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Cretaceous red beds from southern Neuquén Basin (Argentina): age, distribution and stratigraphic discontinuities

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Abstract. The Cretaceous System in western central Argentina overlies and is followed by marine rocks as the Jurassic/Cretaceous and Cretaceous/Tertiary boundaries are recognized in the Vaca Muerta/Picún Leufú Formations (Mendoza Group) and Jagüel Formation (Malargüe Group) respectively. Excellent outcrops of an almost entirely continental Cretaceous in red bed facies are exposed in southern Neuquén basin. The oldest red bed unit is the Bajada Colorada Formation which is separated by the Catanlilican unconformity (Intravalanginian) from the marine Agrio Formation. The Initial Miranican unconformity is located between the transition zone (gypsum evaporites and clays) of the Agrio Formation and the fluvial conglomerates of the La Amarga Formation. The Lohan Cura Formation follows next, overlying the La Amarga, Bajada Colorada and Agrio Formations by means of the Middle Miranican unconformity (Intraptian). Separated from the underlying strata by the Main Miranican unconformity, a series of wholly continental red beds, namely the Neuquén Group, was laid down during the Cenomanian to early Campanian. This comprises conglomerates, sandstones and claystones corresponding to fluvial, alluvial and playa lake environments. They are arranged in recurrent fining upwards sequences composed of the Candeleros, Huincul and Cerro Lisandro formations (Río Limay Subgroup), Portezuelo and Plottier formations (Río Neuquén Subgroup) and Bajo de la Carpa and Anacleto formations (Río Colorado Subgroup). The unconformity located in the Cerro Lotena area at the base of these red beds, is locally accentuated by inversion tectonics along the Huincul Fault. Such continental sedimentary conditions, together with a large supply of coarse clastics from the west, point to the final isolation of the basin from the Pacific Ocean. The Huantraiquican unconformity (Intracampanian), separates the Neuquén Group from the Malargüe Group, the latter developing at its base fluvial and lacustrine facies (Allen Formation) plenty of plant and terrestrial tetrapod remains, which are overlain by rocks corresponding to a Maastrichtian marine flooding episode (Jagüel Formation) that connected for the first time the Atlantic with the Pacific Ocean.

Key words. Argentina. Neuquén. Cretaceous. Stratigraphy. Red beds. Dinosaurs.

Introduction

Recent geological mapping performed by the Geological Survey of Argentina in southern Neuquén basin (Neuquén and Río Negro provinces) between 39 ° to 40 ° S and 69 ° to 66° 30 W, established the regional distribution of several Cretaceous red bed units at the formation level for the first time. The conclusions of this paper are therefore based on field observations over a nearly 45,000 km² area. Fossil findings, namely terrestrial reptiles, can thereafter be assigned to their true provenance horizons more precisely. The recognition of a number of stratigraphical discontinuities of regional significance was the key to solve previous problems to correlate these Cretaceous red beds and to understand their tectosedimentary evolution. Therefore, the aim of this paper is to summarize the continental red bed units from southern Neuquén basin, pointing out their distributions and ages, as well as their mutual stratigraphical relationships. The terrestrial tetrapod content from each unit is also briefly commented. The Cretaceous System stratigraphic chart of southern Neuquén basin is shown in table 1.

