GEOTHERMAL RESERVOIRS OF THE NORTH GERMAN BASIN - THE EXAMPLE OF THE EXTER FORMATION (UPPER TRIASSIC, RHAETIAN)

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The North German Basin (NGB) is the largest geotectonic structure of the Central European Basin (CEB) with most promising opportunities for geothermal heat production as well as the storage of natural gas and CO2. Based on previous studies the sandstones of the (1) Middle Buntsandstein, (2) Schilfsandstein, (3) Rhaeto-Liassic, (4) Middle Jurassic and (5) Lower Cretaceous are generally considered as main geothermal reservoirs (Feldrappe et al. 2008). Beside others the geothermal heating stations at Neubrandenburg, Neustadt-Glewe and Waren (Mecklenburg-Vorpommern) are already operating with reservoirs of the Exter Formation (Rhaetian). But up to now a more intensive use is hampered because the knowledge about sedimentology and petrology of the main geothermal reservoirs is rather preliminary. Especially the spatial distribution of sandstones with considerable reservoir properties (porosity, permeability) is unknown.

We report first results of a starting R&D project that aims to investigate Triassic and Jurassic geothermal reservoirs using an integrated sedimentological, petrophysical and petrological approach. Preliminary results of the Exter Formation (Rhaetian) in NE Germany point to deposits of a larger terminal fluvial fan (Lower Exter Fm) and large fluvial deltas (Middle to Upper Exter Fm). In both, thick sandstones are limited to rather narrow distributaries that are laterally associated with overbank environments of fluvial and deltaic plains (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:

Feldrappe, H., Obst, K., Wolfgramm, M. (2008): Die mesozoischen Aquifere des Norddeutschen Beckens und ihr Potential für die geothermische Nutzung. – Z. geol. Wiss, 36, 4-5: 199-222.

Franz, M. & Wolfgramm, M. (2008): Sedimentologie, Petrologie und Fazies geothermischer Aquifere des Norddeutschen Beckens am Beispiel der Exter-Formation (Oberer Keuper, Rhaetium) NE-Deutschlands. – Zeitschrift für Geologische Wissenschaften, 36 (6): 223-248.

Geothermal Reservoirs of the North German Basin - the Example of the Exter Formation (Upper Triassic, Rhaetian)

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Gefördert durch:
Bundesministerium, für Umwelt, Naturschutz und Reaktorsicherheit
aufgrund eines Beschlusses des Deutschen Bundestages
Projektträger Jülich Forschungszentrum Jülich

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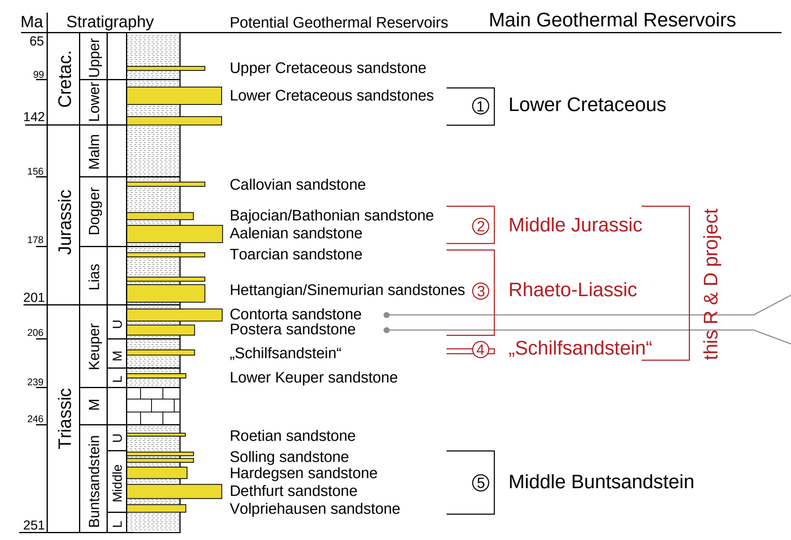
1. Introduction

