PARTICIPATION ON FIRST EAST AFRICAN RIFT GEOTHERMAL CONFERENCE - ARGEO - C1

24 TH NOVEMBER - 2 ND DECEMBER, 2006

UNITED NATION CONFERENCE CENTER

ADDIS ABEBA, ETHIOPIA

PRESENTATION ON DJIBOUTI GEOTHERMAL DEVELOPMENT PROJECT

Title : Chemistry of Geothermal fluid, scale deposit and salinity in Assal drilled wells

BY

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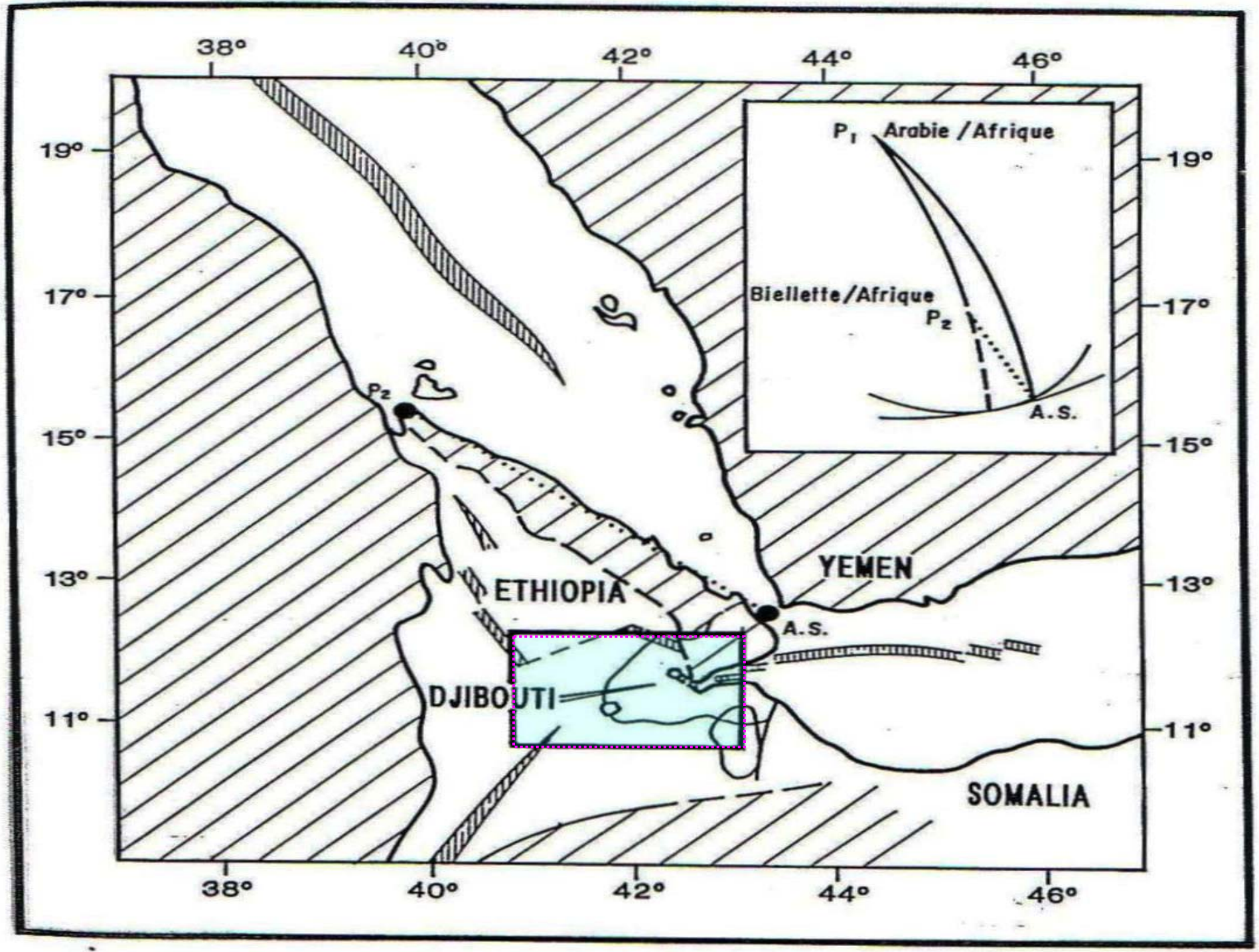
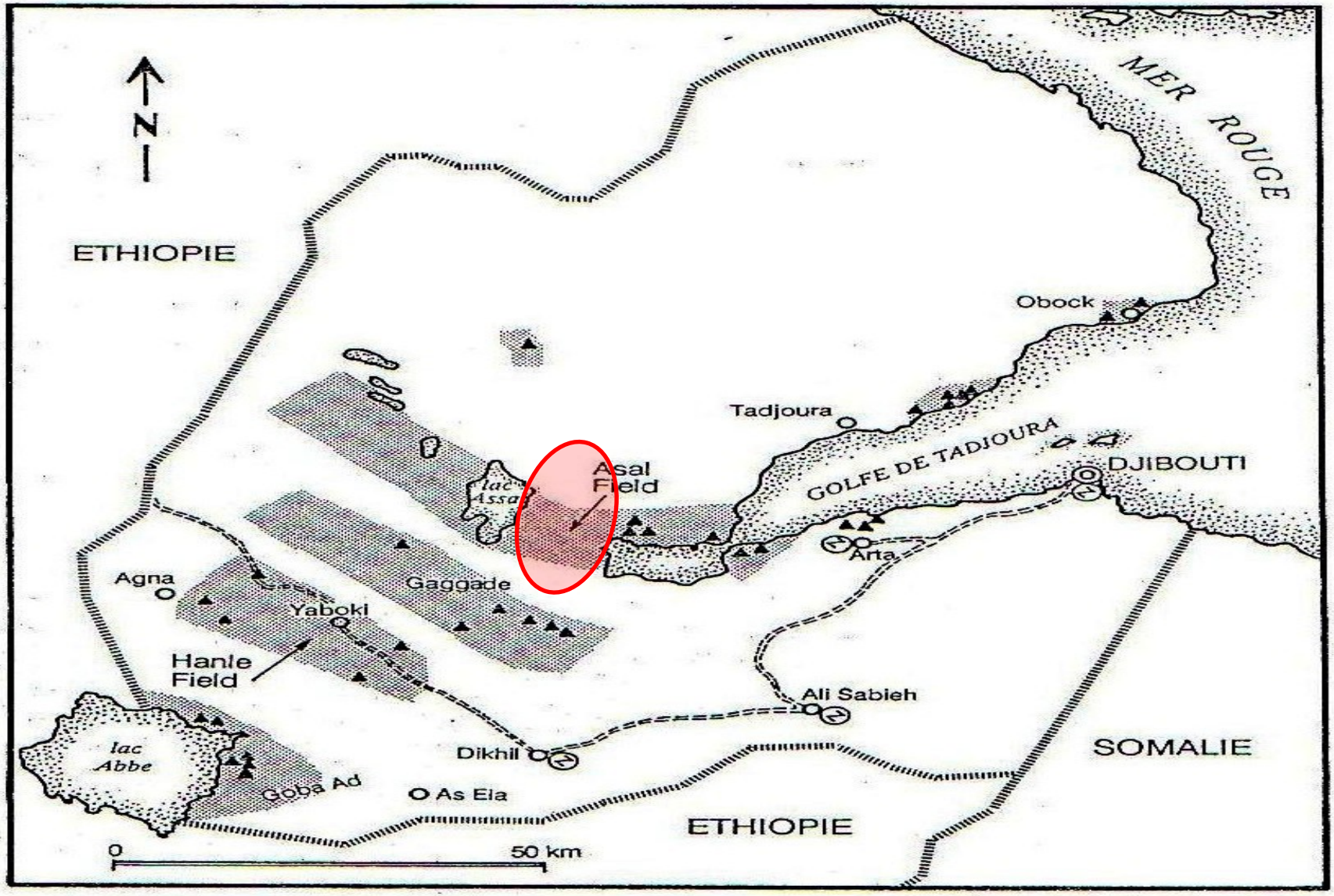
INTROCUTION

- The geologic characteristics of the territory of the Republique of Djibouti are exceptionally favorable for the industrial development of geothermal energy. In particular, Djibouti include Afar depression, also called the Danakil depression, located at the intersection of the three important tectonic structures: RED SEA, Gulf of Aden, East African rift see fig.1.1.
- It appears that Djibouti has a large geothermal potential which could almost entirely meet the country's future power demand.
- The main geothermal development project's objective was to explore the country's only known source in order to prove commercially exploitable geothermal reserves.


