

# Well Testing & Reservoir Engineering Studies at Aluto-Langano & Tendaho Geothermal Fields, Ethiopia

Yiheyis Amdebrhan

GSE, P.O.Box 40069, Addis Ababa, Ethiopia

[yamdebrhan@yahoo.com](mailto:yamdebrhan@yahoo.com)



ARGeoC1

November 28, 2006

Addis Abeba- Ethiopia



# CONTENTS

## **1. INTRODUCTION**

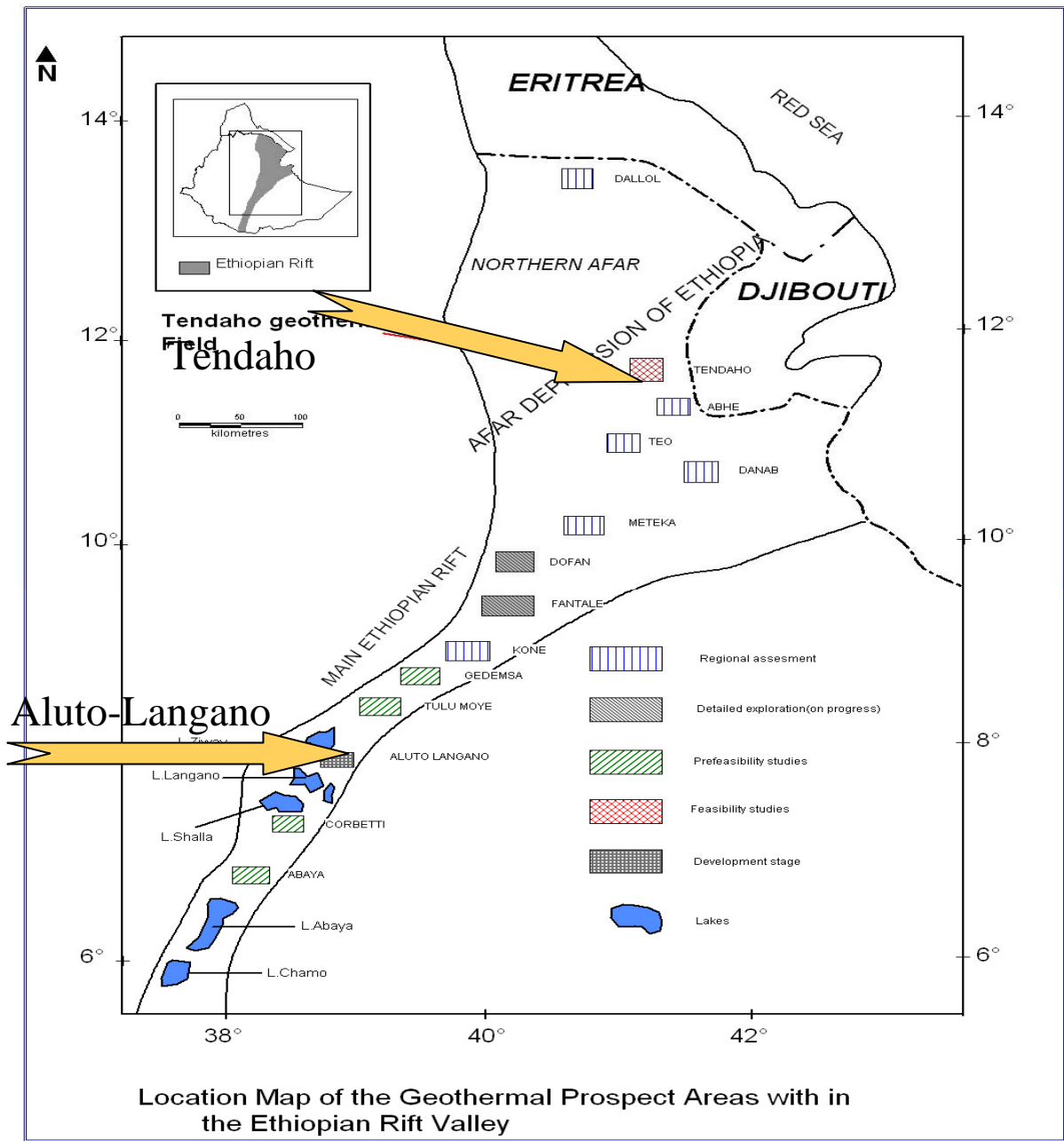
## **2. ALUTO LANGANO GEOTHERMAL FIELD**

