



# Geophysical Survey of Tendaho Geothermal Field

By

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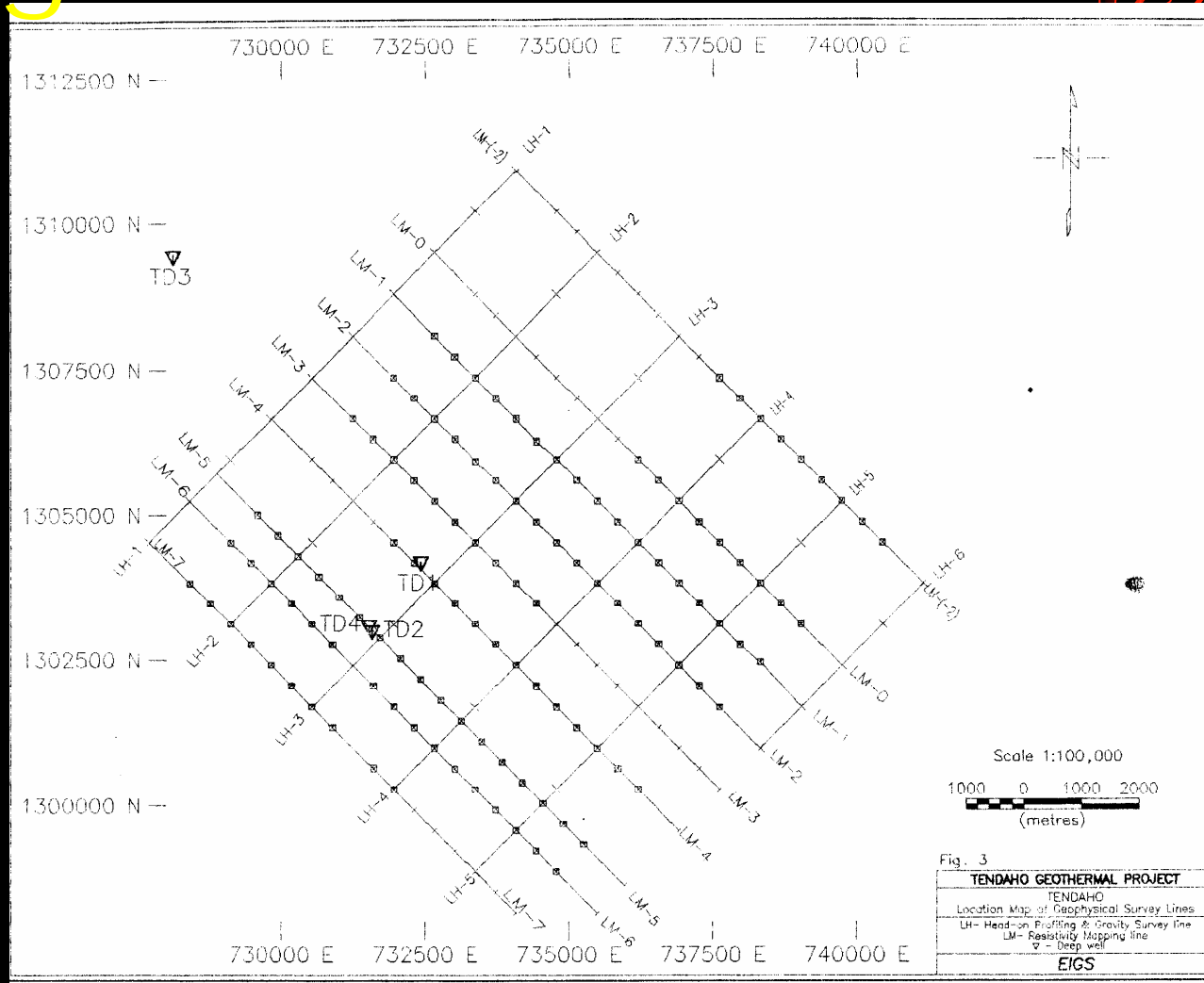
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# Introduction and location of the survey area



- Found in the central part of Afar depression, 600km from Addis Ababa
- Structurally the area is known as Tendaho graben 50Km wide and 100Km long
- Altitude ranges between 370m-1000m
- Based on the geo-scientific results obtained in the previous time four exploratory wells were drilled
- TD1=2196m, TD2=1811m, TD3=1918 and TD4=466m with a maximum temperature of 240°C - 278°C

