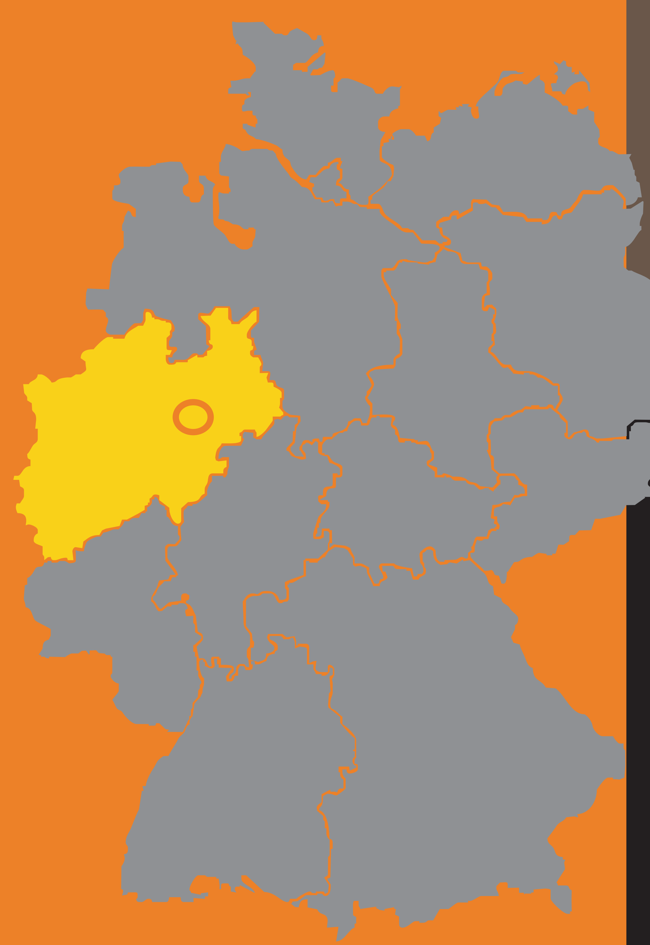
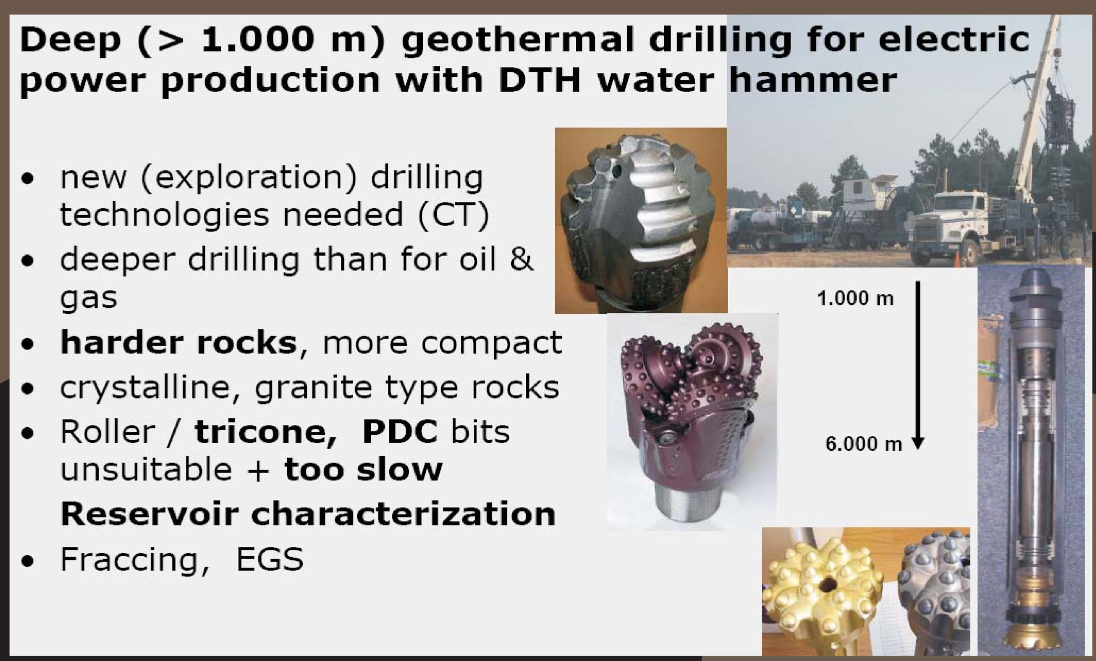
GZB International Geothermal Center

