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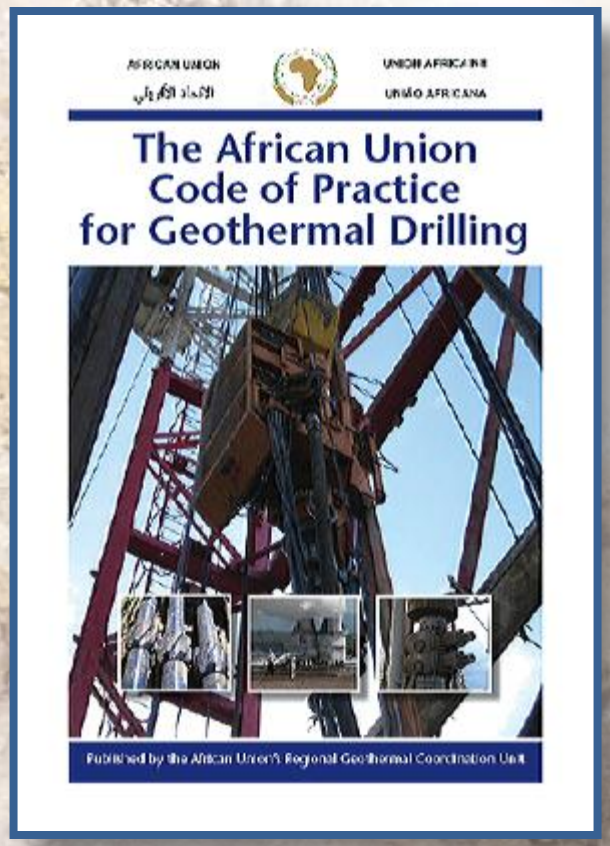


# Best Practices in Geothermal Drilling

African Union

BGR Bundesanstalt für Geowissenschaften und Rohstoffe

June 13-14, 2018
Addis Ababa, Ethiopia

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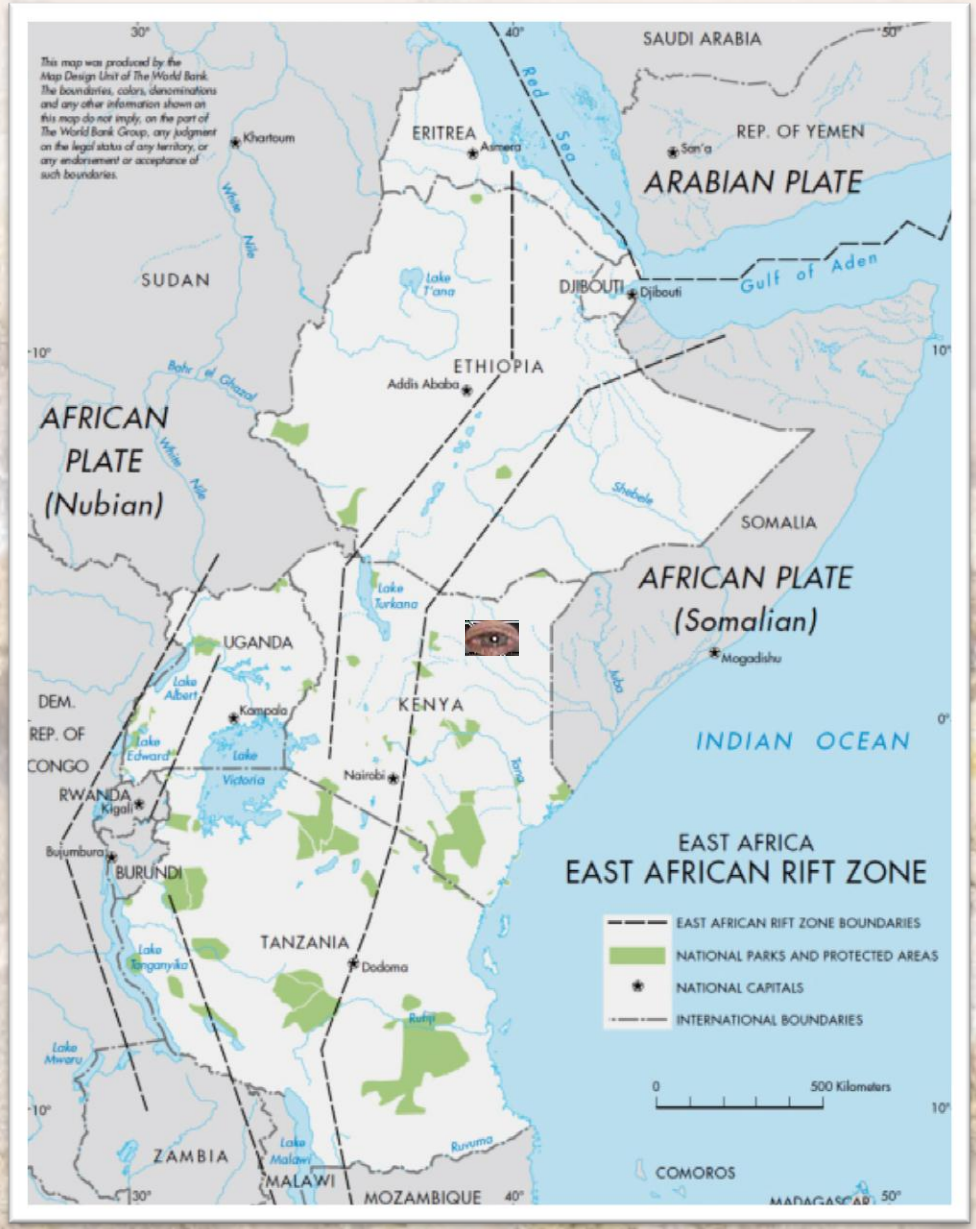
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Shebele
SOMALIA
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0
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ZAMBIA
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Ruvuma
COMOROS
MALAWI
MOZAMBIQUE
MADAGASCAR