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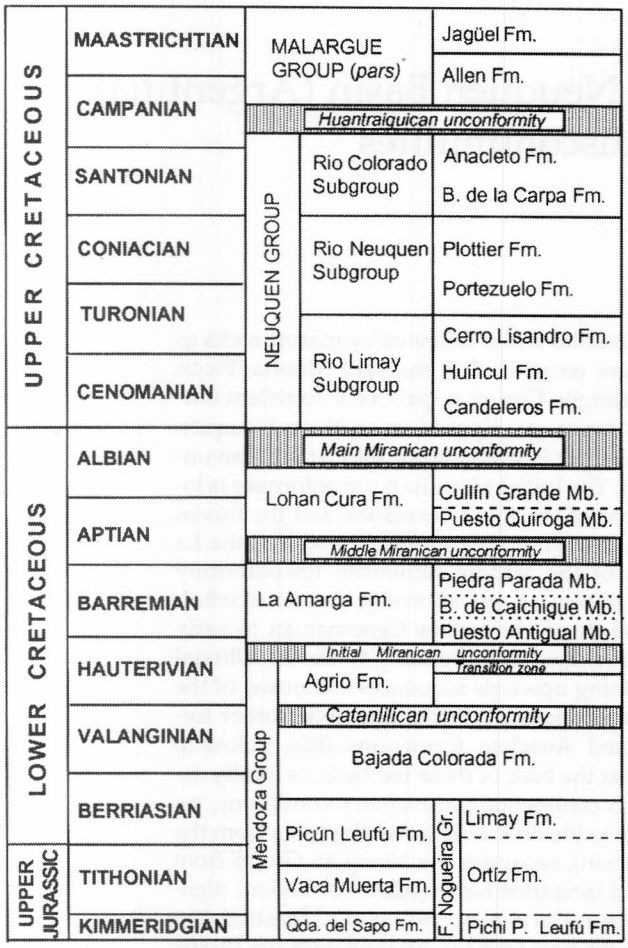
Cretaceous red beds from southern Neuquén basin (table 1)

Bajada Colorada Formation

This unit was established by Roll (1941) and its type locality is located on the left bank of the Limay river on national route 237, half way between the Picún Leufú and Piedra del Aguila towns. For a long time it was considered as part of the Rayoso

Table 1. Upper Jurassic and Cretaceous stratigraphic chart of southern Neuquén Basin



Formation, overlying the La Amarga Formation. However, seismological and surface geological studies (Foucault *et al.*, 1987, Leanza and Hugo, 1997) indicated that they belong to the Mendoza Group and hence is of Lower Cretaceous (Valanginian) age. The Bajada Colorada Formation is considered a continental red bed unit that conformably overlies the marine Picún Leufú Formation and is unconformably overlain by the marine Agrio Formation. It is assumed that this unconformity was the result of the Catanlilican phase which took place during intra - Valanginian times. The thickness of the Bajada Colorada Formation reaches 350 m and is composed of red and greenish brown, fine to medium grained sandstones with well developed bands of light brown siltstones and reddish claystones. The paleoenvironment is mostly dominated by a fluvial regime. The Bajada Colorada Formation is a time equivalent of the marine Mulichinco Formation. Paleosols are present. Scarce vertebrate remains, namely fragmentary terrestrial reptile bones from this unit were reported (Leanza and Hugo, 1997) but none of them has yet been identified.

La Amarga Formation

This continental unit was established by Musacchio (1970). Its type locality is located around the La Amarga creek and in the nearby of the northern slope of the China Muerta hill. It unconformably overlies the transition zone of the marine Agrio Formation and is overlain by the continental Lohan Cura Formation. Based on basin analysis, stratigraphical relationships and tectosedimentary aspects, it can be regarded as latest Hauterivian to Barremian and likely early Aptian in age. The total thickness of La Amarga Formation attains 159.2 meters. It is divided into three subunits which from base to top are: the Puesto Antigual, the Bañados de Caichigüe and the Piedra Parada members (Leanza and Hugo, 1995). The Puesto Antigual Member (28.9 m) is composed of fluvial channel sands of braided rivers with well-developed paleosol tops. A remarkable fossil discovery in this unit is the dicraeosaurid sauropod *Amargasaurus cazaui* Salgado and Bonaparte (1991), which is characterized by notable expansions on its cervical and dorsal vertebrae. Together with this sauropod, mammal remains of *Vincelestes* were also reported from this Member (Bonaparte, 1998). The Bañados de Caichigüe Member (20.9 m) is composed of white to yellowish lacustrine limestones alternating with black shales and greenish siltstones, from which rich ostracod and palynomorph associations were reported (Musacchio, 1970; Volkheimer, 1978). The Piedra Parada Member (109,4 m) follows next, and it consists of a thick succession of light brown and reddish, fine to medium grained sandstones in alternation with pink, reddish and brown-greenish siltstones. The paleoenvironment belongs to fluvial systems with well-developed channels and flood plain deposits, some swamp lenses and paleosol tops.

