



Research paper

Probable aestivation burrows from the Eocene/Oligocene transition in south-eastern France and their palaeoenvironmental implications

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Abstract

Enigmatic biogenic structures are reported from the Palaeogene of south-eastern France in the Castellane-Blieux area (Alpes de Haute-Provence French Department). They occur at the Eocene/Oligocene transition at the top of the Marnes Bleues Formation, which corresponds to a clearly defined regressive sequence, where thick marls are overlain by lacustrine limestones or sandstones. The marls have abundant shallow marine fauna and the upper part of the Formation corresponds to a rapid transition to non-marine deposits. The studied structures exhibit three main morphologies: vertical shafts, furrows, and tunnels. They can also form dense clusters and cross-cut marginal marine crustacean burrows such as *Psilonichnus*. By comparison with modern and fossil examples, these trace fossils are interpreted as probably aestivation burrows. The possible trace-makers could be lungfish (in particular for the common vertical burrows) or amphibians (for the furrows and tunnels). The occurrence of these different aestivation burrows defines the border of a basin and probably indicates increasing droughts on the coastal plain. This could reflect the well-known development of arid conditions in south-eastern France at the beginning of the Oligocene.

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1. Introduction

Uncommon large burrows characterize marginal marine to terrestrial deposits occurring in south-eastern France at the transition between Eocene and Oligocene. They have been only briefly described in the French literature (Gitton, 1978), but their origin and the identity of the trace-makers have never been determined. They are associated with more common crustacean burrows (*Thalassinoides* and *Psilonichnus*). These trace fossils occur in sediments deposited at the end of a regression event recorded in the French Subalpine Basin. They are also possibly related to the climatic evolution occurring during this period, which is indicated by a global cooling and drying. Because of their potential palaeogeographical and palaeoclimatical significance, these trace fossils could be good environmental indicators in this succession. The aim of this work is to describe these

burrows, to discuss the possible identity of the trace-makers, and to evaluate their palaeoenvironmental significance.

2. Geological setting

2.1. Palaeogeography

During the Palaeogene time, the palaeogeography of Western Europe was characterized by a complex patchwork of different environments (Meulenkamp et al., 2000). The south-eastern France area, which belonged to the old Tethys domain, today is characterized by a complex geology resulting from tectonic evolution of the Alps. In front of the first newly formed mountain belt, a curved foreland basin occurred. The French western and southern limits of this basin are well known (Bodelle, 1971; Cavalier, 1984). This basin was fully marine in the late Eocene (Priabonian). During the early Oligocene, an important regression occurred and a sharp transition occurred from eastern deep marine deposits to western shallow marine and lacustrine deposits. Such palaeogeography is well documented from the late Rupelian (early Oligocene, 32–29 Ma) (Fig. 1). The study

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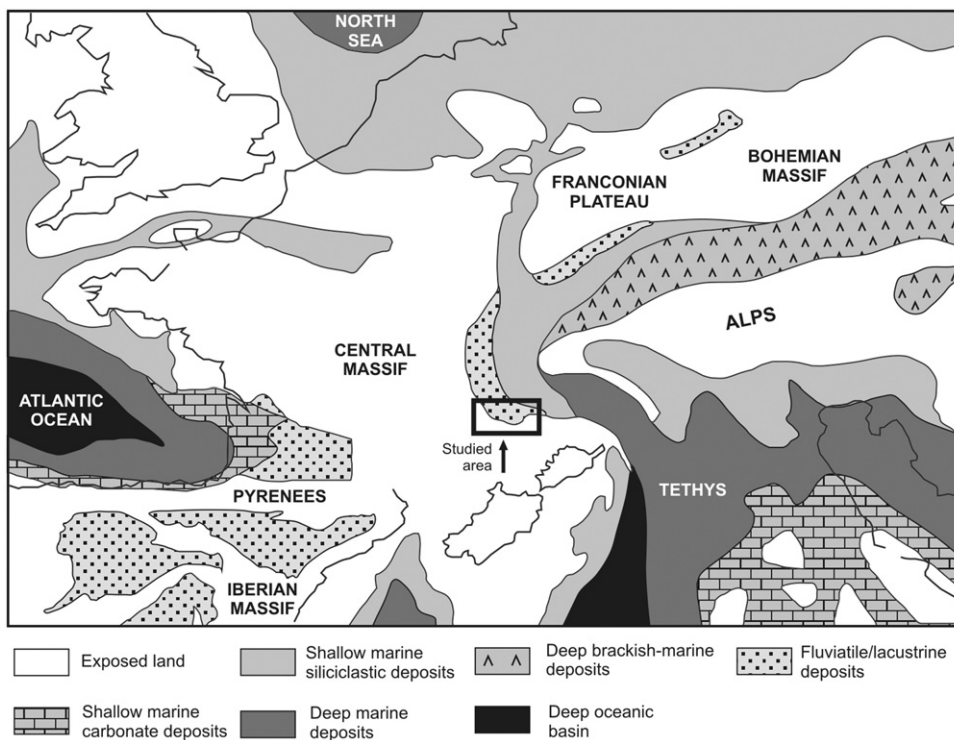


