

Session 3

- Appropriate drilling techniques for geothermal drilling
- Drilling problems that may be encountered
- Loop Install – what can go wrong

Appropriate Drilling Techniques

Plan the equipment movement
around the site



Get
Organised

Tidy Site means an efficient site



Efficient equipment.

Grouter to service 3 or 4 rigs on a site at a time



Often holes are in gardens



Appropriate Drilling Techniques



If this is what you are used to drilling with perhaps don't take on a 250 m double loop install for the first job !



Medium capacity rig capable of going to more than 100 m but has the driller ever done it?

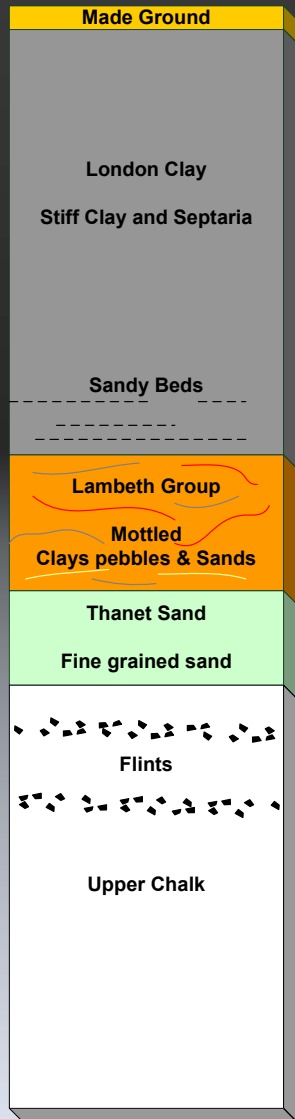


Water well rigs capable of drilling deeper to 500 m but again, has the driller ever done it

Drillers in the UK that have gone beyond 200 m are fairly few and far between.

Know your limitations and those of your equipment

Appropriate Drilling Techniques



Site Investigation in this strata may have been to piling depth or 40 m into London Clay

Drilling to the top of the Chalk is likely to be with Tungsten Insert Drag bit or similar

However, penetrating Bullhead Beds and the Chalk and Flints is likely to require a rock roller bit or PCD. Many drillers trip out and change bits at the Chalk

Geothermal boreholes far more likely to go to depth and into the Chalk due to limited space on site and the better thermal properties of the Chalk

Appropriate Drilling Techniques

Ability to Adapt



Have a string of casing if possible.



Have a barrel or two of polymer or bags of bentonite. Always have sealing crystals !!

Have a selection of bits. Just enough to be able to change and keep going until suppliers can get the right bits to you



Appropriate Drilling Techniques

Air Drilling and the spoil.

Where is the water going to go? Is there a drain, do you have permissions to discharge from site? How do you get the water clean enough for discharge?



Think about the dust you might generate with air. Control it with mist injection

Appropriate Drilling Techniques

Air Drilling and the loop install.



If there is no water in the hole, the loop must still be detached from the loop reeler and so weight is an important consideration.

An empty double 32 mm loop to 150 m depth could weight as much as 240 Kg

Throw in water and loop weights and the loop could be tipping the scales at over

600 Kg

Appropriate Drilling Techniques

Mud Drilling and the spoil.

Mud rotary drilling can be more time consuming to move around site and set up.

Mud settlement will be needed. This can range from tanks or even mud pits if the site is suitable to full mud processing equipment



It is important to try and settle or remove the solids from the liquids as disposal costs for solid waste is considerably cheaper than liquid waste

Appropriate Drilling Techniques

Mud Drilling and the loop install.



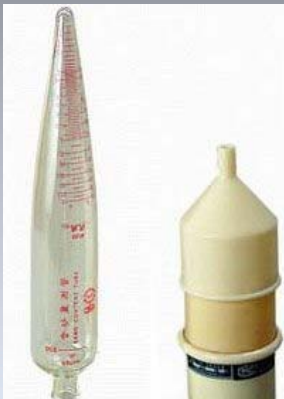
Mud Balance is used to measure the weight of the mud during drilling but also before the rods are pulled out.

A weight calculation should be done by the driller to know the minimum amount of weights to add to the loop



The Marsh Funnel is used to measure the mud viscosity during drilling and also used to understand the condition of the mud before pulling out the rods.

