THE JURASSIC EVENTS IN THE GREATER CAUCASUS BASIN (NORTHERN NEOTETHYS) AND THE NEUQUÉN BASIN (WEST GONDWANA): A COMPARISON

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ABSTRACT

Quite a few common tectonic, palaeoenvironmental, and palaeobiological events have been recognized in the Jurassic evolution of the Greater Caucasus basin (Northern Neotethys) and the Neuquén basin (West Gondwana). Both basins were originated by the same planetary-scale tectonic force, i.e., by the activity of the Intrapangaean Shear Zone stretching eastwards along the Eurasian margin as the Northern Tethyan Shear Zone. An oxygen depletion occurred in both studied regions in the Toarcian as a result of global anoxia, which provoked a mass extinction. In both basins, the Callovian was a time for the carbonate platform growth, although in the Greater Caucasus, a carbonate platform appeared only in the Late Callovian. A salinity crisis occurred in the Greater Caucasus during the Kimmeridgian-Tithonian, whereas the same took place twice in the Neuquén basin - in the Middle Callovian and in the late Oxfordian-Kimmeridgian. These events were related to the global epoch of evaporite deposition. Some important differences between the considered basins are also documented. Palaeontological data from the Neuquén basin suggest against the mass extinction at the Jurassic-Cretaceous transition. In contrast, data from the Greater Caucasus basin permit to recognize this global event, although its regional peak occurred in the Berriasian. The Jurassic transgressions and regressions in the Greater Caucasus and western Argentina differed, facts that may be explained by the differences in the regional geodynamics. The only common pattern was a stepwise transgression during the Sinemurian-Pliensbachian.

Key words: *Anoxia, Salinity crisis, Mass extinction, Greater Caucasus, Neuquén.*

RESUMEN: *Comparación de eventos entre la cuenca del Gran Cáucaso (Neotetis septentrional) y la cuenca Neuquina (Gondwana occidental).*

Se han reconocido una serie de eventos tectónicos, paleoambientales y paleobiológicos comunes entre la cuenca del Gran Cáucaso (Neotetis septentrional) y la cuenca Neuquina (Gondwana occidental) en el Jurásico. Ambas cuencas se habrían originado por la misma fuerza tectónica a escala planetaria, relacionada con la actividad de la Zona de Cizalla Intrapangea, que se extiende hacia el Este a lo largo del margen de Eurasia como la Zona de Cizalla del norte del Tetis. La escasez de oxígeno que se produjo en ambas zonas durante el Toarciano, como consecuencia de una anoxia global, provocó una extinción en masa. En ambas cuencas, el Caloviano fue una época de crecimiento de plataformas carbonáticas, aunque en el Gran Cáucaso la plataforma carbonatada se desarrolló sólo en el Caloviano Tardío. En el Gran Cáucaso se produjo una crisis de salinidad durante el Kimeridgiano - Titoniano, mientras que en Neuquén ocurrió en dos ocasiones, en el Caloviano Medio y en el Oxfordiano - Kimeridgiano Tardío. Estos eventos estuvieron relacionados con un evento global de depósito de evaporitas. Se han encontrado también algunas diferencias importantes entre las cuencas estudiadas. Los datos paleontológicos de la cuenca Neuquina no apoyan una extinción en masa en la transición Jurásico-Cretácico. Por el contrario, los datos de la cuenca del Gran Cáucaso permiten reconocer este evento global, aunque su pico regional ocurrió en el Berriasiano. Las transgresiones y regresiones Jurásicas difieren en el Gran Cáucaso y en Argentina occidental, lo que puede ser explicado por diferencias en el contexto geodinámico. El único patrón común, en este sentido, fue una transgresión escalonada durante el Sinemuriano - Pliensbaquiano.

Palabras claves: *Anoxia, Crisis de salinidad, Extinción en masa, Gran Cáucaso, Neuquén.*

INTRODUCTION

The geological comparison of far-located regions produces two types of knowledge. First, it permits to enfill the understanding of the evolution of a poorly known area with the help of a better-known one. Second, such a comparison is an efficient tool to explore the planetary-scale mechanisms. The present knowledge on the Jurassic tectonics, stratigraphy, palaeontology, and palaeoenvironments grows rapidly but it has to be tested with data from some regions other than Western Europe, where the "classic"

studies of the Jurassic are attempted.
This paper deals with the comparison of the Jurassic tectonic, palaeoenvironmental, and palaeobiological events of two far-located sedimentary basins, namely the Greater Caucasus basin and the Neuquén basin. The former stretches from the Black Sea to the Caspian Sea through the territories of Southwestern Russian, Northern Georgia, and Northwestern Azerbaijan, whereas the latter occupies a large area of Western Argentina and a part of Chile. In respect to the Jurassic World, whose reconstructions have been recently attempted by Stampfli and Borel (2002), Golonka (2004), and Scotese (2004), the Greater Caucasus basin was situated on the northern active margin of the Neotethys Ocean, whereas the Neuquén basin was located in West Gondwana, close to the Panthalassa (or Proto-Pacific) Ocean (Fig. 1). Both regions represent the intriguing records of various Jurassic events.

