Exploring the potentiality of geothermal energy in Egypt using multi data sources and models

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LEAP-RE

Long-Term Joint EU-AU Research and Innovation Partnership on Renewable Energy

Geothermal Atlas for Africa (GAA)

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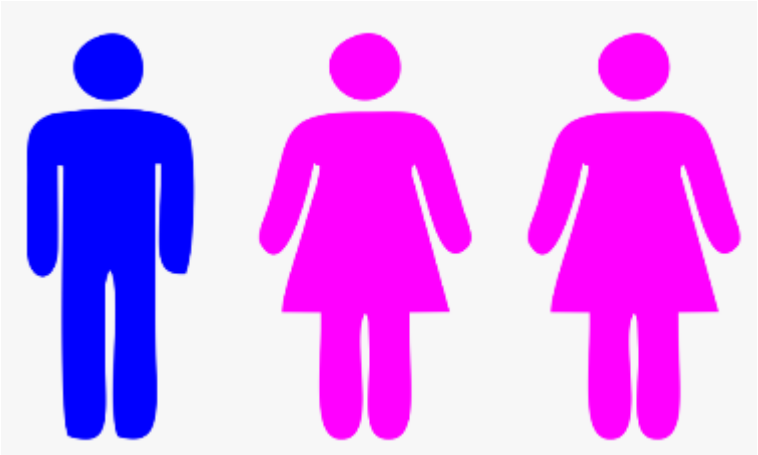
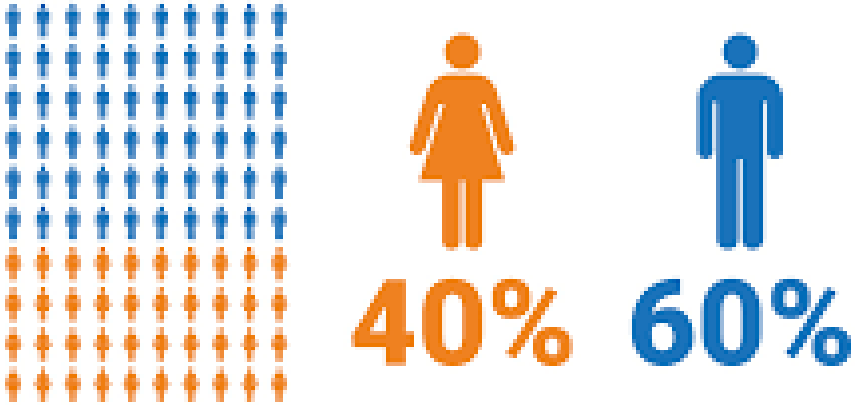


Project Gender Balance



Overview

- ***Background***
- ***Geothermal energy in Egypt***
- ***Data and models***
- ***Potentiality of geothermal***
- ***Way forward***
- ***Conclusion***

