
Origin of the hydrographic network in the Eastern Paris Basin and its border massifs.

Hypothesis, structural, morphologic and hydrographic consequences

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Former hypothesis about the installation of the river network

In the Eastern Paris Basin, the problem of the installation of the river network was pointed out since the end of the nineteenth century (Davis, 1895). In fact, in the Northern Lorraine and Champagne regions, the main rivers flow northwards updip and cross through the Ardenne and Rhenish Shield, which are higher than the Lorraine plateaus (450 m at the “Borne de Fer” compared to 816 m in the Hunsrück and 746 m in the Eifel Massifs) (Fig.1).

Since the nineteenth century, the authors imagined a river network installation on a planar continental surface which was successively the northwards-dipping peneplain of Davis (1899) and the Oligocene-Miocene main surface of Tricart (1948) which was later tilted northwards and reworked in the Mio-Pliocene period.

Some German authors suggested an installation of the rivers on a accumulation surface built with detritic materials which would have buried the cuestas relief (Liedtke, 1989). However, the correlative remains of such a surface were not clearly evident.

New hypothesis : installation on the Upper Cretaceous marine regression surface

Nevertheless, the more recent papers have insisted on the existence of Eocene paleoreliefs and paleovalleys incised into the Eifel basement (Löhnertz, 1978, 1994) and have also pointed out the polygenic surface which is preserved at the top of the Lorraine cuestas. This surface was completed in the Pliocene because it is anterior to the Plio-Pleistocene downcutting of the rivers (Le Roux and Harmand, 1998; Le Roux, 1999, 2000; Harmand, 2001).

According to the eustatic reconstructions levels (Haq *et al.*, 1987), the East of the Paris Basin may have been covered with Upper Cretaceous formations. Indeed, such a cover exists in the bordering regions of Burgundy, Champagne and Ardenne where there diachronic remnants (residual flints) were dated from Maastrichtian in the North-East, in the “Hautes Fagnes” (Demoulin, 1995).

The retreating of the Upper Cretaceous regression sea organized the Eastern Paris Basin rivers network. So, the rivers grew on the Cretaceous marine regression surface retreating to the North (Le Roux *et al.*, 2003) (Fig. 3, 5). Therefore, the hydrographic network appeared sooner in the South, later in the North. This diachronic network would have grew more or less perpendicularly to the regressive shorelines towards the early Cenozoic gulf which preexisted in the North Sea area (Ziegler, 1988). So, the installation of the rivers on the Ardenne and Rhenish Shield, overlaid by the Cretaceous Chalk, occurred when the Ardenne-Eifel block was turned into a low plain, allowing the installation of the rivers draining to the North.

Later, the Chalk is washed out by erosion, especially during the hot and wet climates which prevailed in the beginning of the Cenozoic (Quesnel, 1997), and the hydrographic network embanked into the basement and the discordant Triassic and Jurassic formations, under the Infracretaceous surface.

Consequences of the regressive shorelines hypothesis

This Infracretaceous surface, which corresponds to the 400 m surface in the Eastern Paris Basin (Fig. 2), was of course reworked during the Cenozoic, as proved by the Palaeogene deposits in the Northern Lorraine and the Ardenne-Eifel Massif (Löhnertz, 1978, 1994; Voisin, 1988; Quesnel *et al.*, 2002).