38°
40°
42°
44°
46°
19°
17°
15°
13°
11°
P1
Arabie /Afrique
Biellette/Afrique
P2
A.S.
P2
ETHIOPIA
YEMEN
A.S.
DJIBOUTI
SOMALIA

Republique de Djibouti

GEOTHERMAL RESOURCE AND THE CENTRE OF CONSUMPTION



Legend

- ▲ Thermal manifestation
- Zone of geothermal interest
- Principal centre of consumption

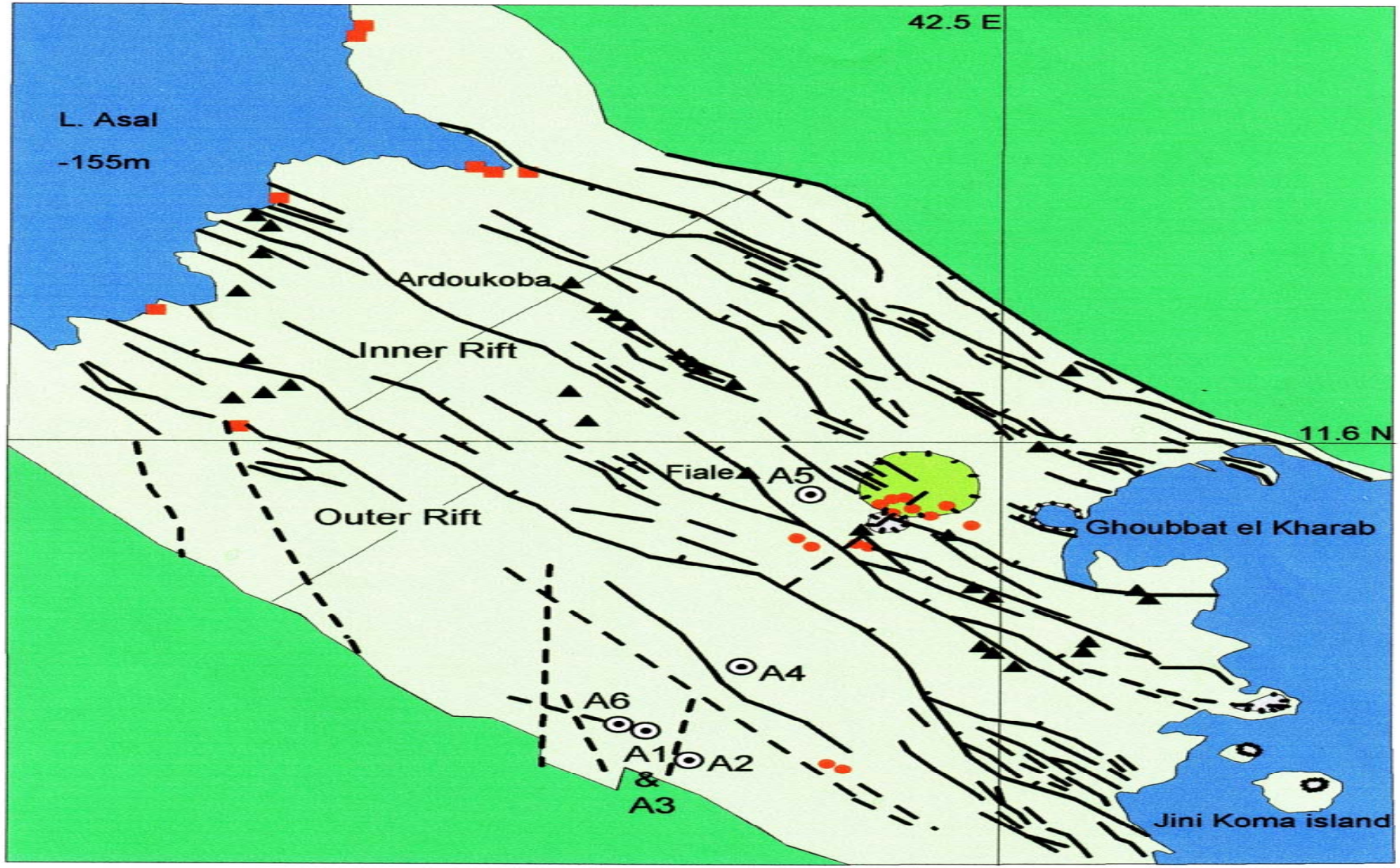


Fig. 1 Schematic Geological Map of Asal

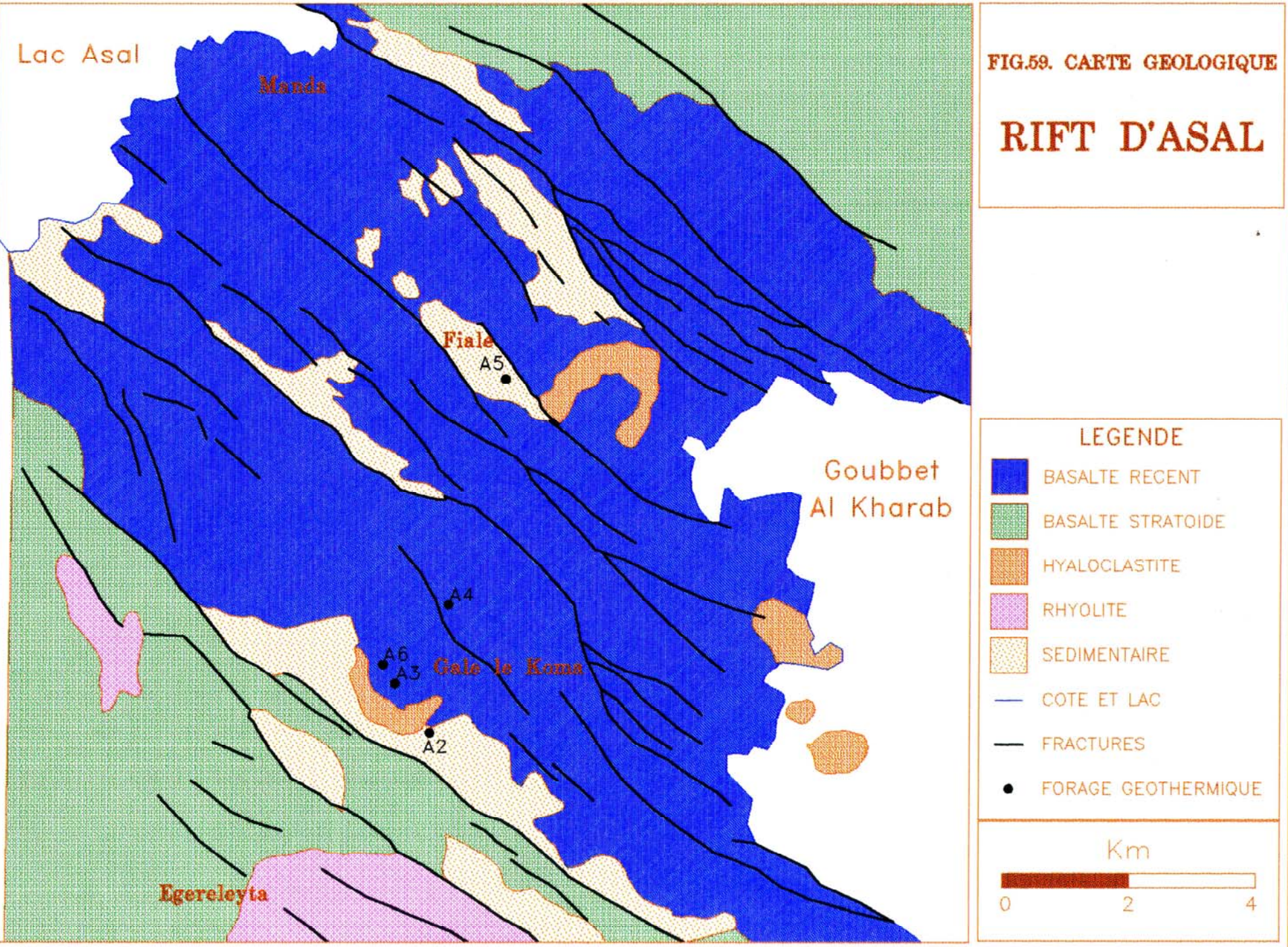

Lac Asal
Manda
Fiale
A5
Goubbet
Al Kharab
A4
A6
A3
Gale le Koma
A2
Egereleyta
FIG.59. CARTE GEOLOGIQUE
RIFT D'ASAL
LEGENDE
BASALTE RECENT
BASALTE STRATOIDE