Innovative Hydraulic DTH Drilling Technology based on Coiled Tubing for deep, hard rock Geothermal Drilling

WITTIG, Volker & BRACKE, Rolf
International Geothermal Center, Bochum, GERMANY
Bochum School of Geothermal Technologies
geothermie@geothermie-zentrum.de



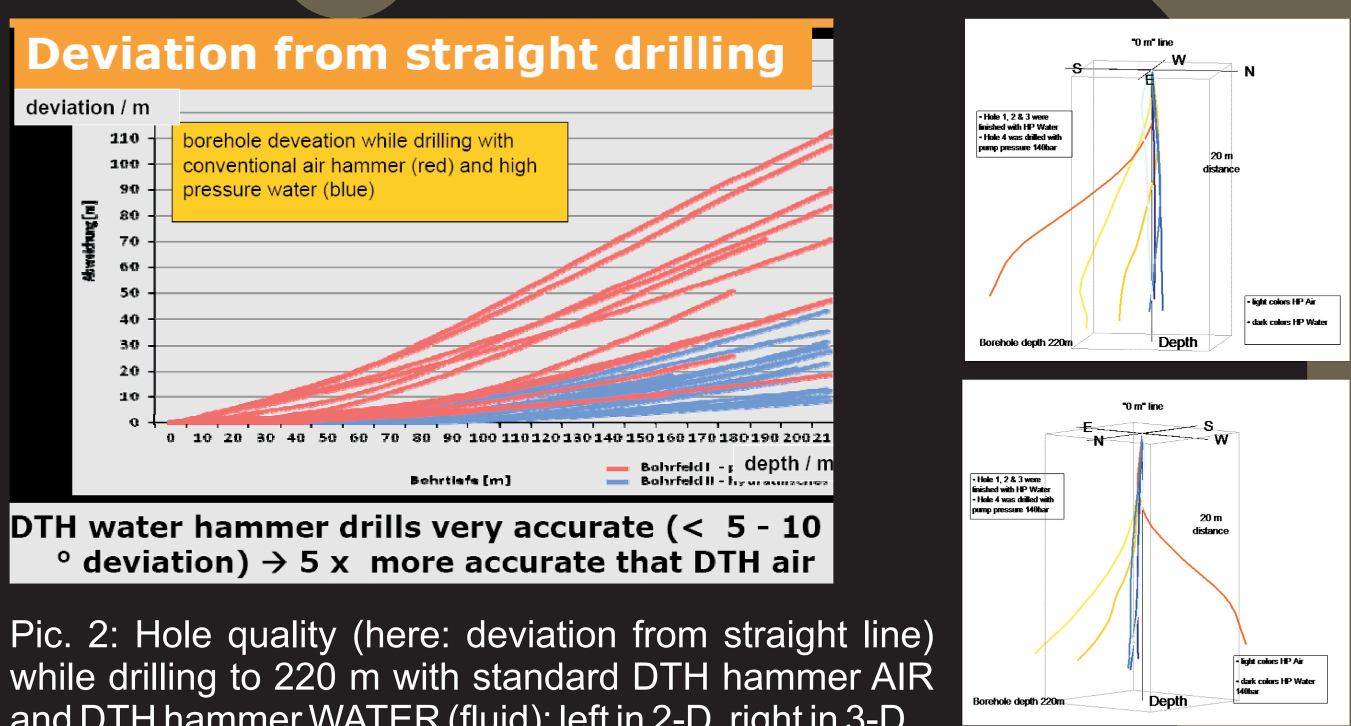
Abstract: The exploration and exploitation of low to medium enthalpy geothermal reservoirs for residential district heating and power generation is closely linked to the development of petro thermal systems. These reservoirs represent 85% of the total geothermal potential in Central Europe. Another 15% is characterized by hydrothermal systems (e.g. in the North Alpine Molasse Basin) and those which are related to tectonically affected parts of the upper crust (e.g. in the Upper Rhine Graben). Geothermal productions from these regimes are technically and geo scientifically established and may generally be defined as state of the art. In contrast, the majority of the petro thermal reservoirs need to be explored and exploited by methods from the mining sector and the hydrocarbon industry.