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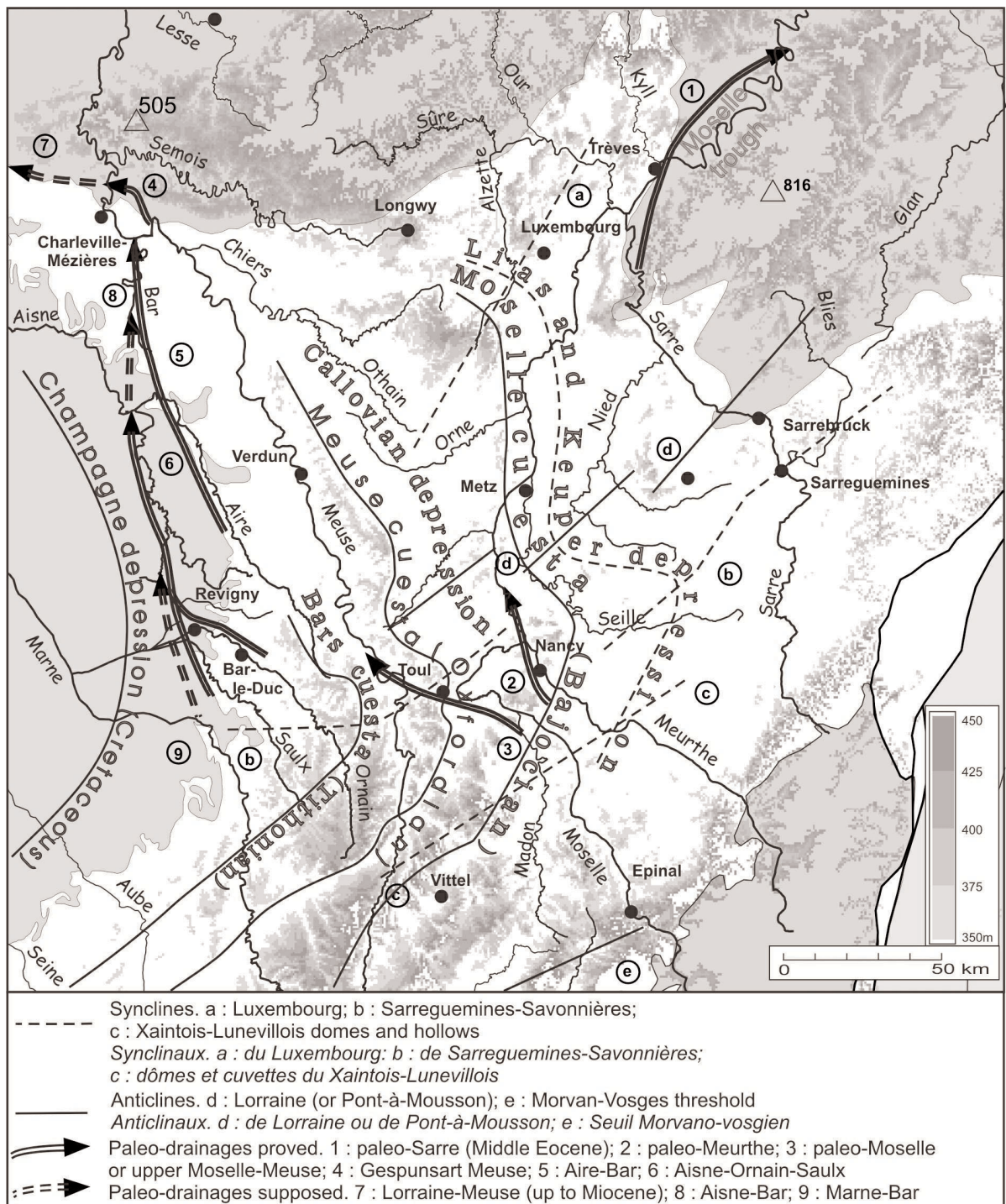


Fig. 1.- Morphostructural and 400 m top surface maps.

Structural consequences

The continuity of the 400 m surface and the low variations in height of this surface which truncates at once the Triassic-Jurassic sedimentary cover and the Hercynian basement, proves the great stability of the Eastern Paris Basin since the end of the Mesozoic.

Also, the shape of the Eastern Paris Basin mainly dates from the end of the Cretaceous (Fig. 4).

Accordingly, during the Pyrenean and Alpine compressive stages, only minor vertical deformations would have taken place, and the extensive Oligocene movements occurred only in local normal faults and small grabens (Le Roux, 2000).