HYALOCLASTITE
RHYOLITE
SEDIMENTAIRE
COTE ET LAC
FRACTURES
FORAGE GEOTHERMIQUE
Km
0
2
4

Table 2.1 CHARACTERISTICS OF ASSAL DRILLED WELLS

N°	Dilled wells	Beginning Of drilling	End of drilling	Final depth (m)	Temperature at bottom (°C)	Total mass flow (t/h)	Salinity g/l	Drilling last (days)
1	Assal 1	8-03-75	12-06-75	1146	260	135	120	97
2	Assal 2	1-07-75	10-09-75	1554	233 (926m)	-	-	72
3	Assal 3	11-06-87	11-09-87	1316	264	350 (WHP = 12,5Bars)	130	93
4	Assal 4	15-09-87	21-12-87	2013	359	-	180	97
5	Assal 5	7-01-88	7-03-88	2105	359	-	-	61
6	Assal 6	8-04-88	10-07-88	1761	265	150	130	94
							Total	524

Table 3.1 **ASSAL 3 WELL FIRST AND SECOND DELIVERABILITY PARAMETERS**

TOTAL MASS FLOW			
Well head pressure (barg)	**19/12 – 22/12 1989 (day 1-4) Kg/s**	**17/03 – 22/03 1990 (day 89 – 90) Kg/s**	**Percent of original flow remaining**
13.6	51.7	38.7	75%
16.5	45.3	33.2	73%
19.3	36.5	26.2	72%

Table 3.1.1 CHEMICAL COMPOSITION OF THE BRINE FROM ASSAL 3 WELL

(Shown as residual value in ppm by weight)

Element	Na	K	Ca	Mg	Fe	Li	Zn	Pb	Cl	SO_4	SIO_2	H_3BO_3	CO_2	$HC0_3$	H_2
Concentration	29000	5500	18500	30	35	35	32	3	81000	25	470	50	2000	30	40