Lohan Cura Formation

This unit was established by Leanza and Hugo (1995) in order to designate the continental deposits which unconformably overly the La Amarga Formation and are overlain by the Candeleros Formation. This unit is well exposed in the southern portion of the Neuquén basin, extending from the China Muerta hill (route 40) along the China Muerta creek up to the nearby of the Limay river. Apart from La Amarga Formation, its lower terms cover also the Bajada Colorada and Agrio Formations by means of the Middle Miranican unconformity. Based on tectosedimentary aspects and field relationships, the Lohan Cura Formation can be ascribed to the late Aptian and Albian. Leanza and Hugo (1995) divided

the Lohan Cura Formation (177 m) into two subunits: the Puesto Quiroga and the Cullín Grande Members. The Puesto Quiroga Member (85 m) begins with a well litified, brown-reddish thinning upwards polimictic conglomerate of 4 m in thickness, followed by an alternation of 24 m of red and red brownish conglomeradic sandstones and siltstones. Next follows a sequence of 57 m composed of red purple and brown-greenish shales and some intercalations of gray-greenish and light green siltstones. This sequence belongs to the China Muerta facies of Roll (1939), the stratigraphic position of which was doubtful some years ago. The Cullín Grande Member (92 m) shows excellent development of fluvial channels with high angle cross stratification with reddish conglomeradic sandstones, in alternation with brown-greenish siltstones showing poor stratification. The general trend of the sedimentation pattern is fining and thinning upwards, the brown and light red colored siltstones and claystones becoming dominant. From the Cullín Grande Member in the locality of Cerro Los Leones near the Picún Leufú town, Leanza and Hugo (1997) discovered reptile bones and reported this finding to Dr. José Bonaparte. Later on the team under his leadership unearthed from this site the new remarkable sauropod *Agustinia ligabuei* Bonaparte (2000), which displays notable osteoderms on the dorsal spines divided in two laminae each of them being at least of 0.8 m long. Chelid turtles, crocodiles and new sauropods presently under study have been recovered in association with *Agustinia*.

Neuquén Group

Red beds containing dinosaur bones are known since the turn of the century in western central Argentina. They were termed for a long time as the "Estratos con Dinosaurios" (Keidel, 1917) or "Formación del Neuquén" (Roll, 1941). The first authors that used the name Neuquén Group according with the present stratigraphic code were Stipanicic *et al.* (1968). Cazau and Uliana (1973) established almost the subdivision of the Group, which is divided from base to top in the Río Limay, Río Neuquén and Río Colorado subgroups. The Neuquén Group was laid down during the Cenomanian to early Campanian with a total duration of 24 My. This comprises conglomerates, sandstones and claystones corresponding to fluvial, alluvial and playa lake environments arranged in a recurrent fining upwards sequence.

Río Limay Subgroup

This stratigraphical unit established by de Ferraríis (1968) comprises the Candeleros, Huincul and Cerro Lisandro formations, and has a minimum thickness of 350 m. On the basis of basin analysis its age range can be regarded as Cenomanian to early Turonian. It is widespread in southern Neuquén basin to the east of national route 40 up the Santa Lucía de El Cuy region in northwestern Río Negro province.

Candeleros Formation

It is the basal unit on the Neuquén Group and was established early by Keidel (in Wichmann, 1927), its type locality being the Candeleros hill east of Cerro Lotena in southern Neuquén. It was regionally studied by many geologists, outstanding Roll (1939), Herrero Ducloux (1946) and Leanza and Hugo (1997). The El Chocón Dam through the Limay river has been built on this unit. In the El Chocón area the Candeleros Formation outcrops are impressive displaying abrupt cliffs down to the Limay river valley. Its maximum thickness may attain nearly 300 m. It is mainly composed of massive coarse and medium grained sandstones and conglomerates, violet, purple, dark red and brownish in color, deposited in a fluvial environment under braided and meandering regimes. Sequences are arranged in a thinning and fining upwards pattern. Paleosols are frequent in some horizons, whereas dark-brownish siltstones and claystones are present in thin packages, some representing swamp conditions. The dinosaurs discovered in this unit are remarkable. The giant carnivorous dinosaur *Giganotosaurus carolinii* Coria and Salgado (1995) and the medium sized sauropod *Andesaurus delgadoi* Calvo and Bonaparte (1991) were found near the El Chocón area, together with a notable association of foot prints of theropod, sauropod and ornitischian dinosaurs (Calvo, 1989, 1991) as well as turtles, crocodiles and anuran remains. The age of the Candeleros Formation can be regarded as early Cenomanian.