Background

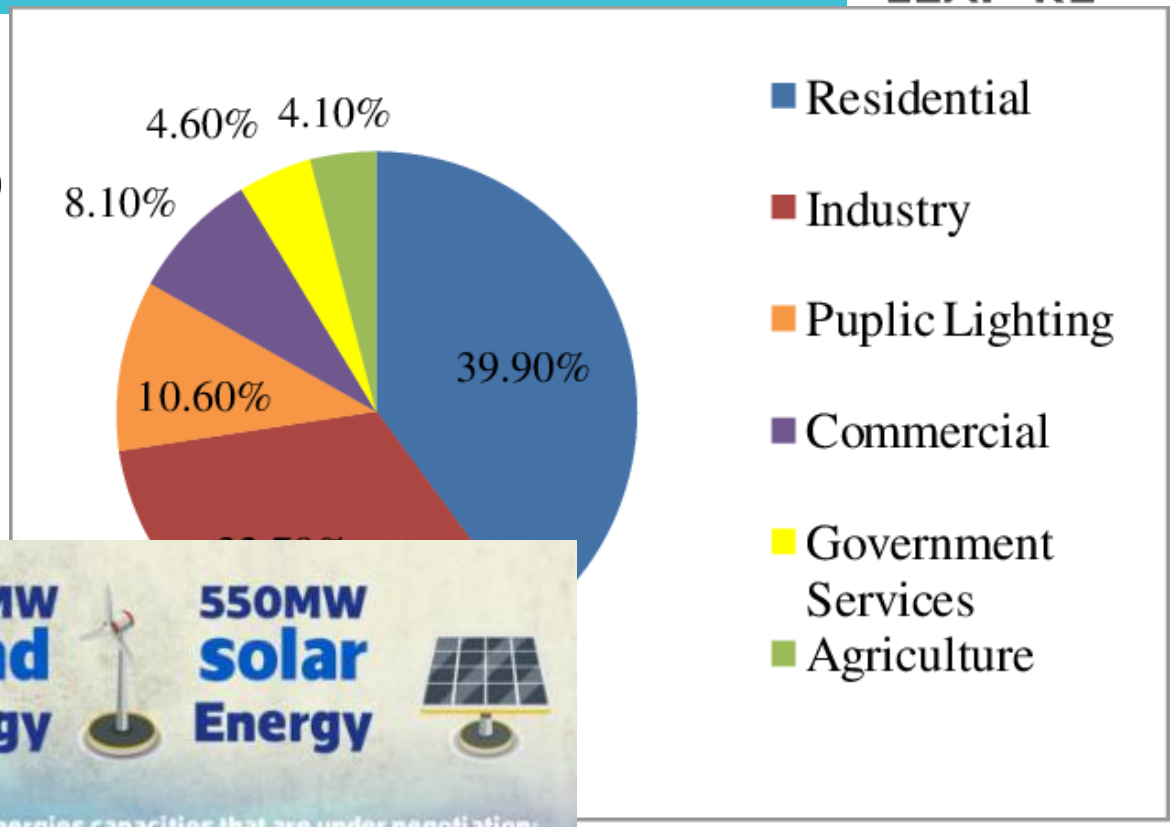
- ***Egypt's demand for electricity is growing rapidly to meet population growth, urbanization and economic growth.***

- ***Egypt energy budget is limited and needs to develop alternative power resources is becoming urgent. Therefore, renewable energy production is on the top agenda.***