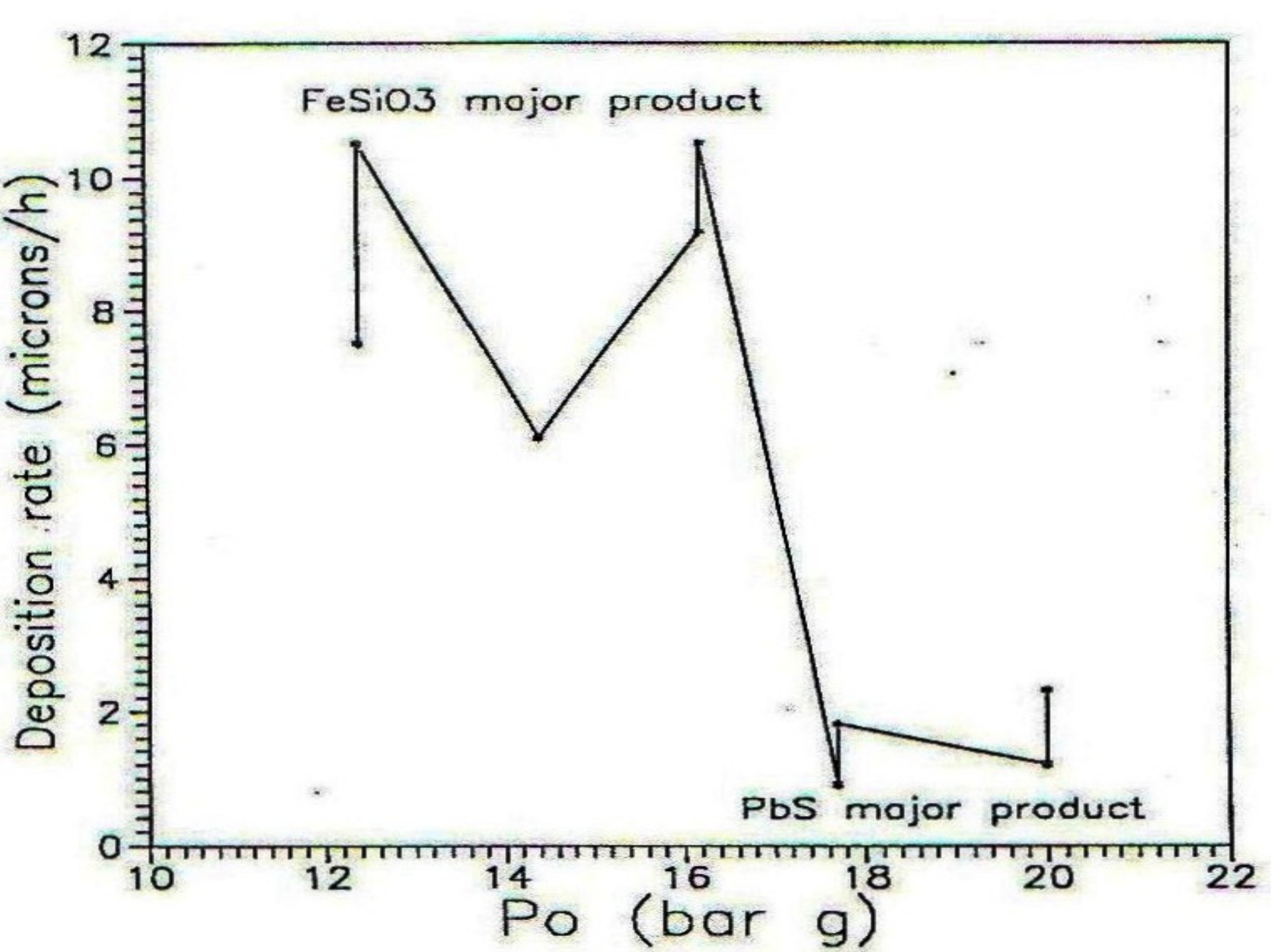
Temperature 262°C ; PH = 4.2

Before the inhibitor injection the scaling look like:

- At well head pressure ranging between 18-20 bars g
  ➔Precipitation of lead sulphide Pbs – galena and Zinc sulphide Zns – sphalerite

- At well head pressure ranging 16 – 12 bars g
  ➔ Precipitation of iron silicates

- At well head pressures < 12 bars g
  ➔ Precipitation of amorphous silica


FeSiO3 major product
PbS major product
Deposition rate (microns/h)
Po (bar g)
0
2
4
6
8
10
12
10
12
14
16
18
20
22

Conclusion

With the Assal drilled wells (A1 to A6) the highly potential geothermal reservoirs useful for power generation have been proved to exist. In particular well Assal 3 is considered still usable and has a capacity to generate about 6MW; somehow some rehabilitation of this well will be necessary.

The following useful informations have to be mentioned:

- **First :** Well Assal 3 not has been discharged since 1990 and scaling inside the well increases as it discharges an air lift pipe has been left inside during the discharging test.
- **Second :** Geothermal potential (size and chemical and physical characteristics) of the reservoir and geothermal structure have not been verified.

The man recommendation are the following :

- Extensive field tests lasting more 6 moths should be performed to obtain more accurate data for estimating the actual size and capacity of the reservoir.

- Apparently there is an extensive high permeability aquifer at 400-600m with 130°C. This temperature is very suitable for utilization with a binary condensing turbine, an investigation of this aquifer is recommended.