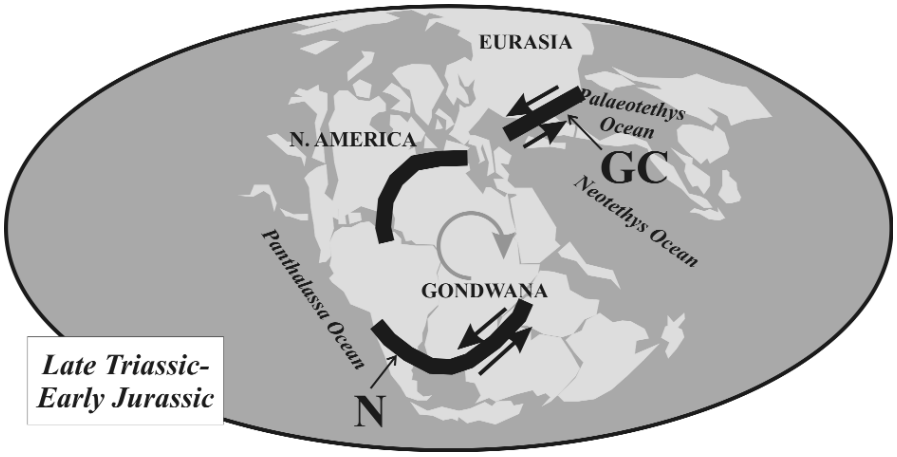

Figure 1: Palaeotectonic position of the Greater Caucasus basin (GC) and the Neuquén basin (N) at time of their configuration. Global plate tectonic reconstruction is simplified from Scotese (2004). Bold lines trace the major shear zones, and arrows indicate strike-slip displacements.

GEOLOGICAL SETTING

The Greater Caucasus basin was configured during the Early Jurassic and remained active until the Pliocene. Its Jurassic evolution has been recently studied by Ershov *et al.* (2003), Kazmin and Tikhonova (2006), Ruban (2006 a,b, 2007a), and Saintot *et al.* (2006), who updated many "traditional" theories. However, a number of interpretations remain controversial. In general, the Greater Caucasus basin was an elongated, deep enough back-arc (?) sedimentary basin, that stretched along the southern periphery of the Russian Platform (also referred to as Baltica). It was bordered by an island arc from the south. The Northern Transcaucasian Arc existed until the end of the Aalenian, when it collided with the Southern Transcaucasian Arc to form the single Transcaucasian Arc (Ruban 2006a). The main subduction zone of the Northern Neotethys was located far southwards. The regional Jurassic chrono- and biostratigraphic framework was developed by Rostovtsev *et al.* (1992), and was later normalized by Ruban (2006a, 2007a). The Jurassic sedimentary succession of the Greater Caucasus basin can be subdivided into two large packages divided by a remarkable unconformity (Ruban 2007a,b). The lower package comprises siliciclastic-dominated deposits up to 10,000 m thick, which age ranges between the Sinemurian and the Bathonian (Fig. 2). The upper package includes the Callovian - Tithonian carbonate- and evaporite-dominated deposits with a total thickness up to 3,000 m (Fig. 2). These deposits were accumulated in the Caucasian Sea, which deepest part stretched along the steep slope of the island arc, whereas a large shallow-water shelf existed in the north, where it joined with the shallow sea of the southern Russian Platform. This sea was generally warm with a normal salinity (Jasamanov 1978, Ruban 2006b) and well connected with the other marginal seas of the Northern Neotethys (Ruban 2006a).
The geology of the Neuquén basin was recently overviewed by Howell *et al.* (2005). This basin was originated in the Late Triassic - Early Jurassic along with a regional extension. During the Jurassic, it became a subsided back-arc basin bordered by an island arc from the west (Digregorio *et al.* 1984). A major subduction zone of the Eastern Proto-Pacific was located behind this arc. A thick sedimentary succession (Fig. 3), which encompasses the pre-Cuyo cycle, the Cuyo Group, the Lotena Group, and the lower part of the Mendoza Group, is represented by marine and somewhere continental siliciclastic and carbonate strata (Legaretta and Uliana 1996, Howell *et al.* 2005). They were accumulated in a large sea, whose embayment covered an adjacent territory of the South American counterpart of Gondwana.
The geological settings of the Greater Caucasus basin and the Neuquén basin appear to be very similar. This creates a valuable basis for their comparison. Some more detailed information on both studied basins is given below.

