Real Time Reservoir Data Transmission From the Menengai Field to Nakuru and Nairobi Office by Use of Fibre Optic and Radio Link

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Fiber optic, well head, radio systems, lip pressure

ABSTRACT

The practice of manual reservoir data collection is much debated and criticized because it is time consuming and expensive. Automation and real time data transmission from the Menengai Geothermal field will create a strong economic value for Geothermal Development Company. This paper will present the result of an integrated system that utilizes fiber optic technology and radio systems to provide real time reservoir data, to reservoir engineers and technicians in the comfort of their office both in Nakuru and Nairobi offices.

It will allow reservoir engineers to carry out any reservoir design within a short period depending on the output of the wells.

Introduction

Menengai Crater is a massive shield volcano inside one of the biggest calderas in the world, located in the Great Rift Valley inKenya, with a surface area of 90 sq km. Farmland occupies its flanks. Menengai is located 10 km northeast of Nakuru, the third-biggest town in Kenya. Its Elevation is 2,278 m (7,474 ft).

Why Carry Out Well Testing

Geothermal well testing plays a key role during exploration drilling, production well drilling, well maintenance and geothermal field monitoring. Quick analysis of testing results with interpretation of down-hole, pressure-temperature data to assist reservoir engineer in real time decision making .Computer modeling of geothermal reservoir production and injection history helps to improve estimation of reserves and make better informed decisions regarding well field development.

Online analysis is aimed at gathering information on well characteristics and production potential as well as reservoir properties and conditions. In real-time, immediate processing of data provides instant confirmation of a transaction. Real time operations creates a collaborative environment that enables faster, better decisions to be made about reservoir development. With real-time connectivity, well operations can be linked directly to

Figure 1. Well one discharge.

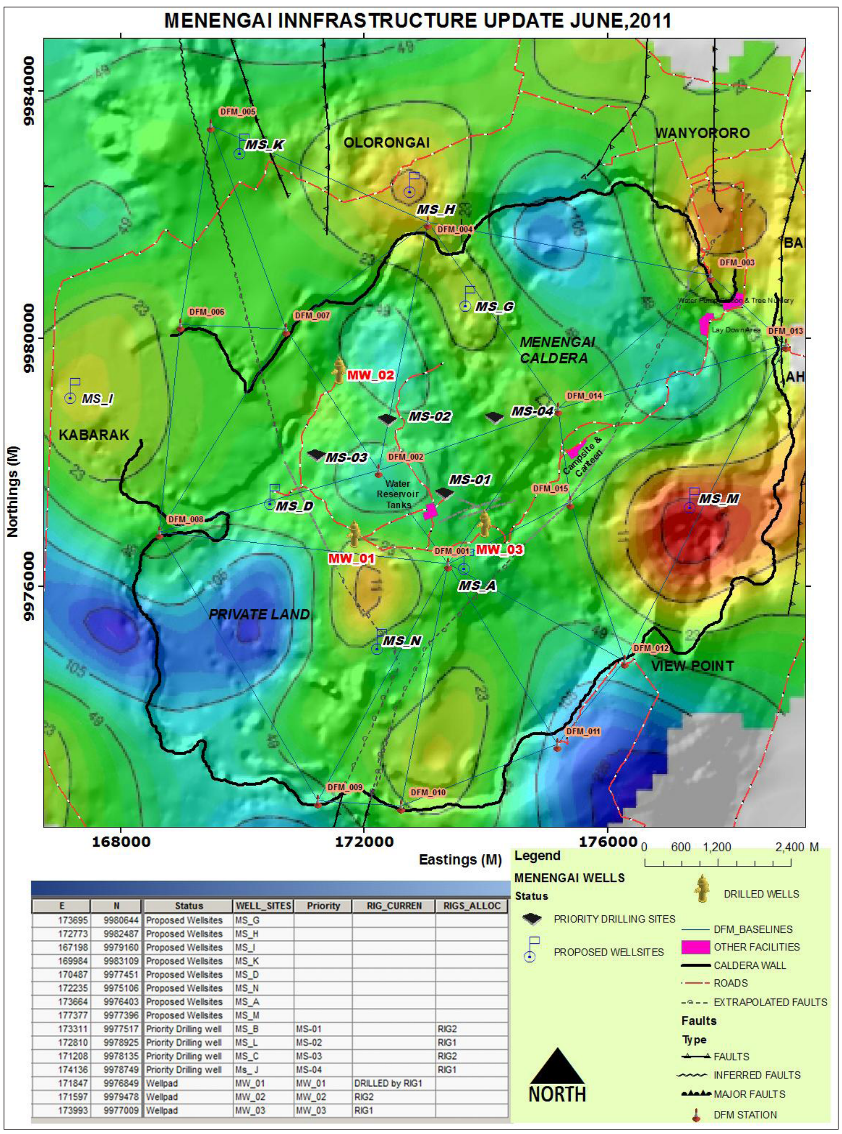
Figure 2. Menengai Crater.