# Introduction

1. What are the areas we will try to cover during the next few days?
2. What we hope to accomplish during these next few days?

# Introduction

(Continued)

3. Background: Why we are here and what led to the holding of this workshop?
   - Lake Navisha, Kenya Workshop
   - Entebbe, Uganda Workshop
   - New Zealand Code of Practice

# Introduction

(Continued)

4. Why is the regulation of geothermal drilling important?
5. What are the primary functions of a Code of Practice?
6. What is the role of the legal, institutional and regulatory framework and why is it so critical to development.

# Introduction

(Continued)

7. What information must be acquired during drilling operations and how will that information be managed to provide greatest benefit to both the developer and to the country where the operations are taking place?

The speakers will be providing lectures over the next few days that will provide insights into:

- Why the establishment of a robust legal, institutional and regulatory framework is essential;
- Planning and conducting drilling operations; and
- The importance of data acquisition and management.

Why do we see a tremendous increase in interest in the  develop of geothermal resources throughout East Africa?

The drivers have been:

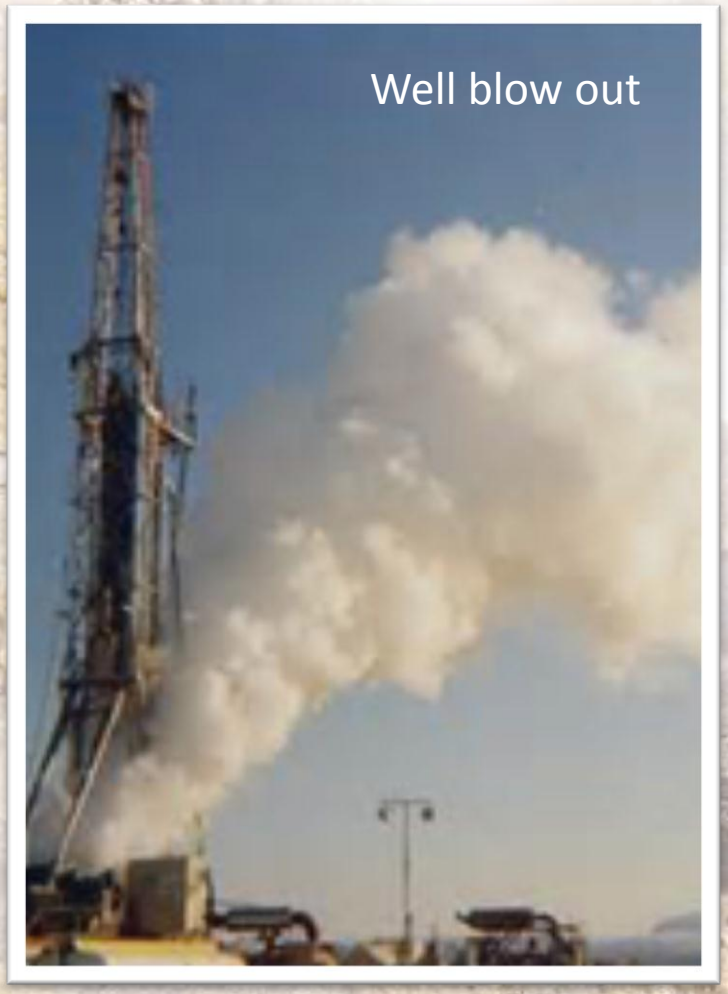
- Expansion of Olkaria
- ARGeo support and coordination
- GRMF Grants


