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MICHAEL R. HOUSE

Delimitation of the Frasnian

ABSTRACT: A clearer definition of the Frasnian stage as an internationally recognised subdivision of the Devonian System is required. Following tradition the base of this stage should be taken as the base of the Upper Devonian. Pending international agreement on the definition of the limits of the Frasnian, it is recommended that the base should continue to be defined as the base of the Assise de Fromelennes. This level agrees with the boundary currently accepted by the Conseil géologique de Belgique; and seems close to the concept accepted by Gosselet when he proposed the Frasnian in 1879. This horizon appears, on present evidence, to fall within the *varcus* Zone of the conodont chronology: it may not be far from the base of the goniatite Lunulicosta Zone and Manticoceras Stufe. The serious repercussions of current proposals to change the definition to the base of the Assise de Frasnes are outlined. The upper limit of the Frasnian is now defined as the base of the Assise de Senzeille and it is recommended that it should remain so until international agreement recommends a change. A case is argued for considering a slightly higher horizon within the conodont *triangularis* Zone and at the base of the Cheiloceras Stufe, since it is this boundary, in practice, which has widest international acceptance at present. The need for international discussion of correlations and definitions of these boundaries is emphasised. Selected aspects of these problems are considered in detail.

INTRODUCTION

Many problems arise from the diverse interpretations in current literature both of the base of the Upper Devonian and of the limits of the Frasnian stage.

It is generally acknowledged that some internationally agreed subdivision for the stratigraphic systems is required: this to facilitate scientific precision, to simplify stratigraphic terminology, and to provide international uniformity of usage. The stage has come to occupy this rôle.

Despite the existence of a number of other claimants, it is the Frasnian Stage which has by far the greatest international acceptance for the early Upper Devonian. This contribution is essentially concerned with the problems related to an international definition of the Frasnian Stage; in large part it is an extension of the discussion initiated by McLaren (1970) in his Presidential Address to The Paleontological Society.

That stages should be the standard subdivision of systems on the biostratigraphical scale was accepted by the International Subcommission in 1960 but the terms were agreed as early as the Second International Geological Congress held in 1881. It is the matter of their definition which has attracted most recent comment and consideration in the stratigraphic codes produced by many countries.

Two schools of thought have developed among those agreeing on the need for boundary definition. Some, and these seem in the ascendancy at present, prefer a 'golden spike' in a given section, defining immutably and for ever the boundary position irrespective of subsequent discovery: these argue that only by such means will nomenclature be stabilised. Others argue that a boundary is no more precise than the means (faunal or floral) which can be used to correlate it with other areas, and since these means are continually being improved, a sufficient measure of precision would be provided by definition with respect to a palaeontological zone, and the possibility of subsequent improved definition should be allowed. Whilst it is acknowledged that any modern refined definition needs to take into account historic priority, it has also become clear that there are often far too many uncertainties in most original designations for this to be more than a general guiding rule.

It is not proposed to consider further these points of view. In the case of the Frasnian an internationally agreed definition using any of these criteria would be a substantial improvement over the present situation.

No consideration will be given here of other names which have been used for approximately the same time-interval as the Frasnian. The two most serious rivals are Adorfian (*cf.* Kutscher & Schmidt 1958, p. 334) and Senecan (Willmarth 1957, p. 1955; Rickard 1964), but both are local names and are usually applied as group or series names, rather than as stages. It seems to the author unlikely that the term Frasnian will be replaced for international use by either of these.

DEFINITION OF THE BASE OF THE FRASNIAN

There are two distinct problems, one the definition of the base of the Frasnian, the other, the definition of the base of the Upper Devonian. However, since endless confusion would result if these two were not

coincident, these problems are here regarded as the same. For the convenience of the non-specialist reader conodont zonal names are italicised, those of goniatites treated as proper nouns.

Definition at the base of the Assise de Fromelennes

It has been the practice of most geologists to accept the definition of stages as adopted in their country of origin. In the case of the Frasnian this boundary lies between the Calcaire de Givet and Assise de Fromelennes as formally ratified by the Conseil géologique de Belgique in 1952 and analysed in the Lexique Stratigraphique International (Waterlot 1957, p. 199—205) where it is stated that the type section is in the area between Couvin and Frasnes in southern Belgium. A recent study by Coen & Coen-Aubert (1971) has reviewed a number of sections of the Assise de Fromelennes and they essentially confirm Mailleux's critical evidence defining the division, and for referring it to the Upper Devonian, that is, the evidence for the sudden entry of cyrtospiriferids at the base.

It is arguable that this boundary is similar to that envisaged by Gosselet (1879, p. 133) when the term *Frasnien* was first clearly used (*contra* Waterlot 1957, p. 199). It is clear from earlier papers by Gosselet (especially Gosselet 1876, p. 37) that it was the entry of cyrtospiriferid types which he considered important in drawing the boundary in the type area.

There seems little doubt that this boundary is well defined in the area considered by the *Lexique* to be the type area. That being so there seems little reason peremptorily to set it aside.