- **WELL TESTING & RESERVOIR ENGINEERING STUDIES AT ALUTO**
- **RESULTS**

## **3. TENDAHO GEOTHERMAL FIELD**

- **WELL TESTING & RESERVOIR ENGINEERING STUDIES AT TENDAHO**
- **RESULTS**

## **4 SUMMARY: CURRENT STATUS & FUTURE PLAN**



# Aluto-Langano Geothermal Field



11/12/05

# LOCATION OF ALUTO-LANGANO GEOHERMAL WELLS

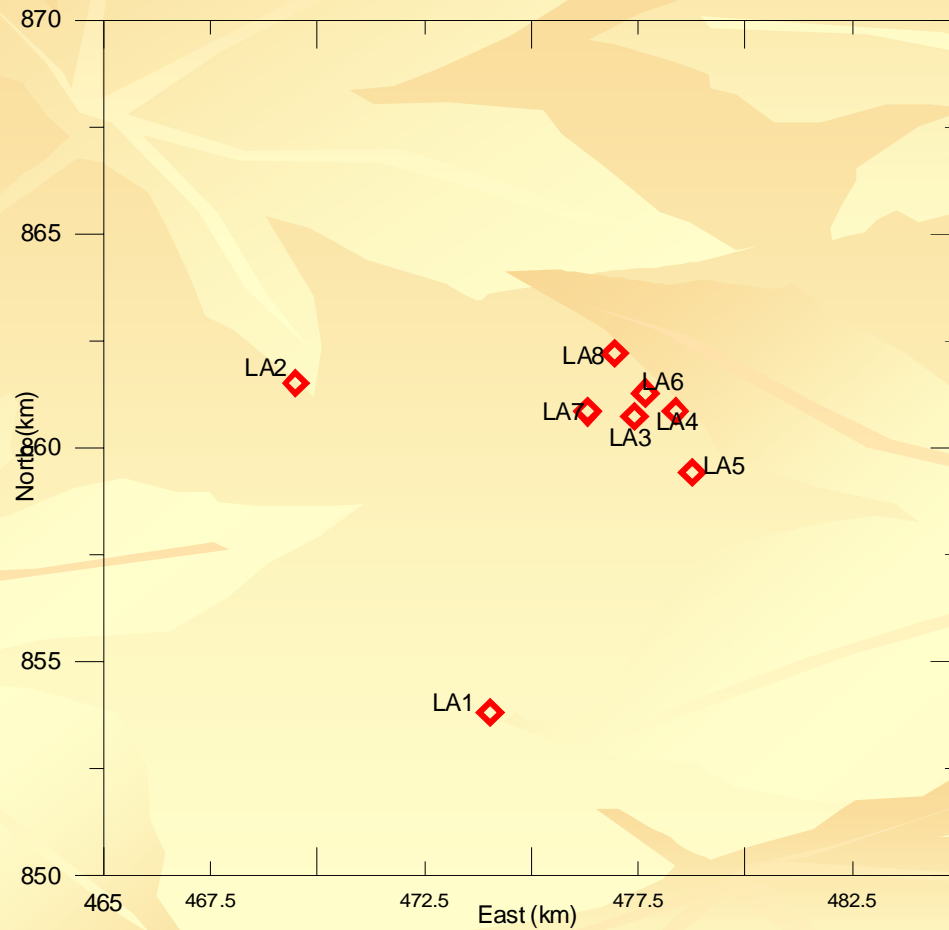
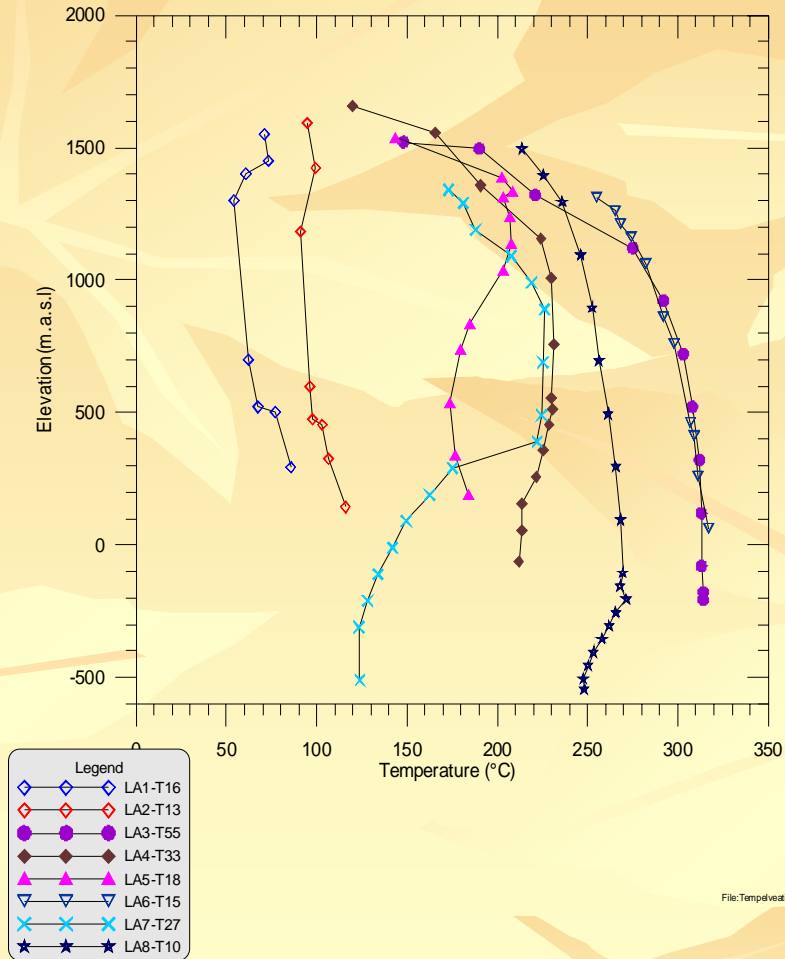


Table 1. Salient data on the exploratory wells drilled at Aluto

Well	LA3	LA4	LA5	LA6	LA7	LA8
Drilled depth (m)	2144	2062	1867	2203	2448	2500
Elevation (m.a.s.l)	1921	1956	2037	1962	1891	1895
Permeable zones	2000-2121	1445-1800	-	2000-2200	2100-2300	2300-2500
Maximum T (°C)	322	240	210	335	228	284
Status of the well	Productive	Productive	Non-productive	Productive	Reinj. well	Productive