Huincul Formation

This unit was established by Keidel (in Wichmann, 1927). The type locality is located in the vicinity of the Plaza Huincul city. Its is well exposed in southern Neuquén basin in the Neuquén and Río Negro provinces to the east of national road 40 to the area of Planicie de Rentería and Santa Lucía de El Cuy regions in the Río Negro province (Hugo and Leanza, 1998). It conformably overlies the Candeleros Formation from which it clearly contrasts by its lighter green-yellowish colors. The Huincul Formation is conformably overlain by the red claystones and siltstones of the Cerro Lisandro Formation. The thickness of this unit may vary be-

tween 50 and 250 m (see Roll, 1939, Leanza and Hugo, 1997). It is composed of yellowish and greenish fine to medium grained sometimes tuffaceous sandstones. In the Cerro Policía region a level of a white tuff up 1 m thick is present in its basal terms. On the basis of basin analysis the age of the Huincul Formation can be regarded as late Cenomanian. The most remarkable reptile discovery in this unit corresponds to one of the biggest sauropod dinosaur of the world, *Argentinosaurus huinculensis* Bonaparte and Coria (1993) which is housed in the Carmen Funes Museum in Plaza Huincul (Neuquén province). Fossil trunks are also frequent in this unit.

Cerro Lisandro Formation

This is the youngest unit of the Río Limay Subgroup. It was described for the first time by Herrero Ducloux (in Fossa Mancini *et al.*, 1938). Its type locality is situated at Cerro Lisandro, 22,5 km northwest of Senillosa City in eastern Neuquén province. It is easily recognizable by its massive red colored siltstones and claystones. It conformably overlies the yellowish sandstones of the Huincul Formation and is overlain conformably by the sandy Portezuelo Formation. The thickness of this unit varies between 35 to 75 meters. The best exposures are located around at the foothills of sierra Barrosa. Some ceramic industries of the region use claystones from this unit for their productions. The age of the Cerro Lisandro Formation can be regarded as late Cenomanian-early Turonian. Crocodilian and turtle bones, and fresh water bivalves, indicating swamp conditions, were recorded in this unit.

Río Neuquén Subgroup

The Río Neuquén Subgroup was established by Cazau and Uliana (1973). It is widely exposed in the southern of the Neuquén Basin. Excellent outcrops may be seen in the region around Sierra del Portezuelo and Sierra Barrosa (Neuquén Province) and in the Planicie de Rentería region (Río Negro province). The sandy Portezuelo Formation below and the argillaceous Plottier Formation above comprise this subgroup.

Portezuelo Formation

This unit was established by Keidel (in Wichmann, 1927) and its type locality is located in the Sierra del Portezuelo region. It conformably overlies the Cerro Lisandro Formation and upwards it passes gradually to the Plottier Formation. The Portezuelo Formation is composed of fluvial yellowish and red-brownish medium grained sandstones and siltstones, alternating with light red claystones in a fining and thinning upwards sequence. A frequent feature of this unit is the presence of paleosol tops, those indicating stable conditions through relatively long periods, favoring animal life. The thickness of the Portezuelo Formation may vary between 95 m to 130 meters. The age of the Portezuelo Formation can be regarded as late Turonian-early Coniacian. The paleontological record in this unit is eloquent, as Novas (1997) recently reported two remarkable theropod dinosaurs with avian characteristics named *Patagonykus puertai* Novas and *Unenlagia comahuensis* Novas and Puerta. Notosuchian and baurusuchid crocodilian remains (see Gasparini *et al.*, 1992), were also mentioned from this unit.

Plottier Formation

This unit was defined by Herrero Ducloux (in Fossa Mancini *et al.*, 1938). The type locality is at the north of Plottier, in the vicinity of the Neuquén city airport. It conformably overlies the Portezuelo Formation, and is overlain by the Bajo de la Carpa Formation. It probably is the unit of the Neuquén Group more difficult to distinguish in the field, the only difference from Portezuelo Formation being the higher proportion of argillaceous input. It is composed of light red colored massive claystones with thin layers of pink siltstones. Its maximum thickness is nearly 25 meters. Its age can be regarded as Late Coniacian. Fossil records are restricted to trunk fragments and fresh water bivalves.

