Field Guide

The Jurassic of the Neuquén Basin

a) Neuquén Province

Guía de Campo

El Jurásico de la Cuenca Neuquina

a) Provincia del Neuquén

C. A. Gulisano - A. R. Gutiérrez Pleimling

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Cover:

View of the Cuyo Group along the northern flank of the Picún Leufú anticline, 40 km south of Zapala. To the lower right, Lower Bajocian offshore and prodeltaic shales of the Los Molles Formation, grading upwards to delta front sandstones and shales (lower part of the Lajas Formation). Middle and upper left, Lower to Upper Bajocian estuarine channels covered by tidal bars (upper Lajas Formation).

This guide was prepared for the 4th International Congress on Jurassic Stratigraphy and Geology (Neuquén-Mendoza, October 15-27, 1994).

Contribution to
IGCP 322
JURASSIC EVENTS IN SOUTH AMERICA

Prefacio

La Dirección Nacional del Servicio Geológico y la Asociación Geológica Argentina han considerado de utilidad la publicación de Guías de Campo de alcance regional, dedicadas a mostrar en el terreno el conocimiento geológico y temático de una región determinada.

La actividad geológica se basa, fundamentalmente, en el registro e interpretación de las observaciones que se realizan de la corteza terrestre. Tal actividad se expresa mediante mapas, gráficos y textos, cuyo grado de detalle suele guardar relación con la superficie abarcada. Debido a ello, la geología de áreas extensas usualmente se presenta en publicaciones de tipo general, donde la información detallada es escasa o se halla ausente.

Una excepción la constituyen las llamadas Guías de Campo, que ofrecen síntesis de carácter regional sobre un tema geológico determinado, ejemplificadas con descripciones e ilustraciones precisas de aquello que se observa en el terreno, en localidades representativas y accesibles.

De esta manera, las Guías de Campo posibilitan el estudio directo de una región (y temática) específica. Tal facilidad resulta de suma utilidad, no sólo para estudiantes avanzados o graduados recientes en geología, sino también para profesionales de experiencia y especialistas, pues son éstos quienes contrastan las interpretaciones a las que los ejemplos elegidos se supone dan fundamento.

Particularmente útiles resultan las guías referidas a regiones donde existe un buen conocimiento geológico, tal como sucede con el Jurásico del centro - oeste de la Argentina.

En tal sentido, ha resultado oportuno que, en ocasión del 4th International Congress on Jurassic Stratigraphy and Geology (Neuquén - Mendoza, 15-27 de octubre de 1994), se hayan preparado tres guías de campo en las que se muestra, ejemplificado con perfiles seleccionados, el grado de avance del estudio del Jurásico de la Cuenca Neuquina. Una de estas guías es la presentada aquí por la Dirección Nacional del Servicio Geológico y la Asociación Geológica Argentina.

Foreword

The Mining Secretary of the Argentinian Government and the Geological Society of Argentina both value the publication of regional field guides in order to illustrate the state of geological knowledge of selected areas.

A principal component of geological activities is based on field records and observations and their interpretational summary in the form of maps, accompanying text and diagrams. The degree of detail of the information is directly related to the size of the area concerned; large areas are usually dealt with as regional synthesis. Field guides, however, are an exception where this regional geological synthesis is augmented by detailed and precise description and illustration of field observations.

Field guides, therefore, facilitate the study of both specific geographical regions and specialised subjects, and as such they are invaluable to senior undergraduates, postgraduates, experienced professionals and specialists alike. Field guides dealing with renowned geological areas, such as the Jurassic of west-central Argentina are particularly valuable.

It is timely, therefore, that three field guides prepared for the 4th International Congress on Jurassic Stratigraphy and Geology (Neuquén-Mendoza, October 15-27 1994) demonstrate on the basis of selected sections, the present state of our knowledge of the Jurassic of the Neuquén Basin. One of the guides is now published jointly by the Mining Secretary and the Geological Society of Argentina.

Roberto F.N. Page
Director Nacional
Dirección Nacional del Servicio Geológico

Alberto C. Riccardi
Presidente
Asociación Geológica Argentina

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CHAPTER I

INTRODUCTION

The outcrops of Jurassic and Cretaceous rocks in Neuquén and Mendoza provinces have been known since the end of the last century. Both their high quality of lithology, exposure and fossil content and the eventual discovery of oil in the region were strong incentives for the development of research and hydrocarbon exploration. Because of this, the Neuquén basin and in particular a longitudinal belt surrounding the Andean foothills, is one of the best known geological areas in Argentina.

The elaboration of the following field guide arose as a need to complement the field excursions programmed for the 4th International Congress on Jurassic Stratigraphy and Geology.

The aims of this field guide are to provide: a brief summary of the stratigraphy and tectonic history of the basin, a synthesis of the stratigraphical and palaeogeographical distribution of the Jurassic System and a description of the stratigraphical sections be to examined.