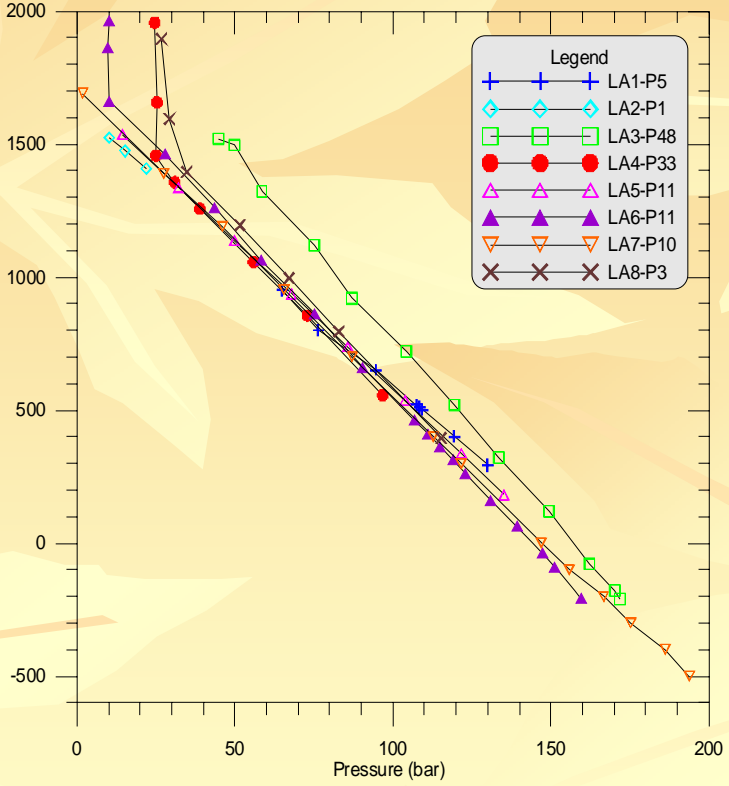


# DOWNHOLE TEMPERATURE PROFILES (ALUTO-LANGANO)



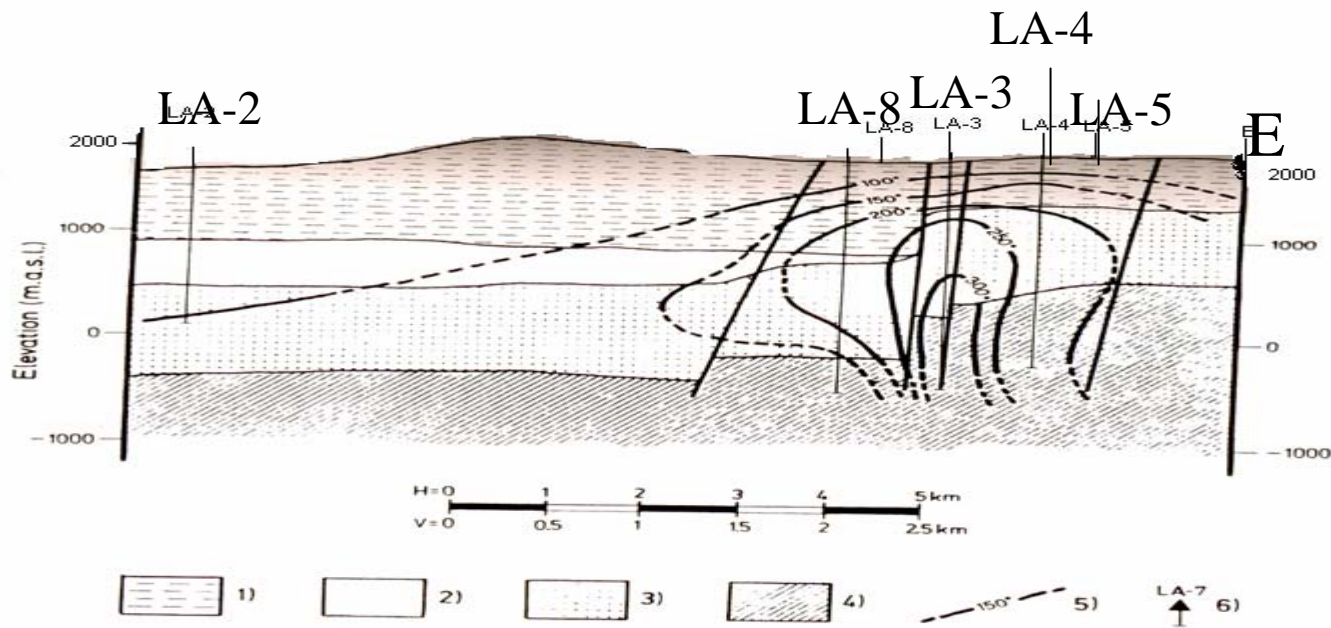
# DOWNHOLE PRESSURE PROFILES

## (ALUTO-LANGANO)



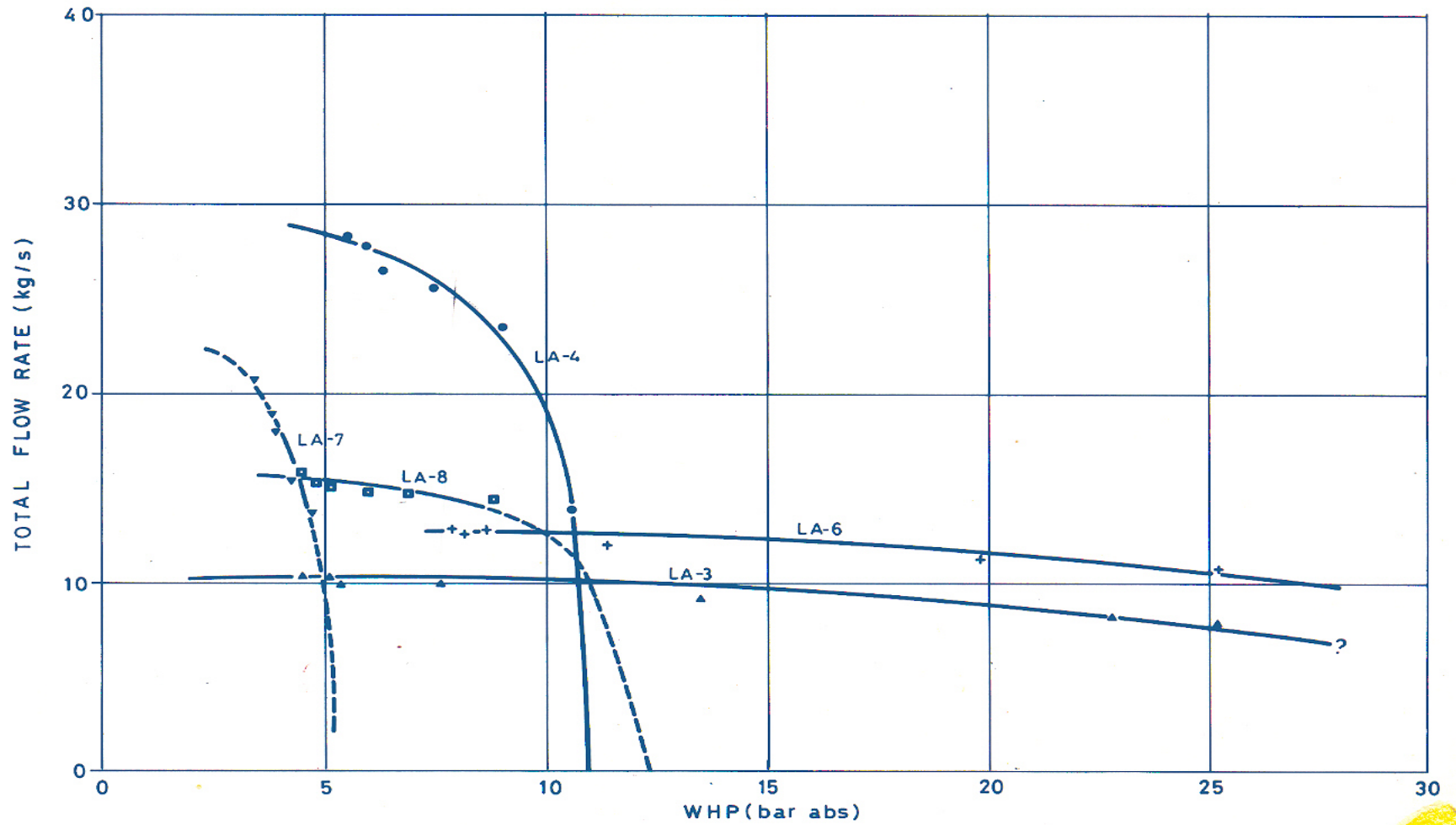


# TEMPERATURE CROSS SECTION OF ALUTO-LANGANNO GEOTHERMAL FIELD (After MT, 1996)

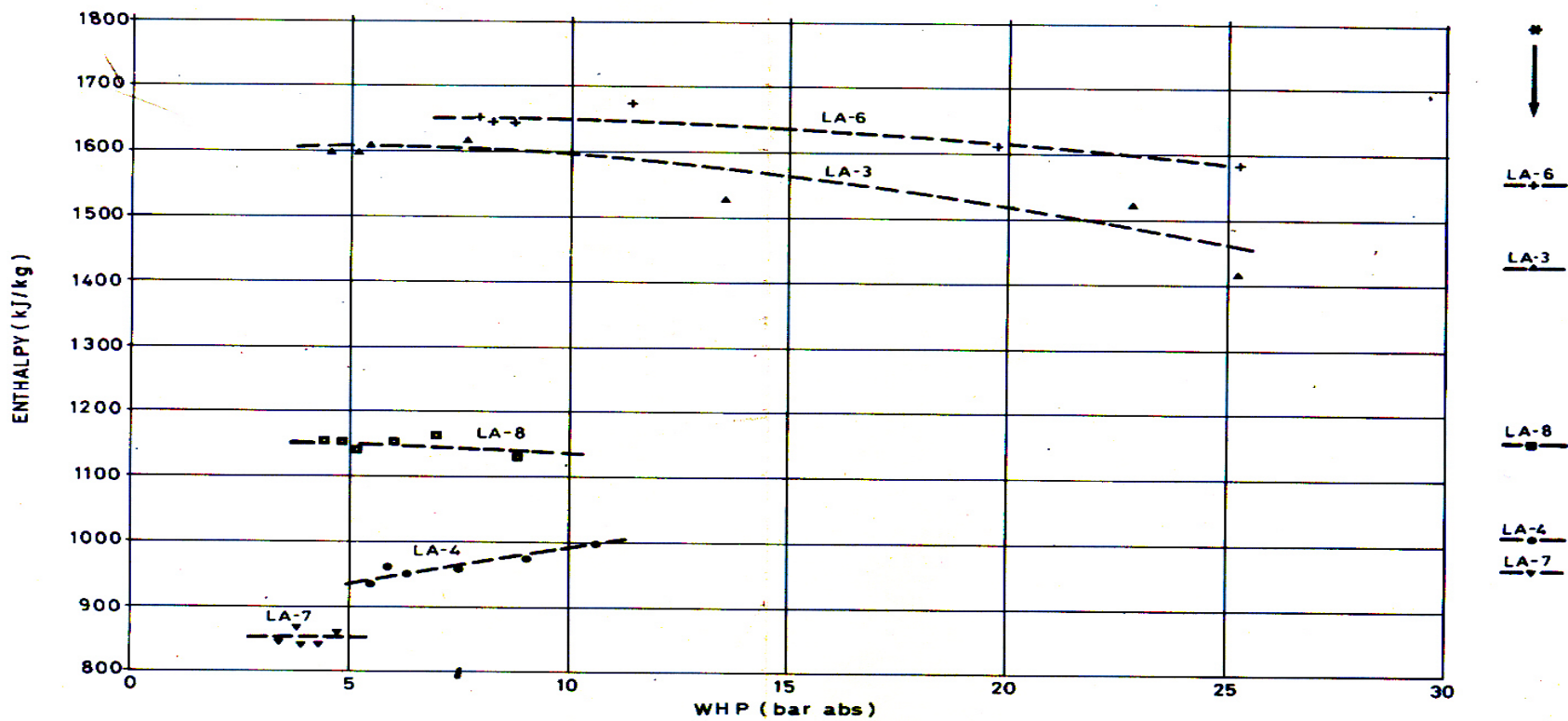


(1) Recent Pyroclastics and lava flows; (2) Lacustrine sediments; (3) Bofa basalt formation; (4) Tertiary ignimbrite unit; (5) Isotherms, and (6) Deep wells.

# OUTPUT CHARACTERISTICS OF ALUTO-LANGANO WELLS (After ELC, 1986)



# ENTHALPY OF ALUTO-LANGANO WELLS



\* Enthalpy corresponding to liquid water at the maximum temperature measured in the well

# RESOURCE EVALUATION

- Reservoir volume: - Proved  $4\text{km}^3$   
- Probable  $6\text{km}^3$
- Reservoir capacity - Proven 20-35MW  
- Probable (+) 30-35MW
- Numerical modeling  $\Rightarrow$  30MW for 30years

# FEASIBILITY STUDY

- Completed in 1986
- Recommended 3 phase development
  - 3.5MW back pressure unit
  - 15MW condensing unit
  - 15MW condensing unit
- Installation of 8.52MW capacity pilot power plant completed in June 1998



