Cyclic lagoonal sedimentation of the Oxfordian/ Kimmeridgian within the Sierra del Madero, Northwestern Iberian Range, Soria province

H. MENSINK*, D. MERTMANN* and S. WILDE**

In Memoriam Prof. Dr. Hans MENSINK 1927-1988

**D. Mertmann, Institut für Geologie, Freie Universität Berlin, Altensteinstraß 34 a, 1000 Berlin 33, FRG*

***S. Wilde, Kornweg 3, 4630 Bochum 1, FRG*

RESUMEN

Durante el Oxfordiense y Kimmeridgiense inferior en la parte occidental de la Sierra del Madero se desarrolló un *lagoon* costero mareal con sedimentación carbonatada cíclica de ambiente somero, submareal a intermareal. La alternancia de facies señala sucesivos episodios transgresivos y regresivos. El *lagoon* quedaba aislado de la plataforma marina abierta por barras oolíticas y deltas siliciclásticos procedentes del Macizo del Ebro y del Alto de Soria-Ateca. Las dataciones se basan en los foraminíferos y las algas.

Palabras claves: Bioestratigrafía, Facies, Paleogeografía, Formación Aldealpozo, Jurásico superior (Oxfordiense-Kimmeridgiense inferior), España (provincia Soria, Sierra del Madero).

ABSTRACT

During the Oxfordian and Lower Kimmeridgian a lagoon developped in the area of the western Madero. There a cyclic carbonate sedimentation of shallow subtidal to intertidal environment took place. The alternation represents a number of transgressive and regressive facies variations. Oolitic bars and clastic delta sediments from the Ebro Massif and the Soria-Ateca-High isolated the lagoon from the open marine shelf situated southeast of Olvega. The age determinations are based upon foraminifera and algae.

Key words: Biostratigraphy, Facies, Paleogeography, Aldealpozo Formation, Upper Jurassic (Oxfordian-Lower Kimmeridgian), Spain (province Soria, Sierra del Madero).

Cuadernos de Geología Ibérica N.º 14, 215-224. Madrid, 1990.
Edit. Universidad Complutense.

ZUSAMMENFASSUNG

Im Oxfordium bis Unter-Kimmeridgium entstand in der westlichen Madero eine ausgedehnte Lagune, in der zyklische sub- und intertidale Sedimente abgelagert wurden. Sie zeichnen zahlreiche transgressive und regressive Sedimentationsphasen nach. Ooidbarren und Sandschüttungen von Deltasystemen des Ebro-Festlands und Soria-Ateca-Hochs trennten die Lagune vom offenmarinen Bereich im SE ab. Die Datierungen gelangen mit Foraminiferen und Algen.

INTRODUCTION

In the Madero area between Soria-Olvega-Noviercas (Fig. 1) the lower part of the Upper Jurassic consists of an alternation of calcareous sandstones and grainstones to mudstones (IGME, 1972, 1973, 1981).

This was named Aldealpozo Formation by Dragastan *et al.* (1987). The sequence is underlain by sandstones, calcareous sandstones and overlain by bioclastic, coral bearing limestones (Benke *et al.*, 1981; Errenst, 1987; Mensink, 1966; Wilde, 1987, 1988; Wnendt-Juber, 1985).

Gómez (1979) and Gómez & Goy (1979) considered the evolution of the lithostratigraphical units within the Jurassic of the Iberian Ranges as a whole.

Mauthe (1975), for the first time, thought the environment of the facies concerned to be formed in shallow marine agitated water. He discussed the discontinuities as subaerial karst solution processes during emersion of the firmground.

Benke (1981) correlated those often repeated discontinuities with far reaching condensation, stagnation and omission during regression around the Middle/Upper Jurassic boundary. He connected them with the movements of the Ebro and Soria-Ateca High. Benke *et al.* (1981) and Conze *et al.* (1984) determined some ammonites from the formation itself, as well as from the overlying coral limestones of the Kimmeridgian. Dragastan *et al.* (1987) worked out the cyclicity of the facies succession, the microfauna and microflora.

