Al Direttore del Dipartimento di Scienze della Terra,
dell'Ambiente e delle Risorse (DiSTAR)
Università degli Studi di Napoli Federico II
Complesso di Monte Sant'Angelo (Edificio L),
Via Vicinale Cupa Cintia, 21
80126 NAPOLI

Oggetto: BANDO DI SELEZIONE PER IL CONFERIMENTO DI DUE INCARICHI DI CONSULENZA PROFESSIONALE **(Rif. Bando_1_Cons Progetto CARG - Foglio n. 417 Teano_Codice progetto: CUP E65F21001550005)**.

Il sottoscritto Randisi Andrea nato a Piedimonte Matese (CE) il 24/05/1978, residente in via De Gasperi, 62 – 81058 Vairano Patenora (CE),
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telefono: +39 333 4901394 (*)

C H I E D E

di essere ammesso alla selezione in oggetto.

Il sottoscritto, consapevole delle sanzioni penali previste dall'art. 76 del D.P.R. n. 445/2000 per le ipotesi di falsità in atti e dichiarazioni mendaci, sotto la propria responsabilità:

D I C H I A R A

1. di essere nato a Piedimonte Matese (CE) il 24/05/1978;
2. di essere residente a Vairano Patenora (CE) in via De Gasperi n. 62;
3. di possedere la cittadinanza Italiana;
4. di essere in possesso del Diploma di Laurea in Scienze Geologiche, conseguito presso Università degli Studi "Federico II" di Napoli in data 18/12/2002 con voti 107/110;
5. di essere in possesso dei requisiti di ammissione richiesti all'art. 1 dell'avviso pubblico relativo alla presente procedura di valutazione comparativa, come specificato nell'allegato curriculum vitae.

Data, 22 marzo 2023

Firma

Il sottoscritto allega alla presente domanda, in carta semplice:
- elenco documenti e titoli ritenuti utili ai fini della valutazione;
- curriculum vitae in formato europeo debitamente sottoscritto;
- elenco, in carta semplice, dei titoli presentati in allegato alla domanda.

Il sottoscritto esprime il proprio dissenso alla diffusione e comunicazione dei propri dati personali a soggetti estranei al procedimento concorsuale.

Data, 22 marzo 2023

Firma

Andrea Randisi
22.03.2023
18:23:27
GMT+01:00

ALLEGATO 1

DICHIARAZIONE SOSTITUTIVA DELL'ATTO DI NOTORIETA'
(Artt. 19 e 47 del DPR 445 del 28/12/2000)

Il sottoscritto Randisi Andrea nato a Piedimonte Matese (CE) il 24/05/1978 residente a Vairano Patenora (CE) in via De Gasperi n. 62, codice fiscale RND NDR 78E24 G596X (*)

per i cittadini stranieri indicare anche lo Stato

D I C H I A R A

sotto la propria responsabilità, consapevole delle sanzioni penali previste dall'art. 76 del D.P.R. n. 445/2000 per le ipotesi di falsità in atti e dichiarazioni mendaci, che **le fotocopie**, **relative ai documenti di seguito indicati ed allegati alla presente dichiarazione, sono conformi all'originale**:

1. principali pubblicazioni scientifiche attinenti il bando,
2. attestato di svolgimento attività scientifica come assegnista di ricerca presso l'Università degli Studi di Chieti-Pescara "G. D'Annunzio",
3. certificato dottorato di ricerca.

Data, 22 marzo 2023

Firma

(*) Allega, a tal fine, copia fotostatica non autenticata di un documento di identità.

ALLEGATO 2

DICHIARAZIONE SOSTITUTIVA DI CERTIFICAZIONE E/O DI ATTO DI NOTORIETA'
(Artt. 46 e 47 del DPR 445 del 28/12/2000)

Il sottoscritto Randisi Andrea nato a Piedimonte Matese (CE) il 24/05/1978 residente a Vairano Patenora (CE) in via De Gasperi n. 62, codice fiscale RND NDR 78E24 G596X (*)

Per i cittadini stranieri indicare anche lo Stato

D I C H I A R A

sotto la propria responsabilità, consapevole delle sanzioni penali previste dagli artt. 46 e 47 del D.P.R. n. 445/2000 per le ipotesi di falsità in atti e dichiarazioni mendaci, di essere in possesso dei seguenti titoli valutabili, ai sensi dell'avviso pubblico (dichiarare specificamente natura, oggetto durata di un incarico, Ente conferente, punteggi, ecc.), per la valutazione dei titoli da parte della Commissione (*):

1. svolgimento dell'attività di rilevamento geologico di successioni ceno-mesozoiche e depositi quaternari di un'area di circa 69 kmq, per la redazione del foglio geologico n. 418 "Piedimonte Matese" in scala 1:50.000 progetto CARG, incarico ricevuto da Dipartimento di Scienze e Tecnologie dell'Università degli Studi di Napoli "Parthenope", periodo di svolgimento 2021-2022,

2. svolgimento dell'attività di ricerca scientifica come Assegnista presso il Dipartimento di Scienze della Terra dell'Università degli Studi di Chieti-Pescara "G. D'Annunzio", periodo 2008-2009,

3. svolgimento dell'attività di rilevamento geologico di successioni ceno-mesozoiche e depositi quaternari di un'area di circa 45 kmq, per la redazione del foglio geologico n. 405 "Campobasso" in scala 1:50.000 progetto CARG, incarico ricevuto da Dipartimento di Scienze e Tecnologie per l'Ambiente ed il Territorio dell'Università degli Studi del Molise, periodo di svolgimento 2008-2009,

4. Dottorato di ricerca in Scienze e Ingegneria del mare, XX ciclo, conseguito presso l'Università degli Studi di Napoli "Federico II" della durata triennale, periodo 2005-2007,

5. iscrizione all'Albo Professionale dell'Ordine dei Geologi della Regione Campania al n. 2273 sez. A dal 26/02/2004 e all'Albo Professionale del Consiglio Nazionale dei Geologi,

6. Laurea in Scienze Geologiche conseguita presso l'Università degli Studi di Napoli "Federico II" della durata quinquennale, periodo 1997-2002.

Data, 22 marzo 2023

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La presente dichiarazione debitamente sottoscritta deve essere accompagnata da copia di un documento d'identità in corso di validità.

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Data, 22 marzo 2023

Firma

Informativa ai sensi dell'art. 13 del D. Lgs. n. 196/03, recante norme sul trattamento dei dati personali: i dati personali sopra riportati sono raccolti ai fini del procedimento per i quali vengono rilasciati e verranno utilizzati esclusivamente per tale scopo e, comunque, nell'ambito delle attività istituzionali dell'Università degli Studi di Napoli Federico II, titolare del trattamento. All'interessato competono i diritti di cui all'art. 7 del D.Lgs. n. 196/03.

Data, 22 marzo 2023

Firma

ALLEGATO 3 - CURRICULUM VITAE

DICHIARAZIONE SOSTITUTIVA DELL'ATTO DI NOTORIETÀ
(ART. 47 D.P.R. 28/12/2000, n. 445)

Il sottoscritto Randisi Andrea nato a Piedimonte Matese (CE) il 24/05/1978 e residente a Vairano Patenora (CE) in via De Gasperi, 62, codice fiscale RNDNDR78E24G596X,

valendosi delle disposizioni di cui all'art. 47 D.P.R. 28/12/2000, n. 445 e consapevole delle pene stabilite negli art. 483, 495, e 496 del codice penale per le false attestazioni e per le mendaci dichiarazioni

DICHIARA

il seguente curriculum vitae degli studi e delle proprie attività professionali, in formato europeo:

RANDISI ANDREA

INFORMAZIONI PERSONALI

Cognome e Nome		**RANDISI ANDREA**
Data di nascita		24/05/1978
Indirizzo		62, VIA DE GASPERI, 81058, VAIRANO PATENORA (CE), ITALIA
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ESPERIENZA PROFESSIONALE

• Date (da – a)		OTTOBRE 2009 - AD OGGI

• Nome e indirizzo del datore di lavoro		Ministero dell'Istruzione (di ruolo dal 2017 - vincitore concorso scuola 2016)
• Tipo di azienda o settore		Pubblico
• Tipo di impiego		**Docente di Scuola Secondaria di 1° grado**
• Principali mansioni e responsabilità		Docente di Matematica e Scienze

• Date (da – a)		GENNAIO 2009 - AD OGGI
• Nome e indirizzo del datore di lavoro		
• Tipo di azienda o settore		Privato
• Tipo di impiego		**Libero professionista**
• Principali mansioni e responsabilità		Geologo, consulente per la progettazione di manufatti civili, per la pianificazione territoriale finalizzata alla mitigazione dei rischi geologici, committenti sia privati che Enti locali. Alcune principali commesse: ➢ Microzonazione sismica e analisi della condizione limite per l'emergenza del territorio comunale; ➢ Piano di emergenza di protezione civile; ➢ Studi geologici per la progettazione di centrali di trasformazione e di reti per il trasporto dell'energia elettrica.

• Date (da – a)		OTTOBRE 2021 - DICEMBRE 2022
• Nome e indirizzo del datore di lavoro		Università degli Studi "Parthenope" di Napoli Dipartimento di Scienze e Tecnologie
• Tipo di azienda o settore		Pubblico
• Tipo di impiego		**Rilevatore CARG di successioni carbonatiche ceno-mesozoiche e depositi quaternari**
• Principali mansioni e responsabilità		Rilevatore di un'area di circa 69 kmq ricadente nel foglio geologico n. 418 "Piedimonte Matese" in scala 1:50.000 - Progetto CARG

• Date (da – a)		LUGLIO 2008 - GIUGNO 2009
• Nome e indirizzo del datore di lavoro		Università degli Studi di Chieti "G. D'Annunzio" Dipartimento di Scienze della Terra
• Tipo di azienda o settore		Pubblico
• Tipo di impiego		**Assegnista di ricerca**
• Principali mansioni e responsabilità		Sedimentologo e stratigrafo

• Date (da – a)		LUGLIO 2008 - GENNAIO 2009
• Nome e indirizzo del datore di lavoro		Università degli Studi del Molise Dipartimento di Scienze e Tecnologie per l'Ambiente e il Territorio
• Tipo di azienda o settore		Pubblico
• Tipo di impiego		**Rilevatore CARG di successioni carbonatiche ceno-mesozoiche e depositi quaternari**
• Principali mansioni e responsabilità		Rilevatore di un'area di circa 45 kmq ricadente nel foglio geologico n. 405 "Campobasso" in scala 1:50.000 - Progetto CARG

ISTRUZIONE E FORMAZIONE

• Date (da – a)		**GENNAIO 2005 - DICEMBRE 2007**
• Nome e tipo di istituto di istruzione o formazione		Università degli Studi "Federico II" di Napoli Istituto per l'Ambiente Marino Costiero, CNR - sede Napoli
• Principali materie / abilità professionali oggetto dello studio		Scienze della terra - Sedimentologia - Stratigrafia - Geomorfologia
• Qualifica conseguita		**Dottore di Ricerca in Scienze e Ingegneria del mare - XX ciclo**
• Livello nella classificazione nazionale (se pertinente)		Dottorato di Ricerca

• Date (da – a)		**NOVEMBRE 1997 - DICEMBRE 2002**
• Nome e tipo di istituto di istruzione o formazione		Università degli Studi "Federico II" di Napoli
• Principali materie / abilità professionali oggetto dello studio		Scienze della terra
• Qualifica conseguita		**Laurea in Scienze Geologiche**
• Livello nella classificazione nazionale (se pertinente)		Laurea

• Date (da – a)		**SETTEMBRE 1992 - LUGLIO 1997**
• Nome e tipo di istituto di istruzione o formazione		Liceo Scientifico Statale "Leonardo Da Vinci" di Vairano Patenora (CE)
• Principali materie / abilità professionali oggetto dello studio		Materie scientifiche
• Qualifica conseguita		**Diploma di maturità scientifica**
• Livello nella classificazione nazionale (se pertinente)		Diploma di Scuola secondaria di secondo grado

COMPETENZE LINGUISTICHE

MADRELINGUA		**Italiano**
ALTRE LINGUE		**Inglese**
Capacità di lettura		Base
Capacità di scrittura		Intermedio
Capacità di espressione orale		Base

COMPETENZE DIGITALI

HARDWARE & SOFTWARE		Windows Office - Arcgis - Global mapper - Surfer - AutoCAD - Corel Draw - Geopsy - SeisImager - Strata - Pacchetto Geostru

PUBBLICAZIONI

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13. **A. Randisi**. Variazioni relative del livello marino e dinamica recente della piana di Sibari (Italia meridionale). Volume dei riassunti del XVII Congresso dell'Associazione Italiana di Oceanologia e Limnologia. Napoli, 3-7 luglio 2006.

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VAIRANO PATENORA, LÌ MARZO 2023

ANDREA RANDISI PH.D.
GEOLOGO

ALLEGATO 4

C.C.O. per Domanda Bando DD n. 26 del 15032023


Scadenza : 24-05-2026
Diritti : 5,16

AX 3483817

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REPVBBLICA ITALIANA

COMVNE DI
VAIRANO PATENORA

CARTA D'IDENTITA'

N° AX 3483817

DI

RANDISI ANDREA

Cognome RANDISI
Nome ANDREA
nato il 24-05-1978
(atto n. 1978 P. 1 S. A 1978)
a PIEDIMONTE MATESE
Cittadinanza Italiana
Residenza VAIRANO PATENORA (CE)
Via A DE GASPERI 55
Stato civile CONIUGATO
Professione GEOLOGO

CONNOTATI E CONTRASSEGNI SALIENTI

Statura 178
Capelli Castani
Occhi Castani
Segni particolari NESSUNO

Firma del titolare

VAIRANO PATENORA 25-08-2015

Impronta del dito indice sinistro

IL SINDACO
L'UFFICIALE D'ANAGRAFE

Vairano Patenora, lì marzo 2023

CARBONATE-PLATFORM PRODUCTION AND EXPORT POTENTIAL RECORDED IN UPPER JURASSIC BASE-OF-SLOPE DEPOSITS (CENTRAL APENNINES, ITALY)

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ANDREA RANDISI AND CRISTIANO RICCI
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Abstract: Upper Jurassic base-of-slope and inner-platform carbonate successions have been studied in the Lazio–Abruzzi and northern Campania–Molise sectors of the central Apennines. Based on the analysis of systematic trends in thickness, grain size, lithofacies proportion, and evolution, these successions have been subdivided into decametric depositional cycles. The stacking pattern of these cycles shows a larger-scale stratigraphic organization, corresponding to a long-term cycle entirely encompassing the Upper Jurassic studied interval. Composition of base-of-slope resedimented deposits indicates that they were exported from the inner platform and the reef margin. The inner-platform cycles reflect changes in carbonate production, whereas base-of-slope cycles reflect changes in inner-platform and reef-margin export potential. Biochronostratigraphic tie points allow us to compare production and export patterns recorded by platform and base-of-slope successions. Sedimentary features of the shallow-water cycles indicate that sea level controls the inner-platform production. The correlation between the shallow-water and the base-of-slope sedimentary cyclic record indicates that the inner-platform production and export potential are comparable. The hierarchical architecture of the shallow-water cycles indicates that sea-level fluctuations had two different frequencies (low and high). During low-frequency sea-level fluctuations, inner-platform production and export directly correlate with long-term phases of platform accommodation. During high-frequency sea-level fluctuations, inner-platform production and export depend on whether the shallow-water cycles modulate long-term phases of platform accommodation. The internal organization of base-of-slope depositional cycles shows that, during high-frequency sea-level fluctuations, the inner-platform and the reef-margin sediment export is time-shifted. This export pattern is interpreted as the response of the inner platform size and of the reef biotic system to sea-level fluctuations. During the early stages of platform flooding (early HST), the reef-margin export potential is low, because sediments produced fill the available space. During slowing sea-level rise (late HST), the space created is rapidly filled, allowing the reef margin to gently prograde and its export potential to progressively increase. During both early and late HST, the extent of the inner-platform area is at its maximum, and production and export are high. When emersion takes place on the platform, during the LST, the size of the productive inner-platform area reduces, and the inner-platform input decreases or ceases. The reef margin is forced to prograde basinward, and its export potential records the highest values.

Key words: carbonate production, carbonate export, Late Jurassic, Central Apennines, carbonate platform, carbonate base of slope, highstand shedding

INTRODUCTION

The slope and the base of slope of carbonate platforms are the ultimate sinks for much of the excess sediment produced by the carbonate factory. Their stratal architecture, defined by the alternation of shallow-water-derived and pelagic sediments, and the composition of resedimented deposits, represent a valuable source of information about changes in the evolution of the shallow-water depositional system and changes in carbonate export potential (Shanmugam and Moiola, 1984; Droxler and Schlager; 1985; Haak and Schlager, 1989; Schlager et al., 1994; Kindler and Hearty, 1996; Zempolich and Erba, 1999; Pittet et al., 2000; Betzler et al. 2000; Rendle-Buhring and Reijmer, 2005; Schlager, 2005)

The apparent simplicity of base-of-slope depositional architectures contrasts starkly with the complex system of process interplay and feedback that affects the sediment source area. In fact, the volume and type of offshore exported sediments depend on a multitude of interacting factors influencing the carbonate factory, such as sea level, biological components, and oceanographic components (e.g., Pomar, 2001). For this reason, the ascription of base-of-slope stratigraphic architectures to specific

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controls of the platform evolution is often complex and may give equivocal interpretation (e.g., Andresen et al., 2003; Knoerich and Mutti, 2003; Pomar et al., 2004; Betzler et al., 2005).

Previous works on the Quaternary turbidites in the Bahamas have demonstrated that exposure and flooding of the carbonate platform, related to Late Quaternary sea-level cycles, control the production and export of bank-derived grains, in terms of frequency and composition of calcareous turbidites (highstand shedding of Schlager et al., 1994). Droxler and Schlager (1985) found that accumulation and frequency of turbidites are higher during interglacial highstands and lower during glacial lowstands. Moreover, Haak and Schlager (1989) have shown that compositional variations in calciturbidites are strictly linked to glacial–interglacial cycles, with nonskeletal components mostly abundant in interglacial periods, and skeletal components in glacial periods (Schlager et al., 1994).

In this contribution, our aim is to investigate to what extent the highstand-shedding model can be applied to a Late Jurassic carbonate depositional system. We document the sedimentary architecture and composition of five depositional cycles in the base-of-slope successions of some intraplatform seaways, scattered on the Late Jurassic Lazio–Abruzzi promontory, an archipelago of several isolated or loosely interconnected platforms located on the northern sector of the Apulia main carbonate bank (Ricci et al., 2006). The sediment composition and the stratigraphic architecture of these cycles have been used to evaluate the export potential recorded in Upper Jurassic base-of-slope successions. In addition, these cycles have been correlated with the sedimentary record of the northern Campania–Molise (Matese) platform, a nearby shallow-water domain, in order to relate the export potential recorded by base-of-slope successions to the shallow-water carbonate production potential. The shallow-water record has been used also to relate the carbonate production and export patterns to relative sea-level cycles.

GEOLOGICAL FRAMEWORK

The Lazio–Abruzzi and northern Campania–Molise (including Matese) areas are part of the north- and northeast-verging late Tertiary fold-and-thrust belt of the central Apennines (Fig. 1). In this belt, derived from the closing of the Alpine Tethys, Mesozoic and early Tertiary carbonate sequences are juxtaposed on the siliciclastic deposits of the Miocene–Quaternary Apenninic and peri-Adriatic foredeep basins (Fig 1). Prior to the deformation, the area was part of the Adria continental margin, which experienced widespread extension during the Late Triassic and Early Jurassic, due to rifting processes connected with the Neotethys and Alpine Tethys oceanic opening, respectively (e.g., Stampfli and Borel, 2004; Finetti et al., 2005 and references therein). The rifting processes produced a complex system of main isolated carbonate banks, similar in size, facies, and architecture to the carbonate banks of the Bahamas archipelago (Bernoulli, 1972, 2001; D'Argenio et al., 1975; Bosellini, 1989; 2002; Eberli et al., 2004; among others), and large basins (Stampfli and Borel, 2004; Finetti et al., 2005). In this paleogeographic context, the Matese area represented one of those main carbonate banks, whereas the Lazio–Abruzzi area corresponded to a complex system of relatively small, isolated platforms and intraplatform seaways, scattered along the Apulia promontory (Fig. 2; Ricci et al., 2006, and references therein). In the early Jurassic, at the end of the Alpine Tethyan rifting, regional decrease in subsidence rates and healthy carbonate systems

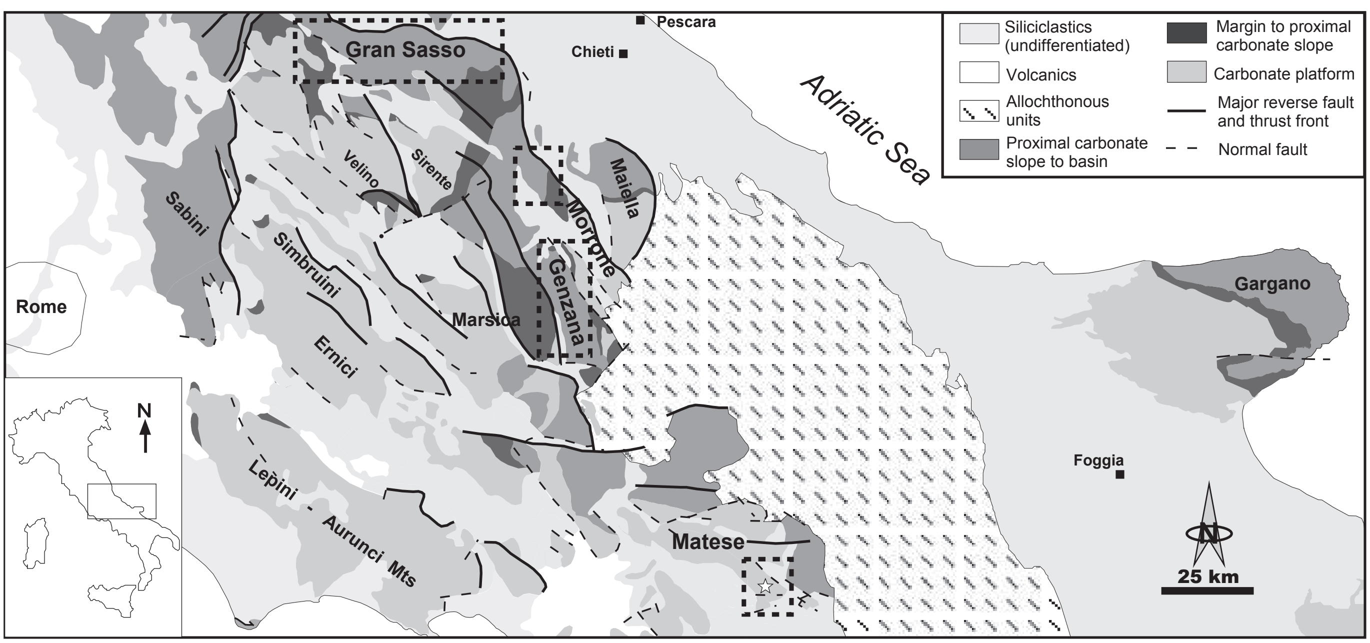


FIG. 1.—Geological map of the central Apennines, showing the distribution of inner-platform, margin, and basin facies in the Lazio–Abruzzi area. Platform-to-basin transitions, evidenced by margin facies distribution, were generally sites of tectonic decoupling during the Neogene Apennines orogenic phase. The dashed rectangles indicate the four studied key areas: three of them mark the studied Lazio–Abruzzi base-of-slope areas (Gran Sasso, Morrone, and Genzana), and the southernmost one delimits the Matese area, where the platform succession is located. Geological map was compiled after Servizio Geologico d'Italia (1934, 1942, 1955), Accordi and Carbone (1988), Bonardi et al. (1988), Vezzani and Ghisetti (1997), and Servizio Geologico d'Italia (2006a, 2006b, 2006c, and 2006d).

