

## WISE-PUTH : STIMULANT FOR FURTHER EXPLORATION ? (1)

by

M.J.M. BLESS<sup>(2)</sup>, J. BOUCKAERT<sup>(3)</sup> & E. PAPROTH<sup>(4)</sup>

(4 figures)

**RESUME.**— Une coopération internationale, multidisciplinaire depuis 1976, a fourni plusieurs modèles de travail qui peuvent servir de base à l'exploration des roches pré-permiennes. Un de ces modèles postule l'existence d'un bassin, à l'est du Massif de Brabant, dans la région de Visé-Puth, qui aurait une séquence dévono-dinantienne épaisse avec peut-être des intercalations d'évaporites. Cette hypothèse a été testée par une prospection gravimétrique et magnétique et ensuite par deux sondages de 500 mètres chacun : Heugem-1/1a et Kastanjelaan-2.

Le résultat de ces investigations semble confirmer le modèle de travail et encourage à poursuivre l'exploration. Une telle exploration pourrait être basée sur l'expérience qui serait acquise par deux nouveaux sondages de 1000-1500 m proposés ici dans la région de Visé-Puth.

**ABSTRACT.**— Multidisciplinary, international cooperation since 1976 has yielded several working models which may serve as a basis for exploration in Pre-Permian rocks. One of these working models postulates the existence of a basin, east of the Brabant Massif in the Visé-Puth area, with a relatively thick Devonian-Dinantian sequence with possibly intercalated evaporites. This hypothesis has been tested by a gravity and magnetic survey, and subsequently by two 500 m holes, Heugem-1/1a and Kastanjelaan-2.

The results of these investigations seem to confirm the working model, and encourage further exploration. Such exploration might be based on the experience to be obtained in two new 1000-1500 m boreholes in the Visé-Puth area, which are being proposed here.

In 1981 two 500 m holes, Heugem-1/1a and Kastanjelaan-2, have been drilled in the Maastricht area (South Limburg, the Netherlands ; Bless and al., 1981). They were the result of five years of multidisciplinary, international cooperation between geologists in northwestern Europe. The principal object of this cooperation was a better knowledge about the pre-Permian deposits in northwestern Europe. This might serve as a basis for possible future exploration. This is not a merely utopian idea. Renewed exploration for coal in the Upper Carboniferous strata is now going on in Britain, northern Belgium, the southern Netherlands and in the Federal Republic of Germany. Upper Carboniferous to Middle Devonian rocks are becoming included in the exploration for hydrocarbons around the Brabant Massif in northern France, Belgium, the southern Netherlands and the Federal Republic of Germany. Moreover, Middle Devonian to Dinantian carbonates are being investigated on the occurrence of warm water for geothermal energy in Belgium, on thermal mineral water in South Limburg, and on karst properties for the storage of gas in northern Belgium.

However, these will remain high-risk projects as long as no reliable working hypothesis about the nature and distribution of the Pre-Permian in the subsurface has been produced. International cooperation is essential for the achievement of such working models.

The present project consisted of three phases.

The first phase included a critical review of the literature completed with bio- and lithostratigraphical studies of boreholes and outcrops. The results of these studies can be summarized as follows (also cf. Bless *et al.*, 1980a). Northwestern Europe formed part of a vast sedimentation belt that reached its maximum extension during the Dinantian period (fig. 1). During that period,

(1) *Manuscrit reçu le 15 septembre 1981 ; communication présentée le 3 novembre 1981.*

(2) *Museum of Natural History, Bosquetplein 7, 6211 KJ Maastricht, the Netherlands.*

(3) *Geological Survey of Belgium, Jennerstraat 13, 1040 Brussel, Belgium.*

(4) *Geologisches Landesamt Nordrhein-Westfalen, De-Greif-str. 195, 4150 Krefeld, Federal Republic of Germany.*