remote real time operations Centers and Visualization Rooms or, through desktop connectivity, to offices and homes. This connectivity helps to create a virtual, collaborative team environment.

The technology foundation for information management continues evolving to multiple databases, structured (data) and unstructured (documents) data management, Web services, and portals. It's about building on technology advancements to provide an integrated and innovative solution that has real and measurable value to the GDC business. New client problems must now be solved, including the management of disruptive applications and growing data complexity, frequency, and volume.

Current Mode of Data Collection

After drilling has been completed and before the initial discharge, the well downhole conditions are measured using K10 geothermal electronic logging kuster tool which has an option of using a digital display or laptop attached to the USB port.



E	N	Status	WELL_SITES	Priority	RIG_CURREN	RIGS_ALLOC
173695	9980644	Proposed Wellsites	MS_G			
172773	9982487	Proposed Wellsites	MS_H			
167198	9979160	Proposed Wellsites	MS_I			
169984	9983109	Proposed Wellsites	MS_K			
170487	9977451	Proposed Wellsites	MS_D			
172235	9975106	Proposed Wellsites	MS_N			
173664	9976403	Proposed Wellsites	MS_A			
177377	9977396	Proposed Wellsites	MS_M			
173311	9977517	Priority Drilling well	MS_B	MS-01		RIG2
172810	9978925	Priority Drilling well	MS_L	MS-02		RIG1
171208	9978135	Priority Drilling well	MS_C	MS-03		RIG2
174136	9978749	Priority Drilling well	Ms_ J	MS-04		RIG1
171847	9976849	Wellpad	MW_01	MW_01	DRILLED by RIG1	
171597	9979478	Wellpad	MW_02	MW_02	RIG2	
173993	9977009	Wellpad	MW_03	MW_03	RIG1	

Figure 3. Map Showing the Menengai Area and the sites where wells have been drilled and where wells will be drilled in future.

Figure 4.

- Displays and records depth and line speed
- Depth Correlation
- 24MB non-volatile memory
- Real-time display
- USB interface

The current mode of data collection involves reservoir engineers and technicians working in shifts for more than forty eight hours and spending their nights at the well during the completion test. The process starts with a dummy run and then a profile run is done at intervals of 50 or 100 meters. Water is then pumped at given intervals before another profile is taken. The instrument is then left at a specified level for a period of time before the well is shut to give it time to build up.

Standard practice is to initially do an injection (or completion) test, that is sometime at a series of flows, where the temperature, pressure, and flow rate using a spinner tool are measured at intervals down the open hole section of the well. The well is then shut in an allowed to fully heat up. This can take less than four days for a steam well or more than six months for a deep well with poor permeability. The downhole condition during heat- up is measured at intervals. The well is shut in to minimize circulation so that conditions in the cased-off section can be measured and so that the gas column can depress the liquid in the well to the upper feed zone. The downhole measurement will reveal the production zones in a well because hot geothermal fluids circulating at the production zones will cause these areas to heat up faster. The pressure profile can reveal the water level in a well.