The uplift of the border old blocks had just a tiny influence on the present morphostructural framework of the Eastern Paris Basin. The edge between the Paris Basin

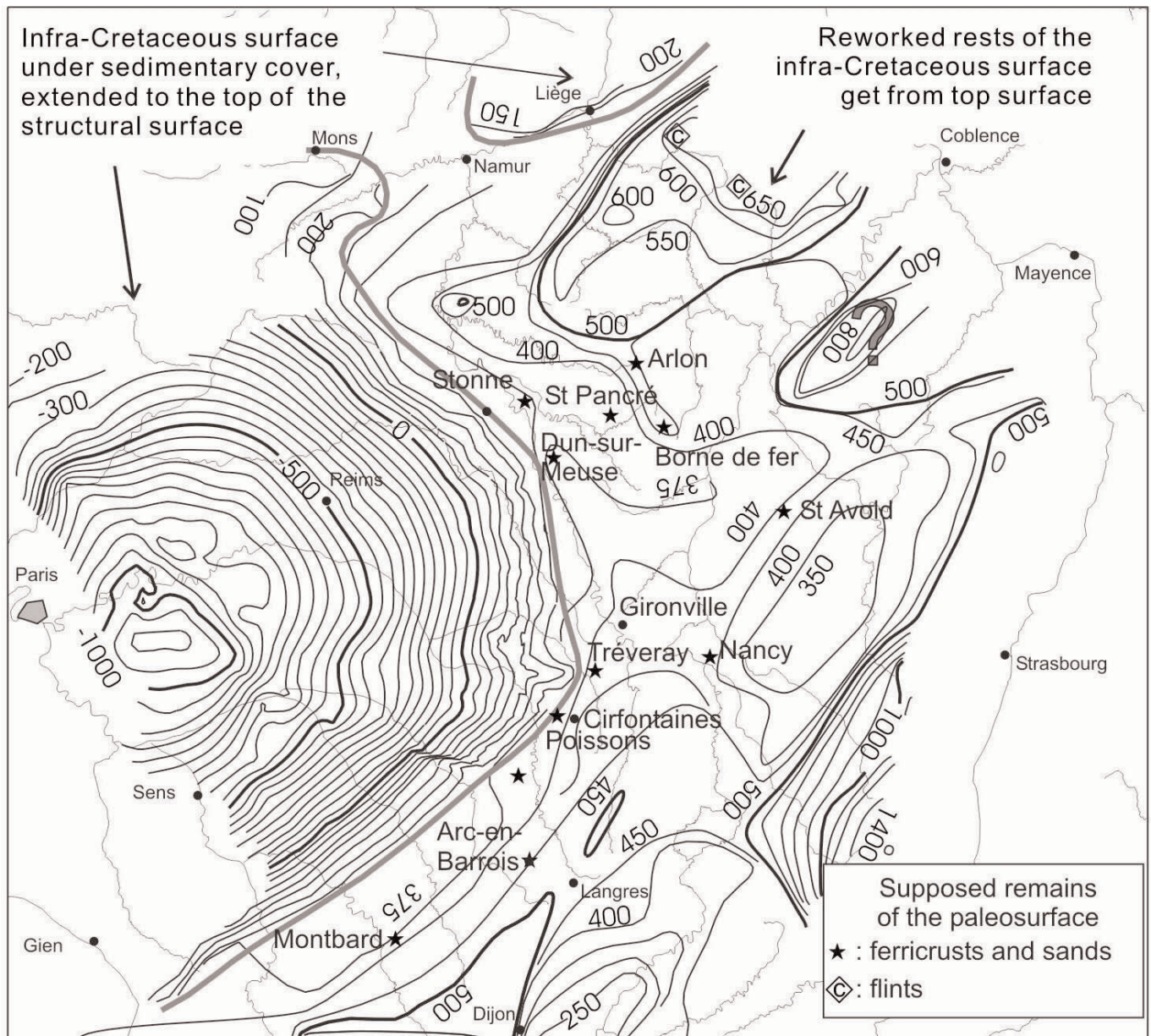


Fig. 2.- The infra-Cretaceous surface map.

and the Hercynian massifs corresponds clearly to an important flexure of the Infra-Cretaceous surface (Le Roux and Harmand, 2003).

Morphological and hydrographic consequences

The model of the river network installation explains the non conformity of the rivers with the tectonic features and the top surface.

The rivers courses have kept a great stability in the Eastern Paris Basin, since the end of the Upper Cretaceous. They grew downstream in the Tertiary periods, especially in the Belgium regions (Grimbérieux *et al.*, 1995;

Robaszynsky et Dupuis, 1983) and in the middle of the Paris Basin during the episodes of retreating seas.

The main rivers captures (Haute Moselle, Aire, Aisne, Harmand, 1992) date from the Quaternary, and occur still today. These hydrographic reorganizations were and are still controlled by selective erosion and climatic variations.