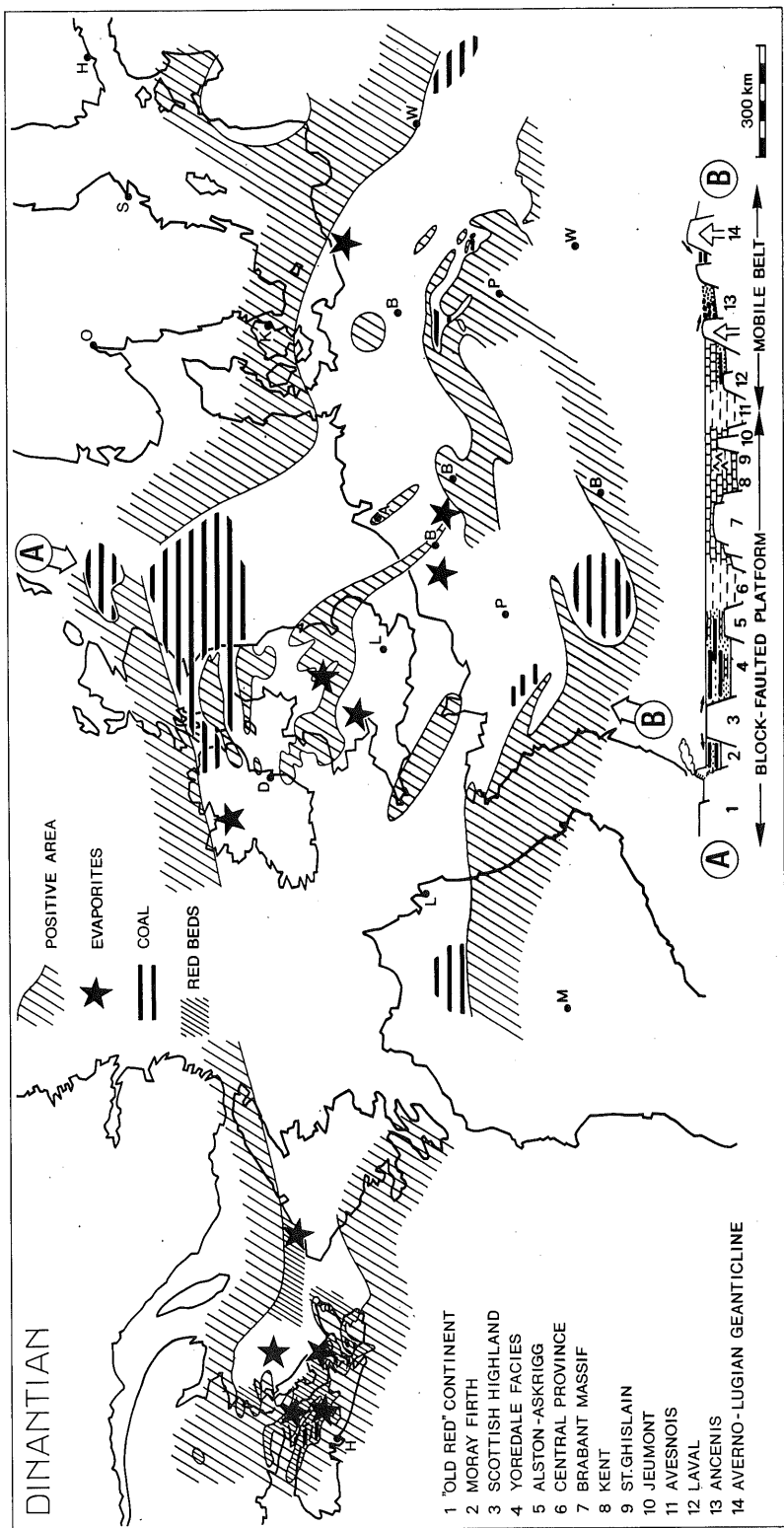


Figure 1.- Paleogeography of northwestern Europe during the Dinantian. The schematized cross-section has been palinspastically restored to the original position of the basins. Note the occurrence of evaporites from Nova Scotia through northwestern Europe into northern Poland.

this belt extended from the European part of the U.S.S. R. into southeastern Canada (Nova Scotia). To the north this belt was bordered by the Old Red Continent (including several cratonic areas such as the Laurentian and East-European Platform, and the Caledonian fold belt). In the south, a gradually northward expanding mobile belt with a high relative relief came into existence during the late Devonian. The main sedimentation area was structurally subdivided in a block-faulted platform with several sub-basins separated by horsts in the north, and a more geosynclinal foredeep in the south. The latter became largely included within the mobile Variscan or Hercynian belt during later orogenic phases.