Olkaria

# And in Ethiopia…

- The World Bank
- Japan International Cooperation Agency (JICA)
- French Program
- New Proclamation
- Negotiated Power Purchase Agreement
- Rules and Regulations

Olkaria




Such a situation could bring serious negative consequences to the entire region if drilling activities are not properly conducted, as well as the loss of tremendously valuable geologic/geothermal information that can only be obtained at the time of drilling.

At this time, there appears to be little appreciation for the risks that geothermal drilling can present.

# Safety

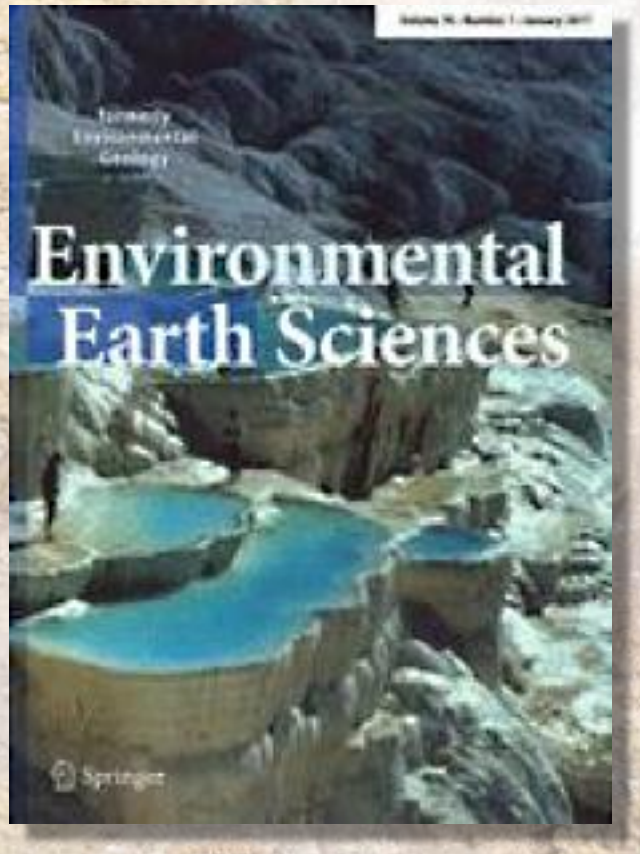
Los Angeles Times

June 15, 1991

## Blowout Shuts Geothermal Unit in Hawaii

Hawaii state officials ordered a geothermal company to halt all drilling Friday after a well blowout spewed toxic gas and routed 75 people from their home on the island of Hawaii.

# More Recent Safety




January 2017

## Blowout mechanism of Alasehir (Turkey) geothermal field and its effects on groundwater chemistry

Alasehir is the most important geothermal site in western part of Turkey. Many geothermal wells have been drilled in Alasehir Plain to produce the geothermal fluid from the deep reservoir in the last 10 years. **A blowout accident happened during a geothermal well drilling operation in Alasehir Plain, and significant amount of geothermal fluid surfaced out along the fault zone in three locations. When drilling string entered the reservoir rock about 1000 m, blowout occurred….**

In addition to safety concerns, we could also experience numerous failed drilling projects if drilling operations are not carried out using best practices.

