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ISOTOPIC DATING OF GLAUCONITES FROM THE UPPER CRETACEOUS IN NETHERLANDS AND BELGIAN LIMBURG, 1

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ABSTRACT

K-Ar dates of seven glauconites from Campanian and Maastrichtian horizons in Netherlands and Belgian Limburg are consistent with their stratigraphical position.

INTRODUCTION

Upper Cretaceous (Campanian and Maastrichtian) chalks, sandstones and minor shales are exposed around the ancient city of Maastricht in the former Duchy of Limburg, along the present-day borders between The Netherlands, Belgium and Germany. The type-section of the Maastrichtian is situated immediately south of Maastricht in Netherlands Limburg, in the E.N.C.I. quarry of the St. Pietersberg close to the Belgian border (R o m e i n, 1962, 1963). Both the Campanian and the Maastrichtian strata contain several glauconite-rich horizons. A project of isotopic dating of these glauconites has been initiated by the Z.W.O. Laboratory of Isotope Geology in Amsterdam, in cooperation with the Geological Survey of The Netherlands at Haarlem.

This paper reports the K-Ar dates obtained from six samples. The sampling sites are listed, together with their lithostratigraphical position, in Table 1. Our samples and their K-Ar dates are also plotted on a schematic W-E section through the Belgian-Netherlands border region (fig. 1), from the quarry Hallembaye, opposite Visé in the Meuse Valley in Belgium, to Epen in The Netherlands. For the western part of this section the division of C a l e m b e r t (1956) is followed, while the division in the eastern part is according to H o f k e r (1966).

Regarding the stratigraphical position of the lithological units, there is general agreement that the "Smectite de Herve" (Cr2, also designated as "Herve Greensand" or "Vaals Greensand") belongs to the upper part of the Lower Campanian. Likewise, an Upper Campanian age is generally accepted for the "Craie Blanche" (Cr3a and Cr3b/white). A conspicuous phenomenon in the Upper Cretaceous succession of the region is a hard ground truncating the Craie Blanche. This hard ground probably developed over the whole region in Upper Campanian/Lower Maastrichtian time. However, there are places where this horizon is lacking, possibly due to upheaval and erosion in Maastrichtian time; for example, in borehole RGD61H18 at Rijckholt, where our sample 71 Lim 7 was taken, the Herve Greensand is directly overlain by glauconitic chalk Cr3b/yellow. In the lowermost Maastrichtian minor sedimentation took place upon the hard ground, at some places only as a filling of burrows in the hardening sea-bottom (e.g., Hallembaye), elsewhere as a normal deposition of a few metres of sediment (e.g., Bovenste Bosch). Regarding the next lithostratigraphic unit, the Craie Grise (Cr3b/yellow), these is so far no agreement as to its precise stratigraphical position. Some authors prefer to assign it to the Upper Maastrichtian on the basis of the occurrence of *Belemnitella ex. gr. junior* at the very base of the Craie Grise at Hallembaye (S c h m i d, 1967), others consider the foraminifera association (*Bolivinoides australis-Gavelinopsis voltziana-Neoflabellina reticulata* in the Cr3b/

Table 1
Stratigraphic position and geographic location of the investigated samples.

71 Lim 1	Gulpen Chalk. Cr3a, base-level Upper Campanian. Tourist road Epen-Vaals, South Limburg, The Netherlands.
71 Lim 2	Gulpen Chalk, base Cr3b/Yellow, Maastrichtian*. Quarry Bovenste Bosch, near Epen, South Limburg, The Netherlands.
71 Lim 3	Gulpen Chalk, base Cr3b/Yellow, Maastrichtian*. Roadcut at Mheer, South Limburg, The Netherlands.
71 Lim 7	Gulpen Chalk, probably Cr3b/Yellow, Maastrichtian*. Borehole RGD16H18, Rijckholt (depth 47.5 m), South Limburg, The Netherlands.
73 Lim 9	Craie Blanche, base-level of Upper Campanian. Quarry Hallembaye, Limburg, Belgium.
73 Lim 10	Smectite de Herve, top-level of Lower Campanian. Quarry Hallembaye, Limburg, Belgium.

