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Multidisciplinary study of the wealden deposits of the Mons Basin (Belgium): a progress report

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ABSTRACT

New results related to the wealden deposits of the Mons Basin (Belgium) are discussed. In the western part of the Basin, we present an unpublished general succession of about 283 meters thick. In the eastern part of the Basin, occurrences of dinoflagellates suggest evident marine influences in the wealden deposits. Special attention is given to the precise ages and the mineralogical contents of the sediments. A general interpretation of the wealden deposits in western Europe is also suggested.

KEYWORDS

Clay mineralogy, Mons Basin, palynology, wealden deposit, western Europe

Introduction

The wealden deposits, also called "wealden facies" or "Hainaut Group" of the Mons Basin (Belgium) are mined since the Middle Ages and studied since the beginning of the 19th century. These deposits are specially interesting because of their "continental facies" and their exceptional palaeontological contents (the famous specimens of genus *Iguanodon* found at Bernissart in 1878).

In Belgium, the wealden deposits occur (Robaszynski *et al.*, 2002):

- in kilometric outcrops or weakly buried sediments in the northern part of the Mons Basin, from Hautrage to Thieu (Marlière, 1946) – Hautrage Clays Formation, Baudour Formation and lower part of the Saint-Pierre Formation,
- in filling several sinkholes developed on carbonates and siliciclastic sediments (for example at Bernissart) in the Mons Basin and elsewhere in Belgium (Legrand, 1968; Vergari & Quinif, 1997),
- as white sands and sandstones containing lignite and glauconitic material in the eastern part of the Mons Basin (upper part of the Saint-Pierre Formation).

However several fundamental aspects of the wealden deposits remain unknown. Since 1997, numerous boreholes and trenches were carried out in the Hautrage Clays Formation to prospect new clayey materials. Moreover one quarry has been enlarged and previous boreholes stocked in the Geological Survey of Belgium have been revised. The so collected cores and samples are studied with a multidisciplinary approach.

Aims and methods

Several ways of research are in progress to investigate the wealden deposits of the Mons Basin, including:

- make an inventory of the wealden deposits to propose a general succession of these deposits;
- characterise the deposits by Transmission Electronic Microscope (TEM), petrographic, granulometric, mineralogical (including the fraction < 2µm) and geochemical analyses;
- precise the age of the sediment by using:
  - palynological study - determinations of the dinoflagellates, spores and pollens (including angiosperms);
  - K-Ar geochronological method (Cassignol & Gillot, 1982) on glauconites;
- clarify the palaeoenvironments at the "wealden times" in the Mons Basin and integrate the wealden deposits of the Mons Basin into the geological context of the western Europe.