Conclusions

The hypothesis about the hydrographic network installation in the Eastern Paris Basin on the Upper Cretaceous marine regression surface points out that :

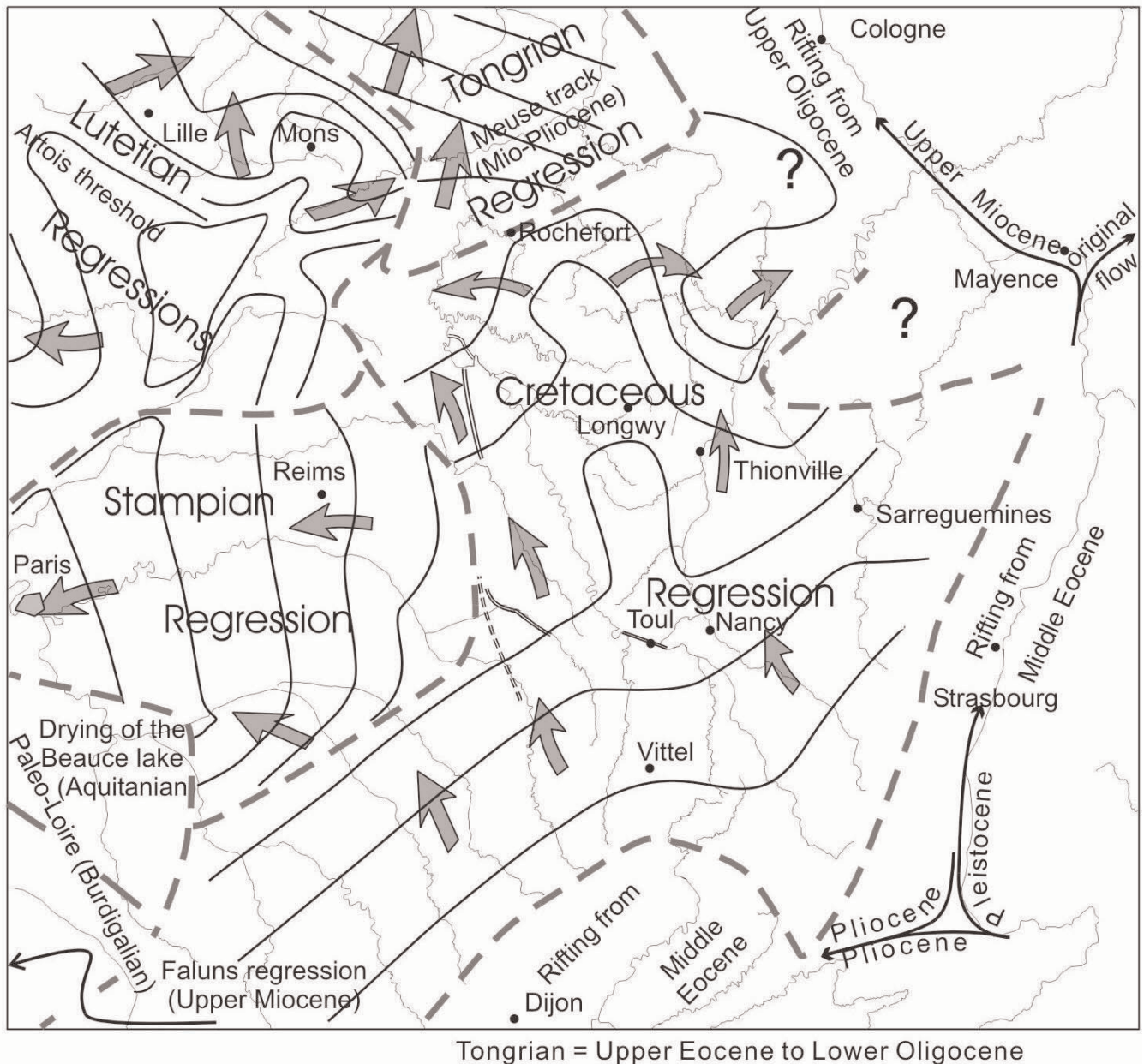


Fig. 3.- Installation of the rivers on the regression shorelines.

