An overview of the saprolites of Belgium and their potential kaolinitic supplies to Mesozoic and Cainozoic sediments

Introduction

This paper aims to get an overview of the kaolinitic weathering events (= primary kaolinite) that affect the Belgian rocks over geological times. The kaolinite formed in these events can be later eroded, transported and deposited within younger sediments (= secondary kaolinite). We focus here on the dating of the primary kaolinite neoformations and on the dating of the potential inherited secondary kaolinitic sediments from Belgium.

Special attention is given to the following question: could the extensive stock of neoformed kaolinite in the Ardenne area supply the kaolinitic Wealden facies of the Mons Basin? We therefore present new results on 1) geochronological dating of some weathering profiles from the Ardenne and 2) precise palynological dating of the Wealden facies of the Mons Basin.

Overview of the saprolites of Belgium (= primary kaolinite)

We suggest to group the numerous saprolites into “geological and/or geographical units”. Each so-called unit includes saprolites which are 1) covered by the same discordant sediments (when present) and 2) homogeneous by the geological (i.e. Brabant Massif or Stavelot Massif) and/or geographical (i.e. Haute-Lesse area, Welkenraedt area) points of view. The weathering dating is mainly based on “stratigraphic” arguments. The weathering phase(s) is (are) indeed:

- younger than the age of the host-rocks and younger than the last (pre-weathering) tectonic event (major thrust faulting, uplift) that affected the host-rocks,

- older than the age of the overlying discordant cover.

From the North to the South of Belgium, we can distinguish 12 main units summarized in the Table 1 and roughly located on the Figure 1. The Figure 2 shows the stratigraphy of the host-rock, the last (pre-weathering) tectonic event and the sealing sediments of all these units. The weathering age of five of the units (Southern part of the Brabant Massif, Campine, Malmédy area, Western part of Belgium and Gaume) can be deduced from the “stratigraphic” arguments. The ages of the weathering on the Haute-Lesse and the Plateau des Tailles areas are discussed below. On this basis, at least four Mesozoic and Cainozoic main kaolinitic weathering events can be highlighted at the Permian-Early Triassic, Early (to “mid”?) Cretaceous, Palaeocene-Eocene interval and the Early Miocene. These events do correlate with the major weathering phases deciphered in the whole Northwestern Europe (Quesnel et al., 2002 a,b). The weathering age of the other areas remain too poorly constrained.
Table 1.- Ages of the host-rock, last (pre-weathering) tectonic event and the discordant sedimentary cover of each weathered unit in Belgium.

<table>
<thead>
<tr>
<th>weathered unit</th>
<th>Age of the host-rock</th>
<th>Age of the last (pre-weathering) tectonic activity</th>
<th>Age of the discordant cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern part of the Brabant Massif</td>
<td>Early Palaeozoic</td>
<td>Late Jurassic</td>
<td>Turonian</td>
</tr>
<tr>
<td>Campine</td>
<td>Westphalian</td>
<td>Late Carboniferous</td>
<td>Late Permian</td>
</tr>
<tr>
<td>Stavelot Massif:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Welkenraedt area</td>
<td>Namurian</td>
<td>Late Carboniferous</td>
<td>Santonian</td>
</tr>
<tr>
<td>Hautes-Fagnes area</td>
<td>Cambrian (Revilhian)</td>
<td>Late Carboniferous</td>
<td>Campanian - Oligocene?</td>
</tr>
<tr>
<td>Malmedy area</td>
<td>Cambrian (Revilhian)</td>
<td>Late Carboniferous</td>
<td>Permian</td>
</tr>
<tr>
<td>Plateau des Tailles area</td>
<td>Cambrian (Revilhian)</td>
<td>Late Carboniferous</td>
<td>Quaternary</td>
</tr>
<tr>
<td>ESEM &amp; Condroz areas</td>
<td>Famennian</td>
<td>Late Carboniferous</td>
<td>Paleocene-Eocene interval</td>
</tr>
<tr>
<td>Central part of the Mons Basin</td>
<td>Thanetian</td>
<td>“Sparianian”</td>
<td>Ypresian</td>
</tr>
<tr>
<td>Northern Namur Synclinorium</td>
<td>Namurian</td>
<td>Late Carboniferous</td>
<td>Barremian to Albian</td>
</tr>
<tr>
<td>Rocroi Massif</td>
<td>Cambrian</td>
<td>Late Carboniferous</td>
<td>Paleocene-Eocene interval</td>
</tr>
<tr>
<td>Haute-Lesse area</td>
<td>Early Devonian</td>
<td>Late Carboniferous</td>
<td>Quaternary</td>
</tr>
<tr>
<td>Gaume area</td>
<td>Early Devonian</td>
<td>Late Carboniferous</td>
<td>Permian</td>
</tr>
</tbody>
</table>

* Entre-Sambre-Ét-Meuse

Fig. 1.- Simplified geological map of Belgium with the locations of the main weathered units.
Fig. 2.- Tentative synthesis of the kaolinitic paleoweathering events in Belgium and stratigraphy of the potential inherited kaolinitic deposits.
Overview of the kaolinitic deposits of Belgium (≈ secondary kaolinite)

The stratigraphy of the main potentially inherited kaolinitic deposits of Belgium is mentioned in the Figure 2. These sediments can inherit kaolinite only from areas where this latter has already neoformed: for example the kaolinite from the Sinemurian Luxembourg Formation can not be inherited from the Early (to mid?) Cretaceous weathering event…

Dating a case-study weathering profile (Ardenne area) and a potential secondary kaolinitic deposit (Wealden facies of the Mons Basin)

We show here that the precise dating of the weathering that affected an area and the precise dating of kaolinitic deposits in another area may be powerful tools to improve paleogeographical investigations. We can therefore focus on a case-study hypothesis (Dupuis, 1992 and Dupuis et al., 1997) : the kaolinite of the Wealden facies of the Mons Basin may have been inherited from the weathered profiles of the Ardenne area.