Once the well is fully heated, it needs to be discharged to rid it of geothermal drilling mud, fluid, and debris before the well can be put into service. The initial discharge is normally a vertical one due to the erosive nature of the materials. The well is then tested to determine its output characteristics that are the mass flow rate and enthalpy as a function of the wellhead pressure. Chemical sampling is also done during output test. These data are very important because they comprise the baseline information.

The well output can be measured by several methods. A method unique to the geothermal well test is the James lip pressure method. This method makes use of discharging two phase fluid at choked flow condition through an open pipe. By measuring the static “lip” pressure at the open end of the pipe, the flow rate can be determined from the correlating equation. The equation now is in several forms.

A well output is most accurately measured by the separator method. The well is discharged into a separator. The steam phase is measured in a stem pipe using an orifice plate and the water is measured by a weir plate in a weir box at the silencer.

There are other well such as downhole well pressure and temperature measurements that are normally done with the well on bleed. For the successful, safe operation and maximum utilization of a geothermal well, it is of imperative that the reservoir engineer observe the following four parameters for consecutive days;

1. Flow rate of steam.
2. Well heads pressure.
3. Lip pressure.
4. Weir flow.
5. Flow rate of the water being pumped into the well.

Geothermal wells need to undergo a test program before they are used. This is so that the baseline conditions of both the wells and the geothermal aquifers that they trap can be determined. This baseline data are critical because all the future information is compared against them.

The discharge of a well may interfere with the flow of a nearby well. Interference tests can be done by either measuring the downhole pressures or measuring the discharge from a well while a nearby well is discharging at different flow rates.

After enough wells have been tested to confirm the geothermal field’s capacity and suitability for the production of electricity, steamfield design needs to be carried out. This is to determine the best method for collecting the geothermal fluids and processing them.

Design Criteria for the Online Well Monitoring System

AIM

The aim is to provide a high-speed communications network connect the well to the desktop by use of a combination of fiber optic and radio link. These connections will allow high-speed transmission of data, video and voice through a secure network supporting all the important real time operations.

The improved ability to share knowledge with every team member, anywhere, anytime, helps improve real-time collaboration, decision making and results. In addition, eliminating travel to a wellsite helps save time and money and helps reduce travel and well site risks to health and safety.

The Various Methods Available That Can Be Used to Link Menengai With the Nairobi Office Via GDC Nakuru Office

– By use of existing infrastructure

- Which includes use of fiber optic cable which is available at the view point and can be leased from Telkom Kenya.
- By use of radio link transmitters and receivers which can be mounted on the existing masts available close to the view point and are owned by mobile telephone providers.
- Use of winlink which can also be mounted on the existing masts.
- By partly using Motorola canopy and the optic fiber optic cable already available. Motorola canopy uses infrared light as a medium for transmission and therefore has no annual cost payable to CCK.

The Challenge

Being able to locate the Base Station on a high site. Minimum 15 m. The terrain is rough and filled with wild animals especially snakes.