# Survey area of Tendaho geothermal field





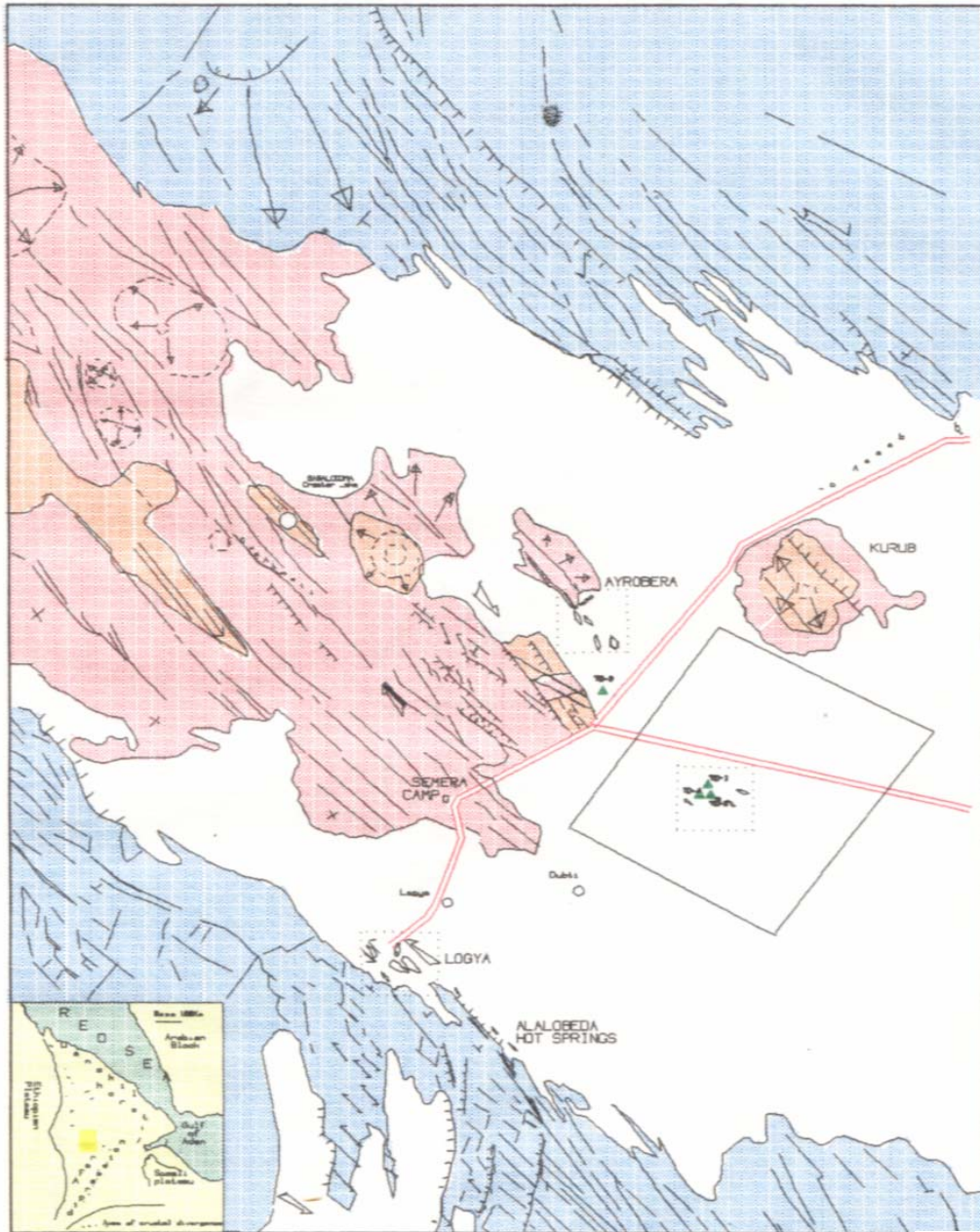


















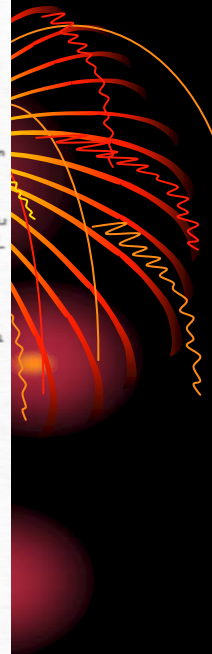
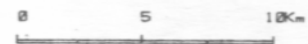
FIG.2 STRUCTURAL MAP OF TENDAHO

(Modified from Aquater 1995.)

LEGEND

-  Sedimentary filling of the Tendaho rift : alluvial lacustrine evaporite and aeolian deposits. These sediments may be partly overlain by the upper Extrusive complex. Pleistocene to present.
-  Upper extrusive complex: basalts(b) and andesite rhyolites(r). Pleistocene. Very recent Lava Flows(L). Pleistocene to present.
-  Middle Extrusive Complex: basalts of the Afer Stratoid Series(b) with associated rhyolites(r). Pliocene to Pleistocene(early).
-  Main lineaments of the regional faults pattern
-  Geophysical Survey Area
-  Main volcanic centres
-  horizontal and tilted flows
-  Strike-slip motion from earthquake focal mechanism and field check (Gouin et al., 1979)
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-  Local faults where strike slip is suggested by air photographs and satellite images
-  Open fissures(Echelon)
-  Active and fossil hydrothermal deposits alignments shown by solid and light symbols, respectively. Arrows indicate the strike-slip movements.
-  Geothermal well(s)
-  Areas covered by detailed mapping
-  Lakes
-  Main road

