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EVAPORITES OF DEVONO-DINANTIAN AGE IN THE SOUTHEASTERN NETHERLANDS ?

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ABSTRACT. - During the Devonian and Carboniferous Northwestern Europe formed the eastern part of the Old Red Continent. This continent slowly drifted northwards across the equator during that timespan. In Dinantian times, the southern half of the continent was within the reach of a warm-arid climatic belt whereas the northern half was in an equatorial position. This is reflected in the formation of peat deposits (later transformed into coal layers) in Melville, Sverdrup and Svalbard, and in the deposition of red beds and/or evaporites in Canada, Britain, Northern France, Belgium, Germany and Poland. Devono-Dinantian evaporites may also occur in the Southeastern Netherlands where the presence of rock salt near Maastricht is presumed.

RESUME. - Pendant le Dévonien et le Carbonifère, l'Europe du Nord-Ouest formait la partie orientale du continent des Vieux-Grès-Rouges. Au cours de cette période, ce continent a dérivé lentement vers le Nord, recoupant l'équateur. Au Dinantien, la moitié méridionale du continent était située dans la ceinture climatique chaude et aride tandis que la moitié septentrionale se trouvait en position équatoriale. Ceci est attesté par la formation de tourbes (transformées ultérieurement en charbon) dans diverses régions (Melville, Sverdrup et Svalbard) et par le dépôt de couches rouges et/ou d'évaporites (Canada, Grande-Bretagne, nord de la France, Belgique, Allemagne et Pologne). Des évaporites d'âge dévono-dinantien peuvent aussi exister dans le Sud-Est des Pays-Bas où la présence de roches salines (près de Maastricht) est supposée.

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There is little doubt that North America and Northern Europe formed one continental mass, the Old Red Continent (ORC, also called Euramerica by McELHINNY, 1973 and J. G. JOHNSON, 1979, Laurussia by ZIEGLER et al., 1977, Eurasia by G.A.L. JOHNSON, 1980), during the Devonian and Carboniferous. According to some authors (e. g. TARLING, 1980, ZONENSHAIN et al., 1984) this ORC was separated by oceans from other continents such as Angara to the NE and Gondwana to the S. Only at the end of the Carboniferous, these continents became assembled in the megacontinent Pangea. However, others (e. g. BOUCOT & GRAY, 1979) suggest that Pangea existed already in the Early Paleozoic. Whatever may be the right solution, most authors coincide in assuming that the ORC drifted northwards across the equator during the Devono-Carboniferous. This is deduced not only from paleomagnetic measurements (TARLING, 1980, ZONENSHAIN et al., 1984), but also from investigations on the paleoclimate (HECKEL & WITZKE, 1979, BLESS et al., 1984).

During the Devonian, the ORC was largely dominated by an arid to semi-arid climate. This is testified by the widespread occurrence of red-coloured sediments (Old Red Sandstone deposits) and evaporites. At the close of this period, the climate become more humid in the N, where swamps with a rich vegetation developed until the end of the Dinantian in a.o. the Melville, Sverdrup (DOUGLAS, 1972) and Svalbard (GJELBERG & STEEL, 1981) areas. Further to the S, arid to semi-arid conditions prevailed as shown by randomly scattered Dinantian evaporites in North America, Northern Europe (BLESS et al., 1984) and even on the northern margin of Gondwana in NW Africa (Morocco : FELLAHI et al., 1970; Libya : VACHARD & MASSA, 1984). Only locally, some coal swamps occurred in this southern realm (e. g. Nova Scotia : HACQUEBARD, 1972).

From the Namurian onwards, the warm-humid climate shifted to the S, where vast swamps covered large parts of the USA, SE Canada, Northern, Central and Southern Europe, and even NW Africa (notably during the Westphalian). At the same time, a more arid climate influenced the Sverdrup-Svalbard area, where evaporites of Namurian age occur (DOUGLAS, 1972, GJELBERG & STEEL, 1981). At the end of the Westphalian, the arid to semi-arid climate extended southward across the ORC and even into NW africa as shown by the widespread occurrence of red beds and the local presence of evaporites (Late Westphalian of Western USA : WANLESS, 1969; Stephanian of Algeria : CHARDAC et al., 1979). Coal swamps only persisted in intramontane basins of the Hercynian belt during the Stephanian and Autunian. This overall change into more arid conditions at the end of the Carboniferous may be explained as the result of the northward drift of the ORC, or as the effect of a worldwide change in the distribution of climates, possibly induced by Late Carboniferous to Early Permian glaciations.

