SAGA Report Number 6

Report of **Workshop Number 5 – March 2007** - Reykjavik Iceland

Executive Summary & Recommendations

An informational workshop concerning the IDDP was held at Orkugarður on 7-8th March and was followed by a meeting of the SAGA committee, designed to review the current situation, to reconsider goals and plans in view of new circumstances, and to make recommendations to the oversight committee, Deep Vision.

The SAGA committee was heartened to learn of the increasing interest and support of the Icelandic energy industry in investigating the potential of utilizing supercritical energy and in collaborating with the international scientific community to that end, to the mutual advantage of both. It now seems likely that, in the next few years, deep (> 3.5 km) exploratory boreholes will be drilled in each of three major geothermal fields in Iceland. From the outset SAGA has supported the concept of a multi-year, multi-well drilling program for the IDDP. Reviewing the history of geothermal development in Iceland it is evident that in the early days of exploration of geothermal fields such as Reykjanes and Krafla, it was necessary to drill several wells before a commercially viable well was successfully completed. Hopefully we can do better in developing Iceland's Deep Unconventional Geothermal Resources (DUGR's). We believe therefore that it is essential in drilling the first deep investigation wells to obtain the maximum information necessary for characterization of the potential supercritical reservoir. This will allow optimization of the strategies adapted for future exploration, economic assessment and commercial development. Success will lie in making best use of both science and technology.

A member of the Deep Vision Committee explained that the science program must fund its own costs. This is a reasonable starting point for discussion. However the needs of the industrial consortium and those of the science program are not clearly distinct. Thus making arbitrary distinctions between an "exploration/ production" well versus a "science" well is counter-productive as the sampling needs and interests of the energy companies and those of the international science community are interlocking and overlapping, particularly in the area of fluid sampling and analysis. The add-on science that the science team will carry out will be a major contribution to the IDDP. Similarly any cores obtained may yield the best and most robust data from the well necessary to calibrate geophysical surveys, understand supercritical fluid/rock interaction, and how permeability is created and destroyed in that environment.

Because deep drilling plans are furthest along at Krafla, the committee focused on that field first. Of prime concern is the recent large escalation of cost estimates for drilling, coring, fluid sampling and testing of a deep geothermal well. This means that we must attempt to maximize the essential information obtained from the first exploratory borehole while reducing costs. The members of SAGA with drilling expertise made several suggestions of ways to review the drilling schedule and cost estimates. However SAGA's unanimous recommendation is that obtaining drill cores, especially in the transition from subcritical to supercritical and in the supercritical regime, remains an essential requirement for characterizing the deep reservoir. If this coring effort has to be supported entirely by funds from abroad, we suggest concentrating the coring efforts deeper than the 3.5 km well casing. The strategy for balancing the desire for depth versus amount of core will depend on the relative costs and technical requirements for continuous coring versus spot coring. Continuous wireline coring is much more preferable in terms of characterizing the nature of the resource.

There could be a considerable cost saving if it is possible to continue with the same drill rig after setting the 3.5 km deep casing. One attractive option would be to explore what is required to modify the top drive of a Jarðboranir Ltd. drilling rig so that it could easily switch between rotary and wireline drilling. Further inquiries should also be made into the relative merits and costs of using the DOSECC hybrid coring system, the ICDP 6 ¼ in drill string and possibly the GFZ InnovaRig for drilling and coring.

One major cost saving is to simplify the fluid sampling and handling program that was recommended in the Feasibility Report (2003), by abandoning the system referred to as "The Pipe", and replacing it with a less technically challenging and expensive sampling system, as described below.

Another contribution that the international science team can make is to review existing data and offer suggestions about the best location of the well in the light of the known geology, geophysics, and permitting situation. Furthermore the members of SAGA who are drilling specialists have offered to review the detailed drilling plans and to offer suggestion on how they might be simplified to reduce cost estimates.

In attempting to reconcile the goals of the industrial consortium with those of the science program, the overriding question is, "What would be the minimum criteria for success in this first deep drilling enterprise in Iceland?" We could both agree that the aim is to determine if we can drill into the supercritical zone and obtain sufficient rock and fluid samples and data to begin to understand its nature and potential. This will require many man-years of effort and expenditure of large sums over the next decade. The international scientific community welcomes this opportunity to participate in assisting Iceland in making a major step forward in developing new sources of "green energy".