- the main Mesozoic subsidence guidelines, which appeared at the beginning of the Jurassic, were still active in the end of the Cretaceous. Indeed, the tributaries of the Seine river, from the Yonne to the Aisne rivers, flow towards the middle of the Paris Basin; the Maas river flows northwards on the Barrois threshold; the Mosel river flows towards the Luxembourg syncline;

- the structuration of the Eastern Paris Basin was almost completed at the end of the Cretaceous. The uplift of the border old blocks has not any influence on its present structure;

- the rivers courses were directly inherited from the paleogeographic features of the end of the Cretaceous, which involve the surimposition of the valleys in the Hercynian Ardenne and Rhenish Shield. Therefore, the hydrographic network has had a great stability for 65 Ma, and had embanked vertically, with few variations along its course;

- three factors explain the Quaternary piracy : the regressive erosion of the Rhine tributaries, because of the subsidence of the Cologne and Rhine grabens, the important incision of the tributaries in the Seine, and, the renewal of the positive tectonic movements in the Ardenne massif.

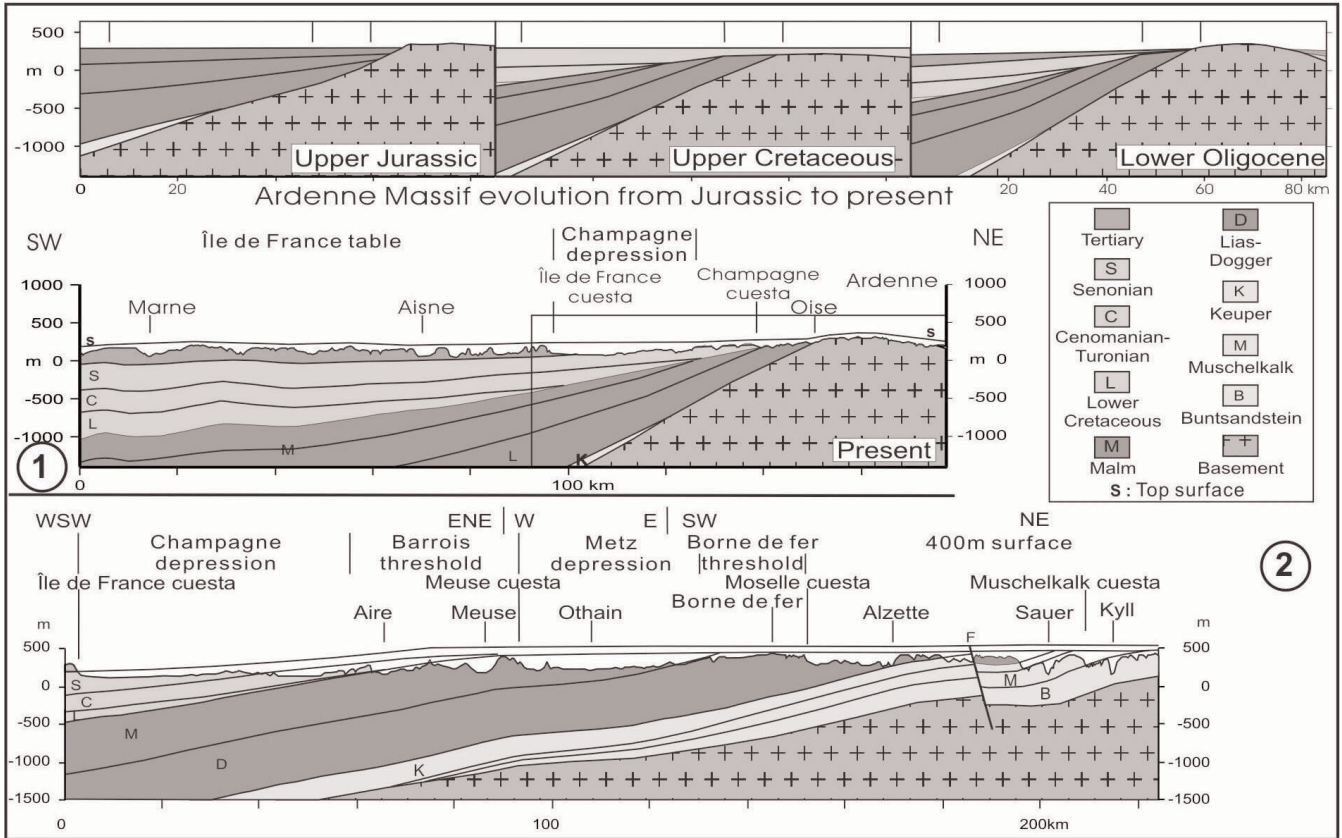


Fig. 4.- Geological and morphological cross-sections.