In the following chapters the biostratigraphical and lithological features of the lagoonal realm within the section of Soria, Renieblas, Aldealpozo, Villar del Campo and Tajahuerce are presented (Fig. 2).

BIOSTRATIGRAPHY

The foraminifera and algae are listed in Table 1. The age determinations are based on special assemblages of the microfossils (Dragastan *et al.*, 1987).

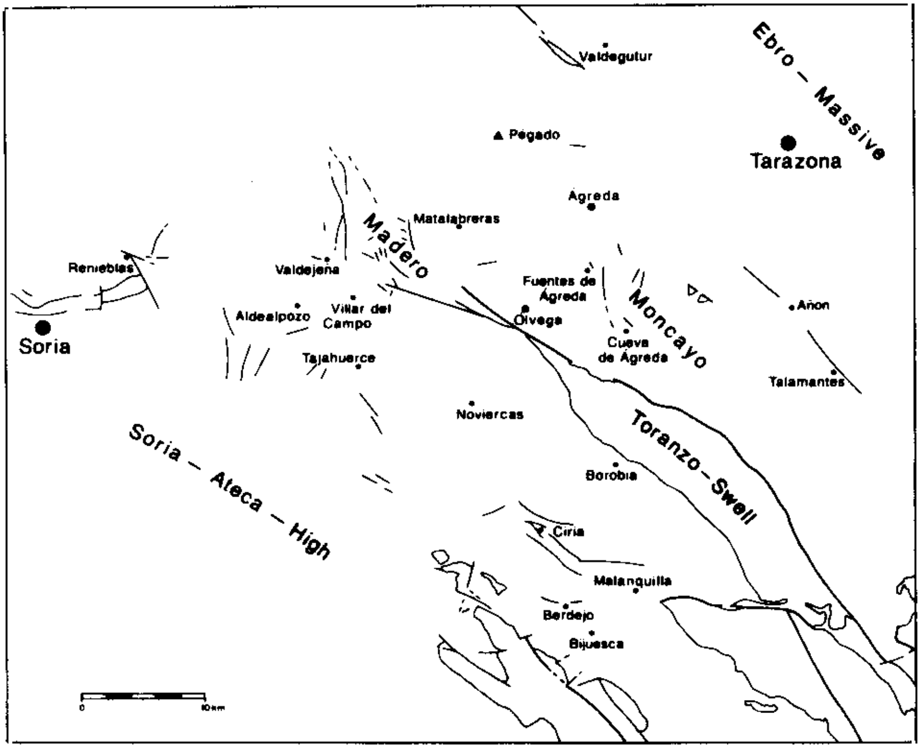


Fig. 1.—The sedimentation area is situated between the Ebro Massif and the Soria-Ateca High in the northwestern part of the Iberian Ranges. The Aldealpozo Formation is distributed within the western Madero in the area of Soria-Olvega-Noviercas.

Fig. 1.—El área de sedimentación está situada entre el Macizo del Ebro y el Umbral de Soria-Ateca en la parte noroeste de la Cordillera Ibérica. La Formación Aldealpozo se extiende al oeste del Madero en el área de Soria-Olvega-Noviercas.

The one chosen for the Oxfordian of the Aldealpozo section is characterized by *Kurnubia palastiniensis* HENSON, *Rectocyclammina gr. chouberti* HOTTINGER and *Pseudocyclammina parvula-muluchensis* HOTTINGER. Even in Villar del Campo the latter one indicates Oxfordian age too, in Renieblas only *Urgonina* sp. is safely attributed to it. To separate it from the Kimmeridgian, in Aldealpozo *Trocholina alpina* (LEUPOLD), *Trocholina elongata* (LEUPOLD), *Acicularia elongata* CAROZZI and *Salpingoporella pygmaea* (GÜMBEL) are used. Especially the last one is considered to be typical for the Kimmeridgian to Tithonian. In Renieblas *Parurgonina caeliensis* CUVILLIER *et al.*, and *Nautiloculina oolithica* MOHLER are occuring frequently together with *Rectocyclammina* gr. *chouberti* HOTTINGER and *Pseudocyclammina parvula-muluchensis* HOTTINGER.

