Facies Analysis of the Gulpen, Maastricht, and Houthem Formations (Late Campanian–Danian, Cretaceous) in the Molenbeersel Borehole, Roer Valley Graben, Northeast Flanders

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Background

Current understanding concerning the distribution of the uppermost Cretaceous formations in the southeastern Netherlands limits the presence of the Gulpen and Maastricht formations (late Campanian–early Danian) to the Campine Basin in South Limburg. The younger (Danian) Houthem Formation is more widely distributed and also present in the Roer Valley Graben, where the former two formations are thought to have been **eroded** during **Late Cretaceous inversion**.

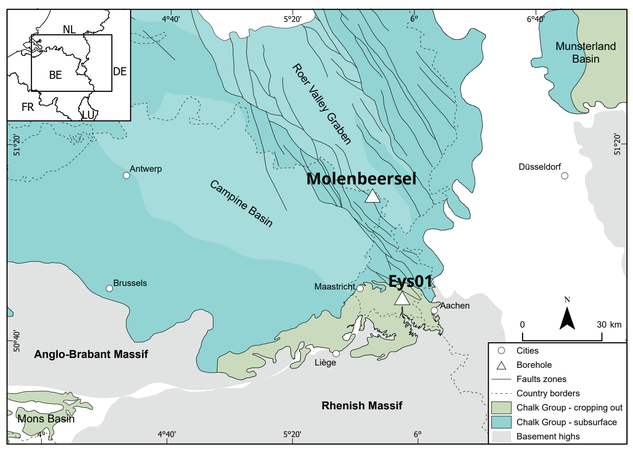


Figure 1 | The Molenbeersel borehole is located in northeastern Flanders. Note how the location of the borehole is in the fault zone on the southern edge of the Roer Valley Graben, whereas the Eys01 borehole is in South Limburg, where the lithostratigraphic formations have been defined.

This study

Here, we present a facies analysis of the uppermost Cretaceous to Danian deposits in the Molenbeersel borehole, northeast Flanders (Figure 1), which was located just inside the Roer Valley Graben. This borehole contains deposits of similar biostratigraphic age to the Gulpen, Maastricht, and Houthem formations. The Gulpen and Maastricht formations were deposited in a **shallow-marine** environment close to a **siliciclastic sediment** source. The Houthem formation is also shallow marine but has no siliciclastic material and is more **coarsely bioclastic**.

We contrast the deposits of the Molenbeersel borehole to the same formations in South Limburgh (Eys01 borehole).