Thus it can be concluded that the climatological conditions in Devono-Dinantian time have favoured the local or regional deposition of evaporites in NW Europe. In fact, evaporites have been described from Northern Ireland (SEVASTOPULO *in* HOLLAND, 1981) Central England (GEORGES et al., 1976), Central North Sea (ZIEGLER, 1982), Northern France (BLESS et al., 1980a), Belgium (DEJONGHE et al., 1976) and NW Poland (DADLEZ, 1978). In all cases, the evaporites occur in shallow-marine carbonate sequences linked to nearby former land areas or local highs. The importance of the deposits may vary considerably, from isolated anhydrite nodules, sparsely scattered in the sediment, to very thick sequences of anhydrite with (usually) subordinate gypsum in Central England, Northern France and SW Belgium. Rock salt has not yet been reported from the Devono-Dinantian of Europe. But this is known from the USA, W and SE Canada (e. g. EVANS, 1970). Since the overal Devono-Dinantian depositional environment and climatological conditions were very similar in North America and in Northern Europe, rock salt may as well occur in Europe. This possibility has been investigated in South Limburg, in the SE Netherlands since 1977 (KIMPE et al., 1978).

In 1979, a gravity survey in South Limburg and surroundings established some negative gravity anomalies (BLESS et al., 1980b). These suggest a narrow SW-NE directed graben-like depression in the NE outliers of the Brabant Massif, filled with a thick sequence of Devono-Dinantian sediments which might include evaporites. Subsequently, the first part of that idea has been confirmed by two boreholes, Heugem-1 and Kastanjelaan-2 (BLESS et al., 1981). These show a considerably increased thickness for the Upper Dinantian in Heugem-1 (Lower Dinantian and Devonian not penetrated) as compared to that around Visé (some 10 km to the S) and in Kastanjelaan-2 (some 4 km to the NNW). Moreover, a few calcite lenses (presumably pseudomorphs after anhydrite) were recognized in Heugem-1. Unfortunately, these boreholes were located at some distance from the actual gravity lows.

Several working models explain these gravity lows as caused by evaporite (rock salt) accumulations of either Middle Visean or pre-Middle Visean age (STOPPEL et al., 1981). Most likely, halokinesis of a pre-Middle Visean or rather pre-Dinantian rock salt formation triggered by tectonic movements along the eastern border of the Brabant Massif, might explain both the gravity lows in this area and the thick Middle Visean shallow-water carbonates (possibly representing the filling of a secondary peripheral sink or "rim syncline" sensu TRUSHEIM, 1960 (STOPPEL, 1982).

Eventually, it is noticed that the groundwater composition in the Devono-Dinantian strata of Heugem-1 and Kastanjelaan-2 - and notably the Br/Cl ratios - support the hypothesis that this water consists of infiltrated rain water enriched by dissolved rock salt

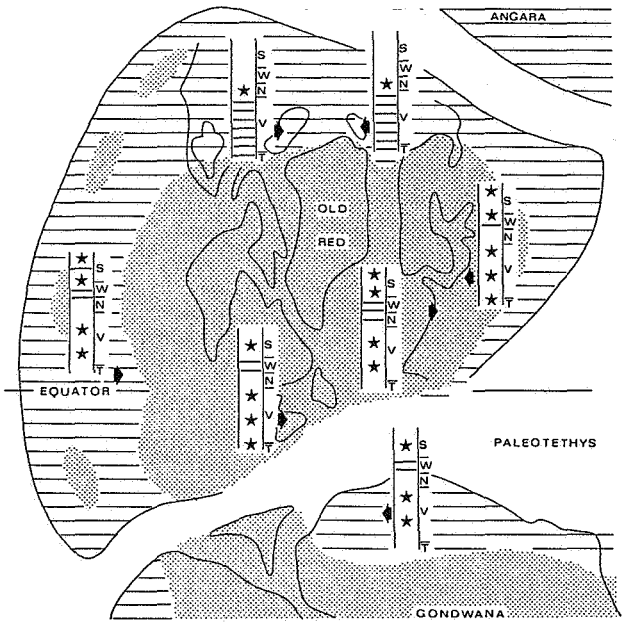

Figure 1 -
Cartoon showing the generalized paleogegraphy of the Old Red Continent at the end of the Carboniferous. Stippled : land. Horizontal hatching : shelf seas with local isles. Columns show some characteristic deposits for the Tournaisian, Visean, Namurian, Westphalian and Stephanian. Stars : evaporites or red beds. Bars : coal. Note differences in stratigraphic position of evaporites/red beds and coals between northern (Sverdrup, Svalbard) and southern (USA, Netherlands/Belgium, Rügen/Poland, NW Africa regions.

