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A GUIDE-LEVEL OF THE UPPERMOST HAUTERIVIAN (LOWER CRETACEOUS) IN THE PELAGIC SUCCESSION OF UMBRIA-MARCHE APENNINES (CENTRAL ITALY): THE FARAONI LEVEL

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Riassunto. In questo lavoro si propone la definizione di un livello guida nella Maiolica dell'Appennino umbro-marchigiano, denominato Livello Faraoni. Gli Ammoniti consentono di attribuire il livello all'Hauteriviano terminale, zona a *angulicostata*, sottozona a *catulloi*. Oltre alla presenza di abbondanti Ammoniti in uno strato guida riconoscibile a scala regionale, il Livello Faraoni è caratterizzato dall'alternanza di micriti bianche e black shales ad elevato contenuto in materia organica.

Abstract. The definition of a regional guide-level, named Faraoni Level, in the Maiolica limestone of the Umbria-Marche Apennines is proposed in this paper. The age of the Faraoni Level is latest Hauterivian. Abundant ammonites date it as *angulicostata* zone, *catulloi* subzone. The level is characterized by the alternation of white micritic limestones and black shales with high organic matter content.

Introduction.

The study of the ammonite biostratigraphy of the upper part of the Maiolica limestone has been recently undertaken in the Umbria-Marche Apennines (Cecca & Pallini, in print).

Ammonites are usually rare in the Maiolica. Furthermore they are often badly preserved because they occur as internal moulds affected by bioturbation and crushed. This sometimes makes the taxonomic identifications very difficult. However, we were

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able to recognize ammonite biozones in the uppermost Hauterivian - Barremian interval. These have been directly correlated with magnetic chrons, planktonic foraminifera and calcareous nannofossil biounits (Cecca et al., in print).

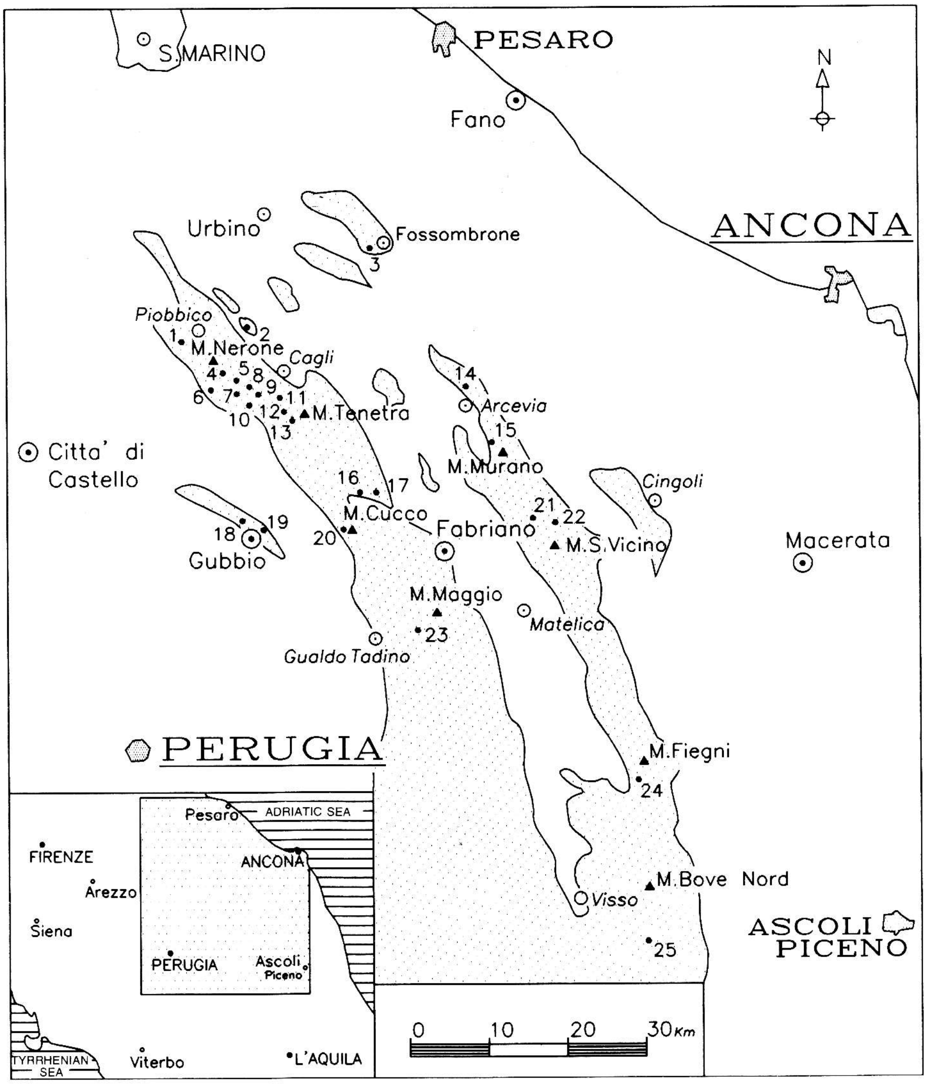


Fig. 1 - Location of the studied outcrops: 1) Sette Vene, Apecchiese road, km 33.7; 2) Gorgo a Cerbara; 3) Fossombrone; 4) Ranchi; 5) Stirpeto; 6) Bugarone; 7) Pieia; 8) Northern slope of Monte Petrano; 9) Monte Petrano road; 10) Bosso; 11) Burano; 12) Ranco Pierello; 13) Monte Tenetra; 14) Palazzo di Arcevia; 15) Monte Murano; 16) Casacce, Arceviese road, km 63.8; 17) Cantoniera Pantana, Arceviese road, km 59.4; 18) Gubbio-Contessa; 19) Gubbio-Bottaccione; 20) Monte Cucco-Pianacce; 21) Poggio San Romualdo; 22) Frontale; 23) Gualdo Tadino-Val Sorda; 24) Lago del Fiastrone; 25) Monte Spina di Gualdo. Dotted areas: meso-caenozoic folded formations.