MATERIALS AND METHODS

The information on the Greater Caucasus basin was compiled from a number of sources, from which a book by Rostovtsev *et al.* (1992) is an essential reference. These compilations together with results from the author's personal studies, published in a series of papers (Ruban 2004a, 2005, 2006 a and b, 2007a and b), permit to enlarge the knowledge about the regional geology and to improve the previous constraints and interpre-

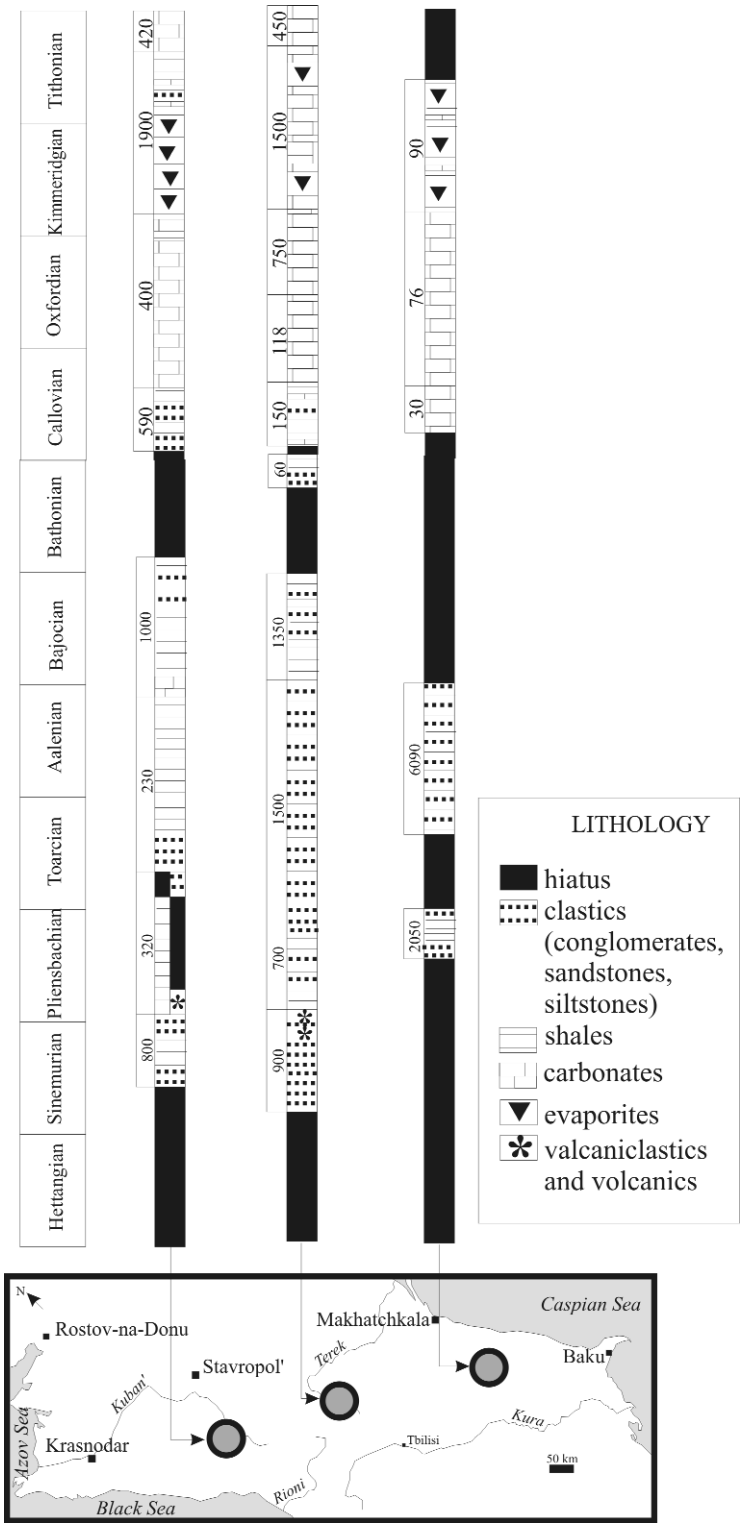

Figure 2: Representative composite sections of the Jurassic deposits of the Greater Caucasus basin (after Rostovtsev *et al.*1992, Ruban 2007a).

tations. The data on the Neuquén basin are derived principally from the volume edited by Veiga *et al.* (2005), whereas a number of other sources are listed below. The modern geology is dominated by an "event concept" (*e.g.* Walliser 1995, Babin 2007), meaning essentially a discrete definition of the geological history. However, a discrete and a continual understanding of the latter can be integrated easily (Ruban 2006c). A principal method used in this paper is a comparison of events recognized in the Jurassic history of the considered basins. This concerns two procedures, namely a comparison of potentially similar geological phenomena (1) and a comparison of their timing (2). The events comparing in this paper are grouped as tectonic, palaeoenvironmental, and palaeobiological, and they are as follows: basin configurations, anoxia episodes, carbonate platform growth, regional salinity crises, regional transgressions and regressions, the Pliensbachian/Toarcian and the Jurassic/Cretaceous mass extinctions.

