BIBLIOGRAPHY

FELDER, P.J. (Sjeuf), BLESS, M.J.M., DEMYTTENAERE, R., DUSAR, M., MEESSEN, J.P.M. Th. & ROBASZINSKY, F., 1985. Upper Cretaceous to Early Tertiary deposits (Santonian-Paleocene) in northeastern Belgium and South Limburg (The Netherlands) with reference to the Campanian-Maastrichtian. *Min. v. Econ. zaken, Adm. der mijnen-Geologische Dienst van België,* prof. Paper 1985/1 - 214: 1-151.

FELDER, P.J. (Sjeuf) & BLESS, M.J.M., 1989. Biostratigraphy and ecostratigraphy of Late Cretaceous deposits in the Kunrade area (South-Limburg, S.E. Netherlands). *Ann. Soc. géol. Belg.,* 112 (1): 31-45.

MATURITY INDICATORS IN THE WESTPHALIAN KEY-WELL KEMPERKOUL-1

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ABSTRACT.- Well Kemperkoul-1 (South Limburg, The Netherlands) was drilled during a coal-inventory programme that ran from 1982-1986. The borehole yielded an unusual amount of high quality data.

Carboniferous strata between 489 m and 1665 m depth were continuously cored. The age of this interval ranges from Early Westphalian B to Late Westphalian C.The Westphalian sediments are unonformably overlain by Cretaceous and younger sediments.

The Westphalian sediments show an alternation of terrestrial sand, clay and peat, occasionally interrupted by marine or brackish clay, together depicting a paralic facies.

Various depth-related rock-parameters have been analysed. Special attention has been given to the thermal maturity of the organic matter in shales and coals. The vitrinite reflectance values of the Westphalian coals from this well range from 0.65-1.25 %Rm. These values coincide with the oil generation window. Volatile matter (VM) decreases from 40% to 27%. The Thermal Alteration Index (TAI) increases from 3.5 to 5.5 over the total Westphalian depth interval. The moisture content decreases from 6% to 1% in this inverval Tmax increases from approximately 430°C to 470°C. There is a relatively small scatter in Tmax values of coals as compared to the shales.

The Hydrogen Index (HI) is generally very low, ranging between 100 and 300 in coals and between 50 and 180 in shales, which confirms the predominantly gasprone type III kerogen character of the coals and shales. The Production Index (PI) is extremely low in the coals, not exceeding 0.06 in coals, and up to 0.20 in shales. These values indicate that the residual petroleumpotential is very low indeed.

The parameters all show distinct interrelations, which allows the establishment of calibration functions. These are considered of importance for the Dutch hydrocarbon exploration activities, in particular because the maturity interval of Kemperkoul-1 (0.6-1.25 %Rm) largely covers the oil window. The relative depth dependence of the parameters and their interrelations are statistically quantified by minimum least-squares curve fitting. Third order polynomial regression equations generally yield satisfactory results.

The maturation history of the Westphalian strata is complex. At the end of the Carboniferous the area was deeply buried. The overburden of Westphalian C-D, Stephanian (?) and Permian (?) strata may have been more than 2000 m at Kemperkoul, but is nowadays completely removed. This overburden is either related to an northward areal extention of nappe-like structures from the Variscan mobile belt, or a molasse-like deposition of sediments in front of the Variscan Orogeny. No information is known about the local lithological characteristics of these eroded rocks. Eventual hydrocarbon plays are all removed during subsequent erosion. Extrapolation of the moisture content values to depth makes the occurrence of deep-seated hydrocarbon plays in the area extremely unlikely. There are indications that at or around the time of maximal overburden two major thermal events acted upon the Carboniferous strata of Kemperkoul-1. One distinct coalification pattern in the area is related to the Variscan orogeny during which the Ardennes were formed, somewhat to the south. Towards the north of South Limburg a local magmatic body in the neighbouring German area has influenced the maturity pattern as well. Both events may have taken place somewhere towards the end of the Carboniferous or at the beginning of the Permian. There are also indications that during the time interval between the two thermal events a compressional phase took place that resulted in the formation of a local anticlinal structure, *i.e.* the Visé-Puth anticline. The coalification trends seem

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to cut diachronically through this structure. The spacial distribution of coalification data is currently studied into much greater detail. After the Permian no significant thermal events influenced the deeply eroded, relatively shallow Carboniferous in the area.

CONCLUSIONS

In summary, the most important conclusions of this investigation are:

1. Hydrocarbon generation took place at the end of the Carboniferous.

2. Thermal maturation is related to two events, *i.e.* one directly to the Variscan orogeny, the other to a magmatic (?) body in the north-east.

3. The coals and shales acted as gas-source rocks.

4. Reservoirs and scals are removed during (post-)Permian erosion.

5. No secundary gas-generation occurred after the Permian.

6. The residual potention for oil is extremely low.

7. The coalification data indicate an extreme overburden, related to the Variscan orogeny. Two models are proposed: One model postulates a northern extension of the Variscan nappe structures. The second model postulates a molasse-deposit north of the Variscan belt.

SPINES IN LOWER DEVONIAN PLANTS, AN EXPLANATION ?

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(3 figures)

ABSTRACT.- Many Lower Devonian plants bear epidermic protuberances known as «spines» or «emergences». Typical examples are *Sawdonia* (fig.1), *Crenaticaulis* (fig.2) and some species assigned to *Psilophyton* (fig.3), as well as at least three new taxa recently discovered in Belgium (Gerrienne, 1990).

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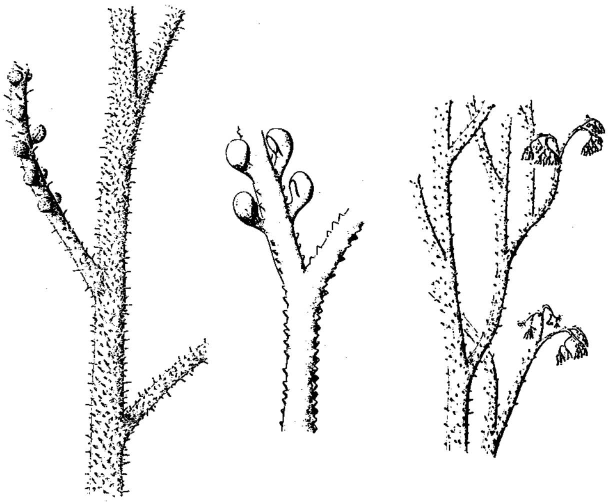

Fig. 1.- *Sawdonia acanthotheca* Gensel, Andrews & Forbes
Fig. 2.- *Crenaticaulis verruculosus* Banks & Davis
Fig. 3.- *Psilophyton princeps* Dawson

Several explanations have been forwarded for the occurrence of theses spines:

- They increase the epidermal surface and allow a better respiration (photosynthesis). Thus they may represent the onset of an evolutionary process leading to the microphyllous leaf.
- The spines were meant as a self-defence system against predators (Molluscs, Acaridans, etc.).

The three following observations form the basis for an alternative hypothesis:

- The stability of mine galleries can be improved considerably by slim boreholes perpendicular to the direction of the main gallery. Also roof bolts consisting of the same material as the roof support enhance the stability of these galleries.
- When trees break down in a storm, the fracture is usually located in that part of the trunk which is devoid of branches. Apparently, branches deflect and lessen the force of the wind.
- Along numerous beaches and riversides, sticks are driven into the ground in order to deflect the strength of waves and currents and to diminish erosion.

We suggest that the first vascular plants used spines in a similar way, i.e. to moderate the pressures of (alternating) winds, waves and