# Tendaho Geothermal Field



# LOCATION OF TENDAHO GEOTHERMAL WELLS

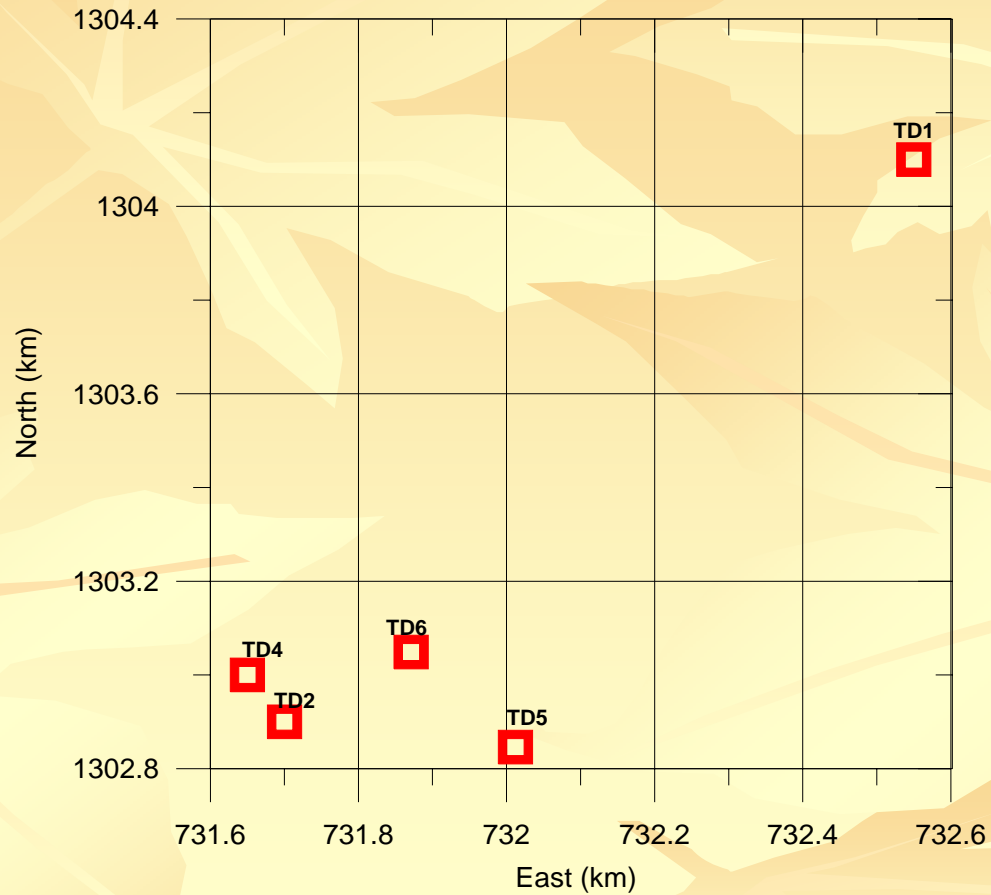


FIGURE 2: Location of Tendaho Geothermal Wells

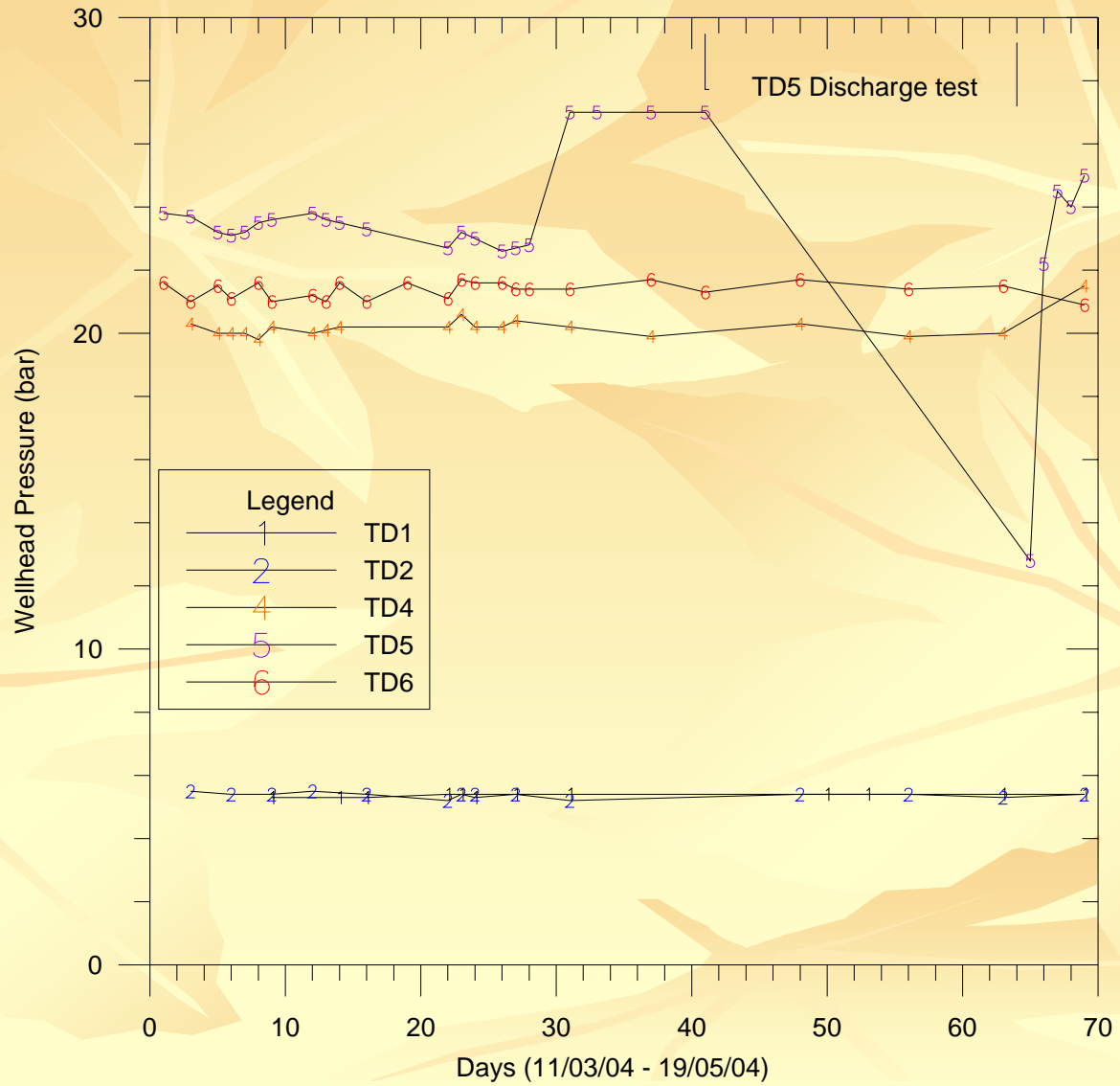


**Table 2. Salient data on the exploratory wells drilled at Tendaho**

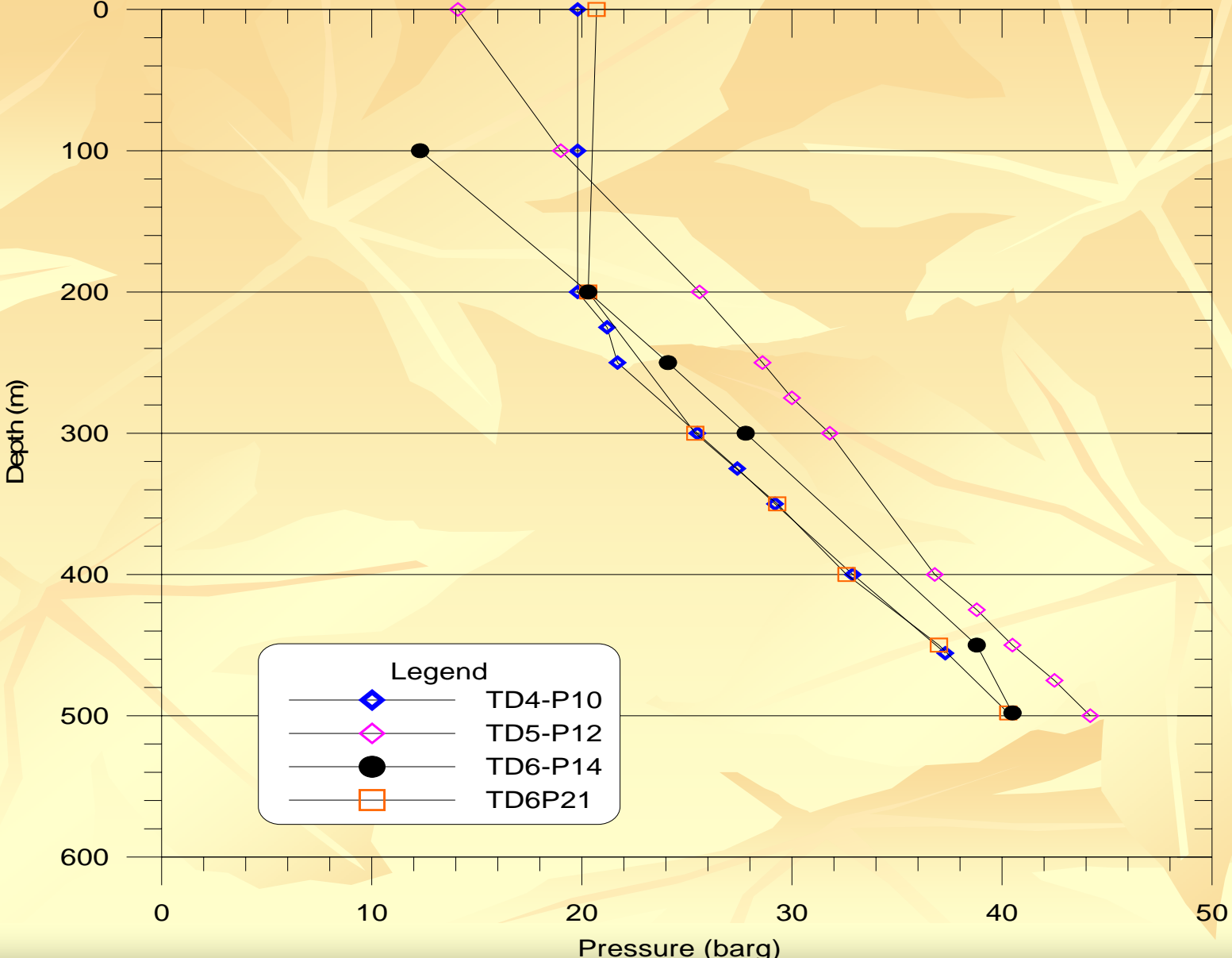
Well	TD1	TD2	TD3	TD4	TD5	TD6
Elevation (m.a.s.l)	365.9	365.7	366.8	365.2	366.3	366
Drilled depth (m)	2196	1811	1989	466	516	505
Permeable zones (m)	400-600* 1200-1300	900-950, 1040-1050	-	250 - 330	300 - 500	300 - 500
Maximum T (°C)	278	245	198	247	253	248
Status of the well	Non-productive	productive	Non-productive	productive	productive	productive
Note: * Cased						

