Cretaceous Research 75 (2017) 193–204

Contents lists available at ScienceDirect

Cretaceous Research

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

A high precision U–Pb radioisotopic age for the Agrio Formation, Neuquén Basin, Argentina: Implications for the chronology of the Hauterivian Stage

Beatriz Aguirre-Urreta [a, *], Mark Schmitz [b], Marina Lescano [a], Maisa Tunik [c], Peter F. Rawson [d, e], Andrea Concheyro [a], Mariano Buhler [f], Víctor A. Ramos [a]

[a] Instituto de Estudios Andinos Don Pablo Groeber (UBA-CONICET), Universidad de Buenos Aires, Ciudad Universitaria, Pabellón 2, 1428, Buenos Aires, Argentina
[b] Department of Geosciences, Boise State University, 1910 University Drive Boise, Idaho, ID, 83725, USA
[c] Universidad de Río Negro, Sede Alto Valle, 8332, General Roca, Río Negro, Argentina
[d] School of Environmental Sciences, University of Hull, Cottingham Road, Hull, HU6 7RX, UK
[e] Department of Earth Sciences, University College London, Gower Street, London, WC1E 6BT, UK
[f] YPF S.A., Talero 360, 8300, Neuquén, Argentina

ARTICLE INFO

Article history:
Received 16 November 2016
Accepted in revised form 26 March 2017
Available online 30 March 2017

Keywords:
Geochronology
Biostratigraphy
Ammonites
Nannofossils
Cretaceous

ABSTRACT

A new CA-ID TIMS U–Pb age of 130.39 ± 0.16 Ma is presented here from the Pilmatué Member of the Agrio Formation, lower Hauterivian of the Neuquén Basin in west-central Argentina. This high precision radioisotopic new age, together with the two former ones from the upper Hauterivian Agua de la Mula Member of the Agrio Formation and modern cyclostratigraphic studies in the classical sections of the Mediterranean Province of the Tethys indicate that the Hauterivian Stage spans some 6 Ma, starting *ca.* 132 Ma and ending *ca.* 126 Ma. These radioisotopic ages are tied to ammonite biostratigraphy and calcareous nannofossil bioevents and biozones recognized in the Neuquén Basin which in turn are correlated with the Mediterranean standard zones. A new geological time scale for the Valanginian–Hauterivian stages in the Mediterranean region integrating astrochronological and radiochronological data differs with the current official geological time scale which still maintains poorly constraint absolute ages for the Berriasian-Aptian interval.

1. Introduction

Up to now, the global 'standard' Upper Jurassic and Lower Cretaceous stages have been based on stratigraphic sections in the Mediterranean Province of the Tethys, and are mostly defined by ammonite biostratigraphy and calcareous nannofossil bioevents that have been calibrated with the M sequence of geomagnetic polarity chrons. But the lack of precise radioisotopic ages from this region has hindered the construction of an accurate Late Jurassic and Early Cretaceous numerical time scale despite the efforts of the International Commission on Stratigraphy (Cohen et al., 2013). Since the international stratigraphic chart published by Remane (2000), each four years a new global geological time scale has been produced (Gradstein et al., 2004, 2012, Ogg et al., 2008, 2016). But only slights adjustments are proposed in these successive contributions to the Late Jurassic and Early Cretaceous timescale and the boundaries between stages and their duration remain uncertain (including the important Jurassic/Cretaceous boundary).

Our studies in the Neuquén Basin in west-central Argentina are aimed at reducing these uncertainties. Here numerous tuff bands occur, interbedded with often richly-fossiliferous sediments. Vennari et al. (2014) and Aguirre-Urreta et al. (2015) provided high precision radioisotopic ages which are beginning to fill a gap of over 14 million years in the numerical calibration of the current global Early Cretaceous geological time scale.

A new CA-ID TIMS U–Pb age of 130.39 ± 0.16 Ma is presented here from the Pilmatué Member of the Agrio Formation. The measured section is El Portón (Fig. 1A) where a tuff layer is interbedded with beds containing ammonites indicating the base of the

* Corresponding author. Instituto de Estudios Andinos Don Pablo Groeber (UBA-CONICET), Universidad de Buenos Aires, Ciudad Universitaria, Pabellón 2, 1428, Buenos Aires, Argentina.
E-mail address: aguirre@gl.fcen.uba.ar (B. Aguirre-Urreta).