Scale



# Instruments used for the survey



## Resistivity

- Briggs and straton 8hp motor generator
- IPC 7 2.5 K.W transmitter
- IPR 10 Receiver
- Steel current electrodes
- Copper potential electrodes

## Gravity

- Lacoste and Romberg model G-780 gravimeter was used

# Data collection and interpretation



- A total of 428 Schlumberger resistivity measurements at 107 points along 8 profiles with an areal coverage of 72 Km<sup>2</sup> were completed
- 315 Head-on resistivity data along 6 profiles oriented perpendicular to the graben on 105 points with an area coverage of 70 Km<sup>2</sup> was completed

# Contd....



- Three Vertical Electrical sounding (VES) measurements were conducted at three boreholes Td1, TD2 and TD 4
- 60 Gravity stations were established covering an area of 100 Km<sup>2</sup> on the same line with the head-on profiling

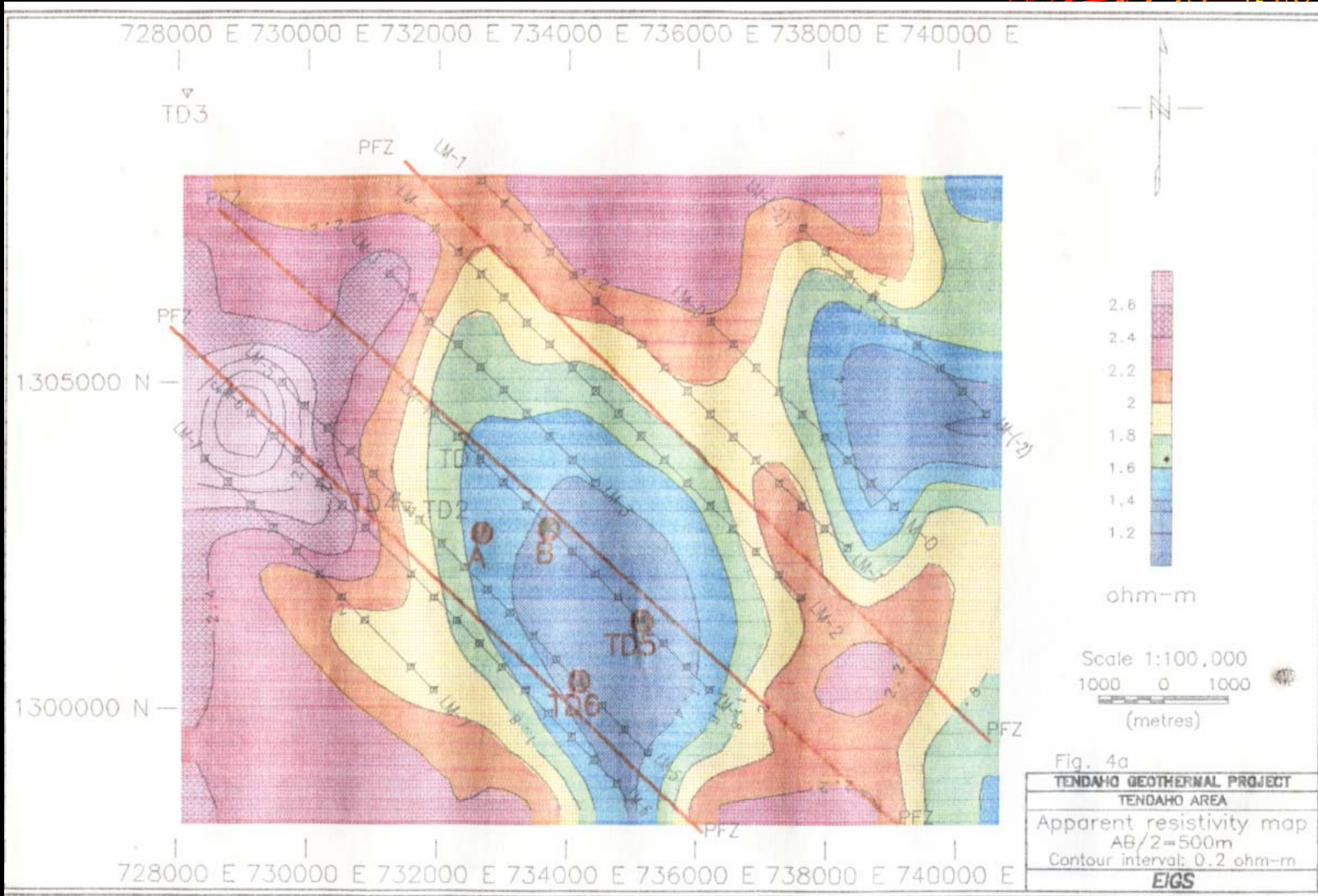
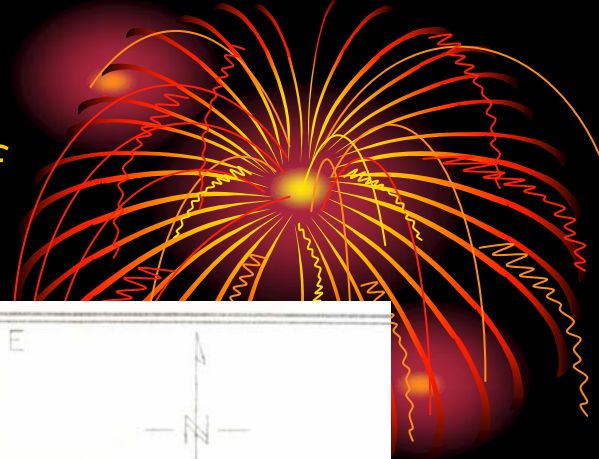


