Reconstructing the Late Paleocene-Early Eocene continental paleosurface in and around the Paris and adjacent basins: new insights for paleogeographic, geodynamic and climatic studies

Florence Quesnel, Christian Dupuis, Johan Yans, Caroline Ricordel-Prognon, Setareh Rad, Jean-Yves Storme, François Barbier, Emile Roche, Chantal Bourdillon, Thierry Smith, et al.

To cite this version:
Florence Quesnel, Christian Dupuis, Johan Yans, Caroline Ricordel-Prognon, Setareh Rad, et al.. Reconstructing the Late Paleocene-Early Eocene continental paleosurface in and around the Paris and adjacent basins: new insights for paleogeographic, geodynamic and climatic studies. GNS Miscellaneous series, 2009, 18, pp.102-106. hal-00740721

HAL Id: hal-00740721
https://hal-brgm.archives-ouvertes.fr/hal-00740721
Submitted on 10 Oct 2012

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
RECONSTRUCTING THE LATE PALEOCENE–EARLY EOCENE CONTINENTAL PALEOSURFACE IN AND AROUND THE PARIS AND ADJACENT BASINS: NEW INSIGHTS FOR PALEOGEOGRAPHIC, GEODYNAMIC AND CLIMATIC STUDIES

F. Quesnel¹, C. Dupuis², J. Yans³, C. Ricordel-Prognon¹, S. Rad¹, J.-Y. Storme³, F. Barbier¹, E. Roche⁴, C. Bourdillon⁵, T. Smith⁶ and P. Iacumin⁷

¹BRGM (French Geological Survey), GEO/G2R, 1, Avenue Claude Guillemin, BP 36009, 45060 – Orléans Cedex 2, France: f.quesnel@brgm.fr; ²Polytechnics, GFA, rue de Houdain 9, 7000 – Mons, Belgium; ³UCL-Namur, FUNDP., rue de Bruxelles, 61, 5000 – Namur, Belgium; ⁴ULg, Paléontologie végétale, Sart Tilman, B18/P40, 7000 – Liège, Belgium; ⁵ERADATA, 5, Allée des Magnolias, 72100 Le Mans, France; ⁶IRSNB, Département de Paléontologie, 29 rue Vautier, B-1000 Bruxelles, Belgium; ⁷Università di Parma. Dipartimento di Scienze della Terra Via Usberti 157/A. 43100 – Parma, Italy.

INTRODUCTION, AIMS AND METHODS

The geological archive records "hyperthermal" crises, along with their consequences for the biotic and physical environment. Among these, the Paleocene–Eocene Thermal Maximum (PETM) is considered the closest analogue to the current climate crisis, due to its global character and speed at which the CO₂ rate and average temperatures increased (Higgins and Schrag 2006; Zachos et al. 2001, 2008). Some 55.8 Ma, it affected the Earth for a period of almost 200 k.y. (Röh l et al. 2000; Westerhold et al. 2007), and continental and marine paleoenvironments were marked by a negative δ¹³C anomaly coinciding with a negative δ¹⁸O anomaly indicative of a notable temperature rise (3–8°C).

We are developing a multi-disciplinary study in the coastal to continental paleoenvironment of the Sparnacian facies preserved within the Paris and adjacent basins, and also on the neighbouring basements that are sites of contemporary weathering. We aim to integrate the upstream to downstream sequence of diversified paleoenvironments, their landscapes and ecosystems, in order to assess the impact of the PETM climate crisis on each and the whole sequence.

The preliminary work described here has involved:

- studying occurrences of paleo-weathering and continental deposits, dating these using a variety of tools (e.g. litho, bio and chemo-stratigraphy, paleomagnetism, Ar/Ar geochronology), and relating them to the P–E continental paleosurface;
- organizing all the data in a GIS Database, using these to digitally reconstruct the current geometry of this paleosurface at 1:1 000 000 scale, then drawing the geological cross sections through the studied basins and their borders;
- reconstructing the continental paleogeography of the Paris and adjacent basins and their surroundings during this interval (Fig. 1).

FIRST RESULTS

Historically, the Paris and adjacent basins are the cradle of stratigraphy, where the notion of "Sparnacian" took shape (Dollfus 1880; see the detailed lithostratigraphy in Aubry et al. 2005). The Sparnacian facies, mainly continental to coastal, often display paleo-weathering features. Near the Mesozoic cover and older basement surrounding those basins, many fluviatile sands and conglomerate units seal or incise older thick kaolinitic weathering profiles. Sedimentological and stratigraphic studies and the mapping of those deposits show them associated with a major unconformity, spanning the uplifted areas to the lowlands of the shallow basins where they incise marine formations of Late Thanetian age. Almost all these paleo-weathering profiles and fluviol deposits are oxidized and/or leached and silicified in and around the studied...
basins, with pedogenic silcretes upstream and quartzitic silcretes on the leached fluviatile deposits of the lowlands, originally rich in lignite and pyrite. These silcretes are probably the most striking geological markers of the P–E paleo-weathering, and were long known to geologists and geomorphologists who tried to map the “Eocene continental paleosurface”. They are often ascribed to Late “Landenian” to the north of the Paris-Belgian Basins and correlated to Sparnacian continental deposits to the south, west and east of the Paris Basin.
The kaolinitic weathering profiles were clearly the lower Ypresian transgression. Additionally, occurred after the Late Thanetian and prior to produced the silcretes and oxidized sandstones (e.g. “Pays d’Ouche” in Normandy and Grandglise Sandstones in Belgium).