During our field researches we discovered an important level characterized by an ammonite-rich calcareous bed overlain and underlain by marly interbeds (Cecca & Pallini, in print). Further researches allowed us to recognize this level in 25 localities of our study area (Fig. 1), thus demonstrating its regional significance. Because of its stratigraphic isochrony, as well as its peculiar lithologic and palaeontologic characteristics, we propose in this paper a formal definition of this level, which we name Faraoni Level, after the name of Paolo Faraoni, the person who discovered it and firmly believed in its regional extent.

In this paper we also present some preliminary results of studies on the organic carbon content and palynofacies, which will be discussed in detail in a subsequent publication.

Lithostratigraphic position of the Faraoni Level (F. C., A. M., G. P.).

The Faraoni Level occurs in the upper part of the Maiolica Formation whose upper boundary, according to Coccioni et al. (1987), coincides with the last occurrence of black cherts in the few metres below the beginning of the marly sedimentation of the Marne a Fucoidi Formation.

Due to the thickness of this level, ranging from 25 to 40 cm, its identification and consequently its detailed stratigraphic analysis strongly depends on the exposure in the field. Thus, the study has been realized on the basis of a detailed lithologic description of only 14 sections among the 25 reported on Fig. 1. Ten logs are shown on Fig. 2. The geographic coordinates of the localities studied are listed on Tab. 1.

In most of the outcrops faults or vegetation isolate the interval containing the Faraoni Level from the rest of the succession, thus preventing the measurement of the thickness between the level and the top of the Maiolica. In those sections where the undisturbed stratigraphic sequence can be measured (2, 3, 5, 14 in Fig. 1) it usually occurs 65-70 metres below the top of the Maiolica. However this distance is greater in the southern outcrops (80 m and 86 m in sections 24 and 25) whereas in the Contessa (Fig. 3) and Bottaccione sections (18 and 19 in Fig. 2), this distance is about 40 m. This is related to the presence of "slumps" at the top of the Maiolica. These slumps have been interpreted as back-thrusts by De Feyter & Menichetti (1988).

Lithologic description of the Faraoni Level (F. C., A. M., G. P.).

The most detailed observations have been carried out on the best exposed sections (Fig. 2) where the thin black shale levels are easily visible. The Faraoni Level can be divided into 3 intervals which are described from bottom to top as: Lower interval, Guide-bed and Upper interval. The Lower and Upper intervals are further subdivided in layers which are indicated with letters in alphabetical order from bottom to top (A-G).

Outcrop	Latitude	Longitude
1 Apecchiese road, km 33.7	43°34'40''	0°02'00''
2 Gorgo a Cerbara	43°35'58''	0°06'05''
3 Fossombrone	43°40'57''	0°19'19''
4 Ranchi	43°34'15''	0°04'32''
5 Stirpeto	43°32'06''	0°08'00''
6 Bugarone	43°33'00''	0°05'15''
7 Pieia	43°31'35''	0°05'15''
8 N slope M. Petrano	43°31'49''	0°09'12''
9 M. Petrano road	43°31'22''	0°09'49''
10 Bosso	43°31'04''	0°07'07''
11 Burano	43°31'05''	0°11'22''
12 Ranco Pierello	43°30'04''	0°11'41''
13 M. Tenetra	43°29'21''	0°12'25''
14 Palazzo d'Arcevia	43°31'39''	0°27'48''
15 Monte Murano	43°26'09''	0°31'22''
16 Arceviese road km 63.8	43°25'11''	0°18'34''
17 Arceviese road km 59.4	43°24'53''	0°20'23''
18 Gubbio-Contessa	43°22'11''	0°06'33''
19 Gubbio-Bottaccione	43°21'31''	0°07'41''
20 M. Cucco-Pianacce	43°21'42''	0°16'33''
21 Poggio San Romualdo	43°21'51''	0°33'37''
22 Frontale	43°20'51''	0°38'14''
23 Gualdo Tadino-Val Sorda	43°15'00''	0°21'34''
24 Lago del Fiastrone	43°03'40''	0°43'49''
25 M. Spina di Gualdo	42°52'20''	0°43'52''

Tab. 1 - Geographic coordinates of the studied outcrops.

Lower interval. The definition of this interval is based on the same lithologic succession of black shales recognized on most of the sections, although some black shales may occur below (see sections 1 and 17 in Fig. 2). Its lower boundary is represented by the occurrence of black chert lenses or nodules (Fig. 4a). However, these have not been observed in some localities; this is probably due to the discontinuous lateral development of the cherts.

Above the cherts the following succession has been observed in 12 outcrops. From bottom to top:

A) laminated black shale layer with marcasite nodules which directly overlies the black cherts; 2 to 6 cm;

B) calcareous layer; 1 to 6 cm;

C) black shale; 0.5 cm.

There is an exception in the section at km 59.4 of the Arceviese road (17 in Fig. 2) where we have found a marly limestone bed with marcasite nodules, corresponding to sample 8 in Fig. 2 and Fig. 4d, intercalated between two laminated black shales. This succession occurs above the black cherts and below the layers correlated with layers B and C. There are two possible explanations: 1) in the other sections the equivalent of bed 8 is absent because of a gap; 2) the black shale layer A is much thicker in this section and develops a marly interval.

Guide-bed (layer D). This bed has been recognized in all the studied outcrops. It consists of a limestone bed which is usually 18 cm thick. The Guide-bed is easily recognizable because, as an exception for the Maiolica Formation, ammonites are very abundant (although their abundance differs from section to section), well preserved, not crushed and bear a pseudomorphic test. Commonly the phragmocone is partly filled by both sparry calcite and partly by micrite, thus constituting a geopetal structure. The normal polarity of this structure indicates that fossils have not been reworked. In this bed marcasite nodules may occur and this character can also help to recognize the level on the field because the weathering produces red-rust coloured bands.