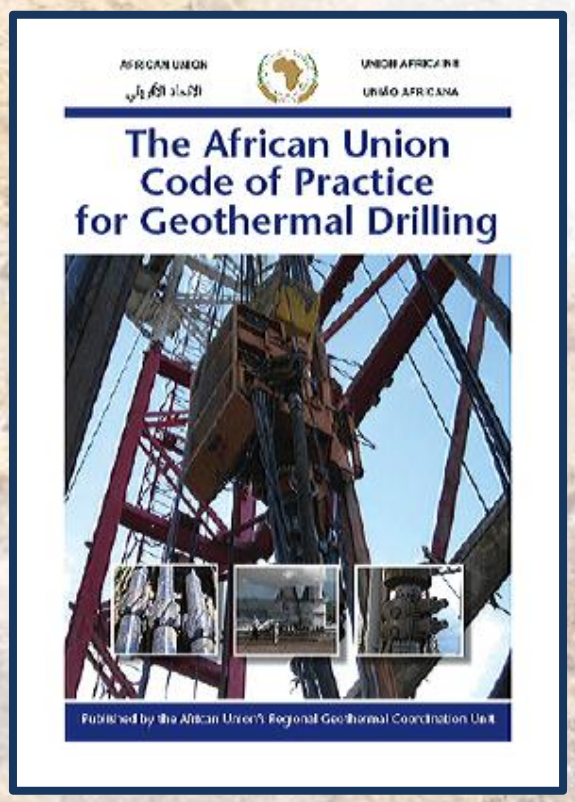
Today there is an almost total lack of understanding of the benefits of regulations that apply to geothermal exploration and development.

And up until now there has been no real uniformly accepted source of guidance as to what constitutes best practices.

And…

…unfortunately, a lack of understanding and appreciation for the benefits that data acquisition can provide in siting and drilling wells or to the contribution that such data can provide to the national geologic/geothermal data base and thus to further facilitating national and regional geothermal development aspirations.

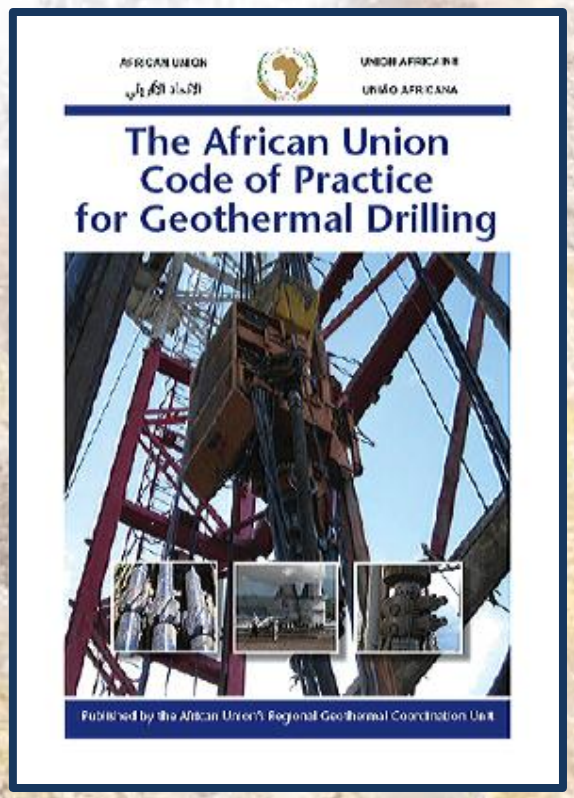
# So How Did We Get Here?