Fig. 1. Palaeogeographical context during late Rupelian (Oligocene). Note that our work deals with a slightly older period characterized by more marine conditions in the studied area (rectangle). Modified after Meulenkamp et al. (2000), map 19.

area (Fig. 2) is located at the south-western termination of this basin and the studied interval is slightly older (mainly the late Eocene).

2.2. Stratigraphy

The stratigraphy of the study area (Fig. 3) records the palaeogeographic transition between the Eocene and Oligocene

(Boussac, 1912; Bodelle, 1971; Gitton, 1978; Cavalier, 1984). The deposits are successively (Fig. 3A): (1) fully marine conglomerates, sandstones, and limestones of the Calcaires Nummulithiques Formation; (2) shallow marine to brackish fossiliferous marls of the Marnes Bleues Formation; and (3) lacustrine limestones or continental sandstones. In the more distal parts of the basin (Fig. 3B), near Barrême or Annot, the Marnes Bleues Formation is more than 250 m thick and

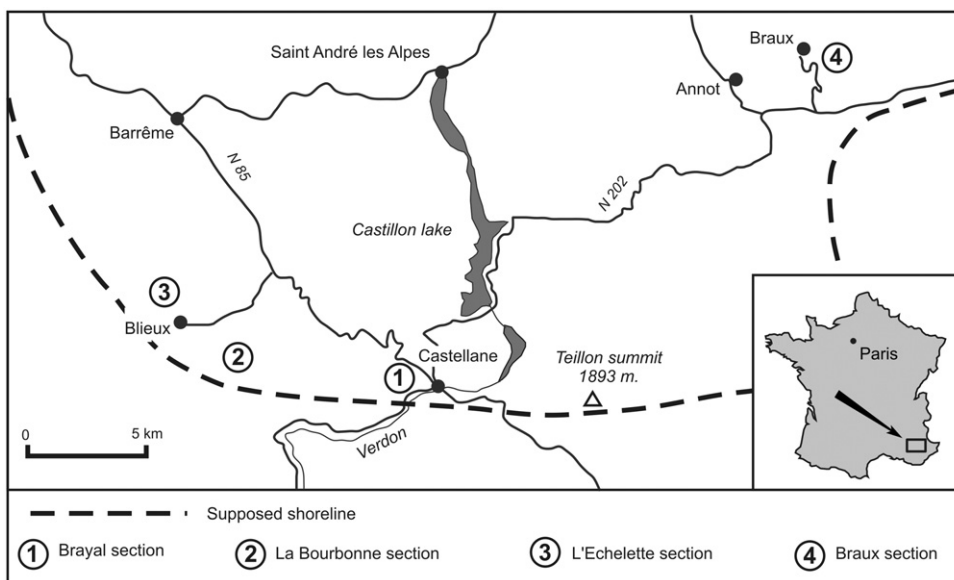


Fig. 2. Location of the studied sections (Brayal, La Bourbonne, Barre de l'Echelette, and Braux). The dashed line indicates the supposed position of the shoreline. Modified after Bodelle (1971), fig. 207.

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