

Preliminary report

The Noduliferum Zone of the Andean Berriasian

The Noduliferum (Standard Chronostratigraphic) Zone (Leanza A.F. 1945) is widely accepted as the lower of the Andean Berriasian chronostratigraphic zonation (Leanza 1981, Aguirre-Urreta et al. 2007, Parent et al. 2011, 2015).

History: see Windhausen (1918), Gerth (1925), Leanza A.F. (1945), Leanza H.A. (1981).

Tethyan Primary Standard		Neuquén Basin	
Stage	Zone	Horizon	Zone
BERRIASIAN	Upper	Boissieri	Damesi
	Middle	Occitanica	Noduliferum
	Lower	Jacobi	
TITHONIAN	Upper	Durangites	Koenei
		Microcanthum	Alternans
	Middle	Ponti	Internispinosum
		Fallauxi	Proximus
		Semiforme	Zitteli [Mendozanus]
	Lower	Darwini	Picunleufuense
		Hybonotum	
	Upper	Beckeri	

Figure 1. Chronostratigraphic ammonite zonation of the Andean Tithonian and Berriasian according to Leanza (1981), Garrido et al. (2018), Parent & Garrido (2021), and references therein. Broken lines for non-standardized zones.

Base: *compressum* Horizon (Parent et al. 2015: 89). As the Noduliferum Zone has been standardized by definition of its base, all the rocks including this horizon upwards and below of the *transgrediens* Hz. belong to the zone.

The *compressum* Hz. is characterized by the association of compressed and evolute morphotypes of *Krantzicerias compressum* (similar to the holotype), weakly ornamented macro- and microconchs of *Groebericeras bifrons*, and evolute and coarsely ornamented macroconchs of *Spiticeras fraternum* illustrated by Leanza (1945) and Parent et al. (2011, 2015). The stratigraphic ranges of most of these species are being expanded regularly by new discoveries, or they are collected in different stratigraphic position. But, the association of the cited morphotypes is statistically very restricted. In some levels above the *compressum* Hz. occur some of these species among others which characterize the zone (see below), but never (at least for now) in the combination of the morphotypes which define the horizon.

Index species: *Argentiniceras noduliferum* (Steuer, 1897).

Biostratigraphic characterization: In the literature there are many citations of ammonites coming from the Noduliferum Zone. However, considering only those papers with figurations and stratigraphic information (Gerth 1925, Leanza 1945, Parent et al. 2015, 2017), the ammonites recorded within the Noduliferum Zone are the following (of course, some may range downwards into the Koeneni Zone or upwards in the Damesi Zone):

- *Argentiniceras noduliferum*. The type species of the genus (*Odontoceras malarguense* Steuer, 1897) is very different from the ammonites commonly assigned to it (e.g. Leanza 1945, Parent et al. 2015). These ammonites bear tubercles from which several finer secondary ribs born, whereas *A. malarguense* do not show any trace of tubercles at comparable diameter, and all ribs are coarse.
- *Argentiniceras bituberculatum* Leanza, 1945. Differs from *A. noduliferum* by an apparent earlier onset of the lateral tuberculation, most likely conespecific.
- *Argentiniceras malarguense* (Steuer, 1897)
- *Krantzicerias compressum* Parent, Scherzinger & Schweigert, 2011
- *Krantzicerias disputabile* Leanza, 1945
- *Substeueroceras permulticostatum* (Steuer, 1897)
- *Subthurmannia? ellipsostomum* (Steuer, 1897)
- *Subthurmannia boissieri* (Pictet, 1867). Early occurrences; the species is much better represented in the Damesi Zone
- *Raimondiceras alexandrense* Howlett, 1989
- *Frenguelliceras magister* Leanza, 1945
- *Frenguelliceras simplex* Leanza, 1945. Differing from *F. magister* by some few ribs in the adult phragmocone which are somewhat stronger; conespecific.
- *Groebericeras bifrons* Leanza, 1945
- *Spiticeras fraternum* (Steuer, 1897), earliest occurrences

The zone is usually recognized as the beds overlying Tithonian ammonite-beds and containing at least some of the most characteristic species (*G. bifrons*, *A. noduliferum*, *K. compressum*, *F. magister*).

Biohorizons. (1) *compressum* Hz. (Parent et al. 2011), type locality Pampa Tril (northern Neuquén Province); and (2) *noduliferum* Hz., type locality Arroyo del Yeso (southern Mendoza Province).

Age of the Noduliferum Zone: the age assignation by time-correlation with the Tethyan Primary Standard, based on the proper ammonite fauna typical of the zone is not strong. This is because most of the species are Andean elements with no evident representation in the Tethys. An early

Berriasian age, Jacobi-Occitanica zones, is suggested by *S. boissieri* and *G. bifrons* (Leanza 1945, Howarth 1992, Aguirre-Urreta & Álvarez 1999, Parent et al. 2015, 2017).

However, the immediately overlying Damesi Zone can be dated with acceptable accuracy within the Boissieri Zone by the concurrence of abundant *S. boissieri*, *S. fraternum*, and *Neocosmoceras malbosiforme* (Steuer, 1897) which is very close, if not identical to *Neocosmoceras sayni* Simionescu, 1899). An association of very closely similar morphotypes has been described by Company & Tavera (1982) from the Boissieri Zone of SE Spain.

About the micropalaeontologic and radiometric datations there is not much to say, further than they produce weak and controversial accessory evidence.

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Horacio Parent
Laboratorio de Paleontología
Instituto de Fisiografía y Geología
FCEIA, UNR, Pellegrini 250, 2000 Rosario, Argentina

Correo-e: parent@fceia.unr.edu.ar
https://www.fceia.unr.edu.ar/fisiografia/parent_h.htm