Above the upstream paleo-weathering profiles, the silcretes and oxidized sandstones are almost never overlain by other formations, preventing any precise dating. Yet they are sealed by lacustrine limestones of Lutetian to Bartonian age in a few small grabens in Normandy, Perche, and on the Beauce margins. In the best preserved successions downstream, these weathering profiles lie above, or are developed upon, marine or continental upper Thanetian formations and are overlain by lower Ypresian marine formations, in England, northern France-Belgium and Upper Normandy. Locally they are the stratigraphic equivalents to fluvial sands containing lignitic units where the PETM has been recorded (e.g. Belgium (Steurbaut et al. 2003) and Northern France (Magainalda unpublished data; Quesnel 2006; Storme et al. unpublished data)). The paleomagnetic ages obtained from the silcretes and oxidized sandstones from the “Pays d’Ouche” and Grandglise Sandstones indicate a paleo-weathering episode around the P–E boundary (Ricordel-Prognon et al. unpublished data). The $^{39}$Ar/$^{40}$Ar dating of the supergene Mn oxides from the Morialmé weathering profile formed on the Ardenne basement also gives an age around the P–E boundary (Barbier et al. unpublished data). Finally, the quartzitic and oxidized silcretes (Sarsenstones and Landenian Sandstones) are reworked in a few small very well rounded pebbles that accompany flint pebbles within the coastal Blackheath and Oldhaven Formations (Early Ypresian) in England (Stamp 1921) and the “Conglomérat à galets avellanaires”, their stratigraphic equivalent in Upper Normandy and Avesnois (Quesnel 2006 unpublished data). All this data implies that the paleo-weathering that produced the silcretes and oxidized sandstones occurred after the Late Thanetian and prior to the lower Ypresian transgression. Additionally, the kaolinitic weathering profiles were clearly formed earlier, and probably under wetter conditions, than the silcretes, mainly during the Early Cretaceous on the old basement and Jurassic formations (Yans et al. 2003; Thiry et al. 2006; Ricordel, 2007; Théveniaut et al. 2007) and during the Paleocene on the Chalk (Quesnel et al. 2007).

**DISCUSSION**

The widespread occurrence of a peculiar paleo-weathering in and around the Paris and adjacent basins is present around the P–E boundary. We have recognised pedogenic, quartzitic and oxidized silcretes in Limbourg, Thiérache, Upper Lorraine, Luxembourg, Brittany, Touraine, northern Aquitaine Basin, around the Morvan and the Massif Central, on the Bresse edge and they are also described in Germany in the Saale-Elbe Basin (Eissmann 2002), Eifel (Löhnhertz 2003 pers. comm.) and in Hesse (Thiry 2003 pers. comm.). The processes involved in generating these types of silcretes are relatively well known in the Paris and adjacent basins and their borders (Dupuis and Steurbaut 1987; Thiry 1999) and some appear to be closely linked to effects in relation with a climate crisis such as the PETM (i.e. marked alternations of flooding, inducing clay deposition in pores and soil cracks, followed by dry phases saturating the ground solutions; acid drainage of highly organic and pyrite-rich sediments, destabilization of kaolinite). The silica may have been provided by the weathering of the quartz sands and of the flints of the Clay-with-flints (Cwf) profiles formed during the Paleocene at the expense of the Chalk, which largely covered the area at the end of the Cretaceous (Quesnel et al. 2007).

Other types of paleo-weathering, such as variegated clay, oxide nodules, gley and pseudogley features formed in the lacustrine and fluviatile formations along the P–E continental paleosurface on the borders of the Sparnacian basin (Buurman 1980; Thiry 1981; Laurain and Meyer 1986). These probably formed in a less well drained paleoenvironment in the clayey lowlands. Sparse calcretes also occur in similar P–E formations south and east of the Paris Basin. These are much more common in the Languedoc, Provence and Pyrenees Garumnian facies (i.e. the Upper Paleocene and Lower Eocene continental formations; Plaziat et al. 2007).
Climatic and Biotic Events of the Paleogene


Quesnel, F.; Bourdillon, C.; and coll. 2007: Résidus à silex de l’Ouest du bassin de Paris (Normandie et Perche), Du terrain à la typologie des faciès, Biostratigraphie des silex résiduels, Cartographie numérique, Modélisation géométrique, évolution des profils d’altération sur le Crétacé supérieur,