Regarding the placing of this boundary with the conodont and goniatite scales much work remains to be done. Bultynck (*in:* Coen & Coen-Aubert 1971, p. 17) recorded *Polygnathus varcus* at the base of the formation and this appears to have been found by others (McLaren 1970, p. 807). Dr. A. N. Mouravieff informs me that it is also his opinion that the early Assise de Fromelennes belongs to the *varcus* Zone. Klapper (*in:* Coen & Coen-Aubert 1971, p. 17) has given some evidence to suggest the correlation of the upper part of the Assise de Fromelennes (F_{1c}) with the lowermost part of the *asymmetrica* Zone. Dr. Mouravieff (*in litt.*) informs me that this is also his conclusion.

There is no goniatite evidence bearing on the matter, but, as is indicated below, the Lunulicosta Zone (and life range of *Pharciceras*) appears to range from the latest *varcus* Zone to the Middle *asymmetrica* Zone (the latter correlation following Ziegler, 1958, and subsequent revisions). A base of the Frasnian defined at the base of the Assise de Fromelennes may not, therefore, be too different from the widely accepted Terebratum Zone/Lunulicosta Zone boundary of the Germans which goniatite workers have accepted for so long.

In Russia the base of the Frasnian has been taken at the base of the Kynov and Paschja horizons (Rzhonsnitskaya 1968, p. 344; Lyashenko 1959, p. 20, 52). This level belongs to the earliest Lunulicosta Zone and yields *Hoeninghausia* (Bogoslovski 1969): Ziegler (1971, p. 284) comments that the conodonts at this level indicate either the *varcus* or the *hermanni-cristatus* Zone. It is too early to say with precision, but this boundary approximately agrees with the Belgian one.

In the standard American section in New York the argument has really been whether the Tully should be included in the Middle Devonian (Cooper & *al.* 1942, Cooper 1969) or Upper Devonian (Williams 1900, House 1962). The type Tully yields pharciceratids and hence would be correlated with the Lunulicosta Zone. It appears also to fall wholly within the *varcus* Zone: the *hermanni-cristatus* fauna has not been located at this locality. Whichever assignment the Tully eventually receives it appears to correlate with the early Assise de Fromelennes.

Since the boundary at the base of the Assise de Fromelennes is the only one formally designated in the type region it should only be set aside by international agreement.

Definition at the base of the Assise de Frasnes

It has been argued by Lecompte & Waterlot (*in:* Waterlot 1957, p. 199—200) that by the time the term Frasnien came to be formally used (Gosselet 1879 *non* 1876) the base which Gosselet actually took was within the upper part of the Assise de Fromelennes (F_{1c}). The relevant literature here is vast and varied, but there seems little in it to justify the view that the base of the Assise de Frasnes as *now understood* has any particular historic priority for the definition of the base of the Frasnian, whatever is inferred from the mixed assignments given before the publication of the major works of Mailleux. It is important to bear this in mind since the view appears to have gained credence in Belgium that their boundary at the base of the Assise de Fromelennes had been defined too low (this despite the fact that to most of us elsewhere it was Belgian type definition we sought to fallow, *cf.* Tsien 1972).

Again the goniatite evidence is limited, but suggests that the level where distinctive goniatites first appear (F_{2b}) may well be in the late Lunulicosta Zone or earliest Cordatum Zone (House 1968). Although I have worked through Mailleux's goniatite collection, I have been unable to confirm his record (1940, p. 44) of *Manticoceras cordatum* group in the earliest parts of the Assise de Frasnes and Dr. Mouravieff informs me that Mailleux's record was stratigraphically incorrect. Both typical Cordatum Zone and Holzapfeli Zone faunas occur higher as was demonstrated

by Matern (1931). A boundary taken at the base of the Assise de Frasnes cannot therefore be placed in the goniatite scale precisely.

Records of conodonts already available (Coen & Coen-Aubert 1971, p. 16) suggest that the basal Assise de Frasnes (F_{2a}) correlates with the younger half of the *asymmetricus* Zone. This was taken to be the equivalent of the Grenz-*tmo/to1* of Ziegler (1958, Table 2) but subsequent work (Kullman & Ziegler 1970) has shown that these faunas are younger than the 'boundary' to which Ziegler (1958) then referred. The effect of this premature correlation (see the discussion of several papers at the Société Géologique de Belgique for 1969 and 1970) was to lead to the view that the base of the Frasnian was placed too low and should be raised. Erroneous past opinions on correlation do not give justification for such a view.

It is premature to be dogmatic on the matter, but on *present evidence,* it seems that a boundary placed at the base of the Assise de Frasnes would not at present find a convenient correlation with the goniatite zonation. The detailed subdivision of the *asymmetricus* Zone by Ziegler might lend itself to better definition.