# WELLHEAD PRESSURES AT SHUT-IN CONDITION

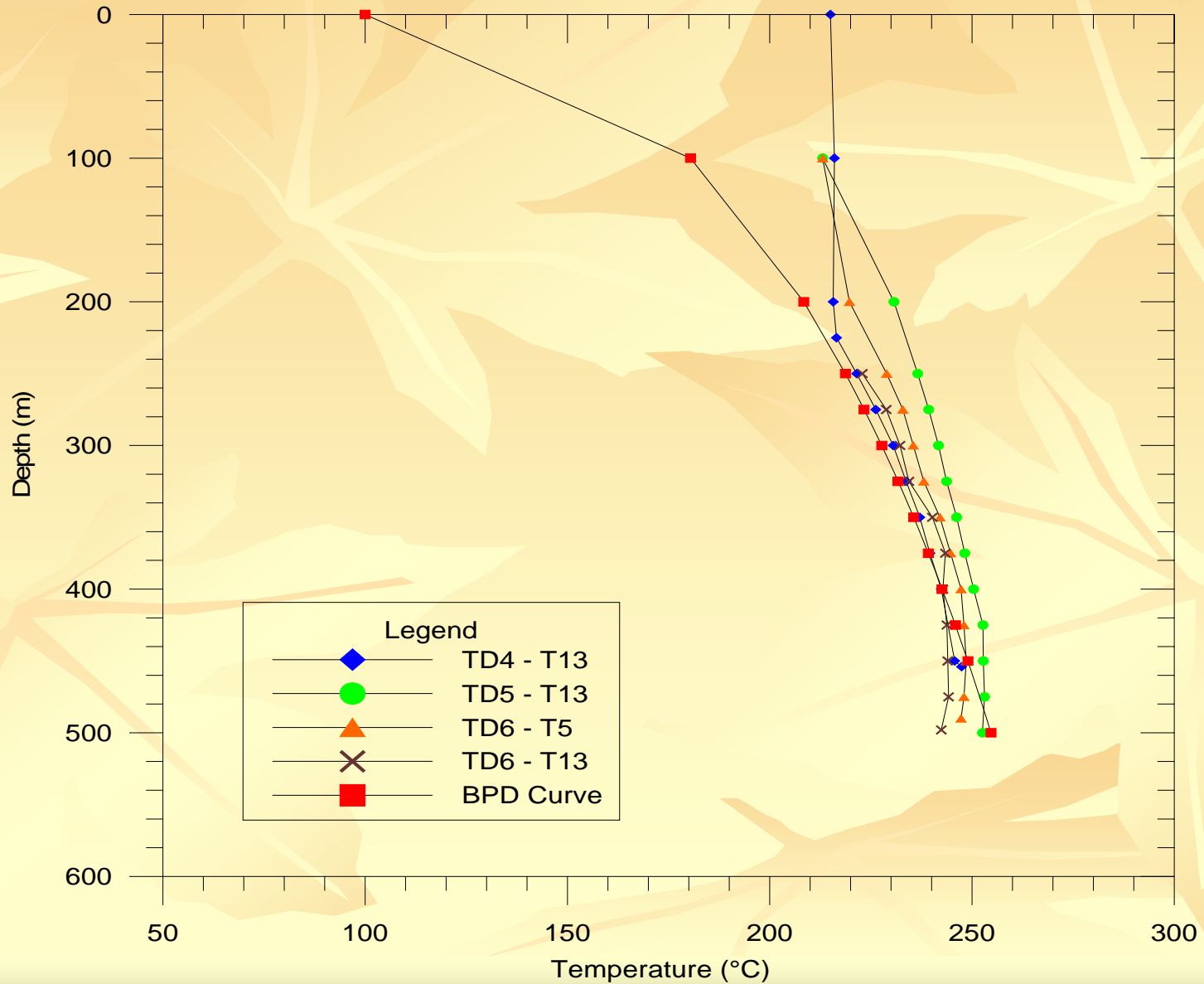
Figure 2. Pressure profiles for the wells wellhead pressure at shut-in condition