During the preparation of this guide, an effort was made to minimize the number of formation names introduced in the text to prevent readers from becoming too confused. In spite of that, the abundance of such names rendered it difficult if not impossible to achieve this end.

The descriptions are presented as objectively as possible, within the current stratigraphical framework. Accompanying them are summarized sedimentological and stratigraphical interpretations.

The age assignment given to the stratigraphical sections is based on the determinations made by Dr. A.C.Riccardi on ammonite material systematically collected by the authors.

CHAPTER II

ACKNOWLEDGEMENTS

The authors greatly thank the following people, without whose help this guide-book could not have been accomplished.

Dr. A.C. Riccardi for his kind invitation to prepare the guide and his permanent encouragement and help during the preparation of the material.

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To Petrolera Argentina San Jorge and Repsol Argentina for allowing the authors to participate in the organization of this International Congress.

CHAPTER III

SUMMARY OF THE STRATIGRAPHY AND TECTONICS OF THE NEUQUEN BASIN

LOCATION

The Neuquén Basin is located in central western Argentina and eastern Chile between latitude 34° and 41° S. It is developed in Argentine territory in the provinces of Neuquén (from which it takes its name), Mendoza, Río Negro and La Pampa (Figure 1).

It extends northwards along the axis of the Andean Cordillera up to 31° S lat. in San Juan Province, where it is called the Aconcagua Basin. Between 34° and 37° S lat. it is restricted to the cordilleran belt as a narrow N-S elongated strip. Southwards from 37° S lat. it broadens eastwards, into extra-Andean domain, where it becomes the Neuquén Embayment (Figure 2).

GEODYNAMIC FRAMEWORK

In late Triassic-earliest Jurassic times, central western Argentina and eastern Chile underwent an extensional tectonic process, linked to the existence of an arc/trench system along the western margin of the South American Plate (Digregorio et al., 1984; Legarreta and Gulisano, 1989; Legarreta and Uliana, 1991).

As a result, a series of fault bounded depressions with a half graben geometry began to form during a rifting episode. The orientation of these taphrogenic depressions was controlled by the structural features of the sialic substrate on which they developed. These depocentres, located to the east of the arc trench system, became progressively inter-connected, to be integrated in Pliensbachian times into an extensive area of marine sedimentation located between the volcanic arc to the west and the South American foreland to the east (Digregorio et al, 1984; Legarreta et al., 1993).

During the early and part of the Middle Jurassic, deposition was strongly controlled by tectonics, a phenomenon that gradually diminished, to give place to a stage of regional subsidence, which lasted from the Middle Jurassic until early in the Tertiary (Legarreta and Gulisano, 1989; Legarreta and Uliana, 1991).

Although most of the basin has mantained an almost continuous subsidence rate, local episodes of elevation, folding, erosion, and evidence of synsedimentary tectonics (Huincul Fault), were recorded.

The regional subsidence persisted until the Palaeocene. After that a stage of elevation and non deposition (Eocene hiatus) and a stage of orogenesis (Oligocene to Miocene) followed.

SEDIMENTARY RECORD

The infill of the Neuquén Basin exceeds 6000 m of marine and continental sedimentary rocks (epiclastics, carbonates, evaporites and pyroclastics) which range from late Triassic to Palaeocene in age (Figures 3 and 4).

This sedimentary infill has been the subject of several recent synthesis (Malumián et al., 1983; Riccardi, 1983, 1984; Legarreta and Gulisano, 1989; Riccardi, 1988; Legarreta and Uliana, 1991; Gulisano and Riccardi, 1992 and Legarreta et al., 1993); most of them attempting to deal with the sedimentary record from the viewpoint of sequence stratigraphy analysis.

Late Triassic to Sinemurian (Precuyano Cycle)

During the late Triassic? to earliest Jurassic sedimentation was confined to isolated depressions which were filled with continental (mostly red) facies with a strong influence of pyroclastic and volcanic materials.