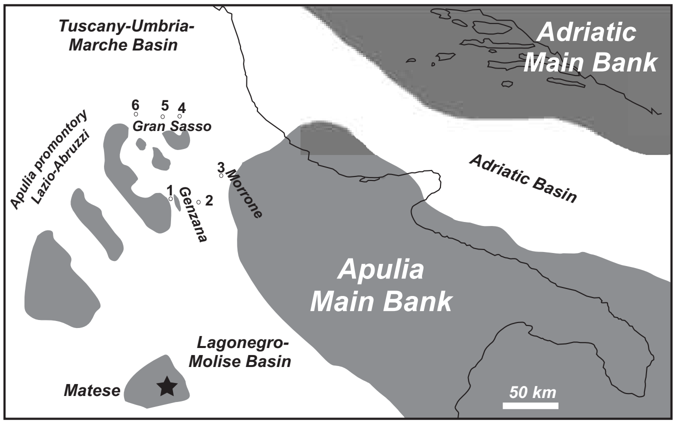


FIG. 2.—Paleogeographic sketch of the central Apennines during the Late Jurassic, showing the location of the studied sections in relation to the main paleogeographic elements.

promoted conditions favorable for high carbonate production. Consequently, a progressive filling of the intraplatform seaways developed, with the ensuing draping of the rift-related morphology, and the change of the platform-margin architecture (e.g., Accordi and Carbone, 1988; Colacicchi and Bigozzi, 1995) from escarpment-bounded (early Jurassic) into depositional (middle–late Jurassic).

The studied Upper Jurassic base-of-slope deposits are located in three key areas of the Lazio–Abruzzo Apennines: Gran Sasso, Morrone, and Genzana (Fig. 1). These sediments were deposited north of the northern margin of the Lazio–Abruzzi promontory (Gran Sasso), and along a large intraplatform seaway, between the Lazio–Abruzzi promontory and the Apulia main carbonate bank (Morrone and Genzana) (Fig. 2).

Upper Jurassic base-of-slope deposits belong to the upper part of the *Calcari bioclastici inferiori*, which correspond to the middle part of the Terratta Group (Fig. 3). The *Calcari bioclastici inferiori* span from the late Toarcian to the Tithonian (Adamoli et al., 1978) and consist of more than 300 m of thick skeletal and nonskeletal fine to coarse calcarenites and calcirudites, interbedded with pelagic limestones and radiolarian cherts. Resedimented deposits are concentrated in two main stratigraphic intervals, dated as late Bathonian–early Kimmeridgian, and Tithonian, respectively (Fig. 3). They are separated by pelagic-dominated intervals, whose lithostratigraphic features are quite similar to their Umbria–Marche basinal equivalent: the upper part of the *Calcari Diasprigni* (*Calcari a Saccocoma e Aptici*) and the lowermost part of the *Maiolica*, respectively, even though, in the Lazio–Abruzzi area, their age is partially different (Fig. 3).

The time-equivalent shallow-water succession is located in the Matese area, presently south of the Lazio–Abruzzi (Fig. 1). Upper Jurassic carbonates accumulated cyclically in lagoonal–tidal tropical environments. They are recorded as 350 m of well-bedded limestones and subordinate dolostones, and dolomitized limestones. Based on depositional textures and related sedimentary features, and fossil associations, different lithofacies associations have been distinguished, suggesting environmental fluctuations from open to restricted shallow-water conditions.

METHODS

The carbonate production and export potentials were investigated through a careful comparative analysis of the stratigraphic architecture and composition of outcropping platform and base-of-slope successions. Six sections belonging to the base-of-slope successions and one representative of the platform setting form the basis of this study. Because it is not achievable to physically trace strata between sections of such different depositional settings, the dating and comparison of the rocks are based on biostratigraphy. The biochronostratigraphic framework is based on open-sea biota (such as tintinnids, crinoidea, chitinoidellids, and calcareous dinocysts) and shallow-water biota (benthic foraminifera and dasycladacean algae) associations, which are used to date Upper Jurassic–Lower Cretaceous platform and basinal successions (De Castro, 1962, 1987; Sartoni and Crescenti, 1962; Crescenti, 1969; Centamore et al., 1971; Chiocchini, 1977; Chiocchini et al., 1994).

The strata of the carbonate-platform section were measured in the field (thickness and attitude), and textures and sedimentary features were sequentially tabulated. About 300 thin sections, integrated with polished slabs and acetate peels, were studied for sedimentological and biostratigraphic data. Analysis of textures (lithofacies and their associations), and related sedimentary features (depositional associations), allowed their vertical organization to be defined.

The definition of base-of-slope cycles is based on the analysis of systematic trends in the thickness, grain size, and lithofacies proportion (stacking-pattern analysis). By using the comparative estimation diagrams of Bacelle and Bosellini (1965), a semiquantitative approach was applied to 312 thin sections, in order to

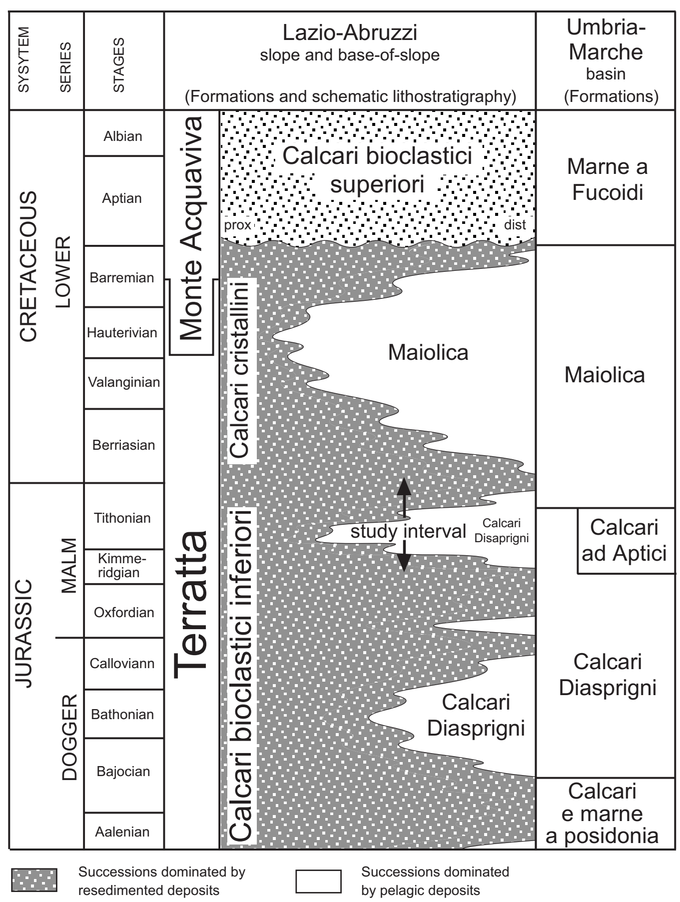


FIG. 3.—Simplified lithostratigraphy of the Lazio–Abruzzi slope and base-of-slope successions and schematic correlation with Umbria–Marche basin formations (from various sources).

obtain a first broad characterization of the lithofacies types defined on outcrops. A quantitative compositional analysis was performed through the point-counting of 55 most representative samples, belonging to the Pizzo Cefalone (Gran Sasso) and Monte della Grotta (Morrone) sections. Micritic limestone samples have not been point-counted. On each section 400 points were counted and then assigned to 11 groups on the basis of their nature (Table 1). For coarser samples both density and volume point counts were made, allowing an estimate of the true composition of the rock, and a volume estimate of the different compositional groups within the sample.

STRATIGRAPHIC ARCHITECTURE OF THE BASE-OF-SLOPE DEPOSITS

General

Six sections were studied to characterize the Upper Jurassic base-of-slope sediments in the Gran Sasso, Morrone, and Genzana key areas (Figs. 1, 4). These successions were deposited on base-of-slope settings adjacent to two main carbonate platforms (Lazio–Abruzzi promontory and Apulia platforms) (Fig. 2). The Gran Sasso successions were deposited north of the Lazio–Abruzzi promontory, merging with the pelagic successions of the Umbria–Marche basin to the north. The Morrone succession developed north of the Apulia platform, whereas the Genzana successions were deposited in an oversupplied intraplatform depocenter (Monte Godi section), along the northeast-verging slope of the Lazio Abruzzi platform, and in an intraplatform seaway (Serra Sparvera section) developed between the Lazio–Abruzzi promontory to the west and the Apulia platform to the southeast (Fig. 2). Differences in the lithostratigraphic signatures, such as the frequency of radiolarian chert intercalations and of resedimented deposits and their grain size, are thus not unexpected among the studied sections, considering their different paleogeographic setting and the distance from their related platform margins.

The studied interval spans from the late Jurassic (late Kimmeridgian) to the Jurassic–Cretaceous boundary, between the FAD of *Saccocoma* sp., at its base, and the base of *Calpionella alpina* biozone, at its top (Fig. 5). Other biostratigraphic events, such as the FAD of *Colomisphaera* sp., *Chitinoidella* sp., *Crassicollaria* sp., and various calpionellids species, provide a relatively high stratigraphic resolution and dating of lithostratigraphic units and a consistent tool for the correlation of sections (Fig. 5).

The lower boundary of the studied interval corresponds to the Saccocoma event (1 in Figs. 4, 5, and 6). It abruptly overlies the thick resedimented-dominated succession of the *Calcari Bioclastici inferiori*, giving rise to a clear morphologic break in outcrops (Fig. 6). The upper boundary is marked by a rather abrupt decrease in resedimented intercalations and an increase of the micritic limestones belonging to the *Maiolica* (Figs. 4, 5), producing a second morphologic break in outcrop profiles (Fig. 6). It corresponds to the Calpionella 2 event, which marks the Jurassic–Cretaceous boundary (6 in Figs. 4, 5, and 6). In the Morrone area, the top of the interval is characterized by an unconformity, whose related hiatus appears to increase towards the platform, spanning from the *Calpionella alpina* to the *Calpionella elliptica* biozones (Fig. 5).

In order to illustrate in detail the stratigraphic architecture of the Upper Jurassic base-of-slope successions, key lithofacies, sediment composition, and facies stacking patterns are reported in the following sections.

TABLE 1.—Point-count groups of resedimented facies used for composition analyses.

Peloids	They are mainly represented by more or less rounded sand-size grains of homogeneous micrite. In several cases, it is difficult to determine their origin, and also irregularly shaped fragments of shallow-water carbonate mud have been included in this group
Shallow-water biota	Mainly green algae and small foraminifera, such as miliolids, textularids, valvulinids, lituolids, nodosarids, bryozoans, *Protopeneroplis* sp., *Trocholina* sp.
Encrusters	Various encrusting organisms, such as foraminifera, algae, microproblematica, *Tubiphytes morronensis*, *Pseudolithocodium carpathicum*, *Lithocodium aggregatum*, *Bacinella irregularis*, red algal nodules and crusts
Reef biota	Corals, calcareous sponges
Shallow-water-derived lithoclasts	Angular fragments of peloidal packstones, containing shallow-water biota, or of cemented packstones–graistones, containing fragments of encrusting and building organisms
Open-sea-derived lithoclasts	Angular to subrounded fragments of pelagic mudstones–wackestones, containing open-sea biota
Undefined biota	Either small light-colored bioclasts which are too small to be identified, or coarser light-colored bioclasts whose internal structure is obliterated or not visible, thus not identifiable
Echinoderms	Crinoid plates and plate fragments
Mollusks	Mollusk shell fragments
Open-sea biota	*Saccocoma* sp., radiolarians, sponge spicules, calpionellids, and other calcispheres
Embedding material	Micrite, micrite-sized peloids, cements

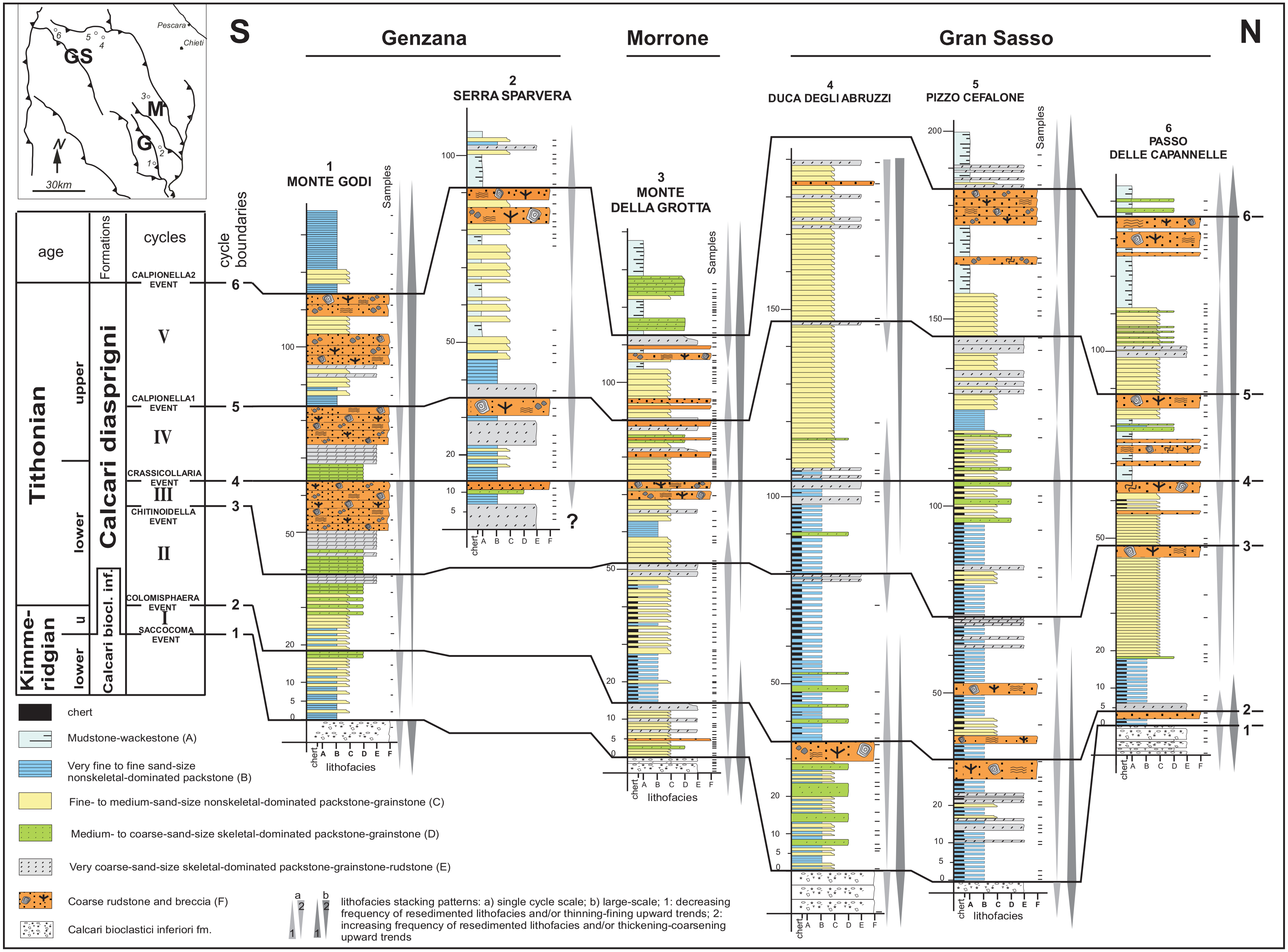


FIG. 4.—Six stratigraphic logs studied in the base of slope of the Lazio–Abruzzi area (see Fig. 1). The black correlation lines represent the boundaries of Upper Jurassic base-of-slope cycles. For each section the lithofacies stacking pattern is shown for single cycles and for the entire Upper Jurassic studied succession.

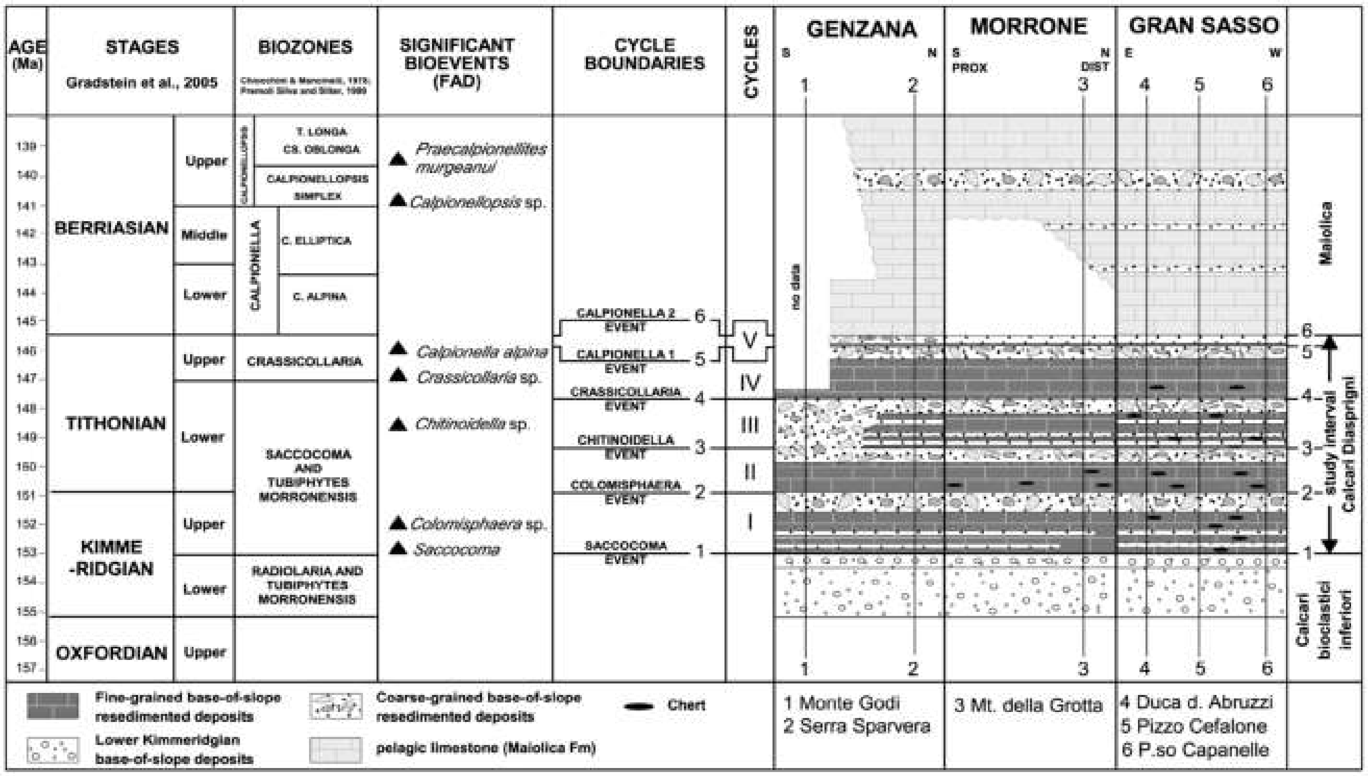


FIG. 5.—Late Jurassic–early Cretaceous chronostratigraphic scheme of the Genzana, Morrone, and Gran Sasso areas. Base-of-slope biozones and significant bioevents (FAD) are also indicated. Along the transects, six significant events have been identified. They are labeled with the name of the nearest occurring bioevent, and they correspond to cycle boundaries.

Key Lithofacies

The Upper Jurassic base-of-slope deposits are characterized by the occurrence of six key lithofacies:

(1) Lithofacies A comprises thin-bedded (from ca. 1 to 10 cm) micritic (< 0.062 mm) limestone (mudstone, wackestone), composed mainly of calcareous mud with dispersed pelagic biota, such as radiolarians and calpionellids (Fig. 7A). Fragments of echinoderms can be dispersed in the matrix. This lithofacies occurs only in the upper part of the studied interval (cycles IV and V) (Fig. 4).

(2) Lithofacies B is represented by very fine- to fine-sand-size (0.062-0.25 mm), well sorted packstone (Fig. 7B). Packstone beds correspond to graded, parallel-laminated and cross-laminated limestones (Fig. 8A), composed of nonskeletal (mainly peloids) and skeletal grains represented by pelagic biota (radiolarians, siliceous sponge spicules, *Saccocoma* sp., and calpionellids) and platform-derived biota, such as echinoderm fragments, benthic foraminifera, and sparse fragments of reef-derived biota (Fig. 9A), generally represented by small *Tubiphytes* sp. (Fig. 7B). This lithofacies dominates the middle part of the Upper Jurassic base-of-slope deposits (cycles II and III) (Fig. 4), where it is densely interbedded with white and red radiolarian chert and chert nodules (Figs. 4, 8A). In the upper part of the studied interval, it occurs sparsely and without intercalations of radiolarian chert and chert nodules (cycles IV and V) (Fig. 4).

