Djibouti Geothermal Project

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Reykjavik Energy Invest

Gestur Gíslason

Reykjavik Geothermal

Second African Rift Geothermal Conference (ARGeoC2)

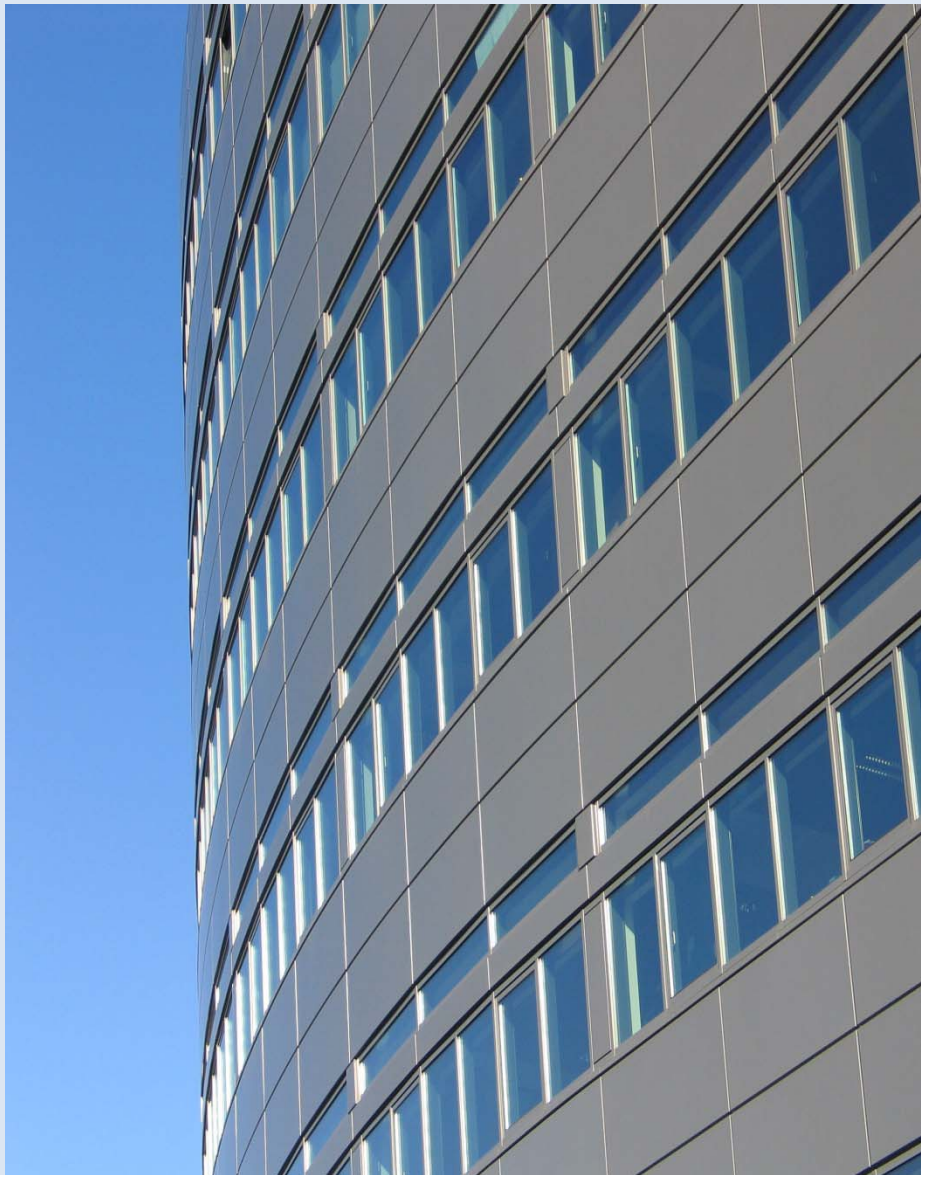
Geothermal Energy for Sustainable Development

24th – 28th November 2008

Entebbe, Uganda

Reykjavik Energy

- Reykjavik Energy is the largest geothermal utility company in Iceland, and one of the largest geothermal companies in the world
- The company provides electricity and hot and cold water to its customers
- Currently the company produces 330 MW of electric power and 1000 MW of thermal power from geothermal sources.
- In the near future about 100 MW electric will be added annually



Reykjavik Energy Invest

- Reykjavik Energy Invest (REI) is Reykjavik Energy's international business development and investment arm.
- REI focuses on creating partnerships to develop geothermal areas.

Reykjavik Energy Invest

Building of 50 MWe Power Plant at the Assal area in Djibouti.

Project status:

- **Pre-feasibility study finished in may 2008**
- **The project is now in the feasibility study phase**
- **Presentation of EMP for the feasibility study in September 2009 – final report finalized**
- **Financing of feasibility study expected to be closed in the first quarter of 2009**
- **Negations with drilling companies in Iceland and China**

Building of 50 MWe Power Plant at the Assal area in Djibouti.

Next steps:

- **Civil work, drilling of shallow wells and other preparation**
- **Drilling of 3 deep wells at site**

Time schedule

- **Exploration drilling expected to be finished late 2009**
- **Designing and building of the Power Plant in 2009 to 2012**
- **Production of electricity expected to begin in late 2012**

Pre-feasibility study: The Assal Area

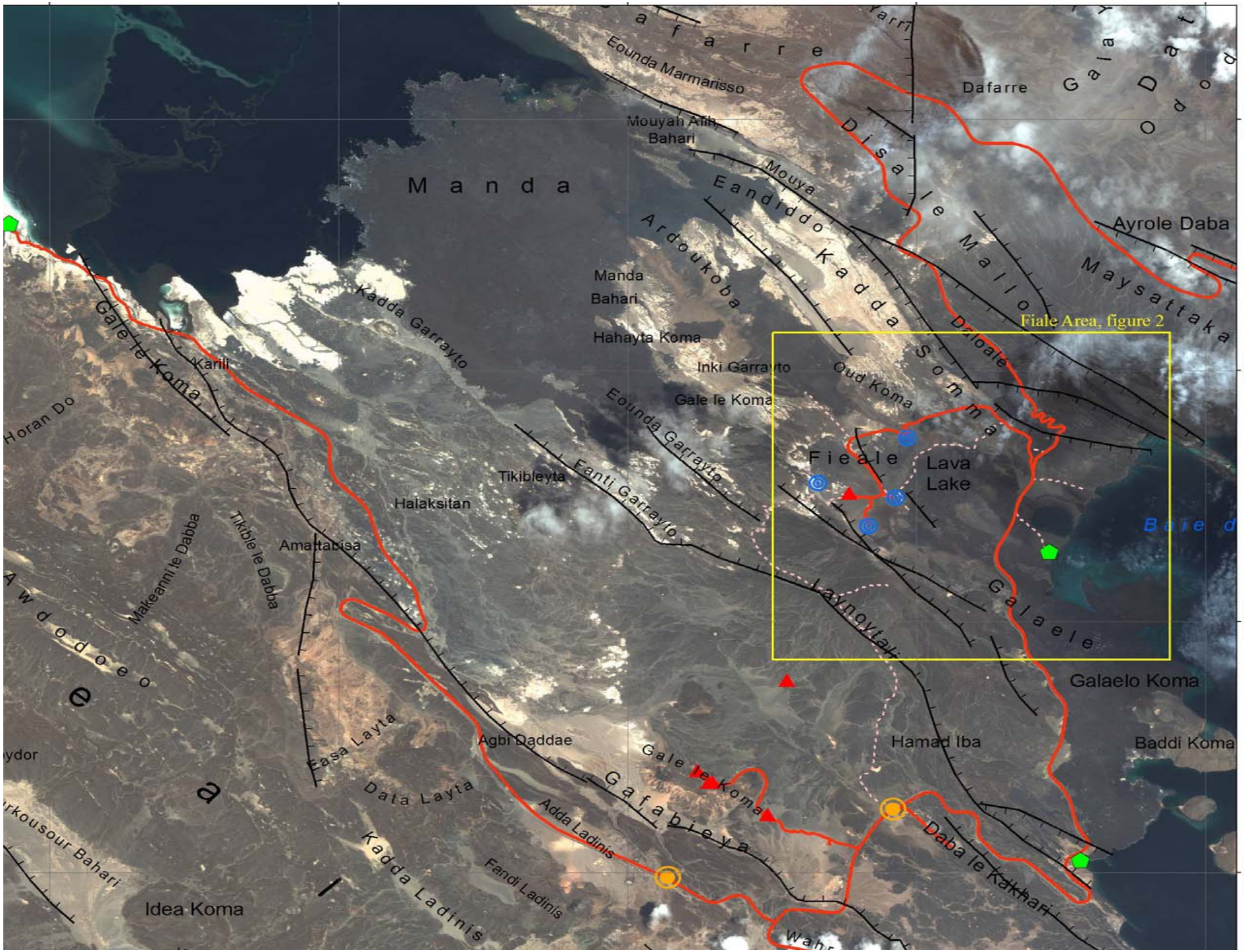
- The Assal Area is a volcanic field in the Afar rift, the last eruption occurred in 1978
- A geothermal resource is demonstrated by fumaroles and hot springs