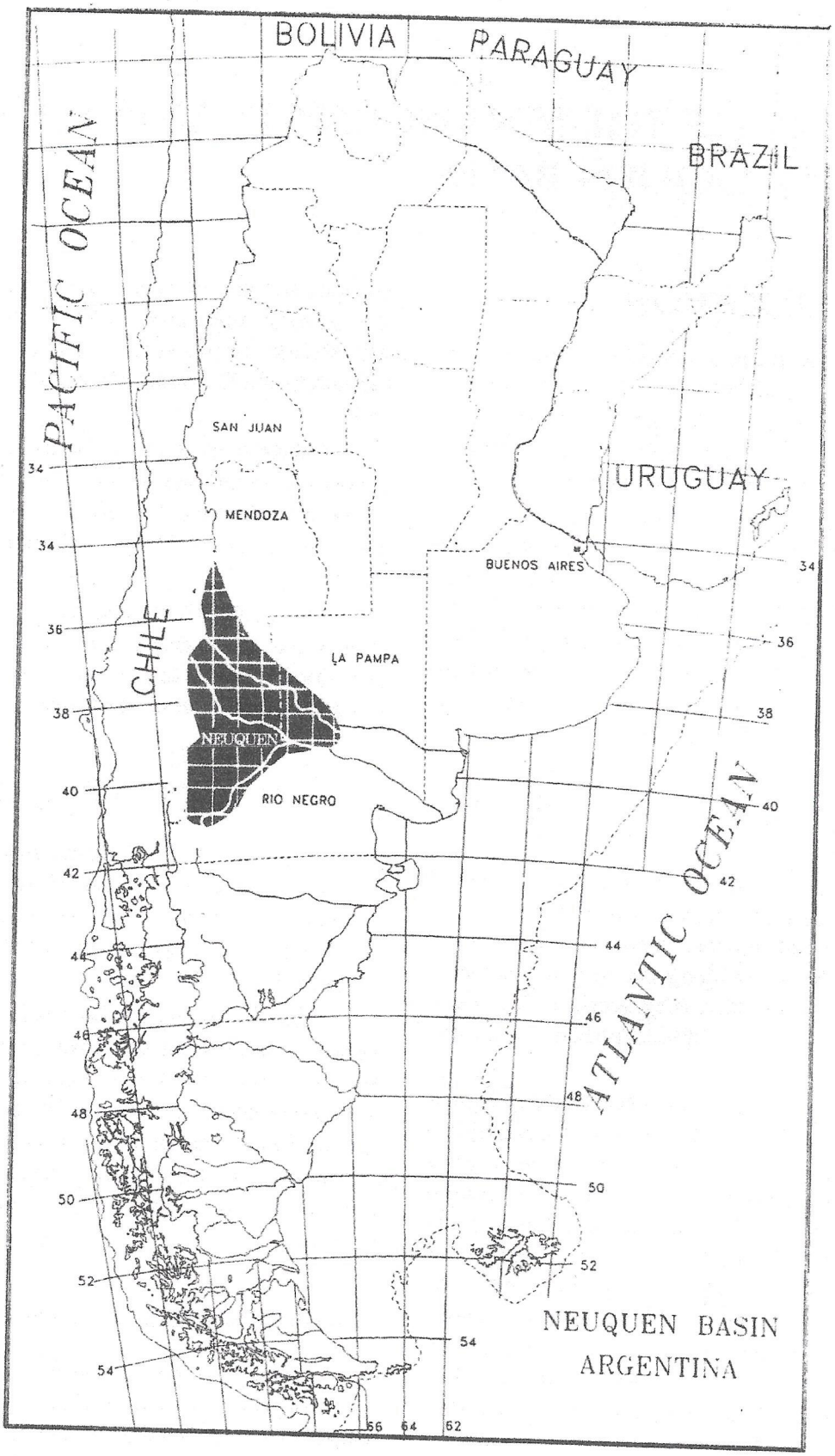

Figure 1: Location map of the Neuquén Basin

These deposits are grouped under the name Precuyano or Precuyo (Gulisano, 1981; Gulisano et al., 1984a; Legarreta and Gulisano, 1989). These deposits may be coeval, although without physical continuity, with marine sediments of Hettangian to Sinemurian age (Legarreta et al., 1993).

Hettangian to Callovian (Cuyo Group)

Over most of the basin, the marine deposition began in the Pliensbachian. However, in the Río Atuel region (southwestern Mendoza) late Sinemurian marine beds are known and recently Riccardi et al. (1988) discovered a succession bearing Hettangian and early Sinemurian ammonites.

Marine conditions prevailed from the early Jurassic until the late Callovian over a great part of the basin. The maximum extent of the area with marine deposition was attained during the Bajocian. From then onwards, the area of sedimentation was gradually reduced until, during the mid Callovian, the basin became virtually cut off from the open sea, resulting in the deposition of evaporites in the centre of the basin. During this interval (Hettangian to Callovian) the facies suggest a complex development with turbiditic, shelf, continental (fluvial and alluvial) and evaporitic deposits.

The various lithostratigraphical units which correspond to this interval are all referred to the Cuyo Group.

Middle Callovian to Oxfordian (Lotena Group)

During the mid to late Callovian, a drastic palaeogeographical change took place as a result of the complete desiccation of the basin. Continental deposits occupied the central part of the basin. They were followed by an expansion of the depositional area favoured by a relative sea level rise. The Callovian to Oxfordian boundary and the remainder of the Oxfordian are represented by deep water clastic facies (turbidites), argillaceous and carbonate deposits laid down in inner basin to shelf environments and central basin evaporites.

