An unexpected record of the PETM in terrestrial and organic sediments of Avesnois, between the Paris and Belgian Basins, NW Europe
Christian Dupuy, Florence Quesnel, Jean-Marc Baele

To cite this version:

HAL Id: hal-01010549
https://hal-brgm.archives-ouvertes.fr/hal-01010549
Submitted on 20 Jun 2014

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.
An unexpected record of the PETM in terrestrial and organic sediments of Avesnois, between the Paris and Belgian Basins, NW Europe

Florence Quesnel (a,b), Jean-Yves Storme (c), Emile Roche (c), Alina Iakovleva (d), Pieter Missiaen (e), Thierry Smith (f), Chantal Bourdillon (g), Jean-Marc Baele (h), Johan Yans (i), Johann Schnyder (j), Paola Iacumin (k), Christine Fléhoc (k) & Christian Dupuis (h)

(a) BRGM (French Geological Survey), Georesources Division, Land Use Geology Unit, 3, Avenue Cl. Guillemin, 45060 Orléans Cedex 2, France. E-mail: f.quesnel@brgm.fr
(b) UMR 7327 of the CNRS/INSU, Orléans University & BRGM, 1A, rue de la Fétoterie, 45071 Orléans, France. E-mail: f.quesnel@brgm.fr
(c) Geological Institute, Russian Academy of Sciences, Pyzhevsky pereulok 7, 119017 Moscow, Russia. E-mail: alina.iakovleva@gmail.com
(d) Geology Dept, Palaeobiogeology-Palaeobotany-Palaeopalynology, Liège University, Allée du 6 Août, 17, 4000 Liège Sart-Tilman, Belgium. E-mail: pieter.missiaen@gmail.com
(e) O.D. Earth & History of Life, Royal Belgian Institute of Natural Sciences, Vautierstraat 29, 1000 Brussels, Belgium. E-mail: thierry.smith@naturalsciences.be
(f) Geological Institute, Russian Academy of Sciences, Pyzhevsky pereulok 7, 119017 Moscow, Russia. E-mail: alina.iakovleva@gmail.com
(g) Geological Institute, Russian Academy of Sciences, Pyzhevsky pereulok 7, 119017 Moscow, Russia. E-mail: alina.iakovleva@gmail.com
(h) University of Namur, Department of Geology, Rue de Bruxelles, 61, 5000 Namur, Belgium. E-mail: johan.yans@fundp.ac.be
(i) ISTeP, Pierre & Marie Curie University-Paris 6, 4, Place Jussieu, 75252 Paris cedex 05, France. E-mail: johann.schnyder@upmc.fr
(j) Earth Sciences Department, Parma University, Viale G.P. Usberti, 157/A, 43100 Parma, Italy. E-mail: paola.iacumin@unipar.it
(k) BRGM (French Geological Survey), Laboratory Division, Isotopes Unit, 3, Avenue Cl. Guillemin, 45060 Orléans Cedex 2, France. E-mail: c.flehoc@brgm.fr

KEY WORDS: Avesnois, Belgian & Paris Basins, Carbon Isotope Excursion, faunal & floral changes, palynology, PETM, stratigraphy

The stratigraphy of the Late Paleocene-Early Eocene has been revised in Avesnois thanks to drillings supporting a geological mapping project. Detailed sampling and analyses were performed along selected drillings, among which sedimentological, mineralogical, biostratigraphic (δ¹³Corg), biostratigraphic and palynological data have been obtained. New Mbs/Fms are defined around the Paleocene-Eocene boundary (PEb) and compared to the lithostratigraphic nomenclatures of the Belgian and Paris Basins (Steurbaut, 1998; Aubry et al., 2005). Biostratigraphy based on the study of foraminifera and mammalian fossils, palynological content and chem stratigraphy enable correlation to be established between adjacent basins as well as sea level and landscape evolutions to be refined during this critical interval.

Uppermost Paleocene to lowermost Eocene terrestrial units

In AVE 007 the Vervins Mbs is unconformably overlain by flint gravels (Mormal Mb), then a pyritic sand (Le Quesnoy Sand Mb, cf. ‘Sables et Grés du Quesnoy’ of Gosselet, 1889), and a lignitic clay (Locquignol Mb), silty and ochreous at the top. All but the top ochreous paleosol contain spores and pollen grains and are devoid of dinocysts, they were thus probably deposited in terrestrial environments. The Carbon Isotope Excursion (CIE) of the PEs begins below the top of the sandy unit and continues in the lignitic clay. The palynological study confirms the Locquignol Mb’s earliest Eocene age and allows correlation with the base of the Tienen Fm.

To the East of AVE 007 along the Belgium-France border, fluvial fossiliferous gravels and sands have been studied in past sand quarries (Erquelinnes Sand Mb). Above a sharp unconformity, they i) overly Upper Thanetian marine sands (Bois-Gilles Fm, NP9a, then Grandglise Mb, NP8), ii) contain a mammalian fauna referred as MP7 in the Mammalian biochronological scale for the European Paleogene (Missiaen et al., 2013) and iii) record the first part of the CIE onset in the basal fossiliferous gravel and marl beds.