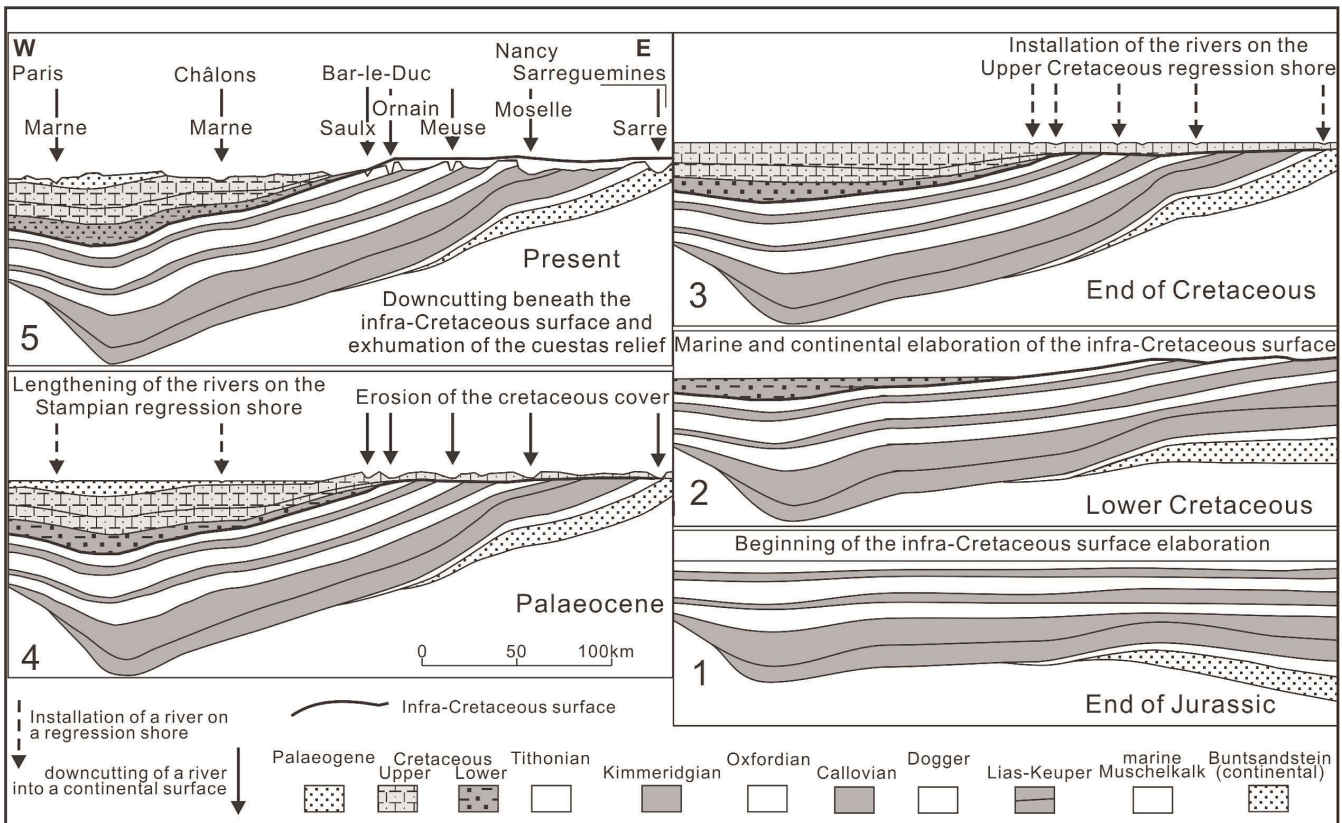


Fig. 5.- Landscape and rivers evolution from Jurassic to Present.

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