Widespread carbonate deposition on this platform took place during the Eifelian-Frasnian and Strunio-Dinantian transgressions. At several places, more or less important evaporite intercalations in these carbonate sequences occur. The Dinantian evaporites include thick

potash salts in Nova Scotia, up to 600 m thick anhydrite beds in southwestern Belgium, and less important anhydrite/gypsum occurrences in Great Britain and Poland. It has been postulated that similar evaporite-bearing deposits of Middle Devonian to Dinantian age may be discovered elsewhere on the platform in northwestern Europe. These may occur south of the Brabant Massif below the thrust plane of the Dinant Nappe, or to the north below the post-Dinantian cover. It was proposed to test this hypothesis in the so-called Visé-Puth area east of Maastricht. The Visé-Puth structure shows several characteristics which point to the existence of a basin east of the Brabant Massif in Middle Devonian to Dinantian times. Such a basin might well include evaporite deposits.

This working model has been tested in the second phase by a gravity and magnetic survey in the Visé-Puth area and its surroundings through the joint effort

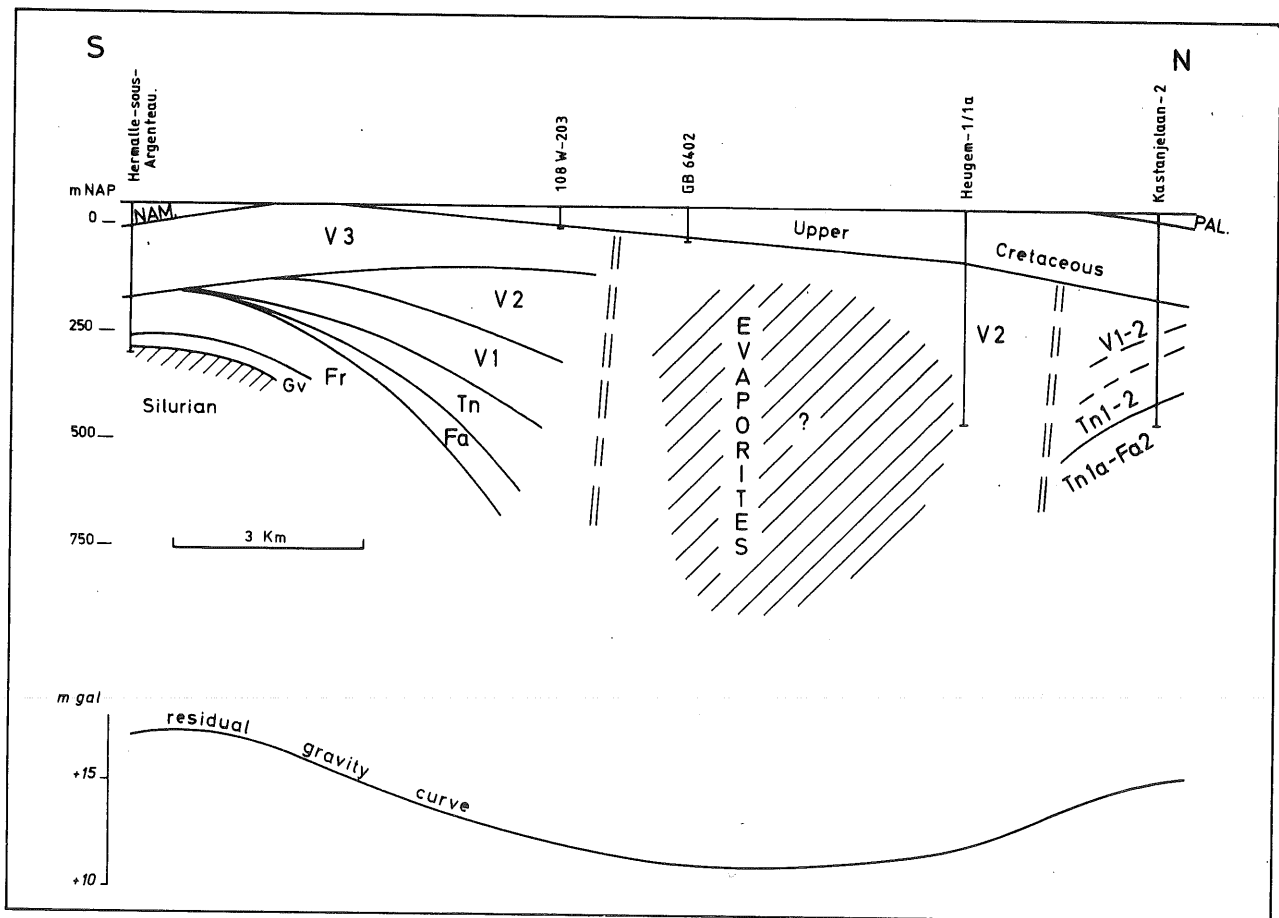


Figure 2.- Simplified south-north section through boreholes Hermalle-sous-Argenteau, 108 W-203, GB 6402, Heugem-1/1a and Kastanjelaan-2. Note general resemblance between residual gravity curve and borehole information. Remember that several minor (calcitized) anhydrite intercalations have been observed in V2 of Heugem-1/1a.

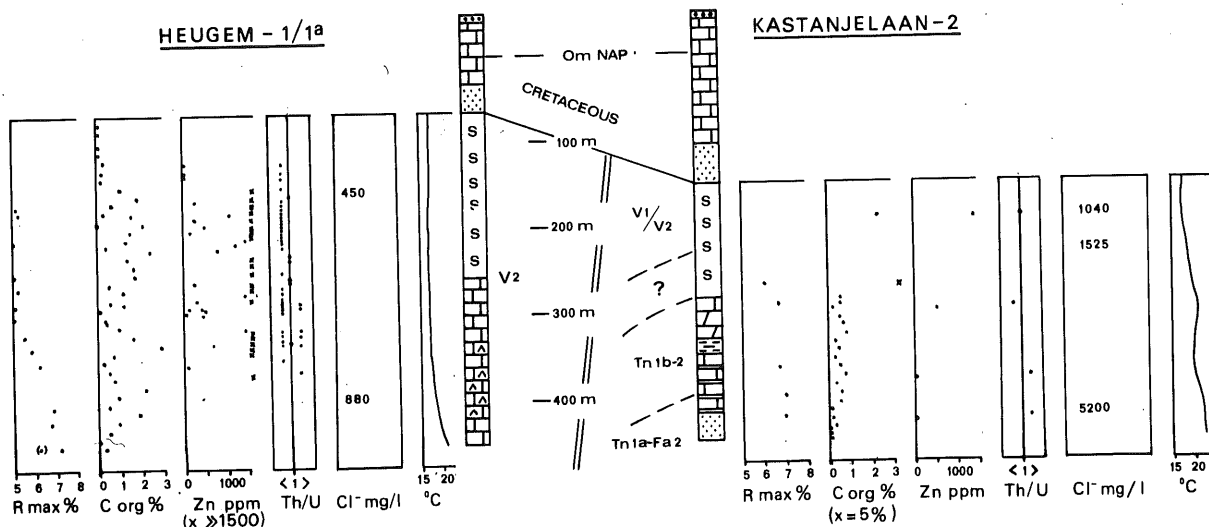


Figure 3.- Synthesis of relevant data from boreholes Heugem-1/1a and Kastanjelaan-2. Location of boreholes indicated on figure 4.

of the geological surveys of Brussels, Heerlen, Krefeld and Hannover (Bless et al., 1980b). That study yielded strong evidence of the presence of a narrow Devonian-Dinantian basin in the Visé-Puth area in which evaporites might occur. It was concluded that only boreholes could provide the final answer.