The Upper Oxfordian comprises an evaporitic sequence (central basin evaporites), deposited during an episode of limited marine connection following a relative sea level fall.

This middle Callovian to Oxfordian interval, composed of clastics, carbonates and evaporites, is known as the Lotena Group.

Kimmeridgian to Barremian (Mendoza Group)

This complex and thick interval is known from the lithostratigraphical viewpoint as the Mendoza Group (see Legarreta and Uliana, 1991). It begins with non marine clastic continental deposits (alluvial, fluvial and aeolian) which have been referred to the Kimmeridgian to lower Tithonian, according to their position in the sequence. The base of this unit coincides with an important palaeogeographical change and, along the Huincul Fault, it is expressed as an angular unconformity due to local tectonic activity.

These continental deposits were followed by argillaceous and calcareous basin and shelf facies, vertically and laterally associated with inner shelf and continental clastic facies which show a strong progradation from the south and southeast (Mitchum and Uliana, 1985; Gulisano et al., 1984b).

In the late early Valanginian, late Valanginian and early Hauterivian short episodes of partial or total desiccation of the basin took place, during which the depositional systems shifted towards the basin centre. These episodes are characterized by the presence of shallow shelf to continental clastics developed between argillaceous facies of deeper water environments.

In the Barremian there was a drastic reduction of the extent of the sedimentation area and a thin sequence of fine grained clastics and shallow marine carbonates is restricted to the deepest part of the basin.

Aptian to Palaeocene (Rayoso, Neuquén and Malargüe groups)

During the Aptian to Cenomanian interval the basin was characterized by the development of thick evaporites, associated with red continental deposits towards the margins (Legarreta and Uliana, 1991; Legarreta, 1985; Legarreta and Gulisano, 1989; Legarreta et al., 1993).

The lower part of the Aptian is represented by continental (fluvial and aeolian) sandstones which