These datations correspond with those based upon ammonites.

Table 1.—The Foraminifera and Algae species determined from the sections Aldealpozo, Renieblas and Villar del Campo.

Tabla 1.—Especies de Algas y Foraminíferos determinados, procedentes de las secciones de Aldealpozo, Renieblas y Villar del Campo.

Oxfordian assemblage

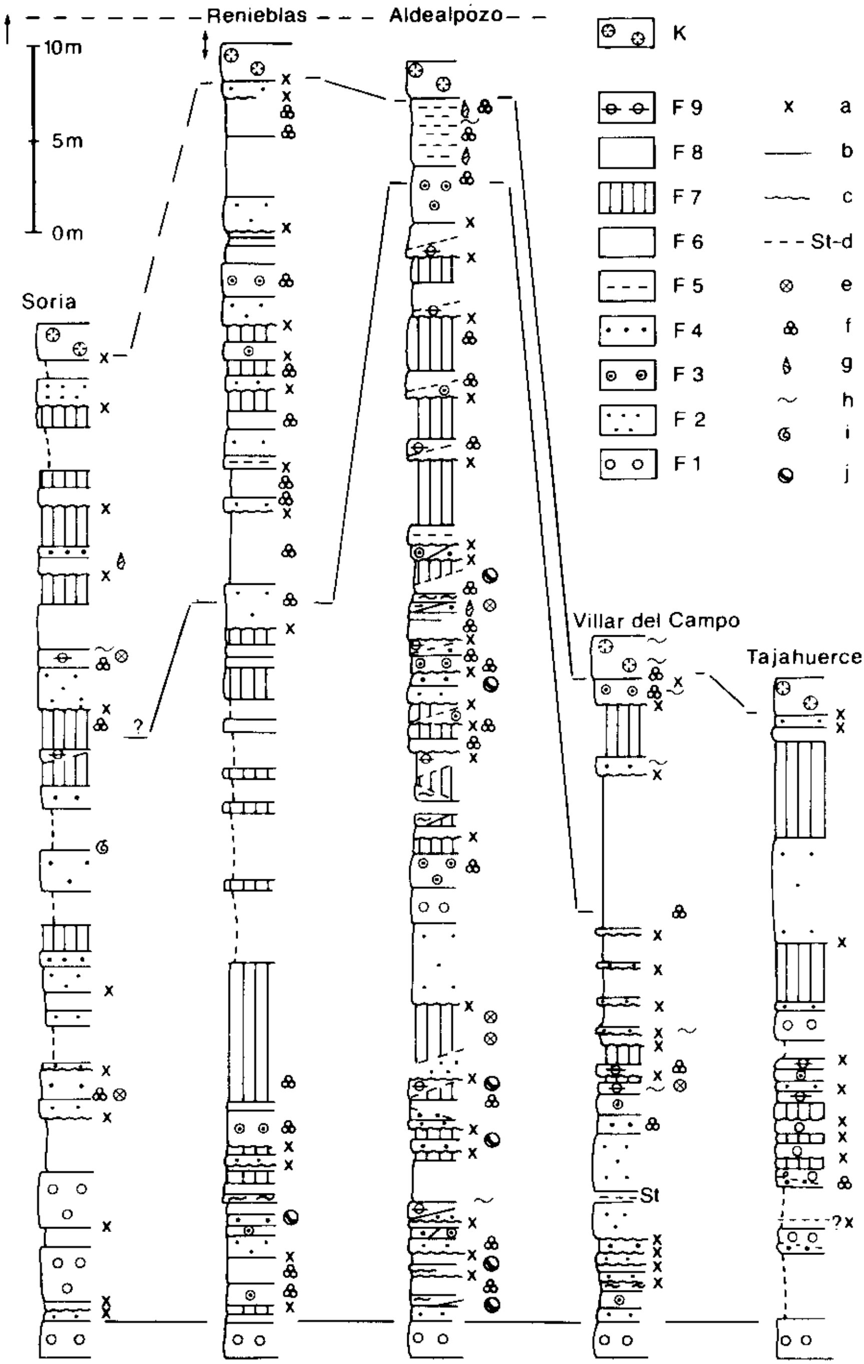
Nautiloculina oolithica MOHLER
Valvulina lugeoni SEPTFONTAINE
Kurnubia palastiniensis HENSON
Rectocyclammina gr. chouberti HOTTINGER
Protopeneroplis striata (WEYNSCHENK)
Pseudocyclammina parvula-muluchensis HOTTINGER
Trocholina alpina (LEUPOLD)
Parurgonia caelensis CUVILLIER *et al.*
Conicospirillina basiliensis MOHLER
Trocholina ex gr. elongata (LEUPOLD)
Trocholina gr. alpina (LEUPOLD)
«Urgonina» sp.
Cladocoropsis mirabilis FELIX
Garwoodia fluegeli DRAGASTAN
Solenopora jurassica (NICHOLSON)
Carpathocodium anae (DRAGASTAN)
Rivularia atanasiui DRAGASTAN
Rivularia lissaviensis (BORNEMANN)