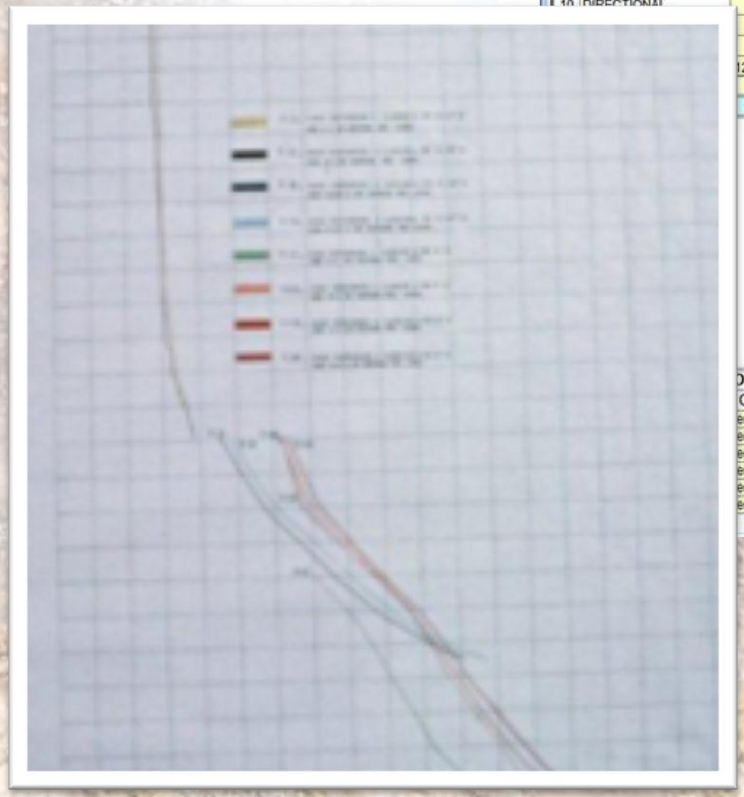

- GRMF discovered need
- Lake Navisha workshop
- Entebbe workshop
- New Zealand Code of Practice
- AUC Code of Practice for Geothermal Drilling

# The African Union Code of Practice for Geothermal Drilling can play an important role in terms of providing for:

**Health, safety** and **environmental protection,** …



**…data acquisition, storage and management,** and...



DAILY DRILLING SUMMARY

JAPAN ENERGY DEVELOPMENT — NAKAJYO FIELD

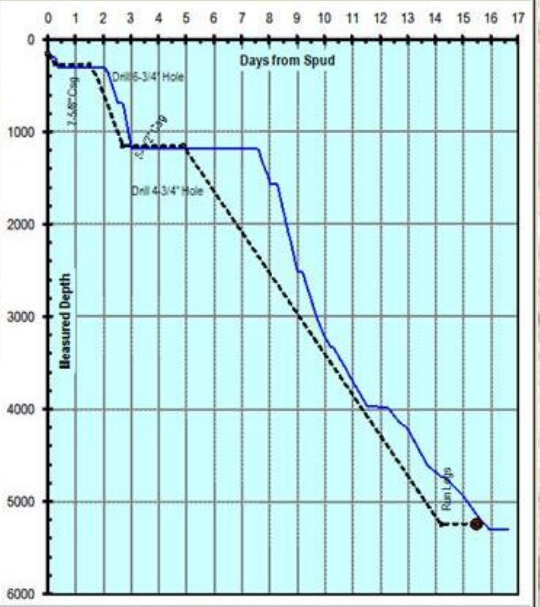
| WELL NAME | DATE | RIG | DAILY COST | $70,910 | DAYS from SPUD | 20.0 |
|---|---|---|---|---|---|---|
| Real Example #1 | 31-Oct-1998 (06:00) | NED Sunrise | CUM COST | $837,402 | DAYS on SITE | 26.0 |
| | | | AFE TOTAL | $1,270,000 | AFE DAYS | 20.5 |

| HOLE DRILLED | NA | WELL TYPE | Straight | PLANNED TD | 5,249 | GL | | DRLG. REP(s) | Mr. Wade Davis |
|---|---|---|---|---|---|---|---|---|---|
| CURRENT MD | 5,299 | SPUD DATE | 11-Oct-98 (07:00) | PBTD | New Well | KB | | | |

EXECUTIVE SUMMARY: Plug and abandon well. All equiment off location on 30-Oct. FINAL REPORT.

TIME DISTRIBUTION

| | | Planned | Not |
|---|---|---|---|
| 1. | MOB/DEMOB | | |
| 2. | DRILLING | | |
| 3. | BIT TRIPS | | |
| 4. | HOLE CONDITIONING | | |
| 5. | MUD SYSTEM | | |
| 6. | PIPE HANDLING | | |
| 7. | CASING OPS. | | |
| 8. | PRESSURE CONTROL | | |
| 9. | RIG | | |




| Code | Additional Remarks (if necessary) |
|---|---|
| ent Ops. | Continue RIH. Tag cement at 334m. |
| ent Ops. | Circulate., POOH with scraper., Make up EZSV and RIH. |
| ent Ops. | Circulate. |
| ent Ops. | Set EZSV at 306m. Test to 30 ksc. |
| ent Ops. | Displace mud with water., POOH laying down drill pipe. |
| ent Ops. | Nipple down BOP's. |

…**successful well drilling, completion, testing,** and **long-term production**.