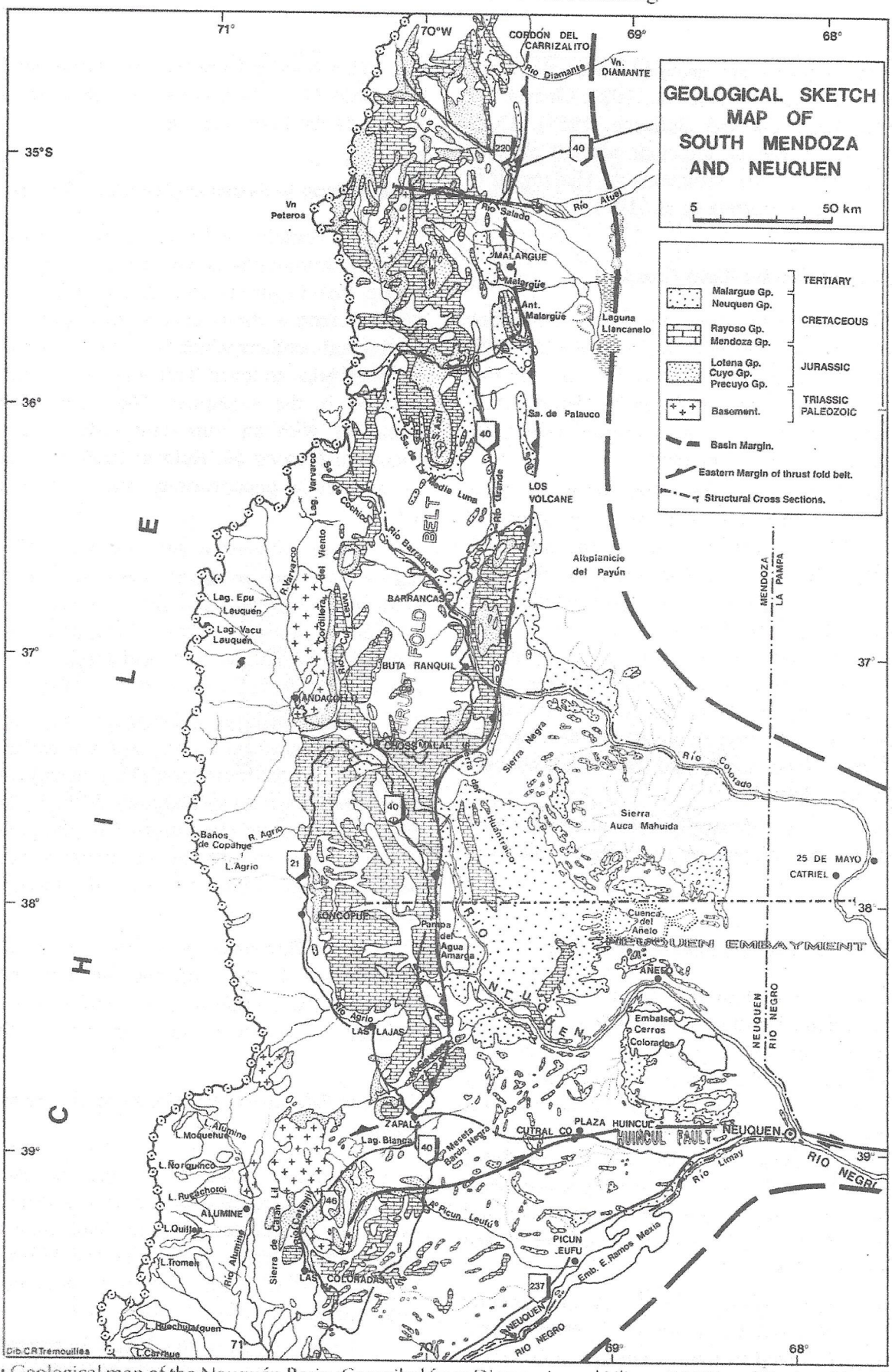

Figure 2: Geological map of the Neuquén Basin. Compiled from Digregorio and Uliana (1975) and Kozlowski et al (1993).

were deposited in incised valleys carved into the shelf platform and the inner part of the basin. Northwards and westwards these facies are linked to evaporitic deposits. They were succeeded by evaporites (gypsum, anhydrite, halite and sylvite) which interfinger with clastics towards the edges. The succession is capped with marine carbonate episodes of abnormal salinity environments which spread considerably towards the foreland. Such deposits correspond to the Huitrín Formation, in the lower part of Rayoso Group.

They were followed by evaporitic deposits of hypersaline marine environments and continental clastics during the late Aptian to mid Cenomanian. These are arranged in recurrent clastic-evaporitic sequences which progressively onlap over the preceding deposits. This package is assigned to the upper part of the Rayoso Group.

Separated from the underlying strata by a regional unconformity, a series of wholly continental red beds, namely the Neuquén Group, was laid down during the late 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.

The unconformity located at the base of these red beds is locally accentuated by 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.

Over these continental deposits, a shallow sea depositioning both clastics and carbonates, transgressed from east to west, i.e. from the Atlantic margin. Over the latter, in turn, continental clastics prograded from west to east. This series of sequences of late Campanian to Palaeocene age are called Malargüe Group.

TECTONICS

A continuous tectogenetic process began during the Tertiary (Eocene to Miocene), dominated by compressional tectonics, remained active until the late Miocene, when the basin reached its final structural configuration.

The Eocene is characterized by leaving neither sedimentary nor volcanic record in the basin. This important hiatus suggests a regional uplift process (Legarreta y Uliana, 1991) followed by a period of compression (Ramos, 1993) which put an end to the extensional conditions of the basin. The angular unconformity that separates the Oligocene - Miocene clastics and volcanics from the Upper Cretaceous to Palaeocene deposits was established by this time. During the Miocene, the eastward migration of the orogenic belt was emphasized, and a foreland basin filled by synorogenic continental deposits was created (Ramos, 1993).

As a result of the Tertiary compresive forces, a thrust fold belt was established to the west and a structural platform with almost no deformation to the east (Figures 2; 5 and 6).

Extensive volcanic activity took place during extensional periods between the main orogenic peaks. From the Oligocene until the Quaternary, the vulcanism spread gradually to the east.

3).