# Interpretation and discussion



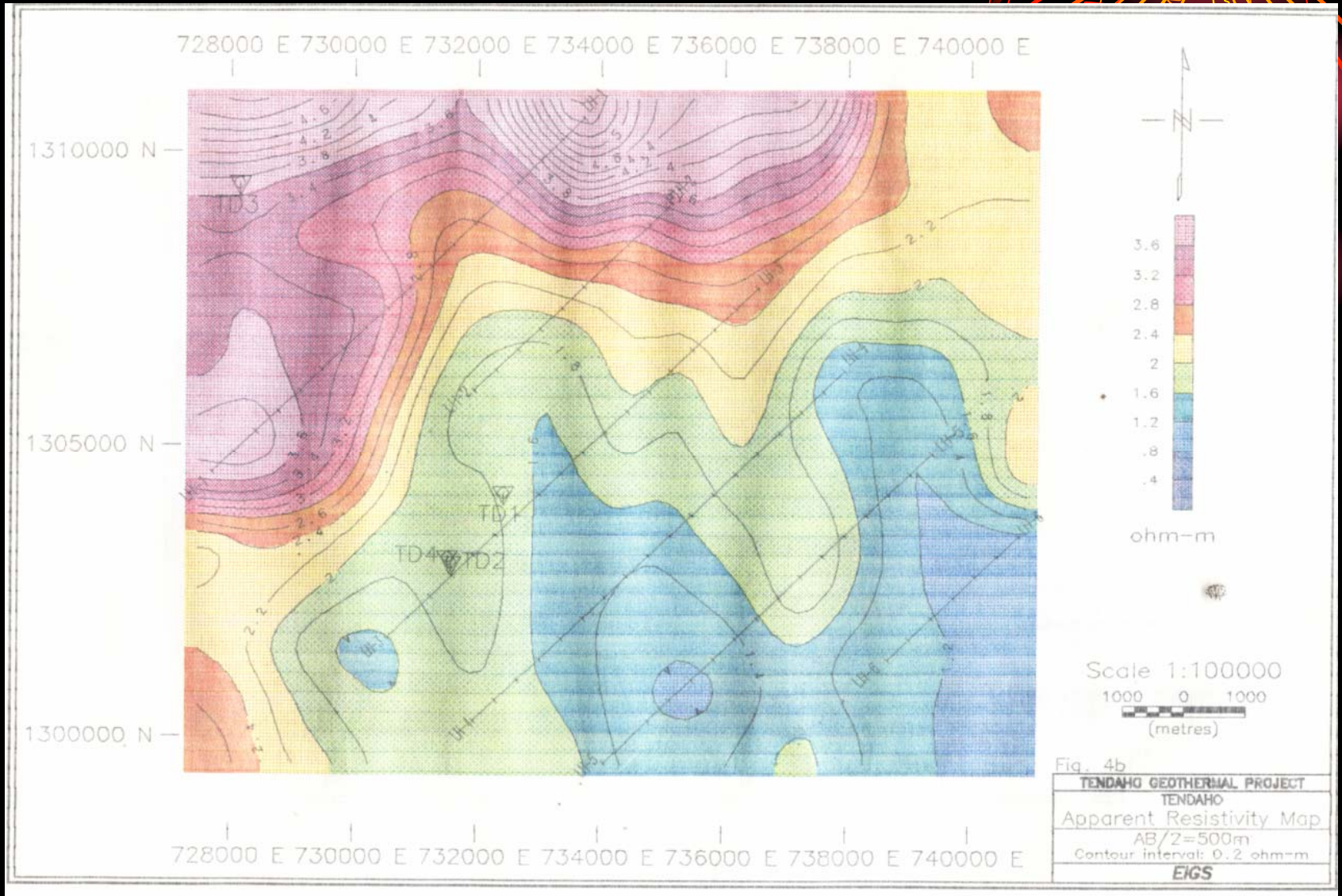
- For the Schlumberger traversing two resistivity maps of  $AB/2=500\text{m}$  and  $1000\text{m}$  is prepared
- For the Head-on profiling three resistivity readings were taken
- Resistivity map for  $AB/2=500$  and one section along six profiles is prepared