Kimmeridgian assemblage

Nautiloculina oolithica MOHLER
Trocholina alpina (LEUPOLD)
Trocholina elongata (LEUPOLD)
Pseudocyclammina parvula-muluchensis HOTTINGER
Rectocyclammina chouberti HOTTINGER
Valvulina lugeoni SEPTFONTAINE
Acicularia elongata CAROZZI
Salpingoporella pygmaea (GÜMBEL)
Hormathonemma sp.
Rivularia atanasiui (DRAGASTAN)
Rivularia lissaviensis (BORNEMANN)
Rivularia moesica (DRAGASTAN & BUCUR)
Thaumathoporella parvovesiculifera RAINERI

Fig. 2.—The facies sequences of the main sections Soria, Renieblas, Aldealpozo, Villar del Campo and Tajahuerce. Abbreviations: F1. sandstones, F2. calcareous pelletal sandstones, F3. calcareous oolitic sandstones, F4. pelletal limestones, F5. bioclastic limestones, F6. sandy micrite, F7. micrite, F8. algal limestones, F9. algal/oncolitic limestones, K. bioclastic Coral Limestone Formation, a. cycle boundaries, b. facies boundaries, c. hardgrounds, discontinuities, d. lateral facies variations, e. corals, f. foraminifera, g. gastropods, h. algae, i. ammonites, j. characeans.

Fig. 2.—Secuencias de facies de las principales secciones de Soria, Renieblas, Aldealpozo, Villar del Campo y Tajahuerce. Abreviaturas: F1. Arenisca, F2. Arenisca calcárea con oolitos. F4. Caliza bioclástica, F6. Micrita arenosa. F7. Micrita, F8. Caliza algal, F9. Caliza algal/oncolítica, K. Formación caliza bioclástica con corales, a. Límites de ciclos, b. Límites de facies, c. «hardground», discontinuidades, d. Variaciones laterales de facies, e. Corales, f. Foraminíferos, g. Gasterópodos, h. algas, i. Ammonites, j. Caráceas.