Three km west of Erquelines and toward AVE 007 a few drillings have recognized a sandy and pyritic unit containing resinate fragments, lignite and peat beds (Vieux Reng Mb), overlying a thin basal flint gravel bed (Mormal Mb).

These five Mormal, Le Quesnoy, Locquignol, Vieux-Reng and Erquelinnes Sand Mbs form the Sambre Fm. Such fluvial gravels and sands, more or less lignitic, clayey or marly are widespread in northern France and southeastern Belgium. They belong to the so-called Upper “Landenian” and are correlated to the ‘Tienen Fm. In AVE 007, they record the CIE onset marking the PEs and 2.5 m of Upper Paleocene fluvial units, in contrast with Belgian drillings such as Doel and Kallo where a hiatus is present at the PEb.
Lower Ypresian hiatus and marine units

In AVE 007, a laminated silty unit overlies the Locquignol Mb, contains dinocysts Wetzeliella sp. and agglutinated foraminifers similar to those of the base of the Orchies Clay Mb. Widespread in Avesnois-Valenciennois that marine unit is named Avesnois Mb, it is locally richer in very fine sand, and correlated to the base of the Kortrijk Clay Fm (Ieper Gp).

In Avesnois, Sparnacian lagoonal units are absent upon the terrestrial ones described above, again marking a reverse trend when compared with the Belgian and adjacent Basins. This may result from restricted terrestrial environments coinciding with Variscan accidents and structural highs between the Artois anticline and Ardenne Massif, or to their deposition followed by subsequent erosion prior to the Lower Ypresian marine transgression (cf. sea level drop 2 of Dupuis et al, 2011).

Correlations and PETM impact on land

All terrestrial units here described fill fluvial channels incised in marine Thanetian and older units such as the Cretaceous or the Variscan basement in Avesnois and Belgium, as already reported elsewhere in northern France (cf. sea level drop 1 of Dupuis et al., 2011). They exhibit locally cross stratification, lignite, flora or vertebrate fauna, for example at Leval, Hoegaardern and Dormaal, and/or are intensively silicified with scarce root or leaf casts.

Similar fluvial sediments and silcretes are recognized in the first Sparnacian units and paleogeography of the Paris, Dieppe-Hampshire and London Basins, where the Pb is also present, the CIE being recorded on thicknesses between 3 m (as in AVE 007) to >20 m (as in Sinceny). These features may be regarded now as constant in those Sparnacian landscapes recording the PETM, with very rapid lateral and vertical facies shift, particular paleosols, a few fossiliferous fluvial to lacustrine units and variable deposition rates/sediments preservation.

Terrestrial sediments, flora and fauna have been described there before the CIE onset as well, for example at Cobham, Vasterival or Rivecourt (e.g. Smith et al., 2014). Lihons, an intermediate outlier situated between AVE 007 and Sparnacian Vasterival or Rivecourt (e.g. Smith et al., 2014). Lihons, an intermediate outlier situated between AVE 007 and Sparnacian Vasterival or Rivecourt (e.g. Smith et al., 2014).

In AVE 007, depositional environments are fluvial for the Mormal and Le Quesnoy Mb, and evolve toward flood plain then palustrine ones for the Locquignol Mb, probably here after the river bed migration, but still recording sporo-pollen fluvial inputs from the hinterland, the whole indicating a rather humid subtropical climate. Compared to the Locquignol Mb, the sporopollinic assemblage of the Mormal and Le Quesnoy Mb (below the CIE onset) is different, particularly regarding the Normapolles distribution, the Tricolpatres, Tricolporates and Monocolpatres relative pollen abundances and the pollen ratio of Picapollis pseudoexcelsus/Juglandaceae.

In the three Mbs, rapid vertical variations characterize pollen and fern spores assemblages, with peaks of particular taxa reaching 25% of the total counts, such as for P. pseudoexcelsius, T. platycaryoides, C. dorogensis, P. mcgregorii, T. robustus. They suggest rapid floral changes in the catchment and/or sources changes in the surrounding landscapes compartments for the rivers supplying the fluvial sediments. Resinite particles are irregularly abundant as well as microcharcoals are occasionally abundant, notably slightly before the CIE onset and 1.5 m above it, still within the CIE.

The clay mineral assemblage is homogeneous along marine Thanetian units and strongly dominated by Illite-Smectite (IS) mixed layers, whatever the facies, while it is more variable in the marine Ypresian silts (abundant IS, followed by Kaolinite, Illite, Chlorite and Vermiculite). In contrast terrestrial units are dominated by IS followed by Kaolinite, Illite and very rare Chlorite, and no variation is observed across the Pb.

Those data would suggest that major environmental changes have regionally begun before the PETM, at the very end of the Paleocene, when terrestrial realm has settled, in relation with a regional uplift. Clay minerals reflect constant reworking of preexisting weathering profiles established upon Cretaceous strata and Variscan basement, while vegetation modifications are subtle and more likely attributable to changes of depositional environments.

REFERENCES


Steburau B. (1998) – High resolution holostratigraphy of Middle Paleocene to Early Eocene strata in Belgium and adjacent area, Palaeontographica, A 247, 91-156.
AN UNEXPECTED RECORD OF THE PETM IN TERRESTRIAL AND ORGANIC SEDIMENTS OF AVESNOIS