TECTONIC EVENTS

One of the most surprising and, at the same time, less understood events in the geological history of both considered basins was their tectonic configuration. According to Ershov *et al.* (2003), Kazmin and Tikhonova (2006), and Saintot *et al.* (2006), the Greater Caucasus basin was formed along a rift at the extended margin of the Russian Platform. This fits well with the traditional understanding of the regional evolution. It is necessary to emphasize, that such an understanding, although it has a modern tectonic basis, is deeply rooted in the geosyncline model, developed for the Caucasus decades ago and introduces this region as always attached to the Russian Platform (*e.g.*, Laz'ko 1975). Recent studies based on the various lithostratigraphical, palaeontological, and palaeomagnetic data demonstrated that the Greater Caucasus did not become a part of this platform until the end of the Triassic. It was a Gondwana-derived Hunic terrane that was located closely to the Carnic Alps during the late Paleozoic-early Mesozoic (Tawadros *et al.* 2006, Ruban 2007b, Ruban *et al.* 2007). The major Northern Tethyan Shear Zone existed along the nor-

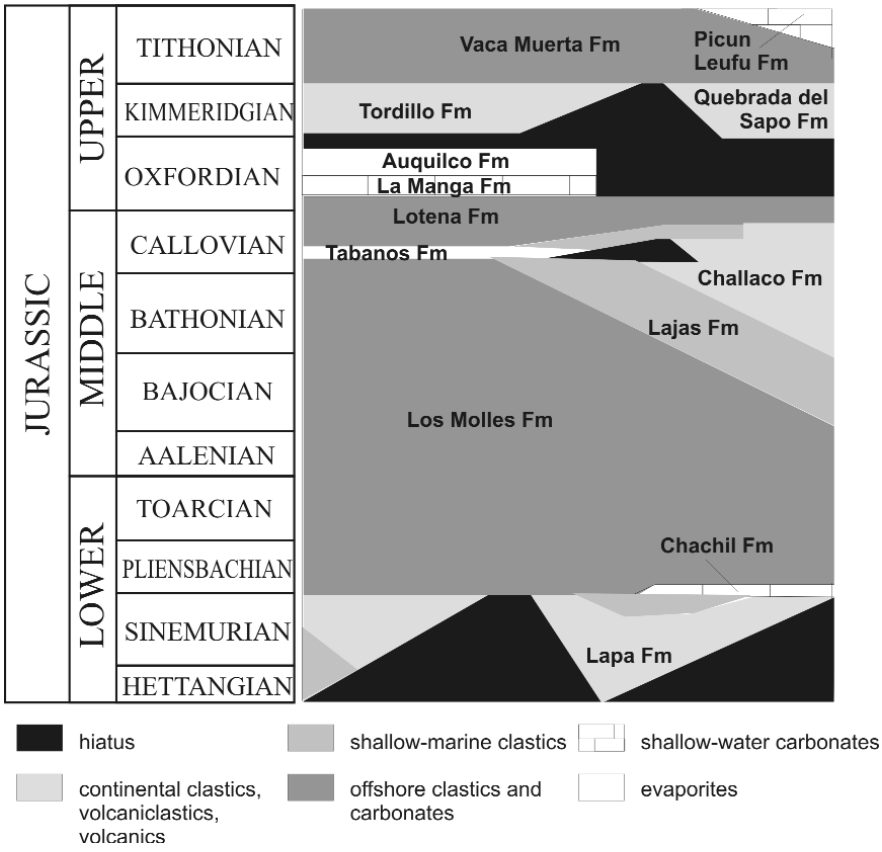

Figure 3: The Jurassic lithostratigraphy of the Neuquén basin (adapted after Howell *et al.* 2005).

thern margin of the Palaeo- and then Neo-Tethys since the mid-Paleozoic (Fig. 1). This feature was first outlined by Arthaud and Matte (1977) and then mentioned by Stampfli and Borel (2002) and Vai (2003). Swanson (1982) and later by Rapalini and Vizán (1993) suggested that dextral strike-slip displacements along this zone in the late Paleozoic were caused by the counterclockwise rotation of Africa. However, a change to a clockwise rotation of Africa was established somewhere in the Middle - Late Triassic (Swanson 1982, Rapalini and Vizán 1993). Ruban and Yoshioka (2005), Tawadros *et al.* (2006), and Ruban *et al.* (2007) argued a hypothesis that these movements might have influenced the geological evolution of structural domains presently included into the south of Russia. The fact that the Greater Caucasus was still located in the Permian much westwards from its present position suggests this terrane was further transported to the east. This might have occurred thanks only to the sinistral movements along the Northern Tethyan Shear Zone, which began in the Middle-Late Triassic after a change in the direction of the African rotation. If so, the Greater Caucasus reached the Russian Platform at the end of the Triassic and a subsequent collision occurred (Ruban 2007b). However, strike-slip deformations continued until the mid-Jurassic or even later (Vai 2003, Ruban 2007b). Consequently, the Greater Caucasus basin might have been originated along this major shear zone, which does not involve a continental extension. However, even if this basin was opened due to such an extension, it was nevertheless rooted to the mentioned shear zone, which brought a terrane to the platform margin and, thus, created a discontinuity at their boundary. In the latter case, the extension did occur already after the docking of the Greater Caucasus at the platform margin and superimposed the later strike-slip displacements.