Attention must be drawn to the serious problems which would be raised if the Conseil Géologique unilaterally raised their definition of the basal Frasnian to the base of the Assise de Frasnes. To name but two: in New York this would appear to entail the raising of the Middle/Upper Devonian boundary to a level well up in the Senecan (Rickard 1964), perhaps as high as the Genundewa; in Russia the famous Domanik fauna might be relegated to the Middle Devonian, as would most *I-alpha* faunas elsewhere. Only international agreement could justify such a major change in usage.

Definition using goniatites

The ammonoid zonation provides what German workers call the orthochronological scale of sub-division. On this scale the Upper/Middle Devonian boundary is drawn between the Terebratum Zone and the Lunulicosta Zone. At this boundary, a remarkable change in the goniatite faunas occurs. This may be expressed by saying that the genera *Agoniatities, Sellagoniatites, Sobolewia, Maenioceras, Wedekindella, Cabrieroceras* and *Foordites* become extinct, although all range close to the boundary. The Lunulicosta Zone, on the other hand, shows the entry of *Pharciceras, Synpharciceras, Neopharciceras, Nordiceras, Ponticeras, "Probeloceras", Timanites* and *Koenenites,* although it is not known whether all these enter at the base of the zone. So far as ammonoids are concerned, no clearer faunal break exists in the Devonian; and it is one of the sharpest faunal breaks within the whole of the Upper Palaeozoic.

The recognition of this faunal break we owe principally to Wedekind, but it should be noted that at first Wedekind did not assign the Lunulicosta Zone to the Upper Devonian, referring to it as the "Grenzschichten" (Wedekind 1913, p. 25). But he called this division *I alpha*. Previous authorities particularly Frech (1897, p. 177) had clearly accepted the Lunulicosta Zone fauna as marking the base of the Upper Devonian. Wedekind's scruple in this regard seems to have been related to his not having found *Manticoceras* at this level. Hence he appears to have been loathe to include it in his Manticocerasstufe, but he regarded the fauna as Upper Devonian.

Substantial work has still to be done on the detailed biostratigraphy of the Lunulicosta Zone. The bizarre variety of goniatites represented in it bears witness to a complex evolutionary radiation. Only in New York, and to a lesser extent in the northern European Russia (Bogoslovski 1971) has sufficient work been done to document some of this radiation.

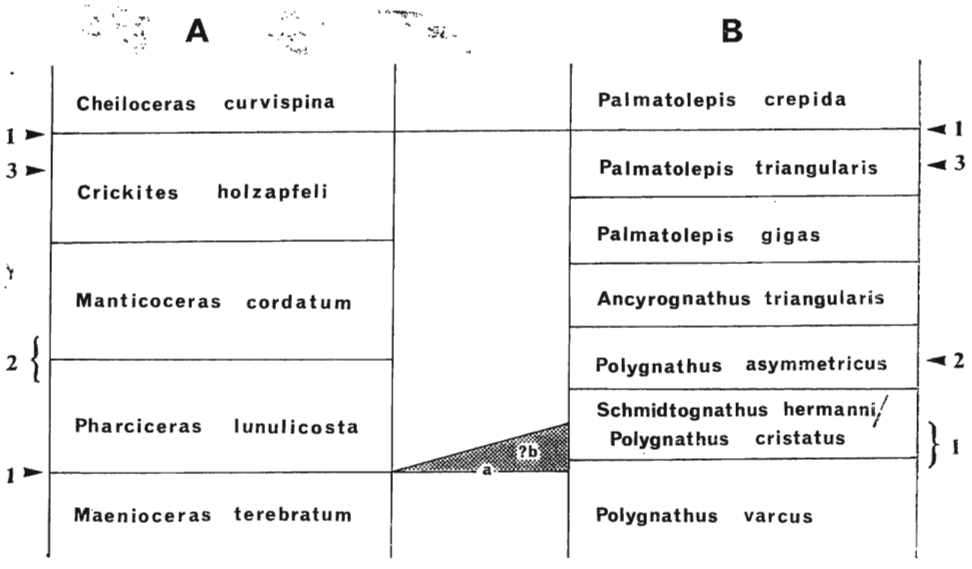

Fig. 1

Subdivisions of the Frasnian Stage
A — Goniatite zonation, **B** — Conodont zonation

1 Limits of Manticoceras Stufe and Frasnian as used by ammonoid workers, *2* Probable position of the top of the Assise de Fromelennes, *3* Probable position of the base of the Assise de Senzeille

a correlation using New York evidence, *b* uncertainty of correlation at Martenberg

It should be noted that the *hermanni-cristatus* Zone is often absent and appears to be a facies fauna, presumably in part of the late *varcus* Zone. Buggisch and Clausen (1972) have concluded that the base of the Cheiloceras Stufe correlates with the base of the upper *triangularis* Zone rather than as shown here

Definition using conodonts

In the major works on Devonian conodont biostratigraphy done in Germany (Bischoff & Ziegler 1957; Ziegler 1958, 1962, 1966; Krebs 1959) it is clear that the presupposition throughout is that the base of the Lunulicosta Zone in the goniatite terminology defines the base of the Upper Devonian, and that the conodont succession is, to that extent, a dependent parachronology. The principal problem has been the correlation between the goniatite and the conodont schemes of zonation. German workers have paid scrupulous attention to this. Substantial confusion has been added to the literature by conodont workers elsewhere who have used premature correlations of the two zonations to make assertions on the Middle/Upper Devonian boundary.