Previous studies

- Donor funded projects in the 1980s:
  - Limited surface exploration
  - Drilling of 6 deep wels
  - Well testing
- The reservoir fluid encountered is very saline brine, Cl level three times that of the sea
- Downhole temperature found in excess of 360°C

REI in Djibouti

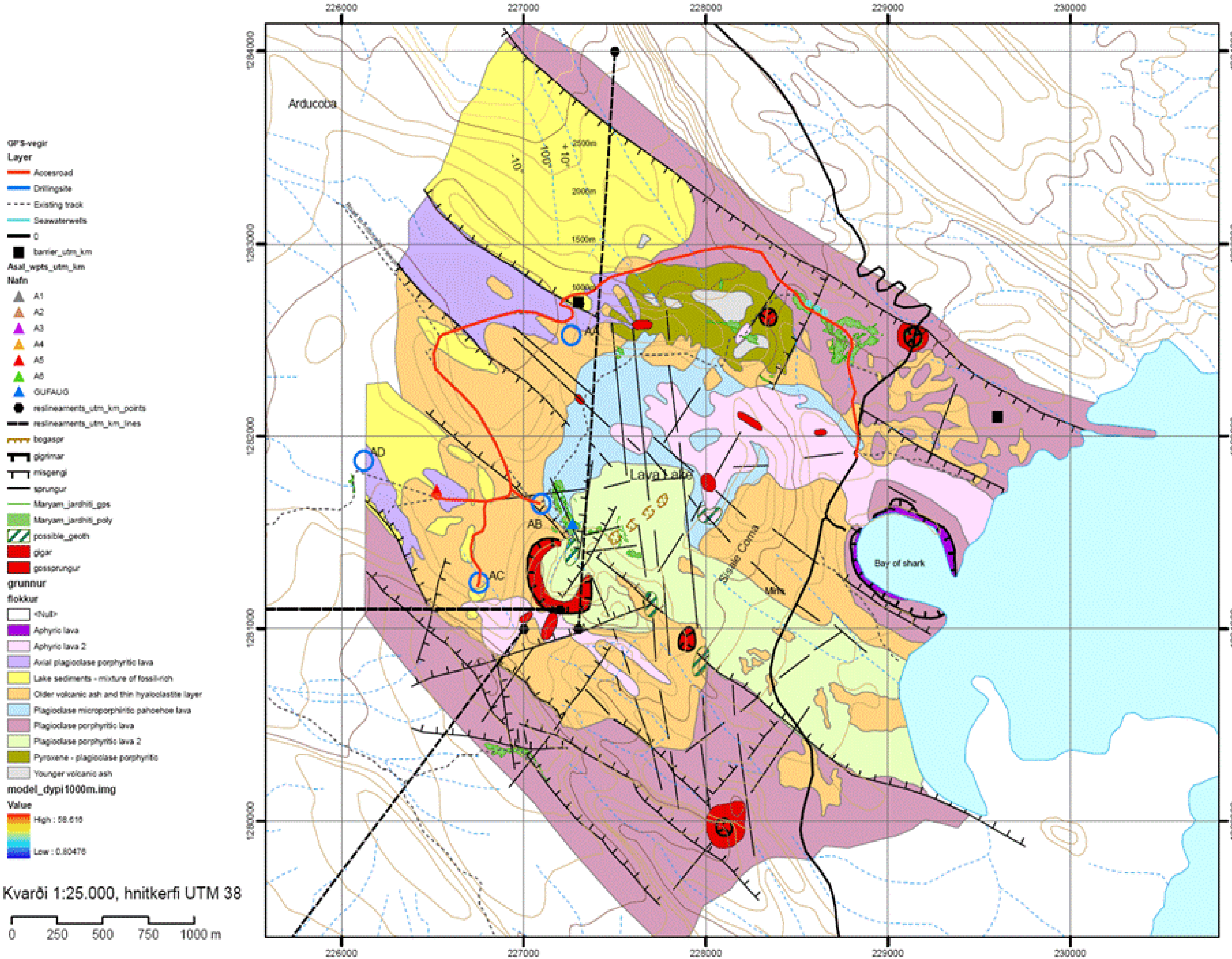
- A contract granting a temporary exclusive license for geothermal utilization in the Assal Rift area between the Government of the Republic of Djibouti and Reykjavík Energy was signed on 29 February 2007.
- An exploration permit was issued by the Djibouti Minister of Energy and Natural Resources on May 23rd 2007.
- The concession area covers 750 km².