Highly viscous mud will drag on the loop pipes as they are installed in particular where double loops are required.



The sand content can lead to contamination of samples, and simply wears parts in the equipment.

It is also possible that sand will drop out into the base of the hole depending on the type of mud used. 10% sand content is potentially 10 m of lost hole if it all settles out !

Appropriate Drilling Techniques

Mud Drilling and the loop install.

Number of loops per bore	2	nr	Volume of fluid displaced	0.434	m ³
Loop Diameter	32	mm	Weight of fluid displaced	477.7	Kg
Hole Depth	135	m	Weight of water in loop	290.7	Kg
Rest Water level	0	m	Weight of loop pipe	137.1	Kg
Bore Fluid Density	1100	kg/m ³	Weight differential	-49.9	Kg
Water in loop density	1000	kg/m ³	Total amount of loop weight to be added to overcome buoyancy by 50%	75	Kg
PE100 Density	955	kg/m ³			

Number of loops per bore	2	nr	Volume of fluid displaced	0.264	m ³
Loop Diameter	32	mm	Weight of fluid displaced	290.2	Kg
Hole Depth	135	m	Weight of water in loop	180.0	Kg
Rest Water level	53	m	Weight of loop pipe	137.1	Kg
Bore Fluid Density	1100	kg/m ³	Positive Weight of Loop Assembly	26.9	Kg
Water in loop density	1000	kg/m ³			
PE100 Density	955	kg/m ³			

Appropriate Drilling Techniques

Sonic Rigs – Great in loose materials



Hollow Stem Augers?
Direct Push?

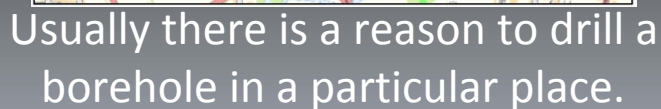
Nothing should be “off the table” but considered for the merits of each drilling method.



Shell & Auger – Cheap to buy, operate and mobilise. Could suit areas local to the drillers base in soft formations



Many closed loop geothermal boreholes are going to be drilled in places where traditionally there has not been drilling.



There may be limited available information but it is important to seek it out.

Drilling problems that may be encountered

Poor Verticality creates issues in any type of drilling unless you are aiming for bent holes !!

- Stress on drill string
- Additional stresses on rig
- Reduced rig depth capacity
- Holes intercepting each other
- Piling through holes after installation
- “Stealing” heat from adjacent properties



If you are splashing out £100,000 on a rig, surely its worth going the extra mile and blowing £15 on a spirit level !!

Drilling problems that may be encountered

Geological Anomalies and issues with minerals

7 nr 140 m loops drilled for the Staufen town hall in Germany by an Austrian Drilling Company

Hit Anhydrites which appear to have then become saturated, dissolved and formed gypsum. This has caused the mineral to swell and heave the ground up.

Up to 2009, the ground was rising at 1 cm per month !



Anhydrite can be found in Cumbria and the North East. Could we potentially have a similar situation.