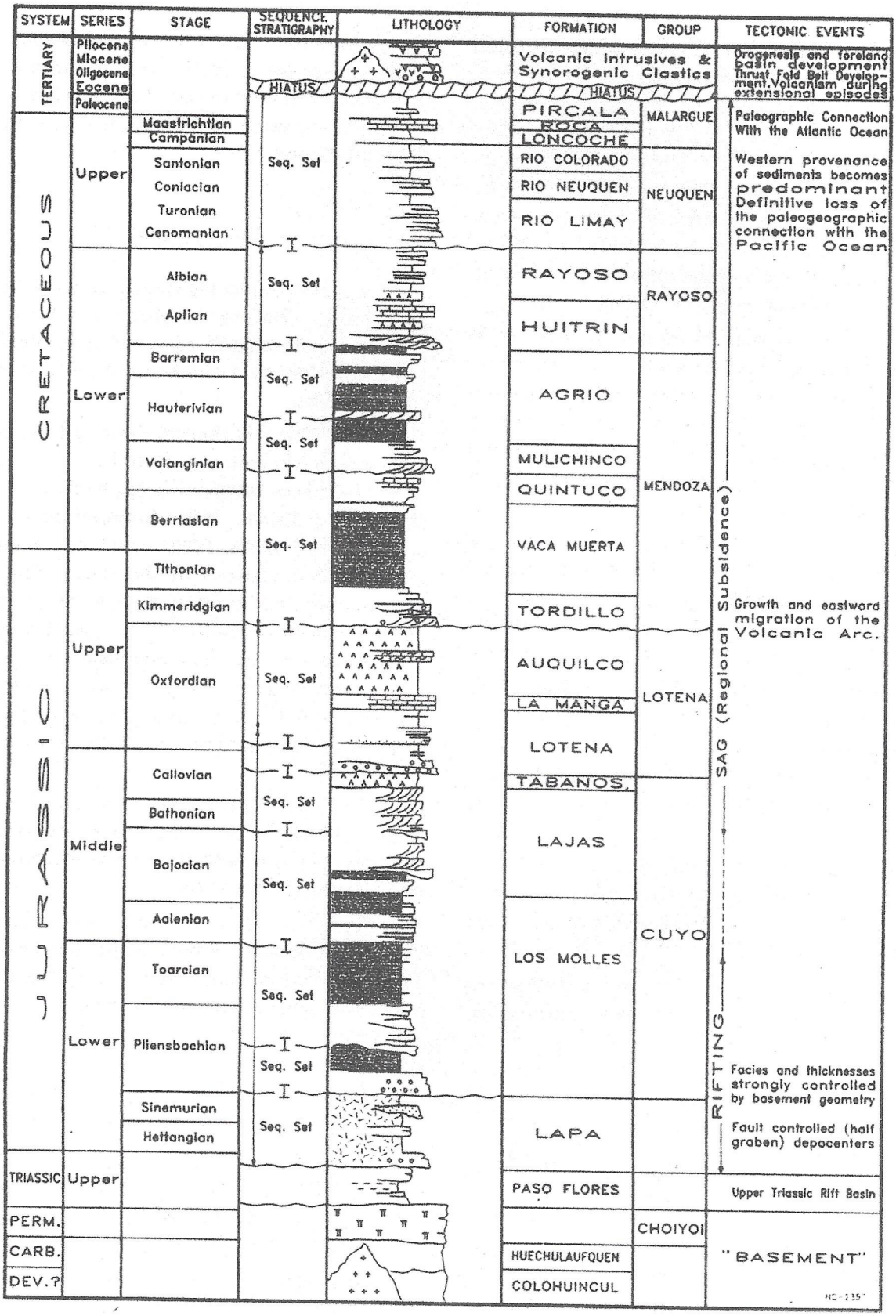

Figure 3: Simplified stratigraphical column. West -Central Neuquén Province.