Río Colorado Subgroup

The Río Colorado Subgroup was established by Cazau and Uliana (1973); it constitutes the upper part of the Neuquén Group. It is widely distributed in southern Neuquén basin. Excellent outcrops may be seen in the region between Neuquén city and Sierra del Portezuelo (Neuquén province), and in the region around de Planicie de Rentería (Río Negro province). The Bajo de la Carpa Formation below and the Anacleto Formation above comprise this subgroup. According to regional geological studies, the age of this subgroup can be regarded as Santonian (Bajo de la Carpa) to early Campanian (Anacleto).

Bajo de la Carpa Formation

This unit, defined by Herrero Ducloux (in Fossa Mancini *et al.*, 1938) is, together with the Candeleros Formation, one of the most constant and characteristic units of the Neuquén Group. It crops out from the Sierra del Portezuelo area in south central Neuquén to the Bajo de Santa Rosa region in northern Río

Negro province (Hugo and Leanza, 1999). It conformably overlies the Plottier Formation and is conformably overlain by the Anacleto Formation. This is the only unit of the Neuquén Group that surpasses to the east the Upper Permian to Middle Triassic plutonic-volcanic basement of the Nordpatagonian Massif. It is composed of coarse-grained, light violet and pink sandstones of fluvial origin with well developed paleosols. Rain drop marks, chemical cretional bodies and siliceous geodes are abundant throughout the unit. Siltstones and claystones reddish in color form thin beds between the hard sandstone layers, and may indicate swamp conditions. The thickness the Bajo de la Carpa Formation may reach 105 meters. According to our studies, the age of this unit can be ascribed to the Santonian. The terrestrial reptile record comprises mostly endemic species as the chicken sized theropod dinosaur *Alvarezsaurus calvoi* Bonaparte, 1991 together with *Neuquenornis volans* Bonaparte, 1991 and *Patagopteryx deferrariisi* Bonaparte, 1991, all displaying avian characteristics (see Bonaparte, 1998).

Anacleto Formation

This unit was defined by Herrero Ducloux (in Fossa Mancini *et al.*, 1938). Its type locality is in the Aguada de Anacleto area, 40 km west of Neuquén City. It conformably overlies the Bajo de la Carpa Formation and is unconformable overlain by the Allen Formation, which is part of the Malargüe Group. It has a uniform lithology. It is composed of purple and dark red claystones with sporadic siliceous light bleu geodes of little size. The thickness of the Anacleto Formation varies between 60 m to 90 meters. From the "Huayquería occidental", immediately to the west of Paso Córdova (Río Negro province), Wichmann (1927) reported dinosaur bones studied by von Huene (1929) who classified them as *Titanosaurus australis*. However, according to Powell (1986) this species does not fit in the true *Titanosaurus* and was ascribed to the new sauropod genus *Neuquensaurus*. Bonaparte (1998) reported the occurrence of the carnivorous dinosaur *Neuquensaurus* Bonaparte and Novas 1985 from the Allen Formation at Lago Pellegrini (Río Negro province), but recent studies by Heredia and Salgado (1999) stated that this species belongs to the Anacleto Formation. Magnetostratigraphic studies by Dingus *et al.* (2000), confirm the early Campanian age assigned to the Anacleto Formation by Hugo and Leanza (1998), and hence the age of the upper boundary of the Neuquén Group.

Malargiie Group

The Malargüe Group or Malalhueyan of Groeber (1946) forms the upper section of the Riograndican cycle. It is separated from the Neuquén Group by means of the Huantraiquican unconformity. It is firstly composed by mostly fluvial and lacustrine beds (Allen Formation), and then suddenly transgressed from east to west, i.e. from the Atlantic margin, by a shallow sea - the Káwas Sea - depositioning both clastics (Jagüel Formation) and carbonates (Roca Formation). This series of sequences ranges in age from the late Campanian to the Danian. It is worth noting that the Cretaceous/Tertiary boundary in the Neuquén Basin occurs in terms of marine sedimentation (i.e. the Jagüel Formation). The Allen Formation displays a varied spectrum of sedimentary facies and a quite remarkable paleontological content. The presence of hadrosaurids and titanosaurids, crocodiles, turtles, and dinosaur eggs as well plant remains have been reported from this unit.