(3) Lithofacies C includes fine- to medium-sand-size (0.25–0.50 mm), well-sorted packstone and grainstone (Fig. 7C) that typically show a relatively well-developed normal grading, parallel lamination, and, locally, cross lamination (Fig. 8B). Thicknesses vary between few centimeters and a few decimeters (Fig. 8B, C). They are composed of nonskeletal and skeletal grains (Fig. 9B). Nonskeletal grains include, in order of abundance, peloids and lithoclasts. Peloids are mostly rounded, sand-size grains of homogeneous micrite. Lithoclasts are very rare and are generally packstones with fragments of shallow-water benthic organisms. Skeletal grains are represented mainly by shallow-water biota such as echinoderm fragments, algae, benthic foraminifera, mollusks, and calcareous sponges. Open-sea biota are generally dispersed in a very fine-grained micritic matrix and correspond to fragments of *Saccocoma* sp., radiolarians, and calpionellids, depending on the stratigraphic position along the section. This lithofacies intercalates frequently along the whole studied interval, but occurs mostly in the upper part of the studied sections (cycles IV and V) (Fig. 4).

(4) Lithofacies D includes medium- to coarse-sand-size (0.5–1 mm), moderately sorted packstone and grainstone (Fig. 7D). It corresponds to generally graded and laminated limestone. Thicknesses vary from a few centimeters to some decimeters (Fig. 8C). These sediments are composed mainly of skeletal grains and subordinate nonskeletal grains (Fig. 9C). Skeletal grains constitute the coarser fraction of the sediments and consist of echinoderm fragments, *Tubiphytes* sp., calcareous

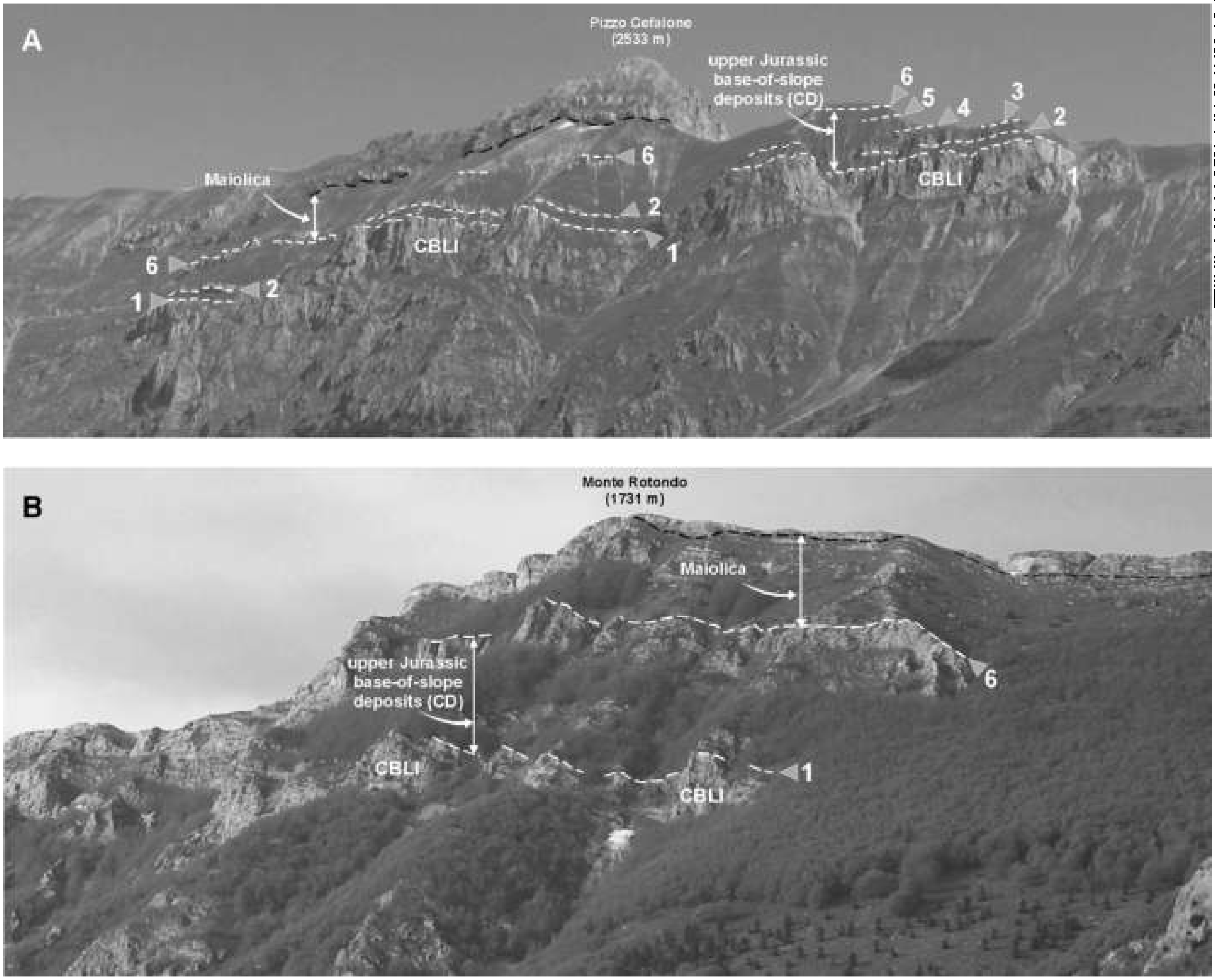


FIG. 6.—Panoramic view of Upper Jurassic–Lower Cretaceous base-of-slope successions. **A)** Pizzo Cefalone, Gran Sasso area; **B**) Monte Rotondo, Morrone area. White dashed lines and numbers correspond to the Upper Jurassic cycle boundaries, and the black line corresponds to the boundary between the Maiolica Fm. and the Calcari bioclastici superiori Fm. (see Fig. 2). Note the morphologic breaks between resedimented-dominated and micritic-dominated intervals. CBLI, Calcari bioclastici inferiori; CD, Calcari Diasprigni.

algae, calcareous sponges, rare mollusks, and benthic foraminifera. Nonskeletal grains are mainly micritic peloids and account for the finer-grained fraction. These grains, together with undetermined small bioclasts, make up most of the rock matrix.

(5) Lithofacies E includes coarse- to very-coarse sand-size (1–2 mm), poorly sorted packstone, grainstone, and rudstone (Figs. 7E, 8D). Beds are a few decimeters to a few meters thick, laterally continuous, and parallel-sided, with sharp planar bases. Thicker beds are massive and structureless, with grading limited to the bed tops (top-grading) and faint parallel lamination. Multilayering and outsized clasts also occur. This lithofacies differs from lithofacies D in that coarser skeletal grains are volumetrically more significant and richer in margin-derived biota (Fig. 9D). The skeletal grains consist of echinoderms, *Tubiphytes* sp. and microproblematica, calcareous algae, calcareous sponges, bryozoans, and coral fragments. The embedding material is composed of finer bioclasts, peloids, cement, and micrite. Most of the coarser beds in the lower and the middle part of the sections are represented by this lithofacies (cycles I to III) (Fig. 4).

(6) Lithofacies F includes very poorly sorted, coarse rudstone and breccia (Fig. 8E), laterally continuous, parallel-sided, meter-scale massive beds, forming amalgamated massive banks, a few meters to ten meters thick. Most beds have sharp planar bases. They appear as rather well-defined graded or disorganized beds, with centimeter-size clasts. In the upper parts of graded beds, very coarse sand occurs. Frequently the clast-supported packing texture is transformed into interpenetrating clast contacts by pressure solu-

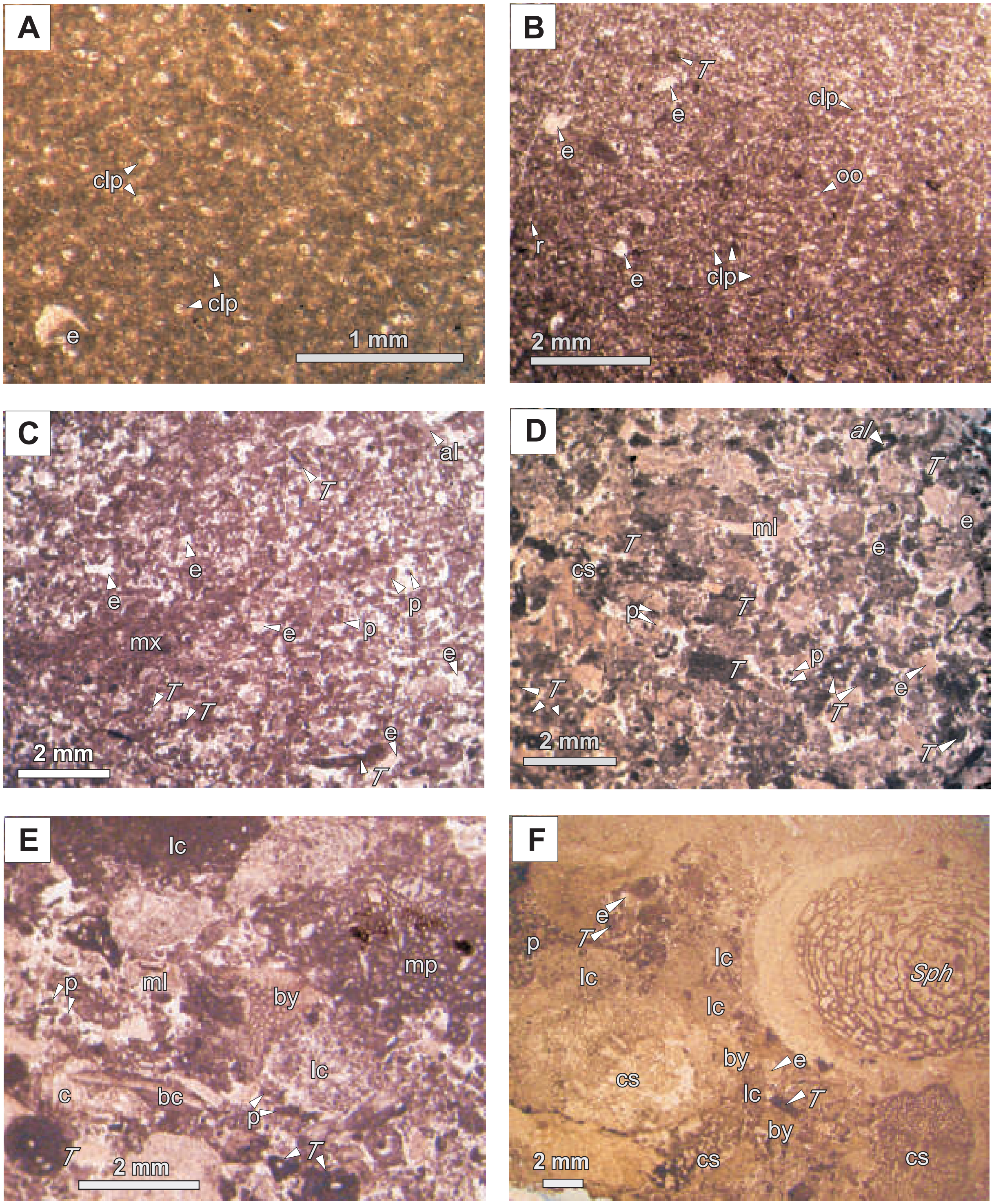


FIG. 7.—Microphotographs of the six key lithofacies recognized in the Lazio–Abruzzi Upper Jurassic slope and base-of-slope succession. A) *Lithofacies A,* micritic limestone with dispersed open-sea biota; B) *Lithofacies B,* well sorted packstone composed of nonskeletal and skeletal grains, platform-derived biota, and sparse fragments of reef-derived biota; C) *Lithofacies C,* well sorted packstone–grainstone composed of nonskeletal and skeletal grains; D) *Lithofacies D,* moderately sorted packstone–grainstone composed mainly of skeletal grains and subordinate nonskeletal grains; E) *Lithofacies E,* poorly sorted rudstone; note the volumetric abundance of margin-derived biota; F) *Lithofacies F,* very poorly sorted coarse rudstone rich in reef biota fragments, which constitute most of the sediment volume. Al, calcareous algae; bc, bioclast; by, bryozoan; c, coral; clp, calpionellid; cs, calcareous sponge; e, echinoderm; lc, lithoclast; ml, mollusk; mx, matrix; oo, ooid; p, peloid; r, radiolarian; *Sph*, *Sphaeractinia* sp.; ss, sponge spicule; *T*, *Tubiphytes morronensis*.

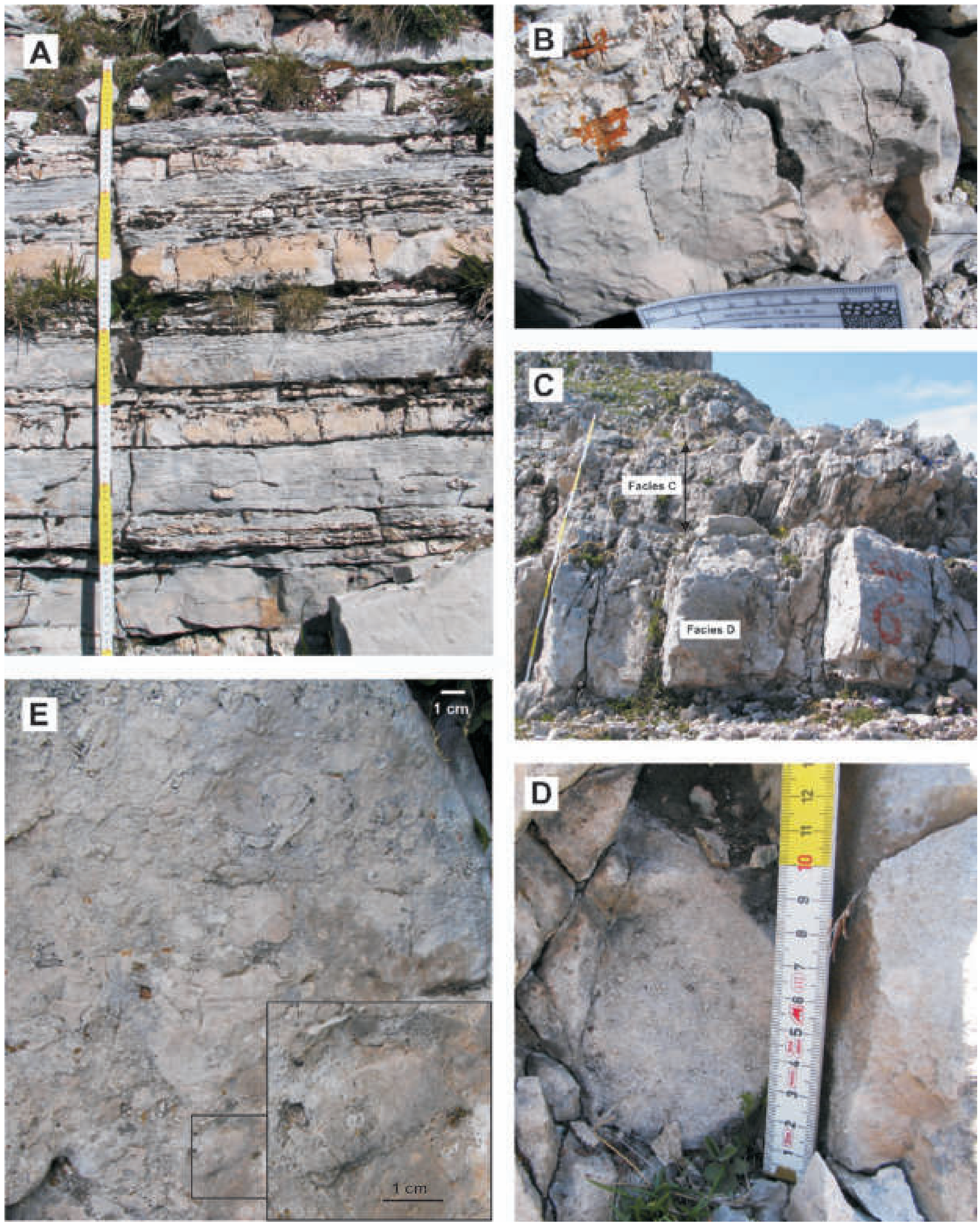


FIG. 8.—Key lithofacies recognized along the Lazio–Abruzzi Upper Jurassic base-of-slope succession. **A)** Frequent alternations of *Lithofacies B*, red radiolarian cherts and chert nodules; **B)** graded and laminated limestone, about 10 cm thick, made up of fine- to medium-sand-size, well sorted packstone and grainstone, typical of *Lithofacies C*; **C)** half-meter-thick coarse grainstone of lithofacies D, interbedded with lithofacies C beds, from a few centimeters to a few decimeters thick; **D)** *Lithofacies E*, limestone about 10 cm thick composed of very coarse-sand-size, poorly sorted bioclastic grainstone–rudstone; **E)** *Lithofacies F*, meter-thick massive graded beds composed of very poorly sorted coarse rudstone; the black rectangle shows an *Ellipsactina* sp., a hydrozoan which frequently accounts for a large amount of the skeletal fraction, in the upper part of the Upper Jurassic base-of-slope successions.

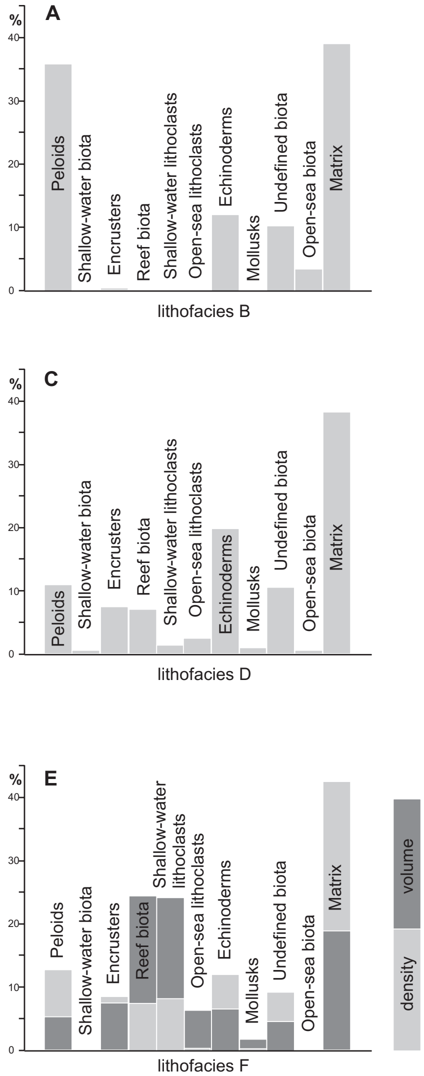


FIG. 9.—Sediment-composition histograms after point-count analysis for lithofacies B to F. The various types of lithofacies show considerable differences in abundance among the point-counted groups, and a first broad separation results between lithofacies B and C, and lithofacies D to F. Lithofacies B and C have up to ca. 42% and 57% of peloids, with mean values of ca. 36% and 35%, respectively. Moreover, lithofacies B and C show lowest amounts of encrusters, reef biota, and shallow-water-derived lithoclasts. In contrast, lithofacies D–F display a rather low abundance of peloids (between ca. 11% and 13%), with mean values about one third lower than lithofacies B and C, and highest amounts of encrusters, reef biota, and shallow-water-derived lithoclasts. These differences are enhanced for lithofacies E and F, by considering volume percentages. The volume percentages differ from the density ones only for lithofacies E and lithofacies F, due to the grain size, so they have been distinguished in the histograms.

tion. This lithofacies is composed of gravel-size angular to subangular lithoclasts and fragments of platform-derived biota (echinoderms, bryozoans, stromatoporoids, bivalves, corals, and algae) (Fig. 7F). In the skeletal fraction, which constitutes most of the sediment volume, reef biotas are largely dominant (Fig. 9F). The coarse nonskeletal fraction is represented by lithoclasts, corresponding to slope-derived pelagic micritic limestone, and fragments of peloidal packstone and grainstone. The embedding material is represented by moderately sorted, very fine to fine packstone, made up of nonskeletal (mainly peloids) and skeletal grains, which show the same composition as the coarser fragments. Beds of this lithofacies occur sparsely in the lower interval of the Upper Jurassic base-of-slope successions (cycles I and II), whereas they persistently characterize the upper part of the sections (cycles IV and V) (Fig. 4).

Stacking Patterns

Based on the analysis of systematic trends in thickness, grain size, and lithofacies proportion (stacking-pattern analysis), five decameters-scale cycles were recognized and correlated across the Upper Jurassic base-of-slope deposits of the Lazio–Abruzzi area (Figs. 4, 5). The best panoramic outcrops are in the Gran Sasso area (Figs. 6, 10).