Upper interval. This interval is characterized by the presence of black shales and mirrors the lower one. From bottom to top, the following succession has been recognized in 14 outcrops:

E) laminated black shale; 1 to 2.5 cm;

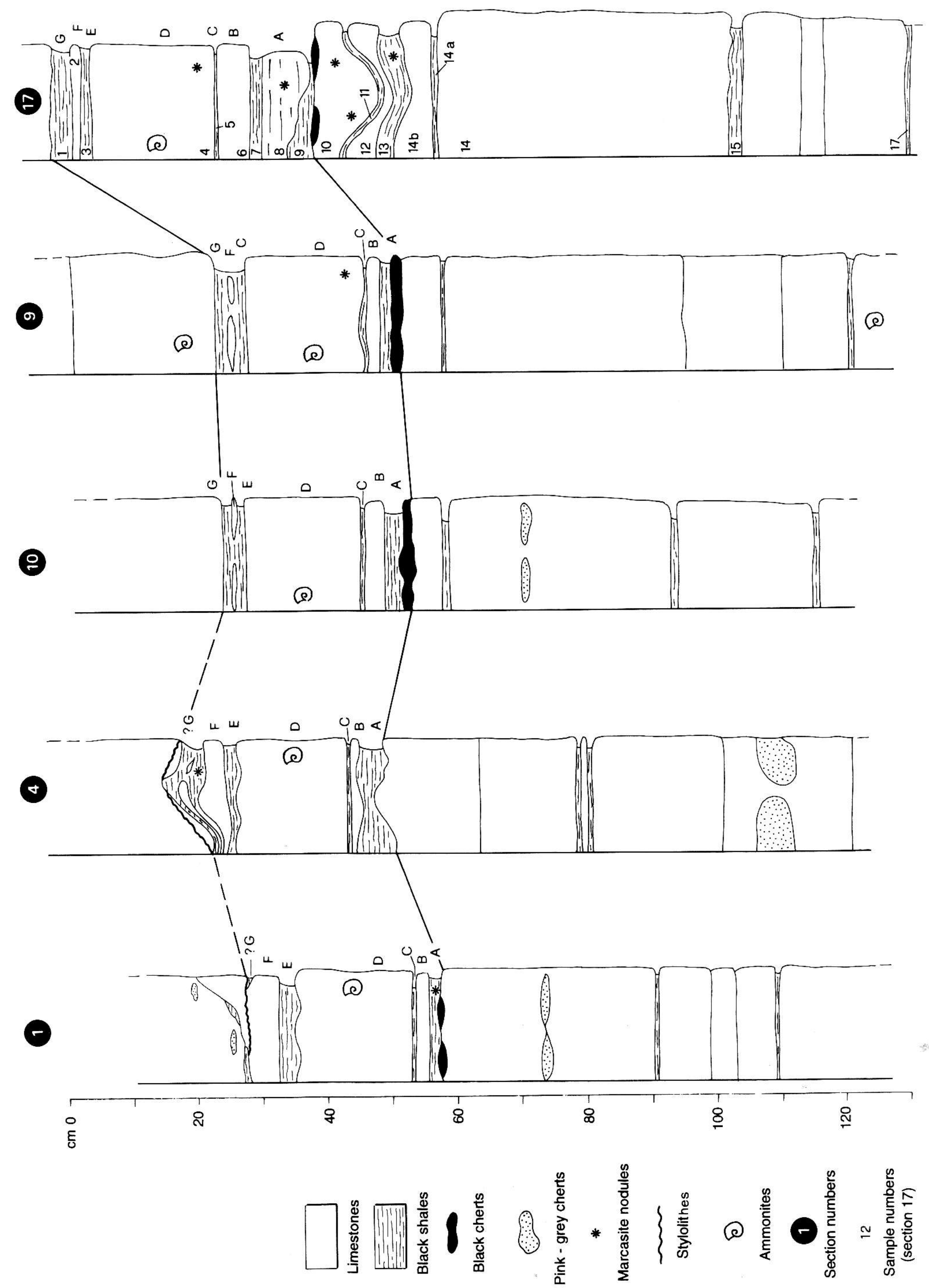
F) calcareous layer which can occur as thin lenses (sections 9 and 10); 1 to 5 cm;

G) laminated black shale; 1.5 to 3.5 cm.

The lenticular bedding of the layer F, which is observed in sections 9 and 10 (Fig. 2), suggests that in the Bottaccione section (19 in Fig. 2), layer G probably overlies layer E directly. It is difficult to correlate the above described succession with the layers overlying the Guide-bed in section 1, as well as the section 4 where another thin calcareous layer is intercalated in the black shale G.

The upper boundary of the Faraoni Level coincides with the black shale G. In most of the sections the overlying sediments are entirely calcareous. However, in the Lago del Fiastrone section (24 in Fig. 2 and 4c), some shaly interbeds have been observed in the beds above the Faraoni Level.

Due to the complete succession of the different levels distinguished above, the good exposure and the easy access we propose the Bosso section (10 in Fig. 2 and Fig.


Limestones
Black shales
Black cherts
Pink - grey cherts
Marcasite nodules
Stylolithes
Ammonites
Section numbers
12
Sample numbers (section 17)
cm 0
20
40
60
80
100
120

