ANALYSIS OF GEOTHERMAL WELL TEST DATA FROM THE ASAL RIFT AREA, REPUBLIC OF DJIBOUTI

ARGeo C2 CONFERENCE
ENTEBBE, UGANDA

Daher Elmi
CERD, DJIBOUTI

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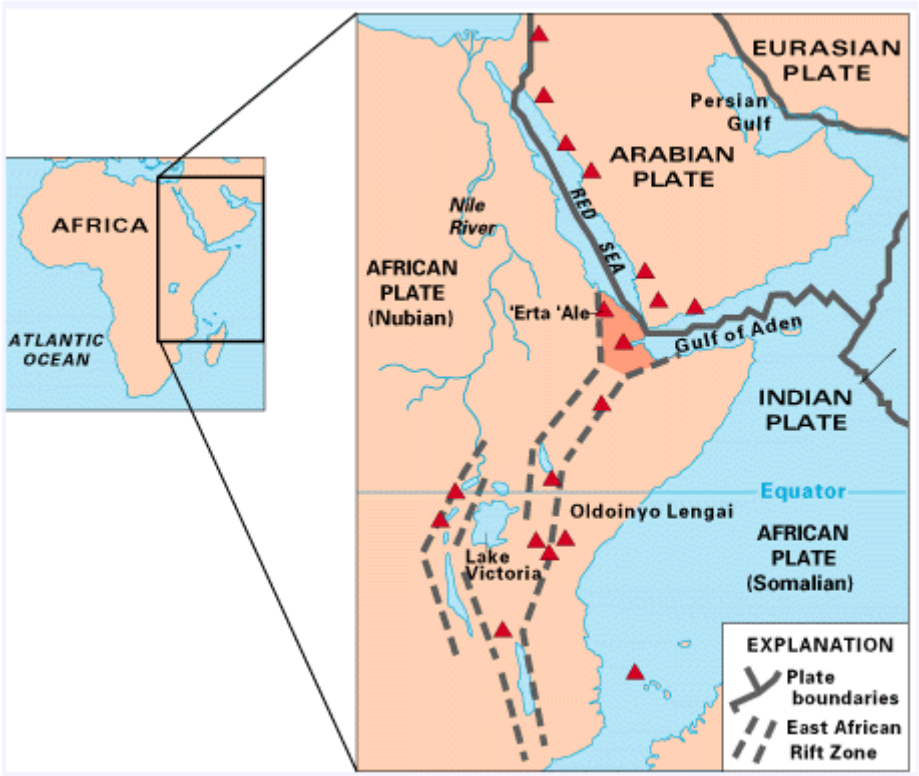
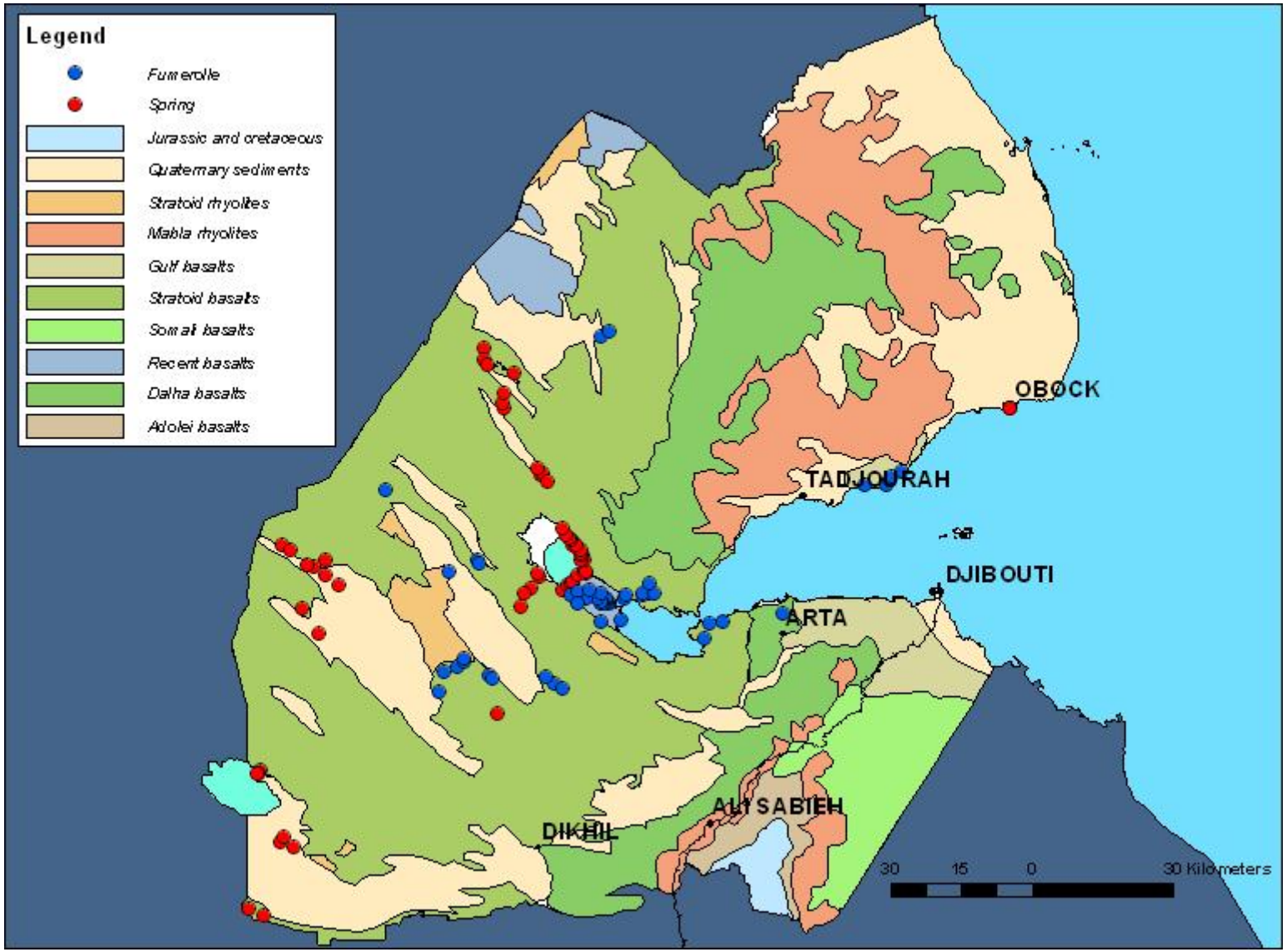
INTRODUCTION