http://dx.doi.org/10.1016/j.cretres.2017.03.027
0195-6671/

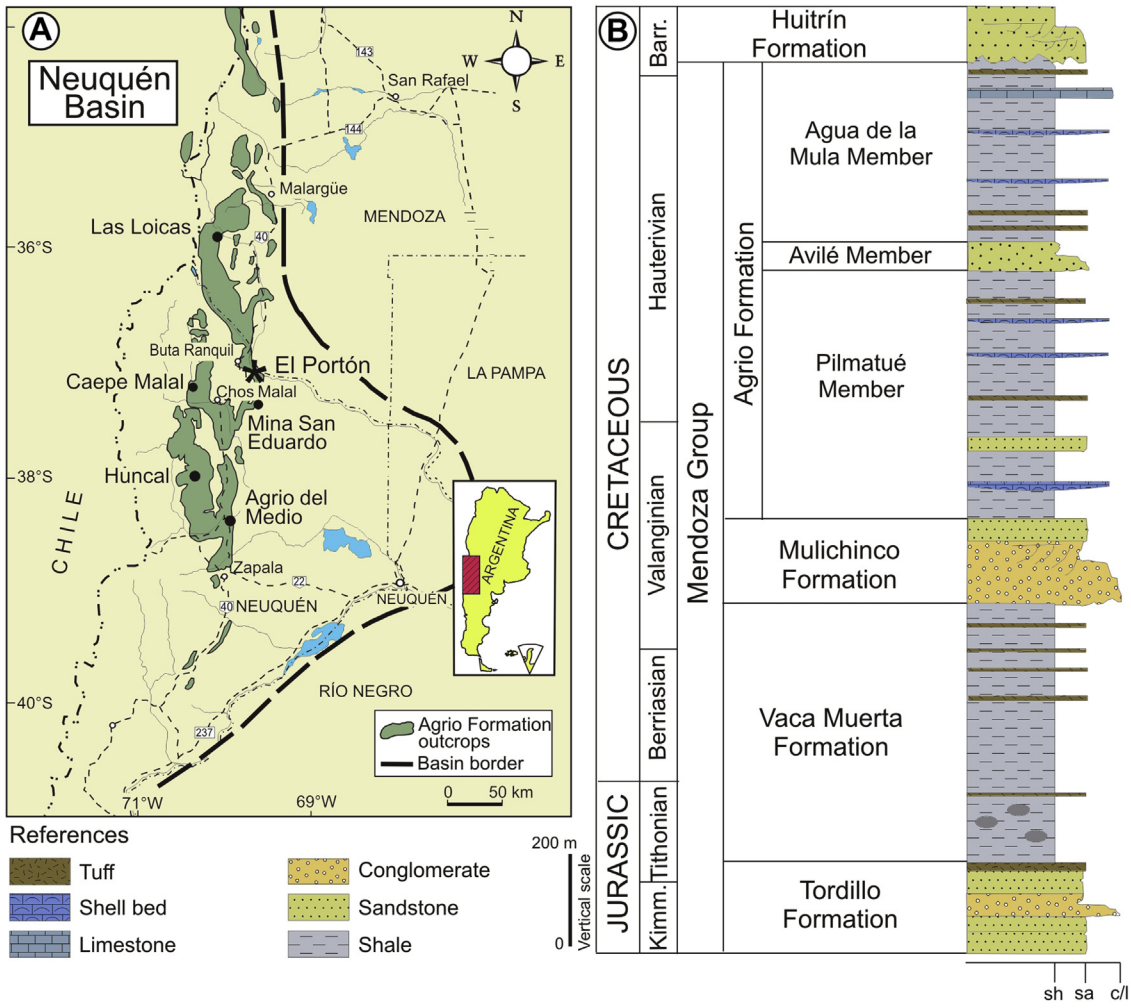

Fig. 1. A. The Neuquén Basin in west-central Argentina with exposures of the Agrio Formation and localities cited in the text. B. Generalized stratigraphic column of the Mendoza Group.

Holcoptychites agrioensis subzone, *Holcoptychites neuquensis* zone, of the early Hauterivian. The Neuquén Basin (Austral) ammonite sequence can be correlated with that of the Mediterranean Province of the Tethyan Realm (Reboulet et al., 2014) while two calcareous nannofossils bioevents recognized in the section also provide tie points with the same events recognized in the Northern Hemisphere.

This new age, together with the two former ones provided by Aguirre-Urreta et al. (2015) from the Neuquén Basin and the cyclostratigraphic studies by Martínez et al. (2015) in the classical sections of the Mediterranean Province of the Tethys indicate that the Hauterivian Stage spans some 6 Myr, starting *ca*. 132 Ma and ending *ca*. 126 Ma.

2. The Neuquén Basin

2.1. Geological setting

The Neuquén Basin is a triangular-shaped, retroarc basin, covering more than 160,000 km^2 that developed in a normal subduction segment at the foothills of the Andes in west-central Argentina (Legarreta and Uliana, 1991; Ramos, 2010) (Fig. 1A). The complex history of the basin began with Triassic rift deposits during a phase of continental extension. Afterwards, the basin was subject to thermal subsidence and eustatic sea level changes. Marine transgressions from the Pacific Ocean led to the deposition of a Jurassic-Cretaceous sedimentary succession more than 7 km thick with several petroleum source rock units and reservoir intervals (Vergani et al., 1995). In the Late Cretaceous a change in tectonic setting led to inversion of the basin and the formation of a fold-and-thrust belt (Ramos, 2010). The last marine deposits in the area (Upper Cretaceous-Paleocene) are related to a transgression from the Atlantic Ocean. Sedimentation then continued under continental conditions, producing synorogenic Tertiary strata which in turn are covered by widespread volcanic rocks of Tertiary or Quaternary ages (Ramos and Folguera, 2005).

The infill of the Neuquén Basin during the Late Jurassic-Early Cretaceous is represented by both marine and continental deposits that are placed in the Mendoza Group (from base to top, Tordillo, Vaca Muerta, Mulichinco/Chachao and Agrio Formations) (Groeber, 1953; Legarreta and Uliana, 1991) (Fig. 1B). Laterally continuous outcrops and an abundant fossil record, combined with the interbedded tuffs, make the basin an excellent site to carry out integrated stratigraphical, paleontological, and radioisotopic studies.

2.2. The Agrio Formation

A transgressive phase in the late early Valanginian led to the deposition of the shales, limestones and sandstones of the Agrio Formation. This unit rests on the Mulichinco Formation of