These cycles are biostratigraphically calibrated throughout the entire studied area by means of confident bioevents (Figs. 4, 5). Thus, their boundaries are assumed to be synchronous sur-

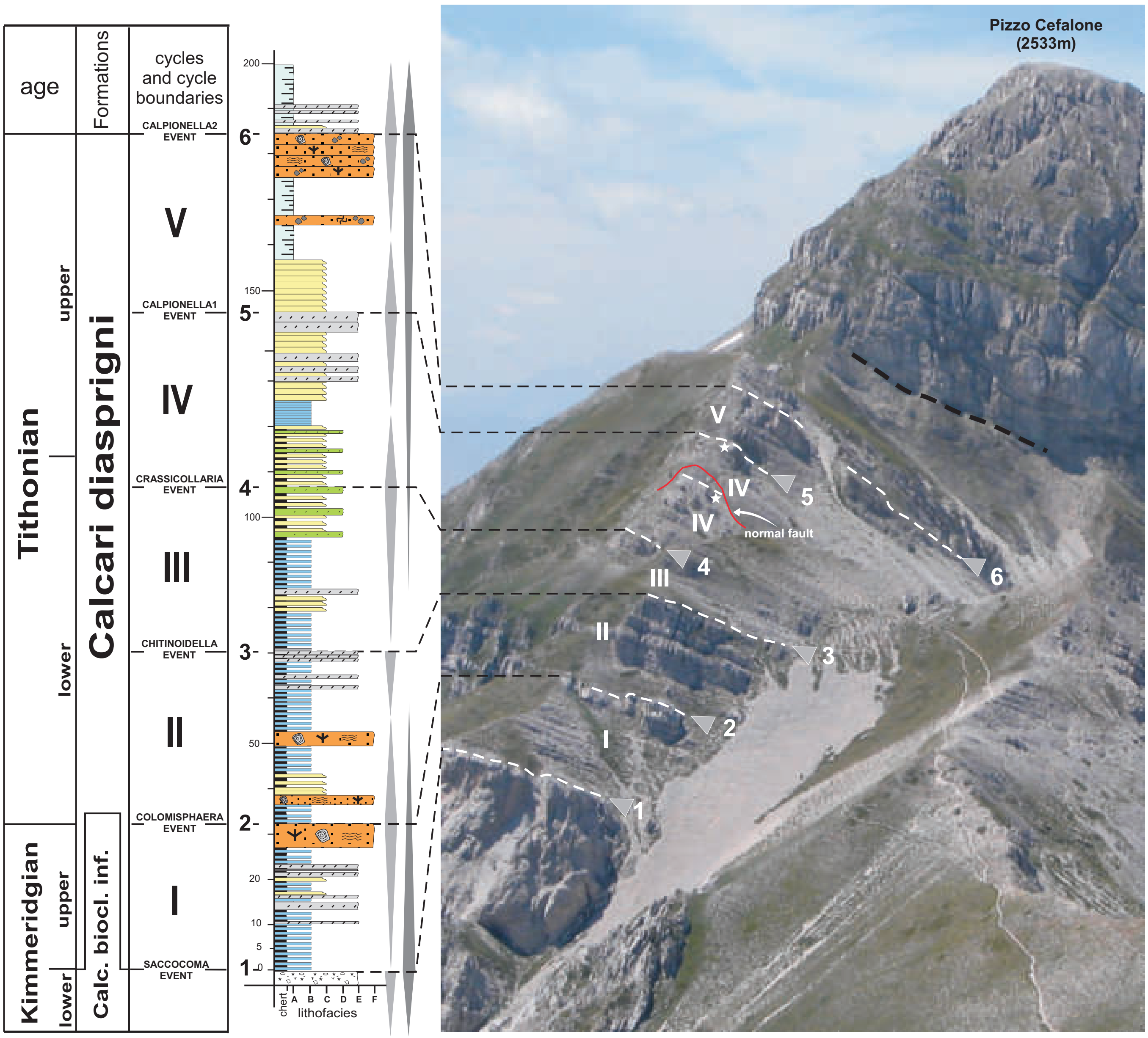


FIG. 10.—Upper Jurassic in the Pizzo Cefalone, in the Gran Sasso range, showing the cycle stacking pattern. From the bottom (Saccocoma event -1-) the resedimented deposits progressively undergo a decrease in bed thickness, grain size, and frequency. This trend is followed by the maximum development of thin-bedded and fine-grained lithofacies and radiolarian cherts in the middle part of the succession, and by the progressive frequency increase, upward thickening and upward coarsening of resedimented deposits in the upper part, culminating in the maximum development of thick-bedded and coarse-grained lithofacies. White dashed lines correspond to the Upper Jurassic significant events bounding the cycles described in the text, and the black line corresponds to the boundary between the Maiolica Fm. and the Calcari bioclastici superiori Fm. (see Fig. 2).

faces that can be traced regionally. They are labelled by the bioevent that occurs near the top or the base of each cycle (Fig. 5).

Cycle I.—

The lower boundary (Saccocoma event) corresponds to the abrupt vertical change between the thick, massive beds of the *Calcari Bioclastici inferiori* and the thinner and finer strata of the *Calcari diasprigni* (Figs. 4, 6, 10). In all sections, this boundary corresponds to the first appearance of the echinoderm *Saccocoma* sp., which marks the transition between the early to the late Kimmeridgian (Fig. 5).

The stratigraphic pattern of this cycle is defined by the upward frequency increase of resedimented deposits, coupled with coarsening- and thickening-upward trends (Fig. 4). In the Monte Godi section (Genzana area), this cycle is ca. 20 m thick, and it is characterized by the progressive frequency increase of the coarse nonskeletal-dominated lithofacies C, and by the intercalation of the skeletal-dominated lithofacies D in the upper interval (Fig. 4).

In the Morrone section this cycle is ca. 15 m thick. The background sedimentation is represented by centimeters-scale beds of the nonskeletal-dominated lithofacies C. The skeletal-dominated packstone–grainstone and rudstone lithofacies (E) intercalates more frequently in the upper interval of the cycle, according to an overall thickening- and coarsening-upward trend (Fig. 4). In the Gran Sasso area, this cycle is thicker in the Duca degli Abruzzi and Pizzo Cefalone sections (ca. 35–30 m), whereas it is only a few meters thick in the Passo delle Capannelle section (Fig. 4). In the Duca degli Abruzzi section, the frequency of coarse nonskeletal-dominated lithofacies C increases upward, as well as the thickness of skeletal-dominated lithofacies D (Fig. 4). The stratigraphic pattern culminates with meter-scale amalgamated beds of lithofacies F. A similar organization is observed in the Pizzo Cefalone section, (Figs. 4, 10). Dense alternations of radiolarian chert and fine-grained packstone of the nonskeletal-dominated lithofacies B dominate in the lower interval of the cycle, whereas skeletal-dominated lithofacies E is frequently intercalated in the upper interval of the cycle (Figs. 4, 10). Similarly to the Duca degli Abruzzi section, a few-meters-thick breccia (lithofacies F) marks the top of the cycle. In the Passo delle Capannelle section this cycle is defined by nonskeletal-dominated lithofacies B and radiolarian chert alternations in the lower interval, and by lithofacies F at the top of the cycle, similarly to the other Gran Sasso sections (Fig. 4).

Cycle II.—

The base of Cycle II is marked by an abrupt vertical change from the coarse and thick beds of lithofacies D to F of the underlying cycle to fine-grained and thin-bedded lithofacies B and C at the base of this cycle (Figs. 4, 10). The lower boundary lies above the FAD of the *Colomisphaera* sp., and it is thus labelled as the Colomisphaera event. It marks the Kimmeridgian-to-Tithonian transition (Figs. 4, 5). Thicknesses are rather constant throughout the sections (ca. 40 m), except for the Monte Godi section (ca. 20 m). In the Genzana and Morrone areas, this cycle shows an overall coarsening-upward trend, culminating with decimeters- to meters-thick skeletal-dominated packstone–grainstone and rudstone beds of lithofacies E (Fig. 4). In the Monte Godi section, an upward increase in the frequency of skeletal-dominated lithofacies D occurs as well. In the Gran Sasso sections, beds of the lithofacies C, D, and E, a few decimeters to a meter thick, are intercalated at the base (Passo delle Capannelle section), or in the lower half of this cycle (Duca degli Abruzzi and Pizzo Cefalone sections) (Figs. 4, 10). Lithofacies pass upward to dense alternations of nonskeletal-dominated lithofacies B and radiolarian chert (Figs. 4, 8A, 10). An upward-coarsening and -thickening trend characterizes the upper interval of the cycle, with the intercalations of lithofacies C and F (Passo delle Capannelle section), or with lithofacies E (Duca degli Abruzzi and Pizzo Cefalone sections) (Figs. 4, 10).

Cycle III.—

Similarly to the previous cycles, the lower boundary of this third cycle is represented by a vertical change from thicker and coarser lithofacies below, to thinner and finer lithofacies above the cycle boundary (Figs. 4, 10). The FAD of *Chitinoidella* sp. bioevent within this cycle allows to label its lower boundary as the Chitinoidella event. The thickness of this cycle varies from ca. 20 to 35 m. It displays a general increase in the amount of resedimented deposits, as compared to the underlying cycle, and an overall thickening- and coarsening-upward trend in the internal organization, in all the studied sections (Fig. 4). In the Monte Godi section, this cycle is represented entirely by skeletal-dominated lithofacies, which display a clear thickening- and coarsening-upward trend (Fig. 4). A similar trend is also recorded in the Gran Sasso sections, even though the resedimented lithofacies are less frequent, thinner, and finer (Fig. 4). In the Morrone area, nonskeletal-dominated lithofacies B and C characterize the lower interval of the cycle, with a thinning- and fining-upward signature. In the upper interval, the fine-grained nonskeletal-dominated lithofacies B disappears, while the intercalation of skeletal-dominated lithofacies E and F defines a thickening- and coarsening-upward trend (Fig. 4).

Cycle IV.—

The thickness of this cycle spans from ca. 20 m (Morrone) to ca. 40 m (Gran Sasso) (Fig. 4). The overall content of resedimented deposits is still increasing along all the studied sections, partially hiding stratigraphic trends (e.g., Morrone and Duca degli Abruzzi sections, Fig. 4). Nevertheless, the lower boundary of this cycle is placed near the most evident change in the vertical organization of lithofacies, marked by the inversion point between thickening/coarsening and thinning/fining trends. Moreover, the FAD of *Crassicollaria* sp. allows to constrain the stratigraphic position of this boundary, labelled as the Crassicollaria event (Fig. 4). Despite thicker beds and coarser lithofacies, thickening- and coarsening-upward trends are clearly visible throughout the cycle in most sections (Monte Godi, Serra Sparvera, Monte della Grotta, and Passo delle Capannelle) (Fig. 4). Conversely, no evident sedimentologic trends can be appreciated in the Duca degli Abruzzi section (Fig. 4). In the Pizzo Cefalone section, the internal organization of this cycle is defined by an initial thinning- and fining-upward trend in the lower interval, evidenced by the change between alternations of lithofacies C and D and lithofacies B, and by a thickening- and coarsening-upward trend in the upper interval of the cycle, marked by the transition from lithofacies B to alternations of lithofacies C and E (Figs. 4, 10).

Cycle V.—

Cycle V shows a variable thickness from 20 m to ca. 60 m. In the Genzana and in part in the Gran Sasso sections (Passo delle Capannelle and Pizzo Cefalone), the lower boundary is well defined by changes in the vertical organization of lithofacies, from thicker and coarser below to thinner and finer above (Figs. 4, 10). In the other sections (Monte della Grotta and Duca degli Abruzzi), lithostratigraphic changes across the boundary are not so evident, but the FAD of the *Calpionella* sp. allows to constrain the stratigraphic position of this boundary, which corresponds to the Calpionella 1 event (Figs. 4, 5).

An overall decrease in the content of resedimented deposits can be observed along this cycle, as compared to the underlying one (cycle IV). Apart from the Monte Godi section, and partially also from the Duca degli Abruzzi section, where thickening- and coarsening-upward trends are clearly visible, in all the other sections the internal organization of this cycle is defined by frequent intercalations of resedimented deposits (lithofacies C, D, E, and F) in the lower interval, by thin-bedded and fine-grained lithofacies (A) in the central interval, and by massive, meter-scale beds of very coarse rudstone (lithofacies F) in the upper interval (Figs. 4, 10).

The upper boundary can be easily traced in all sections, and it coincides with the abrupt vertical change between the thick massive beds of the top of this cycle and the thin and fine-grained strata of the overlying pelagic-dominated succession (Fig. 4), corresponding to the morphologic break between the *Calcari diasprigni* and *Maiolica* formations (Fig. 6).

Large-Scale Stacking Pattern

The stacking pattern of the described cycles depicts a larger-scale cycle, entirely encompassing the Upper Jurassic studied interval (Figs. 4, 10). In the Duca degli Abruzzi and Pizzo Cefalone sections (Gran Sasso), the large-scale organization is more evident, and it is defined by a decrease in frequency of thick and coarse resedimented deposits in the lower part of the sections, through stacked cycles I and II (Figs. 4, 10). This pattern culminates across cycles II and III, where the maximum development of thin-bedded, fine-grained lithofacies B and C, and radiolarian chert is recorded (Figs. 4, 10), and where the turnover in the long-term stacking pattern of the resedimented deposits is observed. The new long-term pattern develops through cycles III, IV, and V, and it is outlined by the end of radiolarian chert intercalations and by an increase in frequency, thickness, and grain size of resedimented deposits (Figs. 4, 10). In the Morrone section the long-term stacking pattern is less evident, but a decrease in frequency of thick-bedded and coarse-grained resedimented lithofacies seems to be always recorded through cycles I and II (Fig. 4). Cycle II records a maximum in frequency of the radiolarian chert intercalations and thin-bedded, fine-grained resedimented lithofacies B and C. Above, thick-bedded and coarse-grained lithofacies newly intercalate through cycles III, IV, and V, similarly to the Duca degli Abruzzi and Pizzo Cefalone sections (Fig. 4). In the Passo delle Capannelle section, the maximum development of radiolarian chert intercalations and thin-bedded, fine-grained resedimented lithofacies B and C characterizes the lower interval of the cycle II. It largely contrasts with the overall stratigraphic signature recorded through cycles III to V, dominated by thick-bedded and coarse-grained resedimented lithofacies (Fig. 4). In the Monte Godi section the large-scale signature is quite different from the other sections, and it is defined by an overall coarsening- and thickening-upward trend of the resedimented deposits all through the section. This difference could be attributed to the peculiar depositional setting recorded by this section, which is related to a very confined slope setting, where oversupply conditions could have masked the more or less evident large-scale stacking pattern observed in less confined depositional settings.

STRATIGRAPHIC ARCHITECTURE OF THE INNER-PLATFORM DEPOSITS

The lithofacies and cyclic subdivision of the Upper Jurassic shallow-water Macchia Diavola section (Figs. 1, 2,11) are illustrated hereafter. Seven lithofacies have been singled out and then grouped into three main lithofacies associations, each of them reflecting different platform depositional subenvironments (Fig. 12).

Key Lithofacies

Foraminiferal and Algal (Foralgal) Limestone (FA).—

This lithofacies association corresponds to grain-supported textures (bioturbated wackestone–packstone) (Fig. 12), characterized by high-diversity fossil associations (different genera of green algae and benthic foraminifera, locally associated with mollusks). It is rare and is represented by two different lithofacies:

(1) FA1: bioturbated wackestone–packstone with green algae and large mollusks (pelecypods and gastropods); foraminifera are subordinated. It occurs at about 275 m from the base of the section.

(2) FA2: bioturbated wackestone–packstone with benthic foraminifera; green algae are subordinated, and there are no mollusks. It occurs at about 55 m from the base of the section.

The high diversity of the fossil associations in the bioturbated wackestone–packstone textures suggests an open-lagoon environment. Moreover, on the basis of textural characteristics, we refer lithofacies FA1 to a more external sector of an open lagoon as compared to lithofacies FA2 (Fig. 12).

Bioclastic and Peloidal Limestone (BP).—

This association, locally affected by minor dolomitization, is the most widespread; it is composed of grain-supported textures (packstone, packstone–grainstone, and grainstone) in which mollusk fragments, benthic foraminifera, and peloids, locally associated with small intraclasts, are very common (Fig. 12). Two lithofacies were discerned:

(1) packstone–grainstone with large bioclasts and micritized grains (BP1).

(2) packstone, packstone–grainstone, and grainstone with peloids, small bioclasts, and rare small intraclasts (BP2).

The grain-supported textures, the absence of gradation, the local transition to foraminifera and ostracod lithofacies associations (FO) and, subordinately, to the above foraminifera and algal lithofacies association (FA) suggest, on the whole, a high-energy shallow marine environment (sand shoals; see Fig. 12).

Foraminifer and Ostracod Limestone (FO).—

This lithofacies association is represented by wackestone and mudstone, locally bioturbated, with oligotypic fossil associations (Fig. 12), and locally overprinted by minor dolomitization. On the basis of the textural characteristics three lithofacies were recognized:

(1) bioturbated wackestone with green algae, small foraminifera, and mollusks (FO1).

(2) wackestone, locally bioturbated, with green algae, locally represented by abundant *Clypeina jurassica* or *Campbeliella striata*, associated with peloids and rare small benthic foraminifera (FO2).

(3) bioturbated mudstone with small foraminifera and ostracodes; fibrous radial ooids may locally occur (FO3).

The pelitic component and the fossil assemblages, sometimes oligotypic (lithofacies FO3), suggest a restricted lagoonal environment (Fig. 12).

Stacking Patterns

Based on the vertical organization of lithofacies and related early diagenetic features (from marine to meteoric) eight decame-

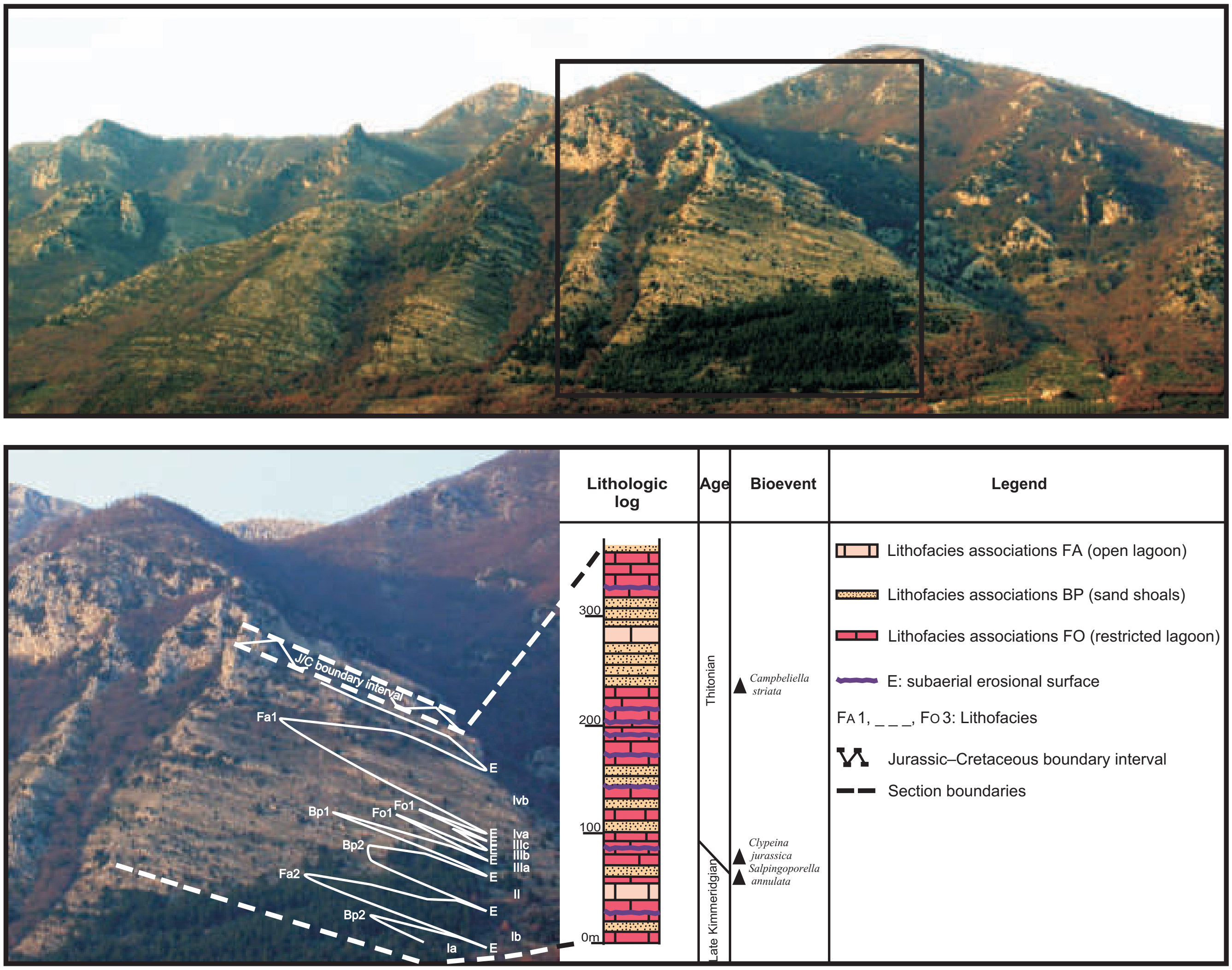


FIG. 11.—Macchia Diavola section, a part of the Triassic–lower Cretaceous strata of Monte Monaco di Gioia, northern Campania. The photo at the lower left illustrates the facies cycles of the studied interval. For further details see Figure 12.

ters-scale unconformity-bounded depositional cycles were recognized (Fig. 12). Cycle boundaries correspond to periods of platform emersion, evidenced by typical subaerial dissolution processes (karstic and/or vadose dissolution), locally associated with pedogenesis (early-meteoric diagenetic features of rendzina type; Wright and Tucker, 1991), directly superimposed on subtidal deposits. In particular, dissolution processes are outlined by karstic cavities (normally millimeters to centimeters in size) occluded by geopetal crystal silt (*sensu* Dunham, 1969), silty–marly, multi-colored fillings, and/or stalactitic cements. In places, peseudoalveolar features and rhizocretions occur, suggesting an early diagenetic fabric related to pedogenesis (Wright and Tucker, 1991; Theriault and Desrocher, 1993). Such processes preclude an interpretation based on tidal-flat progradation–retrogradation, and indicate a phase of sea-level lowering.

Two types of cycle boundaries were recognized (Fig. 12). In the first type, pervasive dissolution (microkarst) and weak pedogenesis mark the upper boundaries of cycles Ia, Ib, II, IVa, and IVb and indicate, on the whole, a minor meteoric influence, due to ephemeral emersions. In the second type of boundary the meteoric overprint is enhanced (karstic dissolution testified by millimeters to centimeters cavities and pedogenesis); it tends to increase from the upper boundary of cycle IIIa to the upper boundary of cycle IIIc, thus suggesting a more prolonged emersion period.

The vertical changes of lithofacies and lithofacies associations throughout single cycles reflect the variability of juxtaposed depositional environments and their evolution through time.