* Lower Maastrichtian according to Hofker (1966), Upper Maastrichtian according to Schmid (1967).

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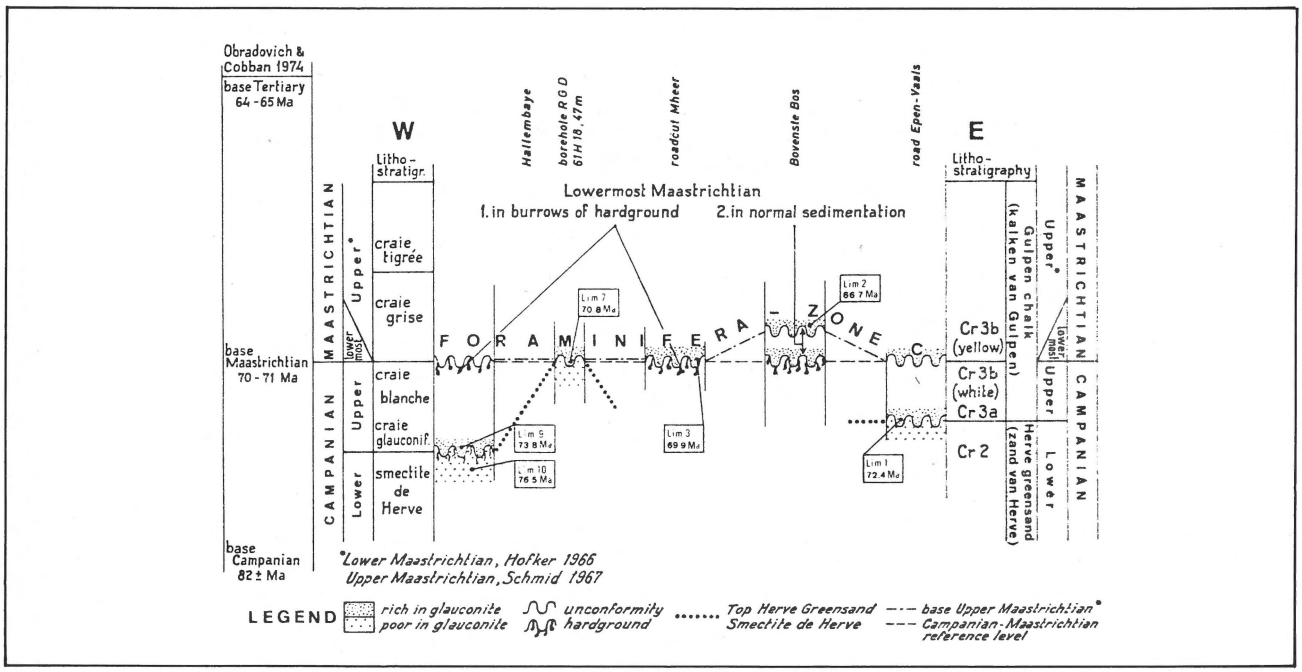

Fig. 1
Schematic W-E section from Hallembaye to Epen (with the Campanian/Maastrichtian boundary as reference level), showing the locations of the investigated glauconites and their K-Ar ages.

yellow unit as indicative of a Lower Maastrichtian age (H o f k e r, 1966).

EXPERIMENTAL PROCEDURES, MINERALOGY AND CONSTANTS

The glauconites were separated from the crushed rocks by means of a Frantz isodynamic separator adapted according to V e r s c h u r e & I J l s t (1969) and the laboratory overflow-centrifuge (I J l s t, 1973b) employing a set of stabilized heavy liquids (I J l s t, 1973a). In all seven samples the glauconite pellets occur in a green and a dark greenish brown variety, both types being identical in all other physical properties. Potassium determinations were made by flame photometry, using a lithium internal standard and Cs-Al buffer. Argon was extracted in a bakeable glass vacuum apparatus and analyzed by isotope dilution techniques (using ^{38} Ar as a tracer) in a Reynolds-type glass mass-spectrometer. The calculated ages are based upon the following constants:

^{40}K: $\lambda_e = 5.85 \times 10^{-11}$/a,
$\lambda_\beta = 4.72 \times 10^{-10}$/a, and
abundance ^{40}K = 0.0118 atom percent total K.