It may, therefore, be appropriate to summarise the current status of this correlation from the viewpoint of an ammonoid worker.

The section in the old open-cast iron working at Martenberg near Adorf, Germany, is the type section for Wedekind's goniatite chronology (Holzapfel 1882, Wedekind 1913, Matern 1929) and this formed the basis for the conodont succession described by Ziegler (1958, p. 10 *et seq.*) and also for the latest statement on the correlation between the two schemes of zonation (Kullman & Ziegler 1970; Ziegler 1971, p. 261).

Several general comments on the Martenberg section seem to be required. In the first place the sequence here is extraordinarily thin and reduced. The total which may be referred to the Frasnian (Manticoceras Stufe) is perhaps 4 m (Paeckelmann *in:* Matern 1929, p. 144): this should be compared, for example, with over 500 m for the thickness of equivalent rocks in southern Belgium (Lecompte *in:* Fourmarier 1954, p. 190) and the Cayuga Lake area of New York (Wells 1959, p. 6). Secondly, accompanying this, is evidence of lateral changes in the thickness of units within a few metres. Clearly a number of problems are bound to arise from such a sedimentary situation.

Now in the latest statements on the matter, Kullmann & Ziegler (1970) give evidence that samples bearing a Lunulicosta Zone goniatite fauna (their samples *7095* and *7096*) carry conodonts of the upper *hermanni-cristatus* Zone and lowest *asymmetricus* Zone. The last horizon bearing Terebratum Zone goniatites (*7033)* yielded a *varcus* Zone conodont fauna. These authors take the Terebratum/Lunulicosta boundary as equivalent to the base of the upper division of the *hermanni-cristatus* Zone.

This is not an accurate deduction to be drawn from their facts. No goniatites having been found in the distance (0.17 m) between their samples *7033* and *7096,* it is possible still to say that the Terebratum/ /Lunulicosta Zone boundary may lie in the uppermost part of the *varcus*

Zone, at the base, within, or at the top of the lower *hermanni-cristatus* Zone, or even within the lowermost part of the upper *hermanni-cristatus* Zone.

The history of the correlation between the goniatite and conodont zones of this boundary has been that further work has successively lowered the boundary in the conodont scale. Thus the approximate Middle/Upper Devonian boundary was drawn by Bischoff & Ziegler (1957, p. 129 etc.) at the base of the *asymmetrica-martenbergensis* Subzone (as it was then called), at a level now known to be well up in the Frasnian. Krebs (1959) did much to correct this. But other workers did not appear to have been aware of the significance of the unsatisfactory nature of the evidence regarding the correlation. For example, Orr & Klapper (1968, p. 1067), using the known fact that goniatites representing the Terebratum Zone occur with representatives of the *varcus* Zone, make the unjustified deduction that therefore the *whole* of the *varcus* zone "is unequivocally classified with the Middle Devonian". This assertion goes well beyond the facts and the problem has still not been resolved (but see below). The matter is not helped by the preliminary report of the Martenberg work by Ziegler (1971, p. 261, but written before Kullmann & Ziegler 1970) in which it is stated that the "lower portion of the *hermanni-cristatus* Zone falls within the range of *Maenioceras terebratum* and is therefore distinctly Givetian in age". There is no evidence for this whatever in the subsequently written account of the Martenberg section (Kullman & Ziegler 1970) from which it is clear, as staged in the previous paragraph, that it has still to be shown where, within and including an interval between the latest *varcus* Zone and early upper *hermanni-cristatus* Zone, the boundary might fall. A related mis-statement of the facts occurs in a footnote quoting information from Ziegler in a paper by Kirchgasser (1970, p. 354).

If the horizon bearing *Pharciceras* type goniatites high in the Tully Limestone of New York and referred to the Lunulicosta Zone (House 1968, p. 1065) really does belong to the top *varcus* Zone, as has been stated (Klapper & Ziegler 1967; Huddle *in:* Klapper & *al.*, p. 298) then this may solve the problem, since it would suggest that the Lunulicosta/ /Terebratum Zone boundary falls within the youngest part of the *varcus* Zone. At least there seems, as yet, no more relevant evidence bearing on the subject. The highest fauna of conodonts mentioned by Klapper & Ziegler from June's Quarry, Tully, seems to come from approximately the same horizon as the *Pharciceras* level (House 1968, p. 1065).

One difficulty over a boundary definition using conodonts alone is the apparent absence of diagnostic *hermanni-cristatus* Zone faunas at a number of localities where they might have been expected. This appears to be due to elements of it being a facies fauna to some degree (*cf.* Seddon & Sweet 1971). It will be for conodont workers when the *hermanni-*

-*cristatus* Zone is absent, to say whether it is the equivalent to parts of the *varcus* Zone or of the *asymmetricus* Zone, or to parts of both. The former would seem the more usual.