10m
5m
0m
Renieblas
Aldealpozo
Soria
Villar del Campo
Tajahuerce
?
St
?x
K
F 9
F 8
F 7
F 6
F 5
F 4
F 3
F 2
F 1
x a
b
c
St-d
e
f
g
h
i
j

The boundary position between the stages is more or less approximated, still; in Aldealpozo it is supposed 5 m, in Renieblas 28 m, in Villar del Campo 14 m and in Soria about 20 m below the bioclastic Coral Limestone Formation (Fig. 2). The limits of the Aldealpozo Formation are obviously diachronous.

PHASES OF SEDIMENTATION AND LITHOLOGY

The manifold sediments developped cyclically near a limnic/brackish lagoonal border, in lagoonal quiet water and in quiet to turbulent shallow subtidal areas. Complete cycles are divisible into 4 parts (Fig. 3) with 9 different facies types attributed to them (Dragastan *et al.*, 1987). Nevertheless incomplete ones are also present; extraclasts in some cases point to the former presence respectively the reworking of older cycle members. The entire «Aldealpozo Cycle» represents generally a more or less «sudden» transgressive and then a regressive phase persisting over more facies types. Inversions of the succession seldom occur.

Transgressive Phase (I)

The cycle starts after an omission period (IIc) with marine sandstones overlying a clear relief. The sandstones are probably relicts of parts of

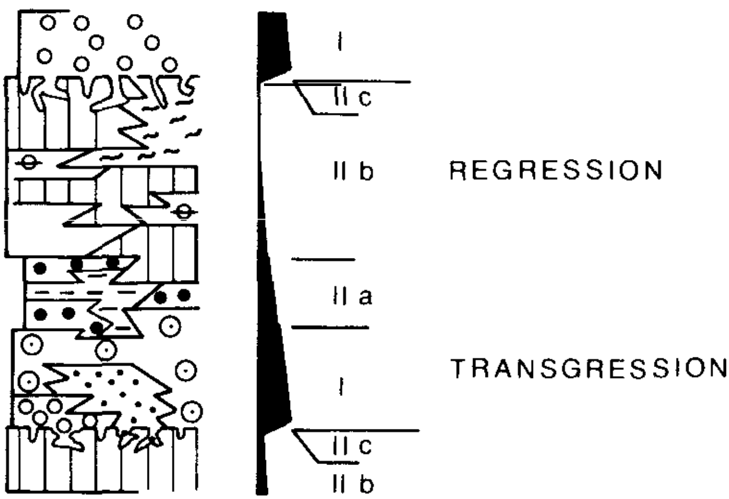


Fig. 3.—Schematic section of the facies relationships and development of an idealized Aldealpozo Cycle. Abbreviations see Fig. 2.

Fig. 3.—Dibujo esquemático de las relaciones de facies y el desarrollo de un Ciclo de Aldealpozo idealizado. Abreviaturas ver Fig. 2.

deltaic systems. The calcareous sandstones contain pellets, coated grains and ooids beside bivalve and echinodermal debris. Sometimes ooids clearly dominate the rest of the components. The deposition took place in shallow subtidal nearshore coastal channels. The carbonate grains were most probably washed in from adjacent areas, the ooids from ooid bars situated more to the south.

Regressive Phase (II)

The regressive phase of the complete cycle is threefold: It is composed of a shallow marine (a), a lagoonal environment (b) and last not least an omission period (c).

a) Characteristic are pelletal and bioclastic carbonates of a shallow subtidal sea. The clastic input decreases considerably, the currents were less intense than before.

b) Sandy micrites and dismicrites as well as algal/oncolitic limestones are typical. The first one with fine grained sandy material, pellets, filaments and a small number of foraminifera, algae, gastropods and ostracods developped in a quiet subtidal sea. The micrites and dismicrites are attributed to an intertidal area. Birdseyes, stromatactis and dessication cracks are present and indicate periods of exposure. In quiet waters algae settled down forming thin mats of bindstones. Reworking of biota and mud led to the formation of oncoids within the tidal zone of the protected lagoon.

c) The regression culminates in an omission-phase. Plane or irregular discontinuities developped. The latter ones are most of all originally hardgrounds with truncations and rare dessication fabrics widened by erosion. Relicts of soils were not observed.