# Apparent resistivity map of $AB/2=500m$

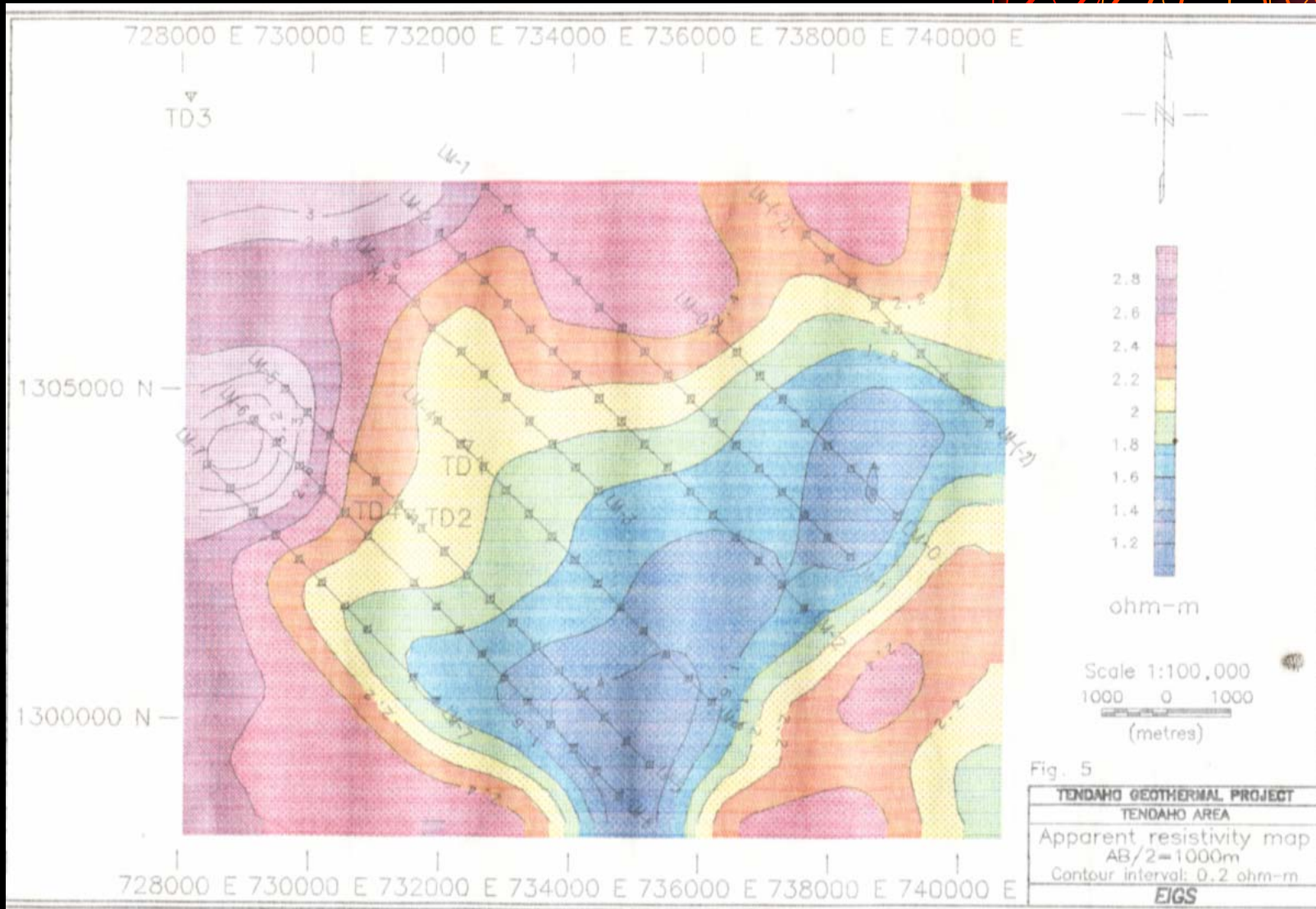




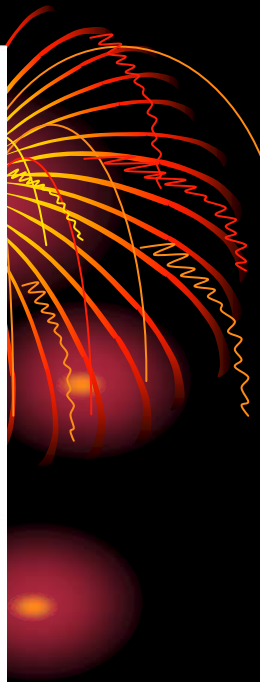