3 major extensional structures as the Red sea, the East Africain rifts and the Gulf of Aden join forming the Afar Depression.

GEOLOGY, SURFACE MANIFESTATIONS AND PROSPECTS



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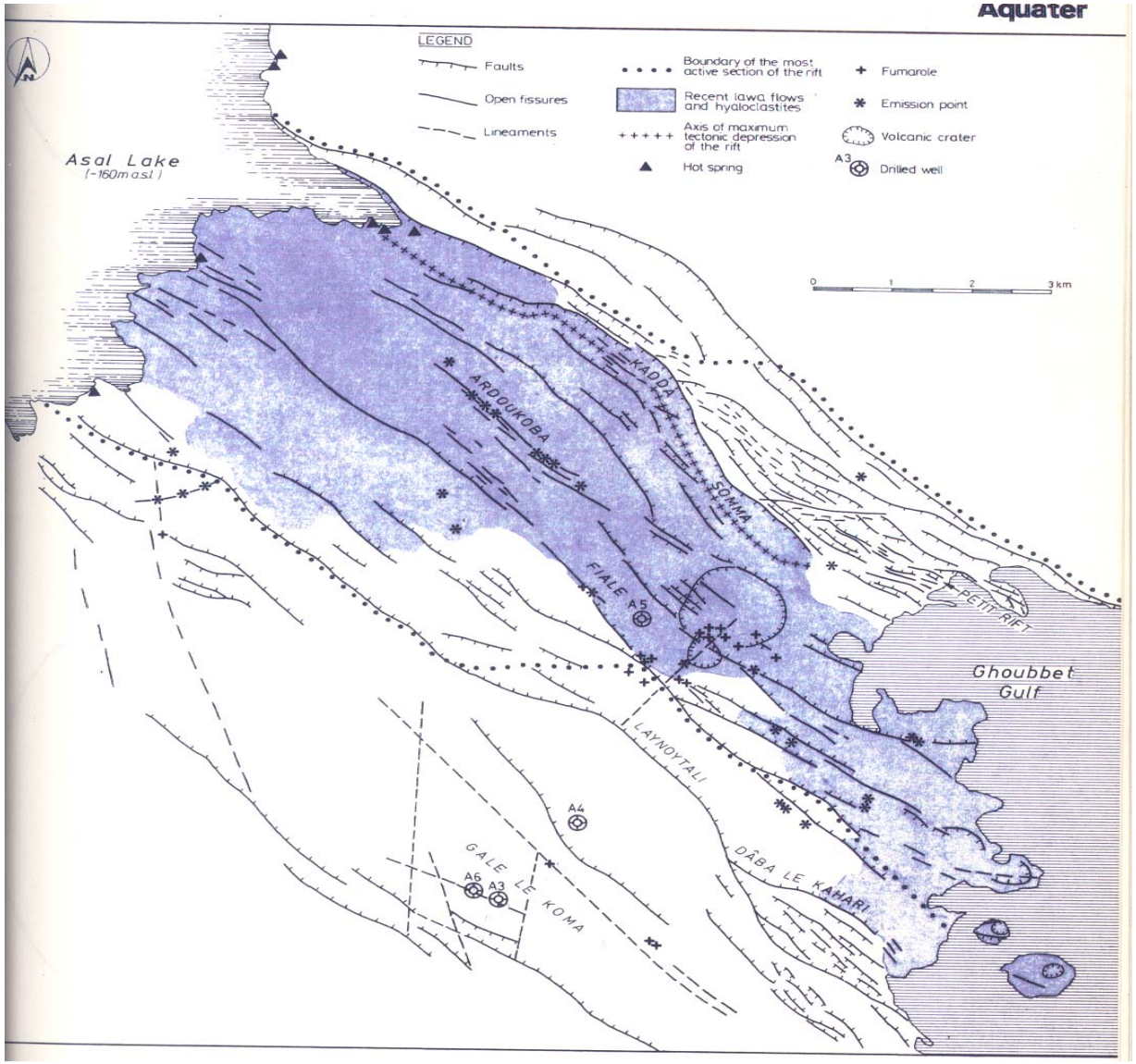
ASAL AREA



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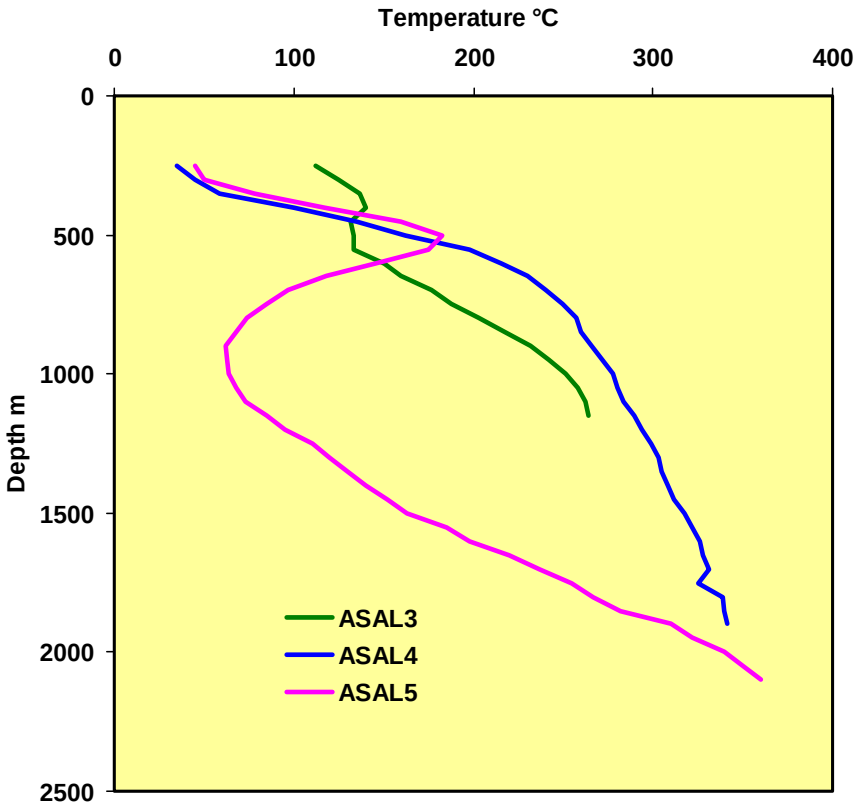
Asal geothermal area. Temperature profiles



