Cyclostratigraphy and Palynofacies Patterns in the Coniacian (Upper Cretaceous) of the Northern Provence, SE France

Olaf Joerdel[1], Annette E. Götz[2] & Susanne Feist-Burkhardt[3]

[1]Senckenberg Institute of Marine Sciences, Wilhelmshaven, Germany
[2]Institute of Applied Geosciences, Darmstadt University of Technology, Germany
[3]Department of Palaeontology, The Natural History Museum London, United Kingdom

Introduction

Cyclic patterns and distribution of sedimentary organic matter were studied in representative outcrop sections of the Coniacian in SE France. The succession exposed in the Massif de la Cèze (Fig. 1) reaches up to 250 m thickness. The shallow-water carbonates build the proximal deposits of a platform which was situated south-east of the Central Massif (Fig. 2).

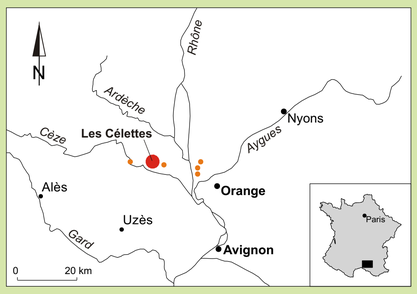

Fig. 1: Location of the studied sections.

A first sequence-stratigraphic concept for the entire Upper Cretaceous of SE France was given by MALARTRE (1994). In our study we present the first results of an integrated sedimentological and palynological analysis of the Coniacian in the upper Rhône Valley (JOERDEL, 2001).

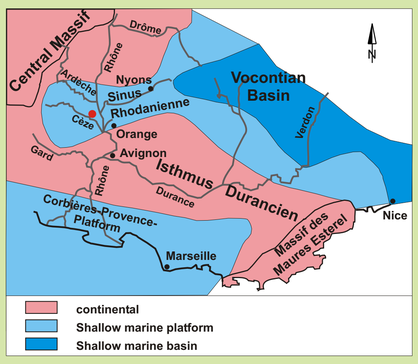

Fig. 2: Palaeogeography of the Coniacian.

Material and Methods

The palynofacies describes the composition of sedimentary organic matter within a specific depositional environment. The palynofacies analysis provides additional data for the reconstruction of a sedimentary basin and the characterisation of the different sediments by the distribution patterns of the sedimentary organic matter. The palynofacies of the studied shallow-water carbonates is composed of a continental (allochthonous) fraction with terrigenous phytoclasts, pollen grains, and spores and a marine (autochthonous) fraction, including dinoflagellate cysts, acritarchs, prasinophytes, and foraminiferal test linings.

Different parameters are used for the cyclostratigraphic interpretation: (1) relative abundance of marine plankton, (2) relative abundance of palynomorphs, (3) content of terrigenous phytoclasts, (4) ratio of continental to marine fraction (CONT/MAR), (5) ratio of opaque to translucent phytoclasts (OP/TR), and (6) ratio of equidimensional to blade-shaped phytoclasts. These parameters document variations in the distribution of sedimentary organic matter, reflecting transgressive-regressive trends (Fig. 3 & 4).