DEFINITION OF THE TOP OF THE FRASNIAN

Although some earlier stratigraphic codes at first took a different opinion, it is currently acknowledged that the upper limits of a stage should be defined by the base of the overlying stage. Therefore the upper limit of the Frasnian should be taken at the agreed base of the Famennian.

The problem of defining the top of the Frasnian, for international use, is still a real one even if the range of possibility on the placing of the boundary is considerably smaller than in the case of the base of the Frasnian.

Definition at the base of the Assise de Senzeille

The currently accepted definition in Belgium is that the boundary lies between the Schistes de Matagne and the Assise de Senzeille, the base of the latter being taken at a calcareous horizon reaching the floor of the railway cutting at Senzeille at about km 101.026 (Sartenaer 1957b, 1960; Bouckaert & Ziegler 1965). The earliest use of the term Famennien (Dumont 1855 *fide* Lecompte & Waterlot, *in:* Waterlot 1957, p. 173) included most of what is now considered to be Frasnian. However, the definition at the base of the Assise de Senzeille (Fa_{1a}) appears to have been accepted in Belgium for about a century with no significant change. Few boundaries are so unambiguously defined.

The evidence of the placing of this boundary on the conodont scale has been discussed by Bouckaert & Ziegler (1965). Unfortunately, these authors did not study the conodont succession across the boundary at the type locality of Senzeille, but commenced their study fractionally above the base of the Assise de Senzeille. They reached the conclusion that the earliest horizon they studied belonged to the middle *triangularis* Zone (Bouckaert & Ziegler 1965, p. 8, 28).

There is some direct evidence bearing on the placing of this boundary on the goniatite scale: this results from studies by the author of museum collections at the University of Louvain and the Musée Nationale d'Histoire Naturelle in Bruxelles. A *Manticoceras* sp. (*IG 10677*) from the Assise de Matagne (F_3) was seen at Bruxelles, the label indicating that it came from close to the km 101 post in the Senzeille section. No goniatites have been seen from higher in this section, but from Fa_{1a} strata on the Aye sheet (locality *4816G*) is a poorly preserved specimen which was determined as *?Cheiloceras* (*Torleyoceras*) sp. (*IG 4849*), indicative of

Cheiloceras Stufe. Tornoceratids also occur from Fa_{1a}, but they are not helpful in this case for correlation. As Matern noted, *Crickites* is common in the Assise de Matagne which therefore correlates largely with the Holzapfeli Zone. In 1957 Sartenaer recognised the Cheiloceras Stufe in a region well east of the type area here considered.

Therefore, ignoring for the moment any indirect correlation using conodonts, there is direct evidence that the base of the Cheiloceras Stufe lies either within or not far from the base of the Assise de Senzeille.

Definition at the base of the Cheiloceras Stufe

The Cheiloceras Stufe on the goniatite scale is characterised by the appearance of the "genera" *Cheiloceras, Torleyoceras, Dyscheiloceras, Staffites, Dimeroceras, Paradimeroceras, Paratornoceras* (*fide* Bogoslovski 1971, p. 174), *Polonites, Sporadoceras, Imitoceras* and *Pseudoclymenia.* Of these it is the *Cheiloceras* group which enter at the base of the *Curvispina* Zone (*do II alpha*). The whole fauna, however, is extremely distinctive.

This boundary does *not* mark the extinction of *Manticoceras* as has been erroneously stated in recent literature (Clausen 1971, p. 204). Two species of *Manticoceras,* both characterised by a 'probeloceratid' shell form have been described from the Cheiloceras Stufe. These are *M. superstes* (Wedekind) (*cf.* Wedekind 1908, p. 575, pl. 40, figs 5, 5a) from a *II-alpha* horizon at Enkeberg, and *M. nehdense* Lange (*cf.* Lange 1929, p. 33, pl. 1, fig. 1; text-figs 1, 2) from a *II-alpha* horizon at Nehden. Clausen himself (1968, p. 212) appears to have recorded a form of this type near Büdesheim from a Cheiloceras Stufe horizon. I have, in my own collections from the celebrated lower Cheiloceras Stufe collecting area at La Serre, in the Montagne Noire, a single manticoceratid of this type among a collection of early cheiloceratids. It is true that there is no record of *M. cordatum* group goniatites, or of *Crickites* ranging so high.

This Cheiloceras/Manticoceras Stufe boundary has been widely used internationally as defining the Frasnian/Famennian boundary and forms a major means for determining this horizon in Europe generally, Russia, especially in the Timan Mountains, the Urals (Bogoslovski 1969, 1971), Africa (Petter 1959), the U.S.A. (House 1962), Canada (House & Pedder 1963) and Australia (Teichert 1943, Jenkins 1966).