Well	Depth (m)	Temp. Max (°C)	Temp. Gradient (°C/100m)
A1 (1975)	1145	261	18
A2 (1975)	1554	235	14.3
A3 (1989)	1316	280	15.51
A4 (1989)	2013	345	15.2
A5 (1989)	2105	360	15.2
A6 (1989)	1761	280	12.75

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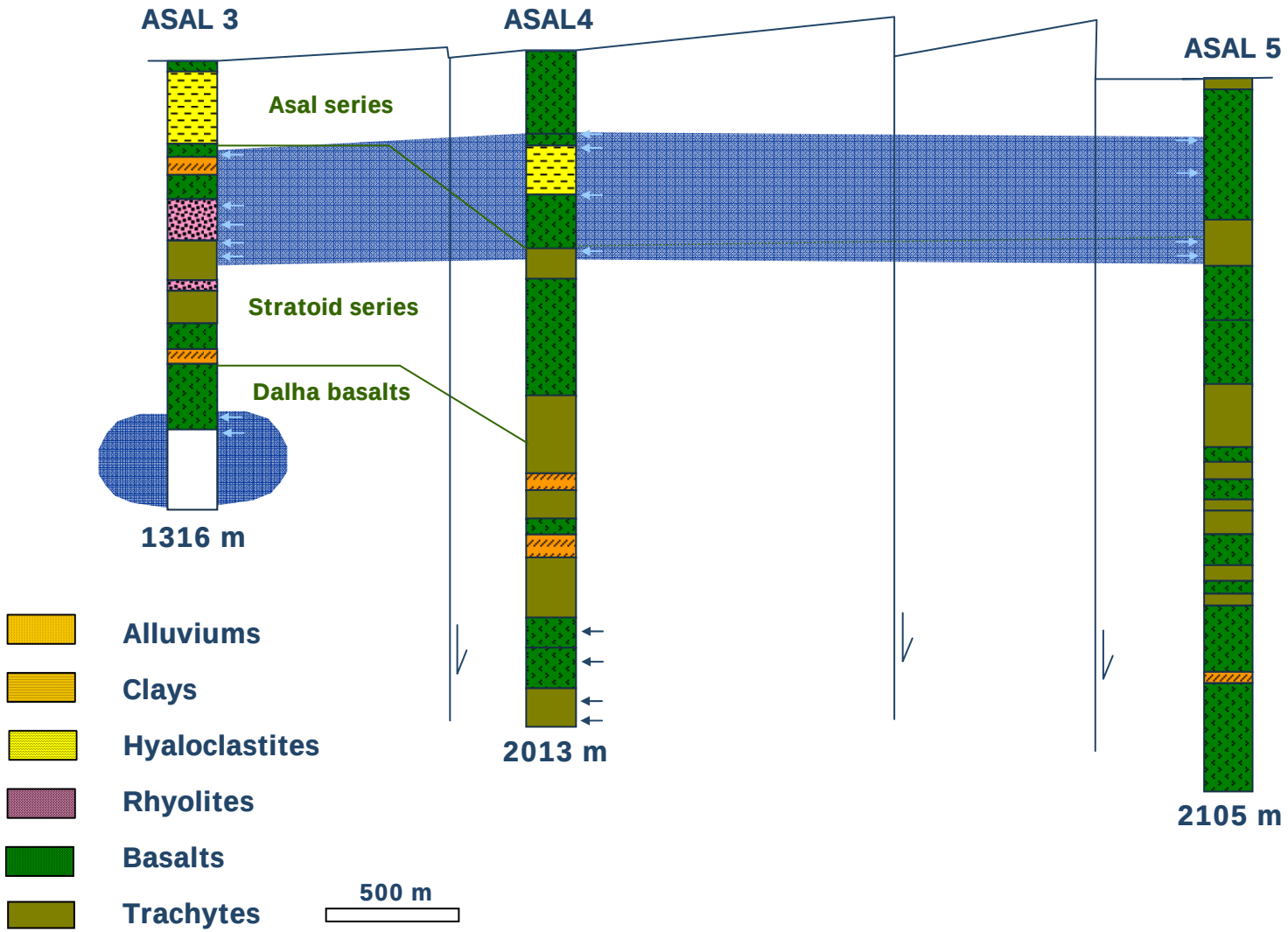
MAIN GEOCHEMICAL RESULTS