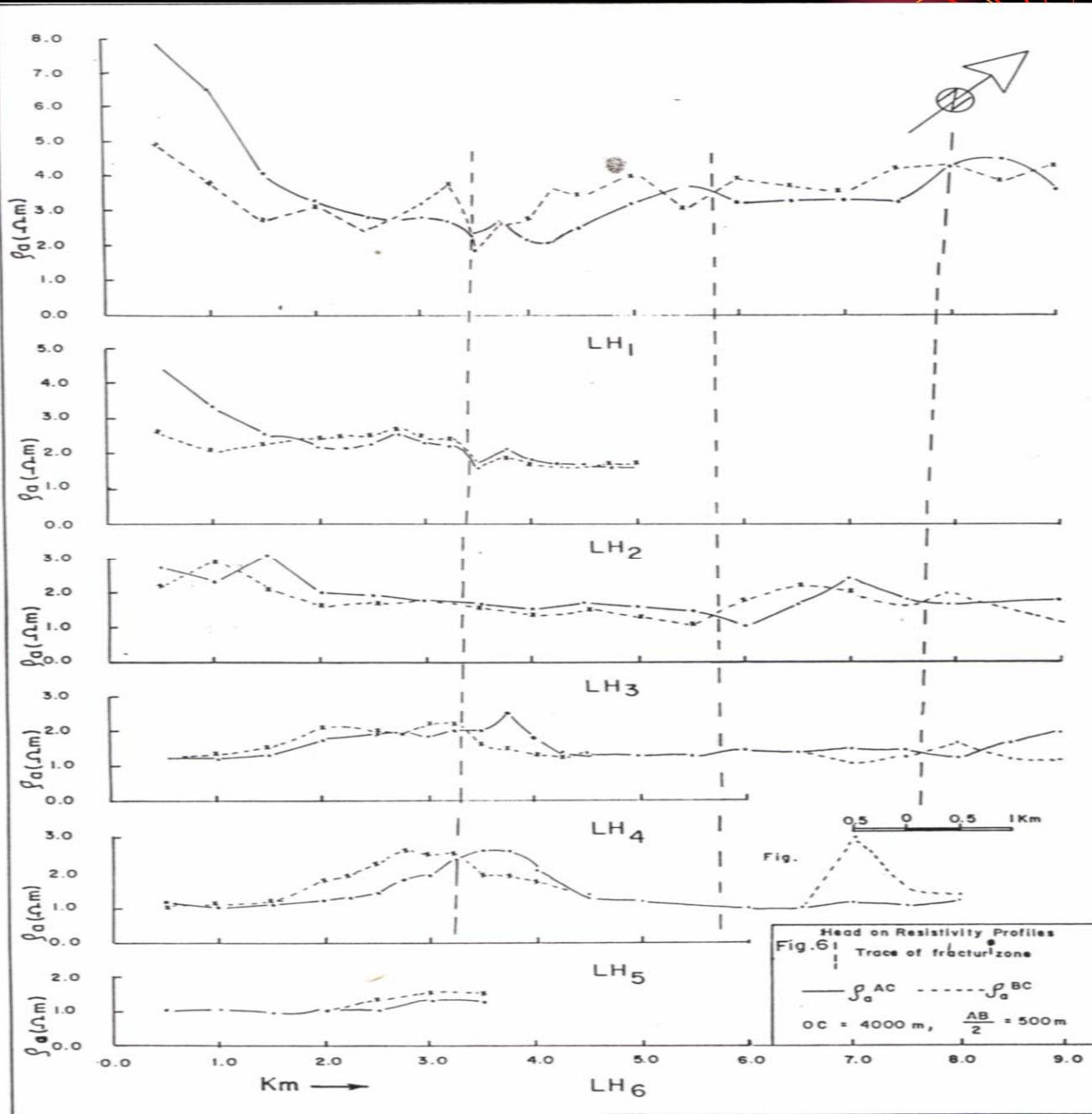
# Apparent resistivity map of $AB/2=500\text{m}$ (Head-on profiling)