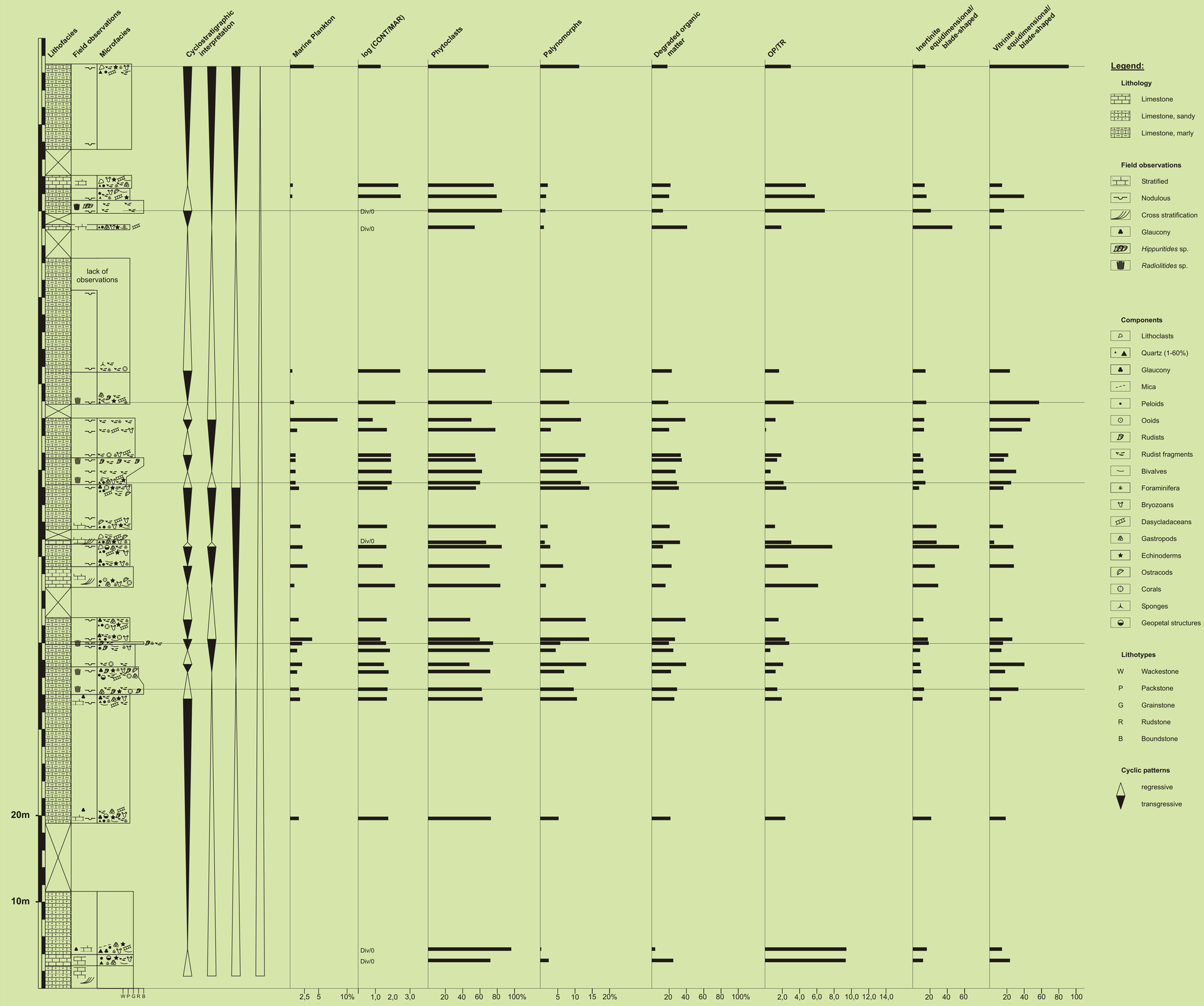

Fig. 3: Lithology, microfacies, palynofacies, and cyclostratigraphic interpretation of the Les Célettes section.