Eounda Marmarisso
Mouyah Afili Bahari
Mouya
Manda
Dafarre
Ayrole Daba
Manda Bahari
Hahayta Koma
Inki Garrayto
Oud Koma
Gale le Koma
Karili
Kadda Garrayto
Eounda Garrayto
Fanti Garrayto
Tikibleyta
Halaksitan
Amattabisa
Tikible le Dabba
Makeanni le Dabba
Fiale Area, figure 2
Fiale
Lava Lake
Galaele
Galaelo Koma
Hamad Iba
Baddi Koma
Agbi Daddae
Gale le Koma
Gafabieya
Adda Ladinis
Fandi Ladinis
Kadda Ladinis
Data Layta
Hasa Layta
Daba le Kakhari
Idea Koma
Horan Do
11°38'N
11°36'N
11°34'N
11°32'N

First stage of REI project

- Review of older studies (from 1970's to 1980's)
- Additional geo-scientific studies
  - Contractor: Iceland Geosurvey (ISOR)
  - Period: October 2007 to January 2008
  - Methods: Geology and geophysics
  - Results: Pre-feasibility report


Main fumarole area


GPS-vegir
Layer
Accesroad
Drillingsite
Existing track
Seawaterwells
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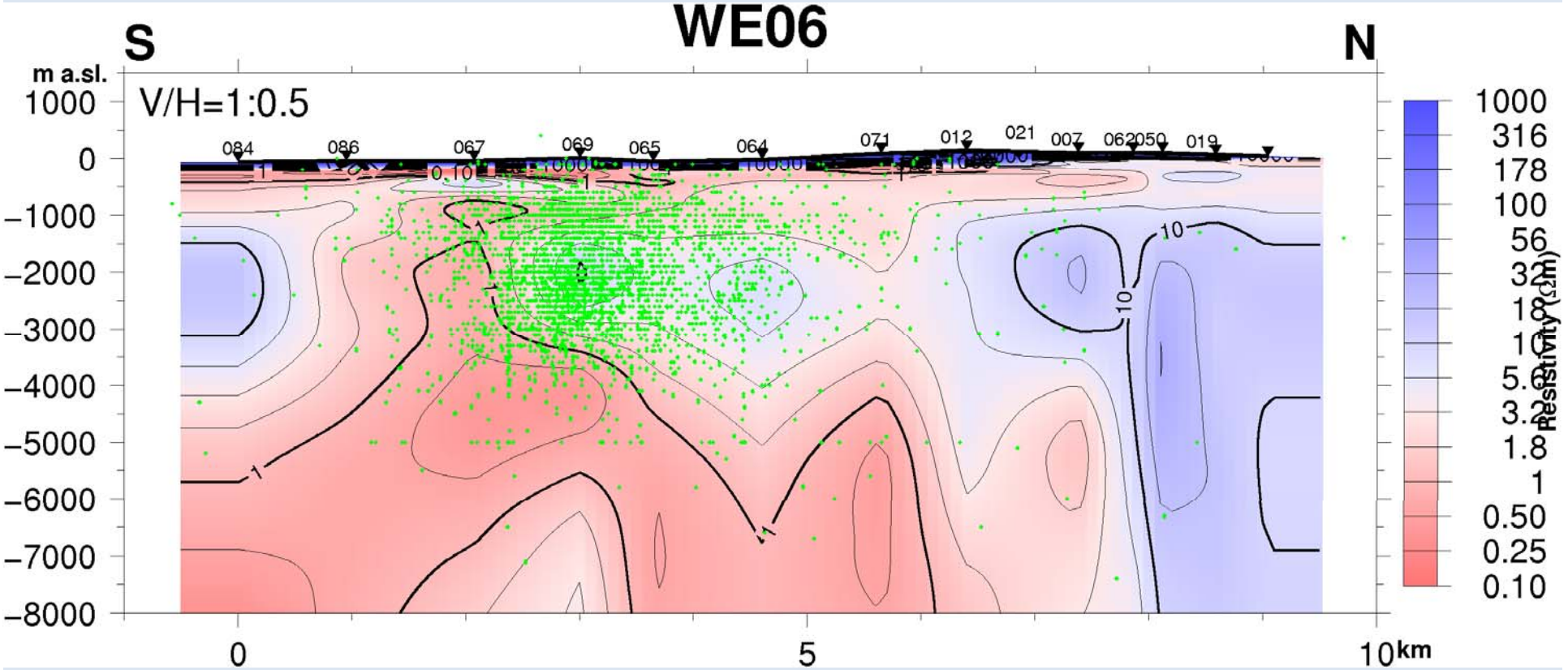
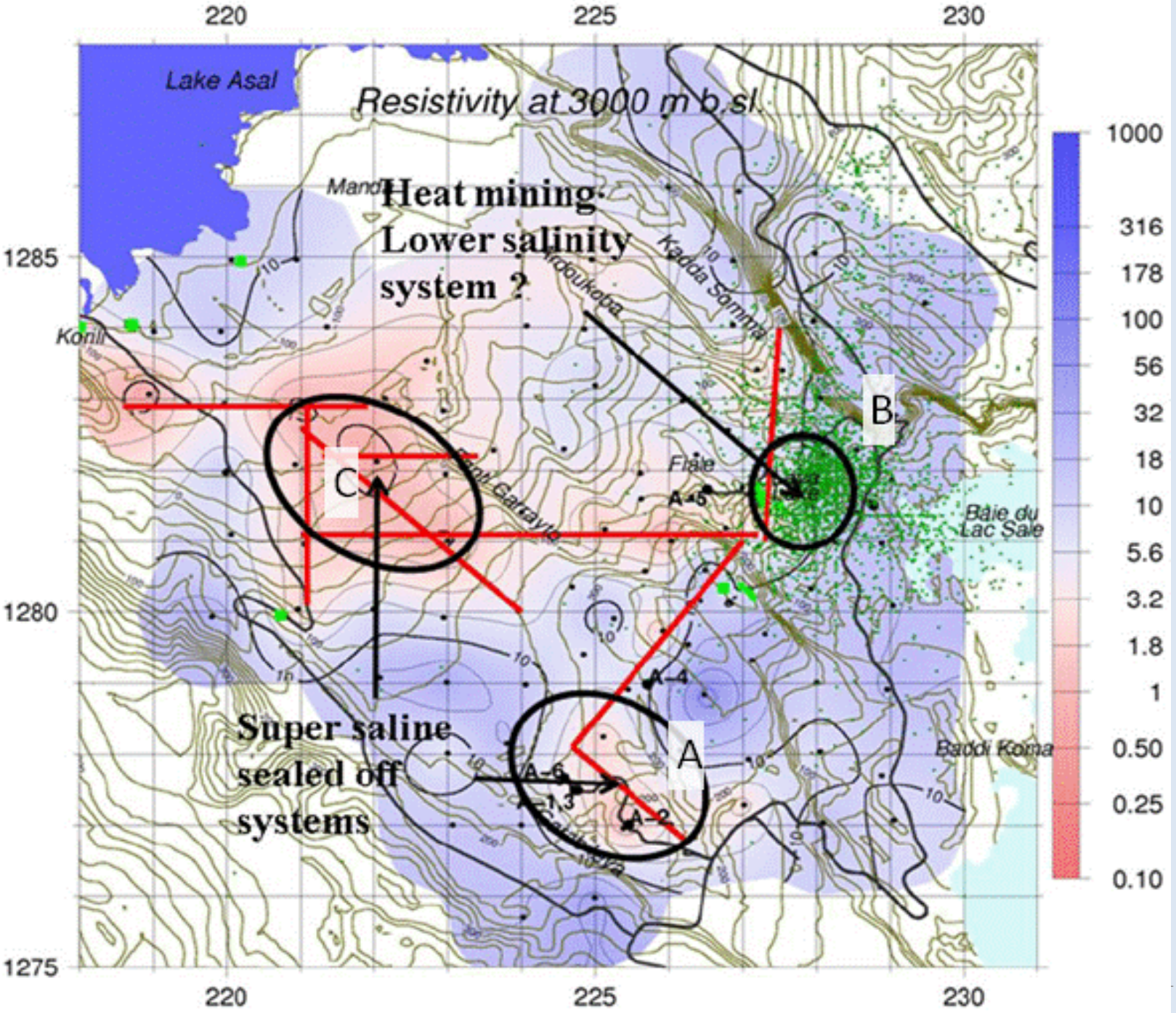
barrier_utm_km
Asal_wpts_utm_km
Nafn
A1
A2
A3
A4
A5
A6
GUFAUG
reslineaments_utm_km_points
reslineaments_utm_km_lines
bogaspr
gigrimar
misgengi
sprungur
Maryam_jardhiti_gps
Maryam_jardhiti_poly
possible_geoth
gigar
gossprungur
grunnur
flokkur
<Null>
Aphyric lava
Aphyric lava 2
Axial plagioclase porphyritic lava
Lake sediments - mixture of fossil-rich
Older volcanic ash and thin hyaloclastite layer
Plagioclase microporphiritic pahoehoe lava
Plagioclase porphyritic lava
Plagioclase porphyritic lava 2
Pyroxene - plagioclase porphyritic
Younger volcanic ash
model_dypi1000m.img
Value
High : 58.616
Low : 0.80476
Kvarði 1:25.000, hnitkerfi UTM 38
0 250 500 750 1000 m
226000
227000
228000
229000
230000
1284000
1283000
1282000
1281000
1280000
Arducoba
2500m
2000m
1500m
1000m
AA
AD
AB
AC
Lava Lake
Sisalle Coma
Bay of shark