Agenda of the Workshop

The agenda of the workshop is given in Appendix 1. The workshop began with a series of talks on technical topics relative to the IDDP. Then at 15.30 the participants separated into two groups for the rest of the afternoon, one to discuss drilling issues and the other to discuss the topic of fluid sampling and handling. These panels continued their deliberations on the morning of March 8th , followed by a joint session to report on and discuss their findings. SAGA, the advisory group to the IDDP, then met that afternoon to discuss the topics raised and possible actions to implement the advice received from the workshop participants. On the morning of March 9th the Co-Principal Investigators, Wilfred A. Elders and Guðmundur Ó. Fridleifsson, together with some members of the SAGA (Dennis Nielson, Hagen Hole and Robert Fournier), met with Deep Vision to relay the recommendations of the committee to the industrial consortium.

Program of the Workshop

The workshop began with an orientation by Guðmundur Ó. Friðleifsson, who reviewed progress since the IDDP Workshop number 4, in April 2006, at which time the recommendation was made to move the location of the deep well to Krafla, in the aftermath of the loss of the well RN-17 at Reykjanes. Preparations for drilling a new IDDP well at Krafla include: (i) completion of detailed designs for a 3.5 km deep borehole (both types A and C); (ii) soliciting bids on drilling this well which are now under negotiation; (iii) tendering for casings, wellhead and valves, and drilling works; (iv) planning of the drill site (camps, drilling water, drill site etc.). Critical issues that have arisen include uncertainty about the participants in the IDDP, that may require renegotiation of the contract between the participants, and the recent rise in the costs in the worldwide drilling market, that will require new and larger cost estimates. These two issues were not the topic of this technical workshop, which was meeting primarily to review fluid sampling and handling and drilling and coring. However given this background, the workshop did consider some ways to reduce costs.

The next speaker was Þorkell Helgason, the Director General of Orkustofnun, the National Energy Authority of Iceland, which is the representative of the Ministry of Industry and Commerce on the Industrial consortium, the other members of which consist of the National Power Company, Reykjavik Energy, and Sudurnes Heating Ltd. He reported that in Iceland public interest is high for the concept of exploring for additional sources of “green energy” by deep drilling. Similarly the aluminum companies represented in Iceland, Alcan, Alcoa, Century and in addition (Norsk) Hydro have been showing keen interest in participating in the project.

At a series of meetings this winter the CEO’s of the four current “owners” of the project have reaffirmed their commitment to the IDDP and have discussed policy issues, and management and financial aspects of the project. It seems likely that there will be a return to the original concept of funding in which one of the involved energy companies would be responsible for the first part of the drilling (to say a depth of 3.5 km) after which they join forces for deepening the hole and financing the unfunded ingredients of the scientific part of the project. He stated that he would not be surprised if we get a proposal for a

IDDP drillhole in the Krafla geothermal area, but also from the other two power companies in the consortium. It is conceivable therefore that three deep, or semi-deep, holes will all be drilled, although only one of them would be selected as the scientific IDDP hole. He hopes that before long – maybe in the wake of this IDDP Workshop – to get a clearer picture of the differences between an exploratory deep well – and potentially a production well – and a well where we also focus on the scientific aspects of the project. This relates to the expected cost of both types and of the time frame involved, i.e. at what stage, at the latest, a well of opportunity has to be selected as the scientific hole.