References

Bonaparte, J.F. 1991. Los vertebrados fósiles de la Formación Río Colorado de la ciudad de Neuquén y cercanías, Cretácico superior, Argentina. *Revista del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Sección Paleontología* 4: 15-123.

Bonaparte, J.F. 1998. Los dinosaurios de la Patagonia argentina. Publicación *Museo Argentino de Ciencias Naturales Bernardino Rivadavia*, 1-46.

Bonaparte, J.F. 1999. An armoured sauropod from the Aptian of Northern Patagonia, Argentina. *Proccedings of the Second Gondwanan Dinosaur Symposium (Tokyo). National Science Museum Monographs* 15: 1-12.

Bonaparte, J.F. and Coria, R.A. 1993. Un nuevo y gigantesco saurópodo Titanosaurio de la Formación Río Limay (Albiano-Cenomaniano) de la provincia del Neuquén, Argentina. *Ameghiniana* 30: 271-282.

Bonaparte, J.F. and Novas, F. 1985. *Abelisaurus comahuensis*, Carnosauria del Cretácico Tardío de Patagonia. *Ameghiniana* 21: 259-265.

Calvo, J.O. 1989. Nuevos hallazgos de huellas de dinosaurios en el Albiano-Cenomaniano de la localidad de Picún Leufú, provincia del Neuquén. Patagonia. Argentina. *6° Jornadas Argentinas Paleontología de Vertebrados (San Juan). Instituto y Museo Ciencias Naturales*, Resúmenes: 66-70.

Calvo, J.O. 1991. Huellas de Dinosaurios en la Formación Río Limay (Albiano-Cenomaniano), Picún Leufú, provincia del Neuquén, Argentina (Ornithischia-Saurischia-Sauropoda-Theropoda). *Ameghiniana* 28: 241-258.

Calvo, J.O. and Bonaparte, J.F. 1991. Andesaurus delgadoi gen. et sp. nov. (Saurischia-Sauropoda), dinosaurio titanosauridae de la Formación Río Limay (Albiano-Cenomaniano), Neuquén, Argentina. *Ameghiniana* 28: 303-310.

Cazau, L.B. and Uliana, M.A. 1973. El Cretácico superior continental de la Cuenca Neuquina. *5° Congreso Geológico Argentino* (Buenos Aires), *Actas* 3: 131-163.

Coria, R.A. and Salgado, L. 1995. A new giant carnivorous dinosaur from the Cretaceous of Patagonia. *Nature* 377: 224-226.

de Ferraríis, C. 1947. Edad del arco o dorsal antigua del Neuquén oriental de acuerdo con la estratigrafía de la zona inmediata. *Revista de la Sociedad Geológica Argentina* 2 : 256-283.

de Ferraríis, C. 1968. El Cretácico del norte de la Patagonia. *3° Jornadas Geológicas Argentinas* (Buenos Aires), *Actas* 1: 121-144.

Dingus, L., Clarke, J., Scott, G.R., Swisher, C., Chiappe, L.M. and Coria, R.A. 2000. Stratigraphy and Magnetostratigraphic/Faunal Constraints for the Age of Sauropod Embryo-Bearing Rocks in the Neuquén Group (Late Cretaceous, Neuquén Province, Argentina). *American Museum Novitates*, 3290: 1-11.

Fossa Mancini, E., Feruglio, E. and Yussen de Campana, J.C. 1938. Una reunión de geológos de YPF y el problema de la terminología estratigráfica. *Boletín Informaciones Petroleras* 15: 1-67.

Foucault,J.E., Vaillard, L.C. and Viñes, R.F. 1987. Estratigrafía de las unidades aflorantes a lo largo del curso inferior del río Limay, provincias del Neuquén y Río Negro. *10° Congreso Geológico Argentino* (San Miguel de Tucumán), *Actas* 1: 139-142.

Gasparini, Z., Fernández, M. S. and de la Fuente, M. 1992. Reptiles marinos jurásicos de la Cuenca Neuquina. *I.G.C.P. Project 322. First Field Conference, Boletín* 1: 13-14.