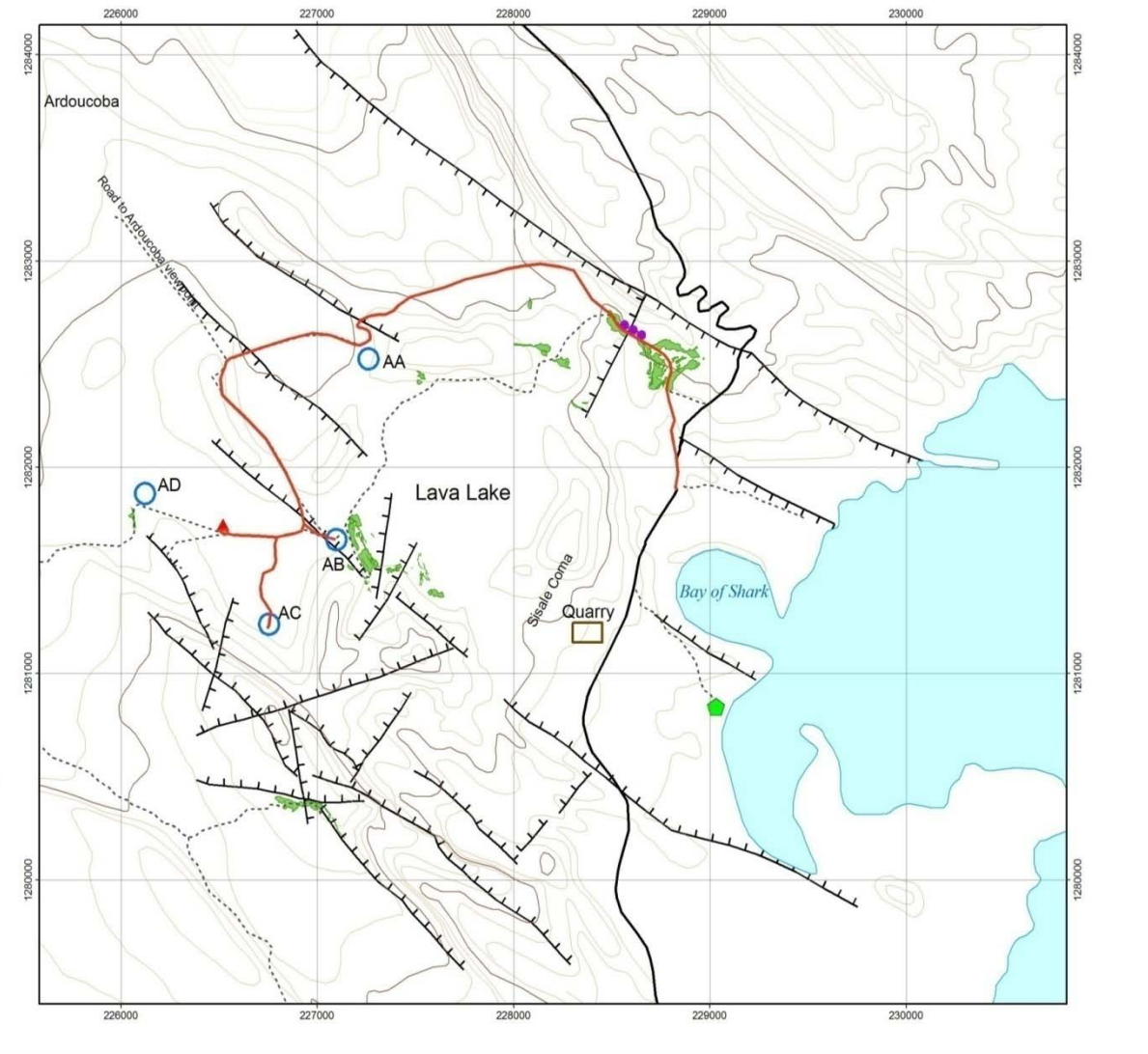
Resistivity and seismicity W-E section

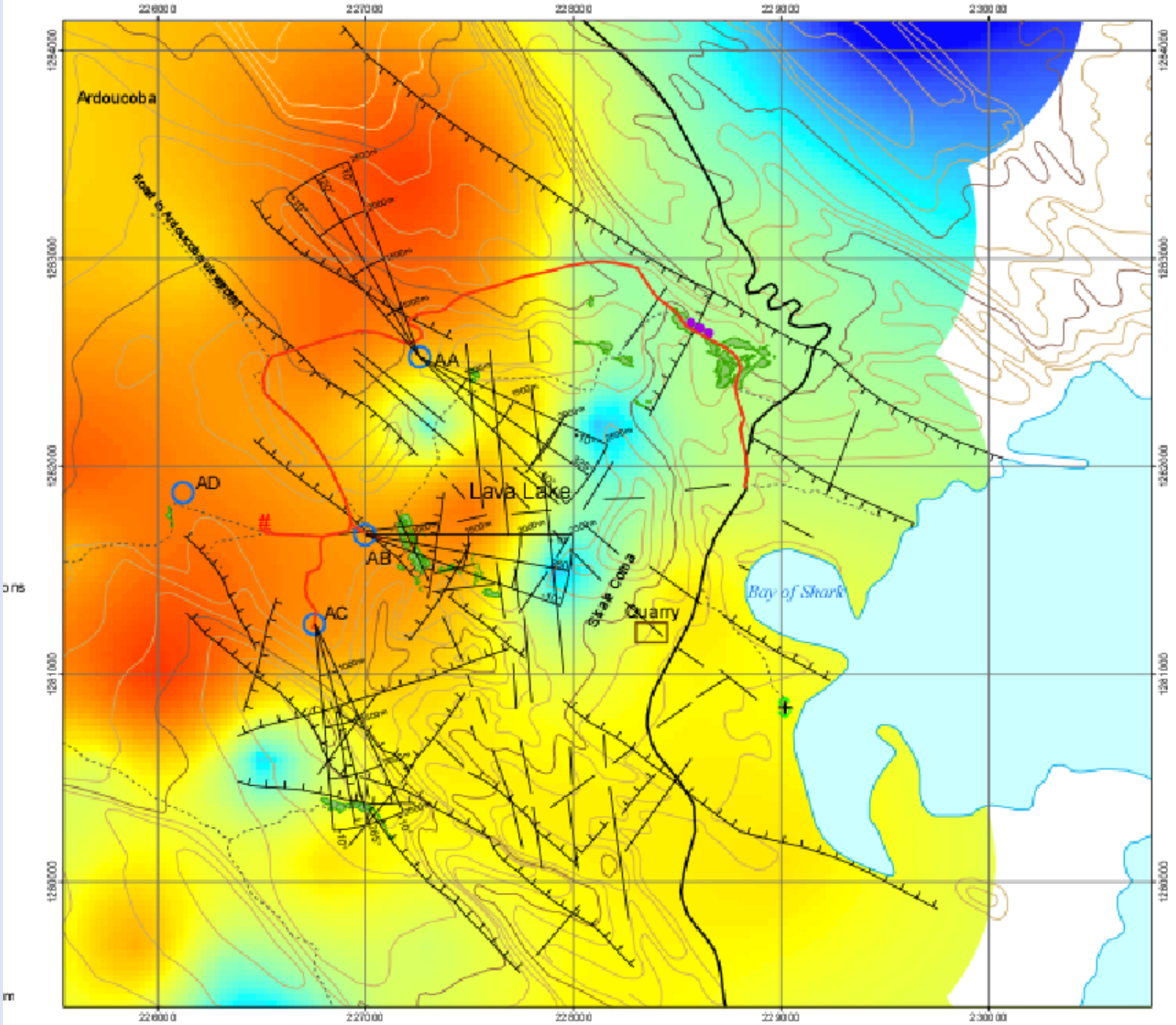



220
225
230
1285
1280
1275
Lake Asal
Resistivity at 3000 m b.sl
Heat mining
Lower salinity
system ?
Mandi
Kadda Somma
Irdoukoba
Konili
Fiale
Baie du
Lac Sale
Baddi Koma
Super saline
sealed off
systems
A
B
C
A-4
A-5
A-6
A-2
1,3
1000
316
178
100
56
32
18
10
5.6
3.2
1.8
1
0.50
0.25
0.10

Findings of the study

- The well location is based on the first conceptual model
- The area of interest is within the Lava Lake
- The physical activities will be outside the Lava Lake
- Drilling targets will be reached by deviated drilling

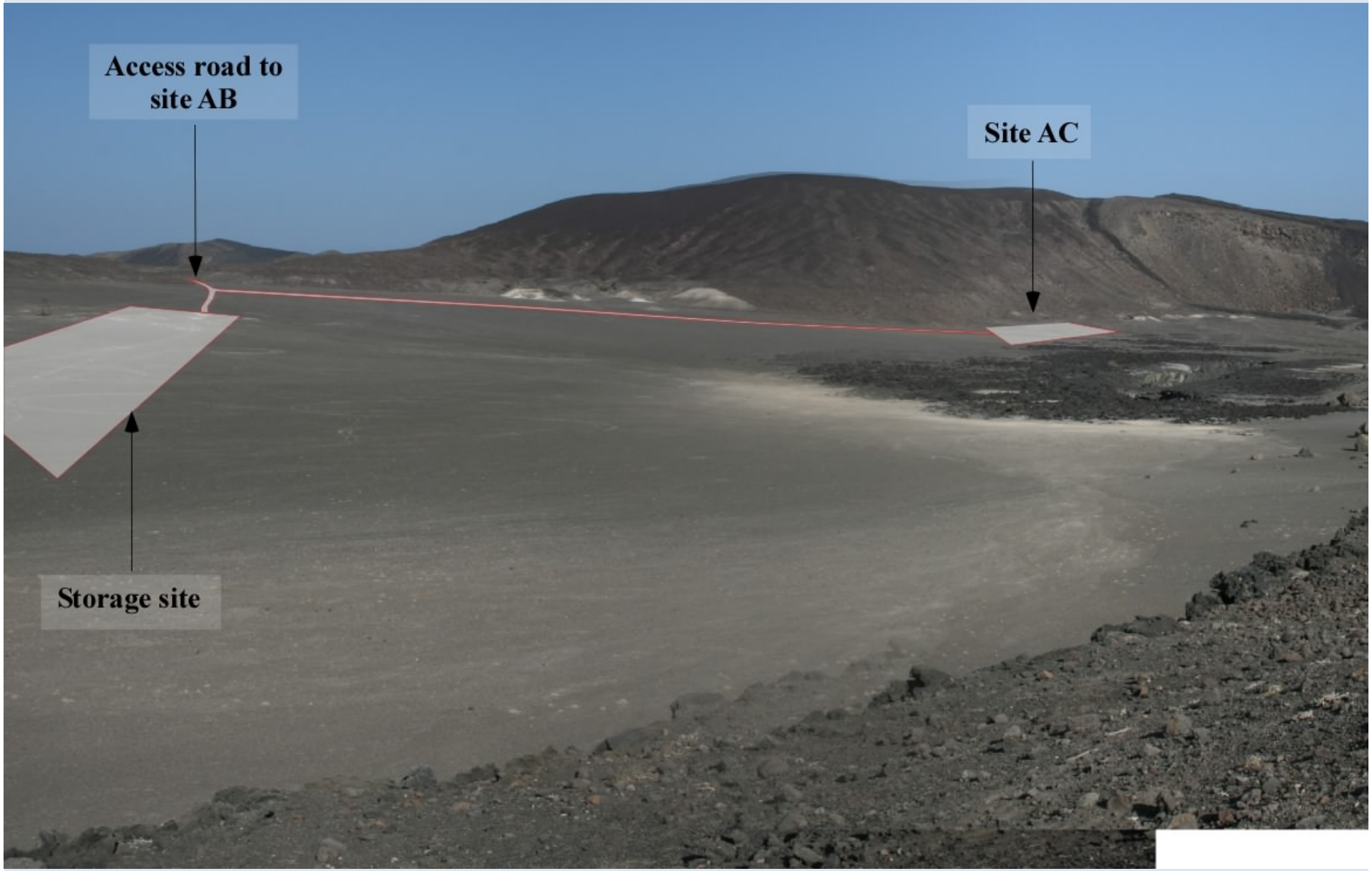



Ardoucoba
AA
AB
AC
AD
Lava Lake
Bay of Shark
Quarry

ARGeo

- ARGeo initially consisted of six African countries, the World Bank and UNEP
- The aim is to promote geothermal development in Africa
- Djibouti and REI have applied for Risk Mitigation from ARGeo funds
- The Environmental Management Plan is prepared according to ARGeo requirements
- If Djibouti receives the ARGeo support it will be the first country to do so


Access road
To Sites AC & AD
Old track into
Lava Lake
Site AB
Access road
Towards Ardoukoba


Access road to site AB
Site AC
Storage site

Reykjavik Energy Invest

From resource to geothermal power production in Djibouti

Financial issues

Kristjan B. Ólafsson

Presentation:

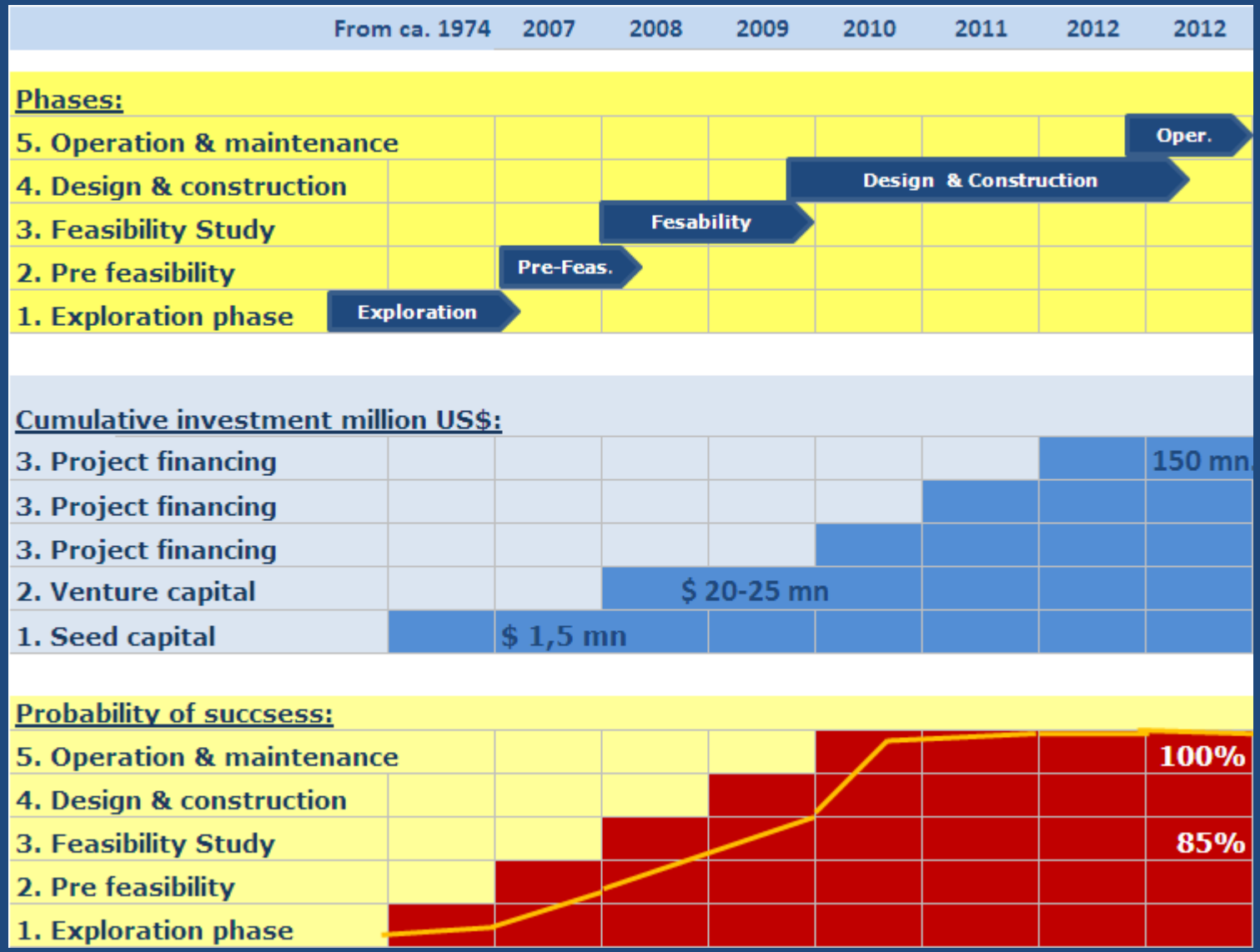
The steps needed to take a power plant project in Djibouti from resource to construction in a financially viable manner.

This presentation discusses the likely cost of power in Djibouti and the competitiveness against other sources of power.

Project Sponsors:

- REI: Reykjavik Energy Invest
  - Gunnar Hjartarson and Kristjan B. Olafsson
- IFC: International Finance Corporation (World Bank Group)
  - Tom Butler

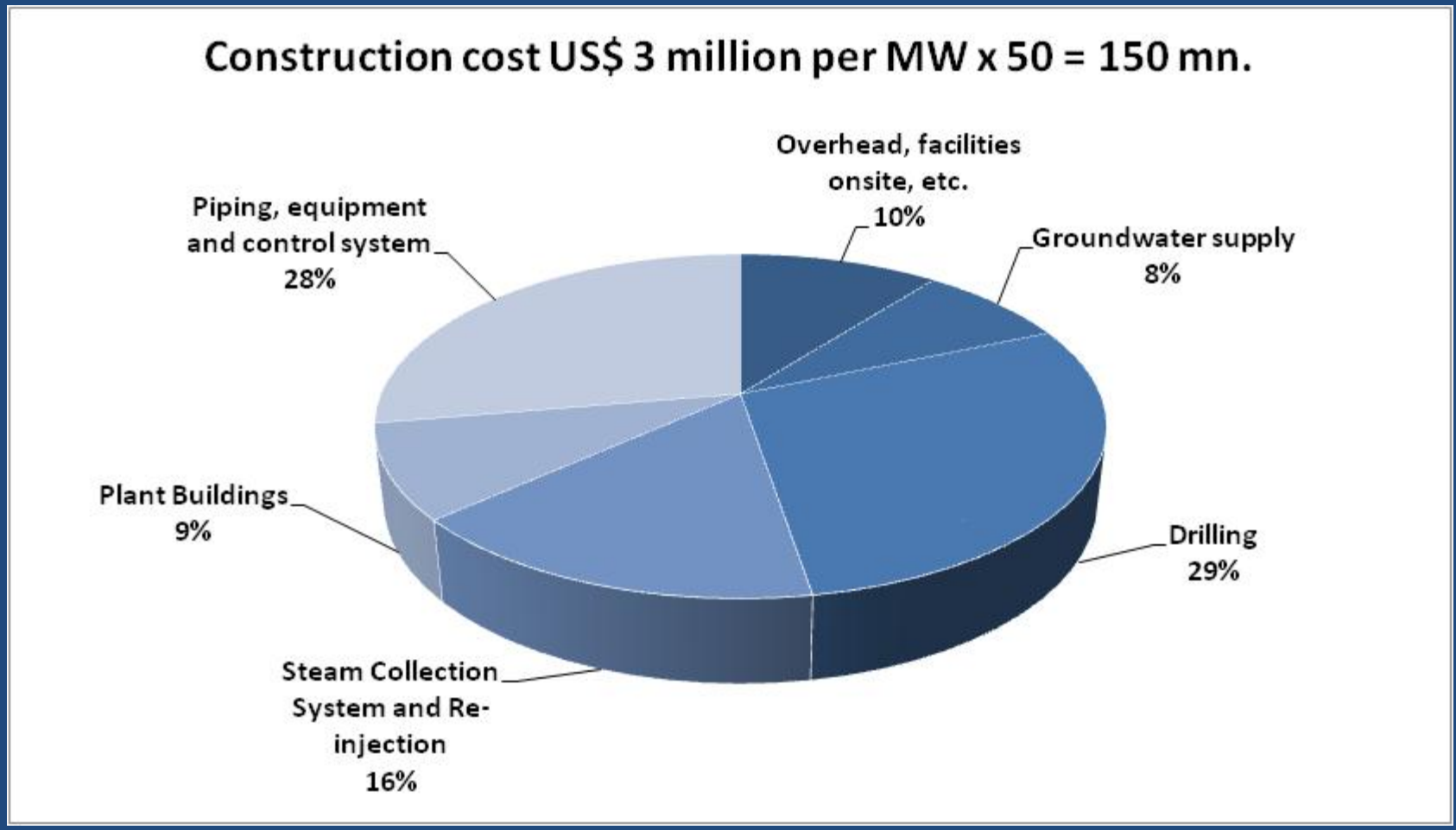
Geothermal project phases, investment and probability of success