- Thermal fluids result from basalt-sea water interaction
- This interaction is influenzed by evaporation
- Some hot springs could be mixed with Asal lake waters

INTERPRETATIVE CROSS-SECTION OF ASAL FIELD



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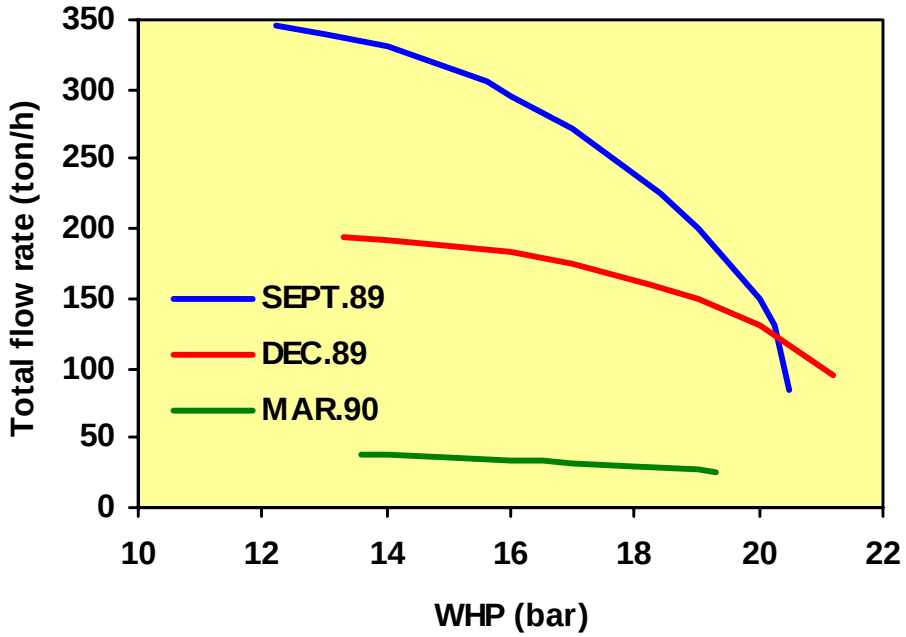
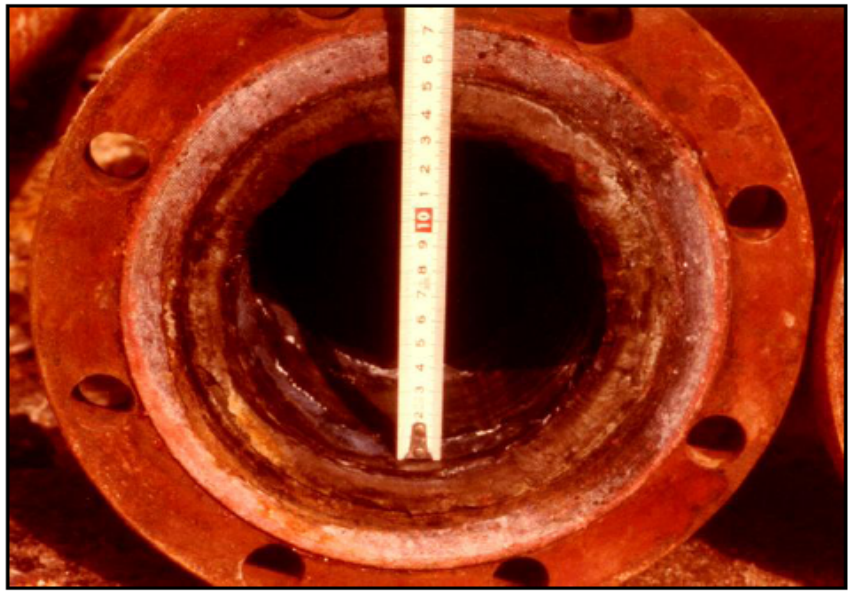
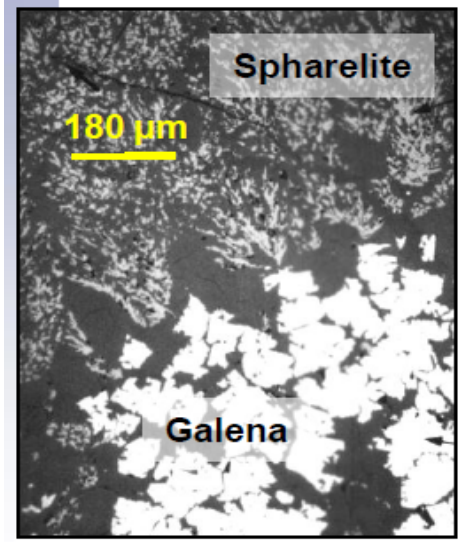
PRODUCTION TESTS OF WELL ASAL 3