Cycles Ia, Ib, II, and IVb, which are the thickest (ca. 65 m and 165 m) recorded along the studied section (Fig. 12), display deepening and shallowing stacking patterns of lithofacies and lithofacies associations (Fig. 13A). The deepening pattern defines the lower interval of cycles, and it is recorded by the progressive transition from restricted lagoon (lithofacies association FO) to open lagoon (lithofacies association FA) (cycles Ib and IVb), or to sand shoals (lithofacies association BP) (cyles Ia and II) (Figs. 12, 13A). The foraminifera and algal lithofacies association (FA) marks the most open marine conditions recorded on the platform top. The shallowing pattern defines the upper intervals of cycles, and it is characterized by a return to the restricted-lagoon conditions (lithofacies association FO) and culminates in the emersion surface (cycle boundary of the first type) (Fig. 13A). During both

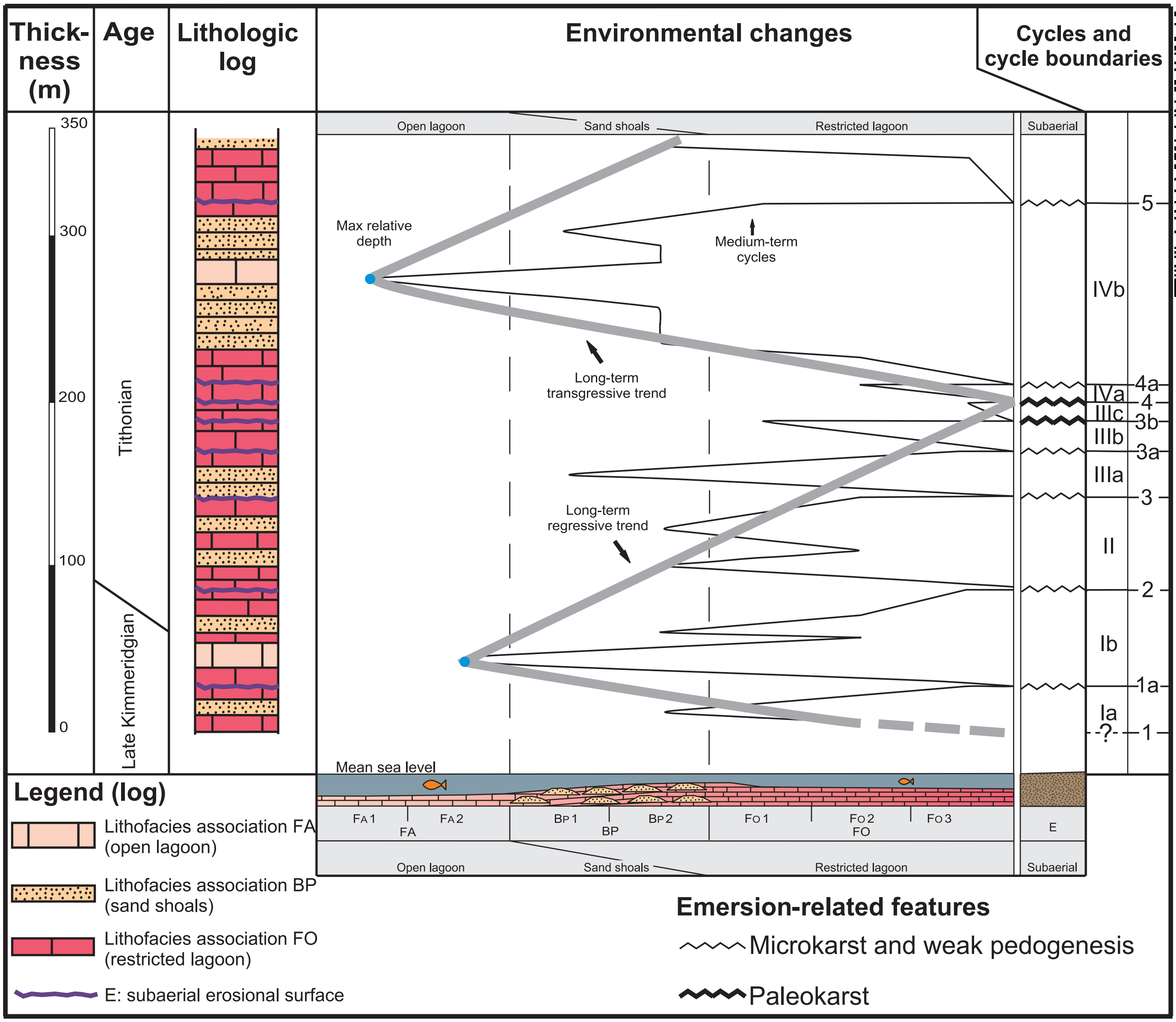


FIG. 12.—Cyclic oscillations recorded in the Macchia Diavola section. On the left, the graphic log shows the vertical variation of the lithofacies associations (FA to FO), and on the right, the paleoenvironmental changes suggested by the vertical organization of the lithofacies (FA1 to FO3) and the related early meteoric diagenetic overprint (E). Note that eight transgressive-regressive sea-level cycles have been identified, each characterized by an erosional upper boundary (horizontal line) with emersion-related products (karstic cavities and/or pedogenetic features) directly developed within the topmost part of the subtidal deposits. Moreover, the upward thinning of the first five cycles and their environmental evolution indicate a long regressive facies trend, while the upward thickening of the last two cycles indicates a long transgressive facies trend.

deepening and shallowing lithofacies stacking patterns, sand shoals (lithofacies association BP) may intercalate at the transition between restricted (lithofacies associations FO, cycles Ia and II) and open (lithofacies associations FA, cycles Ib and IVb) platform conditions (Figs. 12, 13A).

Cycles IIIa, b, c and IVa, which are from 20 to 50 m thick and intercalate in the middle part of the studied section (Fig. 12), are characterized by a shallowing stacking pattern defined by the transition from less restricted to more restricted conditions (lithofacies association FO, cycles IIIb, IIIc, and IVa), or from sand shoals (lithofacies associations BP) to restricted marine circulation (lithofacies association FO, cycle IIIA) (Fig. 13B). They are truncated by emersion surfaces of both types.

Finally, we note that: (1) more restricted environmental conditions tend to spread from cycle Ib to cycle IIIc, while cycles IVa and IVb suggest a return towards more open marine circulation; (2) cycle thickness tends to decrease from cycle Ib to cycle IIIc, whereas it tends to increase from cycle IVa to cycle IVb; (3) this allows to recognize, on the whole, a cyclic stacking pattern which suggests a longer-term decreasing trend of the accommodation from cycle Ib to cycle IIIc, and a longer-term increasing trend of the accommodation from cycle IVa to cycle IVb.

CORRELATION BETWEEN BASE-OF-SLOPE CYCLES AND PLATFORM CYCLES

Based on Apennines platform and slope biostratigraphic zonation, a correlation between the sedimentary record of the two studied regions has been attempted (Fig. 14). As previously seen, the biostratigraphic resolution of the Lazio–Abruzzi base-of-slope successions allows a rather confident stratigraphic definition of the studied interval and of the related depositional cycles (Fig. 5). In contrast, the less frequent bioevents make the biostratigraphic record of the platform less fine.

The micropaleontological content indicates that the investigated shallow-water interval, in the Matese area, includes the upper part of the *Kurnubia palastiniensis* biozone through the *Clypeina jurassica* biozone. This allows to refer the studied section to the uppermost Jurassic (late Kimmeridgian–Tithonian; Figs. 5, 14). Moreover, the studied interval appears to be confined within the late Jurassic, near the Jurassic–Cretaceous boundary, as suggested by the lack of typical lower Cretaceous microfossil association (De Castro, 1962, 1987; Sartoni and Crescenti, 1962; Colacicchi and Praturlon 1965; Crescenti, 1966).

Other key correlation events are represented by the gradual disappearance of *Kurnubia palastiniensis*, in the basal part of the section, and the occurrence and then diffusion of the *Clypeina jurassica* and *Salpingoporella annulata* association, which indicates the Kimmeridgian–Tithonian transition (a in Fig. 14). Moreover, the first occurrence and then the spreading of *Campbeliella striata* in association with *Clypenia jurassica* indicate the upper part of the Tithonian (b in Fig. 14).

In spite of these intrinsic differences, several biostratigraphic tie points serve for correlations of base-of-slope and platform successions and their significant events and cycles (Fig. 14).

Given the above biostratigraphic considerations, the relatively short time duration of the studied interval (ca. 7 My), and the comparable magnitude of base-of-slope and platform cycles, a direct correlation among the main events recorded by the successions of the two areas seems possible (Fig. 14). This correlation suggests that emersion events recorded in the Macchia Diavola section in most cases (1, 2, 3, and 5) correspond to the stacking-pattern culminations (cycle boundaries) of the Lazio–Abruzzi base-of-slope depositional cycles. As for the base-of-slope Crassicollaria event (4), a number of candidates can be identified. For proper correlation with the platform record, the emersion event to the top of cycle IIIc, which records the minimum platform accommodation, appears the best solution (Fig. 14).

DISCUSSION

Sediment Source Areas and Export Mechanisms

The composition of slope sediments suggests that two distinct depositional domains exported sediments. Most grains of the nonskeletal-dominated lithofacies (B and C) were produced on the shallow platform, whereas most grains of the skeletal-dominated lithofacies (D–F) originated from the reef margin.

As to the skeletal resedimented fraction, no difference in composition has been observed downsection, suggesting that, during the late Jurassic, fluctuations in skeletal input through time were not related to turnovers in the reefal benthic communities.

Sedimentary structures suggest that most beds of lithofacies B to E correspond to classic turbidites. Structural and textural differences result mainly from calcareous composition and distance from source area (e.g., Einsele, 1991; Eberli 1991). In contrast, sedimentary structures of lithofacies F suggest resedimentation processes related to debris flows initiated on the platform flank. Resedimented material was largely unlithified platform sediment. Nonskeletal grains (peloids) appear to have been produced mostly on flooded bank tops, whose structure is

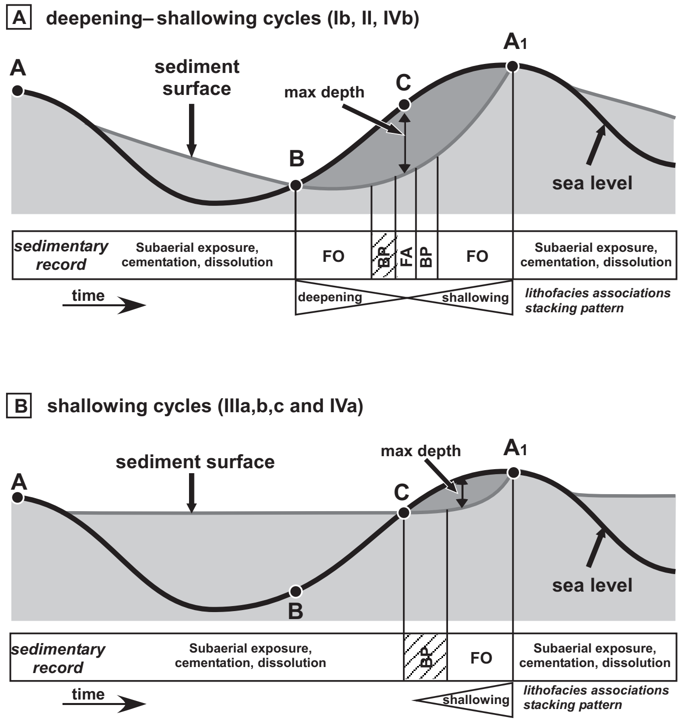


FIG. 13.—Stacking pattern of lithofacies associations during deepening–shallowing and shallowing cycles. The sketch shows the evolution of lithofacies associations during one cycle of sea-level change. A) After emersion and a certain lag time, the increasing rate of sea-level rise produces the deepening trend of lithofacies associations, from restricted-lagoon lithofacies association (FO) to open-lagoon lithofacies association (FA). In some cycles (Ib and IVb) bioclastic and peloidal wave- and current-dominated sand shoals (lithofacies associations BP) may intercalate at the transition between restricted-platform and open-platform conditions. Before the onset of more open marine conditions on the platform top (lithofacies association FA), the decreasing rate of sea-level rise induces rapid infilling of the space created, and a shallowing trend of lithofacies associations, recorded by the return to restricted lagoon conditions (lithofacies association FO). B) In shallowing cycles, flooding of the platform top occurs later as compared to the deepening–shallowing cycles. Along the sea-level curve, this occurs when the rate of sea-level rise starts to decrease. This contributes to the development of solely restricted marine conditions (cycles IIIb, IIIc, and IVa), and a reduced thickness of cycles. In other cases (cycle IIIa), bioclastic and peloidal wave- and current-dominated sand shoals (lithofacies association BP), may occur above the emersion surface. A and A1, points at which sea level starts to fall; B, point at which the rate of the sea-level rise starts to increase; C, point of maximum rate of sea-level rise. Lithofacies associations: foraminifer and ostracod limestone (FO); bioclastic and peloidal limestone (BP); foraminiferal and algal (foralgal) limestone (FA).

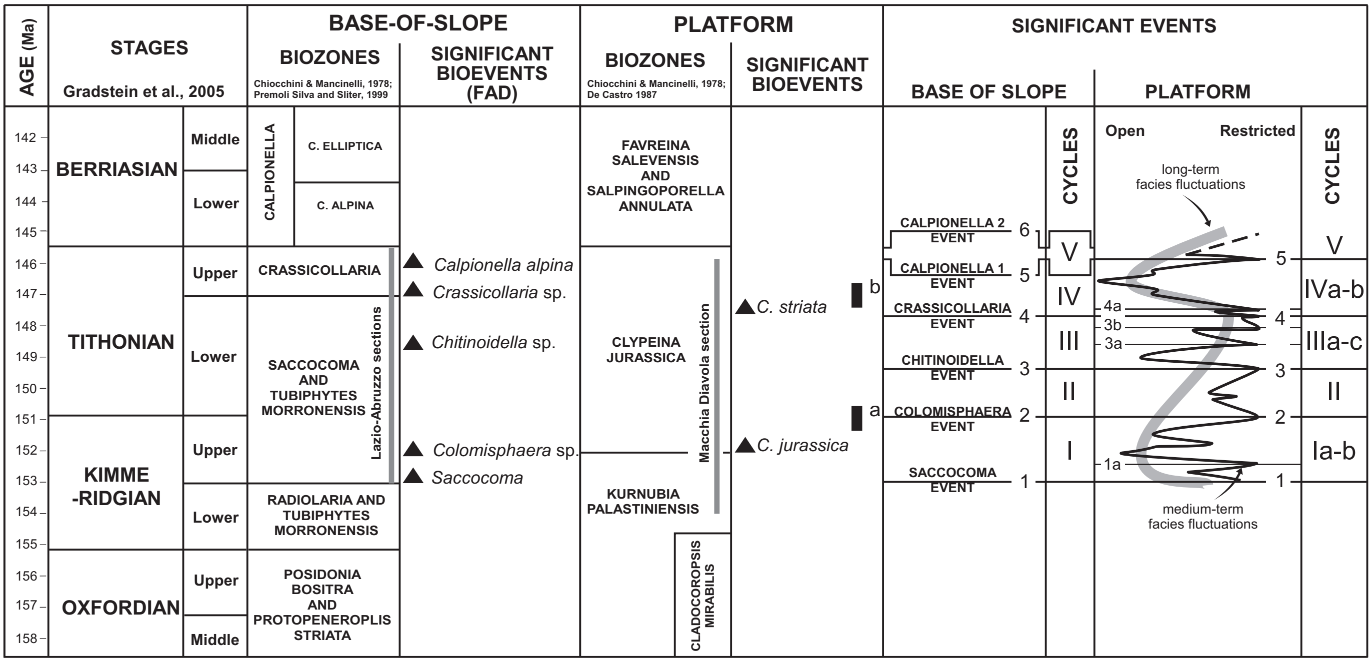


FIG. 14.—Correlation between the sedimentary record of the Lazio–Abruzzi base-of-slope succession and northern Campania–Molise platform succession, illustrating biostratigraphic events used as key points for cycle correlation.

controlled largely by wind and episodic storms. This results in frequent resuspension and offbank transport of excess produced sediment (Hine et al., 1981), normally by storms (Neumann and Land, 1975) or by density cascades (Wilson and Roberts, 1992, 1995). Once triggered, these processes are able to entrain and transport also coarser sediments down the platform margin and slope, and they may evolve into suspension currents (Wilson and Roberts, 1995).

In the case of skeletal-dominated lithofacies (D to F), sediment composition suggests that sediment mobilization and subsequent delivery to the flows took place at the platform margin. In this area loose sediments are readily available for off-platform transport, and flows resulted directly from excess sediments suspended and shed by storms and waves, or from the unstable reef-margin areas, overloaded by enhanced production and progradation.

Export Potential Through Time

The vertical distribution of resedimented deposits through the Upper Jurassic base-of-slope sections reflects export on two different time scales (Fig. 15A, B). The long-term pattern (Fig. 15A) corresponds to the large-scale depositional signature, with higher carbonate export during cycles I, IV, and V and lower export during cycles II and III (Fig. 15A).

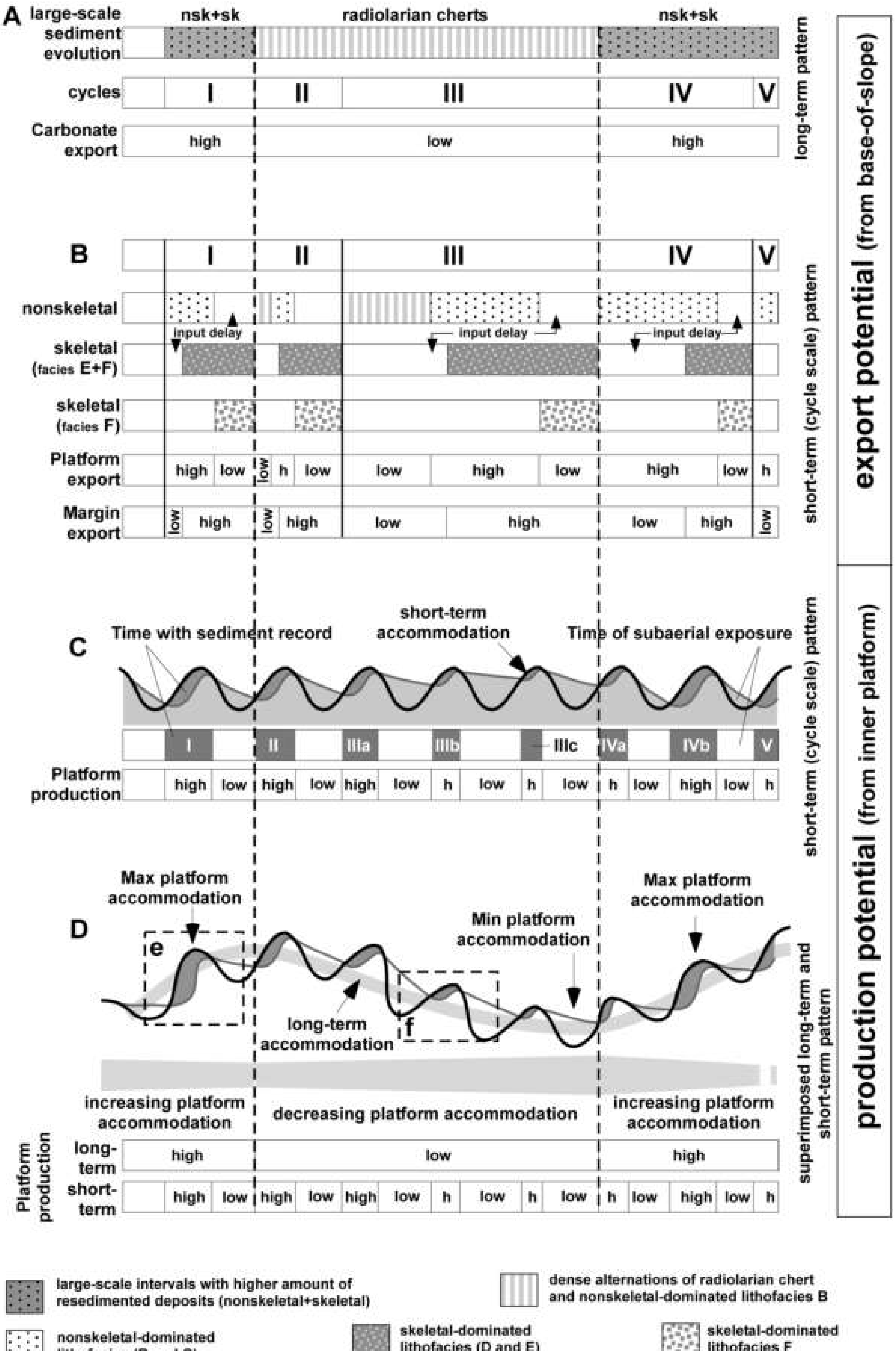
As for the shorter-term export pattern (Fig. 15B), the sediment distribution within single cycles shows that both sediment sources (inner platform and reef margin) concomitantly exported large amounts of excess sediments. On the other hand, a delay in the export patterns is recorded by the reef-margin input compared to the inner-platform input (Fig. 15B), and it is thought to be related to different platform and margin export potential. Furthermore, the volume of reef-margin-derived input (skeletal grains and lithoclasts) of lithofacies F greatly exceeds the inner platform one (peloids and shallow-water biota) in the upper interval of the cycles (Fig. 15B), suggesting a reduction in inner-platform export and an increase in reef-margin export (Fig. 15B).

Inner-Platform Production Potential Through Time

Subaerial features (vadose diagenesis to paleokarst) directly superimposed on subtidal carbonate platform strata are the most diagnostic evidence of relative sea-level fall (D'Argenio, 1976; Schlager, 1991; Strasser, 1991). Buonocunto et al. (1994) and D'Argenio et al. (2004) have shown that reiterated exposure of Cretaceous shallow marine carbonates in the Matese and Maiella platforms was forced by orbitally driven sea-level oscillations. We assume, therefore, that also the Macchia Diavola cycles are related to changes in platform-top accommodation.

Shallow-water deposition corresponds to periods of higher platform accommodation, during which the platform is flooded and the carbonate-factory production area increased. In contrast, platform exposures correspond to periods of lower accommodation, leading to a very strong reduction or demise of carbonate production (Fig. 15C).

