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Magnetotelluric soundings in the North German Basin – new data for Lower Carboniferous palaeogeography and hydrocarbon exploration

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Since 1993, after there unification of the two parts of Germany, new magnetotelluric (MT) measurements in north-east and north-west Germany with a definite hydrocarbon orientation. The aim was to delineate deep conductors which may be regarded as deep source rocks still producing some gas, to establish the regional extent of these layers, to determine their stratigraphical positions, and to integrate electrical parameters derived from magnetotelluric results into geological-tectonic modelling as a contribution to understanding the paleodynamic development of the underground of the North German basin. Up to now, a total of 225 MT soundings has been carried out along several profiles crossing the North German basin perpendicular to its axis, preferably in its eastern part. In comparison with the early measurements in that region, the site positions are much denser and allow 2D interpretation.

Analysis of the new magnetotelluric data shows that there is a deep good conductor at the north-eastern fringe of the North German basin around the islands of Rügen and Usedom and on the mainland north-east of the Anklam fault. By linking up with seismic data and the offshore well G14 this conductor can be correlated with the Scandinavian Alum shales. Although pyrolysis experiments still attribute a certain amount of gas formation potential to the Cambro-Ordovician source rocks, this potential is not realistic due to high maturities.

To the south, an area approximately corresponding to the depocentre of the Rotliegend basin joins up without a deep good conductor. Therefore it can be assumed that a regional distribution of comparable source rocks is unlikely.

South of the Lower Elbe Line, another good conductor appears at depths of 7 – 10 km

in the external Variscan zone. In comparison with geological sections that layer could most probably be correlated with the Early Namurian and the Dinantian bitumen- and pyrite-rich black shales as encountered in the Münsterland 1 and Pröttlin 1 wells. However, it cannot be ruled out that stratigraphically older black shales, possibly from the Cambro-Ordovician, which cannot be resolved by magnetotelluric model calculations, could contribute to the high integrated conductivity of the deep good conductor.

Near the Dutch-German border the conductor might be connected with the Early Namurian Bowland shale formation or equivalents which may extend from the Anglo-Dutch basin into this region. This interconnection, called “East-Friesland Channel”, separates the northern Carboniferous limestone area (Middle England, southern North Sea, North Germany, Northwest Poland) from the southern (Southeast England, Netherland, Belgium, southern Emsland ?). Gas and isotope geochemical studies on gases from producing Rotliegend deposits in the “Ems Estuary” province have shown that black shales have made significant contributions to the contents of the deposits.

Actuell magnetotelluric data from Glückstadt Graben (Schleswig-Holstein) suggest that the Lower Carboniferous black shale facies, probably filling the graben structure and, accordingly, the development of this structure in the Lower Carboniferous alredy.

Magnetotelluric and their integrated modelling together with petrophysical and organo-geochemical data offer new possibilities for the interpretation of basin configurations and consequently new incentives for future hydrocarbon exploration.