- **Reservoir depth: ~ 1000 m**
- **Reservoir temperature: 260°C**
- **MWHP: 21 bars**
- **Flow: 350 ton/h**
- **Vapor fraction: 30-35%**
- **Reservoir fluid: 120 g/l**
- **Kh: 6.3 and 15 dm**
- **Scaling in wellbore**

Scale deposits in 6 inch production liner A1 geothermal well(BRGM-CERD 1981)





Sulphide deposits 300 m depth

Baryte x3000 Silencer deposits

HYDRODYNAMIC PROPERTIES OF THE DEEP RESERVOIR IN ASAL RIFT ZONE

ASAL3 Drawdown tests

		Semilog	Bilog	
Wt ton/h	ΔQ ton/h	kh dm	skin	kh dm
79 - 130	51	15.6	- 5	15.6
Multiple		15.9		
155 - 225	70	15.7 5.7	- 5 - 5	16 6
225 - 300	75	6		
300 - 357	57	13.4	- 5	13.4

ASAL3 recovery tests

Wt ton/h	ΔQ ton/h	kh dm
357 - 0	357	7.3
87 - 0	87	5.8

ASAL4 injectivity test

		Semilog	Bilog
	Q m3/h	kh dm	kh dm
Injectivity	70	0.6	0.7
After injection		0.28	

ASAL6 Drawdown tests

		Semilog	Bilog	
Wt ton/h	ΔQ ton/h	kh dm	skin	kh dm
Multiple		4.11		
Multiple		6.4		
65.2 - 78.3	13.1	6.9	10	3.7

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DEEP RESERVOIR RESULTS IN ASAL

- Reservoir recognized in ASAL 1, ASAL 3 and ASAL 6 (in the same area)
- Temperature 260 °C to 280 °C
- Reservoir: Dalha basalts (9 -4 My), 1050 m to 1300 m
- ASAL 3 production:
  - Initial characteristics: total mass flow 360 t/h for 12.5 WHP
  - Kh: 6.3 dm
  - TDS in the reservoir: 116 000 ppm
  - Scaling in the well (6 to 10 mm): sulphides (PbS, ZnS)
  - Scaling in surface equipment: amorphous Si with Fe and Mn
  - Severe decrease of production rate
  - Decrease of bottom hole pressure