This was followed by three talks of different aspects of fluid sampling, handling and evaluation. Jón Örn Bjarnason began by reviewing the history of discussions on this topic. It is necessary to prepare for a fluid whose temperature, pressure and chemistry are not known. This fluid of unknown properties might potentially permanently damage the well by corrosion and/or scaling during testing. Consequently in the Feasibility Report of 2003 it was proposed to protect the well during the test period, by producing fluid through a 4 inch diameter liner, the "Pipe", that could be removed and replaced if scaling or corrosion became a problem. It was further proposed to monitor temperature and pressure with gauges placed along the "Pipe". After removing the pipe the liner would be retrieved and cut into sections to study scale and corrosion. Unfortunately the necessary high-temperature downhole valves and instrumentation are not yet available. There are also concerns that this liner might not be retrievable as it could part due to thermal stresses and corrosion. Another serious drawback of this approach is its very high cost (~ $8 million USD). Consequently the simpler method of producing the fluid without using an instrumented liner is now the preferred approach. This has the advantage of being cheaper (~ $ 2.5 million USD). However it poses a higher risk of corrosion and scaling in the well and will require closer monitoring of fluids at the surface, and more corrosion resistant and better insulated welhead assemblies. Deployment of downhole fluid samplers would also be desirable.

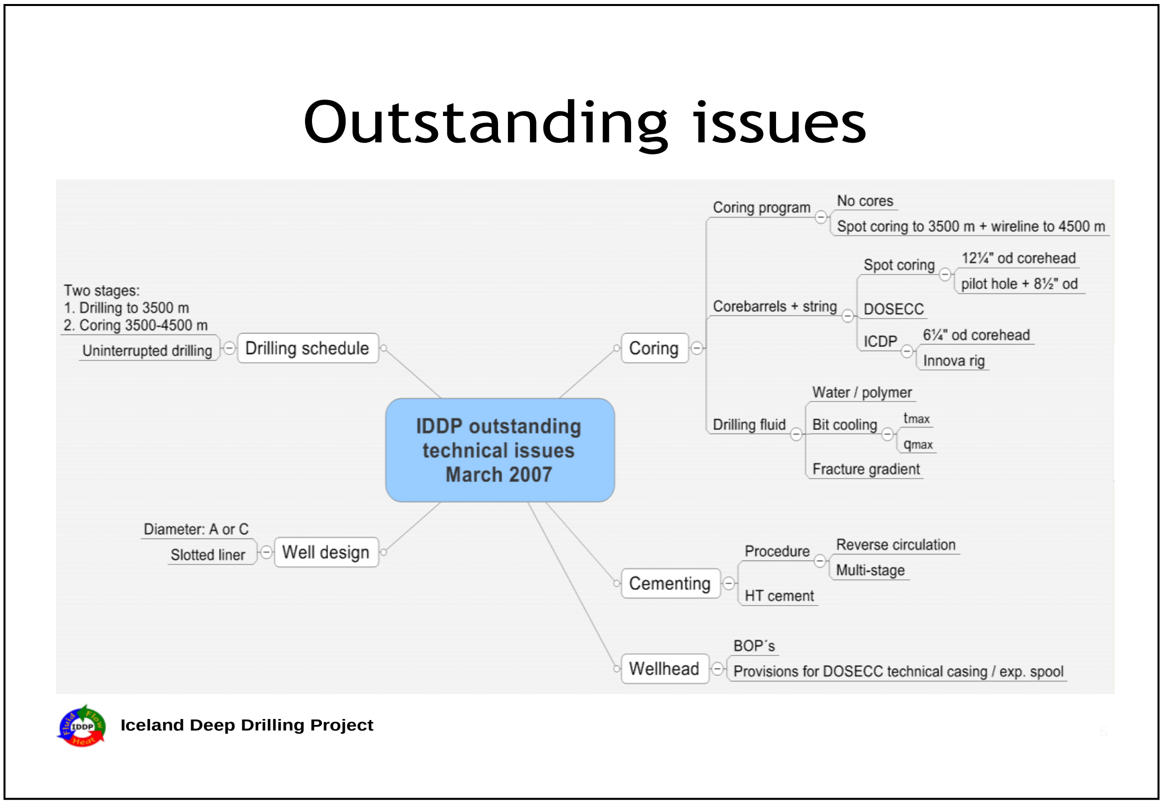
Teitur Gunnarsson, continuing on this theme, discussed the design criteria for the well head assembly for this second alternative. Assuming that a flowing well will have T= 480°C and P= 195 bar, and a closed well will have T= 400°C and P= 220 bar, the choice of materials for the wellhead is limited to ANSI 2500. It will be necessary to specify full bore wellhead valves because of potential scaling. Hydrogen chloride might also be expected. To minimize corrosion it will be desirable to insulate the well head valves to avoid condensation and to avoid cooling the well head due to H_2 and/or H_2S embrittlement.