DISCUSSION

The cyclic alternations described are characteristic for the western Madero (Figs. 4, 5) during the Oxfordian/Lower Kimmeridgian. A narrow, shallow marine strait stretched out between the Ebro Massif and the Meseta respectively the adjacent Soria-Ateca High. The strait is a relict of the marine sea covering wide areas of Spain during earlier mesozoic times. The regression of the Dogger/Malm boundary led to the new determination of the coastlines.

The Aldealpozo formation interfingers with deltaic sands from the neighbouring emerged mainlands and with oolitic grainstones on the one hand, on the other with sandy marls of the open marine sea situated in the southeast. The sadbodies and the oolitic bars isolated the «Aldealpozo Lagoon» almost completely. Sea level fluctuations and/or unsteady rates of

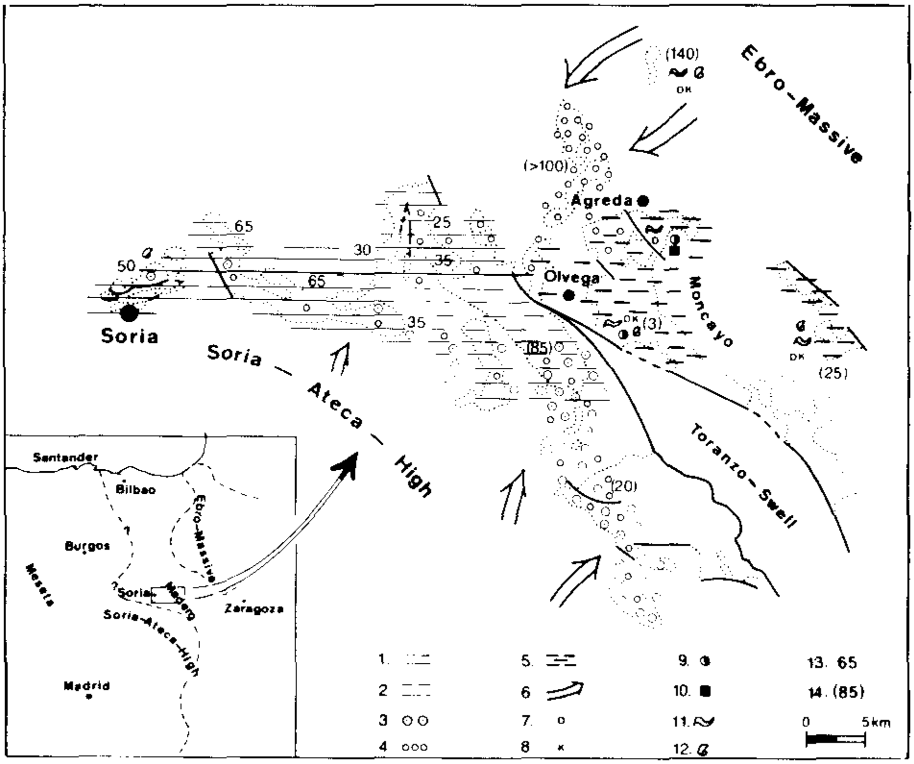


Fig. 4.—Paleogeographical reconstruction of the Madero area during the Oxfordian and Kimmeridgian. The lagoon is bordered by oolitic bars and deltaic sandbodies in the north-east and the south. East of the Toranzo Swell an open marine environment remained. Abbreviations: 1. Distribution of the Aldealpozo Formation, 2. Interfingering of facies 1/3 and 1/4, 3. Oolitic limestones, 4. Sandstones, 5. Marls and limestones, 6. Input of clastic material, 7. Discontinuities, 8. Condensation, 9. Iron-oolitic limestone, 10. Ironcrusts, 11. Spongiolitic limestone, 12. Locations of ammonite discoveries, 13. Thickness of Aldealpozo Formation, 14. Thickness of Oxfordian strata.