# Apparent resistivity map of $AB/2=1000m$









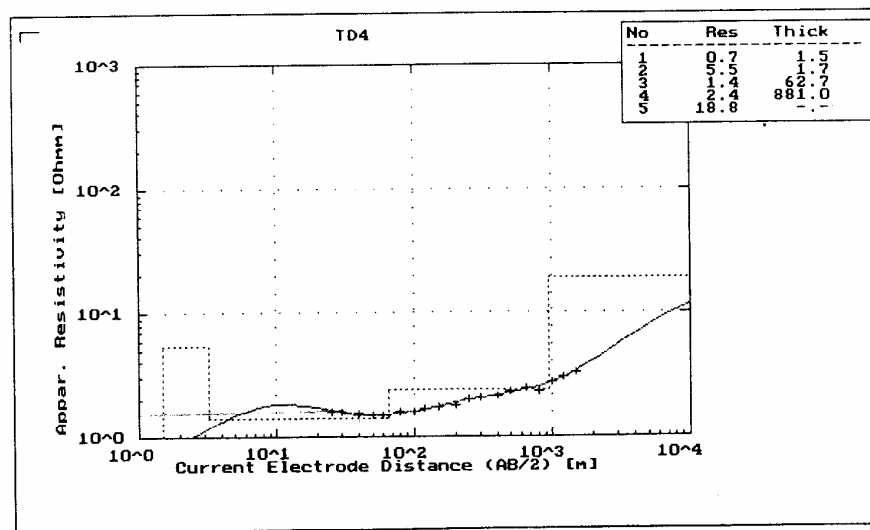
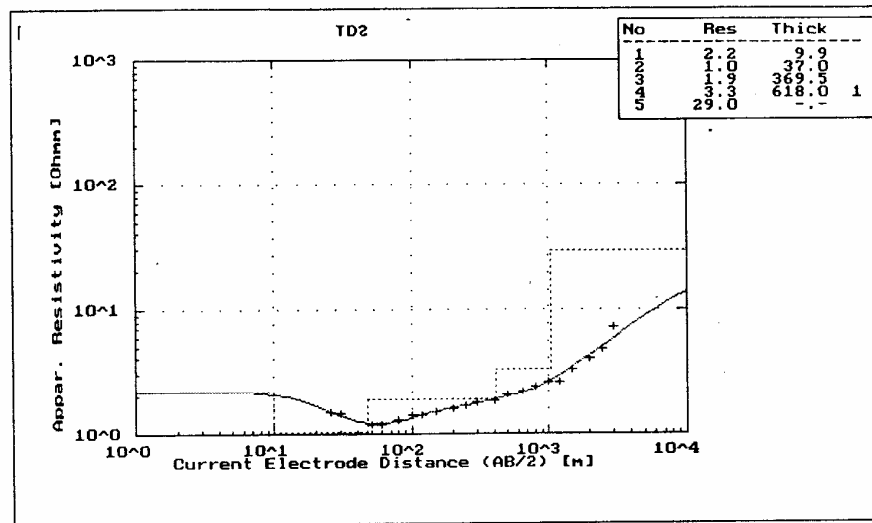
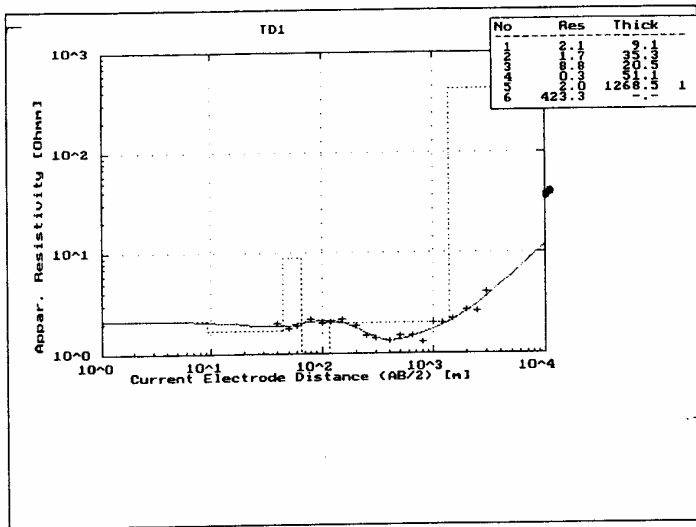