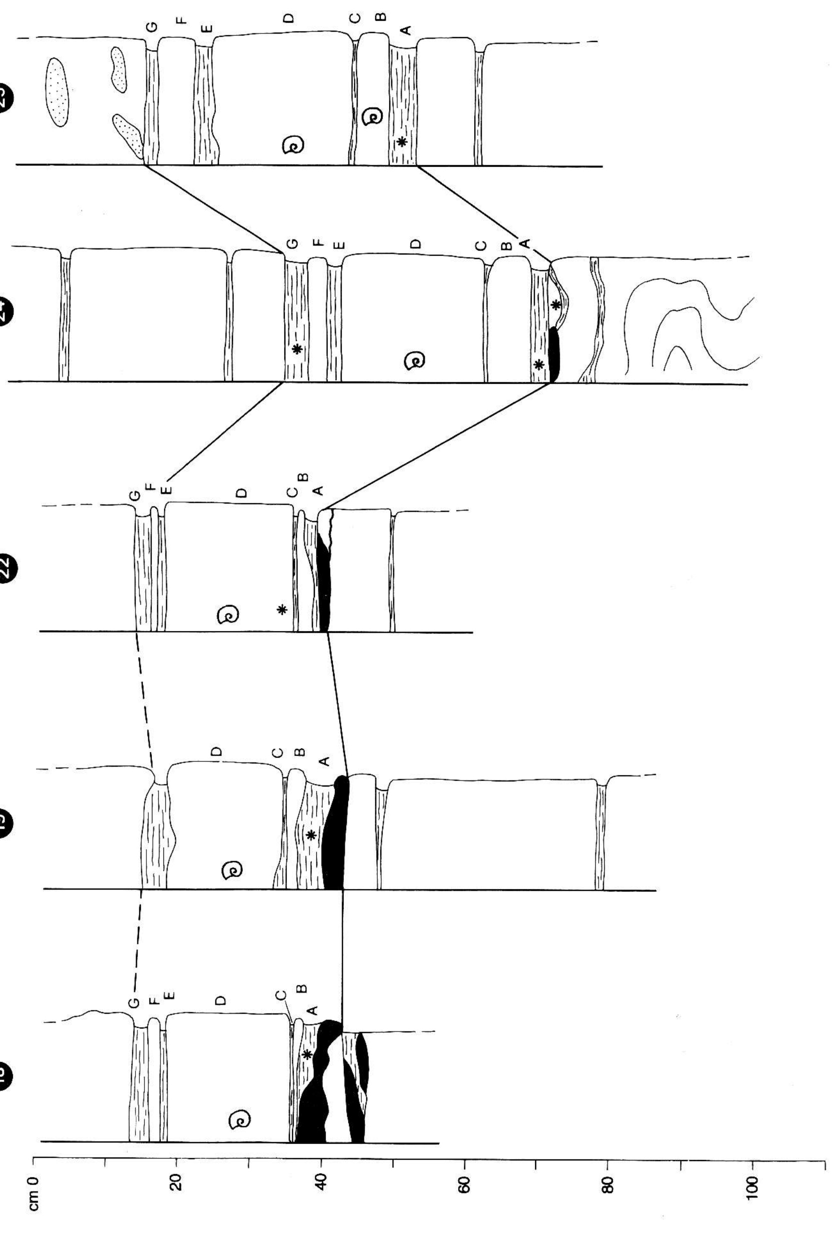


Fig. 2 - Stratigraphic columns of the best exposed sections where the Faraoni Level has been identified. The section numbers refer to the localities as indicated in Fig. 1. Letters from A to G indicate the layers described in the text.

Fig. 3 - Contessa quarry, near Gubbio. The arrows indicate the Faraoni Level. See legenda of Fig. 2 for the detailed lithologic description of this section.

4b) as the reference section for the Faraoni Level. This is exposed along the road from Pianello to Cagli. As additional reference sections we indicate those of Sette Vene, Apecchiese road km 33.7 (1 in Fig. 2 and Fig. 4a), Cantoniera Pantana, Arceviese road km 59.4 (17 in Fig. 2 and Fig. 4d) and Lago del Fiastrone (24 in Fig. 2 and Fig. 4c).

Further observations on lithology. The discontinuous thicknesses of the calcareous beds (Fig. 2), clearly visible in the outcrops, are probably due to dissolution. In fact, they do not display the characteristics of gravity deposits. In section 24 (Fig. 4c) a slump affects the beds below the black chert nodules which correspond to the lower boundary of the Faraoni Level.

The black shales of the Lower and Upper intervals can be missing altogether, as in sections 6 and 11. This is probably due to the action of bottom currents although the bad exposure of some outcrops can be invoked in some cases (2, 13 and some sections on the northern slope of Monte Petrano).

Some black shales, characterized by high TOC values, occur below the Lower interval (sections 1 and 17). However, since they cannot be recognized in all the studied sections, they have been excluded from the definition of the Faraoni Level.