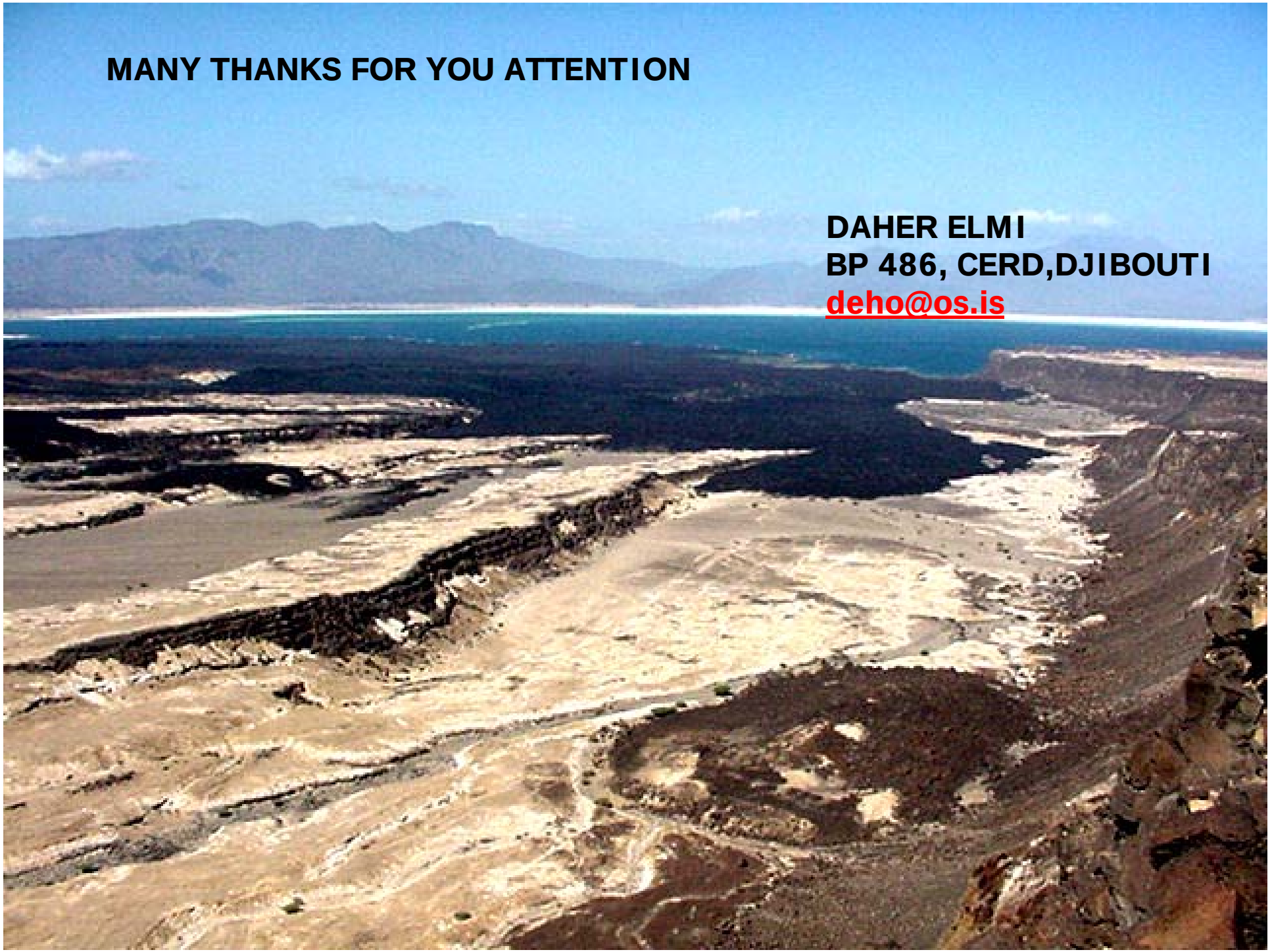
ASAL INTERMEDIATE RESERVOIR

- Recognized in all Asal geothermal wells but not yet studied
- Reservoir: Top of Stratoid series and the bottom of Asal series
- Locatedbetween300 m and 600 m
- Temperature 130 °C to 190 °C
- TDS : 50 g/l

NEXT STAGE FOR ASAL AREA

- All electricity in Djibouti generated with oil.
- Contract between the Government of Djibouti and Reykjavík Energy on a exclusive licence for geothermal exploration signed in February 2007.
- Pre-feasibility study completed before end of March 2008.
- Heads of Terms for a Project Agreement with the Government and a Power Purchase Agreement with Electricité de Djibouti was signed April 2008.
- Initial plans are for a 50 MW plant in the first phase, later extension to 100-150 MW

MANY THANKS FOR YOU ATTENTION



DAHER ELMI
BP 486, CERD,DJIBOUTI
deho@os.is