Pic. 1: Summary of old and new drilling tools like PCD / tricone bits as well as new DTH fluid hammer tooling

Up to now, the technique for hard rock drilling dates back appr. 100 years to the invention of the tricone / roller cone bit by Howard Houghes. This bit revolutionized the oil and gas drilling like a “gold rush”. Today, we are at the brink of a comprable invention by developing hydraulically driven DTH fluid / mud hammers. These hammers are proven to drill up to 10 times faster in hard rock than standard tricone or PCD driven bits. This is why GZB has been working with high pressure water / fluids as a drilling medium in the past decade.

The main advantages, even for shallow (geothermal) drilling are hole quality, low energy consuption, safety and independance of depth and ground water. These main aspects were observed and evaluated in research studies done during actual “life geothermal drilling projects” in Sweden as well as in Germany over the past 4 years.

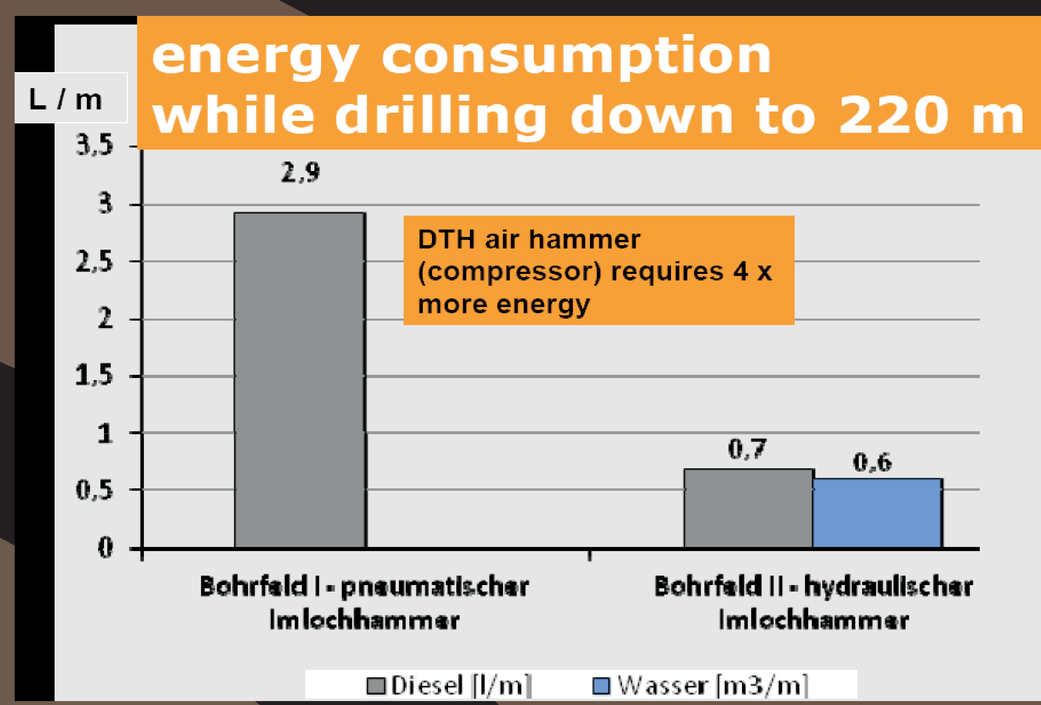


Pic. 2: Hole quality (here: deviation from straight line) while drilling to 220 m with standard DTH hammer AIR and DTH hammer WATER (fluid): left in 2-D, right in 3-D