The Neuquén basin was also originated in an extensional tectonic regime (Howell *et al.* 2005). An important role of strike-slip displacements in its onset is also a subject for discussion. Rapalini and Vizán (1993) hypothesized that an activity of the major Intrapangaean Shear Zone was responsible for origin this basin (Fig. 1). Moreover, these strike-slip movements were also controlled by the Africa rotation, which direction changed during the Middle - Late Triassic. Although the available evidence remains unclear, Nullo (1991) and Rapalini and Vizán (1993) underlined an important role of left-lateral displacements along pre-existing faults in the evolution of South American basins. Another proposal was formulated by Franzese and Spalletti (2001) and also mentioned by Howell *et al.* (2005), who considered strike-slip displacements along the Proto-Pacific margin. It appears that the two mentioned hypotheses do not concur, and both may be valid. Generally, the tectonic origin of the Neuquén basin was probably similar to that of the Greater Caucasus basin. Hypothetically, both basins were configured thanks to the same planetary-scale tectonic force.

PALAEOENVIRONMENTAL EVENTS

A number of intriguing palaeoenvironmental events are known from the Jurassic record of both the Greater Caucasus basin and the Neuquén basin (Figs 4 and 5). They include oxygen depletion, carbonate platform growth, salinity crises, and transgressions and regressions.

In the Greater Caucasus basin, an oxygen depletion is registered within the Toarcian-Aalenian. Although detailed geochemical studies are still lacking, Ruban (2004a) and Ruban and Tyszka (2005) hypothesized a regional dysoxia to anoxia, taking into account such indirect evidences as the black colour of shales, abundant siderite concretions, and dispersed pyrite. In Western Argentina, the presence of the Lower Toarcian black

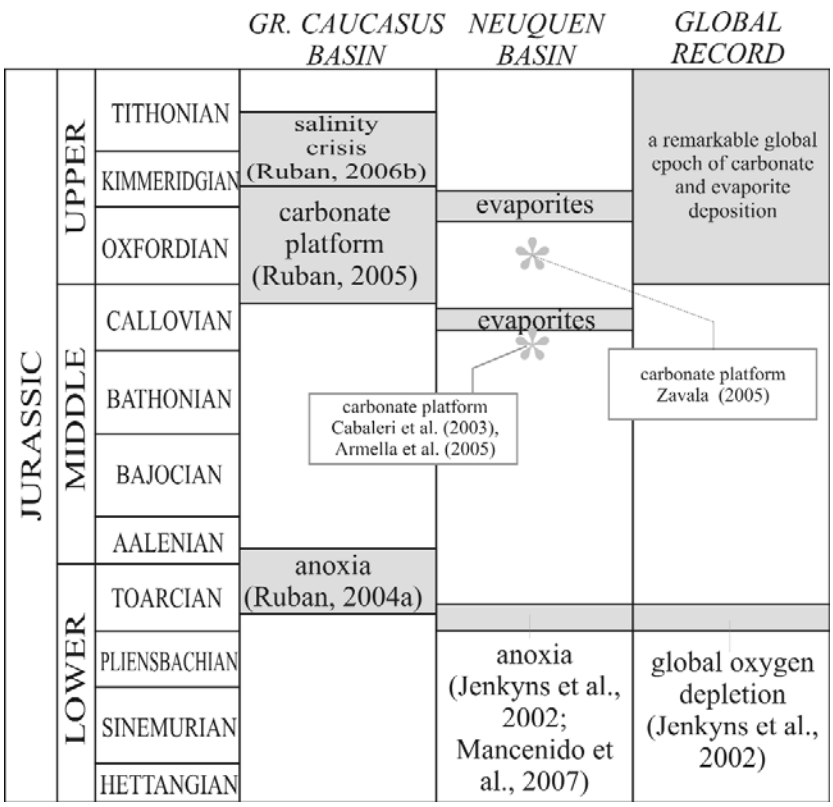

Figure 4: Common palaeoenvironmental events in the evolution of the Greater Caucasus basin and the Neuquén basin.

shales was mentioned by Jenkyns *et al.* (2002) in their global synthesis on the Jurassic chemostratigraphy. Recently, a presence of the global oxygen depletion in the Argentinean Andean basins has been argued by Manceñido *et al.* (2007). Thus, this event stressed the environments in both considered basins (Fig. 4). However, a retardation of the oxygen depletion within the Greater Caucasus, that occurred since the Middle Toarcian and lasted until the Middle Aalenian, should be taken into consideration. Perhaps the maximum of this anoxia was absent because of the establishing of the shallow-water environments in the Early Toarcian (Ruban and Tyszka 2005). If so, the retardation is apparent.

