ENGINE COORDINATION ACTION

Summary of the workshop 4

Cost effectiveness and feasibility of high-temperature drilling

2–5 July 2007, Reykjavik, Iceland

The scope of the workshop was to bring together experts from the ENGINE-consortium and others to discuss state of the art of effectiveness of drilling into geothermal reservoirs and to work out needs and gaps for forthcoming developments for improving drilling cost effectiveness. The workshop was organised by ISOR in Reykjavik (Iceland) with 67 participants from 13 European countries and additional participants and contributions from El Salvador, Phillipines, and Canada. The 30 contributions covered experiences in geothermal drilling into high-temperature reservoirs in deep horizons built up by granitic or sedimentary rocks and in shallower depths in volcanic rocks. Further papers were presented related to stimulation techniques and reservoir assessment. The importance of getting access to existing knowledge by means of collaboration with further active partners in other countries with considerable geothermal activities and the International Energy Agency - Geothermal Implementation Agreement (IEA-GIA) was discussed.

The workshop aimed at yielding a base and a framework to describe the economics of geothermal drilling. However, due to the extremely rapidly changing costs for drilling, energy supply for the operations, and the enormous rising material costs (e.g. for casings) within the last few years, we were not able to compare prices for drilling activities in the different countries. We decided to compare the performances of drilling operations and services by, for example, looking for drilling depth vs time curves, with respect to diameter, geology, and depth which requires a related rig size. It is important to note the different levels of experiences with geothermal drilling that exist, with numerous wells in the high enthalpy countries like Iceland and the Phillipines in comparision to Middle Europe with a few case studies only. The latter must be taken care of by capitalizing on the experiences in hydrocarbon exploitation without neglecting the special requirements of the geothermal utilisation.

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The Research and Development (R&D)-demand is widely spread and the discussion on what may be the “low hanging fruits” respectively the most efficient short time R&D-invest has just started:

- Most important seems to be to focus on the **reliability of drilling operations** which means to keep the required time in a plannable extent. The common problems in geothermal drilling operations i.e. lost circulation, equipment failure, improper drilling practices, cementing problems, casing problems, logistical problems and all other geothermal drilling related problems have to be dealt with based on what was experienced. The standardisation of geothermal activities as implemented e.g. in Iceland is a shining example for other countries. In this context all requirements have to be fulfilled in order to keep the borehole stable and to prevent the loss of the well.
- This can be the result of **system studies** including the economics, a special focus on the organisation of the operation (transports, rig up time, …), the borehole diameter, the aimed fluid flow and the longterm performance, to mention only some aspects. Here the system costs must include the cost of formation evaluation to prevent formation damage. This leads to R&D-demand to realise reliable balanced drilling operations including special studies on drilling mud. Drilling in remote areas such as islands also seems to be a challenge for effective drilling management.
- **Drilling instruments** and tools must be improved such like bit performance in various geological environments. Further **completion components** have to be improved such like casing in order to prevent corrosion, leakage, and scaling. Likewise packers for high temperature purposes e.g. for the forthcoming geothermal flagship IDDP have to be improved. We are not yet at the end of improving cementing technologies. There is a special demand to monitor cementing operations. Expandable casing seems to be an option to penetrat difficult fracture zones without loosing one diameter. In some cases we may even be able to realize one diameter wells.
- Improved MWD (measuring while drilling)-seimics are required to get informations about high temperature reservoirs, in order to locate the drill bit, or to be prepared for challenging zones. We have to learn drilling into overpressurized zones. Drill cores provide essential informations about rock properties but taking cores is still too expensive. We need improved coring systems, which provide us with cores, and thus with crucial data for reservoir characterisation in order to be prepared for future cost effective drilling operations. We need tracers for high temperatures.
- Innovative approaches for fundamentally new drilling techniques have been investigated in the past. The solution of major problems of crushing the rocks, for which energy has to be transported down and the drill cuttings up, are essential prerequisites for revisiting research on spallation drilling. It is under discussion to develop smart drilling techniques for exploration.

The geothermal scientific community has access now to **resources** like the InnovaRig, an instrument for scientific drilling. InnovaRig offers the opportunity to join in a scientific co-operation with the GeoForschungsZentrum Potsdam, in order to investigate innovative geothermal concepts or to address challenges to future geothermal drilling. Especially performing time consuming tests of new methods within the concept of enhanced geothermal systems, which may save additional capital costs for rig time, and providing experimental facilities for service companies to test new technologies outside of commercial drilling operations is possible now with InnovaRig.

There are a number of geothermal fields under development such as in Iceland the IDDP, in El Salvador, and in the Phillipines. Due to the actual “heat rush” in Australia and Germany, there are various innovative geothermal projects under way. Access is available to the scientific projects in Groß Schönebeck, in Soultz sous Forets, and in Windischeschenbach (KTB). Additional projects e.g. in radioactive bearing rocks are being considered.

The discussion at the workshop was targeted to provide **best practise** for different geological settings. The objective of best practice drilling is reaching the target depth with a sufficient casing diameter at the lowest cost, highest degree of safety, and minimal damage to the formation. Achieving this objective requires proven technical capabilities of the operating crew, a proper choice of a drilling outfit and drilling equipment with the highest degree of success in the drilling business, the utilization of proven new drilling techniques and equipment, a proper well design, and an application of proven techniques in dealing with problematic situations. It is necessary to chose or utilise equipment that can improve drilling with respect to a careful cost consideration. An online cost control analysis of non productive time (npt) helps to improve cost effectiveness.

The allocation of a budget for research and development is essential. A regular review and evaluation of practices is required, which will help to exclude compromising on safety issues. It is necessary to coordinate the activities with regulating bodies such as mining authorities and to include environmental issues into the entire project planning.

Well planning should involve parties who will implement the project. This touches questions like cementing the casing as discussed in context with the projects in Soultz-sous-Forets and in Groß Schönebeck.

The design of drilling contracts requires special attention, because weak competition of service providers leads to strong contracts keeping all main operation risks with the client only.

Within a European Geothermal Drilling Programm the chance is given to improve the economics of geothermal projects by addressing new approaches aimed to cut the costs for geothermal drilling and to follow the concept of enhanced geothermal systems.

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