Nigel Halladay, of Calidus Engineering Ltd, UK, then discussed the experience his company has had in the design and fabrication of a downhole 300ºC geochemical fluid sampler over a period of 7 years with a UK£750,000 budget (= $1,446,000 USD). He recommends a heat-shielded, controlled-displacement, sampler with a volume of 0.25 / 0.5 Litre, as the best option. At least a year of fabrication time would be necessary after an order is placed. A surface transfer bench system would also be required, together with transfer bottles for pressurized samples.

Ragnar Ásmundsson then discussed HITI (HIgh Temperature Instruments for supercritical geothermal reservoir characterization and exploitation), a recently initiated project of the European Community under framework FP-6. The main objective of this stage of the HITI project is to develop sensors and methods to determine accurately the existing conditions of the reservoir and fluids in-situ at the base of a deep geothermal system. It involves partners in Iceland, France, Germany, UK (Calidus), Luxembourg, and Greece. The aim is to develop downhole instruments capable of tolerating temperatures over 300°C, and preferably up to 500°C. These instruments include: temperature, pressure, fluid and rock electrical resistivity, natural gamma radiation, televiewer acoustic images, casing collar locator, casing monitoring, fluid flow, chemical temperature sensing and organic tracers. HITI will also adapt an existing high pressure, high temperature laboratory facility at CNRS, Montpellier France, for the measurement of electrical resistivity at appropriate reservoir conditions and varying fluid compositions. Finally HITI will validate the new instruments from the analysis of downhole data and samples (either core or fluid) from field tests either in existing hot wells, or in the new IDDP hole. This project, funded by the European Union with 2.5 million Euro (=$3.3 million), began on January 1st 2007.

The emphasis then shifted to site selection for deep drilling at Krafla. Knútur Árnason discussed a one-dimensional interpretation of recent magnetotelluric (MT) data and passive seismic observations at Krafla. The caldera formed about 110,000 years ago and has suffered about 2 km of E-W dilation in that time. As it was glaciated about 70,000 years ago until about 10,000 years ago, it has experienced 40,000 years of subaerial eruption, 60,000 of subglacial eruption during which hyaloclastites formed, and then another 10,000 years of subaerial eruption. There is a positive residual gravity anomaly of 2 mgal in the centre of the caldera due to subsidence or intrusion of dense rocks and a highly resistive shallow zone corresponding to the chlorite zone of alteration. The new 1-D MT model reveals the presence of a deeper electrical conductive zone beneath this resistive core at a depth of only 2-3 km. Seismic activity is concentrated in this conductive zone. One hypothesis is that this conductive zone is a shallow magma chamber corresponding to the observed zone of seismic S-wave attenuation. Thus the conductor could be magma. On the other hand the seismicity suggests that it could represent the transition from ductile to brittle behaviour, with fractures containing brine. However fluids produced by the geothermal wells at Krafla are in general quite dilute. It is clear that review of these data and further geophysical interpretation would be desirable before siting the deep well which will penetrate to the seismogenic conductor.

Sverrir Þórhallsson then reviewed current progress on well design and drilling plans. Since the last SAGA meeting tender documents have been prepared and detailed design criteria have been developed, and various cost estimates have been made. Procurement is being handled by Landsvirkjun and offers have been obtained after international tendering for drilling services, casings, valves, and wellhead assemblies. There is a 1 year delivery time for casings and wellhead. Negotiations with Jarðboranir Ltd. for drilling services are ongoing. Þórhallsson's summary of outstanding technical issues is illustrated in the figure below. Under the heading of "Drilling Program" a major choice to be made is the well diameter and casing program, type A (with 9-5/8 inch production casing at 3.5 km depth) or type C (with production 7 inch casing). Another major decision is whether the drilling should be done in two separate phases or uninterrupted using the same rig. This depends largely on the amount and strategy for coring proposed, this in turn depends on technical and scientific requirements and budgetary constraints. The options of no coring, spot coring and continuous coring have large impacts on costs.