# DOWNHOLE PRESSURE PROFILES



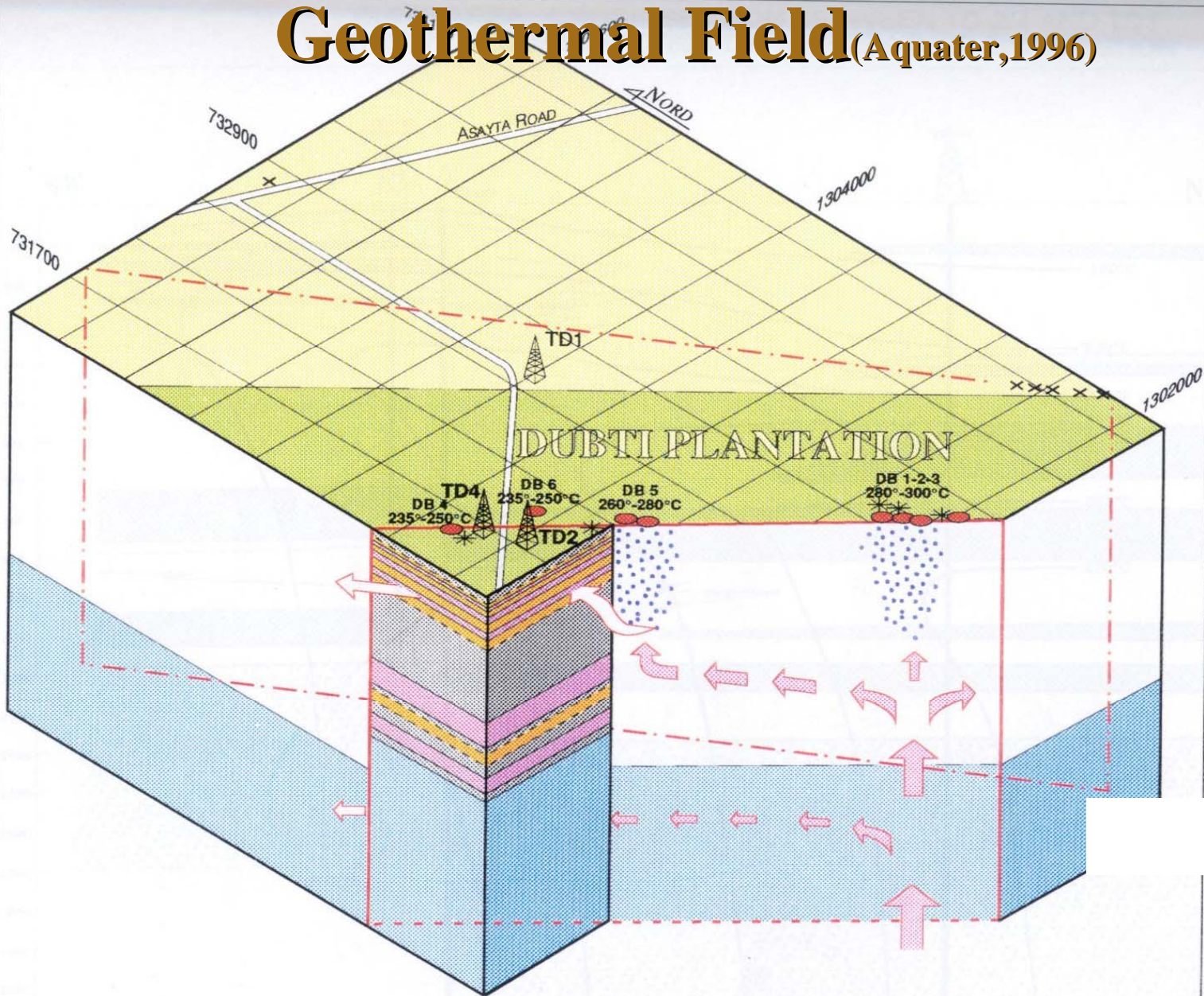
# DOWNHOLE TEMPERATURE PROFILES





# Conceptual Model of the Tendaho

## Geothermal Field (Aquater, 1996)



### LEGEND

#### SEDIMENTARY SEQUENCE

- Undifferentiated
- Mainly Fine Deposits (mudstones, fine-to medium grained siltstones)
- Basalts
- Mainly Coarse Deposits (coarse-grained siltstones sandstones)

#### AFAR STRATOID SERIES

- Basalts
- Fault
- Inferred fault
- Geothermal wells
- Mud cones
- Fumaroles
- Fossil manifestations
- DB 5 Sampled gas manifestation

computed  
ires

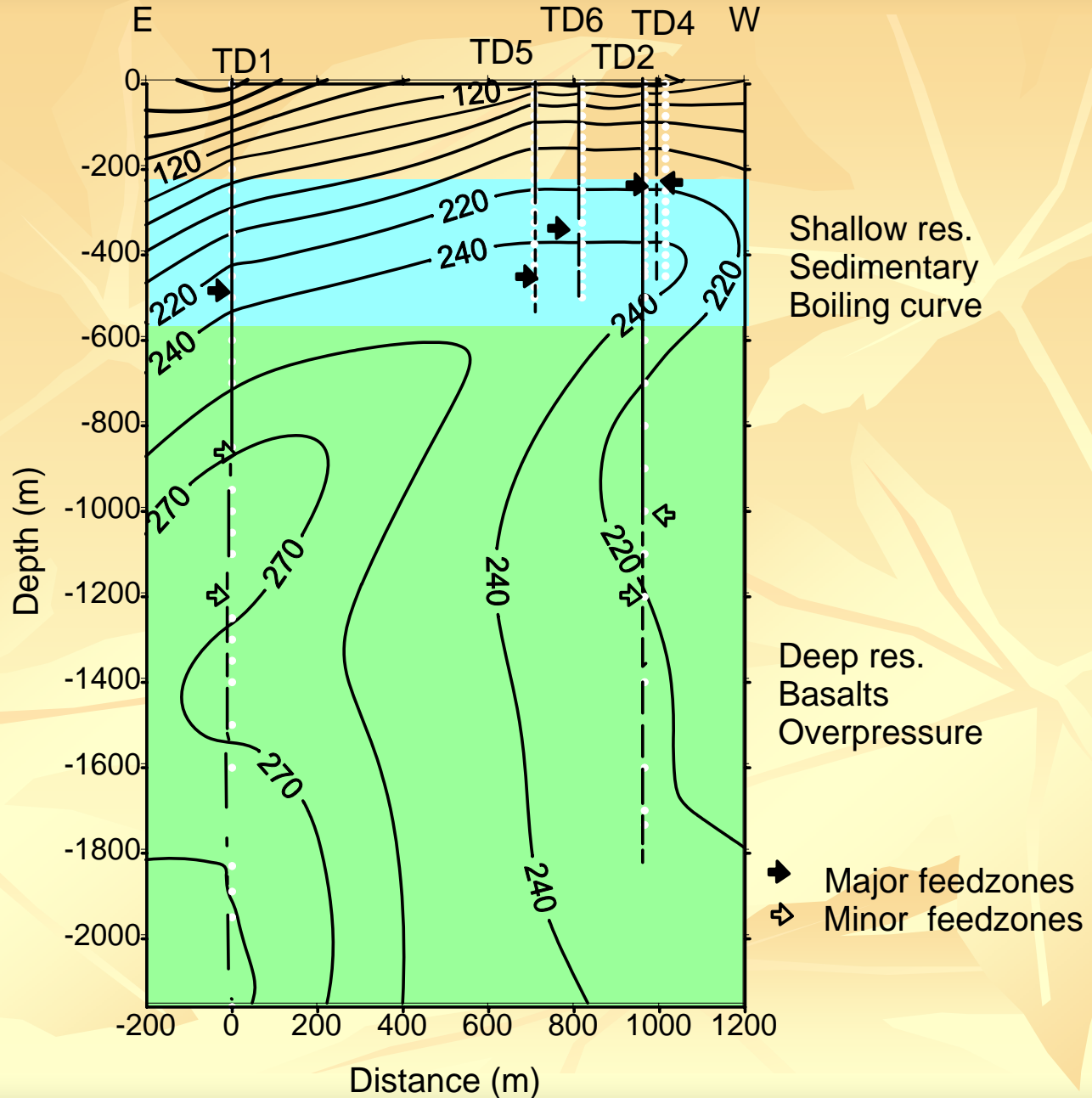
- Inferred fluids pathflow
- Two-phase zone