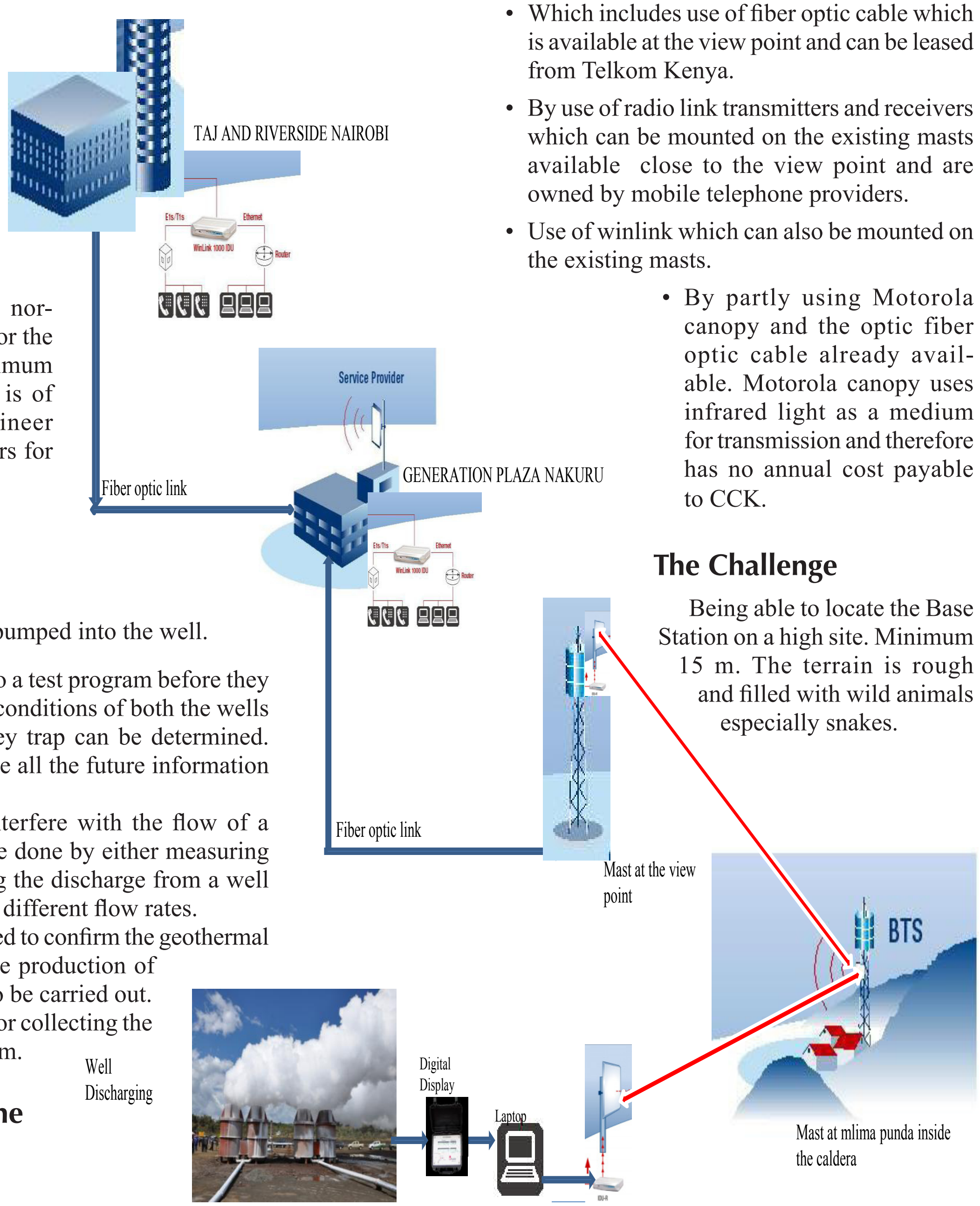


Figure 5. Graphic Presentation of Real Time Reservoir Data Transmission from the Menengai Field to Nakuru and Nairobi Office by use Fiber Optic and Winlink or Radio Link.

Cost and Timeline for Implementation

The entire network infrastructure is already in place. The only remaining part is the purchase of the software and the interfaces to be used at the well head. From our 2012/2013 budget which commences in July this year and we have a budget nine million Kenya shillings earmarked for the finalization of the project.

Simple, easy-to-use, Windows-based software enables the user to effortlessly collect, display, and analyze data. A variety of powerful tools can be used to examine, export, and print professional reports with just a click of the mouse.

Expected Sample's of Displays during Online Well Monitoring is shown in Figures 6, 7, and 8.