Dennis L. Nielson of DOSECC Inc., USA, a non-profit consortium of US Universities involved in scientific drilling, then reviewed one of the options for continuous coring, the DOSECC Hybrid Coring System (DHCS) that combines positive features of both rotary drilling and wireline coring. It mates a wireline coring system to a rotary drilling rig. The conventional rotary rig is used for rotary drilling, tripping drill rods, setting large and multiple casing strings and providing BOP equipment. The attached wireline diamond core drilling equipment retrieves the core barrels on the wireline, thus making fewer trips, provides accurate bit weight and feed rate control, provides the ability to core during complete lost circulation, and above all obtains high quality continuous cores. The DHCS is based on a design of a coring system that was used for continuous coring in geothermal wells in Indonesia, Hawaii, and New Mexico, with bottom hole temperatures of 230-350°C. Further discussions of its expected performance at temperatures of up to 500°C are to be continued.

Lothar Wohlgemuth of the Operational Service Group of the ICDP at GFZ, Potsdam, Germany, discussed other possible options for drilling and coring. In April the GFZ will acquire a newly designed drilling rig for science and exploration, the InnovaRig, which uses a modular construction and a high degree of automation. It has extensive auxiliary equipment for coring, core handling, sampling, mud and gas analysis, a logging unit, and a data acquisition system for drilling progress. It has a 5 km depth capacity and a 3500 kN hookload, with top drive systems for conventional rotary drilling, conventional coring and wireline coring. The costs of operating the rig are still to be formally announced although there will be a two-rate structure, so that the day rate for science projects will cost about two-thirds of the rate for commercial projects. Similarly the procedure for applying to use the InnovaRig and its availability for use by the IDDP remain to be explored. A second option that could be considered is to use the 5,500m wireline drillstring and wireline system owned by the ICDP, currently stored in Germany. This drill rod has a 5½ inch OD (139.7 mm) and uses a 6 ¼ inch (159mm) core bit producing a 3.7 inch (94mm) diameter core. One caveat is that this drillstring would need inspection after its last use in a Chinese scientific drilling project.

At the end of these technical presentations Wilfred A. Elders reviewed the history and status of the IDDP, from 2000 until the present, stressing the decisions made at the last SAGA meeting and the subsequent events. In his opinion, from the perspective of funding the science program, the IDDP was very successful in 2005 in being awarded $1,500,000 USD from the ICDP and $2,200,000 USD from the US National Science Foundation to support obtaining cores from the IDDP borehole. However there are several major issues that need to be resolved as we move forward. The science program needs to respond to the new opportunities that may arise as the plans of the industrial consortium evolve, with the possibility of deep wells at Reykjanes and at Hellisheiði as well as at Krafla. However on the downside there are huge escalations in the projected costs of the project coupled with a continuing decline in the USD/ISK exchange rate. Thus it is mandatory to consider all options to reduce costs. However he restated the reasons why obtaining cores should remain an important part of the IDDP drilling plans for both scientific and technical reasons. There are many potential technical obstacles to drilling into supercritical temperatures and pressures and adequate permeability, and consideration of them should lead to caution in projecting economic returns for the IDDP in the immediate future. None the less, the status of the IDDP is healthy with every expectation of the first deep well being drilled in 2008.

Report of the Fluid Handling Panel

The comprehensive report of this panel was divided into the following stages: (i) drilling phase, (ii) recovery phase, (iii) completion test phase, and (iv) flow test phase. However the panel did not deal specifically with the issues of resources and budget necessary to implement its recommendations.

<u>Drilling Phase.</u> A comprehensive mud-logging suite including measurements of electrical conductivity, pH, chloride content, in addition to the usual temperature, pressure and flow rate and circulation losses is mandatory. It would be desirable to have an onsite field laboratory with a mass spectrometer for noble gas analyses and also a downhole fluid sampler ready to deploy if fluid entries or intra-formational flow is detected. During drilling, studies of fluid inclusions and mineral assemblages in core and cuttings may be the best indicators of downhole fluid compositions and the presence of supercritical conditions. Taking only spot cores may miss sampling the zone of greatest interest. PT logging would be desirable at bit changes.