The stacking pattern of shallow-water cycles may relate to both long-term platform accommodation and carbonate production patterns (Fig. 15D). The decrease in the long-term pattern of platform accommodation and an overall reduction in the total budget of sediments produced, through cycles II to IIIc, is suggested by the progressive upward increase of restricted platform conditions, emersion surfaces, and the progressive decrease in cycle thickness (Fig. 15D). In contrast, the increase in the long-term pattern of platform accommodation and carbonate production, through cycles IVa to IVb is suggested by the progressive upward increase of open lagoon conditions and the progressive cycle thickening through stacked cycles (Fig. 15D). Cycles I and IVb record maximum platform accommodation and carbonate production, whereas cycle IIIc corresponds to minimum platform accommodation and carbonate production.


A
large-scale sediment evolution
nsk+sk
radiolarian cherts
nsk+sk
cycles
I
II
III
IV
V
Carbonate export
high
low
high
long-term pattern
B
nonskeletal
input delay
input delay
input delay
skeletal (facies E+F)
skeletal (facies F)
Platform export
high
low
low
h
low
low
high
low
high
low
h
Margin export
low
high
low
high
low
high
low
high
low
short-term (cycle scale) pattern
export potential (from base-of-slope)
C
Time with sediment record
short-term accommodation
Time of subaerial exposure
I
II
IIIa
IIIb
IIIc
IVa
IVb
V
Platform production
high
low
high
low
high
low
h
low
h
low
h
low
high
low
h
short-term (cycle scale) pattern
D
Max platform accommodation
e
long-term accommodation
f
Min platform accommodation
Max platform accommodation
increasing platform accommodation
decreasing platform accommodation
increasing platform accommodation
Platform production
long-term
high
low
high
short-term
high
low
high
low
high
low
h
low
h
low
h
low
high
low
h
superimposed long-term and short-term pattern
production potential (from inner platform)
large-scale intervals with higher amount of resedimented deposits (nonskeletal+skeletal)
dense alternations of radiolarian chert and nonskeletal-dominated lithofacies B
nonskeletal-dominated lithofacies (B and C)
skeletal-dominated lithofacies (D and E)
skeletal-dominated lithofacies F

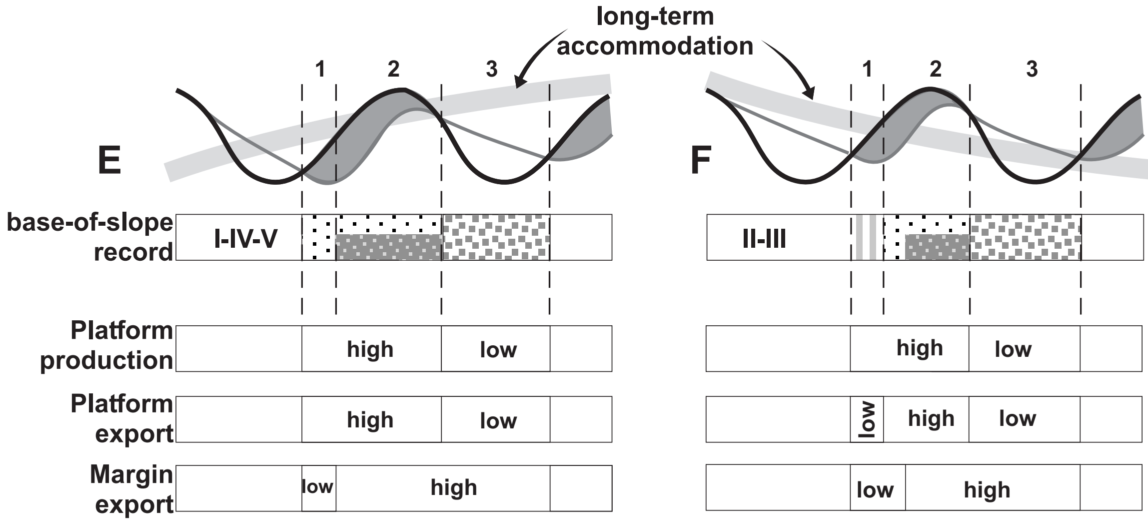


FIG. 15 (facing page and above).—Model of the carbonate production and export potentials as recorded by stratigraphic architecture and sediment composition in Upper Jurassic platform and base-of-slope successions of the central Apennines. A) Large-scale lithostratigraphic signature and related export potential of the Lazio–Abruzzi base-of-slope successions. B) Lithostratigraphic signature and related export potential of the Lazio–Abruzzi base-of-slope cycles. C) Relationships between shallow-water relative sea-level cycles and carbonate production during cycles. D) Long-term evolution of platform accommodation modulated by cycles and related platform production potentials. E) Relationship between carbonate production and export within platform and base-of-slope cycles, during a long-term increasing phase of platform accommodation. F) Relationship between carbonate production and export within platform and base-of-slope cycles, during a long-term decreasing phase of platform accommodation.

Model of Carbonate Production and Export

A first conclusion is that sea level controls cycle formation, carbonate production, and export potential, in both platform and base-of-slope settings. By comparing the large-scale variations in sedimentary regime through time (Fig. 15A, D), it appears that long-term export (Fig. 15A) matches platform production, which is driven by accommodation changes (Fig. 15D). Consequently, the long-term pattern of platform accommodation controls both the long-term evolution of the inner-platform carbonate production and export potential and the large-scale stratigraphic architecture of base-of-slope successions. This picture is similar to what is predicted by the "highstand shedding" model of Droxler and Schlager (1985), in terms of frequency and abundance of resedimented deposits during sea-level changes.

A second important issue is that the relationships between the carbonate production and export potential, recorded by platform and base-of-slopes cycles, result from the combined effects of the two superimposed orders of sea-level changes and from the role of the reef-margin source area in the total budget of export.

The changes recorded by stacked platform cycles indicate that carbonate production potential depends on the position of cycles along the low-frequency relative sea-level curve (Fig. 15D, E, F). Thus, carbonate production is higher when shallow-water cycles modulate a long-term increasing platform accommodation (cycles I, IVb, and V) (Fig. 15E), whereas it is lower when shallow-water cycles modulate a long-term decreasing platform accommodation (cycles II, IIIa–c) (Fig. 15F). This is particularly evident during the early stages of base-of-slope cycles, as indicated by more frequent, coarser and thicker platform-derived nonskeletal turbidites in those cycles formed during a long-term increase in platform accommodation (point 1 in Fig. 15E) and by less frequent, finer and thinner platform-derived nonskeletal turbidites in those cycles formed during a long-term decrease in platform accommodation (point 1 in Fig. 15F). Thus, the two different sedimentary signatures of base-of-slope cycles can be related to the interplay between superimposed orders of relative sea-level changes. This interplay possibly controlled the total budget of sediments produced during the long-term platform accommodation, and the effects of shorter relative sea-level changes on carbonate production and export potential. When the interference between superimposed orders (lower and higher frequency) of relative sea-level changes is positive, the effects on sediment production and export are enhanced during shorter relative sea-level changes (Fig. 15E). Conversely, when the interference is negative, the effects on sediment production and export are smoothed during shorter relative sea-level changes (Fig. 15F).

In spite of lack of data on carbonate production potential of reef-margin areas, important information about the export from this environment are provided by the resedimented skeletal fraction. As previously mentioned, the reef-margin input is generally delayed as compared to the inner-platform one (Fig. 15B, E, F). This suggests that the reef-margin export potential is low during the early stages of platform flooding (early HST, point 1 in Fig. 15E and F), it progressively increases during the late HST (point 2 in Fig. 15E and F), and it becomes highest during the LST (point 3 in Fig. 15E and F), i.e., when the inner-platform production was strongly reduced or ceased altogether.

The delay of the reef-margin input and its increase during the late HST and LST can be viewed as the response of the biological system to relative sea-level change (Fig. 16). During the early HST, sediments produced by the reef margin filled the available space. Sediments produced were trapped on the platform, and basinward export was low (Fig. 16A). The balance between aggradation and progradation turned toward aggradation. Dur-

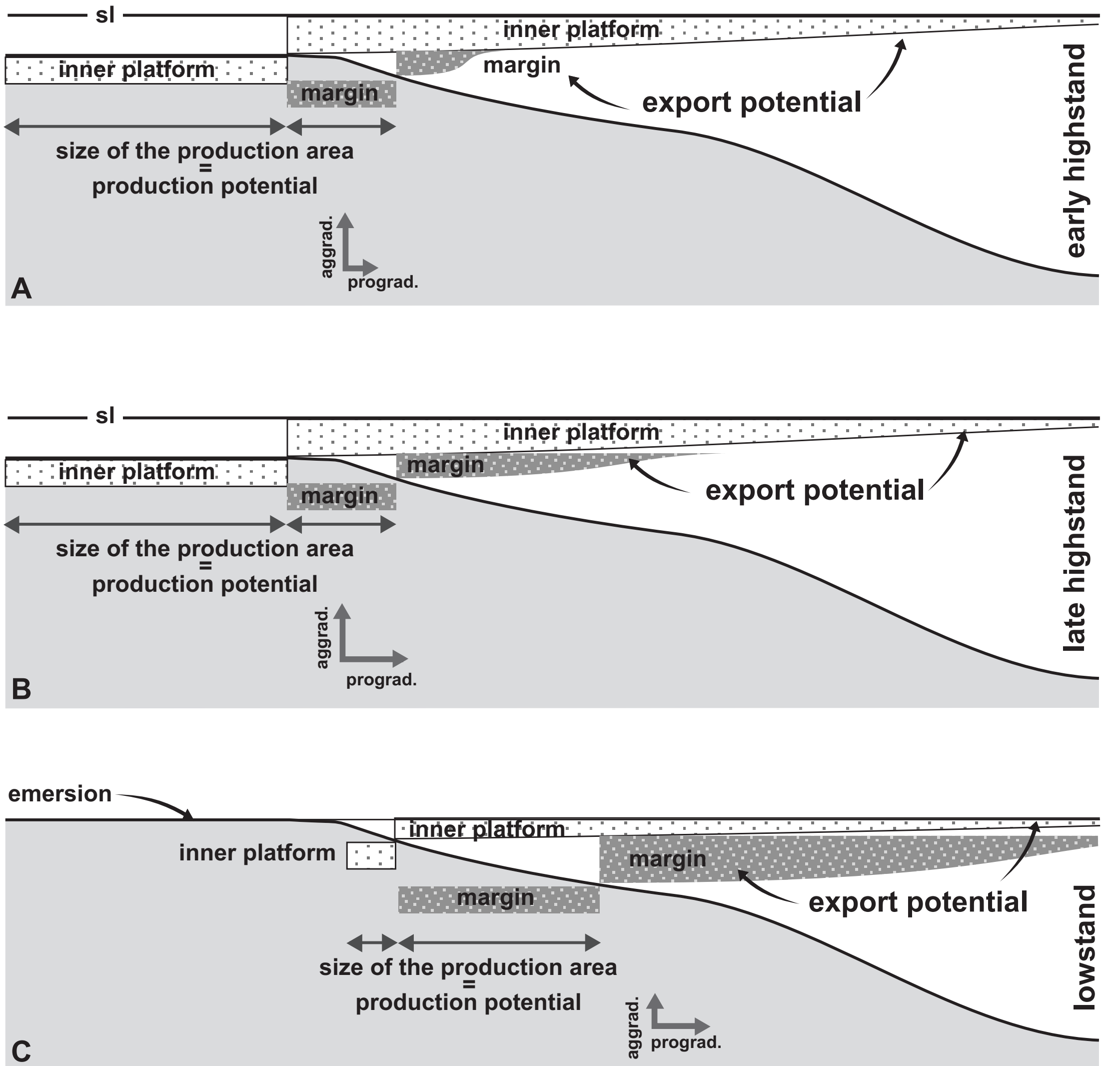


FIG. 16.—Schematic cartoon illustrating the interpreted relationship between the reef-margin and inner-platform sediment input during a sea-level cycle. Inner-platform and margin production potentials (dotted rectangles, below the depositional profile) represent the extent of the related production areas. The inner-platform and reef-margin export potentials (dotted wedges, above the depositional profile) represent the amount of sediment exported from these two source area during a sea-level cycle. The interpreted relationship between aggradation and progradation is represented by the gray arrows (vertical arrow, aggradation; horizontal arrow, progradation). During highstand, the inner platform is flooded, and production and export are high. As for the reef margin, the related sediment input is low during early highstand, because the production rate is lower than or equal to the rate of sea-level rise. During late highstand, the reef-margin production rate becomes higher than the rate of sea-level rise, and export of sediments toward the basin starts to increase. During lowstand, the inner platform is emergent, and its production potential is greatly reduced. Sea-level fall forces the depositional system to prograde, favoring downslope shedding of coarse skeletal-dominated deposits.

ing slowing sea-level rise (late HST), the space created was rapidly filled, allowing the reef margin to gently prograde and the export potential to progressively increase (Fig. 16B). The ensuing reef-margin progradation produced coarsening- and thickening-upward trends in skeletal-dominated deposits (lithofacies D and E), within cycles. During both the early and the late HST, carbonate-platform production and export were high (Fig 16A, B). When emersion took place on the platform, during the LST, the size of the carbonate-factory area was reduced considerably, and the inner-platform input decreased drastically. The reef margin was forced to prograde basinward, favoring downslope shedding of coarse skeletal-dominated deposits of lithofacies F (Fig 16C).

This distribution pattern of sediment type along Upper Jurassic Lazio–Abruzzi base-of-slope cycles, and its inferred relationship to relative sea-level variations, as deduced from the Matese shallow-water record, contrasts partially with those patterns of sea-level-related distribution of sediment types predicted by the "highstand shedding" model of Droxler and Schlager (1985), Haak and Schlager (1989), and Schlager et al. (1994). An explanation could be based on the possible different morphology of the

Lazio–Abruzzi Upper Jurassic platform system, as compared to the rimmed Bahamas model. A gentler morphology of the Lazio–Abruzzi platform-to-basin depositional profile could have reduced the effect of the highstand shedding on the composition of resedimented deposits. A similar picture has been described for the Miocene distally steepened carbonate ramp of the Bahamas (Betzler et al., 1999; Betzler et al., 2000), and in the Triassic prograding platform of the Dolomites (Reijmer, 1998). Such depositional profiles would have allowed the reef margin to further prograde farther basinward, favoring downslope shedding of coarse skeletal-dominated deposits of lithofacies F during the lowstand. In gentler depositional profiles, in fact, lowstand platforms can grow and partially compensate for the termination of platform-top carbonate production (Schlager, 1991; Schlager et al., 1994).

CONCLUSIONS

- Sedimentary architecture and sediment composition of the Upper Jurassic Lazio–Abruzzi base-of-slope successions was closely related to carbonate production and export potentials of two source areas: inner platform and reef margin.

- Cyclic oscillations of sea level appear to have been the main controlling factor for both platform and base-of-slope cyclic depositional signatures.

- Cycle architecture depends on the interaction of two superimposed orders of sea-level changes and on their effects on the inner-platform and reef-margin carbonate production and export potential. During long-term increase in platform accommodation, carbonate production and export are higher, and nonskeletal turbidites are more frequent, coarser, and thicker in the lower intervals of the cycles. During a long-term decrease in platform accommodation, carbonate production and export are lower, and nonskeletal turbidites are less frequent, finer, and thinner in the upper intervals of the cycles.

- Sea level appears also to have been the main controlling factor as regards cyclic shedding timing of the two provenance areas, and related sediment types. During early highstands, the inner platform is the only source able to export sediments, represented mostly by nonskeletal grains. During late highstands, the reef margin starts to export in concomitance with the inner platform, and skeletal and nonskeletal grains occur together in base-of-slope cycles. During lowstands, inner-platform export terminates, due to platform emersion; the reef margin remains the only source able to export sediments, it progrades basinward, and its related coarse-grained sediments reach the base of slope.

This study demonstrates that stratigraphic architectures and sediment composition of Upper Jurassic Lazio–Abruzzi base-of-slope successions varied significantly in response to changes in shallow-water carbonate production and export potential, which were controlled by sea-level cycles. Moreover, the link between stratigraphic architectures, compositional changes, and platform evolution suggests that variations in sediment input in base-of-slope sediments reflect lateral shifting of the platform-margin system.

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Cyclic organization of Late Jurassic carbonate platform strata. Matese mountains, Southern Apennines

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ABSTRACT

A sedimentologic-stratigraphic study at decimetre to metre scale was carried out on carbonate platform deposits, late Kimmeridgian-Tithonian (Late Jurassic) in age. The studied section, 350m thick, crops out at Macchia Diavola, along the south-western side of Monte Monaco di Gioia (Matese mountains, Campania Apennines). Seven lithofacies, grouped in three main lithofacies associations, have been distinguished. Their vertical organization, together with related early diagenetic features, suggests environmental changes developed in an inner carbonate platform domain. At a scale of metres to tens of metres, a total of 11 relative sea level cycles have been recognised, frequently characterized by erosional boundaries which truncate lagoonal deposits, showing subaerial-exposure related traits (karstic cavities and/or pedogenetic features) in their uppermost part. While the thinner cycles document more restricted lithofacies associations, whose upward thinning stacking pattern indicates long-term Regressive Facies Trends, the thicker cycles, characterized by more open lithofacies associations, show a stacking pattern suggestive of a long-term Transgressive Facies Trend. This cyclic organization is well comparable with that of the Cretaceous carbonate platform successions previously studied in Central and Southern Italy. It is suggested here that the rhythmic Late Jurassic environmental changes, like those of the Cretaceous recorded in the Matese area, were prevailingly controlled by external mechanisms, even if minor autocyclic influences cannot be excluded.

KEY WORDS: *carbonate rocks, sedimentology, biostratigraphy, sedimentary cyclicity, Late Jurassic, southern Italy.*

RIASSUNTO

Ciclicità sedimentaria nel giurassico superiore di piattaforma carbonatica. Matese, Appennino Meridionale.

Vengono presentati i primi risultati di uno studio sedimentologico, condotto in chiave stratigrafica sul Giurassico Superiore dell'area del Matese (Campania, Italia meridionale). Sono stati misurati a scala da decimetrica a metrica 350 m della successione carbonatica di Macchia Diavola (Kimmeridgiano superiore-Titoniano), bene esposta lungo il versante sud-occidentale del Monte Monaco di Gioia (fig. 1). L'analisi sedimentologica ha consentito l'individuazione di 7 litofacies raggruppate in 3 principali associazioni di litofacies; la loro interpretazione ambientale suggerisce un modello sedimentario di piattaforma carbonatica in cui bassifondi sabbiosi facevano passaggio, verso i domini più interni, ad ambienti di laguna a circolazione ristretta e, verso l'esterno, ad ambienti di laguna a circolazione e salinità normale (fig. 4).

La curva, costruita sulla distribuzione verticale delle litofacies e delle loro associazioni, documenta 11 cicli di spessore da metrico a decametrico (Trend Trasgressivo/Regressivi a medio termine di cui 2 incompleti, rispettivamente alla base e alla sommità della successione), di regola delimitati da superfici di erosione subaerea. Queste ultime sono evidenziate da cavità carsiche e strutture pedogenetiche nella parte sommitale dei depositi subtidali (fig. 5). Inoltre, mentre i cicli di spessore maggiore sono prevalentemente costituiti da depositi dell'associazione di litofacies FA e/o BP (rispettivamente ambienti di laguna aperta e bassifondi sabbiosi, fig. 4), quelli più sottili mostrano al loro interno una maggiore diffusione dei depositi dell'associazione di litofacies FO (ambienti lagunari a circolazione ristretta). Infine, più lunghi trend Trasgressivo/Regressivi sono suggeriti dall'organizzazione verticale dei trend a medio termine, il cui spessore tende a diminuire dal ciclo 2 al ciclo 7 (intervallo «regressivo») per poi aumentare dal ciclo 8 al ciclo 9 (intervallo «trasgressivo»; fig. 5). Queste caratteristiche riflettono una organizzazione ciclica gerarchica, analogamente a quanto riscontrato nel Cretacico dell'Italia Centrale e Meridionale.

Gerarchia di cicli e tipi di limiti (superfici di erosione subaerea che troncano depositi subtidali) suggeriscono, nel complesso, che l'evoluzione paleoambientale di Macchia Diavola è stata prevalentemente controllata da meccanismi esterni al sistema deposizionale, anche se influenze locali (autociclicità) non possono essere escluse. Studi di dettaglio (scala da centimetrica a decimetrica) di altre successioni coeve sono necessari per definire con maggiore precisione la gerarchia delle oscillazioni e confermare così la loro natura allociclica, analoga a quella messa in luce da lungo tempo con lo studio di successioni Cretaciche e Triassiche, in facies di piattaforma carbonatica dell'Italia centrale e meridionale.

TERMINI CHIAVE: *rocce carbonatiche, sedimentologia, biostratigrafia, ciclicità, Giurassico superiore, Italia meridionale.*

INTRODUCTION

In the last two decades a total of about 1500m of Cretaceous carbonate platform strata cropping out in Central and Southern Italy (e.g. D'ARGENIO *et alii*, 1987, 1997, 1999, 2004; BUONOCUNTO *et alii*, 1994, 1999; RASPINI, 1998, 2001; FERRERI *et alii*, 2004; AMODIO, 2006) and in Montenegro (Dinarides; SANDULLI, 2004) were measured and sedimentologically studied at centimetre to decimetre scale. This allowed: (*a*) to interpret the depositional dynamics of the analyzed successions, (*b*) to develop an appropriate sedimentary model and (*c*) to understand the role of climatic oscillations in their development. It was possible to recognize a hierarchical organization of the stratal sequences in elementary cycles, bundles (groups of 2 to 5 elementary cycles) and superbundles (groups of 2 to 4 bundles). This hierarchy of cycles is related to the Earth's orbital perturbations: the elementary cycles are associated with the precession and/or the obliquity periodicities and the bundle and superbundles with the short- and long eccentricity of the Earth's orbit, respectively (e.g. LONGO *et alii*, 1994; BRESCIA *et alii*, 1996; D'ARGENIO

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et alii, 1997). Moreover, the above cycles appear to be superimposed on lower frequency (medium- to long-term Transgressive/Regressive Facies Trends, see e.g. D'ARGENIO *et alii*, 2004).