In both basins, the Callovian was a time of carbonate platforms growth (Fig. 4). In the Greater Caucasus, a large carbonate platform emerged in the Late Callovian and existed until the mid-Kimmeridgian (Kuznetsov 1993, Ruban 2005, 2006a, b), when the regional environments were stressed by an increase in salinity. This carbonate platform is identified as a rimmed shelf attached to the northern margin of the basin. It was bounded from the south by a chain of reefs, which are preserved as particular mountain peaks of the present-day Lago-Naki Plateau. Carbonates with the total thickness of up to 1,000 m are represented by packstones, reefal limestones, and dolomitized limestones (Kuznetsov *et al.* 1993). Episodes of carbonate platform growth are also recorded in the Neuquén basin (Cabaleri *et al.* 2003, Armella *et al.* 2005, Zavala 2005). The facies of the Calabozo Formation relate to a carbonate ramp. This regional episode is dated as Early Callovian. Thus, it occurred a bit earlier than that in the Greater Caucasus. However, the Oxfordian episode of carbonate ramp growth in the Neuquén basin, which is represented by the La Manga Formation (Zavala 2005), corresponded to the accumulation of the above-mentioned carbonates in the Greater Caucasus basin (Fig. 4).

A salinity crisis occurred in the Greater Caucasus during the Late Kimmeridgian - Middle Tithonian (Ruban 2006b). Anhydrites, gypsum, and salts are overlain by siliciclastics with a variegated co-lour. The total thickness of these deposits reaches 2,000 m (Rostovtsev *et al.* 1992). The most intriguing is the fact that coral reefs survived this crisis successfully (Kuznetsov *et al.* 1993, Ruban 2006 b). The causes of this event remain controversial. It appears that possible explanations could be linked to a regional aridization and basin isolation. Evaporite deposition in the Neuquén basin took place twice - in the Middle Callovian and in the Late Oxfordian - Kimmeridgian (Howell *et al.* 2005). Despite of such a similarity between the considered basins (Fig. 4), an important difference is observed. Since evaporite deposition in the Greater Caucasus basin occurred during a transgressive episode (Ruban 2007a), the same in the Neuquén basin took place at the time of the prominent regression (Legarreta and Uliana 1996). Such dissimilarity suggests a fundamentally different character of evaporite deposition. Taking into account the present models of evaporite origin (Boggs 2006, Veeken 2007), it seems that evaporite deposition during a regression is more typical to the lagoonal environments, whereas evaporites might have been accumulated at a time of a transgression from the dense brine waters. However, there is an evidence that evaporites in the Neuquén basin were also formed in transgressive environments (Zavala and Gonzalez 2001, Zavala 2005). If so, this is similar to what do we observe in the Greater Caucasus basin.

The Jurassic transgressions and regressions were documented in detail in both considered basins (Fig. 5). The Caucasian Sea changed its area cyclically during this period with a general trend to transgression (Ruban 2007a). Somewhat the same occurred in the Neuquén basin (Legarreta and Uliana 1996). However, a detailed comparison of transgressive and re-

gressive events suggests a strong difference between these basins. For example, a prominent regression in the Late Aalenian, which occurred in the Greater Caucasus, is not documented in Western Argentina. Vice versa, a regression in the latter at the Oxfordian - Kimmeridgian transition is not clear in the Greater Caucasus. The only evident similarity concerns a stepwise transgression during the Sinemurian-Pliensbachian. Such a dissimilarity between both regions can be easily explained by differences in the local tectonic activity.

PALAEOBIOLOGICAL EVENTS

Two major palaeobiological events might have occurred within the considered regions during the Jurassic, namely the Pliensbachian/Toarcian and the Jurassic/Cretaceous mass extinctions.

In the Greater Caucasus, brachiopod, foraminiferal, and bivalve communities were disturbed during the Pliensbachian-Toarcian transition (Ruban 2004a, 2006b, Ruban and Tyszka 2005). The crisis started in the Late Pliensbachian, whereas the recovery began in the Early-Middle Toarcian. The most stressed were brachiopods. As suggested by data from the Northwestern Caucasus (Ruban 2004a), one species of these fossils is only known from the Late Pliensbachian, namely Lobothyris punctata (Sowerby), whereas no brachiopods have been found in the Early Toarcian. A recovery lasted until the end of the Toarcian, but the species diversity never reached its Early Pliensbachian value. Faunal turnover and biodiversity drop is known in southern South America (Manceñido *et al.* 2007), and this region was used by Aberhan and Fürsich (1997) as a reference one to test the extinction patterns among bivalves. Thus, both regions seem to have been affected by this Early Jurassic catastrophe.