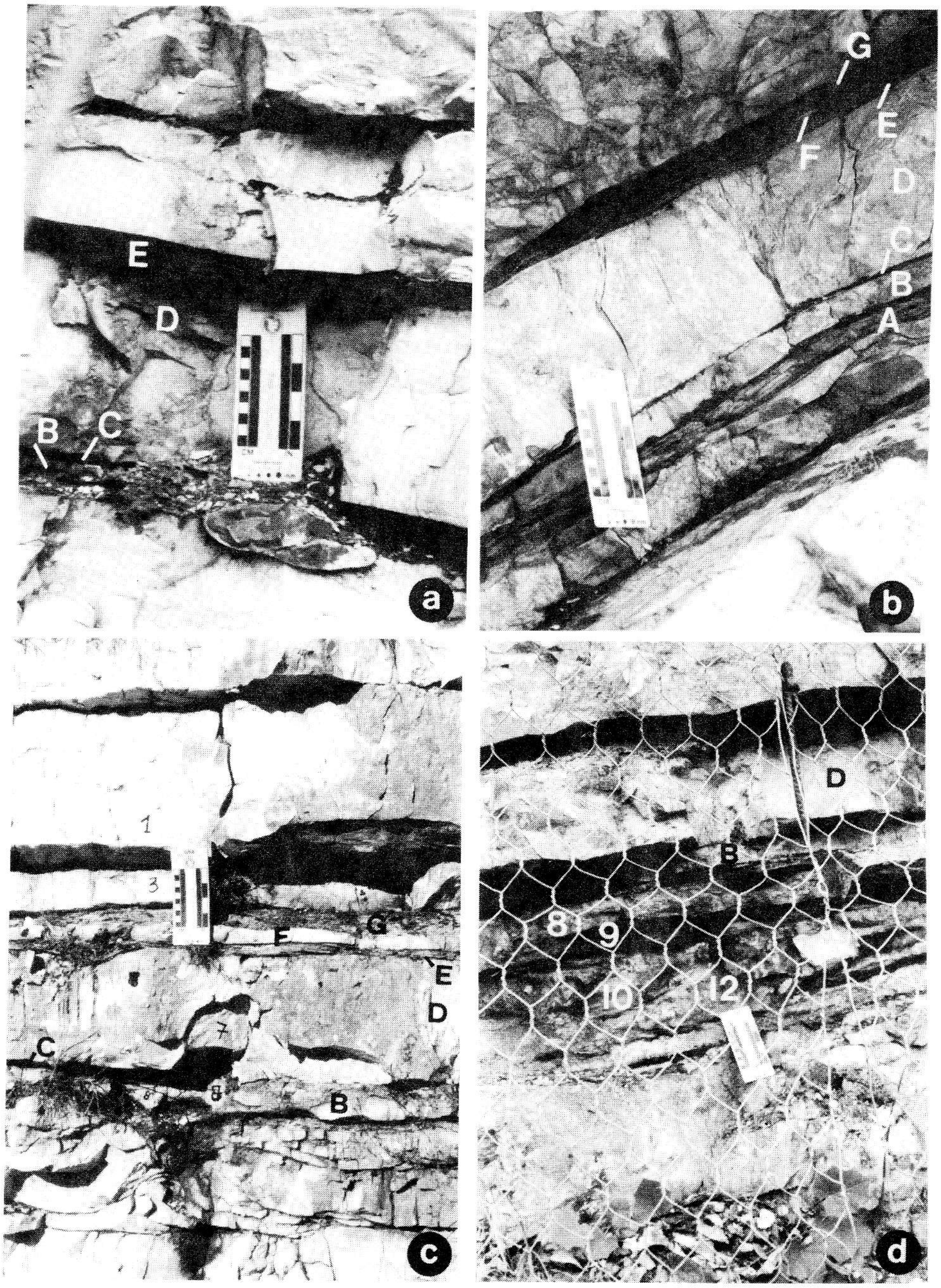


Fig. 4 - Sette Vene, Apecchiese road, km 33.7 (4a), Bosso (4b), Lago del Fiastrone (4c) and Cantoniera Pantana, Arceviese road km 59.4 (4d) sections. The letters indicate some of the layers distinguished in the Faraoni Level: A-C) Lower interval; D) Guide-bed; E-G) Upper interval. In 4c) the numbers visible on the beds refer to samples. In 4d) the white numbers refer to some of the samples studied for organic matter content and palynology. See legenda of Fig. 2 for further details.

Ammonite fauna and age of the Guide-bed (F. C.).

Among the identified species we mention: *Phyllopachyceras infundibulum* (d'Orbigny) (Fig. 5b), *Hypophylloceras tethys* (d'Orbigny), *Eulytoceras anisoptychum* (Uhlig) (Fig. 5f), *Neolissoceras grasi* (d'Orbigny), *Hamulinites* aff. *munieri* (Nicklès), *Acrioceras* cf. *tabarelli* (Astier), *Emericiceras imlayi* Sarkar (Fig. 5e), *Emericiceras* sp., *Pseudothurmannia angulicostata* (d'Orbigny) in Lapeyre, 1974, which corresponds to *P. ohmi* (Winckler) according to Hoedemaeker (in Company et al., 1992), *P. mortilleti* (Pictet & de Loriol) s. str. (Fig. 5d) and morphotype *catulloi* (Parona) (Fig. 5c), *P. belimelensis* Dimitrova (Fig. 5a), *Psilotissotia* sp. n., *P. bertrandi* (Nicklès), *P. reigi* (Nicklès), *P. (Buergliceras) favrei* (Ooster) (Fig. 5g), *Valdedorsella* sp. n. microconch / *Valdedorsella (Puezalpella)* cf. *haugi* (Breskowski) Macroconch, "*Valdedorsella*" *compsense* (Kilian) Macroconch / "*Valdedorsella*" *crassidorsata* (Karakasch) microconch, *Paraspiticeras* sp.