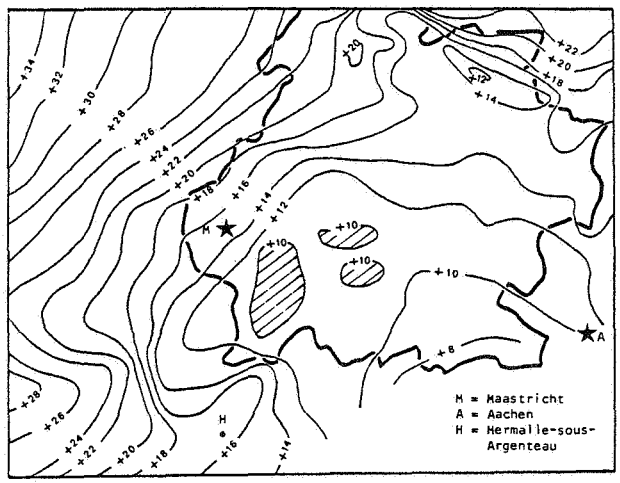

Figure 2 -
Residual gravity map of South Limburg (SE Netherlands) after BLESS *et al.*, 1980b.

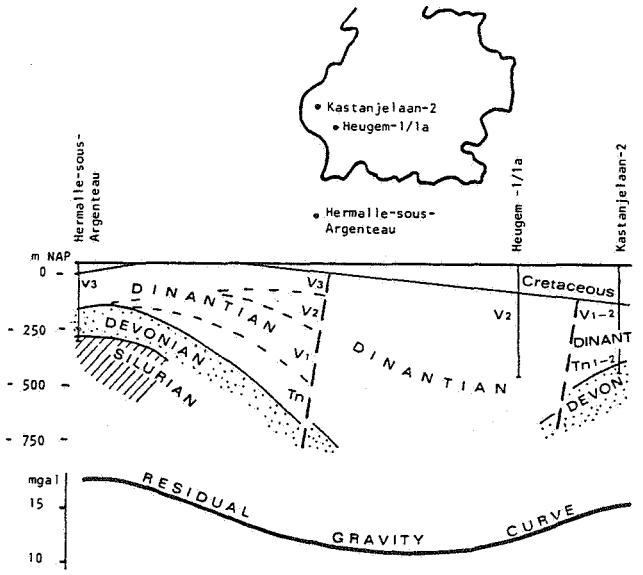

Figure 3 -
Simplified S-N section through boreholes Hermalle-sous-Argenteau, Heugem-1 and Kastanjelaan-2. Note general resemblance between residual gravity curve and borehole information. After BLESS *et al.*, 1981.

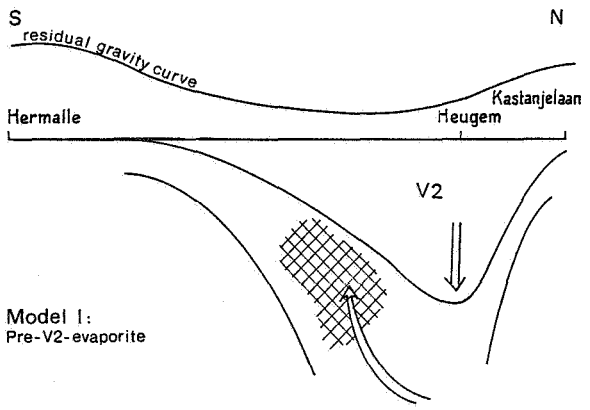

Figure 4 -
Cartoon showing possible relationship between thick Middle Visean carbonates in South Limburg and postulated occurrence of pre-Dinantian evaporites at position of gravity low. After STOPPEL *et al.*, 1981.

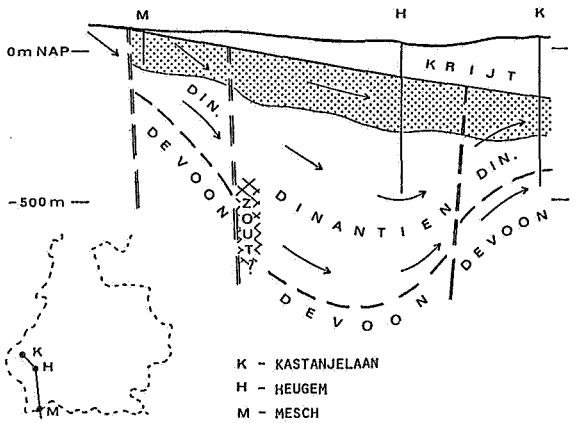

Figure 5 -
Schematic cross-section of the subsurface of South-Limburg through the boreholes Mesch, Heugem-1 and Kastanjelaan-2. The upper portion of the Dinantian rocks below the Cretaceous is silicified (stippled). Arrows indicate the direction of the groundwater flow through fissures and caves to the North. Presumably, the water is enriched by dissolved rock salt that is supposed to occur between Mesch and Heugem. From BLESS & BOUCKAERT (1985).

(GLASBERGEN, 1985; figure 5).

However, this suggestion must be tested by future boreholes which preferably should be drilled in the gravity lows South-East of Maastricht.

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