Needs to be done :

1) some investigations of the wells by
removing the scale inside the well
and removal of the left pipe are necessary

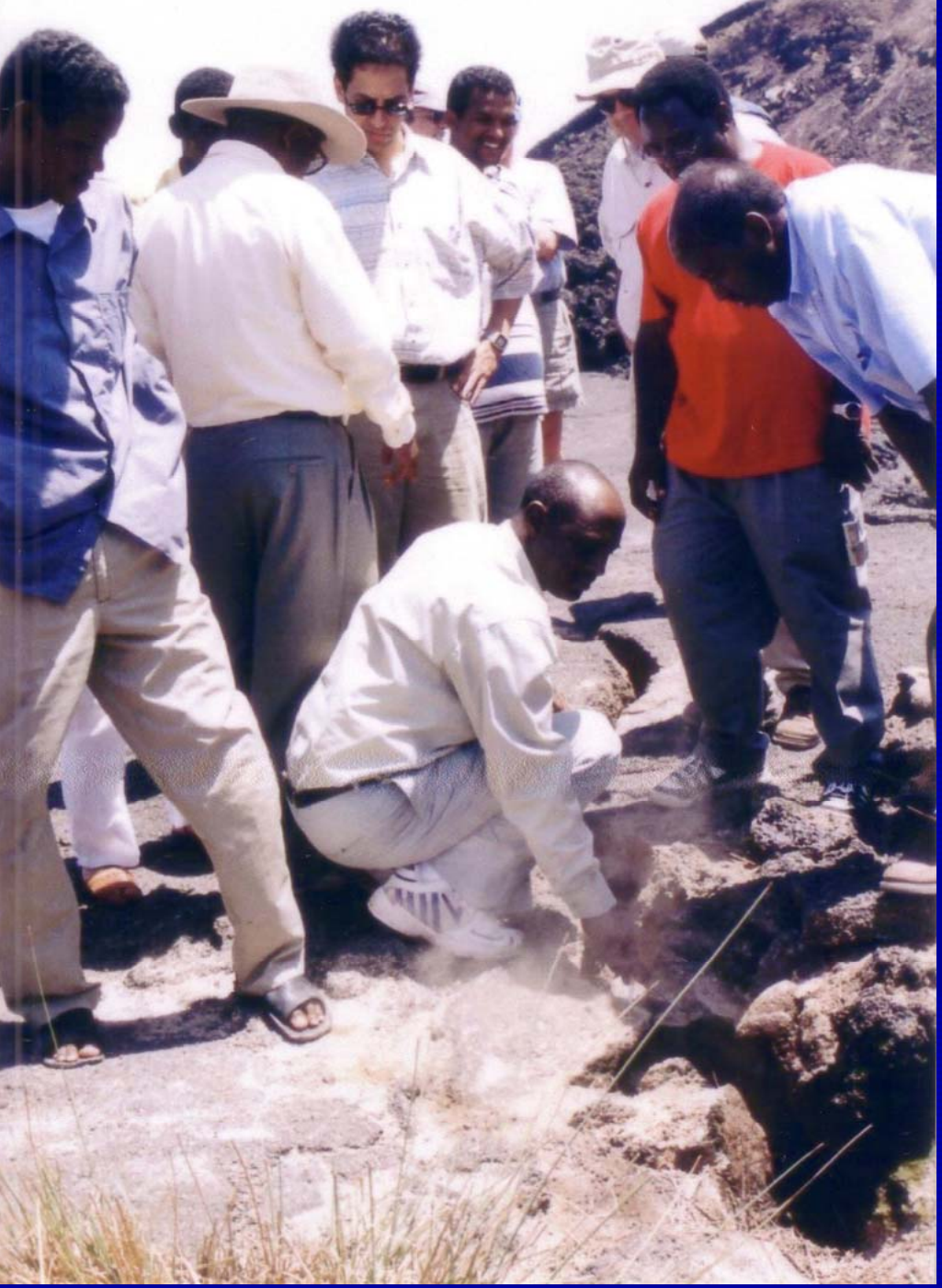
2) Resource feasibility study for future 30 MW geothermal power development.

For that the planned field activities are the following:

- **Firt** : to clean up well Assal 3 by means of rig operations
- **Second** : to develop 5-10 MW pilot plant
- **Third** : to construct power line to the power center, Djibouti city
- **Fourth** : to carry out the detailed feasibility study for future development.

After the completion of the study the following recommendation were formulated :


Aquatar

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