C. R. Palevol 13 (2014) 383–402

Contents lists available at ScienceDirect

Comptes Rendus Palevol

www.sciencedirect.com

General palaeontology, systematics and evolution (Taphonomy and fossilisation)

The lithographic limestones of Cerin (southern Jura Mountains, France). A synthetic approach and environmental interpretation

Les calcaires lithographiques de Cerin (Jura méridional, France). Approche synthétique et interprétation environnementale

Paul Bernier[a,*], Georges Barale[b], Jean-Paul Bourseau[a], Eric Buffetaut[c], Christian Gaillard[a], Jean-Claude Gall[d], Sylvie Wenz[e]

[a] *Université Claude-Bernard (Lyon-1), département des sciences de la Terre, 43, boulevard du 11-Novembre-1918, 69622 Villeurbanne cedex, France*
[b] *Université Claude-Bernard (Lyon-1), Herbiers, 9, rue Dubois, 69622 Villeurbanne cedex, France*
[c] *CNRS, UMR 8538, Laboratoire de géologie de l'École normale supérieure, 24, rue Lhomond, 75231 Paris cedex 05, France*
[d] *Université de Strasbourg, Strasbourg, France*
[e] *Muséum national d'Histoire naturelle, Paris, France*

ARTICLE INFO

Article history:
Received 26 March 2013
Accepted after revision 22 January 2014
Available online 14 May 2014

Keywords:
Lithographic limestone
Late Jurassic
Jura Mountains
Lagerstätten
Laguna
Taphonomy

ABSTRACT

The lithographic limestones of the Cerin quarry (southern French Jura Mountains), of Late Kimmeridgian age, were famous during the 19th century for their quality and consequently the quarry was intensely exploited. From 1975 to 1994, scientific excavations were carried out in these limestones in order to investigate the depositional environment, the burial of organisms and their taphonomy. A large set of data was collected about various organisms, unusual locomotion tracks, microbial mats and emersion structures. This led to a new interpretation of the environment as a laguna overlying a previously emergent and eroded coral reef. This laguna was episodically connected to the sea by temporary channels, during storms. Lime mud was supplied both from the sea and from the surrounding emergent areas. Most organisms, both marine and terrestrial, were transported, trapped, mixed and buried in the laguna. After death, the preservation of the carcasses was favoured by the presence of microbial mats providing superficial anoxic conditions and protecting them from decaying.

Mots clés :
Calcaires lithographiques
Jurassique supérieur
Jura
Lagerstätten
Lagune
Taphonomie

RÉSUMÉ

Les calcaires lithographiques de la carrière de Cerin, située dans le Jura méridional français, sont datés de la fin du Kimméridgien. Ils ont été très célèbres au XIX[e] siècle, pour la qualité de leur pierre, et exploités intensément pendant cette période. De 1975 à 1994, un chantier de fouilles a été installé dans ces calcaires, afin de comprendre quel était l'environnement de dépôt et comment les organismes ont été piégés et conservés. De nombreux fossiles ont été récoltés, des pistes de locomotion originales observées, des figures d'émersion mises en évidence, ainsi que l'existence et le rôle majeur de tapis microbiens. Ces informations

* Corresponding author.
E-mail addresses: paul.bernier@free.fr (P. Bernier), georges.barale@univ-lyon1.fr (G. Barale), jean-paul.bourseau@wanadoo.fr (J.-P. Bourseau), eric.buffetaut@sfr.fr (E. Buffetaut), christian.gaillard@univ-lyon1.fr (C. Gaillard), jcgall@unistra.fr (J.-C. Gall), wenz.sylvie@orange.fr (S. Wenz).

http://dx.doi.org/10.1016/j.crpv.2014.01.006
1631-0683/

ont conduit à une nouvelle interprétation de ce gisement, désormais considéré comme une lagune installée dans une zone déprimée d'un ancien récif corallien émergé et érodé. Cette lagune était épisodiquement connectée à la mer par des chenaux temporaires, lors de tempêtes. La boue calcaire, à l'origine des calcaires lithographiques, provenait à la fois de la mer et des espaces émergés environnants. La plupart des organismes, marins et terrestres, ont été transportés, piégés, mélangés et ensevelis dans la lagune. L'excellente conservation des fossiles a été favorisée par la présence de tapis microbiens recouvrant les cadavres très tôt, installant des conditions superficielles anoxiques les protégeant de la décomposition.