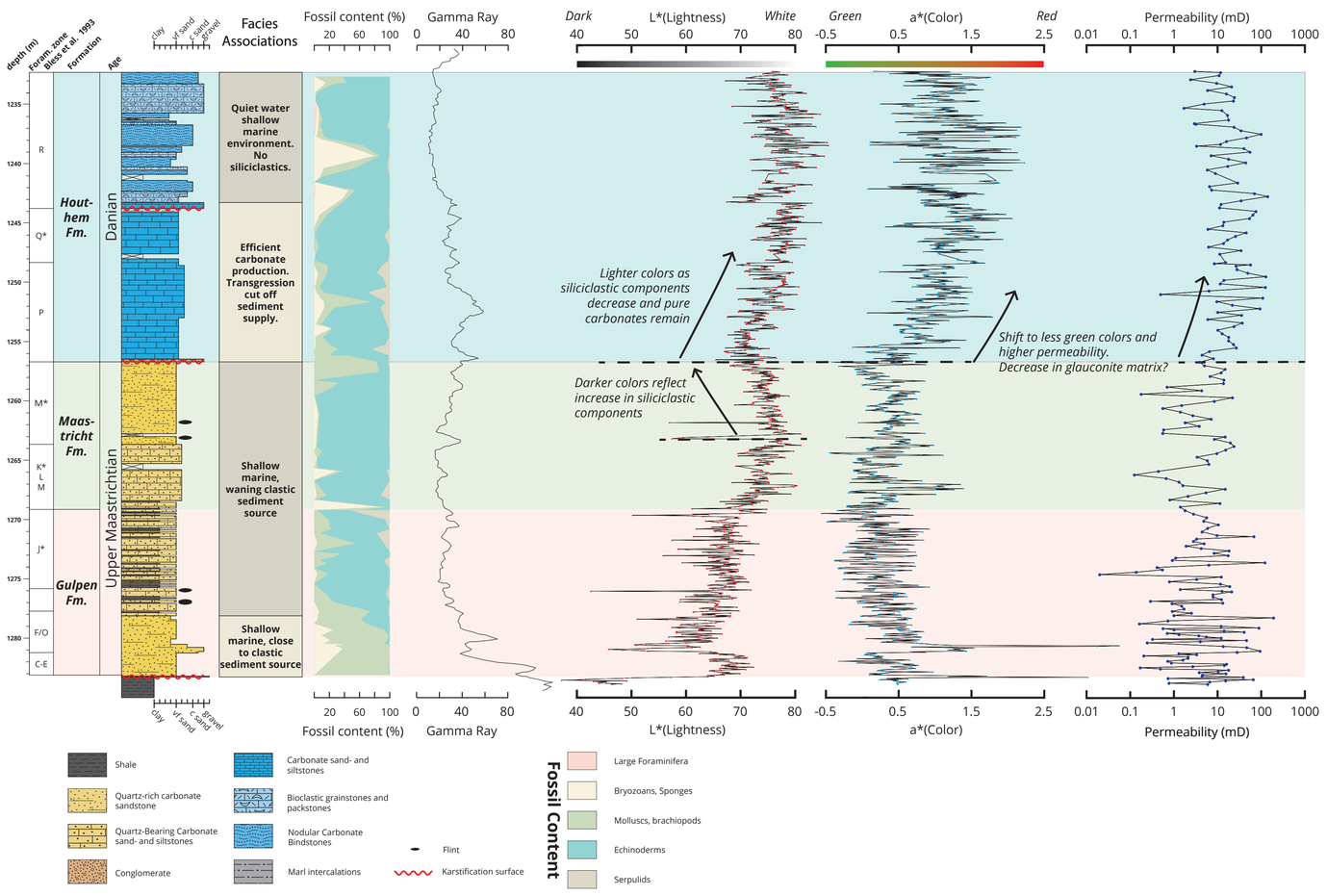


Figure 2 | Lithology, spectrophotometry (color), and permeability of the Molenbeersel core. Biostratigraphic data and fossil content are from Bless et al. (1993). The lightness of the core reflects carbonate content. The Maastricht Formation shows a lightening trend that reverses at 1262 m. This reversal could be the result of either relative sea level rise or uplift in the graben, providing more sediment to the basin. The Gulpen and Maastricht formations are quartz-bearing to quartz-rich (15–60 % quartz) as a result of a nearby sediment source and possibly uplift in the graben.

Lithostratigraphic significance

Our results suggest that the Gulpen and Maastricht formations are present at the southern edge of the Roer Valley Graben. Parts of the Gulpen Formation are lithologically similar to the Gulpen Formation in South Limburg; in the Roer Valley Graben, however, the formation contains conglomeratic layers that do not occur in South Limburg. The Maastricht Formation is lithologically similar to the Maastricht Formation in South Limburg but contains a member with quartz-rich limestones at the top that is not present in South Limburg, possibly due to uplift in the Roer Valley Graben.

Although the deposits in the Roer Valley Graben show similarities to the deposits in South Limburg, a higher amount of siliciclastic material in the Roer Valley Graben raises the question whether they belong to the same lithostratigraphic units.