The two 500 m holes in Maastricht (Heugem-1/1a and Kastanjelaan-2) have yielded several interesting results which support the above model (fig. 2 - 3). These prove the existence of a much thicker and more complete Devonian-Dinantian sequence than the one known in the Visé area (Hermalle-sous-Argenteau borehole). Of special interest is the Middle to Lower Visean in these holes, which is characterized by carbonates deposited in a predominantly intertidal to supratidal environment. The occurrence of several - largely calcitized - anhydrite intercalations and numerous karst breccias in the same suggest that more important evaporite deposits may occur below the gravity lows which mark the central portion of the Visé-Puth structure (fig. 3 - 4).

The coalification rank at 500 m depth is about the same in both boreholes (7 % Rmax). This points to a comparable thickness for the original overburden, and may indicate a reduced thickness for the Middle to Lower Visean in Kastanjelaan-2 as compared to that in Heugem-1/1a. Therefore, the first borehole may be located on the northern border of a narrow basin with its center more or less at the position of the gravity lows.

Presumably, this basin was more or less closed during Middle and Lower Visean times. At least, this is suggested by a.o. the fossil contents (radiolarians, sponge spicules, absence of diverse macrofauna), high content of organic material (Corg between 0.5 and 2.5 %), high amount of zinc (Zn frequently more than 1500 ppm) and low Th/U ratio ( $\text{Th/U} \leq 1$ ).

It is not impossible that similar environments existed during the Middle Devonian and Frasnian.

Pre-Cretaceous leaching and silicification of the upper portion of the Dinantian carbonates is observed in both boreholes. This phenomenon is also found elsewhere in this area where Upper Carboniferous sediments seem to have been eroded shortly after the Variscan movements. The pre-Cretaceous silicification has been deduced from the fact that the oldest Upper Cretaceous deposits of the Aachen Formation largely consist of poorly rounded quartz grains derived from this silicified upper part of the Dinantian carbonates. The mechanism that produced the leaching and silicification is unknown. But somehow it seems related to the warm climate that reigned in northwestern Europe during the Permo-Triassic.

The structural high of Kastanjelaan is distinguished from the Heugem area by high chloride contents in the ground water and by a slightly higher temperature. It is suggested that this structural high is bordered by a fault zone to the south, which might be connected