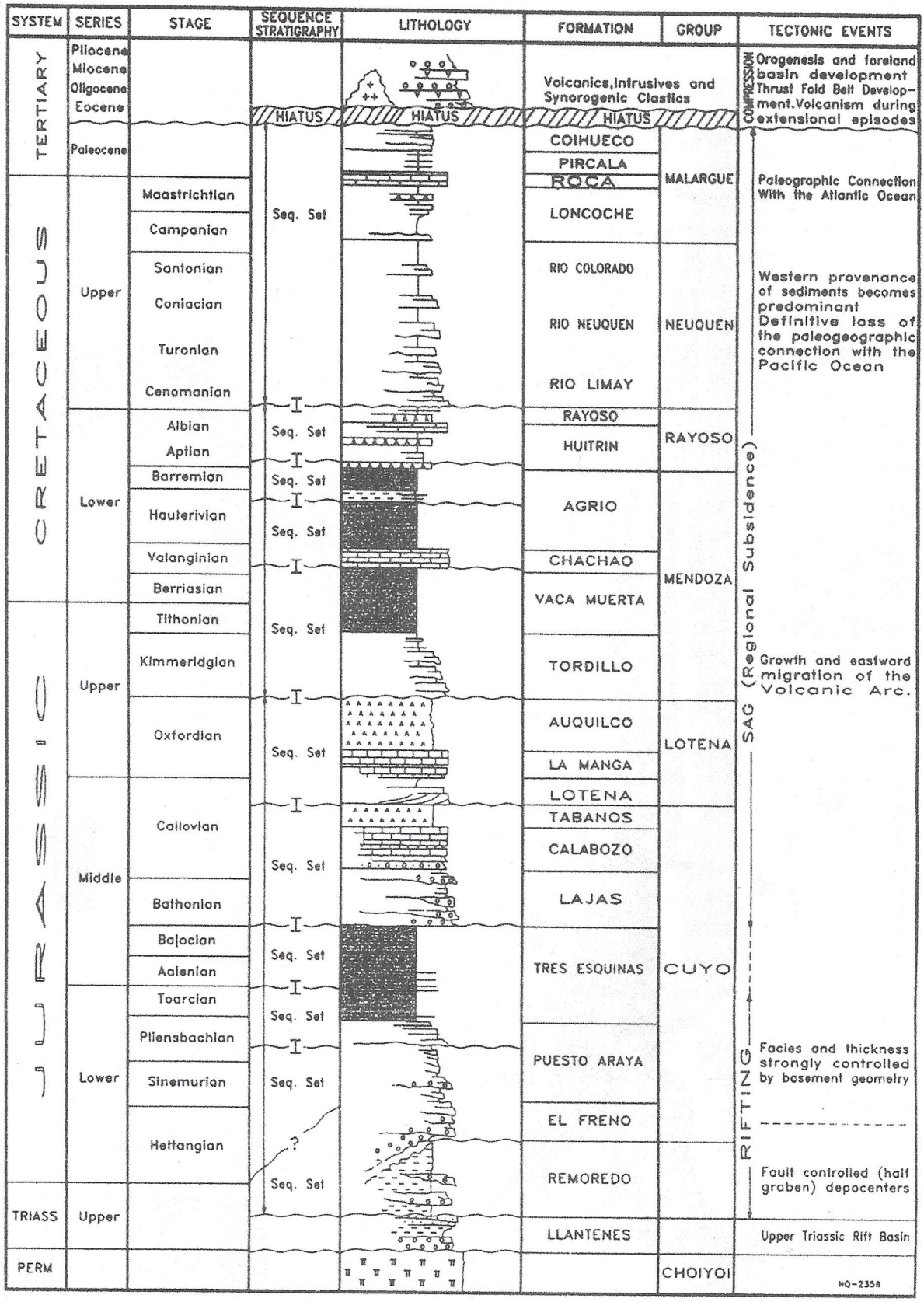

Figure 4: Simplified stratigraphical column. Southwest Mendoza Province.