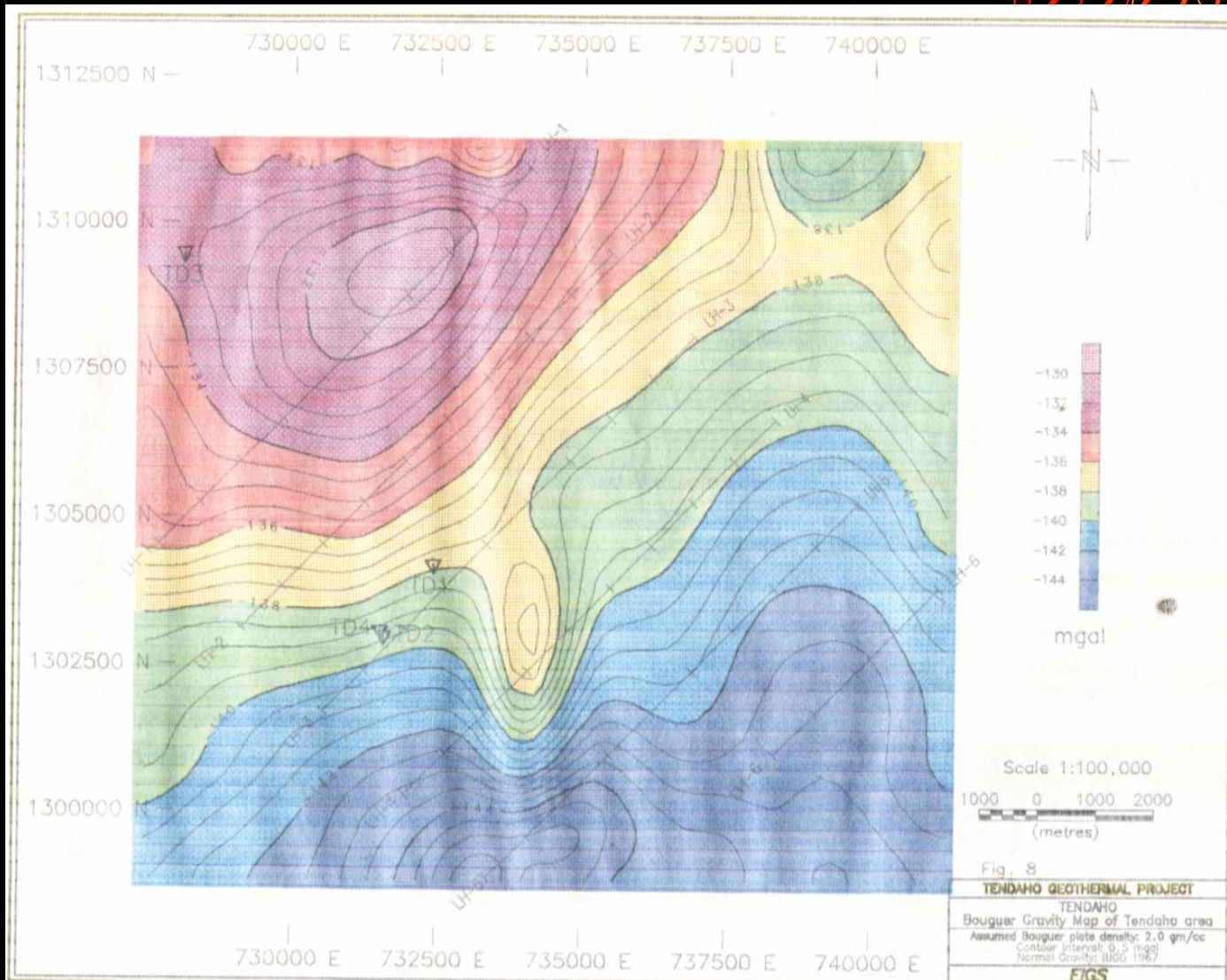
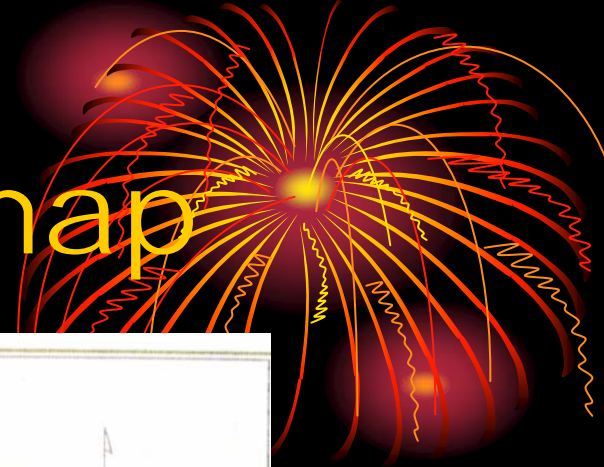
Fig.7 VES Curves & 1-D models of TD<sub>1</sub>, TD<sub>2</sub> & TD<sub>4</sub>

# Gravity data interpretation



- $\gamma = 9780031.85(1 + 0.005278895 \sin^2 \theta + 0.000023462 \sin^4 \theta)$  mgal
- The free air effect of 0.3086 mgal/m was used to calculate the free air anomaly
- $FAA = g_{obs} - 0.3086h$  mgal, (Hochstein 1982)
- The final Bouguer gravity anomaly was estimated by the formula
- $BA = FAA - 2\pi G\sigma h + T$

# Bouguer Gravity map



# Conclusion

- The geophysical survey reveals the presence of fracture zones oriented NE and NW
- These fractures are also observed in the Bouguer anomaly map
- The alignment of hydrothermal features (steaming ground, weak fumaroles and mud pools) with the low resistivity zone confirms the presence of these fractures



# Contd.....

- In all cases the hydrothermal and geophysical anomaly is controlled by the two regionally dominant structures oriented NW and NE





# Recommendation

- As a result geophysical survey conducted at Tendaho geothermal field, two borehole sites named as site A and B and TD5 and TD6 with an expected depth of 500m in both cases were recommended.



# Result of wells TD4 and TD5 (Amdeberhan, Y. 1998)



Well N°	TD 5	TD 6
Drilling date	20/12/97- 14/01/98	01/02/98 - 20/02/98
Location (UTM)	731558E 1302941N 365.2m.a.s.l	731670E 1302919N 366m.a.s.l
Measured Depth(m)	516	505
Vertical depth(m)	516	505

• Thank you