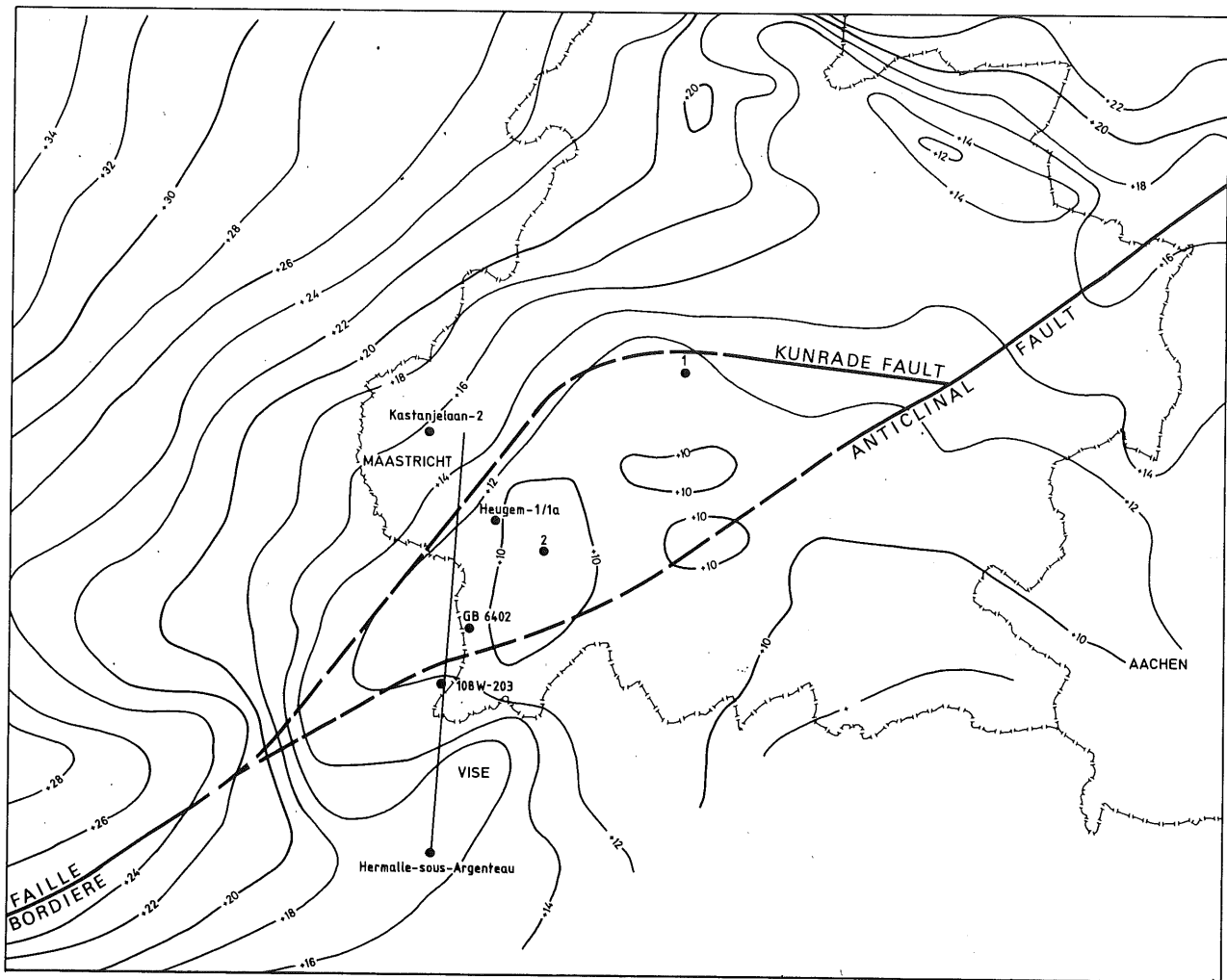


Figure 4.- Residual gravity map of South-Limburg (after Bless et al. 1980b) with location of boreholes Hermalle-sous-Argenteau, 108W-203, GB 6402, Heugem-1/1a and Kastanjelaan-2. Note that the Faille Bordière, Anticlinal and Kunrade Faults may be connected by fault zones (thick interrupted lines) which roughly border the gravity lows of Visé-Puth. The approximate position of these fault zones is indicated in the south-north section on figure 3. Two locations for future 1000 m holes (marked "1" and "2") are indicated east and south-east of Maastricht. Borehole 1 should investigate the possible existence of a northern border of the Visé-Puth Graben in Dinantian times. Borehole 2 is meant to study the possible occurrence of thick evaporites in the Visean.

in the southeast with the Faille Bordière and in the east with the Kunrade Fault. It seems also possible to connect the Faille Bordière and Anticlinal Fault by a fault zone that roughly borders the gravity lows of the Visé-Puth structure to the south.

If we do so, the gravity lows in this area may be explained by an evaporitic body in the subsurface which has been postulated in earlier papers (Kimpe et al. 1978, Bless et al. 1980c) a.o. because of anomalies in the Upper Cretaceous deposits.

The recognition of potential source rocks in the Middle to Lower Visean (and possibly also in the Middle Devonian and Frasnian), the presence of important secondary porosity due to pre-Upper Cretaceous leaching and silicification processes, and the possible occurrence of thick evaporite intercalations in the same deserve further attention. Similar features may occur elsewhere along the northern border of the Brabant Massif.

Secondary porosity of different origin (as frequently observed below the Namurian shales under the form

of dissolution breccias) may occur everywhere, both south of the Brabant Massif below the largely unexplored thrust plane of the Dinant Nappe and to the north below the post-Carboniferous overburden.

However, one should also realize that many questions have remained unanswered.