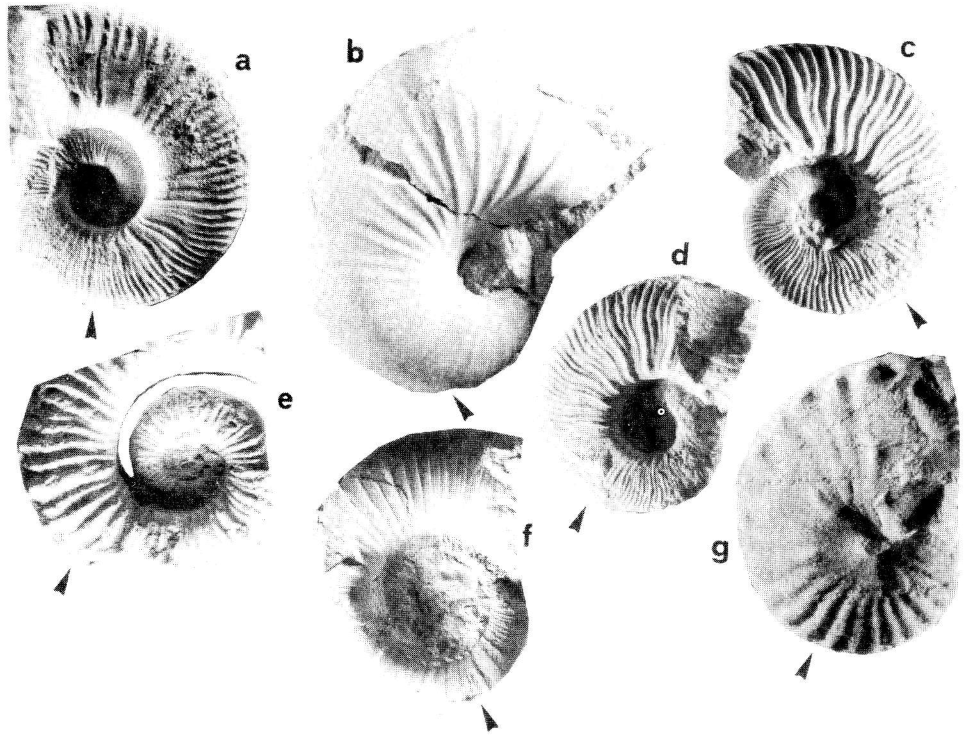


Fig. 5 - Some ammonites from the Guide-bed of the Faraoni Level: 5a) *Pseudothurmannia belimelensis* Dimitrova, Stirpeto section; 5b) *Phyllopachyceras infundibulum* (d'Orbigny), Monte Petrano road; 5c) *Pseudothurmannia mortilleti* morphotype *catulloi* (Parona), Monte Petrano road; 5d) *P. mortilleti* (Pictet & de Loriol) s. str., Stirpeto section; 5e) *Emericiceras imlayi* Sarkar, Northern slope of Monte Petrano; 5f) *Eulytoceras anisoptychum* (Uhlig), Monte Petrano road; 5g) *Psilotissotia (Buergliceras) favrei* (Ooster), Monte Petrano road. The arrows indicate the beginning of the body chamber. All figures natural size.

The most abundant forms are two major groups of Desmocerataceae: the first possibly belongs to the genus *Barremites* whilst the second is composed of ammonites showing almost smooth *Barremites*-like inner whorls and the outer portion of the body chamber with *Plesiospitidiscus* characters (fine ribs between constrictions which correspond to ridges in the preserved test). We stress the difficulties in recognizing the specific and generic position of these ammonites. In fact, there are still enormous taxonomic problems concerned with Desmocerataceae due to the number of species existing in the literature, as well as to the bad definition of the genera.

The palaeontological study of this fauna is in progress. Among 298 specimens studied, 20.1% are Phylloceratidae, 4.3% are Lytoceratidae, 3.35% Haploceratidae, 13.76% Crioceratitinae (12.42% the normally coiled genus *Pseudothurmannia* and 1.34% the uncoiled genera *Acrioceras* and *Emericiceras*). 42.68% are Desmocerataceae (38,6% belong to the group *Barremites/Plesiospitidiscus* and 4.02% to the genus *Valdedorsella*), 14.1% Pulchelliidae, 0.67% Ptychoceratidae, 0.67% Douvilleiceratidae, 0.33% Leptoceratoidinae.

The ammonite fauna indicates the same biostratigraphic interval in all sections. This corresponds to the *angulicostata* Auct. zone (Hoedemaeker & Company, 1993), which is the last Hauterivian biozone and in particular its upper subzone, i. e. the *catulloi* subzone. The occurrence of *Neolissoceras grasi* indicates the base of this subzone.

The direct correlation between ammonite zones and magnetic chrons, which has been realized in the Gorgo a Cerbara section (Lowrie & Alvarez, 1984; Cecca et al., in print) allows us to correlate the Faraoni Level with the middle part of chron CM4.

In some sections (Stirpeto, Petrano, Gorgo a Cerbara) the calcareous bed which directly overlains the black shale G contains again *Pseudothurmannia* specimens which belong to the same subzone as the fauna of the Guide-bed.

Organic content of the Faraoni Level (F. B.).

Methods. Seventeen crushed crude rock samples from the section at km 59.4 of the Arceviese road (17 in Fig. 2) were analyzed using Rock-eval pyrolysis (Espitalié et al., 1985-86). This technique supplies the free and potential hydrocarbons as well as total organic carbon (TOC) content and the Tmax parameter which is a thermal maturation indicator. Calcium carbonate percentages were measured using carbonate bomb. In order to give a wider statistical geochemical characterization of the organic material, all samples were analyzed twice over. Results are reported on Tab. 2.

Results. TOC contents range from 0 to 21 % with important variations related to the lithology (Fig. 6). As expected, the highest TOC values are recorded in black argillaceous shales (Tab. 2) with a mean content around 7.5%, whereas white micritic limestones are characterized by lower values (less than 0.1%). Nevertheless, a singular marly limestone bed corresponding to sample 8 from the Arceviese section contains 0.42% TOC.

Sample	CaCO3	TOC	Tmax	S1	S2	HI	OI
Ar1	52	10.47	417	0.65	27.90	267	91
Ar2	99	0.05					
Ar3	79	3.26	415	0.23	10.00	308	79
Ar4	99	0.02					
Ar5	35	11.65	419	0.76	33.00	283	95
Ar6	98	0.03					
Ar7	28	10.36	416	0.53	28.00	270	86
Ar8	97	0.42	420		1.90	444	36
Ar9	92	0.93	423	0.03	2.50	273	91
Ar10	98	0.01					
Ar11	48	10.27	416	1.00	36.30	353	82
Ar12	98	0.00					
Ar13	16	20.91	417	1.67	64.00	306	96
Ar14a	15	13.86	414	0.36	71.88	519	40
Ar14	96	0.05					
Ar15	11	6.70	423	0.11	23.15	346	36
Ar17	27	1.70	428	0.04	2.31	136	78

Tab. 2 - Samples of section 17, Cantoniera Pantana at km 59.4 of the Arceviese road. Calcium carbonate and total organic carbon (TOC) contents in weight %; Tmax in °C; S1 and S2 in mg hydrocarbons (HC) per g of rock. The hydrogen index (HI = S2/TOC x 100) and oxygen index (OI = S3/TOC x 100) are expressed respectively in mg HC per g of TOC and mg CO2 per g of TOC.

The TOC content of the black shale layers lying below the Faraoni Level s.s (samples Ar13, 14a, 15 and 17) vary from 1.7 to 21%. Sample Ar13, which presents the richest organic carbon content from this section, is within the range of the famous uppermost Cenomanian Bonarelli Level (Arthur & Premoli Silva, 1982; Herbin et al., 1986).

Total hydrocarbons (S1 + S2) expelled during pyrolysis represent the petroleum potential of the rock. The black shales from the Faraoni Level have a mean to good petroleum potential, ranging from 1 to 72 kg hydrocarbons per ton of rock, with a mean value around 23 kg. However the low Tmax values of the studied samples, which average 419°C, indicate a weak thermal maturation of the organic matter relative to the onset of oil generation (Fig. 7).