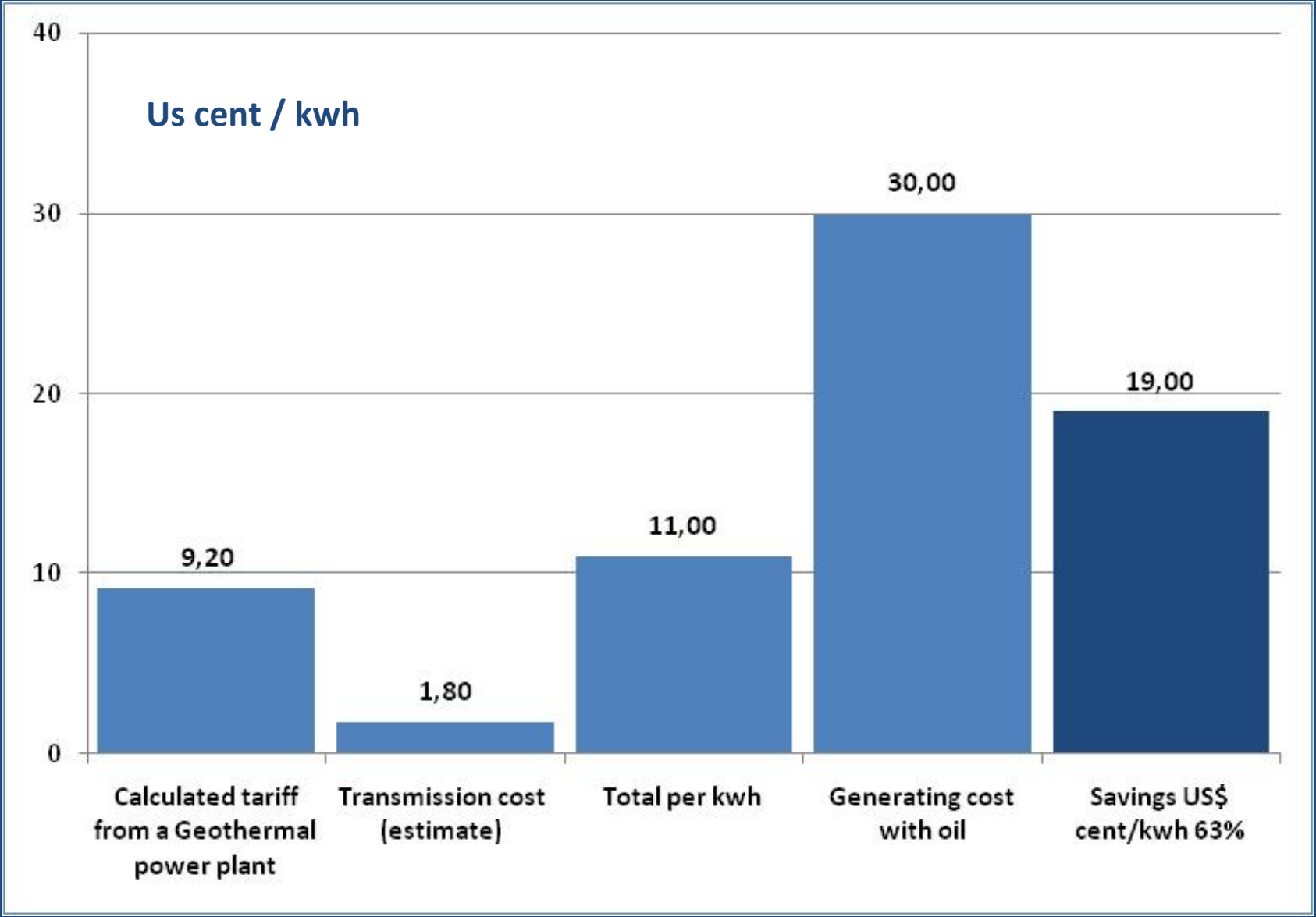
Basic parameters and tariff calculation for a typical 50 MW geothermal power plant with high saline content of geothermal fluids (NB: not Djibouti figures)

1. Construction cost up to US$ 3 million per MW.
2. Operation and maintenance cost per year 4% of construction cost, including make-up of wells.
3. Lifetime +/- 30 years.
4. Return on Equity 20-25%.
5. Equity 30% of total finance.
6. Long term interest rate 8-11%.
7. Tax credit or no tax first years.
8. Using cash-flow model (NPV, IRR, Pay-back):
   Calculated tariff ca. 9,20 US$ cent/kwh.