The Heugem and Kastanjelaan holes have proved the existence of a Devonian-Dinantian basin north of Visé. But the results are ambiguous as far as the question of its northern extension is considered. The reduction of the Visean in Kastanjelaan is not necessarily the result of a paleostructure, but may have been caused (or enhanced) by subsequent faulting and erosion.

There are arguments in favour of the belief that the gravity lows in this area are caused by thick evaporites. But it may also be, that these are produced by other phenomena, such as extremely deep leaching/silicification.

The same arguments forwarded in favour of a small restricted basin might also be used as indications for a much more extensive Kulm-type basin.

Questions like these might be answered by further holes in the Visé-Puth area. Preferentially, these studies should include two 1000-1500 m boreholes. One of these would be drilled in the center of a gravity low in order to establish the presence or absence of Middle to Lower Visean evaporites. A second one slightly further to the north might ascertain the extension of the basin. A relatively reduced Dinantian sequence in that location would indicate that we may expect many similar narrow basins to the north. Otherwise, the existence of a much larger Kulm-type basin seems more likely.

It seems worthwhile to have these stratigraphic test holes drilled before discussing further exploration. But whatever the result of such tests may be, the Maastricht boreholes have shown that our knowledge of the Pre-Permian subcrop is still so incomplete that we cannot reasonably afford to stop that exploration.

But above all, these have shown how much multidisciplinary, international cooperation is able to achieve within such a short time.

## BIBLIOGRAPHY

- BLESS, M.J.M., BOUCKAERT, J., CONIL, R., GROESSENS, E., KASIG, W., PAPROTH, E., POTY, E., VAN STEENWINKEL, M., STREEL, M. & WALTER, R., 1980a. Pre-Permian Sedimentation in NW Europe. *Sedimentary Geology*, 27-1 : 1-81.
- BLESS, M.J.M., BOSUM, W., BOUCKAERT, J., DÜRBAUM, H.J., KOCKEL, F., PAPROTH, E., QUERFURTH, H. & VAN ROOYEN, P., 1980b. Geophysikalische Untersuchungen am Ost-Rand des Brabanter Massivs in Belgien, den Niederlanden und der Bundesrepublik Deutschland. *Meded. Rijks Geol. Dienst*, 32-17 : 313-343.
- BLESS, M.J.M., BOUCKAERT, J., KASIG, W., KOCKEL, F., PAPROTH, E. & STADLER, G., 1980c. Evaporites anté-silésiennes sur la bordure orientale du massif du Brabant et dans le Fossé rhénan : une hypothèse. *Hommage à L. Calémbert, G. Thone, Liège* : 23-32.
- BLESS, M.J.M., BOONEN, P., BOUCKAERT, J., BRAUCKMANN, C., CONIL, R., DUSAR, M., FELDER, P.J., FELDER, W.M., GÖKDAG, H., KOCKEL, F., LALOUX, M., LANGGUTH, H.R., VAN DER MEER MOHR, C.G., MEESSEN, J.P.M.Th., OP HET VELD, F., PAPROTH, E., PIETZNER, H., PLUM, J., POTY, E., SCHERP, A., SCHULZ, R., STREEL, M., THOREZ, J., VAN ROOYEN, P., VANGUESTAINE, M., VIESLET, J.L., WIERSMA, D.J., WINKLER PRINS, C.F. & WOLF, M., 1981. Preliminary report on Lower Tertiary-Upper Cretaceous and Dinantian-Famennian rocks in the boreholes Heugem-1/1a and Kastanjelaan-2 (Maastricht, the Netherlands). *Meded. Rijks Geol. Dienst*, 35-15.
- KIMPE, W.F.M., BLESS, M.J.M., BOUCKAERT, J., CONIL, R., GROESSENS, E., MEESSEN, J.P.M.Th., POTY, E., STREEL, M., THOREZ, J. & VANGUESTAINE, M., 1978. Paleozoic deposits east of the Brabant Massif in Belgium and the Netherlands. *Meded. Rijks Geol. Dienst*, 30-2 : 37-103.