Fig. 4.—Reconstrucción paleogeográfica del área del Madero durante el Oxfordiense y Kimmeridgiense. El lagoon esta bordeado por barras oolíticas y abanicos deltaicos arenosos por el noroeste y sur. Al este del umbral de Toranzo continuó un ambiente marino abierto. Abreviaturas: 1. Distribución de la Formación Aldealpozo, 2. Interdigitación de facies 1/3 y 1/4, 3. Calizas oolíticas, 4. Areniscas, 5. Margas y calizas, 6. Entrada de material clástico, 7. Discontinuidades, 8. Condensación, 9. Calizas con oolitos ferruginosos, 10. Costras ferruginosas, 11. Caliza espongiolítica, 12. Localidades con presencia de Ammonites, 13. Espesor de la Formación Aldealpozo, 14. Espesor de los estratos oxfordienses.

subsidence caused the lot of sedimentary cycles, leading to the formation of alternating transgressive (deepening) to regressive (shallowing) facies types. On the open shelf starvation and condensation events took place simultaneously from the Upper Callovian to the Middle Oxfordian and

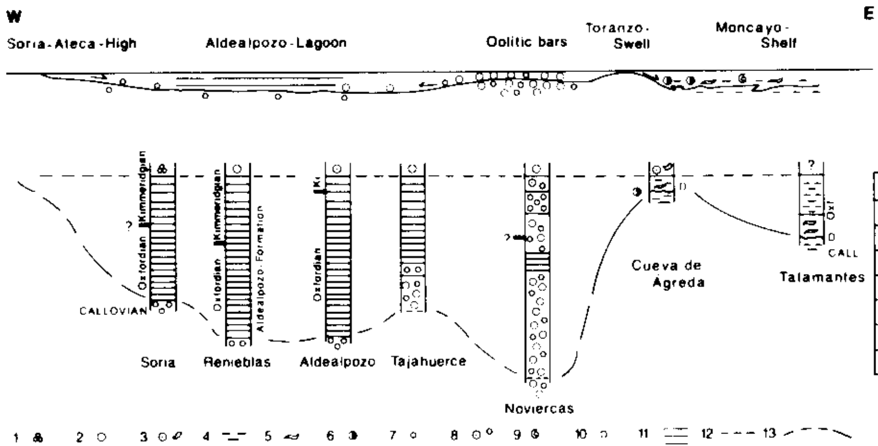


Fig. 5.—Cross-section through the Aldealpozo Lagoon and the adjacent areas of oolitic bars, Toranzo Swell and Moncayo Shelf.
Abbreviations: 1. Foraminiferal limestones, 2. Coral/bioclastic limestones, 3. Oolitic/limestones, 4. Marls and limestones, 5. Spongiolitic limestones, 6. Iron-oolitic limestones, 7. Sandstones, 8. Calcareous oolitic limestones, 9. Ammonite discoveries, 10. Discontinuities, 11. Aldealpozo Formation, 12. Boundary to the bioclastic Coral Limestone Formation, 13. Boundary Callovian/Oxfordian partly presumed.

Fig. 5.—Corte transversal del lagoon de Aldealpozo y de las áreas adyacentes de barras oolíticas, Umbral de Toranzo y Plataforma del Moncayo.
Abreviaturas: 1. Caliza de Foraminíferos, 2. Caliza bioclastica con corales, 3. Caliza oolitica/oncolítica, 4. Marga y caliza, 5. Caliza espongiolítica, 6. Caliza con oolitos ferruginosos, 7. Arenisca, 8. Arenisca calcárea con oolitos, 9. Presencia de Ammonites, 10. Discontinuidades, 11. Formación Aldealpozo, 12. Límite de la Formación calizas bioclásticas con corales, 13. Límite Calloviense/Oxfordiense, parcialmente supuesto.

from then on to the Lower Kimmeridgian represented by thin sedimentation. But a definite correlation of events from the marine shelf to the lagoon is not yet possible.