The North German Basin (NGB) is the largest geotectonic structure of the Central European Basin (CEB) with promising opportunities for geothermal heat production as well as storage of natural gas and CO_2. Since the early 90ies several geothermal heatings stations are already operating in the northeartern part of the NGB, taking advantage of Triassic and Jurassic geothermal reservoirs. Among those, the sandstones of the Exter Formation (Upper Triassic, Rhaetian) comprise high potential for geothermal purpose. Beside others the geothermal heating stations at Neubrandenburg, Neustadt-Glewe and Waren (Mecklenburg-Vorpommern) as well as Rheinsberg (Brandenburg) are already opperating with reservoirs of the Exter Formation. But up to now a larger production of geothermal heat is hampered because of limited knowledge concerning sedimentary facies, petrology and reservoir properties. Especially the spatial distribution of sandstones with considerable thicknesses and proper poro-perm values is unknown.
This poster presents some first results of a starting R&D project that aims to investigate Triassic and Jurassic geothermal reservoirs using an integrated sedimentological, petrophysical and petrological approach.

2. Main Geothermal Reservoirs

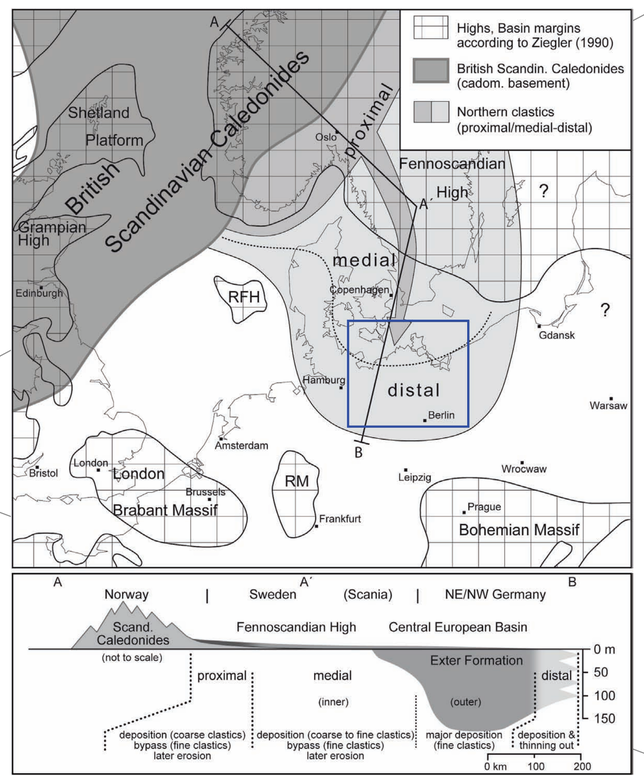
The Mesozoic strata of the NGB comprises numerous sandstone horizons with in part promising reservoir properties. Among these the sandstones of the (1) Lower Cretaceous, (2) Middle Jurassic, (3) Rhaeto-Liassic, (4) „Schilfsandstein“ and (5) Middle Buntsandstein are generally considered as main geothermal reservoirs (Feldrappe et al. 2008).



Mesozoic stratigraphy with potential geothermal reservoirs and main geothermal reservoirs of the North German Basin according to Feldrappe et al. (2008). Numerical ages, Triassic: Kozur and Bachmann (2008), Jurassic: Mönnig and Subcommission Jura (2002), Cretaceous: Hiss et al. (2002).