<u>Recovery Phase.</u> Equipment for discharging and killing of the well is necessary, including a disposal pond or preferably a disposal well with plumbing necessary to

handle discharge rates of 100kg/s and high well head pressures up to lithostatic. During recovery, downhole logging and downhole sampling should be attempted and corrosion and scaling coupons deployed.

Completion Test Phase. Logging runs with standard geothermal logging tools and special high-temperature tools should be carried out, followed by step rate injection tests. During flow stimulation and flow, a microseismic monitoring program would be desirable.

Flow Test Phase. If supercritical fluids are present, a cautious, slow, stepwise increase of flow is necessary as, in the supercritical regime, a change in pressure has a major effect on chemistry. Once the wellhead pressures, temperatures, fluid compositions, and flow rates are established, the surface sampling equipment and procedures can be redesigned and optimized. Downhole fluid sampling is of course preferable to wellhead sampling. The science program also proposes to introduce samples of fractured quartz into different levels in a flowing (or shut- in well) to create synthetic fluid inclusions which may provide the best downhole fluid samples. Preparatory experiments are already underway to test and refine that approach.

Report of the Drilling and Coring Panel

A great deal of careful planning with associated cost estimates has already been carried out on this topic, along the lines recommended at the drilling workshop held in March 2002. In view of the ongoing negotiations between Landsvirkjun and Jarðboranir Ltd. the panel did not review the specifics of those cost estimates, but in general expressed concern about the very high numbers that have been developed recently. These appear to be derived from a combination of “worst case scenarios” and the panel suggested that members of the SAGA committee with drilling expertise should be given the opportunity to review and comment on the approaches taken in deriving these cost estimates. However one worse case scenario that should not be ignored is dealing with the potential of encountering hazardous gases.

The desire for as much core as possible for both industrial and scientific needs has been stated previously, consequently much of the panel’s discussion concerned the pros and cons of continuous wireline coring versus spot coring. The plan proposed in 2002, and modified in 2004, that has been the basis for the cost estimates, was to rotary drill and case a well to 3.5 km depth, taking spot cores, and then continuously wireline core into the supercritical zone, at a depth that depends on the PT conditions. This was the plan presented to the scientific funding agencies that resulted in the awards in 2005. As mentioned above, the coring budget available is 3.7 million USD (1.3m USD available in 2007 and 2.4m USD available in 2008). As it will be difficult to increase these amounts from these sources, unless other sources of revenue become available, those are the funds available for coring and sampling for the science program. These numbers were calculated not simply as an add-on cost, but also included estimated costs for rig time involved. However these funds may not be sufficient to carry out that coring plan in its entirety given today’s increased costs.

Spot Coring A test of spot coring technique (funded by the ICDP) was carried out in well RN-19 at Reykjanes using Baker Hughes coring services, using a PDC bit, and a pilot hole to guide the bit. It was generally accepted that the advice and bits used by Baker Hughes were probably not optimum for hard rock geothermal drilling. A variety of natural diamond bits (surface set and impregnated) plus roller core bits (such as 'KorKing') and four or six cone roller bits should perform better. For 6-10 m core runs, with a properly stabilized BHA, a pilot hole should be not be necessary.

Available funding will determine how many spot cores would be possible. A cost effective option would be to combine coring with pipe trips for drilling bit changes. Bit life is likely to be of the order of 200m. To further reduce costs the panel also recommends that spot coring should be concentrated in the depth range between 2500m and 3500m. The shallower levels of the Krafla system have been penetrated in numerous existing wells and the information obtained from them could be augmented by taking the opportunity to spot core in other production wells that are to be drilled.

It would be beneficial to use as small a kerf ratio as practicable for the core in order to leave as much of the main hole intact to seat the next conventional rotary drill bit and not overstress it unduly when re-starting drilling. Spot coring can be in a variety of sizes and can use a water flush rather than expensive polymer muds. It would be a good idea to investigate using the existing coring BHA available in Iceland and tailor core bits to suit. Core bits are available from a variety of manufacturers. Oil industry suppliers also make mining-style core bits, so there is a wide market to choose from. The temperature of the drilling fluid (mud) could be an issue but for spot coring there should not be any abnormal temperature problems as it can controlled by normal drilling and circulation practices.