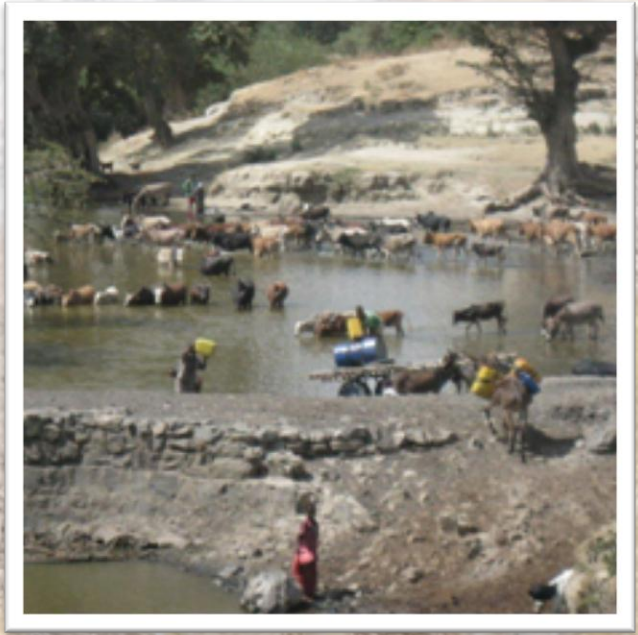
## Safety for:

Drilling crews and associated personal, including regulatory personal and visitors to the site, and for local inhabitants, and their livestock.

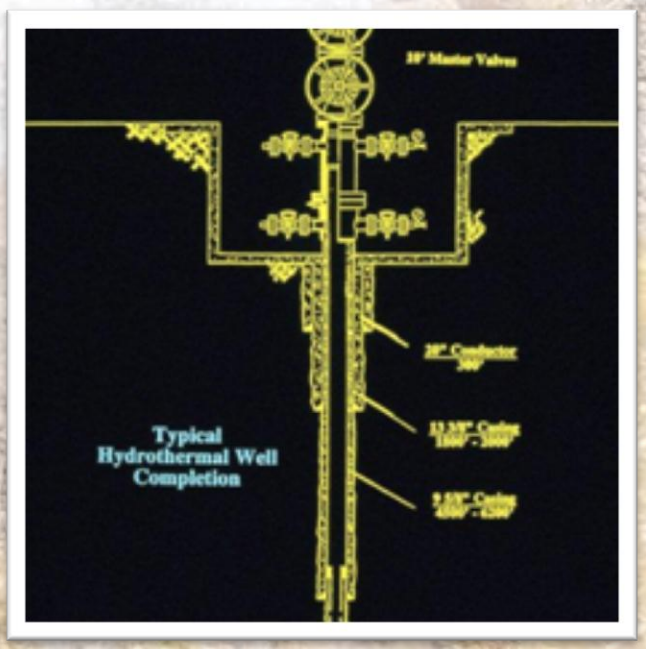
# Environmental protection for:

Surface water – rivers, streams, lakes and ponds, and…

…ground water, as a source of domestic water, as well as water for livestock watering and irrigation.

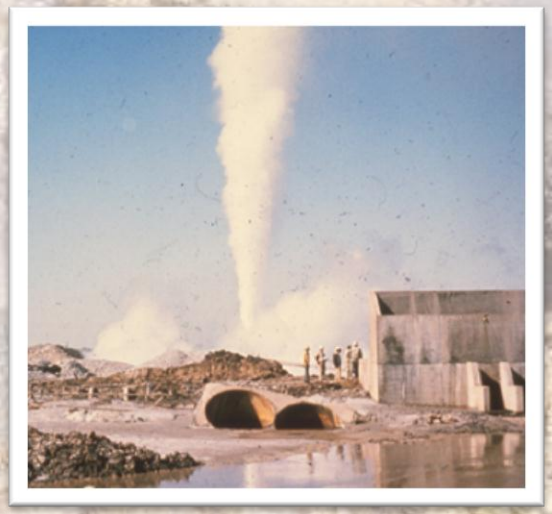


The **African Union Code of Practice for Geothermal Drilling** can help ensure that well drilling and completion is done in the best and safest possible manner.