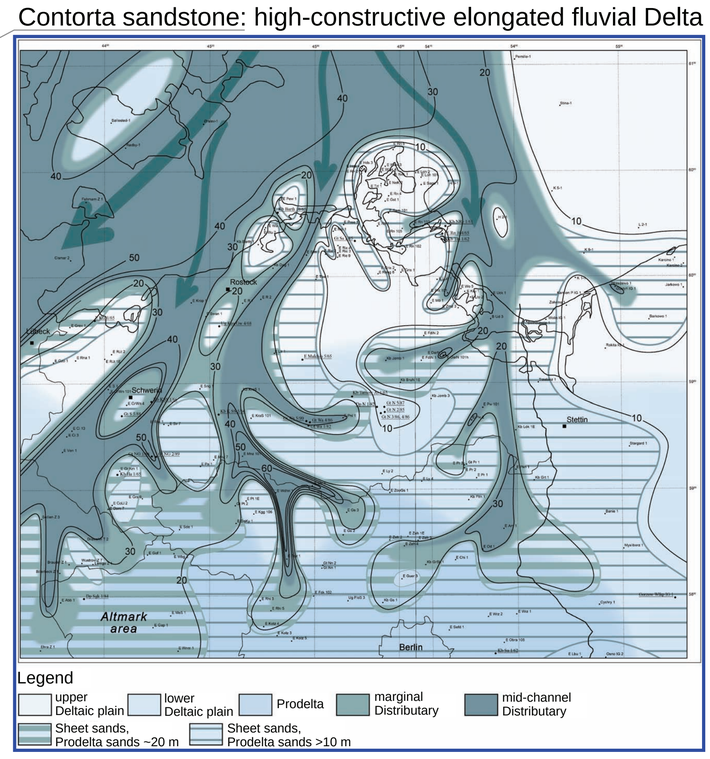
3.1 Working area

Central European Basin and northern source areas

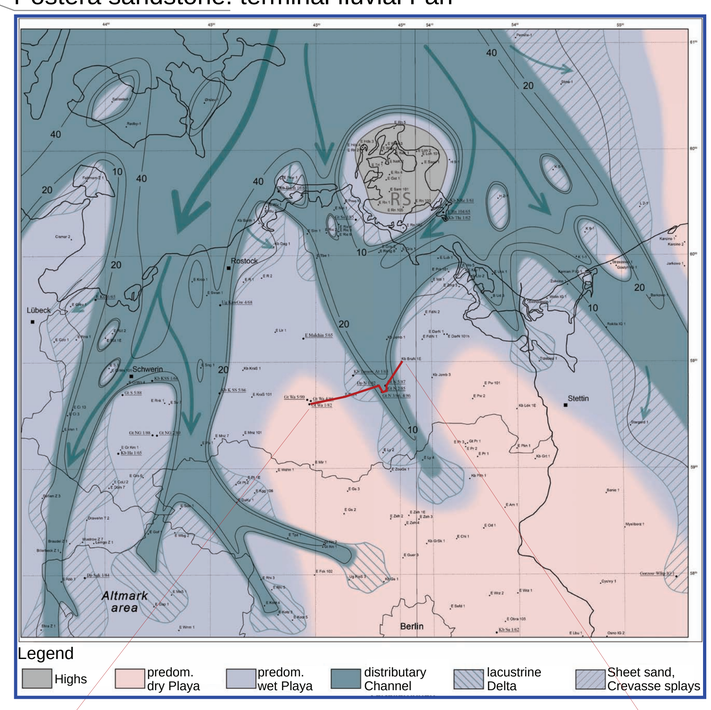


3.2 High resolution facies analyses

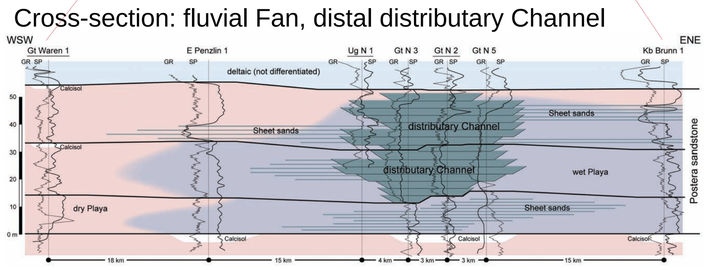
Contorta sandstone: high-constructive elongated fluvial Delta



Postera sandstone: terminal fluvial Fan

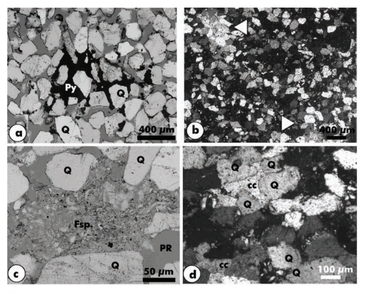


Cross-section: fluvial Fan, distal distributary Channel



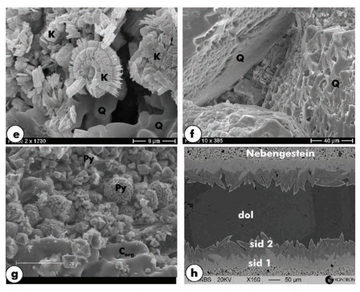
3.3 Petrology

<u>Postera sandstone</u>
- well sorted
- angular to well rounded
- fine to medium grained
- 82 % Quartz
- 4 % Kalifeldspat
- 3 % Plagioklas
- 3 % Lithics
- 3 % Kaolinite
- 4 % Illite/Chlorite/Smectite and 1 % Carbonates
- Porosities: 9-37 %
- Permeabilities: 29-3000 mD, average 750 mD (Neubrandenburg)