The hole quality is a major factor in terms of perpendicular drilling axis (straight line) and borehole wall roughness. The DTH fluid hammer can be guided by default far tighter than an air tool, as water (fluid) can NOT be compressed and thus, doesn´t expand. That also explains the smoother borehole wall with water hammer drilling, as the return flow rate and its compositon is very constant and rather homogenous, causing very little abrasive damage, no caverns, “mini fraccs” etc, as air drilling does due to expansion, “explosion” of compressed air.
This makes hydraulik water drilling also very safe, as it works in similar pressure range or lower as any modern hydraulic construction equipment like back hoes, drill rigs etc. do.

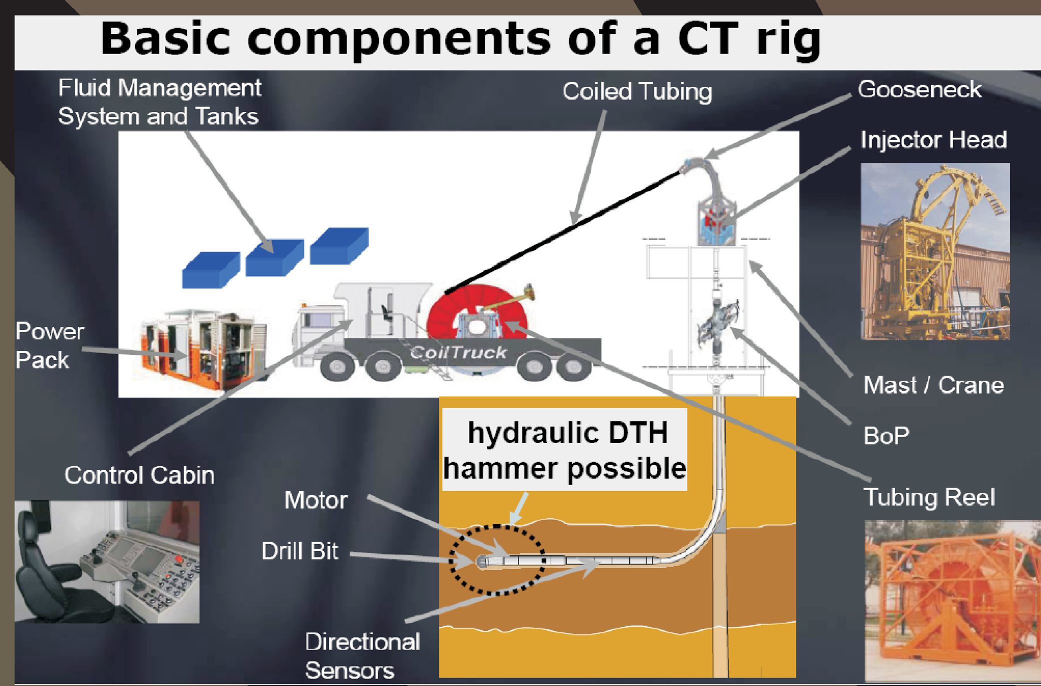
Summary

Harvesting the potential geothermal energy trapped in so called petro thermal reservoirs requires the development of new drilling tools (BHA), e.g. the above mentioned hydraulic DTH fluid hammer systems. This will enable very fast, economic and safe drilling in hard rock formations, resulting in stable holes where coiled tubing may be deployed easily. The overall objectives are