In this paper we extend our study to the Jurassic deposits of Southern Italy, where this type of cyclostratigraphic approach had not yet been carried out. In order to recognize medium- to long-term Transgressive/Regressive Facies Trends, we have choosen a metre-scale sampling density. The studied section crops out along the southern side of Monte Monaco di Gioia, a part of the Matese, Central-Southern Apennines, extending from the eastern Campania to the western Molise (fig. 1). The Matese backbone is prevailingly composed of carbonate rocks, Mesozoic in age, followed by Miocene calcareous and terrigenous deposits and by thin Quaternary continental beds. In this area, the whole Jurassic reaches a thickness of about 800m and we discuss here its uppermost interval, 350 m thick, well exposed at Macchia Diavola. Beds are made up of limestones and minor dolomitized limestones, light brown to grey in colour. Their thickness ranges from 0,25 to 1m, with a strike of N7°W and an average dip of 27°NE. Although the Matese mountains underwent a complex deformational history of compression and extension (e.g. FERRANTI, 1997; CALABRÒ *et alii*, 2003), at the outcrop scale only mild tectonic deformations and intrabed displacements locally affect the studied succession, therefore no significant change of the original thickness of the studied interval has been considered.

THE MACCHIA DIAVOLA SECTION

METHODOLOGY

Bed thickness and attitude were sequentially measured in the field. Their characterizing biota (fig. 2) as well as their textural variations, including sedimentary structures and early diagenetic features (fig. 3) were also tabulated. Fossil associations (mostly foraminifers and green algae) were first recognized in the field, using a 10× hand lens and later analyzed in thin section; the first occurrence of the most significant biota is indicated (FO, in fig. 2). About 300 thin sections, integrated with polished slabs and acetate peels, were used for microfacies analysis.

BIOSTRATIGRAPHY

The Late Jurassic is evidenced by benthonic foraminifers and green algae, among which: *Kurnubia palastiniensis* HENSON, *Kurnubia* sp., *Salpingoporella annulata* CAROZZI, *Salpingoporella* sp., *Clypeina jurassica* FAVRE, *Clypeina* sp. and *Campbelliella striata* (CAROZZI). At 59 and 68 m from the base of the section the First Occurrence (FO in figs. 1, 2) of *Salpingoporella annulata* and *Clypeina jurassica* respectively has been recognized; moreover *Campbelliella striata* occurs between 219 and 323 m from the base. According to SARTONI & CRESCENTI (1962), CATENACCI *et alii* (1963), CHIOCCHINI & MANCINELLI (1977), DE CASTRO (1987) and CHIOCCHINI *et alii* (1994) the above reported fossil associations suggest a late Kimmeridgian to Tithonian interval. Moreover, the gradual disappearance of *Kurnubia palastiniensis* at about 55 m from the base and the appearence of *Clypeina jurassica*, associated with *Salpingoporella annulata*, suggest that the Kimmeridgian-Tithonian transition is included in an interval about 30 m thick. Finally, the FO of *Campbelliella striata* (which is very abundant between 219 and 258 m from the base), associated with *Clypeina jurassica,* indicate that the upper Tithonian is recorded in the uppermost part of the Macchia Diavola section (figs. 1, 2). However, time-resolution of these benthonic biozones, in this part of the Jurassic, is not in excess of one million years (see, e.g., DE CASTRO, 1987).

LITHOFACIES AND LITHOFACIES ASSOCIATIONS

A careful sedimentological study has allowed us to identify and interpret the most significant sedimentary structures and early diagenetic features, like bioturbation, micritization, paleokarst and pedogenesis (fig. 3). In the analyzed section we have identified 7 lithofacies, grouped in 3 main lithofacies associations (FA, BP, FO), each belonging to a main depositional environment (fig. 4).

As to the use of *lithofacies* and their associations, let us briefly summarize our understanding in regards. *Lithofacies* has been defined (BUONOCUNTO *et alii*, 1994; D'ARGENIO *et alii*, 1997) as discrete rock volume (a bed or part of it, seldom more than a single bed), distinguished on the basis of its specific physical characteristics such as texture, type of constituent grains (including fossils or their fragments, considered as grains), colour and sedimentary structures. Each lithofacies was laid down in a specific depositional (sub-) environment and may have a variable early diagenetic overprint. However, if an environmental interpretation is desired, a single lithofacies cannot provide a univocal answer: to better establish its depositional setting it must be framed into a *lithofacies association*. In this sense a lithofacies association is a group of lithofacies that occur together in discrete sequence intervals and are considered to be genetically related to each other (COLLINSON, 1969; WALKER, 1992; READING, 1996). It follows that a *lithofacies association* represents the product of depositional processes that, in our case, are: an open lagoon, a sand shoal, a restricted lagoon and so on. All the lithofacies forming an association derive from sub-environments belonging to a specific environment characterized by similar parameters (salinity, hydrodynamics, water oxygenation and the like). This also implies that any single lithofacies can belong to a lithofacies association only. Finally, we consider some clastic textures, frequently intercalated in the above litho-

Fig. 1 (A) - Panoramic view of the Macchia Diavola outcrop; in the box: the studied strata. (*B*) On the left: interval sampled at decimetre to metre scale (dashed line); on the right: a lithostratigraphic log with location of the most significant samples, biozones, stages and first occurrence (FO) of the main bioevents. (*C*) Location of the Macchia Diavola section (southern-western side of Monte Monaco di Gioia, eastern Matese).
– (A) *Veduta panoramica dell'affioramento di Macchia Diavola; nel riquadro la successione analizzata.* (B) *A sinistra: sezione campionata (linea tratteggiata); a destra: log litostratigrafico con l'ubicazione dei campioni raccolti, la distribuzione delle biozone, l'età e i bioeventi più significativi.* (C) *Ubicazione della sezione di Macchia Diavola (versante sud-occidentale del Monte Monaco di Gioia, Matese orientale).*

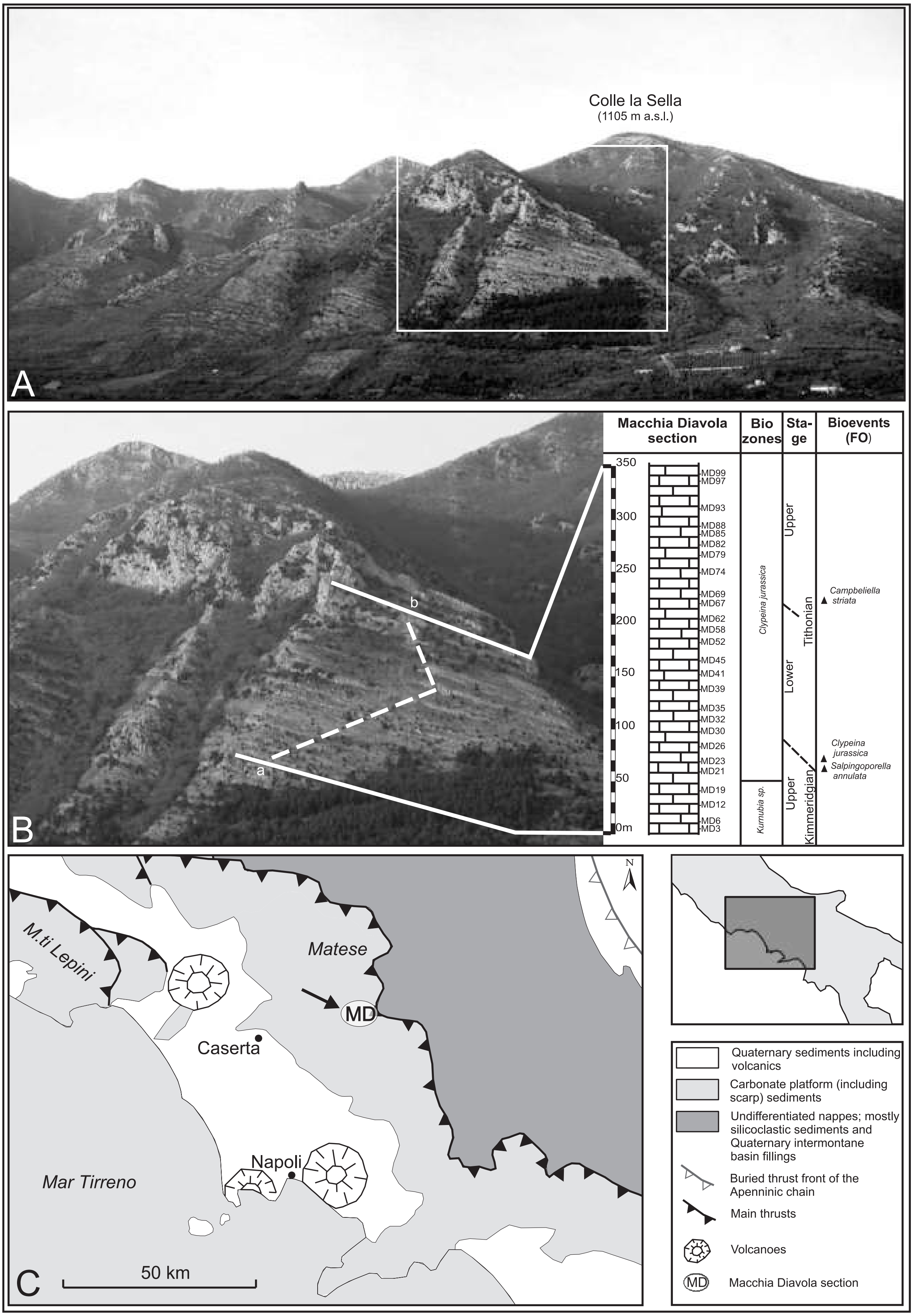
Colle la Sella
(1105 m a.s.l.)
A
Macchia Diavola section
Bio zones
Sta-ge
Bioevents (FO)
350
300
250
200
150
100
50
0m
MD99
MD97
MD93
MD88
MD85
MD82
MD79
MD74
MD69
MD67
MD62
MD58
MD52
MD45
MD41
MD39
MD35
MD32
MD30
MD26
MD23
MD21
MD19
MD12
MD6
MD3
Clypeina jurassica
Kurnubia sp.
Upper
Lower
Tithonian
Upper
Kimmeridgian
Campbeliella striata
Clypeina jurassica
Salpingoporella annulata
a
b
B
M.ti Lepini
Matese
MD
Caserta
Napoli
Mar Tirreno
50 km
C
N
Quaternary sediments including volcanics
Carbonate platform (including scarp) sediments
Undifferentiated nappes; mostly silicoclastic sediments and Quaternary intermontane basin fillings
Buried thrust front of the Apenninic chain
Main thrusts
Volcanoes
Macchia Diavola section

Fig. 1.

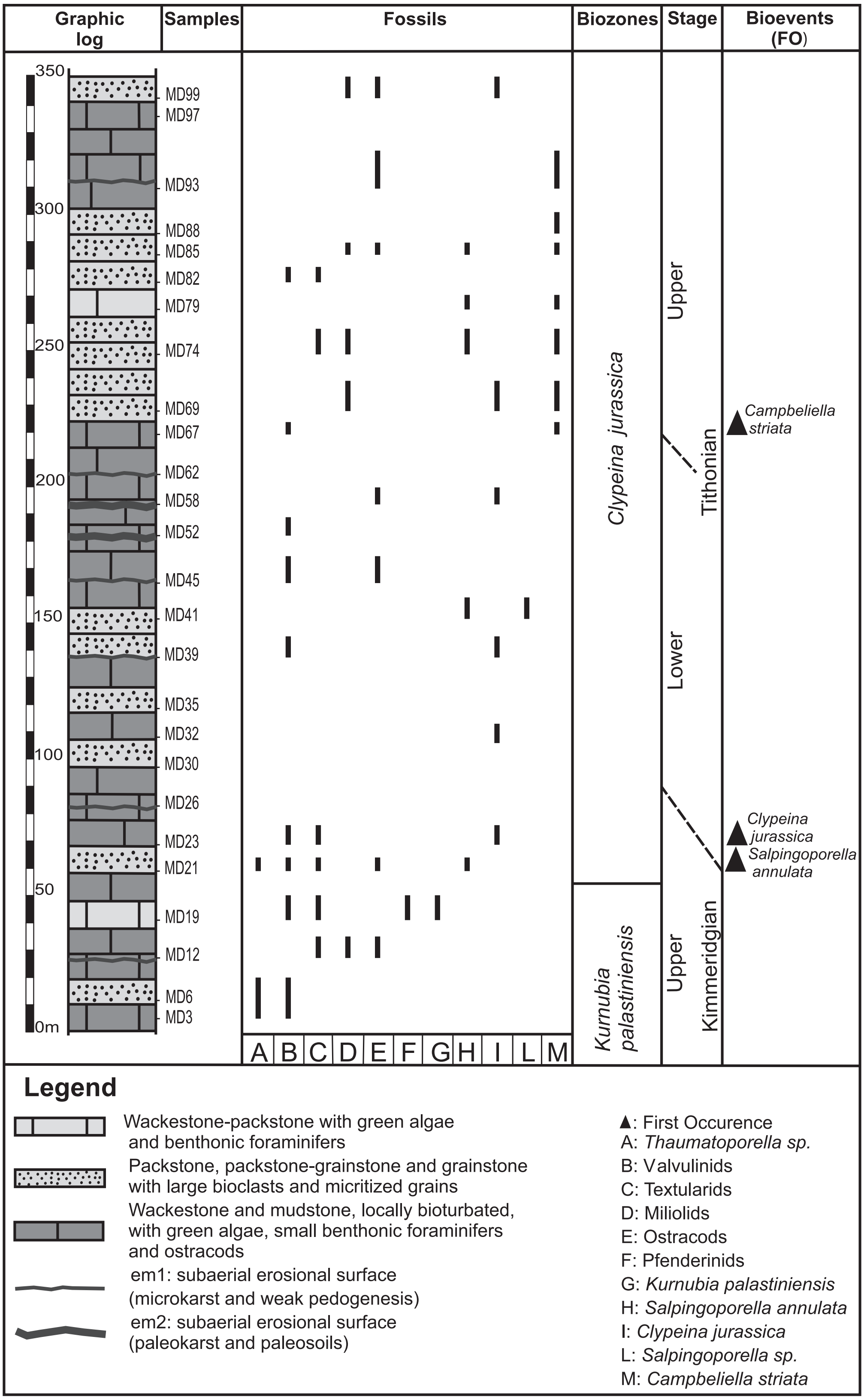

Fig. 2 - Stratigraphic distribution of the most significant microfossils (foraminifers and algae) and biozones of the analyzed Macchia Diavola section. FO: First Occurrence.
– *Distribuzione stratigrafica dei microfossili più significativi (foraminiferi e alghe) e biozone della successione di Macchia Diavola. FO: prima comparsa.*

Samples	Textures (G P W M)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Remarks
MD99	P		x	x				x												Packstone with peloids and small bioclasts.
MD97	M		x			x	x	x				x								Mudstone with small benthonic foraminifers and ostracods.
MD93	W–M		x		x	x	x					x		x		x				Bioturbated wackestone-mudstone with green algae (among which *Campbeliella striata*) and small molluscan shells; microkarst, pervasive dissolution and pedogenesis.
MD88	G–P	x	x			x		x			x									Packstone with peloids and small bioclasts passang to a grainstone with large bioclasts and subordinate intraclasts.
MD85	P		x	x	x	x		x												Packstone with peloids and small bioclasts; cross lamination.
MD82	P			x	x	x		x											x	Packstone with peloids and small bioclasts.
MD79	W		x		x	x				x		x								Bioturbated wackestone-packstone with green algae (among which *Campbeliella striata* and *Salpingoporella* sp.), large molluscan shells (pelecypods and gastropods).
MD74	P		x	x				x										x		Packstone with peloids and small bioclasts (among which fragments of *Salpingoporella annulata*).
MD69	G–P		x	x				x		x	x									Packstone-grainstone with peloids and small micritized intraclasts.
MD67	W		x	x														x		Weakly dolomitized wackestone with *Campbeliella striata* and rare small benthonic foraminifers.
MD62	W		x									x					x			Bioturbated wackestone with *Clipeyna Jurassica*; microkarst.
MD58	M						x		x	x			x	x	x	x	x		x	Mudstone with ooids, peloids and micritized grains showing erosional transition to a packstone with intraclasts, bioclasts and peloids (tempestite); pedogenetic and microkarstic features occur in the uppermost part.
MD52	W		x	x		x										x	x			Wackestone with *Campbeliella striata* associated with green algae, small benthonic foraminifers and gastropods; microkarst.
MD45	M			x			x					x					x			Bioturbated mudstone with small benthonic foraminifers and ostracods; microkarst.
MD41	P		x					x		x										Packstone with fragments of green algae (among which *Campbeliella striata Salpingoporella* sp.), micritized grains and peloids.
MD39	P		x	x				x								x			x	Packstone with peloids passing to wackestone with *Clypeina jurassica*; microkarst.
MD35	P							x												Packstone with peloids.
MD32	W		x					x												Wackestone with *Clypeina jurassica* and peloids.
MD30	G–P							x			x									Packstone-grainstone with peloids and small intraclasts.
MD26	M											x			x	x				Bioturbated mudstone; microkarst.
MD23	W		x	x																Wackestone with *Clypeina jurassica* and rare small benthonic foraminifers.
MD21	P		x	x				x			x									Packstone with peloids, small bioclasts (among which fragments of *Salpingoporella annulata)* and intraclasts.
MD19	P–W			x			x			x		x			x					Bioturbated wackestone-packstone with benthonic foraminifers (among which *Kurnubia palastiniensis),* ostracods and micritized grains; microkarst.
MD12	M			x			x							x		x	x		x	Mudstone with ostracods and small benthonic foraminifers; pedogenesis and microkarst.
MD6	G–P		x	x				x												Packstone-grainstone with peloids and rare bioclasts (small benthonic foraminifers and *Thaumatoporella* sp.).
MD3	W		x	x								x								Bioturbated wackestone with rare, small benthonic foraminifers and *Thaumatoporella* sp.

Fig. 3 - Textural and diagenetic features of the analyzed samples. G) grainstone; P) packstone; W) wackestone; M) mudstone. 1: *Cayeuxia*; 2: green algae; 3: benthonic foraminifers; 4: gastropods; 5: pelecypods; 6: ostracods; 7: peloids; 8: ooids; 9: micritized grains; 10: intraclasts; 11: bioturbation; 12: erosional surface; 13: pedogenesis; 14: *fenestrae*; 15: pervasive dissolution; 16: geopetal cavity; 17: dolomitization; 18: stylolitization.

– *Tessiture deposizionali e diagenetiche riconosciute nei campioni analizzati. G) grainstone; P) packstone; W) wackestone; M) mudstone. 1:* Cayeuxia; *2: alghe verdi; 3: foraminiferi bentonici; 4: gasteropodi; 5: lamellibranchi; 6: ostracodi; 7: peloidi; 8: ooidi; 9: granuli micritizzati; 10: intraclasti; 11: bioturbazione; 12: superfici erosive; 13: pedogenesi; 14:* fenestrae; *15: dissoluzione pervasiva; 16: cavità geopete; 17: dolomitizzazione; 18: stilolitizzazione.*

LITHOFACIES ASSOCIATIONS	LITHOFACIES	PALEOENVIRONMENT
FORAMINIFERAL-ALGAL LIMESTONES (FORALGAL - FA)	**FA1**: bioturbated wackestone-packstone with green algae and large molluscan shells (pelecypods and gastropods). **FA2**: bioturbated wackestone-packstone with benthonic foraminifers.	OPEN LAGOON
BIOCLASTIC-PELOIDAL LIMESTONES (BIOPELOIDAL - BP)	**BP1**: packstone-grainstone with large bioclasts and micritized grains. **BP2**: packstone, packstone-grainstone and grainstone with peloids, small bioclasts and rare micritized intraclasts.	SAND SHOALS
FORAMINIFERAL-OSTRACOD LIMESTONES (FOROSTRACOD - FO)	**FO1**: bioturbated wackestone with green algae, small benthonic foraminifers and molluscan shells. **FO2**: wackestone, locally bioturbated, with green algae, rare small benthonic foraminifers and peloids. **FO3**: bioturbated mudstone with small benthonic foraminifers and ostracods.	RESTRICTED LAGOON

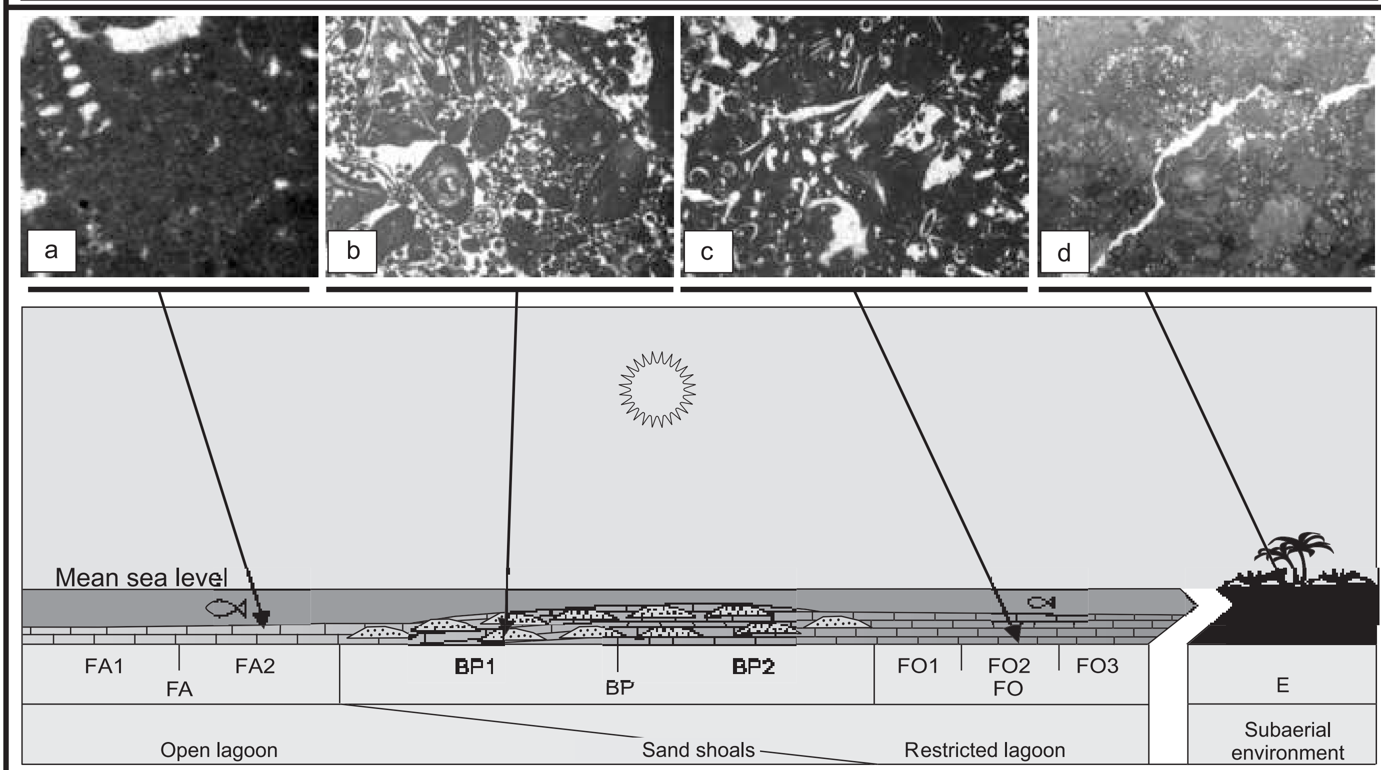

Fig. 4 - Upper row: lithofacies, lithofacies associations and their environmental interpretation. Lower row: sedimentary model for the Late Jurassic of Macchia Diavola. Note that a discontinuous belt of sand shoals is located at the transition between restricted and open lagoon environments. Thin sections (positive prints) of some lithofacies are also shown: *a*) micritized and bioturbated wackestone-packstone, with benthonic foraminifers and ostracods (lithofacies FA2, about 20×); *b*) grainstone-packstone with bioclasts (lithofacies BP1, about 20×); *c*) wackestone with *Campbelliella striata* and peloids (lithofacies FO2, about 15×); *d*) diagenetic texture; the early meteoric overprint (pervasive dissolution and pedogenesis) partially obscures the primary depositional texture of a peloidal-intraclastic packstone (lithofacies BP2, about 15×).