Proper casing and cementing of the well during construction can ensure protection for surface and groundwater for the life of the well.

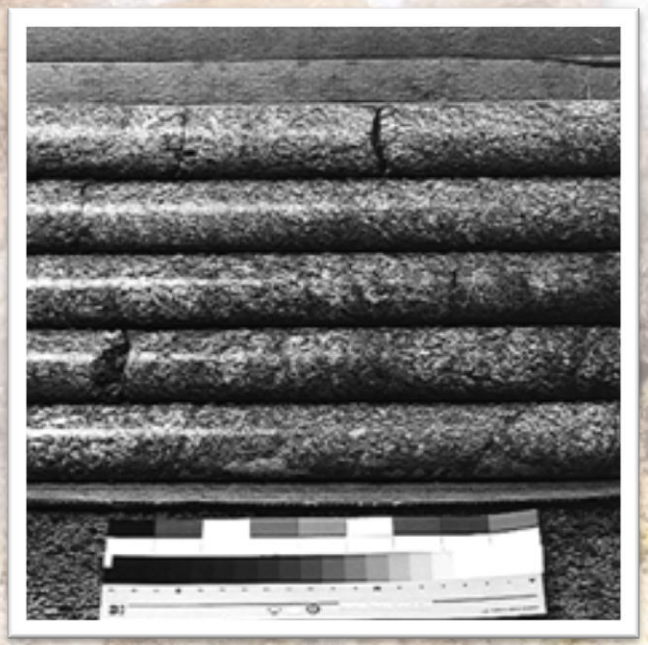
Unfortunately many consequences of geothermal drilling activity exist far into the future – for as long as a well is in active (or in standby mode) – and ultimately until it is properly plugged and abandoned. In fact, the decisions made during drilling and well completion will have long-term implications.



But the **African Union Code of Practice for Geothermal Drilling** goes far beyond simply providing for safety and environmental protection. It can be equally important in ensuring that data acquisition and retrieval from drilling and well testing operations is obtained and maintained as an important tool in designing future drilling operations and as an addition to the national geological/geothermal data base.

This includes – for example – information obtained from drilling operations, as well as from:

- Well cores
- Wireline logs
- Mud logs
- Well test results



This information can prove to be extremely beneficial in better defining the geothermal potential of an area and in constructing conceptual models of the subsurface that are so critical to well siting and well targeting – and eventually to reservoir maintenance, including the drilling of make-up wells.

It is our responsibility to ensure that all wells are drilled based on best practice in all aspects of drilling from early planning through casing and cementing, well completion, well testing and well operation.

All too many wells are lost, under perform or suffer an early “death” when best practices are not followed.

The role of each and every one of us involved in the geothermal industry is to:

**Make every possible effort to employ best practices in every aspect of exploration, drilling and production. If everyone does so, the industry will enjoy greater success and the people throughout East Africa will be the real beneficiaries of the efforts.**

However, the **African Union Code of Practice for Geothermal Drilling** will not have a positive impact on the development of geothermal projects unless the required legal, institutional and regulatory framework is not well established.

This framework must include:

- Secure access to the resource through granting of concessions and exploration/development licenses
- Availability of required environmental permits and drilling licenses

And…

- Reasonable Feed in Tariff (FIT) and Power Purchase Agreement (PPA)
- Attractive tax policy
- And much more

Development of a robust legal, institutional and regulatory framework is critical if the **private sector** is to play an ever increasing role in African geothermal developments.

From the Financier's perspective, regulatory risk is as important as resource risk in determining where to invest capital. Serious delays caused by delays in securing the required permits and licenses will have a serious negative impact on project implementation and thus it's ability to generate revenue.

And as much energy and resources should be devoted to creating such a framework as you give to other aspects of geothermal development. If not, the best designed and implemented exploration and drilling programs will have little impact on geothermal development.

# Why a Robust Legal and Regulatory Framework is Essential

**Investments are tied up for long periods of time**

- Development timeframes are long:
  - ✓ 2 - 3 years to resource discovery
  - ✓ 5 - 7 years from exploration to power on line
- Private sector developers/financiers cannot/will not invest where regulatory risk is a major concern and returns-on-investment is not assured, even if the resource is viable.