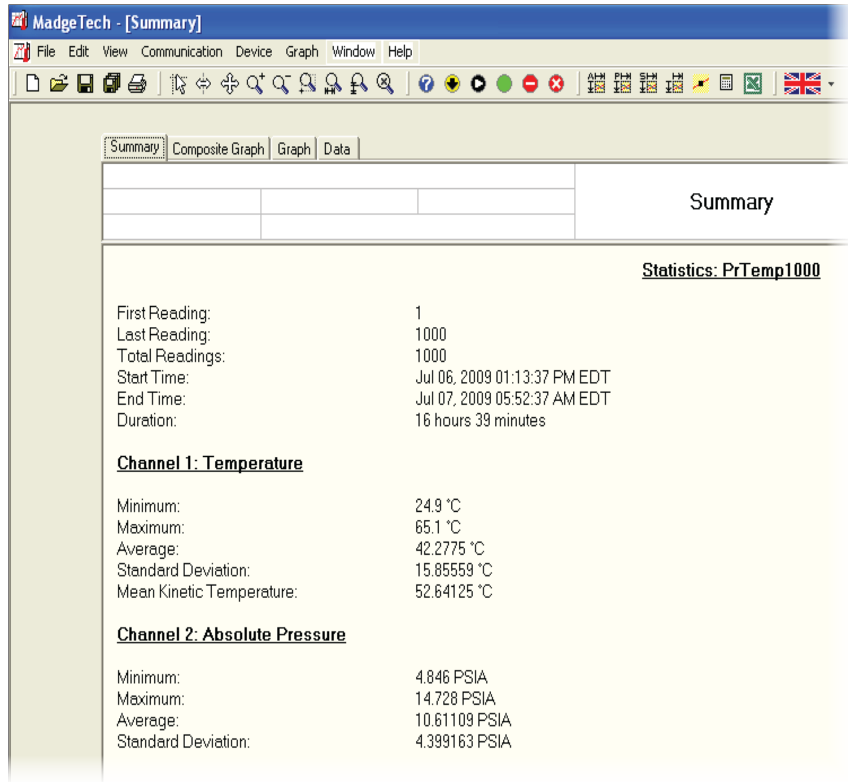


Figure 7. Summary of temperature and pressure sample data collected.

Validation of Results

- Real-time processing requires the master file to be available more often for updating and reference.
- Real-time processing has fewer errors than batch processing, as transaction data is validated and entered immediately.
- Infrequent errors may occur in real-time processing; however, they are often tolerated. It is not practical to shut down the system for infrequent errors.
- Steps in a real-time update involve the sending of a transaction data to an online database in a master file. The person providing information is usually able to help with error correction and receives confirmation of the transaction completion.
- Updating in real-time uses direct access of data. This occurs when data are accessed without accessing previous data items. The storage device stores data in a particular location based on a mathematical procedure. This will then be calculated to find an approximate location of the data. If data are not found at this location, it will search through successive locations until it's found. The information technology used could be a secondary storage medium that can store large amounts of data and provide quick access (thus the common choice of a magnetic disk). It requires a user-friendly software.