As was the case with the early Frasnian, so here, there is still some uncertainty on the correlation between the conodont and goniatite zonations. Currently (Ziegler 1971, chart 4) the Manticoceras/Cheiloceras Stufe boundary is taken to be coincident with the *triangularis/crepida* zone boundary and the middle and upper *triangularis* Zone is referred to as *post do I delta.* The latter is a designation by conodont workers for a period with *Manticoceras* but without *Crickites holzapfeli.* As has

already been demonstrated, however, *Manticoceras* ranges into the Lower Cheiloceras Stufe. But Buggisch & Clausen (1972) show that the boundary lies close to the base of the upper *triangularis* Zone.

In New York *Crickites* is last seen about 10 m below the top of the Hanover Shale (House 1968, p. 1066) and *Cheiloceras* first occurs above in the Gowanda Shale. Now Huddle (*in:* Klapper & *al.* 1971, p. 304) refers the upper part of the Hanover to the upper *triangularis* Zone. In which case it would appear that in New York the Manticoceras/Cheiloceras Stufe boundary lies within the *triangularis* Zone. This confirms the correlation favoured in Europe, but also indicates that the separation of a *'post do I delta'* interval (Ziegler 1971, chart 4) is incorrect.

There are other factors which would need to be taken into account if any change in the Belgian stratotype is envisaged. McLaren (1970) has drawn attention to the major faunal changes which appear to take place near this boundary. Until more detailed correlation at this horizon is accomplished, and these changes precisely documented, it would be premature to propose any change. However, the author has elsewhere (1968) argued that faunal boundary determined by conodonts and goniatites near the *triangularis/crepida* Zone boundary, and the Manticoceras/ /Cheiloceras Stufe boundary, seems a more satisfactory boundary for international correlation than the stratotype at Senzeilles, but it is acknowledged that any change is a matter for international agreement.

SUMMARY AND CONCLUSIONS

It is recommended that the base of the Frasnian should be taken as the base of the Upper Devonian.

Pending any international agreement, the base of the Frasnian should continue to be taken at the base of the Assise de Fromelennes. This horizon seems to fall within the *varcus* Zone, but may not be far distant from the Terebratum/Lunulicosta Zone boundary of the goniatite sequence.

A boundary raised to the base of the Assise de Frasnes would refer to the Middle Devonian famous *I-alpha* faunas of America, Russia and elsewhere, long assigned to the Upper Devonian. This seems to be a substantial reason against any change.

The top of the Frasnian is at present defined at the base of the Assise de Senzeille. If there is any international pressure to change this, then the slightly higher faunal boundary at the level of the Manticoceras/ /Cheiloceras Stufe, within the *triangularis* Zone might be preferable since it is these boundaries, in practice, which have traditionally been taken as

the base of the Famennian in many parts of the world. The base of the Cheiloceras Stufe has been so taken for about sixty years.

Department of Geology
The University of Hull,
Hull HU6 7RX
Yorkshire, England.
Kingston upon Hull, March 1972

REFERENCES

BISCHOFF G. & ZIEGLER W. 1957. Die Conodontenchronologie des Mitteldevons und des tiefsten Oberdevons. — Hess. Landesamt Bodenforschung Abh., H. 22, p. 1—136, 21 pls. Wiesbaden.

BOGOSLOVSKI B. I. 1969. Devonskie Ammonoidei. I, Agoniatiti. — Trudy Paleont. Inst. Moscow, t. 124, p. 1—341, pls 1—29. Moskva.

— 1971. Devonskie Ammonoidei. II, Goniatiti. — *Ibidem*, t. 127, p. 1—228, pls 1—19.

BOUCKAERT J. & ZIEGLER W. 1965. Conodont stratigraphy of the Famennian stage (Upper Devonian) in Belgium. — Mém. serv. l'explic. cartes géol. min Belgique, no. 5, p. 1—30, pls 1—5.

BUGGISCH W. & CLAUSEN C. D. 1972. Conodonten-und Goniatiten-Faunen aus dem oberen Frasnium und unteren Famennium Marokkos (Tafilalt, Antiatlas). — Neues Jb. Geol. Paläont., Abh., Bd. 141, p. 137—167. Stuttgart.

CLAUSEN C. D. 1968. Das Nehden in der Büdesheimer Teilmulde (Prümer Mulde/ /Eifel). — Fortschr. Geol. Rhein. Westfalen, Bd. 16, p. 205—232. Krefeld.

— 1971. Geschichte, Umfang und Evolution der Gephuroceratidae (Ceph.; Oberdevon). — Neues Jb. Geol. Paläont., Abh., Bd. 137, p. 175—208. Stuttgart.

COEN M. & COEN-AUBERT M. 1971. L'Assise de Fromelennes aux bord sud es est du Bassin de Dinant et dans le Massif de la Vesdre. — Ann. Soc. Géol. Belgique, t. 94, p. 5—20. Bruxelles.

COOPER G. A. 1968. Age and correlations of the Tully and Cedar Valley. — Alberta Soc. Petrol. Geol., Intern. Symp. on Devonian Syst. Vol. 2, p. 701—709. Calgary.