Groeber, P. 1946. Observaciones geológicas a lo largo del meridiano 70° 1. Hoja Chos Malal. *Revista de la Sociedad Geológica Argentina* 1: 177-208.

Heredia, S. and Salgado, L. 1999. Posición estratigráfica de los estratos supracretácicos portadores de dinosaurios en Lago Pellegrini, Patagonia septentrional, Argentina. *Ameghiniana* 36: 229-234.

Herrero Ducloux, A. 1946. Contribución al conocimiento geológico del Neuquén extrandino. *Boletín de Informaciones Petroleras* 23: 1-39.

Hugo, C.A. and Leanza, H.A. 1998.[Hoja Geológica 3969-IV, General Roca provincias del Neuquén y Río Negro. *Instituto de Geología y Recursos Naturales. SEGEMAR*. Buenos Aires, 145 pp, Unpublished]

Hugo, C.A. and Leanza, H.A. 1999. [Hoja Geológica 3966-III, Villa Regina provincia Río Negro. *Instituto de Geología y Recursos Naturales. SEGEMAR*. Buenos Aires, 98 pp, Unpublished]

Huene, F. von, 1929. Los Saurisquios y Ornitisquios del Cretácico Argentino. *Anales Museo de La Plata*, 2ª serie, 3: 1-196 and Atlas.

Keidel, J. 1917. Über das patagonische Tafelland und ihre ziehungen zu den geologischen erscheinnungen in den argentinischen Anden gebiet und Litoral. *Zeitschrift der Deutsche Akademie der Wissenschaft* 3: 219-245.

Leanza H.A. and Hugo, C.A. 1995. Revisión estratigráfica del Cretácico inferior continental en el ámbito sudoriental de la Cuenca Neuquina. *Revista de la Asociación Geológica Argentina*, 50: 30-32.

Leanza H.A. and Hugo, C.A. 1997. Hoja Geológica 3969-III - Picún Leufú, provincias del Neuquén y Río Negro. *Instituto de Geología y Recursos Naturales. SEGEMAR* (Buenos Aires). Boletín 218: 1-135.

Musacchio, E. 1970. Ostrácodos de la Superfamilias Cytheraceae y Darwinulaceae de la Formación La Amarga, (Cretácico Inferior), provincia del Neuquén, Argentina. *Ameghiniana* 7: 301-318.

Novas, F.E. 1997. Anatomy of *Patagonykus puertai* (Theropoda, Avilae, Alvarezsauridae) from the late Cretaceous of Patagonia. *Journal of Vertebrate Paleontology* 17: 137-166.

Powell, J.E.1986. [*Revisión de los Titanosauridae de América del Sur*. Tesis Doctoral. Facultad de Ciencias Naturales . Universidad Nacional de Tucumán, San Miguel de Tucumán, 340 p, Unpublished]

Roll, A. 1939. [*La Cuenca de los Estratos con Dinosaurios al sur del río Neuquén*. Yacimientos Petrolíferos Fisales, 112 p., Unpublished]

Roll, A. 1941. Über die Ortiz und Roca Schichten des oberen Kreide der Río Negro senke (Nord Patagonien). *Neues Jahrbuch. für Mineralogie, Geologie und Paläontologie* 85 (B): 144-190.

Salgado, L. and Bonaparte, J.F. 1991. Un nuevo saurópodo Dicraeosauridae: *Amargasaurus cazaui* gen. et sp. nov. de la Formación La Amarga. Neocomiano de la provincia del Neuquén. *Ameghiniana* 28: 333-346.

Stipanicic, P.N., Rodrigo, F., Baulíes, O.L. and Martínez, C.G. 1968. Las formaciones presenonianas del denominado Macizo Nordpatagónico y regiones adyacentes. *Revista de la Asociación Geológica Argentina*, 23: 367-388.

Volkheimer, W. 1978. Microfloras fósiles. In: Relatorio Geología y Recursos Naturales del Neuquén. *7° Congreso Geológico Argentino* (Neuquén): 187-207.

Wichmann, R. 1927. Los Estratos con Dinosaurios y su techo en el este del Territorio del Neuquén. *Dirección Nacional de Minería, Geología e Hidrogeología*, Publicación 32: 1-22.

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