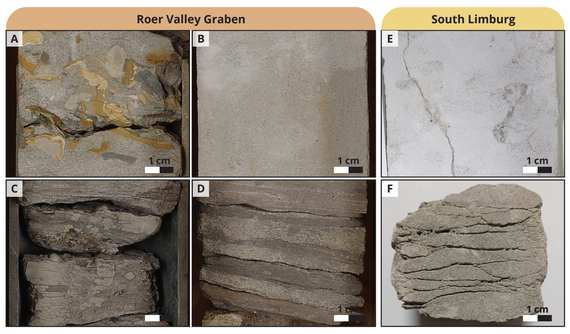


Figure 3 | Gulpen Formation in the Molenbeersel core in the Roer Valley Graben (**A–D**) and in the Eys01 core from South Limburg (**E–F**). The Gulpen formation in the Molenbeersel core predominantly consists of shallow-marine quartz-rich calcareous sandstones (**B**) and the bottom interval contains two conglomeratic layers (**A** and **C**), of which the bottom one (**A**) contains reworked Jurassic clasts, suggesting uplift in the graben. The Gulpen Formation in South Limburg mainly consists of bioturbated calcareous mudstones (**E**) and quartz-bearing carbonate sandstones (**F**).

Gulpen Formation

Parts of the Gulpen Formation in the Molenbeersel borehole (**B**) are similar to the quartz-bearing facies of the Gulpen Formation in South Limburg (**F**). However, the calcareous mudstones that occur in South Limburg (**E**) are not present in the Roer Valley Graben and the conglomeratic layers that occur in the Roer Valley Graben (**A** and **C**) do not occur in South Limburg.

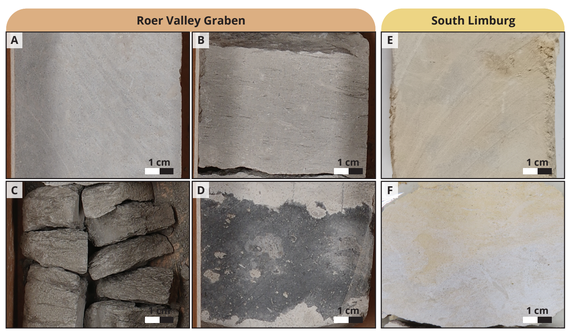


Figure 4 | Maastricht Formation in the Molenbeersel core in the Roer Valley Graben (**A–D**) and in the Eys01 core from South Limburg (**E–F**). The Maastricht formation consists of quartz-bearing carbonate sand- and siltstones (**A**). It contains 10 cm thick clay-rich intervals at ~60 cm spacing (**B** and **C**) and two chert layers (**D**). The Maastricht formation in South Limburg consists of bioclastic packstones and grainstones that contain less than 10 % quartz.

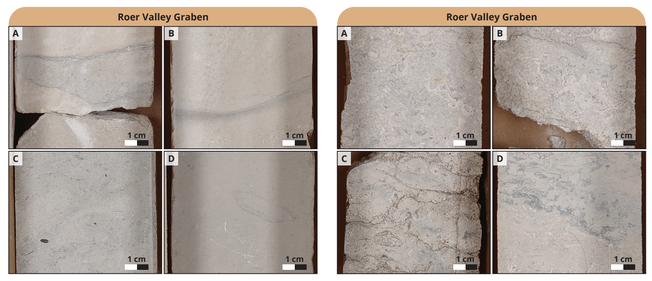
Maastricht Formation

The Maastricht Formation in the Molenbeersel borehole is more quartz-rich than the Maastricht Formation in South Limburg (15–60% vs <10 % quartz). The Maastricht Formation shows a gradual decrease in siliciclastic material compared to the underlying Gulpen Formation. This trend reverses in the upper part of the formation, possibly due to uplift in the Roer Valley Graben.

Houthem Formation

The Houthem Formation overlies a major karstification surface and consists of very fine calcareous sandstones (**C**) and siltstones (**D**). The interval contains clay seams at ~50 cm intervals (**A** and **B**).

The upper part of the core consists of bioclastic grainstones and packstones (**E** and **F**) alternating with nodular carbonate bindstones (**G** and **H**). This is interpreted as a quiet shallow-marine environment with high carbonate productivity. A major transgression is interpreted to have cut off sediment supply which allowed for more efficient carbonate production.



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