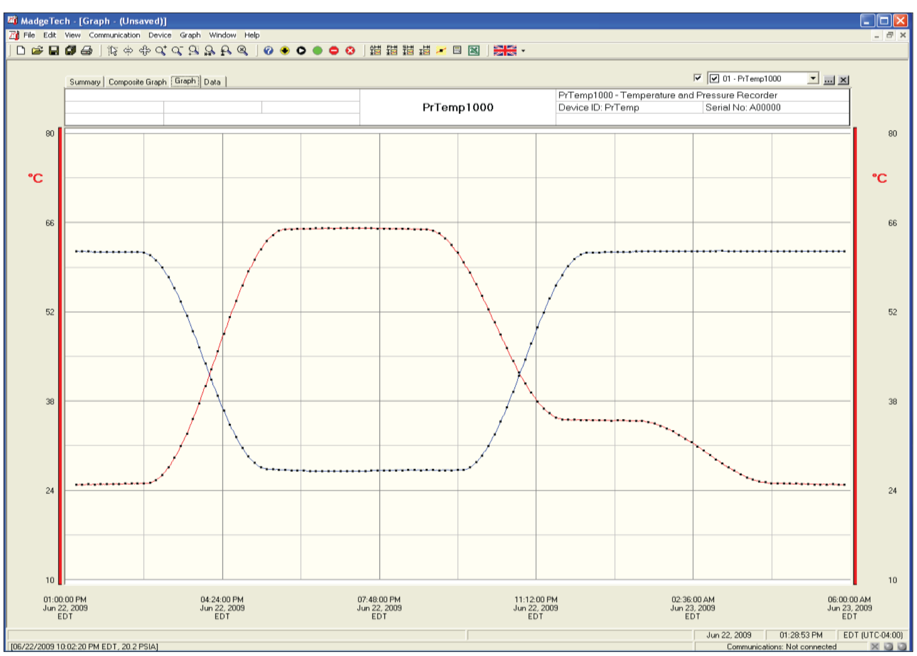


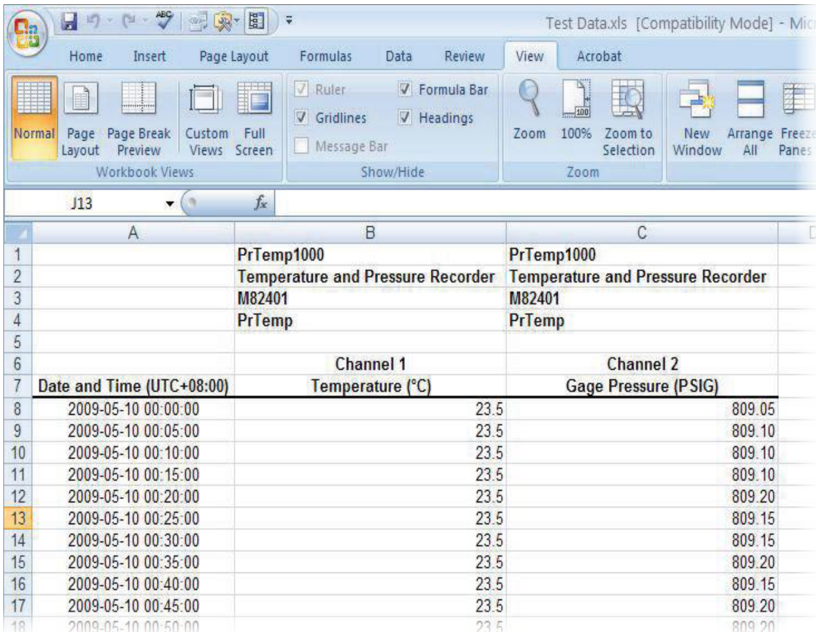
Figure 6. Sample of Pressure/Temperature Graph.

Security of the Data

- Will Use Secure Socket Layer (SSL) encryption.
- Will Requires user name, password and URL (Uniform resource locator).
- Will Operate on a secure fire wall.
- Will Allow authorized personnel to access all the well data through a GDC extranet portal.

Flexibility of the System

- View real-time data on any PC during all phases of well completion.
- Configure and combine displays to your preference.
- Save your preferred view to your profile.



	A	B	C
1		PrTemp1000	PrTemp1000
2		Temperature and Pressure Recorder	Temperature and Pressure Recorder
3		M82401	M82401
4		PrTemp	PrTemp
5			
6		Channel 1	Channel 2
7	Date and Time (UTC+08:00)	Temperature (°C)	Gage Pressure (PSIG)
8	2009-05-10 00:00:00	23.5	809.05
9	2009-05-10 00:05:00	23.5	809.10
10	2009-05-10 00:10:00	23.5	809.10
11	2009-05-10 00:15:00	23.5	809.10
12	2009-05-10 00:20:00	23.5	809.20
13	2009-05-10 00:25:00	23.5	809.15
14	2009-05-10 00:30:00	23.5	809.15
15	2009-05-10 00:35:00	23.5	809.20
16	2009-05-10 00:40:00	23.5	809.15
17	2009-05-10 00:45:00	23.5	809.20
18	2009-05-10 00:50:00	23.5	809.20

Figure 8. Sample of Online Temperature and Pressure Data Collected at an Interval of Five Minutes.

- Place server anywhere in the network.
- View and print numerous display types.
- Present data from any service provider.
- All design parameters are stored in one place.

Benefits of the System

- Collaborate with team members in real-time.
- Manage well site situations as they arise more intelligently.
- Make faster, smarter decisions.
- Participate in and control multiple operations from one location.
- Deploy expertise and resources more efficiently.
- Helps reduce travel and wellsite health and safety risk.
- Increased data processing and reporting efficiency.
- Improved reservoir test planning.
- Reduced data processing time.
- Standardized reports.
- Data quality and consistency checks.
- Simulation software to check the calculated data trend and create a model for further reservoir simulations.