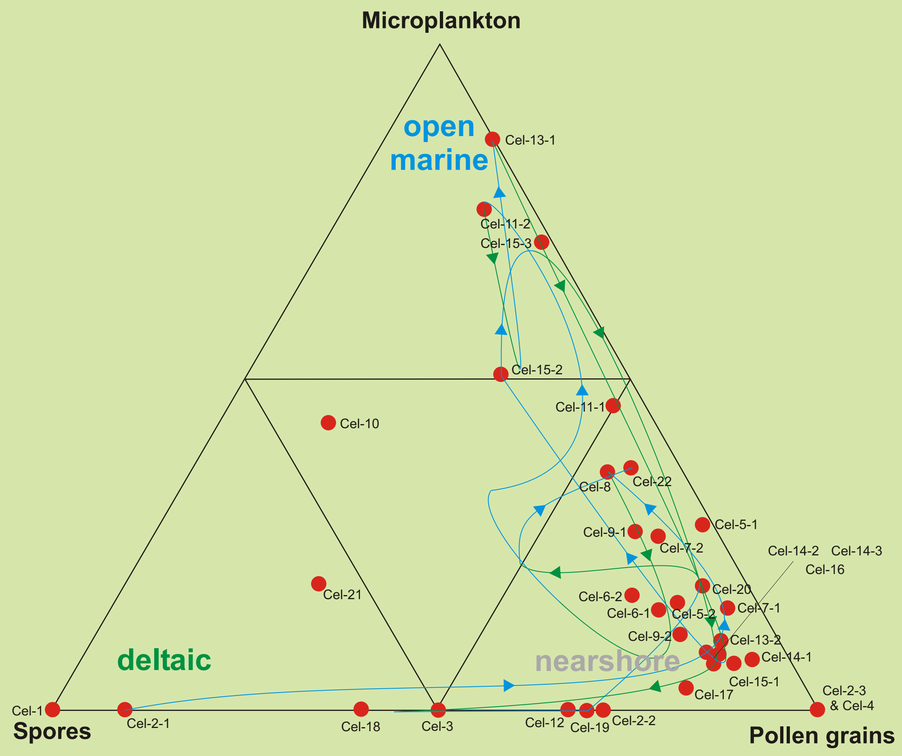

Fig. 4: Ternary diagram for describing total palynomorph assemblages. Microplankton-spore-pollen plot after FEDEROVA (1977) and DURINGER & DOUBINGER (1985).

In the highly proximal setting of the studied sections the indicated fields open marine, nearshore and deltaic represent a shift towards and within these depositional environments. Blue paths describe a transgressive trend, green paths a regressive trend.

A general regressive trend is observed within the entire Coniacian (sample numbers increase within the Les Célettes section). Metre-scale cycles are the basic stratigraphic building blocks of the carbonate succession. The observed palynofacies patterns within these cycles display short-term fluctuations of relative sea-level (Fig. 5).

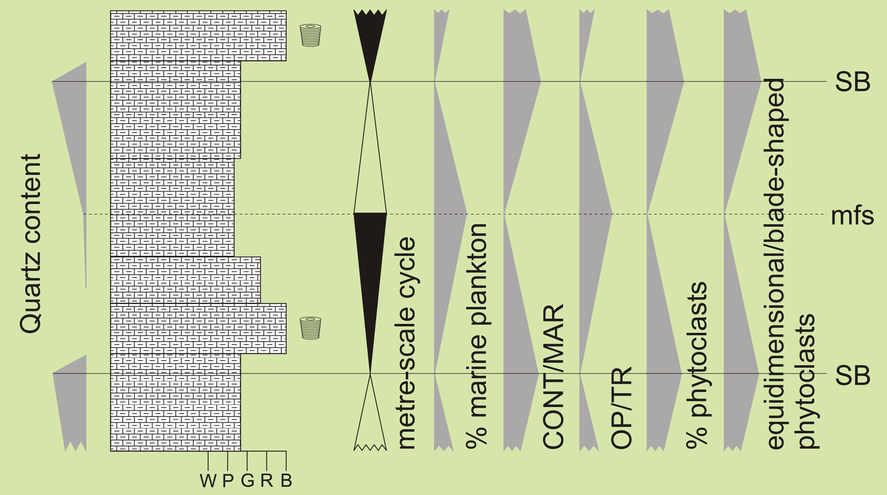

Fig. 5: Idealized metre-scale transgressive-regressive cycle, displaying the main lithological features and palynofacies signatures.

The main parameters used for the cyclostratigraphic interpretation are (1) relative abundance of marine plankton, (2) ratio of continental to marine fraction (CONT/MAR), (3) ratio of opaque to translucent phytoclasts (OP/TR), (4) relative abundance of terrigenous phytoclasts, and (5) ratio of equidimensional to blade-shaped phytoclasts.

