillas, 1985, 1986). On the basis of these characteristics, four lithostratigraphic units (members) have been identified in the Metán subbasin (Fig. 2) (Marquillas and Salfity, 1989).

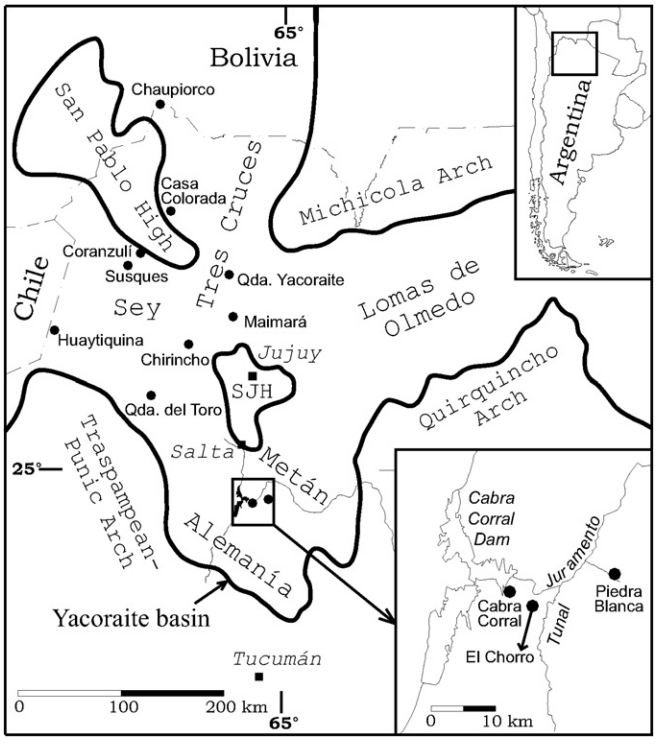

Fig. 1. Palaeogeographic map of the Yacoraite basin (without palynspastic reconstruction) with location of the sites studied (dots), subbasins (Alemanía, Metán, Lomas de Olmedo, Tres Cruces, and Sey), and structural positive elements (highs and arches) (Salfity and Marquillas, 1994). SJH: Salta-Jujuy High.

The isotopic results herein are interpreted and discussed for each member.

1.1. Geological setting

Sedimentary deposits of the Salta Group (Neocomian–Palaeogene) are extensively distributed in the Andean to sub-Andean region of northwestern Argentina (Marquillas and Salfity, 1988; Marquillas et al., 1993; Salfity and Marquillas, 1994). The Yacoraite Formation (Maastrichtian–Danian) is a lithostratigraphic unit accumulated during the initial stage of thermal subsidence of the Salta rift (Marquillas et al., 2005). The Yacoraite basin (Fig. 1) records the marine incursion at the end of the Cretaceous in most of South America (Zambrano, 1981, 1987; Riccardi, 1988; Salfity and Zambrano, 1990). The main lithology of the formation is carbonate–calcareous and dolomitic–but also contains shale and sandstone (Figs. 2 and 3). The maximum thickness is 200 m.

The depositional environment of the Yacoraite Formation has long been discussed (Castaños et al., 1975; Marquillas, 1985, 1986; Gómez Omil et al., 1989; Salfity and Marquillas, 1994; Marquillas et al., 2005). The isotopic study in the present contribution confirms the marine character of the deposit, in opposition to other proposals that point to a continental origin (Hernández et al., 1999; Palma, 2000). Nevertheless, the paleontological evidence (e.g., euryhaline invertebrate association composed of ostracodes, bivalves, gastropods, and foraminifers and different types of charophytes) indicate shallow marine conditions and localized mixing of fresh and brackish water (see the paleontological record in Marquillas et al., 2005).

On the basis of their lithological features, several members can be identified within the Yacoraite Formation in the southern subbasins (Alemanía and Metán, Fig. 1). Members that are more extensively distributed are, from base to top, the Amblayo, Güemes, Alemanía, and Juramento (Fig. 2) (Reyes, 1972; Marquillas and Salfity, 1989). The Amblayo Member, composed of limestone and dolomitic limestone (Marquillas et al., 2000), constitutes the base of the Yacoraite Formation and is the thickest and most extensively distributed in the basin (Fig. 4a). The Güemes Member (Fig. 4b) comprises grey to whitish or brown to reddish sandstones and minor limestone levels. The Alemanía Member is a succession of grey dolomitic limestones and green shales (Fig. 4c). The Juramento Member is a thin, extensively distributed level of grey lime-