Functionality of the System

- Access your real-time data with a single click.
- Compare real-time data against offset wells.
- Download data as plots, tables, charts, text, gauges, etc.
- Use a single web server to manage data from multiple wells.
- Request e-mail or pager notification of user-selected events.

Online Realtime Reservoir Data System Can Also Be Used When Conducting

Interference Test

The discharge of a well may interfere with the flow of a nearby well. Interference tests can be done by either measuring the downhole pressures or measuring the discharge from a well while a nearby well is discharging at different flow rates for a given period of time.

After enough wells have been tested to confirm the geothermal field's capacity and suitability for the production of electricity, steamfield design needs to be carried out. This to determine the best method for collecting the geothermal fluids and processing them.

Reservoir Seismic

Reservoir seismic services are crucial to the delineation, discovery, quantification, and monitoring of a reservoir through its entire lifecycle. Online data acquisition will provide the high-quality data required to optimize geophysical analysis. By repeating well seismic surveys over time experts can discern and continue to monitor changes in the reservoir caused by fluid movements from injection and production operations.

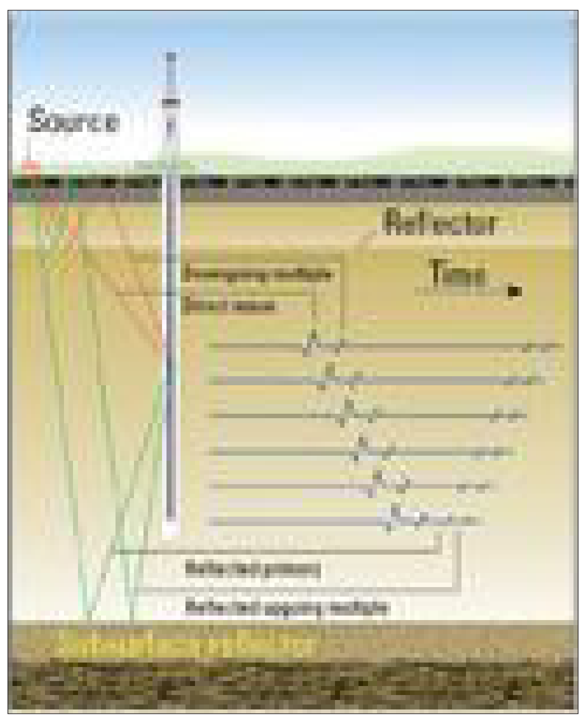


Figure 9. A reservoir seismic setup.

4D Seismic Technology

The time-lapse, or 4D, seismic method involves acquisition, processing, and interpretation of repeated seismic surveys over a producing Geothermal field. The objective is to determine the changes occurring in the reservoir as a result of steam production or injection of water or air into the reservoir by comparing the repeated datasets. A typical final processing product is a time-lapse difference dataset (i.e., the seismic data from Survey 1 is subtracted from the data from Survey 2). The difference should be close to zero, except where reservoir changes have occurred.

- Video conference at all the 12 rigs and hired rigs in Olkaria.
- Integrate a GSM system on all the 12 rigs which will transmit short text messages to senior managers and engineers in drilling when major alarms occur.

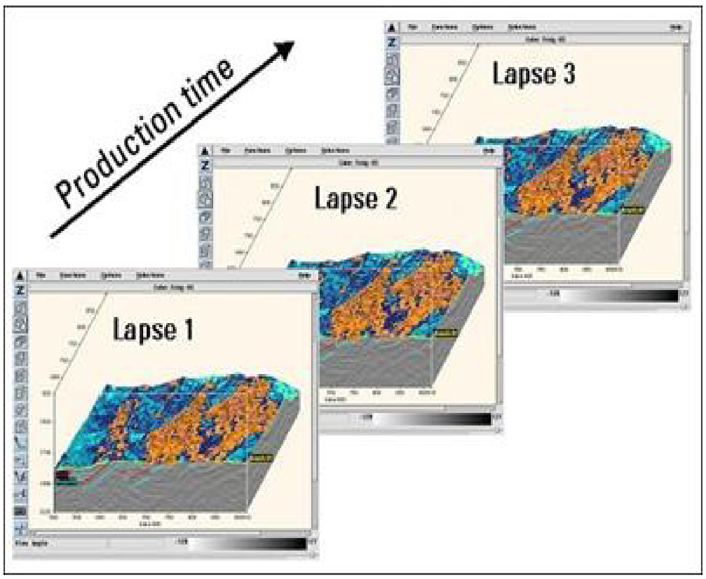


Figure 10. 4D Seismic Technology.