– *In alto: litofacies, associazioni di litofacies e loro interpretazione ambientale. In basso: modello sedimentario del Giurassico superiore di Macchia Diavola, mostrante l'organizzazione areale degli originari ambienti deposizionali (litofacies e loro associazioni); si noti una fascia discontinua di bassifondi sabbiosi localizzata alla transizione fra ambienti di laguna aperta e di laguna ristretta con esempi di alcune litofacies:* a) *wackestone-packstone bioturbato, con foraminiferi bentonici ed ostracodi, diffusa micritizzazione dei granuli (litofacies FA2, circa 20×);* b) *grainstone-packstone con bioclasti (litofacies BP1, circa 20×);* c) *wackestone con* Campbelliella striata *e peloidi (litofacies FO2, circa 15×); d) tessitura diagenetica; la dissoluzione pervasiva e la pedogenesi parzialmente oscurano le caratteristiche primarie, rendendo problematica l'interpretazione dell'originaria tessitura deposizionale (litofacies BP2, circa 15×).*

facies associations, as the result of higher energy depositional processes such as storm events (tempestites, see D'ARGENIO *et alii*, 1987; BUONOCUNTO *et alii*, 1994).

Foraminiferal-algal limestones (Foralgal, FA)

This lithofacies association is characterized by bioturbated wackestone/packstone, showing a high diversity of fossil associations (different genera of green algae and benthonic foraminifers commonly associated with molluscan shells). It occurs rarely and is represented by 2 lithofacies, here indicated as FA1 and FA2:

– bioturbated wackestone-packstone with green algae and large pelecypod and gastropod shells; the foraminifers are subordinate. It occurs at about 275m from the base of the section (FA1);

– bioturbated wackestone-packstone with benthonic foraminifers; green algae are subordinate and there are no molluscan shells. It occurs at about 55m from the base of the section (FA2).

Environmental interpretation. The high diversity of the fossil associations in the bioturbated W/P textures allows us to attribute the two lithofacies of this association to an open lagoon environment. Moreover, on the basis of the above characteristics, we consider the lithofacies FA1 as pertaining to a more external sector of an open lagoon, as compared to lithofacies FA2.

Bioclastic-peloidal limestones (Biopeloidal, BP)

This association, occasionally affected by minor dolomitization, is widespread throughout the section. It is represented by grain-supported textures (packstone, packstone-grainstone and grainstone) in which molluscan shell fragments, benthonic foraminifers and peloids are very frequent, at times associated with small intraclasts. Two lithofacies are individuated:

– packstone-grainstone with large bioclasts and micritized grains (BP1);

– packstone, packstone-grainstone and grainstone with peloids, small bioclasts and rare small intraclasts; cross lamination may occur (BP2).

Environmental interpretation. The grain supported textures, the absence of grading, the local occurrence of cross lamination, as well as the gradual transition either to deposits of lithofacies association FO (see below) or, subordinately, to deposits of lithofacies association FA (see above), suggest, on the whole, a shallow-marine environment characterized by high energy (inner platform sand shoals).

Foraminiferal-ostracod limestones (Forostracod, FO)

This lithofacies association groups wackestone and mudstone characterized by oligotypic fossil associations. These deposits are commonly bioturbated and may be affected by minor dolomitization. Three lithofacies are recognized:

– bioturbated wackestone with green algae, small foraminifers and molluscan shells (FO1);

– wackestone, locally bioturbated, with *Clypeina jurassica, Campbelliella striata,* in association with green algae, peloids and rare, small foraminifers (FO2);

– bioturbated mudstone with small foraminifers and ostracodes (FO3).

Environmental interpretation. The pelitic component of this lithofacies association and the characteristics of the fossil assemblages, sometimes oligotypic (lithofacies FO3), suggest depositional processes in a lagoonal environment with restricted circulation.

The above lithofacies alternate along the studied succession, revealing environmental variations forced by relative sea level changes (fig. 5).

CYCLIC CHANGES

The vertical variation of lithofacies, lithofacies associations and related diagenetic features (from marine to meteoric) suggests that the Macchia Diavola sedimentary environment oscillated from a platform setting, characterized by higher hydrodynamic energy (sand shoals, lithofacies association BP), to lagoonal areas with restricted circulation (lithofacies association FO) and, subordinately, to open lagoonal environments with normal marine circulation (lithofacies association FA).

The vertical organization of lithofacies and their association shows a cyclic recurrence that has been analyzed in terms of depositional and early diagenetic features. On this basis, two main types of shallowing-upward cycles have been identified (medium-term Transgressive/Regressive Facies Trends in fig. 5). In the first type there is no evidence of subaerial exposure and the shallowing-upward trend is only indicated by lithofacies changes (from more open to more restricted), allowing depositional boundaries to be recognized (cycles 3 and 9, fig. 5). In the second type the upward shallowing is testified by karstic and/or pedogenetic features at the top of the subtidal deposits (upper diagenetic boundaries of cycles 1, 2, 4 to 8 and 10, fig. 5). In this case recurrent subaerial-exposure episodes are clearly recorded, due to sea level lowering controlled by allocyclic mechanisms, basin to global scale, independent from the local depositional settings (*diagenetic cyclothems* in D'ARGENIO, 1976, see also D'ARGENIO *et alii*, 1997, 1999). In particular, weak pedogenetic features, pervasive dissolution and/or mm-size karstic cavities indicate an early diagenetic fabric developed in a meteoric regime (em1-type subaerial-exposure surfaces, fig. 5), whilst cm- to dm-size karstic cavities, locally marked by paleosol and/or by cm-thick clayey horizons, suggest, on the whole, a solution network due to a more extended platform exposure (em2-type subaerial-exposure surfaces, fig. 5). It is worth noting that there is a direct relationship between cycle thickness and its sedimentary facies: thinner cycles are normally characterized by a prevalence of more restricted lithofacies (e.g. cycles 7, 8), whereas the thicker cycles show a prevalence of more open marine deposits (e.g. cycles 2, 6, 10).

Finally, looking at the stacking pattern of the medium-term cycles we note that: (*a*) more restricted environmental conditions tend to spread from cycle 2 to 7, while cycles 8 and 9 suggest a return towards more open marine circulation; (*b*) the cycle thickness tends to decrease from cycle 2 to 7 while it tends to increase from cycle 8 to 9. This allows us to recognize a long-term Regressive Trend (from cycle 2 to 7) followed by a long-term Transgressive Trend (cycles 8 and 9, fig. 5).

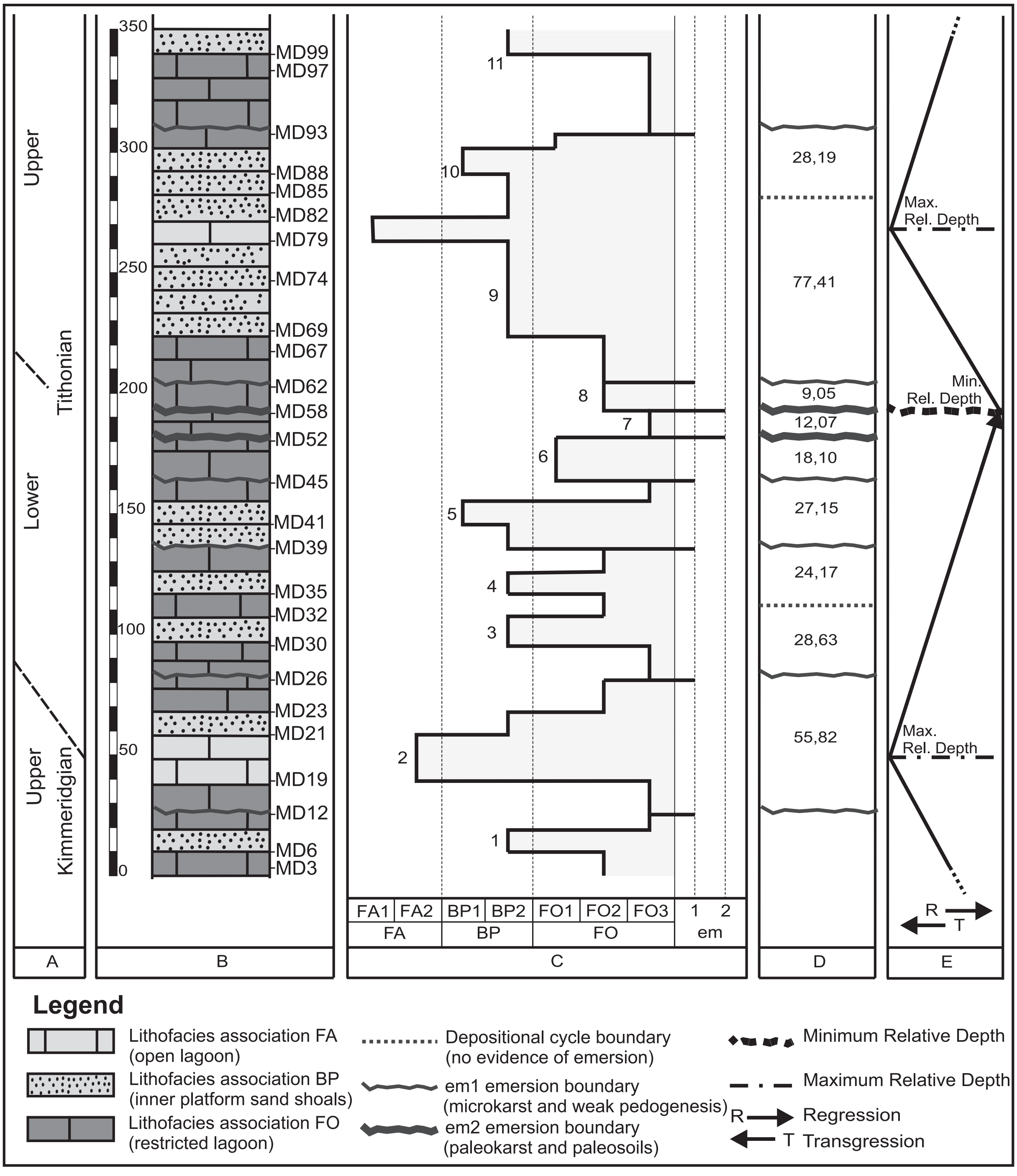

Fig. 5 - Lithology and cyclicity of the Macchia Diavola section. (*A*) Stages. (*B*) Graphic log showing the vertical organization of the lithofacies associations recognized in the field; letters and numbers to the right of the lithologic column indicate the analyzed samples (see also fig. 3). (*C*) Relative sea level curve showing the medium-term Transgressive/Regressive Facies Trends as revealed by the vertical change of lithofacies (FA1 to FO3. analyzed samples) and their associations (lithologic log in column B) as well as by marine to meteoric early diagenetic overprint (horizontal line); em1 and em2 indicate subaerial-exposure related surfaces whose karstic and/or pedogenetic features increasingly penetrate downwards; overall 9 complete metre-to-decametre scale cycles (from 2 to 10) and 2 incomplete cycles (1 and 11) have been recognized. (*D*) Thickness change (in metres) of the medium-term relative sea level cycles; the related boundaries (depositional and diagenetic) are also shown. (*E*) Long-term Transgressive/Regressive Facies Trends as revealed by thickness stacking pattern of the medium-term cycles (columns C and D); note the related Maximum Relative Depth suggested by the more open cycles 2 and 9 and the Minimum Relative Depth indicated by the more restricted cycle 7.

– *Litologia e ciclicità della sezione di Macchia Diavola.* (A) *Piani.* (B) *Log grafico mostrante l'organizzazione verticale delle associazioni di litofacies individuate in campagna; le sigle riportate sul lato destro della colonna litologica indicano i campioni analizzati (vedi anche fig. 3).* (C) *Curva delle oscillazioni relative del livello marino (cicli a medio-termine Trasgressivo/Regressivi) suggerite dalla variazione verticale delle litofacies (FA1-FO3, campioni analizzati) e loro associazioni (log litologico in colonna B) e dal rinvenimento, lungo la successione, di superfici di emersione subaerea (em1 e em2). Nel complesso sono stati individuati 9 cicli di spessore metrico-decametrico (dal ciclo 2 al 10) e 2 cicli incompleti (ciclo 1 e 11).* (D) *Variazione dello spessore (in metri) dei cicli a medio-termine, per i quali sono anche rappresentati i tipi di limiti (deposizionali e diagenetici).* (E) *Trend Trasgressivo/Regressivi a lungo-termine suggeriti dall'organizzazione verticali dei cicli a medio-termine (colonne C e D); si noti il riconoscimento delle fasi di massima profondità relative in corrispondenza dei cicli 2 e 9 (più aperti) e di minima in corrispondenza del ciclo 7 (più ristretto).*

CONCLUSIONS

It is well known that the stratal organization resulting from high- and low-frequency sea-level cycles is ubiquitous in the Cretaceous carbonate platform sequences of central and southern Italy, as demonstrated by many cyclostratigraphic studies (cm to dm scale) carried out in the last 20 years (see, e.g., D'ARGENIO *et alii*, 1987, 1997, 1999, 2004; BUONOCUNTO *et alii*, 1994, 1999; RASPINI, 1998, 2001; FERRERI *et alii*, 2004; AMODIO, 2006). Here we have extended these studies to an earlier interval, in order to investigate the Late Jurassic cyclic signal suggested by the paleoenvironmental changes recorded at a scale of tens of metres. To this purpose the Macchia Diavola strata, well exposed along the south-western side of Monte Monaco di Gioia (Matese mountains, Campania Apennines), were measured at decimetre to metre scale, to analyze the stacking pattern of lithofacies, lithofacies associations and early diagenetic features (marine to meteoric). Seven lithofacies were recognized and grouped in three main lithofacies associations (fig. 4). Their environmental interpretation allowed us to conclude that the analyzed carbonate strata sedimented under shallow marine environmental regimes. This is indicated by the recurrence, throughout the succession, of deposits of the lithofacies associations BP (sand shoals), showing gradual transition either to deposits of the lithofacies association FO (lagoonal areas with more restricted circulation) or to deposits of lithofacies associations FA (open lagoonal sectors, with normal marine circulation). Karstic microcavities and/or vadose dissolution features, locally associated with pedogenetic features, have been often recognized in the topmost part of several subtidal strata. They indicate erosion surfaces due to lowering of sea level (em1 and em2 cycle boundaries, column C and D in fig. 5).

Eleven cycles (medium-term Transgressive/Regressive Facies Trends) have been individuated, revealed by the curve constructed on the basis of the vertical organization of the lithofacies, lithofacies associations and subaerial exposure surfaces, the latter suggesting periods of subaerial exposure of the carbonate platform (column C in fig. 5). Finally, a long-term Regressive Trend is recorded from cycle 2 to 7, while a long-term Transgressive Trend from cycle 8 to 9. This ordered cyclic organization is comparable to that of the Cretaceous carbonate platform strata analyzed in central and southern Italy during the last two decades. We conclude that the paleoenvironmental evolution of the Late Jurassic deposits cropping out in the Matese area were prevailingly controlled by allocyclic mechanisms. It follows that microstratigraphic (cm scale) studies may allow investigation of higher frequency cyclicity, superimposed on the medium-term Transgressive/Regressive Facies Trends. Should an orbital control be recognized, a high precision long-distance correlation (at 100- to 400ky scale) may be undertaken also in the Jurassic of the Central-Southern Apennines area.

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Università degli Studi "G. d'Annunzio"
CHIETI - PESCARA

PROT. N. 5286 RISPOSTA A NOTA N. .... DEL ....

OGGETTO: Dott. Andrea Randisi, nato a Piedimonte Matese (CE) il 24.05.1978 – Conferimento assegno per la collaborazione ad attività di ricerca ex art. 51, sesto comma, L. 27/12/1997, n. 449.

Chieti, lì 01 LUG. 2008

AL SIG. DIRETTORE DEL DIPARTIMENTO DI SCIENZE DELLA TERRA
ALL'AREA 2 – GEST. EC. E FINANZIARIA
ALL'UFFICIO STIPENDI
SEDE

e,p.c. DOTT. ANDREA RANDISI

Il nominato in oggetto è risultato vincitore del concorso per n. 1 assegno per la collaborazione ad attività di ricerca dell'importo netto annuo di € 16.138=, Area 04, Sett. sc. disc. GEO/02, "Studio stratigrafico sedimentologico delle successioni di margine e scarpata del giurassico medio-superiore e del cretaceo inferiore dell'Appennino centrale" (Affisso all'Albo il 28.12.2007) bandito con decreto n. 192 del 28.12.2007.

Si rende noto, al riguardo, che ai sensi del D.M. in data 26.02 2004 prot. n. 45/2004, il suddetto importo è elevato ad annui € 16.138,00 al netto degli oneri previdenziali posti in vigente normativa a carico di questa Amministrazione, restando a carico del titolare dell'assegno gli oneri assicurativi, nonché la quota di quelli previdenziali posti a carico del suddetto dalla richiamata normativa

L'interessato inizierà la propria attività, presso il Dipartimento di Scienze della Terra, a decorrere dal 1.07.2008.

Si comunica altresì che l'assegno di cui sopra, ha durata di anni uno ed è rinnovabile, ai sensi e nei limiti di cui al comma sesto dell'art. 51 della legge 27 dicembre 1997, n. 449, a condizione che, antecedentemente alla data di scadenza del contratto, di cui si trasmette copia al Sig. Direttore del Dipartimento e all'Ufficio Stipendi, il tutor ed il Consiglio di codesto Dipartimento, esprimano parere favorevole sull'attività svolta dal conferitario dell'assegno medesimo e codesto Dipartimento assicuri inoltre la relativa copertura finanziaria per il suddetto rinnovo.

All'Ufficio Stipendi si comunica altresì che l'assegno di cui sopra è corrisposto in rate mensili posticipate di pari importo e che ad esso si applicano, ai sensi della norma indicata in oggetto, in materia fiscale, le disposizioni di cui all'art. 4 della Legge 13.08.1984, n. 476 e successive modificazioni ed integrazioni, nonché, in materia previdenziale, quelle di cui all'art. 2, commi 26 e seguenti, della Legge 08.08.1995, n. 335 e successive modificazioni ed integrazioni.

La spesa di cui sopra sarà imputata al Cap. F.S. 2.03.15 del Bilancio.

La Divisione Affari Patrimoniali provvederà alla copertura assicurativa per infortuni e per responsabilità civile in favore del nominato in oggetto, per l'arco temporale sopra indicato e comunicherà l'importo del relativo premio all'Ufficio Stipendi, che curerà il recupero del medesimo dall'assegno corrisposto all'interessato in unica soluzione.

Il Sig. Direttore del Dipartimento vorrà attestare alla scrivente Amministrazione che il Dott. Andrea Randisi ha effettivamente iniziato l'attività collaborativa a decorrere dalla data suindicata.

Distinti saluti.

IL RETTORE
(Prof. Franco Cuccurullo)

UNIVERSITÀ G. D'ANNUNZIO CHIETI-PESCARA

AA.GG./FDF/dspc

SI PREGA DI CITARE NELLA RISPOSTA IL PROT. DELLA PRESENTE

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N° 993 DEL
REGISTRO RILASCIO
DOCUMENTI.

UFFICIO DOTTORATO, ASSEGNI E BORSE DI STUDIO

Si certifica che il Dott. Andrea Randisi, nato a Piedimonte Matese (CE) il 24/05/1978, ammesso a frequentare il dottorato di ricerca in Scienze ed ingegneria del mare 20° ciclo – di durata triennale, presso l'Università degli Studi di Napoli Federico II, ha sostenuto presso quest'Ateneo con esito positivo, l'esame per il conseguimento del titolo di dottore di ricerca il giorno 29.02.2008 con la Commissione giudicatrice 2008 in "Scienze ed ingegneria del mare", presentando una dissertazione finale dal titolo: "Evoluzione morfotettonica tardo-quaternaria nella Piana di Sibari, Calabria settentrionale. Un'approccio multidisciplinare".

Il presente certificato si rilascia in carta semplice per gli usi consentiti.

Napoli, li 27 MAR. 2008

L'IMPIEGATO ADDETTO

IL CAPO DELL'UFFICIO
Dott.ssa Concetta Bernardo

Sig. Canestrelli Fiorenzo
Area Amministrativa - Cat. C4

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