Drilling problems that may be encountered

Mine – Coal, Salt, Gypsum, Limestone

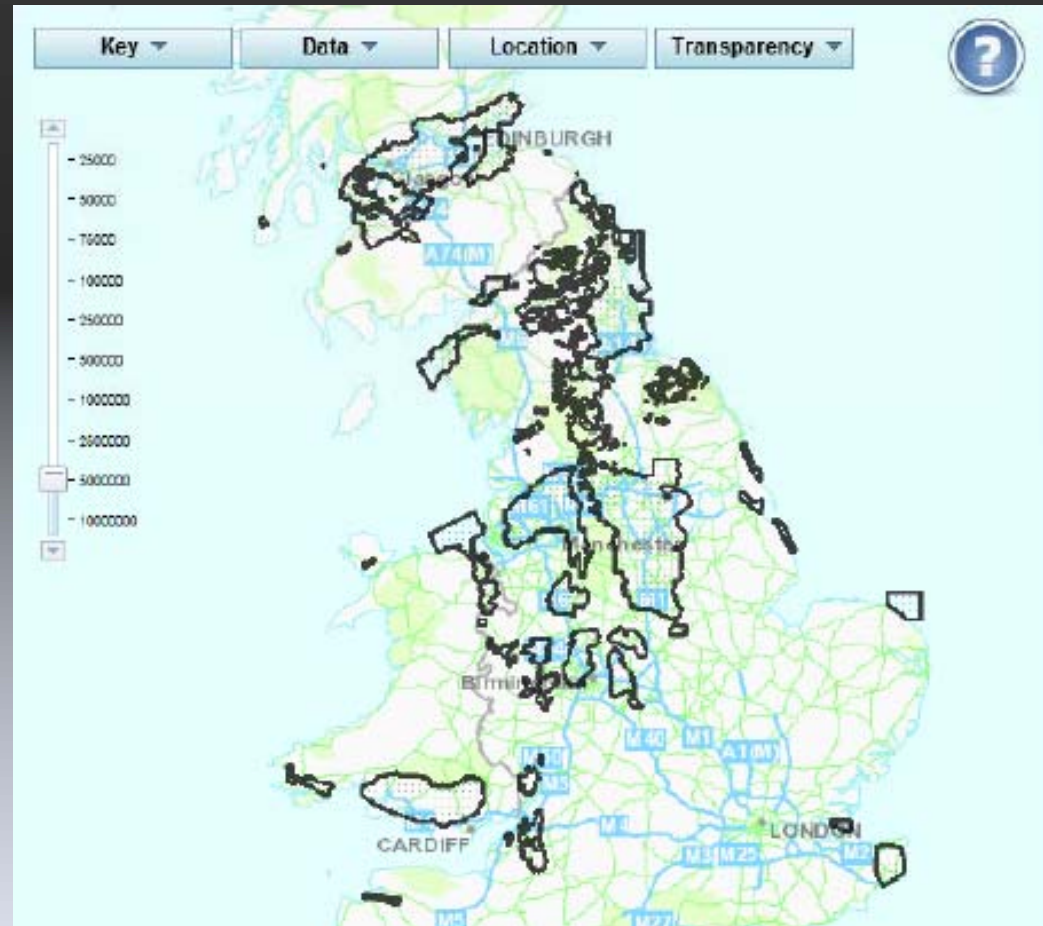
Various activities have taken place in the UK for extraction of underground resources.

They can crop up in places where you wouldn't expect it.

The designer should have checked for mining activity as far as is possible.

However some records simply may not exist or are very hard to unearth !

Coal Authority – Online Map



Drilling problems that may be encountered

Saline Water – Impacts Grout and Muds

In many areas of the UK there are saline ground water horizons. Saline water can cause several potential hazards to Geothermal Drilling works.

The water salinity and chemical make up can degrade drilling muds and affect grouting materials used to seal boreholes.

In some areas, such as the Oxford area, boreholes can be artesian and also contain Saline waters.

It is important in such areas to take grout and drilling mud manufacturers advice before drilling to ensure that the correct ground and drilling fluids are selected.

Drilling problems that may be encountered

Artesian Ground Water

It could be a trickle



It is surprising just how many areas of the UK have ground water that is likely to overflow at the surface.

Again due to the fact that in many areas, geothermal boreholes may be the deepest in an area, they may encounter conditions that are simply not known until that first deep borehole is drilled.

It could be more than a trickle



It could be a catastrophe
if you don't know its
coming !!!

Drilling problems that may be encountered

Everything else you can think of !!

Then of course there are all of the other drilling problems that can be encountered with any type of drilling, such as caving, fluid loss, broken ground, rods dropped and twisting off etc etc



Everything gets worse the deeper
you go !!

Loop Install – What can go wrong

We already know....

- Loops may not go in because the hole is not straight or plumb
- Loops may not go in because mud is too heavy
- Loops may not go in because the hole is not fully cleared or has collapsed

But what else can go wrong with the installation...

Loop Install – What can go wrong

Damaged on site or before it even gets there



Scratch found as loop being lowered into borehole

Loop damaged by fork loader



Store and handle loops carefully



Loop Install – What can go wrong



Loop Install – What can go wrong

Enemy No.1 Agency excavator driver

Holes marked with yellow paint
and casing, bunged and taped



Despite doing it the day before,
enemy No.1 does it again !



End result !



Loop Install – What can go wrong

If left open debris can get in and block it

Loop tails simply heated with a hot gun or small blow lamp and then squashed flat



Debris flushed from a loop .. Luckily..
This one had bungs and tape seals.



Q & A on session 3

Any questions....

Any slides you want to go back to?

Break for Coffee