**High front end costs before generating revenue**

Reservoir confirmed costs can be 30 – 50 million USD and extend over and extended period of 3 to 5 years.

**Given lengthy timeframes and high initial costs**

Investors/developers will not undertake deep well drilling and project development without

- An off-taker agreement with a reasonable tariff and agreeable terms in the PPA are a prerequiste
- A robust and equitable legal and regulatory framework
- A regulatory process that is easy to navigate
- Regulatory responses within reasonable timeframes

## Clear Goals, Legal and Regulatory Framework are Critical

**Key Steps:**

- Adopting a geothermal Proclamation (Law)
- Implementing a clear regulatory framework for the timely granting of concessions and licenses
- Developing a model PPA
- Develop FIT
- Develop Power Plant operational licenses

# Hierarchy of Laws | Regulations | Directives

## Laws

- Define terms
- Create institutions
- Establish institutional responsibilities
- Establish basic framework for government roles and responsibilities
- Enacted by Parliament
- Difficult to amend

COMPLETED

# Hierarchy of Laws | Regulations | Directives

## Regulations

- Provide framework for licensing and development
- Adopted by ministry or responsible agency
- More easily amended
- Force of law
- May be relied upon by developers and regulators

ALMOST COMPLETED

# Hierarchy of Laws | Regulations | Directives

## Directives

- Identifies specific processes, requirements, standards for development
- Crafted by ministry or agency
- Flexibility – May be changed
- Useful in providing guidance to regulators and developers
- Some level of discretion by regulators
- Often reflecting state-of-the-art in technology

# Overview of Regulatory Framework: Drilling

- General guidance and standards are established in regulations
- Regulation references requirements in **African Union Code of Practice for Geothermal Drilling**
- To assure projects meet standards, review processes required at several stages
- **As regulatory staffing and institutions are built up, a peer review process** ensures appropriate technical review and approval of drilling plans and design

# Drilling Plan of Development

**Reduces financial entities' risk by ensuring developer considers key issues early in the process**

- Overall program of the infrastructure and facilities proposed for development of the project
- Roads, pipelines, wells, sumps, water source development and water storage facilities
- Health and safety plan
- Baseline environmental information

# Drilling Program

- Describes how the Licensee will drill for and test the geothermal resources covered by its license
- May include multiple locations where the Licensee proposes to drill within the license area
- Describes the number of well pads and number of wells that are anticipated to be developed

*Continues…*

# Drilling Program

*Continued*

- Reviewed by Licensing Authority with health and safety authorities
- Assures protection of community and environment
- Must provide sufficient information to assess environmental and social impacts, including:
  - ✓ Well pad layout and design
  - ✓ A description of existing and planned access roads
  - ✓ A description of other facilities/infrastructure required, i.e., water supply

*Continues…*

# Drilling Program: Requirements

- Social and community assessment, safety safeguards, any other information the Licensing Authority may reasonably require

# Well Design Plan

- Must conform to the provisions of the **African Union Code of Practice for Geothermal Drilling** and/or directives
- Submitted for each individual well
- Provide sufficient information to determine the suitability of the design including:
  - ✓ Description of the geologic target
  - ✓ Any proposed directional drilling
  - ✓ Detailed casing program and materials

# Data Management

**Good data management is essential to reduce resource risk**

- Establish consistent standards for data collection, reporting, analysis
- Build databases that can be accessed upon request
- Establish standards/limitations on protection of developer data and proprietary information
- Provide processes to allow access to data

# Keys to Success: Reducing Regulatory Risk

- Establish clear legal and regulatory requirements and institutions
- Incorporate best practices
- Require current drilling standards: **African Union Code of Practice for Geothermal Drilling**
- Establish Advisory Committee to support regulators as needed, as the government builds capacity

*Continues…*

# Keys to Success: Reducing Regulatory Risk

*Continued*

- Establish peer review process to support regulatory decision-making at critical decision points
- Data management and careful documentation support resource development long-term
- Support capacity-building at a regional level

I hope that each of you will find the next few days to be both informational and technically beneficial to you as you consider the need to employ best practices for geothermal drilling.

Thank You!

**R. Gordon Bloomquist, Ph.D.**

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Geothermal Scientist

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