1. Geographical location

The Cerin quarry is located between Geneva and Lyons. In this area, the Rhône River flows with a sinuous course. It crosses through the southern end of the Jura Mountains at the boundary between the folded Jura Mountains (Bugey) on its northern side and the tabular Jura (Île Crémieu) on its southern side.

The hamlet of Cerin (which belongs to the village of Marchamp and is frequently referred to as Cerin–Marchamp) is located in the first foothills of the folded Jura Mountains; it is at an elevation of 650 m, about 80 km east from Lyons, and 15 km from Belley, the main town in this area (Fig. 1).

2. Historical overview

The cliff that towers above the hamlet of Cerin was exploited to extract lithographic limestones from 1835 to 1910, used mainly for printing newspapers, advertisements and various illustrations–an activity that disappeared mainly when the advent of photography made lithography obsolete. During the exploitation period (Bourseau et al., 1984), numerous fossils were found, preserved, bought, studied and published by several authors (Lortet, 1892; Meyer, 1851; Saporta, 1873, 1891; Thiollière, 1848, 1851, 1852, 1854, 1858, 1871, 1873). Most of these fossils are kept at the Musée des Confluences, Lyons (Barale et al., 1985; Philippe et al., 2004), but others are scattered in various museums all over the world.

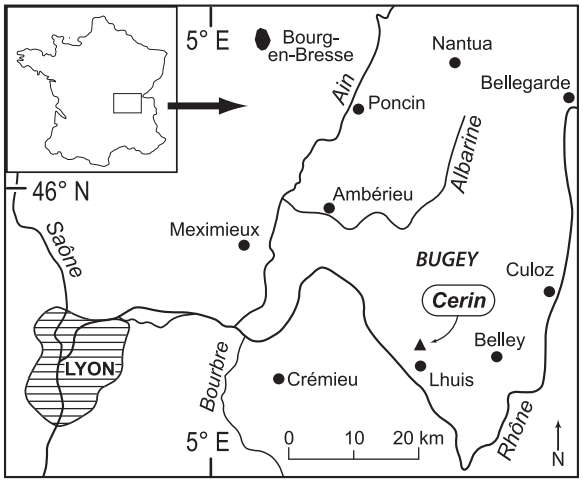

Fig. 1. Location map of the Cerin quarry (Ain, France; 45° 46′ 44″ N–5° 33′ 15″ E).
Fig. 1. Situation géographique de la carrière de Cerin (Ain, France ; 45° 46′ 44″ N–5° 33′ 15″ E).

Thereafter, the quarry was abandoned, and the studies focused more on palaeoecological aspects than on purely palaeontological problems (Enay, 1972; Gübler and Louis, 1956; Saint-Seine, 1950). Some of the Cerin reptiles were published by Cocude-Michel (1963) and by Fabre (1981).

From 1975 to 1994, the Department of Earth Sciences of the University Claude-Bernard in Lyons organized scientific excavations (managed by P. Bernier) on a small part of the quarry. During six summer weeks, every year, 15 to 20 scientists and students worked there. Each week of work was supervised in turn by scientists from the Universities of Lyons (P. Bernier, G. Barale, J.-P. Bourseau, C. Gaillard) and Strasbourg (J.-C. Gall), CNRS (E. Buffetaut) and MNHN (S. Wenz).

In the course of the excavations, more than 500 beds (each bed is 3 to 30 cm thick) were excavated. The studied cliff is about 15 m high and the upper excavated surface approximates 70 m^2. At the base of the cliff, a second, larger site (150 m^2) only a few meters thick was opened. Important technical methods (under the supervision of J.-C. Reniaud) were necessary for safety (scaffolding) and excavation (pneumatic drill, crane and bulldozer). Researchers and students were housed in an old restored sheepfold and other shelters; a well was dug and an electric line was installed.

Each bed was completely excavated before the next one was removed. Thus, the bed surfaces were clearly exposed to reveal the fossil contents and their orientation in the sediment as well as important palaeoenvironmental data. Common tracks and traces were identified that had not been observed previously. Each bed was photographed and illustrated. Sedimentary structures and the orientation of the fossils were positioned into a grid. The most interesting specimens were photographed and sampled after casting (under the supervision of G. Sirven). All data were recorded on bed data cards (Bernier et al., 1991b).

3. Questions about fossil remains

Many questions remained unanswered when the scientific excavations started in the quarry in 1975. Why were the collected fossils so diverse and originated from various environments? Why were terrestrial reptiles and terrestrial flora associated with marine fossils (e.g., fishes, echinoderms, crustaceans, molluscs)? Why did some fishes originate from the open sea (sharks, coelacanths) and others were living in coastal environments, or on the