Three main types of organic matter can be distinguished from pyrolysis studies using hydrogen and oxygen indices. Types I and II are related to lacustrine or marine reducing environments and are derived mainly from phytoplanktonic organisms. They are characterized by high hydrogen indices and relatively low oxygen indices. Type III, with lower hydrogen indices, is derived from terrestrial plants, transported to marine or non-marine environment with a moderate level of degradation. Mixtures are common, particularly between type II and III. Hydrogen indices of the studied samples are medium to good and vary from 136 to 519 mg HC/g TOC. In the HI-OI diagram (Fig. 7), most samples are located between type II (marine) and III (continen-

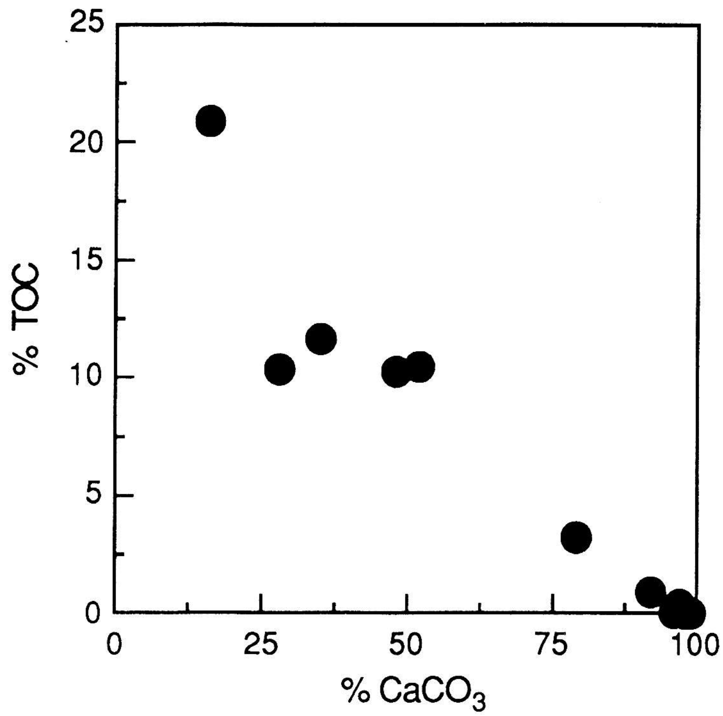


Fig. 6 - Calcium carbonate content (%CaCO3) versus total organic content (% TOC) of the black shale layers from the Arceviese section.

tal) organic matter. Relatively high oxygen indices (around 85 mg CO2/g TOC) suggest a slight oxidation of the organic content. The highest hydrogen-rich sample, which corresponds to the black shale Ar14a of the section, clearly indicates a marin origin of the organic matter.

Discussion. These preliminary geochemical results on the Faraoni Level show very high organic-carbon content in the black shales whereas white micritic beds are devoid of organic matter. The alternation of black shales with homogeneous, bioturbated white limestones is probably due to short-term variation in the sedimentary inputs (organic, carbonate and terrigenous) together with changes in the redox conditions of the water column. According to the relatively low hydrogen indices, the source of organic matter may be a mixture of marine and terrestrial organic matter or a selective biodegradation of marine organic matter.

The organic matter content of the Faraoni Level is similar to the other Mesozoic black shale intervals of the Umbria-Marche basin, especially the Bonarelli Level (Arthur & Premoli Silva, 1982; Herbin et al., 1986), the Selli Level (Coccioni et al., 1987; Premoli Silva et al., 1989) or the Lower Toarcian black shales (Baudin et al., 1990a, b; Bartolini et al., 1992). The concentration of organic matter observed in the Faraoni Level could be due to: 1) an increase in the phytoplankton productivity; 2) a weaker

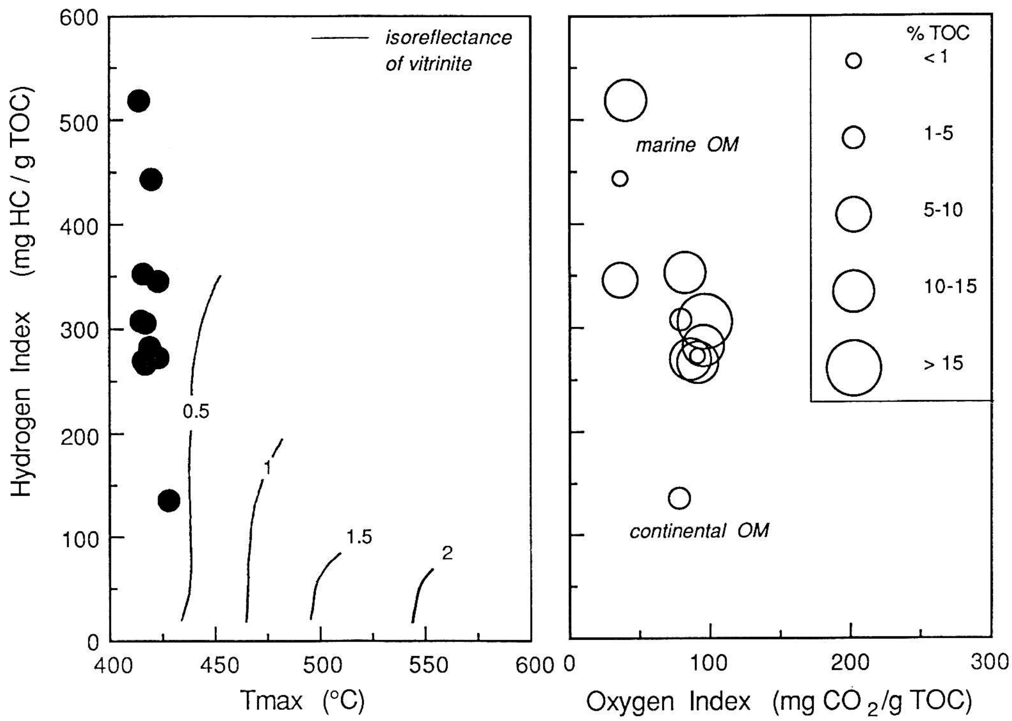


Fig. 7 - HI-Tmax diagram showing the low thermal maturation of the Faraoni Level from the Arceviese section. The nature of the organic matter appears as an oxidized marine organic matter or a mixture between marine and continental organic matter in the HI-OI diagram (circles are proportional to the TOC percentage of the sample).

dilution of the marine organic matter by terrigenous or autochthonous carbonate inputs and 3) a periodic better preservation of the organic matter in relation with fluctuation of the oxygen-minimum zone. Further studies are necessary to complete this preliminary depositional model.