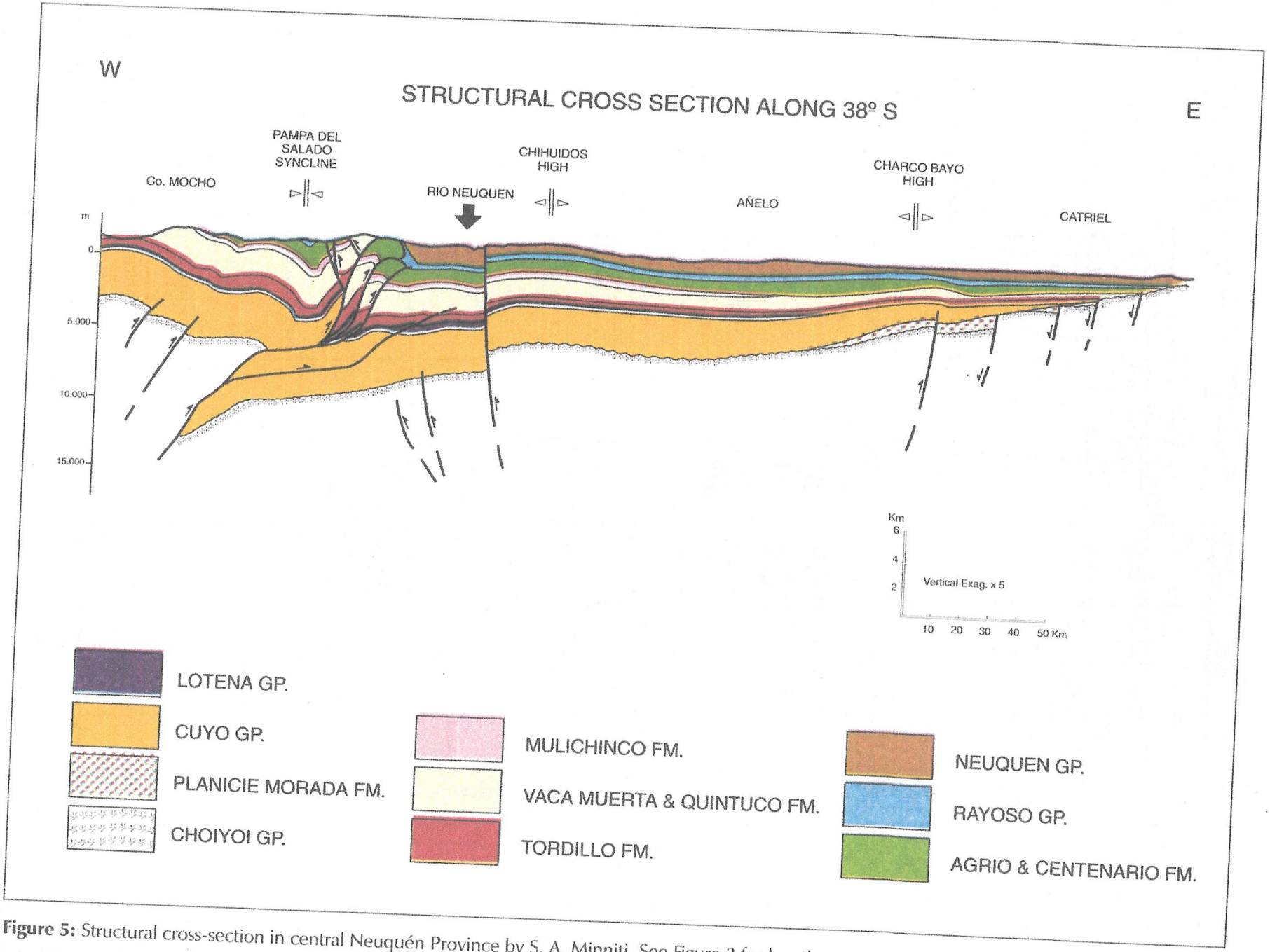

Figure 5: Structural cross-section in central Neuquén Province by S. A. Minniti. See Figure 2 for location.

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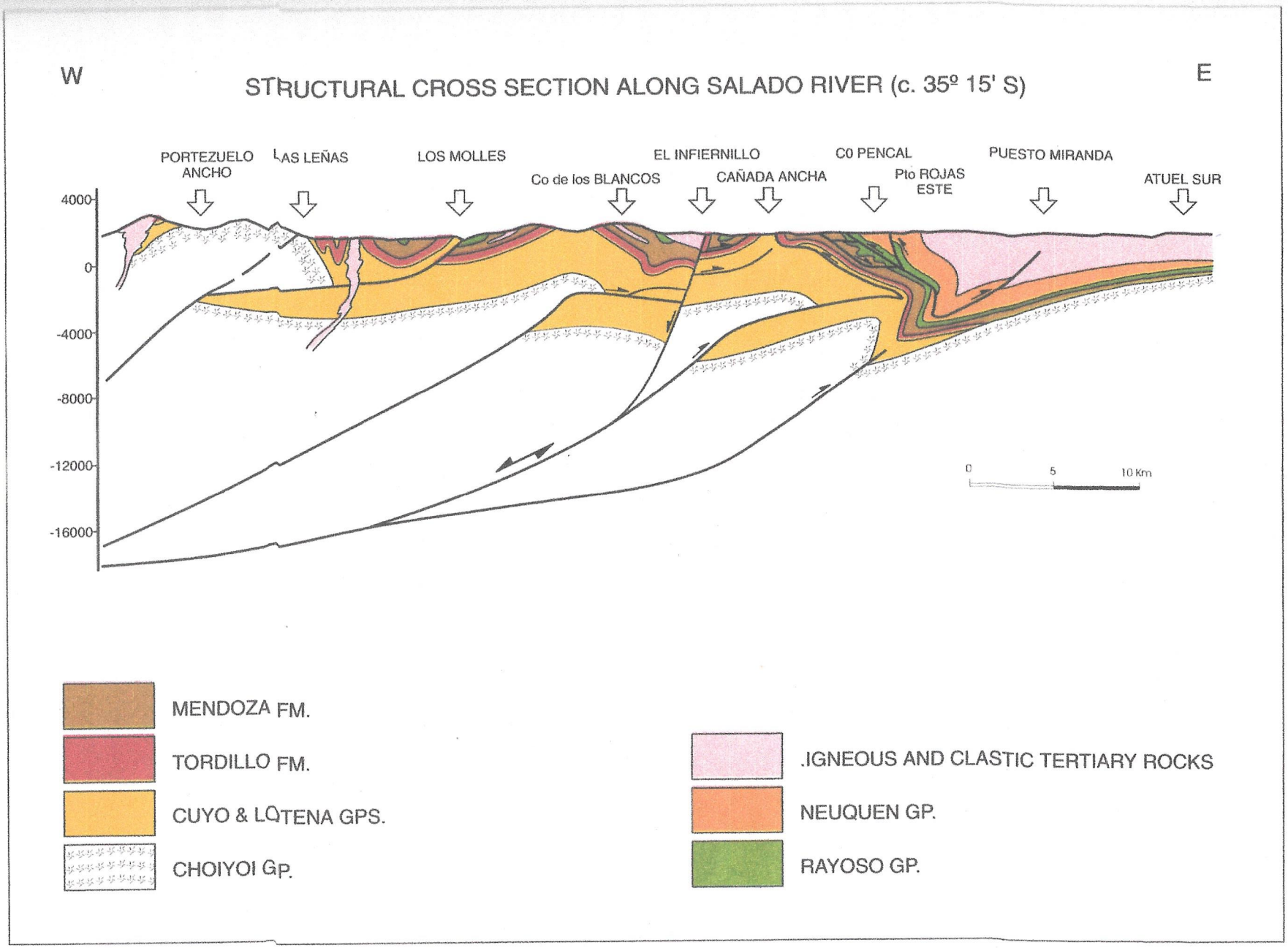

Figure 6: Structural cross-section of southern Mendoza Province from Kozlowski et al. (1993). See Figure 2 for location.