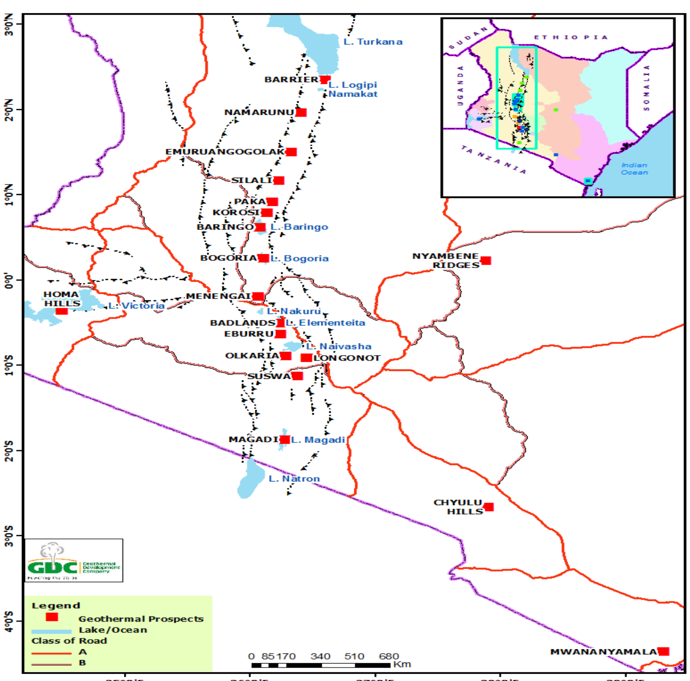


Figure 11. Geothermal Steam Production Fields.

- Future is to also to provide full-mesh network capability and support dynamic routing across the network. To include all the geothermal areas shown in the map below and to be controlled from one central control point in Nakuru or Nairobi.
- Provides voice and IP-based data services to all GDC Geothermal.
- Supports intranet/extranet/VPN technology.
- Deliver ERP and e-mail access to remote sites.
- Include ccvt on all the rig sites for security.
- Remote video monitoring allows you to watch your drill sit go downs pipe yards, and office assets, via cameras remotely, and in real time, from another location such as the Nakuru office or Nairobi office.
- The system should be fully integrated into GDC wide area network.

Conclusions

In summary, real time reservoir data transmission from the Menengai field to Nakuru and Nairobi office by use fiber optic and winlink or radio link improves on maximum utilization of steam production from the well reservoir and ensures accurate and precise design of steam line and well head for the purpose of Power generation. To automate the menengai reservoir data is a simple and inexpensive solution to improve on steam production and utilization. This will help us achieve our objective economically. Online accurate downhole, pressure, temperature, permeability or productivity will increase our confidence in reservoir characterization. The reservoir information obtained will save time and allow us to update our reservoir model

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References

Winlink TM1000 Broadband wireless transmission system. User manual and installation guide. Version 1.75 pg 13-21.

Motorola canopy wireless broadband internet access platform. October 2002 configuration guide pg 2- 13.

Kuster production logging tool (KPLT) Manual pg 1.

Geothermal Reservoir Engineering (second edition) copyright © 2011 elsevier inc. pg 6- 10.

Motorola wireless Networking solutions catalog pg 2- 15.

GoldenGate software inc. "real-time data integration for data warehousing and operational BI. By GoldenGate software white paper san Fransisco Ca. pg 16-17.

IBM infospere change data capture "data sheet" pg 10- 11.

Wireline open hole services by Schlumberger 2011.