The most interesting would be to compare the faunal changes at the Jurassic-Cretaceous transition. Palaeontological data from the Neuquén basin, which concerns particularly marine reptiles, suggest against a regional appearance of this mass extinction (Gasparini *et al.* 1999, Gasparini and Fernández 2005). In contrast, data from the Greater Caucasus permit to recognize this global event with a regional peak occurring in the Berriasian (Ruban 2004b). In the western part of this basin, 95 foraminiferal species are known from the Tithonian, whereas only 36 species are known from the Berriasian. As a result of an incomplete recovery, the foraminiferal diversity raised up to 52 species in the Valanginian. Such a dramatic decline in total diversity would correspond well to the mass extinction. These Caucasian patterns suggest that a high abundance and diversity of any taxa in the end-Jurassic or even at the Jurassic/Cretaceous boundary is not a valuable argument against the regional appearance of this mass extinction, because its peak might have occurred later. Moreover, if even marine reptiles were really successful survivors as suggested by Gasparini et al. (1999), the data on other fossil groups may provide somewhat different conclusions. Consequently, we need further investigations to understand, whether or not this catastrophe took place in the Neuquén basin.

DISCUSSION

Recognition of common events in the Jurassic history of two far-located basins requires a discussion of their relationships with the global events.

A junction of the Intrapangaean Zone with the Appalachian and the North Tethyan shear zones was demonstrated (Rapalini and Vizán 1993). This means that both the Greater Caucasus and the Neuquén basins might have been probably formed by the same planetary-scale tectonic force responsible for the clockwise rotation of Africa since the Triassic. A concept of the global wrench tectonics (Storetvedt 2003) provides a suitable basis to explain these processes. However, a further confirmation of left-lateral displacements at a time of the Neuquén basin configuration is strongly required.

The Toarcian oxygen depletion is a globally recognized event (Jenkyns *et al.* 2002). Mailliot *et al.* (2006) suggest that oxygen depletion was synchronous within the Western Tethys and occurred in the Early Toarcian. This coincides with the above-mentioned evidence from the Neuquén basin. In contrast, a retardation of anoxia recorded in the Greater Caucasus basin corresponds to the same phenomena established recently in the Tibet, where an oxygen depletion occurred in

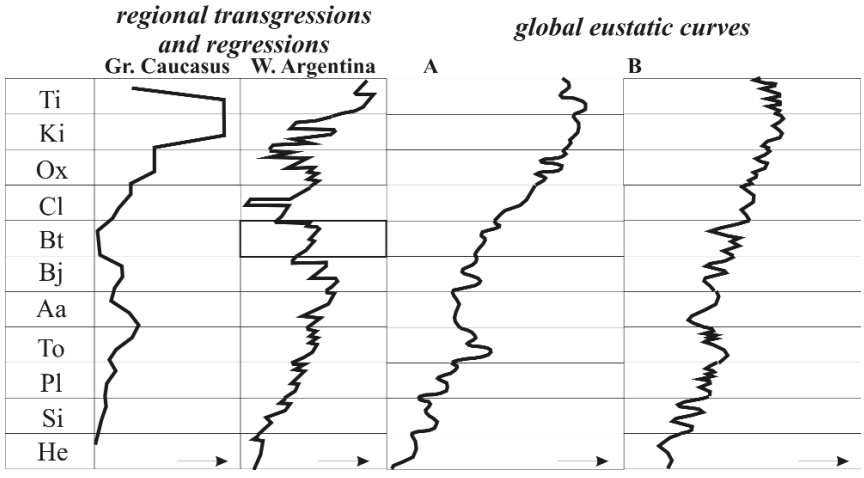

Figure 5: Regional transgressions and regressions (the Greater Caucasus basin - after Ruban 2007a, Western Argentina - after Legarreta and Uliana 1996) and the global eustatic fluctuations (A - after Hallam 1988, 2001, B - after Haq and Al-Qahtani 2005).

the Late Toarcian (Hallam 2006, Wignall *et al.* 2006). Thus, the diachronous nature of this event becomes evident. The global plate tectonic reconstruction attempted by Stampfli and Borel (2002) indicates that Western Europe belongs to another structural domain in comparison to the Caucasus and the Tibet. An opening of the Alpine Tethys Ocean occurred to the south of the former, while both others lay on the northern margin of the Neotethys Ocean. These oceans were separated by major transform boundaries and the opening Pindos, Maliac, and Meliata small oceans. This may explain a difference in the regional tectonic activity, and, therefore, in the regional sea-level changes. Their retardation might have been responsible for the anoxia delay. However, an apparent retardation of oxygen depletion in the Greater Caucasus due to shallow-water conditions in the Early Toarcian (see above) should not be excluded.