— & al. 1942. Correlation of the Devonian Sedimentary formation of North America. — Bull. Geol. Soc. America, vol. 53, p. 1729—1794. Baltimore.

DUMONT A. H. 1855. Carte géologique de Spa, Theux et Pepinster (1 : 20,000). Bruxelles. Étab. géogr. Van der Maelen.

FOURMARIER P. (*Ed.*) 1954. Prodrome d'une description géologique de la Belgique. — Soc. géol. Belgique. 826 pp. Liège.

FRECH F. 1897. Lethaea geognostica, I Theil, Lethaea palaeozoica, Bd. 2, 1 Lf., p. 1—256. Stuttgart.

GOSSELET J. 1876. Le Calcaire de Givet. — Ann. géol. Soc. Nord, t. 3, p. 36—75. Lille.

— 1879. Description géologique du canton de Maubeuge. — *Ibidem*, t. 4, p. 129—211.

HOLZAPFEL E. 1882. Die Goniatiten-Kalke von Adorf in Waldeck. — Palaeontographica, Bd. 28, p. 225—261, pls 1—6. Stuttgart.

HOUSE M. R. 1962. Observations on the ammonoid succession of the North American Devonian. — J. Paleont., vol. 36, p. 247—284, pls 43—48. Menasha.

— 1968. Devonian ammonoid zonation and correlations between North America and Europe. — Alberta Soc. Petrol. Geol., Intern. Symp. on Devonian Syst. Vol. 2, p. 1061—1068. Calgary.

— & PEDDER A. E. H. 1963. Devonian goniatites and stratigraphical correlations in Western Canada. — Palaeontology, vol. 6, p. 491—539, pls 70—77. Oxford.

JENKINS T. B. H. 1966. The Upper Devonian index ammonoid *Cheiloceras* from New South Wales. — *Ibidem*, vol. 9, p. 458—463.

KIRCHGASSER W. T. 1970. Conodonts from near the Middle/Upper Devonian boundary in North Cornwall. — *Ibidem*, vol. 13, p. 335—354, pls 63—66.

KLAPPER G. & ZIEGLER W. 1967. Evolutionary developments of the *Icriodus latericrescens* group (Conodonta) in the Devonian of Europe and North America. — Palaeontographica, Bd. 127, Abt. A, p. 68—83, pls 8—11. Stuttgart.

— & al. 1971. North American Devonian Conodont Biostratigraphy. — Geol. Soc. America, Mem. 127, p. 285—316. Baltimore.

KREBS W. 1959. Zur Grenze Mittel-/Ober-Devon und zur Gliederung des obersten Mittel-Devons und der tieferen Adorf-Stufe nach Conodonten. — Senckenberg. Leth., Bd. 40, p. 357—387, 2 pls. Frankfurt a. M.

KULLMANN J. & ZIEGLER W. 1970. Conodonten und Goniatiten von der Grenze Mittel-/Oberdevon aus dem Profil am Martenberg (Ostrand des Rheinischen Schiefergebirges). — Geologica et Palaeontologica, Bd. 4, 73—85, pl. 1. Marburg.

KUTSCHER F. & SCHMIDT H. 1958. Lexique Stratigraphique International, Europe 5b, Allemagne, Devonien, p. 1—386. Paris.

LANGE W. 1929. Zur Kenntnis des Oberdevons am Enkeberg und bei Balve (Sauerland). — Abh. Preuss. geol. Landes. Berlin. N. F., Heft 119, p. 1—132, pls 1—3. Berlin.

LYASHENKO A. I. 1959. Atlas brakhiopod i stratigrafiya devonskikh otlozheniy tsentralnykh oblastey Russkoy Platformy. — Vses. Nautcho-Issled. Geol. Neftyan. Inst. (VNIGNI), p. 1—451, pls 1—87. Moskva.

McLAREN D. J. 1970. Time, life and boundaries. — J. Paleont., vol. 44, p. 801—815. Menasha.

MAILLEUX E. 1940. Contribution à la connaisance du Frasnien moyen (Assise de Frasne) de la Belgique. — Bull. Mus. Roy. d'Hist. Nat. Belg., t. 16, no. 14, p. 1—44. Bruxelles.

MATERN H. 1929. Die Gliederung des Adorf Stufe, zugleich ein Beitrach zur Nomenklatur von *Gephuroceras* Hyatt (Ceph.). — Senckenberg. Leth., Bd. 13, p. 160—167. Frankfurt a. M.

— 1931. Die Goniatiten Fauna der Schistes de Matagne in Belgien. — Bull. Mus. d'Hist. Nat. Belg. t. 7, p. 1—13. Bruxelles.

ORR R. W. & KLAPPER G. 1968. Two new conodont species from Middle-Upper Devonian boundary beds of Indiana and New York. — J. Paleont., vol. 42, p. 1066—1075, pls 139—140. Menasha.

PETTER G. 1959. Goniatites Dévoniennes du Sahara. — Publ. Serv. Carte Géol. Algérie, Paléontologie, Mém. no. 2, p. 1—313, pls 1—26. Paris.