The base of a metre-scale cycle is build by bioclastic grain-/packstones with a high content of quartz and phytoclasts. The rudist boundstones are overlain by bioclastic rudstones. Both lithotypes are rich in sedimentary organic matter lacking quartz. Maximum flooding is recognized within the bioclastic pack-/grainstones. This lithotype shows the highest amount of marine plankton, the highest OP/TR ratio, a minimum of the ratio CONT/MAR, and a low content of phytoclasts. The amount of quartz increases gradually during regressive phases.

In the uppermost part of this succession peloidal lithotypes may replace the bioclastic ones. This may indicate phases of stagnant lagoonal water conditions in a relatively isolated bay (Fig. 2).

The metre-scale cycles in the uppermost part of the Coniacian are characterised by an increase in quartz. The regressive trend within the late HST of the third-order sequence Co1 is superimposed by shallowing-upward metre-scale cycles.

References:

DURINGER, P. & DOUBINGER, J. (1985): La palynologie: un outil de characterisation des faciès marins et continentaux à la limite Muschelkalk supérieur/Lettenkohle. Science Géologie Bulletin, 38:19-34.

FEDEROVA, V.A. (1977): The significance of the combined use of microphytoplankton, spores and pollen for differentiation of multi-facies sediments. In: SAMOILOVICH, S.R. & TIMOSHINA, N.A. (eds.): Questions of Phytostratigraphy. Trudy Neftyanoi nauchno-issledovatelskii geologo-razve-dochnyi Intitut (VNIGRI), 398: 70-88.

HARDENBOL, J. & ROBASZYNSKI, F. (1998): Introduction to the Upper Cretaceous. - In: DE GRACIANSKY, P-Ch., HARDENBOL, J., JACQUIN, T. & VAIL, P. (eds.): Mesozoic and Cenozoic sequence stratigraphy of European Basins. - SEPM Spec. Publ., **60**: 329-332.

JOERDEL, O. (2001): Zyklostratigraphie und Palynofazies im Coniac der nördlichen Provence, SE Frankreich. - unpubl. Diploma Thesis, Darmstadt University of Technology: 53 pp.

MALARTRE, F. (1994): Stratigraphie séquentielle du Crétacé supérieur du Bassin Vocontien occidental (Sud-Est, France). Comparaison avec d'autres bassins. - Docum. Lab. Géol. Lyon, **131**: 1-219.

Results

The studied carbonate succession is interpreted as the Highstand Systems Tract (HST) of a third order Sequence (Co 1 after HARDENBOL & ROBASZYNSKI, 1998). The maximum flooding zone (mfz) is recognized at the Turonian-Coniacian boundary. The sequence boundary (sb) is marked by an emersion surface within the Santonian. The sedimentary organic matter of these mixed carbonate-siliciclastic deposits is dominated by phytoclasts, indicating a highly proximal depositional environment. The relative abundance of palynomorphs reaches values up to 10%. The general high content of degraded organic matter (on average 25%, maximum 40%) is a significant feature of these highly proximal carbonates. In-situ bio-oxidation and reworking of organic matter is typical for shallow-marine depositional environments. Therefore, the high primary content of phytoclasts is enhanced secondarily. The studied parameters display clearly the regressive trend during the Coniacian. Furthermore, a cyclicity of higher order is documented in the sedimentological and palynofacies data.

Acknowledgements

This study is part of a research project at the Darmstadt University of Technology "*Palynofacies patterns and sequence analysis of the Upper Cretaceous, SE France*" (FE 435/6-1). We thank the German Research Foundation (DFG) for funding and the Globetrotter GmbH for providing field equipment.

Olaf Joerdel
Forschungsstation
Senckenberg am Meer
Schleusenstraße 18
D-26382 Wilhelmshaven
Germany
olaf.j@gmx.de

Annette E. Götz
Institut für Angewandte Geowissenschaften
Schnittspahnstraße 9
D-64287 Darmstadt
Germany
agoetz@geo.tu-darmstadt.de

Susanne Feist-Burkhardt
Departement of Palaeontology
The Natural History Museum
Cromwell Road
London Sw7 5BD
United Kingdom
s.feist-burkhardt@nhm.ac.uk