BIBLIOGRAPHY

BENKE, K. (1981): Die Dogger/Malm-Wende in den NW-Iberischen Ketten (Spanien) und angrenzenden Gebieten. Sedimentologie, Stratigraphie und Paläogeographie. *Facies* 4: 95-164.

BENKE, K., DÜRKOOP, A., ERRENST, Ch. & MENSINK, H. (1981): Die Korallenkalke im Oberjura der nordwestlichen Iberischen Ketten (Spanien). *Facies* 4: 27-94.

BULARD, P. F. (1972): *Le Jurassique moyen et supérieur de la chaine Ibérique sur la bordure de bassin de l'Ebre (Espagne).* These doct.Univ. Nice, vol. I: 702 p.; vol. II: 100 fig., 39 pl.

CONZE, R., ERRENST, Ch. & MENSINK, H. (1984): Die Ammoniten des Ober-Callovium bis Unter-Kimmeridgium in den nordwestlichen Keltiberischen Ketten. *Paläontographica*, A, 183: 162-211.

DRAGASTAN, O., MENSINK, H., MERTMANN, D. & WILDE, S. (1987): Küstennahe Sedimentationszyklen im Ober-Jura der westlichen Madero, Nord-Spanien. *N. Jb. Geol. Paläont., Abh*, 175: 377-398.

ERRENST, Ch. (1987): *Das korallenführende Kimmeridgium der nordwestlichen Iberischen Ketten und angrenzender Gebiete - Fazies, Paläogeographie und Beschreibung der Korallenfauna.* Thesis doct. Univ. Bochum: 1-161.

GOMEZ, J. J. (1979): El Jurásico en Facies carbonatadas del sector levantino de la Cordillera Ibérica. *Sem. Estrat.*, Ser. Mon., 4: 1-683.

GOMEZ, J. J. & GOY, A. (1979): Evolución lateral de las Unidades litoestratigráficas del Jurásico en Facies carbonatadas de la Cordillera Ibérica. *Cuad. Geol.*, 10: 83-93.

IGME (1971): Mapa Geológico de España, Escala 1:200.000, Soria 31. Síntesis de la cartografía existente.

IGME (1973): Mapa Geológico de España, Escala 1:50.000, Olvega 351.

IGME (1981): Mapa Geológico de España, Escala 1:50.000, Agreda 319.

MAUTHE, F. (1975): Paläokarst im Jura der Iberischen Ketten (Prov. Soria, Nordspanien). *N. Jb. Geol. Paläont. Abh.*, 150: 354-372.

MENSINK, H. (1966): Stratigraphie und Paläogeographie des marinen Jura in den nordwestlichen Iberischen Ketten (Spanien). *Beih. Geol. Jb.*, 44: 55-102.

MENSINK, H. & MERTMANN, D. (1988): Die Geologie der Jura-Gebiete um Olvega (Sierra del Madero, del Moncayo und de Toranzo). *Bochumer geol. u. geotech.* 30: 1-93.

WILDE, S. (1987): Das Bathonium und Callovium der Nordwest-Iberischen Ketten (Jura, Spanien) Sequenzen einer sich differenzierenden *Epikontinental* Plattform. Thesis doct., Univ. Bochum: 1-214; publ. (1988) *In*: *Bochumer geol. u. geotechn.*, 31: 1-217.

WNENDT-JUBER, E. (1985): *Die Mikrofauna und -flora der Korallenkalke im Kimmeridgium der NW-Iberischen Ketten (Spanien).* Thesis doct., Univ. Bochum: 1-92.

Recibido: 13 marzo 1989.
Aceptado: 12 julio 1989.