An appearance of the carbonate platforms in both considered basins in the Callovian and their further growth corresponded with high rates of global carbonate accumulation (Ronov *et al.* 1980, Berner 2004, Locklair and Lerman 2005, Mackenzie and Lerman 2006, Peters 2006) and an outstanding peak in reef growth (Kiessling *et al.* 1999). During the Late Jurassic, a remarkable amount of evaporites were deposited globally. If the total halite mass in the Middle Jurassic was just about 300 x 1015 kg, this value increased in about 21.5 times in the Late Jurassic, which total halite mass was evaluated as 6452 x 1015 kg (Hay *et al.* 2006). Thus, the events recorded in the Greater Caucasus basin and the Neuquén basin regions (Fig. 4) might have been referred to the same patterns of global sedimentation.

Ruban (2007a) attempted a broad comparison of the Caucasian Jurassic transgressions and regressions with those in the global record and other basins. Hallam (2001) used the data from Western Argentina (Legarreta and Uliana 1996) to discuss the global sea-level changes during the Jurassic. In both cases, a number of differences between regional and global patterns were observed. The available regional transgressive-regressive curves are plotted herein against two global eustatic curves proposed by Hallam (1988, 2001) and Haq and Al-Qahtani (2005). The latter authors updated the earlier curve by Haq *et al.* (1987). Although the general trends depicted by Hallam (1988, 2001) and Haq and Al-Qahtani (2005) agree, many differences are evident (Fig. 5). It would appear that transgressions and regressions, which occurred in the Greater Caucasus, correspond better to the global events than those recognized in Western Argentina. All these dissimilarities between regional and global events could be explained by the influences of local geodynamics, which was able either to diminish or to enlarge the planetary-scale signals. Another interesting conclusion is that the sharpest differences concern regressive episodes, whilst common transgressions are easier to be recognized. A relation of the Jurassic regressions to the local tectonic activity was already postulated by Hallam (2001).

The Pliensbachian/Toarcian and the Jurassic/Cretaceous mass extinctions are worldwide documented (Hallam 1986, Little and Benton 1995, Aberhan and Fürsich 1997, Hallam and Wignall 1997, Harries and Little 1999, Pálfy *et al.* 2002). Both are also registered by the global biodiversity curves (Sepkoski 1993, 1994, Benton 2001, Newman 2001, Peters and Foote 2001), which concern either continental, marine organisms, or both. Moreover, it appears that the Jurassic/ Cretaceous event was stronger than that occurring at the Pliesnbachian/Toarcian boundary, and a recovery after the former took more time (see curve by Newman 2001). Although an idea about the so-called background extinction is now criticized (Boucot 2006), the earlier modeling by Sepkoski and Raup (1986) suggested that a peak of the Jurassic/ Cretaceous mass extinction elevates over background extinction more than in the case of the Pliensbachian/Toarcian event. If to take into account foraminifers, the regional record of the Northwestern Caucasus (*i.e.*, western Greater Caucasus basin) (Ruban 2004b, Ruban and Tyszka 2005) confirms such a relation of strength of the above-mentioned catastrophes. Species diversity decreased at the Pliensbachian/Toarcian boundary in 1.8 times, but the recovery was so rapid and strong, that no negative event is registered if to calculate the diversity by stages (94 Pliensbachian and 111 Toarcian species are known regionally). In contrast, the species diversity declined at the Tithonian-Berriasian transition in about 2.6 times, and the recovery was not completed even during the Valanginian. Such a strength of the end-Jurassic mass extinction suggests a necessity to explore its patterns in the Neuquén basin.

CONCLUSIONS

A comparison of the Greater Caucasus basin from the Northern Neotethys and the Neuquén basin from West Gondwana permits to highlight a number of similar or comparable events in their Jurassic evolution. They are as follows: the probable tectonic configuration along a major shear zone, the Toarcian oxygen depletion and the related mass extinction, the Callovian carbonate platform growth, the evaporite deposition in the Late Jurassic, and the stepwise transgression in the Sinemurian - Pliensbachian. These similarities are easily explained by their relation to planetary-scale events and processes. This suggests that a probably similar (or even common) origin of the comparing basins cannot explain a similarity of their evolution, and vice versa. Many controls other than tectonics, namely eustasy, climate, global sedimentary budget, etc., were not less efficient to induce a coherence of local depositional environments. Dissimilarities between the Greater Caucasus and Neuquén basins concern a difference between the regional transgressions and regressions and an absence of the regional evi-

dence for the Jurassic/Cretaceous mass extinction in the Neuquén basin. Undoubtedly, both considered basins can be used as important references for the further exploration of the Jurassic World.

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