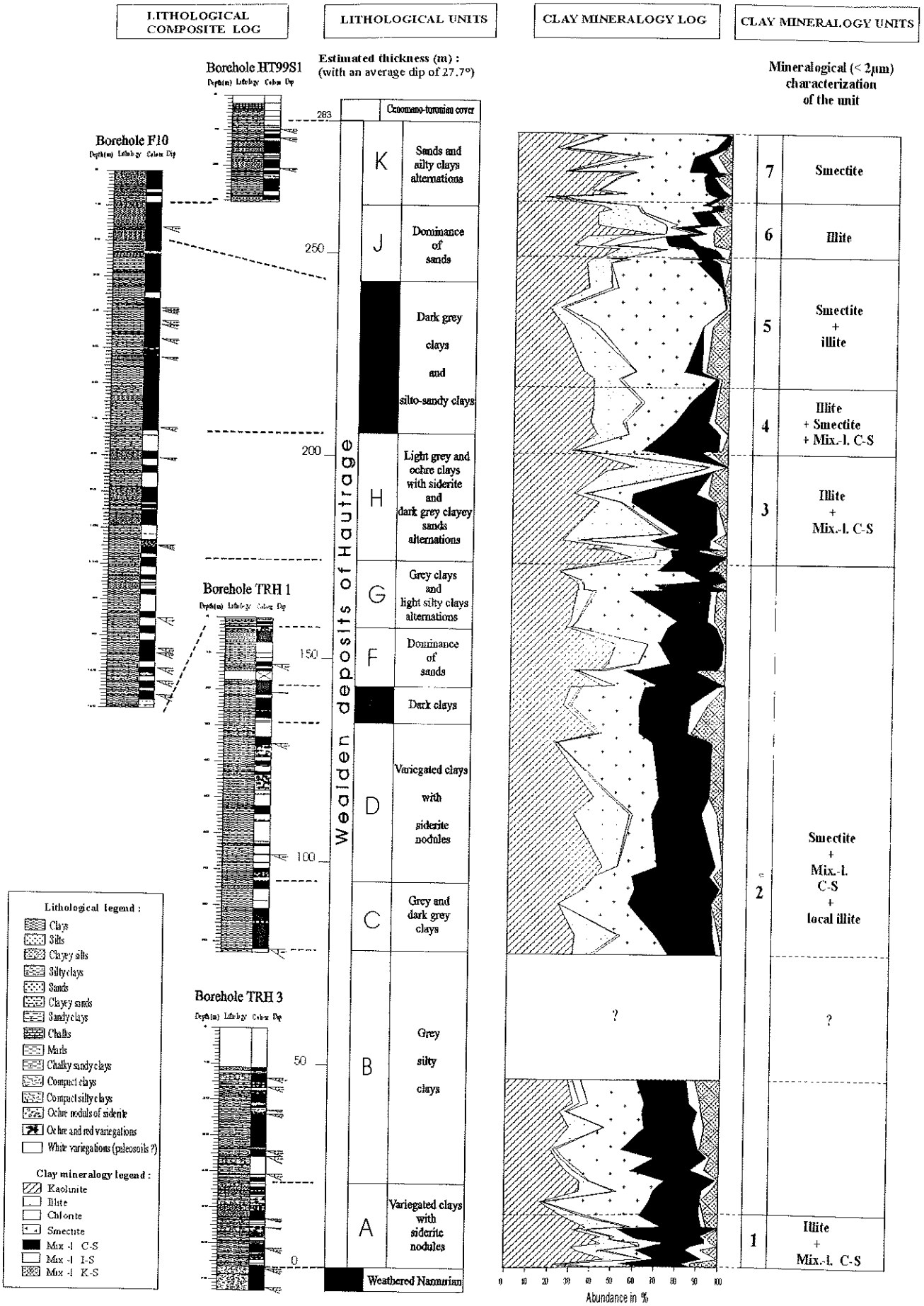

Fig. 1. General succession of the Hautrage Clays Formation.

Results and discussion

The multidisciplinary results are summarised below.

The **Hautrage Clays Formation** (western part of the Mons Basin) shows a succession of sands and clays of about 283 meters thick (Fig. 1) with various proportions of α-quartz, pyrite, siderite, Fe-(hydro)oxides, clay minerals and lignite.

The clay (<2μm) assemblage contains various proportions of kaolinite, illite, smectitic material, chlorite, chlorite-smectite, smectite-illite and kaolinite-smectite mixed-layers. By the light of the clay mineralogy the succession can be divided into 7 main units (Fig. 1).

By using TEM, some clay minerals show a facies with laths (Fig. 2) in the sandy parts of the wealden deposits, suggesting an *in situ* (neo)formation. Single geochemical analyses on the laths are consistent with the smectitic material compositions. Assuming that this determination is confirmed by micro-XRD studies, this suggests that at least a part of the smectitic material is formed *in situ* during the very early diagenesis (Steinberg *et al.*, 1987). We also found this kind of material in the wealden deposits of the Isle of Wight (England). This would be the first description of authigenic smectitic material with laths in such palaeoenvironment.

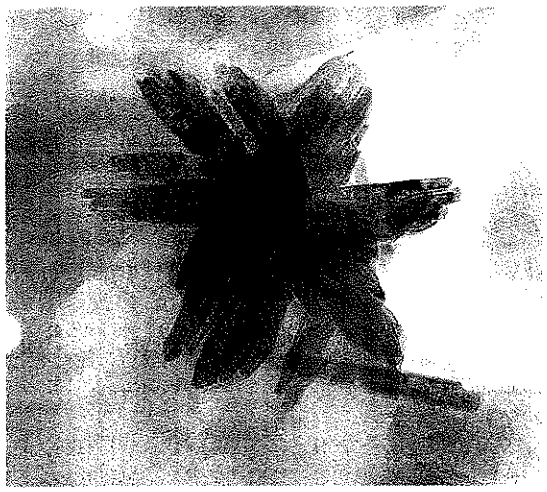

Fig. 2. TEM micrograph of the smectitic material with laths (Isle of Wight - Wessex Formation - sample BSWX17) - x 99.000.