Palynofacies of the Faraoni Level in the section of the Arceviese road km 59.4 (V. B.).

Ten samples from the section of the Arceviese road have been processed with the standard palynological techniques: crushing (1 to 2 mm particles), treatment with hydrochloric acid (30%, 2 hours), hydrofluoric acid (70%, 24 hours) and again hydrochloric acid (30%, 3 hours). The organic residue was sieved using a 10 μm mesh nylon screen. Samples Ar 1, 3, 5, 7, 9, 11 and 13 of finely laminated black argillaceous shales yielded black organic residues. Samples Ar4, 8 and 14 were taken from white micritic limestones. According to their TOC percentage (0.02% and 0.05%) samples

Ar4 and 14 yielded very little pale organic residues but sample Ar8 (TOC 0.42%) yielded a more important black residue.

The palynofacies examinated under an optical microscope are all composed by prevailing amorphous organic matter (AOM > 90%). Two types of AOM are distinguished:

- clotted AOM (sensu Combaz, 1980) made of aggregated granules more or less compactly. The colour is yellow-brown to dark-brown;
- spongy AOM (sensu Combaz, 1980), more homogeneous, apparently without structure. The colour is yellow-brown to dark-brown.

Only two samples contain spongy AOM (Ar8 and Ar9), which is associated with few palynomorphs (miospores) and rare dark woody phytoclasts. This sort of AOM theoretically suggests a thermal evolution more important than the clotted material. Moreover, amongst the samples of the studied section, Ar8 and Ar9 show the highest Tmax values. The clotted AOM prevails in all the others samples and is also associated with few palynomorphs (miospores) and dark brown or black woody phytoclasts. Sample Ar13 is characterized by a lot of fragments of pyritized radiolarians.

The thermal alteration index (TAI) measured on miospores is about 2.5-3. According to Raynaud (1974) and Raynaud & Robert (1976), it approximates a vitrinite reflectance of 0.5 to 1%, which indicates the beginning of the oil window (Tissot & Welte, 1984). Nevertheless, the measured Tmax suggests a lower thermal maturation.

Samples Ar4 and Ar14 yielded some cysts of dinoflagellates whose study is in progress. All the other samples contain miospores. However, this not implies a nonmarine origin of the organic matter because all these palynofacies contain very few land plant remains (phytoclasts). Recognizable marine organic matter may have disappeared for two reasons: 1) the gradual disappearance of membraneous structures caused by catagenesis (Raynaud et al., 1988); 2) the selective destruction of the marine remains by bacterial degradation. Thus, the phytoplankton remains could have been changed into amorphous organic matter. Further geochemical and palynological studies will improve these preliminary observations.

Conclusions (F. C., A. M., G. P., F. B.).

Together with the Lower Aptian Selli Level, at the base of the Marne a Fucoidi Formation (Coccioni et al., 1987) and the uppermost Cenomanian Bonarelli Level at the top of the Scaglia Bianca Formation (Arthur & Premoli Silva, 1982) the Faraoni Level represents an older regional guide-level in the upper portion of the Maiolica Formation. It is characterized by an ammonite-rich bed sandwiched by black shales which display a high organic carbon content. Its importance for the stratigraphy of the Umbria-Marche pelagic succession is also corroborated by the isochrony of the level which is precisely dated as uppermost Hauterivian, *angulicostata* Auct. zone, *catulloi* subzone or, in terms of magnetic stratigraphy, to the middle part of chron CM4.

The Selli and Bonarelli Levels are in fact manifestations of oceanic anoxic events recognized at the global scale (Jenkyns, 1980; Arthur & Premoli Silva, 1982). The Faraoni Level is so far reported from Umbria-Marche Apennines only. Hauterivian organic-enriched facies are reported from the North Atlantic (Meyers et al., 1986; Summerhayes, 1987) but their organic carbon content is lower than in the Faraoni Level. Furthermore their age might be different because the ammonite *angulicostata* zone has been correlated to nannofossil and magnetostratigraphic scales (which are the most used scales for dating of oceanic cores) only recently (Cecca et al., in print). On the other hand, because a positive excursions of $\partial^{13}C$ is usually associated with organic carbon-rich sediments (Schlanger et al., 1987), one might expect a carbon-isotope disturbance of latest Hauterivian age if the event is very widespread. A minor positive excursion of $\partial^{13}C$ curve is actually recorded in the latest Hauterivian of the Southern Alps (Weissert, 1991). In particular, Channell et al. (1993) show this minor excursion in the middle-upper part of magnetic chron CM4 that is, the same stratigraphic position of the Faraoni Level.

The high Total Organic Carbon (TOC) values recognized in most of the black shales of the Faraoni Level make them very important. In fact, these occur in a particular level of a formation devoid of organic matter, precisely dated by means of the ammonite faunas of the Guide-bed. The deposition of such black shales implies an oxygen-depleted environment and/or high productivity. The rhythmicity of laminated black shale layers and white bioturbated organic-depleted limestones suggests that the oxygen minimum zone periodically reached the basin floor. The rhythmic variations in the deep-water redox conditions were probably mainly controlled by short-term fluctuations in the thickness of the oxygen minimum zone. Further studies are needed to understand the causes of this anoxic episode in the Umbria-Marche Apennines.

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