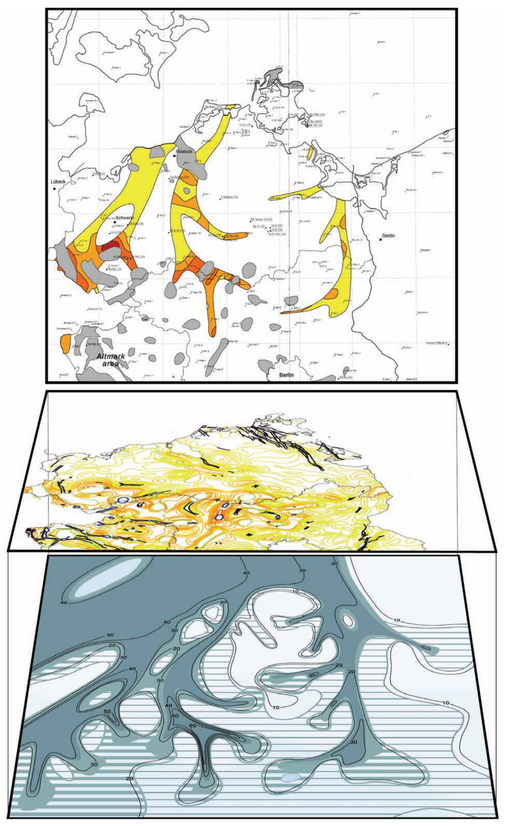
Thin sections: a, c - Neubrandenburg (Postera sandstone), d, b - Neustadt-Glewe (Contorta sandstone).

<u>(Contorta sandstone)</u>
- well sorted, angular to well rounded
- fine to medium grained
- 95 % Quartz
- 3 % Kalifeldspat
- 1 % Plagioklas
- 1 % Kaolinite
- Chlorite
- Porosity: 8 to 35 %
- Permeability: 20-5814 mD, average 600 mD (Neustadt-Glewe), 2000 mD (Waren)



REM images: e, f - Neubrandenburg (Postera sandstone), g - Pritzwalk and h - Karstädt (Contorta sandstone).

4. Reservoir potential



5. Preliminary results

(1) The up to 170 m thick Upper Keuper Exter Formation comprises up to 60 m thick sandstone horizons that have been deposited in distributary channels of fluvial fan (Lower Exter Fm, Postera sandstone) and deltaic environments (Middle Exter Fm, Contorta sandstone).

(2) The Lower Exter Fm represents a large terminal fluvial fan. Laterally, the sandstones of approx. 10 km broad distributary channels (Postera sandstone) are thinning out rather quickly and interfinger with pedogenic mudstones of a predominantly dry playa (see 3.2).

(3) The Middle Exter Fm represents a large fluvial delta with a high-constructive elongated network of sandy distributaries (Contorta sandstone). Laterally, the sandstones interfinger with dark shales of deltaic plain and prodelta environments (see 3.2).

(4) The sandstones of the Exter Fm comprise fine to medium grained, angular rounded to rounded sandstones with high contents of Quartz (Postera sandstone: 82 %, Contorta sandstone: 95 %) and only minor to subordinary contents of Feldspar, Lithics, Clay minerals and Carbonates (Postera sandstone: 18 %, Contorta sandstone: 5 %).

(5) Fluvial fan distributary sandstones (Postera sandstone) have porosities between 9-37 % and permeabilities between 29-3000 mD (average: ca. 750 mD), deltaic distributary sandstones (Contorta sandstone) have porosities of 8-35 % and permeabilities of 20-5814 mD (average: 2000 mD).

(6) Sandstones of both, fluvial fan and deltaic distributaries have, in parts, considerable to high potentials as geothermal reservoirs, whereas interdistributary environments have no potential.