The wealden sediments are usually considered to have been inherited from the Lower Palaeozoic rocks of the Brabant Massif, mainly affected by the caledonian orogenesis (Cornet, 1901). The inherited illites of the wealden sediments in Hautrage are dated 333.5 +/- 4.8 Ma, consistent with a diagenetic formation during the Variscan orogenesis. This implies that at least a part of the wealden material has been inherited from rocks strongly affected by the variscan orogenesis (probably the Namurian weathered shales of the Mons Basin)

The **lower part of the Saint-Pierre Formation** (eastern part of the Mons Basin) shows the following succession (base to the top):

- mainly clays with palaeosoils containing continental organic materials only (spores, pollens, cuticules and wood fragments);
- mainly silts and sands containing dinoflagellates in association with linings of foraminifera, results of evident marine influences. The wealden deposits are not continental everywhere!

The latter sediments are covered by marine glauconitic silts and sands with ammonites, Lower Vraconnian in age (Robaszynski *et al.*, 2002). In this area, angular discordance has never been observed between the wealden deposits and their overlying marine sediments (Cornet, 1921): the sedimentation seems to be relatively continuous, from continental to marine palaeoenvironments. The association of dinoflagellates *Xiphophoridium alatum* and *Odontochitina costata* in the marine lower part of the Saint-Pierre Formation suggests a Late Albian age (including Lower Vraconnian).

Fig. 3. specimen of dinoflagellate Xiphophoridium alatum (sample 141W-380-45-G21) – x 675.

The glauconites of the **upper part of the Saint-Pierre Formation** (eastern part of the Mons Basin) show:

- a high roundness ratio and sizes quite the same as the sizes of the surrounding quartz, consistent with inherited glauconites;
- a very high K-content (6.8 %), suggesting highly evolved glauconites that can be used for dating analyses (Odin & Matter, 1981).

The glauconites are dated 86.6 +/- 1.2 Ma: Turonian to Santonian ages (Odin, 1990). This age corresponds to the formation of the inherited glauconites and not to the age of the wealden deposits. In this area, the overlying sediments (Ville-Pommeroeul Chert Formation) of the Saint-Pierre Formation are Late Turonian (Robaszynski *et al.*, 2002). The age of the upper part of the Saint-Pierre Formation is therefore younger than the age of the glauconites and older than the age of the cover: an Early to Middle Turonian age is suggested. In this area, silicifications of the wealden sands often occur, maybe in relation with coeval other silicifications of the Mons Basin - Meulière de Saint-Denis (Baele, 1999).

In the whole Mons Basin, the wealden sediments are structured in bars and lenses of a few centimeters to several meters thick. They usually show fining-upwards sequences with sharp contacts at the base and palaeosoils at the tops. These sequences get together into one coarsening-upward

succession, from mainly clays at the base to mainly sands at the top. The clayey base of the wealden successions deposited in a fluviatile (including marshes and lakes) sedimentary environment during a Transgressive System Tract (TST). The sandy top deposited in fluviatile environment with local marine influences during a High System Tract (HST).

All these data show that the wealden sediments are:

- the first deposits of the main transgressive event that occurred in the Mons Basin during the late Lower Cretaceous,
- deposited probably in response to a particular tectonic activity partly linked with the dissolution of deep Visean anhydrites (Dupuis & Vandycke, 1989).

In the Weald and Wessex stratotypes areas, the wealden deposits show a "relative continuous" succession from Late Berriasian to Earliest Aptian (Allen, 1989). In the other areas of western Europe, the age ranges of the wealden sediments are not so long. In these latter areas the wealden deposits probably correspond to the first deposits of one main regional transgression (Table 1). This may confirm that the sub-continental wealden sediments have been conserved only if they were deposited 1) during one main transgression and 2) in a relative active tectonic period. In this context, the following marine sediments of the transgression quickly overlie and protect them.

Table 1. Ages of some wealden deposits and ages of the overlying marine sediments in western Europe. From Robaszynski & Amédro (1986), Herngreen (1971) and Allen & Wimbledon (1991).

area	*age of the wealden deposits*	*age of the overlying sediments*
east Netherlands - north Germany	*Berriasian - Earliest Valanginian*	*Valanginian*
Boulonnais (France)	*Late Barremian - Early Aptian*	*Aptian*
Eastern part of the Mons Basin (Belgium)	*Late Albian sensu lato*	*early Vraconnian*

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