Problems with re-starting the hole after coring can be mitigated by careful attention to leaving sufficient rock in the hole for the new drill bit to engage properly. This also has the advantage of not cutting away more rock than is necessary when coring. And of course it is always best if the borehole is vertical.

<u>Wireline Coring.</u> This is the preferable approach to coring as it produces high quality continuous core that is extremely beneficial for characterization of the nature of the reservoir. Wireline coring is particularly important in the deeper part of the borehole where drill cuttings are likely to be smaller, total loss of circulation is likely and logging may not be possible. However it requires inserting a technical liner to protect the vulnerable wireline string and the 9 5/8 inch production casing. If the DOSECC (DHCS) system is used which produces HQ core, the hole diameter will be 96 mm and the core diameter 63.5 mm. The ICDP drill string would produce a 159 mm hole and a core diameter of 94 mm. A topic of discussion was the temperature tolerance of the drill head assembly and if it will be possible to cool it sufficiently given the smaller hole diameters and much lower rates of fluid circulation. Dennis Nielson will provide more data on this issue.

The panel further discussed controlling the well during coring and retrieving core barrels. During drilling it will be desirable to ensure that the well is fluid filled at all times to control "kicks' due to fluid boiling. The risk of a kick going out of control when wireline coring and retrieving or deploying the inner core barrel can also be mitigated by using a lubricator (pressure chamber) with closure valve, and by using the rotary BOP. As a last resort, if an uncontrollable kick occurs we can cut the wireline and revert to full circulation to cool the well.

The downside of employing a wireline coring system is that it creates a 96 mm (=3 3/4 inch) diameter hole (or 159 mm = 6 ¼ inch, if the ICDP drill string is used). Questions raised included: (a) If the cored well is to be left open as under current plans, will it collapse? (b) Is this narrow diameter sufficient to run heat-insulated logging tools? On the other hand logging is less necessary if we have continuous core. (c) How will it effect fluid sampling and flow testing? Can we use the wireline drillstring and technical casing for production of fluids?

SAGA Meeting

At the conclusion of the workshop the SAGA committee met in executive session to discuss recommendations to be offered to Deep Vision. The first topic discussed was the large increase in cost estimates and the price difference between a cored deep well and well with no coring. A cored well is more expensive because it takes longer to drill. Sverrir Þórhallsson has estimated that a type A cored well 4.5 km deep would take 203 days to complete. In this estimate are 20 days of spot coring in the first 3.5 km and 97 days of continuous coring between 3.5 and 4.5 km depth. The committee then asked Sverrir to explain some of the assumptions made in making his estimates and made various suggestions for refining them. The initial impression was that these cost estimates were based on a connected series of worst case scenarios. Members of SAGA with drilling expertise volunteered to work with Sverrir to review the drilling schedule and cost estimates. Specifically an effort should be made to reduce the "flat spots" on the drilling progress line, i.e. those days when the rig is not deepening the borehole. Another cost saving would come from eliminating drilling a pilot hole before taking a spot core.

The committee was unanimous in supporting the recommendation that obtaining drill cores, especially in the transition from subcritical to supercritical and in the supercritical regime, is essential in order to understand the deep supercritical reservoir. If we reduce costs by reducing the amount of core obtained, we suggest concentrating the coring efforts deeper than the 3.5 km well casing. The strategy for balancing the desire for depth versus amount of core will depend on the relative costs and technical requirements for continuous coring versus spot coring. However continuous wireline coring is much more preferable in terms of characterizing the nature of the resource.

Another considerable cost saving would be to drill the 4.5 km deep well continuously using the same drill rig, rather than doing it over two successive years. It was suggested that we look into the possibility of modifying the top drive of a Jarðboranir drilling rig so that it could switch between rotary and wireline drilling. The committee will also inquire into the relative merits and costs of using the DOSECC hybrid coring system, the ICDP 6¼ inch drill string and possibly the GFZ InnovaRig for drilling and coring.