RESULTS AND DISCUSSION

The analytical data and calculated ages are listed in Table 2. In order to compare these dates with a reliable time-scale of the Late Cretaceous, one has to turn to the

Table 2
Analytical K-Ar data and calculated ages.

Sample Nr.	K (% Wt)	rad. ^{40}Ar (ppm Wt)	atmospheric ^{40}Ar (% total ^{40}Ar)	Age (Ma)
71 Lim 1	5.95	31.0×10^{-3}	7	72.4 ± 2.2
	5.94	30.9×10^{-3}	7	
71 Lim 2	5.64	27.0×10^{-3}	10	66.7 ± 2.0
	5.62	26.9×10^{-3}	11	
71 Lim 3	5.87	29.0×10^{-3}	12	69.9 ± 2.1
	5.86	30.0×10^{-3}	7	
71 Lim 7	5.85	29.7×10^{-3}	10	70.8 ±2.1
	5.86	29.9×10^{-3}	9	
73 Lim 9	6.63	34.9×10^{-3}	6	73.8 ± 2.2
	6.63	35.5×10^{-3}	6	
73 Lim 10	5.28	28.6×10^{-3}	10	76.5 ± 2.5
	5.29	29.6×10^{-3}	10	

western interior of North America; in Europe, where the type-sections of the Cretaceous are found, datable interlayered volcanics are virtually absent. In the western interior of North America, on the other hand, numerous bentonites are interspersed throughout a nearly complete sequence of marine sediments ranging in age from latest Albian or early Cenomanian through early Maastrichtian; in this interval 60 ammonite zones have been delineated, a few of which can be precisely correlated with the European type-sections. On the basis of K-Ar dates obtained from bentonites that are well defined stratigraphically. Obradovich & Cobban (1974) recently proposed a time-scale for the Late Cretaceous of the western interior of North America as shown in Table 3.

Table 3
Time-scale of the Late Cretaceous of the western interior of North America, after Obradovich & Cobban (1974).

Base of the Tertiary	64-65	Ma
Base of the Maastrichtian	70-71	Ma
Base of the Campanian	82±	Ma
Base of the Santonian	86 ±	Ma
Base of the Coniacian	87 ±	Ma
Base of the Turonian	89-90	Ma
Base of the Cenomanian	94	Ma

Taking into regard the stratigraphical position of the horizons from which the Limburg glauconites were collected, our K-Ar dates appear to fit in remarkably well into Obradovich & Cobban's time-scale. Glauconite from the upper part of the Lower Campanian has an age of 76.5 ± 2.5 Ma (73 Lim 10). Two glauconites from the base level of the Upper Campanian have ages of 72.4 ± 2.2 Ma (71 lim 1) and 73.8 ± 2.2 Ma (73 Lim 9), respectively. Three glauconites from the next lithostratigraphic unit, either Upper Maastrichtian (Schmid, 1967) or Lower Maastrichtian (Hofker, 1966), have ages of 66.7 ± 2.0 Ma (71 Lim 2), 69.9 ± 2.1 Ma (71 Lim 3) and 70.8 ± 2.1 Ma (71 Lim 7), respectively. Although the latter three glauconites come from the same stratigraphic level (foraminiferal zone C), directly overlying the lowermost Maastrichtian, the glauconite from Bovenste Bosch (71 Lim 2) appears to be somewhat younger than the other two samples. If so, then this may either be due to adsorption of some potassium or loss of some radiogenic argon, or it may indicate that the Cr3b/yellow sedimentation in Bovenste Bosch started relatively late in the time-span of Zone C.

Glauconite, being prone to argon loss and/or potassium adsorption, is usually of questionable reliability for K-Ar dating. Nevertheless, the first K-Ar dates of glauconites from the Upper Cretaceous in Limburg are consistent with their stratigraphical position.

FURTHER INVESTIGATIONS AND ACKNOWLEDGMENTS

Further isotopic dating of the Upper Cretaceous in Limburg will include K-Ar dating of glauconites from the Ma horizon in the Maastricht Chalk (type-section E.N.C.I. quarry St. Pietersberg) and from the Danian/Montian Houthem Chalk. The glauconites will also be investigated according to the Rb-Sr method.

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