Dating the weathering profiles of the Ardenne area

The Haute-Lesse area (Westen part of the Ardenne area) is strongly affected by weathering that results in deep (>60 meters in a borehole at Transinne) profiles (Dupuis et al., 1997). The precise age(s) of the weathering is unknown (Demoulin, this volume) due to 1) the absence of pre-Quaternary cover and 2) the difficulties to find suitable material for dating.

Recently new geochronological dating methods of the weathering (Gilg, this volume) developed on hollandite (BaMn₈O₁₆) - cryptomelane (KMn₈O₁₆) minerals (Vasconcelos et al., 1992) which:

- are quite rich in potassium (K) and allow to use the K-Ar and Ar-Ar methods,
- crystallized within oxidizing conditions (= supergene origin) in genetic relations with kaolinite neoformations,
- are quite common in the weathering profiles,
- do preserve K and Ar after crystallisation due to specific mineralogical properties.

In the Transinne profile we studied two kinds of manganese oxides:

- hollandites from the upper part (15 to 20 m deep) of the profile, by using K-Ar method on mineral powder,
- cryptomelanes from the basal part of the profile, by using Ar-Ar step-heating on single grain and K-Ar methods on mineral powder.

The K-Ar apparent ages of the hollandites range from 126 ± 10 and 131 ± 15 Ma (from Berriasian to Barremian). Moreover paleomagnetic data from the upper part of the profile do support a Mesozoic weathering phase. Note that some other weathering parageneses are thought to be Cretaceous in age:

- the widespread weathering of the Southern part of the Brabant Massif (Dupuis, 1992),
- the lateritic profile of the “Borne de Fer” located in the Northeastern France (Quesnel et al., 2002a,b; Théveniaut et al., 2002),
- the Thermae profile in the Limburg - The Netherlands (Thorez, 1987; Batten et al., 1987).

On the other hand both Ar-Ar (Fig. 3) and K-Ar results suggest that the cryptomelanes of the basal part of the profile are Early Miocene in age (21.1 ± 0.4 Ma). Note that some other weathering parageneses are also Early Miocene in age:

- cryptomelanes collected at the base of the weathering profiles in the Plateau des Tailles area – Eastern part of the Ardenne area (unpubl. data),
- some manganese oxides collected in the Eastern part of the Rhenish Massif - Germany (Hautmann and Lippolt, 2000),
- kaolinites and surrounding monazites in the Entre-Sambre-Et-Meuse area (De Putter et al., 2002; Dupuis et al., this volume),
- meteoric phase (“septarias” neoformation) in the Oligocene Boom Clay Formation (Vandenberghe and Laga, 1986).

Fig. 3. 40Ar-39Ar spectra of the cryptomelane of the basal part of the Transinne profile.
- weathering profiles in the Massif Central (France), Vogelsberg and Fichtelgebirge (Germany), Sudetes (Czech Republic and Poland) - see references in Migon and Lidmar-Bergström (2001 and 2002).

Hence the kaolinitic profiles of the Haute-Lesse area are the result of two paleoweathering phases (“polyphased paleoweatherings”). The Early Cretaceous and the Early Miocene periods seem to offer the favourable conditions (climatic, eustatic and/or tectonic causes ?) allowing for deep weathering process in the Central and Northwestern Europe.

**Dating the kaolinitic deposits: the Wealden facies of the Mons Basin**

A recent synthesis suggests that the Wealden facies of the Mons Basin are roughly dated from Late Jurassic to Early Cretaceous (Robaszynski et al., 2001). On the basis of the 1) angiospermian pollen and 2) dioflagellate contents, new palynological studies demonstrate that the Wealden facies of the Western part of the Mons Basin (Bernissart sinkhole and Hautrage “pocket”) are Late Barremian and that the Wealden facies of the Eastern part of the Mons Basin are Late Albian *sensu stricto* (Yans et al., 2002).

**Integration of the results**

The kaolinite deposition age of the Wealden facies in the Mons Basin (Late Barremian to Late Albian *sensu stricto*) is consistent with the late period (Early Cretaceous) of the kaolinite formation in the Ardenne area. On this basis we may conclude that a kaolinitic supply from the weathered profiles of the Ardenne area to the Wealden facies of the Mons Basin is possible. The potential paleogeographic links between the Ardenne and the Mons areas should be precised by comparing the mineralogical characteristics of the kaolinites from the both areas...

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**Bibliographic orientation**


Migon P., Lidmar-Bergström K. (2001). On the basis of new palynological studies demonstrate that the Wealden facies of the both areas…