To focus discussion of how to prioritize the science program, the committee was asked to define how we would recognize that the first IDDP well had been successful. It was clear from that discussion that the interests of the industrial consortium and those of the science are strongly overlapping. There is no clear distinction between the needs of the industrial consortium and those of the science program. Success would be to drill a well to 4.5 km, to encounter supercritical temperatures and pressures, and to recover sufficient fluid and rock samples to begin to understand the nature of the supercritical geothermal reservoir. Making an arbitrary distinction between an “exploration/production” well versus a “science” well is counter-productive. The sampling needs and interests of the energy companies and those of the international science community are interlocking and overlapping, particularly in the area of fluid sampling and analysis. The add-on science that the science team will carry out will be a major contribution to the IDDP. Similarly any cores obtained may yield the best and most robust data from the well necessary to calibrate geophysical surveys, understand supercritical fluid/rock interaction, and how permeability is created and destroyed in that environment. Thus our aim should be to maximize the data obtained given the technical and budgetary limitations that we face.

Joint Meeting of the Co-PI’s and Deep Vision Committee.

On Friday March 9th the Co-principal Investigators together with some members of the SAGA committee met with Deep Vision. The Deep Vision committee reaffirmed the commitment of the industrial consortium to the IDDP and stated that each of the three energy companies is interested in drilling its own well in order to explore for deeper geothermal resources. It is clear that the IDDP is moving into a new and exciting phase with the prospect of deep (> 3.5 km) exploratory boreholes being drilled in each of three major geothermal fields in Iceland in the next few years. However it is likely to be many years before supercritical geothermal resources are successfully commercialized. The Co-PI’s expressed the view that success will lie in making best use of both science and technology. Thus we should obtain the maximum information on the character of the supercritical reservoir in the first deep well within the limits of available budget. This will allow optimization of the strategies adapted for future exploration, economic assessment and commercial development. Thus there is a wide overlap between the needs of the scientific goals and the economic goals. For example this is particularly clear for fluid sampling.

The Co-PI’s explained the willingness of the SAGA committee to review cost estimates for drilling. They also volunteered to obtain relevant information about the InnovaRig, the DOSECC hybrid coring system, and about the top drive of the Jarðboranir drilling rig. SAGA could also offer suggestions for well site selection in light of the new geophysical surveys and the new wells that have been drilled since the Feasibility Study was concluded.

The meeting ended on a very optimistic note.

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AGENDA

07.03.2007

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09:00	**Opening and Introduction**	**Gudmundur Ó. Fridleifsson**
09:15	**The IDDP consortium**	**Þorkell Helgason**
09:35	**Fluid handling: the story so far**	**Jón Örn Bjarnason**
09:50	**Flow testing and fluid sampling**	**Teitur Gunnarsson**
10:05	**Discussion**	
10:15	***Coffee***	
10:35	**Downhole fluid sampler for 500°C**	**Nigel Halladay**
10:50	**New downhole tools from HITI**	**Ragnar Ásmundsson**
11:05	**Discussion**	
11:30	**New MT and seismic data from Krafla**	**Knútur Árnason**
12:00	***Lunch***	
13:00	**The current IDDP drilling program**	**Sverrir Thórhallson**
13:30	**The DOSECC hybrid coring system**	**Dennis Nielson**
13:50	**The ICDP drill string and Innova rig**	**Lothar Wohlgemuth**
14:10	**Discussion**	
14:45	**Review of current status and planning**	**Wilfred Elders**
15:00	***Coffee***	
15:30	**Split into two working groups (Fluid handling and drilling technique)**	
17:00 +	**Break**	
19:30	***Dinner at the Pearl***	

08.03.2007

09:00	**Working groups continue** **Fluid Handling and Evaluation** **Drilling Technique and Coring**
10:30	***Coffee break***
11:00	**Summary from working groups** **Fluid Handling and Evaluation** **Drilling Technique and Coring** **Discussion**
12:30	***Lunch*** ***Workshop completed***
14:00-17:00	**SAGA MEETING**

09.03.2007

10:00-12:00	**PIs and DeepVision**

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