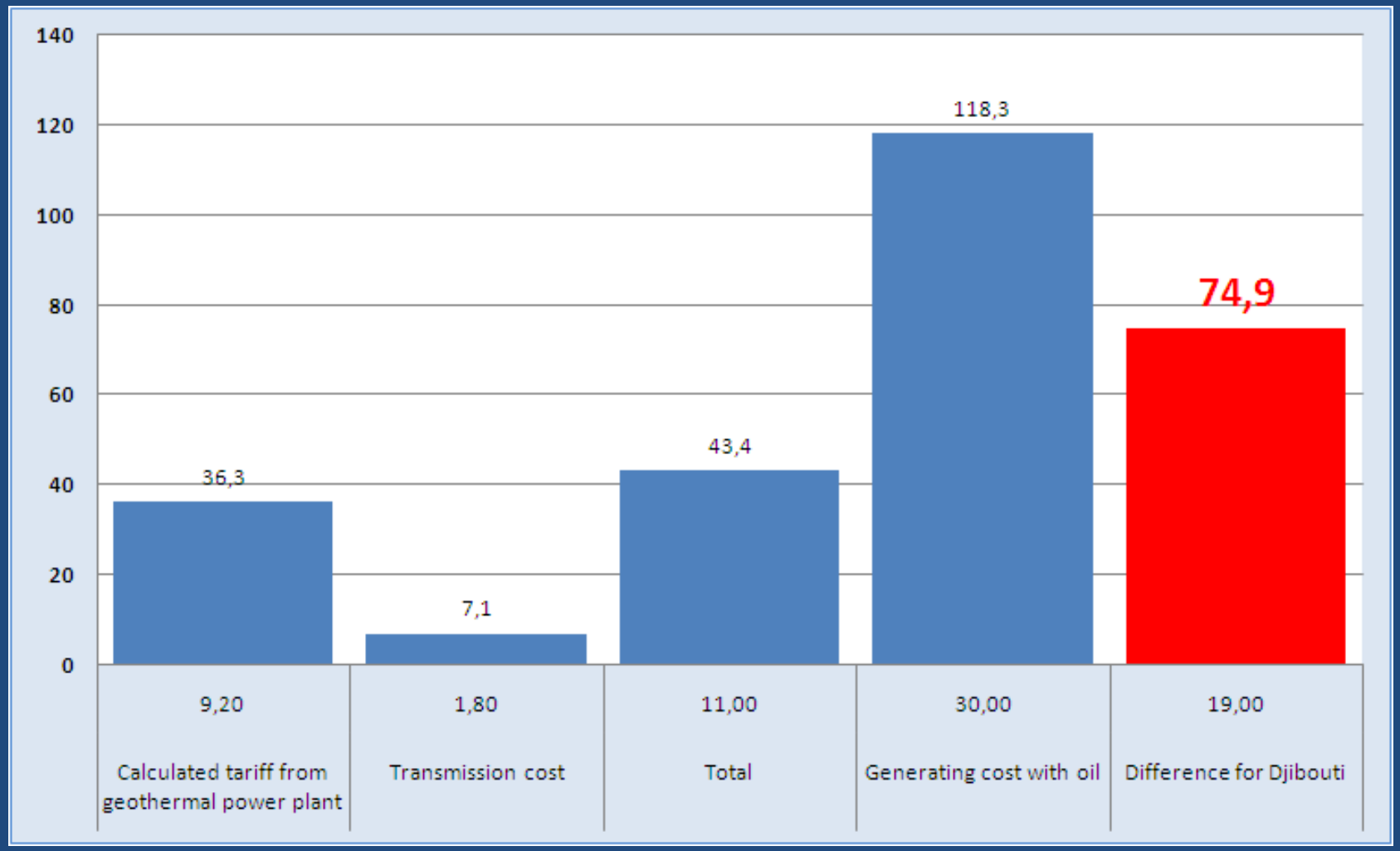
Estimated construction cost



Calculated tariff vs generating cost with oil in Djibouti.



Calculated difference for Djibouti per year in US$ million



For the Djibouti Project

Strengths:

1. Financial strength of Reykjavik Energy
2. Geothermal expertise and technically experienced sponsor
3. Knowledge do deal with high saline content of the geothermal fluids
4. Site-specific knowledge
5. Expected cost-competitiveness of the Project
6. Strong demand for new generation capacity
7. Good opportunity to co-develop a renewable energy project
8. Good prospects for reasonable economic and financial returns
9. Balanced head of terms for a PPA and PA
10. Support of the World Bank and the Government in Djibouti

Risk:

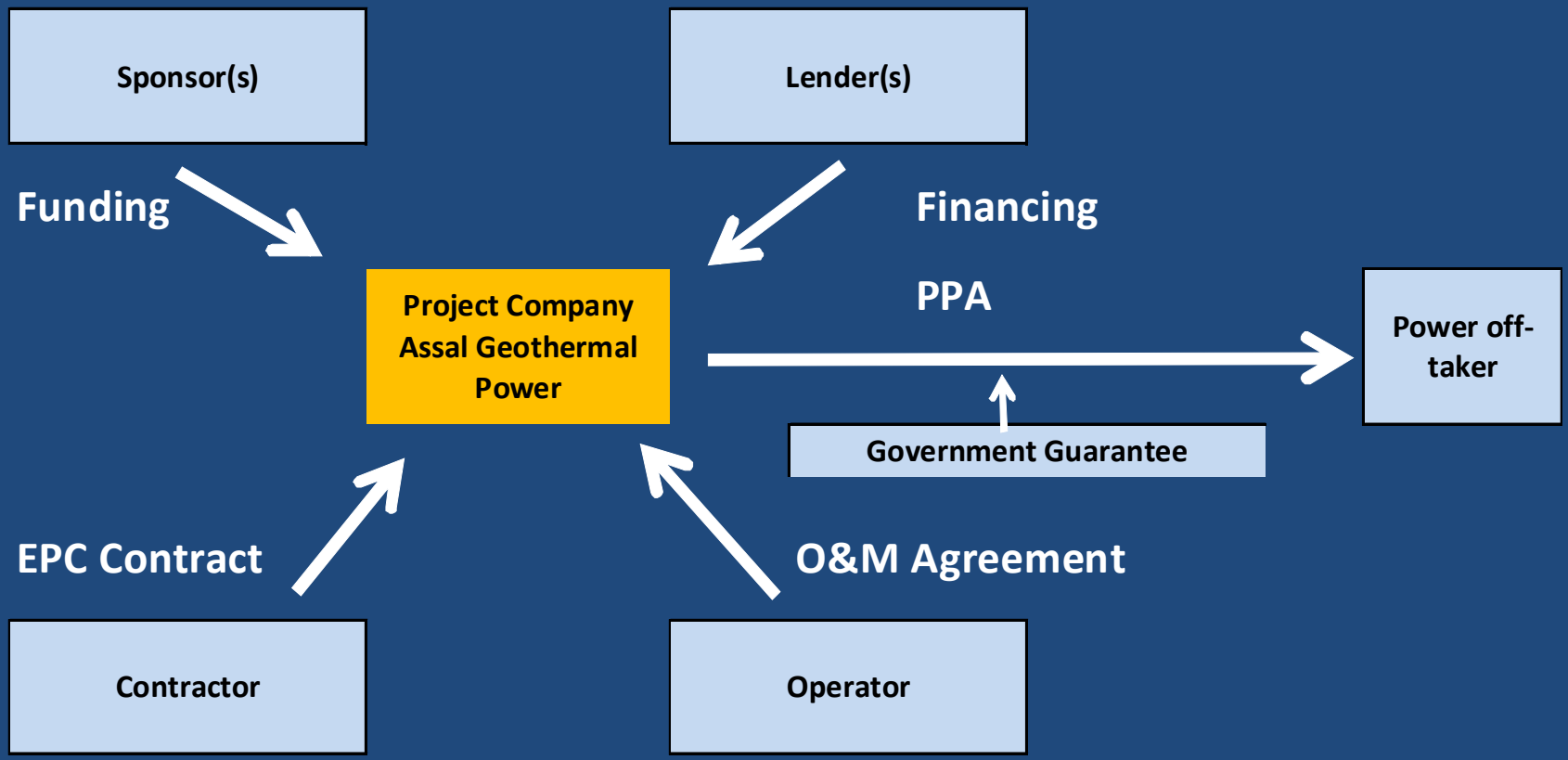
1. Exploration/resource risk
2. High saline content of the geothermal fluids
3. Regulatory and political risk
4. Market and off taker risk
5. Experience with Djiboutian law
6. Price risk from regional electricity market integration
7. Seismic Activity
8. Global financial system in crisis and economy in downturn
9. Difficult to finance Feasibility Study in geothermal projects

Other issues:

1. Carbon credit future revenue
2. Side projects: Water production
3. ARGeo Mitigation

Standard IPP Project Structure

(IPP: Independent Power Producer)



Source: Tom Butler, IFC (World Bank Group), WEC Workshop, London, 22 April, 2008

Conclusion

If the exploration drilling will discover a resource that can be exploited in a sustainable manner, then the project can be economically feasible and with many benefits for Djibouti and investors.

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Thank you