RZHONSNITSKAYA M. A. 1968. Devonian of the U.S.S.R. — Alberta Soc. Petrol. Geol., Intern. Symp. on Devonian Syst. Vol. 1, p. 331—348. Calgary.

RICKARD L. V. 1964. Correlation of the Devonian rocks in New York State. — New York State Mus. Map & Chart. Ser., No. 4. Albany.

SARTENAER P. 1957a. La découverte, en Belgique, de la zone à Cheiloceras. — Ann. Soc. géol. Belge, t. 80, p. B463—470. Bruxelles.

— 1957b. Esquisse d'une division stratigraphique nouvelle des dépôts du Famennien Inférieur du Bassin de Dinant. — Bull. Soc. Belg. Géol., Pal., Hydr., t. 65, fasc. 3, p. 421—446. Bruxelles.

— 1960. Visage 1960 de la "tranchée de Senzeille" (partie famenienne). — *Ibidem*, t. 68, fasc. 3, p. 430—442.

SEDDON G. & SWEET W. C. 1971. An ecologic model for conodonts. — J. Paleont., vol. 45, p. 869—880. Menasha.

TEICHERT C. 1943. The Devonian of Western Australia. — Amer. J. Sci., vol. 241, p. 69—94, 167—184. New Haven.

TSIEN H. H. 1972. Middle Devonian and Frasnian stratigraphy of Belgium. — Document 7, Conseil Géologique, Commission Nationales de Stratigraphie, p. 1—25. Bruxelles.

WATERLOT G. (*Ed.*). 1957. Lexique Stratigraphique International, Europe $4a_1$, France, Belgique, Pays Bas, Luxembourg, Antécambrien, Paléozoïque Inférieur, p. 1—432. Paris.

WEDEKIND R. 1908. Die cephalopodenfauna des höheren Oberdevon am Enkeberge. — Neues Jb. Min., Geol., Paläont., Bd. 26, p. 565—634, pls 39—45. Stuttgart.

— 1913. Die Goniatitenkalke des unteren Oberdevon von Martenberg bei Adorf. — Sitzungsber. Natur. Freunde Berlin, Jg. 1913, p. 23—77, pls 4—7. Berlin.

WELLS J. W. & al. 1959. Geology of the Cayuga Lake Basin. A guide for the 31st Annual Meeting of the N. Y. State Geol. Assoc., p. 1—36. Ithaca.

WILLIAMS H. S. 1900. The Cuboides Zone and its fauna. — Bull. Geol. Soc. America, vol. 1, p. 481—500.

WILLMARTH M. G. 1957. Lexicon of Geologic Names of the United States (including Alaska). — Bull. U. S. Geol. Surv., no. 896, Part 2, M—Z, p. 1245—2396. Washington.

ZIEGLER W. 1958. Conodontenfeinstratigraphische Untersuchungen an der Grenze Mitteldevon/Oberdevon und in der Adorfstufe. — Hess. Bodenforschung Notizbl., Bd. 87, p. 7—77, pls 1—12. Wiesbaden.

— 1962. Taxionomie und Phylogenie Oberdevonischer Conodonten und ihre stratigraphische Bedeutung. — Hess. Bodenforschung, Abh., Bd. 38, p. 1—166, pls 1—14. Wiesbaden.

— 1966. Eine Verfeinerung der Conodontengliederung an der Grenze Mittle-/ /Oberdevon. *In:* Das Mitteldevon des Rheinischen Schiefergebirges, Ein Symposium. — Fortschr. Geol. Rhein. Westfalen., Bd. 9, p. 647—676, pls 1—6. Krefeld.

— 1971. Conodont stratigraphy of the European Devonian. — Geol. Soc. America, Mem. 127, p. 227—284. Baltimore.

M. R. HOUSE

PROBLEM GRANIC PIĘTRA FRAN

(Streszczenie)

Przedmiotem pracy jest dyskusja nad zagadnieniami dotyczącymi rozumienia granic piętra fran. Odnośnie dolnej granicy tego piętra wskazano na identyczność jej z dolną granicą górnego dewonu. Za dolną granicę franu powinno się uznawać spąg *Assise de Fromelennes*, jak to przyjmuje się w Ardenach, i co jest bliskie stanowisku Gosseleta, który po raz pierwszy zaproponował w roku 1879 wydzielenie tego piętra. Rozważane jest położenie dolnej i górnej granicy franu w stosunku do granic zon konodontowych oraz goniatytowych, a także wynikające stąd konsekwencje oraz korektury dotychczasowych korelacji (*vide* tab. 1). Dyskutowana jest także możliwość przesunięcia górnej granicy franu w obrębie konodontowego poziomu Palmatolepis triangularis, a zgodnie ze spągiem piętra cheilocerasowego, gdyż w praktyce właśnie ta ostatnia granica spotyka się z najszerszym uznaniem.

Katedra Geologii
Uniwersytetu w Hull
Kingston upon Hull, Yorkshire, Anglia
Kingston upon Hull, w marcu 1972 r.