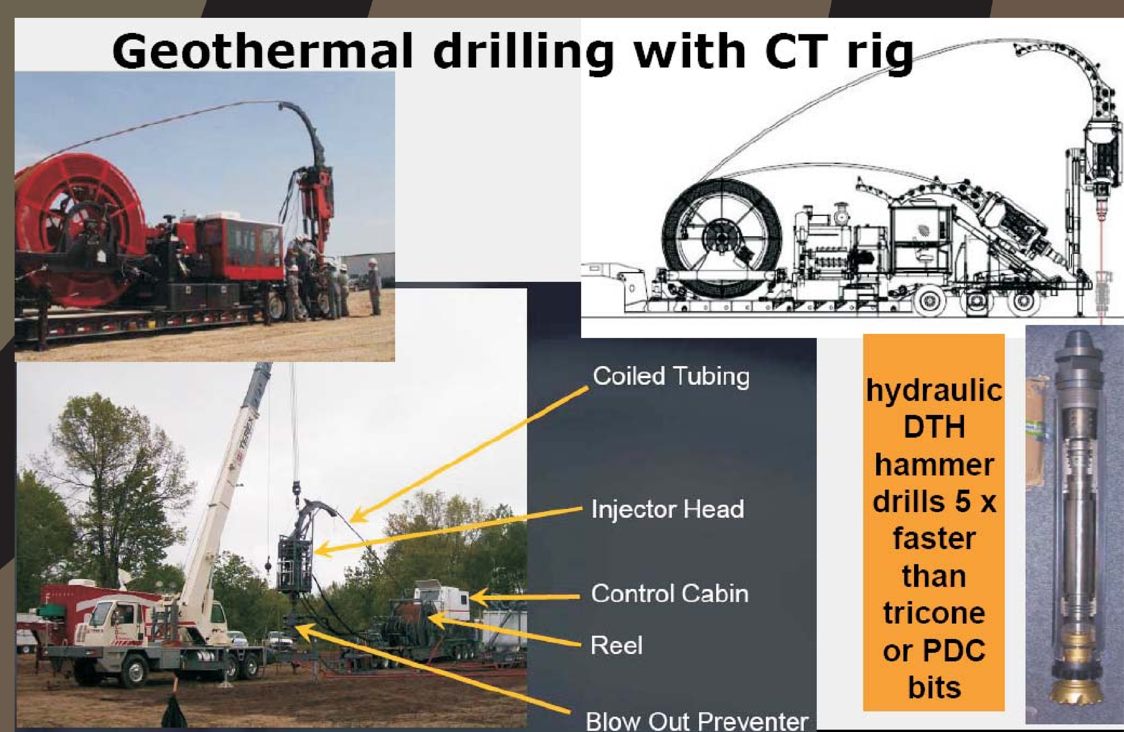
Pic. 3: use of primary energy for shallow drilling to same depth, diameter and same ROP: DTH air hammer left and DTH fluid hammer right

The graph above shows impressively how much more energy is required to drill with air rather than using a fluid as the medium to transport the energy to the bit. On average, the installed / required power per diameter of drilled hole is appr. 3 x higher for the DTH air hammer. This explains the vast difference as seen in Pic. 3 when drilling with air compared to water on comprable terms for hole depth, diameter and ROP.



Pic. 4: Coiled Tubing drill rig and its main components. Hydraulic DTH fluid hammers have been and may be used for deep hard rock drilling, especially on CT rigs for fast, safe drilling into hard rock formation.

These physical and proven technical advantages of drilling with hydraulic DTH fluid hammer tooling make it the ideal tool for deep, hard rock drilling in the 21st century. Further research and new development is still needed in order to be able to handle lower quality water or even mud while drilling. This is one of the primary R&D activities in this field at GZB.



Pic. 5: CT drill rig may easily be fitted with an BHA adapted to hydraulic DTH fluid hammer drilling.

a.) to make deep exploration drilling und thus, reservoir characterization feasible, economical, and, most importantly, safe
b.) to use CT drilling for improved, safe stimulation and fraccing technologies in order to develop the above mentioned petro thermal systems. Thus, the reservoir rock may be stimulated through one vertical and multiple, horizontal boreholes (laterals) with multiple, controlled, stacked fracs.