UTM Coordinates

0 200 400 600m

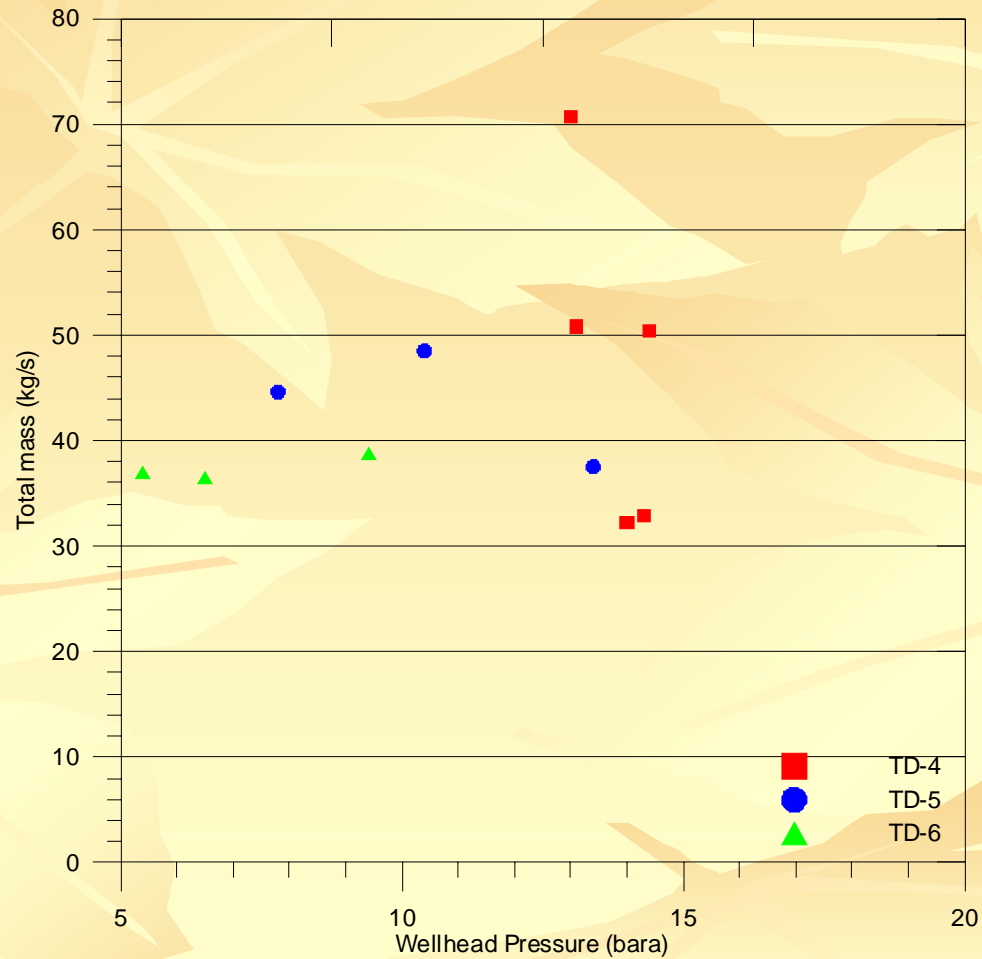
**Aquater**

# TEMPERATURE CROSS SECTION



# PRODUCTION CHARACTERISTICS OF TENDAHO

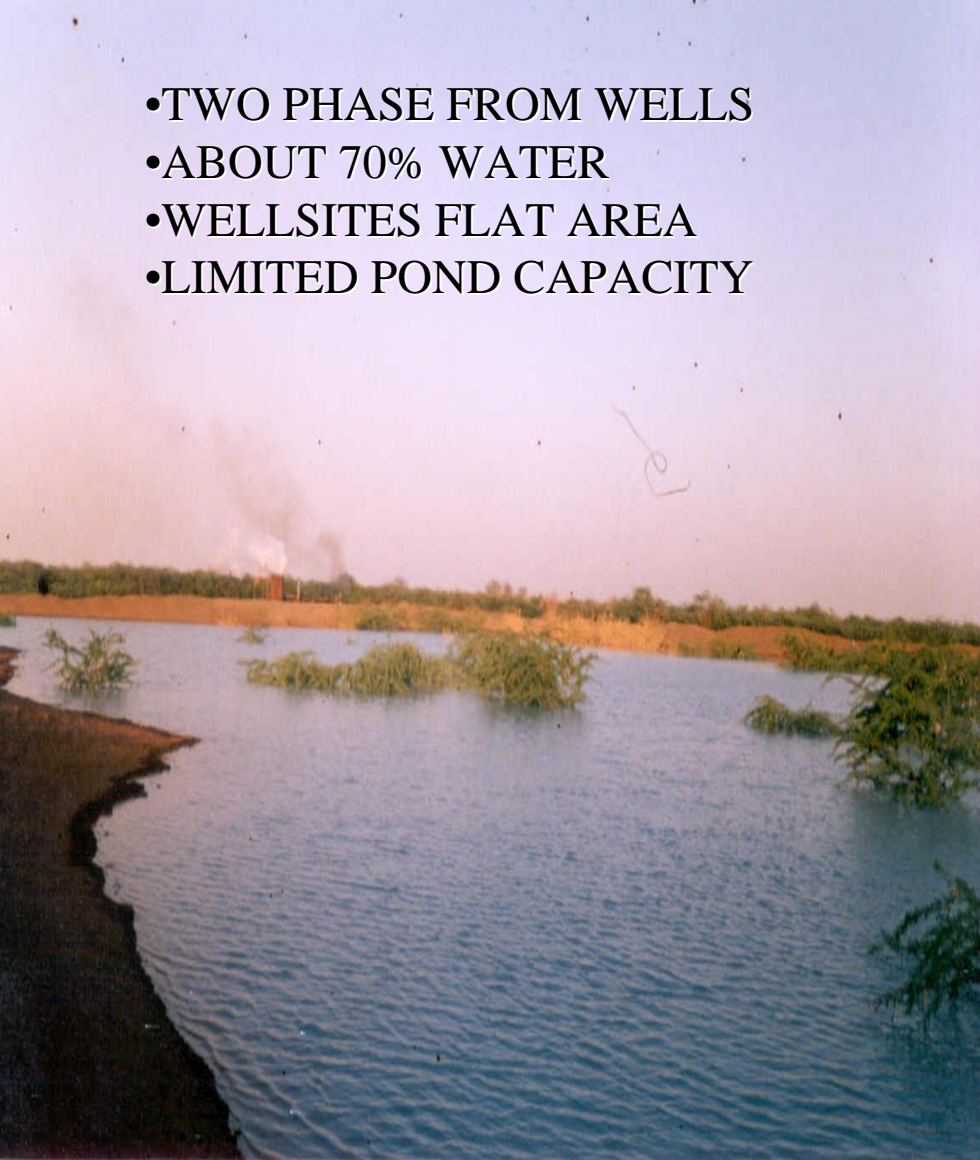
## WELLS (preliminary)





# WASTEWATER DISPOSAL PROBLEM

- TWO PHASE FROM WELLS
- ABOUT 70% WATER
- WELLSITES FLAT AREA
- LIMITED POND CAPACITY



# SUMMARY

## ALUTO-LANGANNO & TENDAHO GEOTHERMAL FIELDS: CURRENT STATUS & FUTURE PLAN





**THE END**

**THANK YOU**

