Triassic Geothermal Reservoirs of the North German Basin

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The Mesozoic of the North German Basin (NGB) comprises numerous sandstone horizons of considerable potential for geothermal use. Based on boundary conditions for commercial exploitation of geothermal reservoirs (>20 m thickness, >20 % effective porosity, >500 mD permeability) four main geothermal reservoir complexes have been recognised: (i) Middle Buntsandstein, (ii) Rhaeto-Liassic, (iii) Middle Jurassic and (iv) Lower Cretaceous (Wolfgramm et al. 2004). Among those the Rhaeto-Liassic comprises the most promising geothermal reservoirs of the NGB since geothermal heating plants are operating with Rhaetian sandstones at Waren, Neubrandenburg und Neustadt-Glewe.

The Lower and Middle Buntsandstein palaeogeography was controlled by a large lake that occupied larger parts of the Central European Basin (CEB). In the Lower Buntsandstein the lake and its marginal facies stretched from the North Sea area up to Central Poland and thus, prevented the progradation of fluvial sandstones into the NGB. Therefore the, in parts, more than 400 m thick Lower Buntsandstein is dominated by shaly lithologies that do not bear any potential as a geothermal reservoir. In the Middle Buntsandstein the lake generally diminished in size and long-term fluctuations of its level resulted in the characteristic progradational-retrogradational pattern of the Middle Buntsandstein formations with prominent sandstones at their bases that are fining-up to alternations of siltstones and claystones. The basal sandstones of the Volpriehausen, Detfurth and Hardegsen formations are up to 50 m thick and can locally attain porosities of 10 to 30% and moderate to good permeabilities and therefore comprise some potential as geothermal reservoir.

The predominantly shaly lithologies of the Upper Buntsandstein and the carbonatic to marly and shaly lithologies of the Muschelkalk do not comprise any potential as geothermal reservoirs in the NGB.

The Muschelkalk/Keuper facies shift favoured the southwards progradation of the mainly continental Keuper that is dominated by shaly lithologies without any reservoir potential. Fluvial sandstones of the Lower Keuper Erfurt Formation and the Middle Keuper Stuttgart Formation occur intercalated and may be locally of interest for geothermal use. Especially the Stuttgart Formation, if developed in sandy facies, can achieve valuable reservoir properties.

The Rhaetian transgression triggered the progradation of large fluvial systems from sources to the North and South. The Upper Keuper Exter Formation comprises deposits of a larger terminal fluvial fan (Lower Exter Fm) and large fluvial delta (Middle to Upper Exter Fm). In both, thick sandstones are limited to rather narrow distributaries that are laterally associated with overbank environments (Franz & Wolfgramm 2008). Sandstones of fluvial fan distributaries have porosities between 9 – 37 % and permeabilities between 29 – 3000 mD (average: ca. 750 mD). Sandstones of deltaic distributaries have porosities of 8 – 35 % and permeabilities of 20 – 5814 mD (average: 2000 mD). In general, sandstones of fluvial and deltaic distributaries comprise high geothermal potentials, whereas the potentials of the respective overbank environments are rather low.

References

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