- ***Geothermal energy is becoming a clean option.***

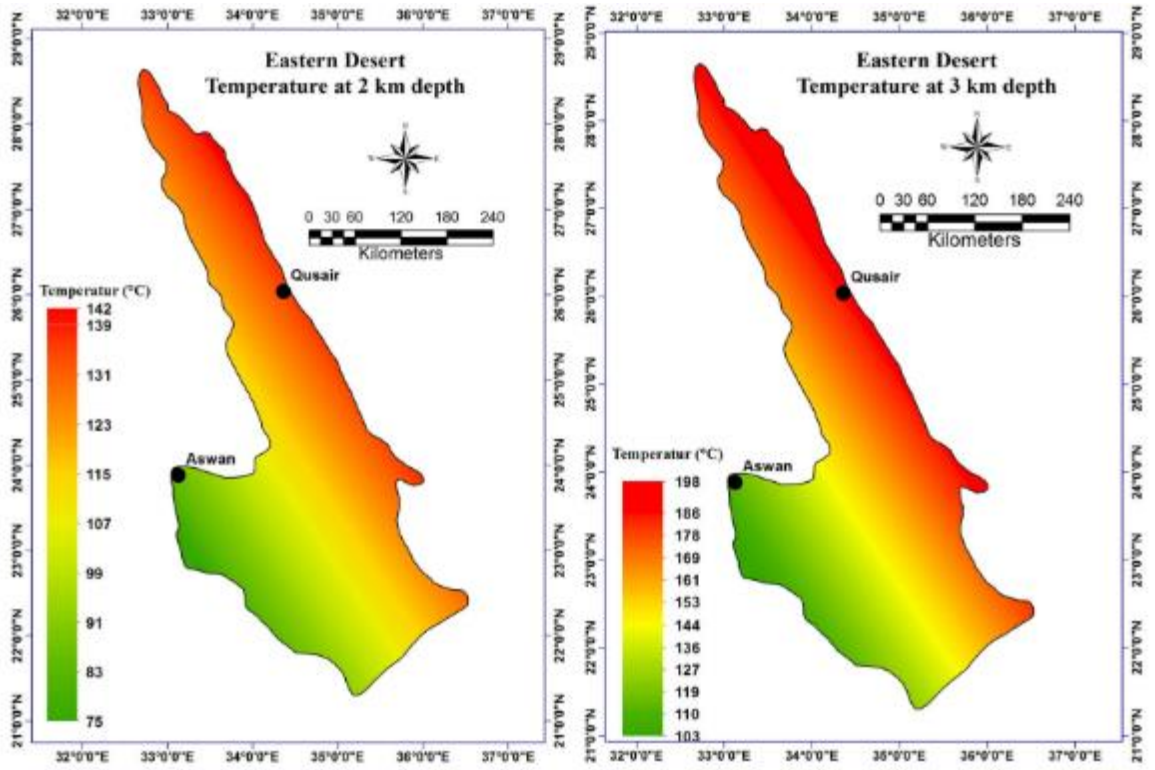
Egypt Energy Status

- Egypt generates nearly 170 TWh to secure its requirements
  - Residential
  - Industry
  - Public lighting
  - Commercial
  - Government service
  - Agriculture



High enthalpy geothermal resources

- **Geothermal anomalies encountered in the rift of depo-centers areas of the Gulf of Suez and Red Sea.**



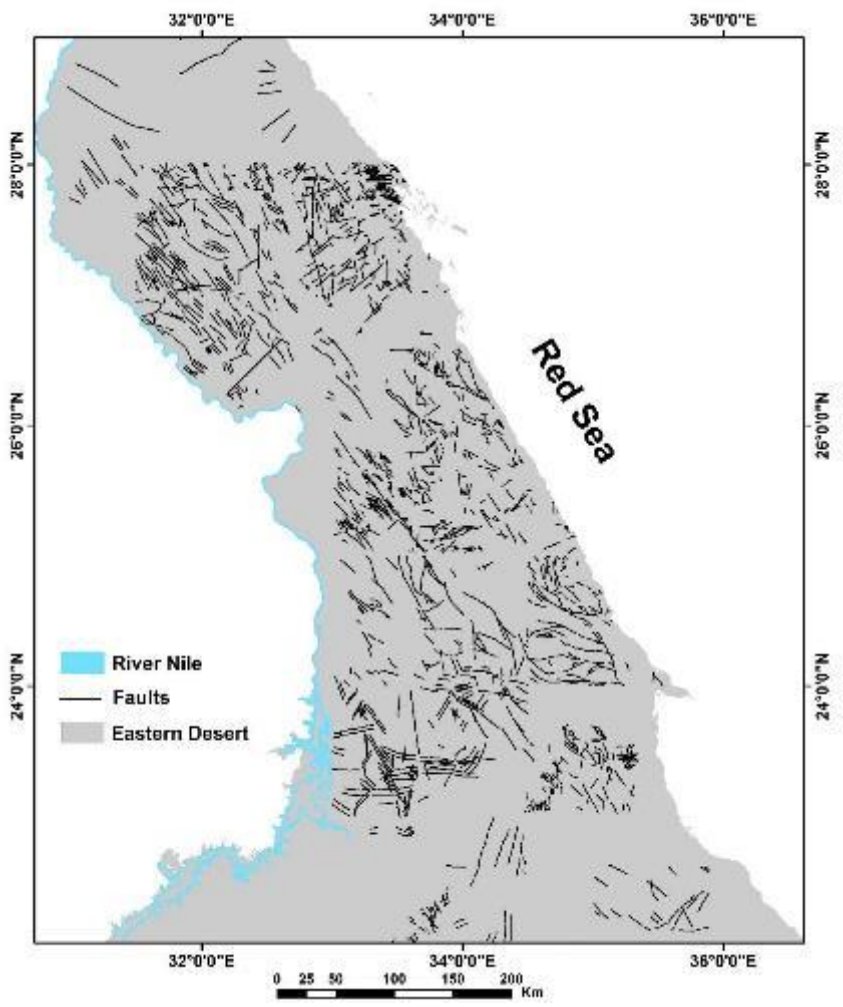
Potential Geothermal Sources-1

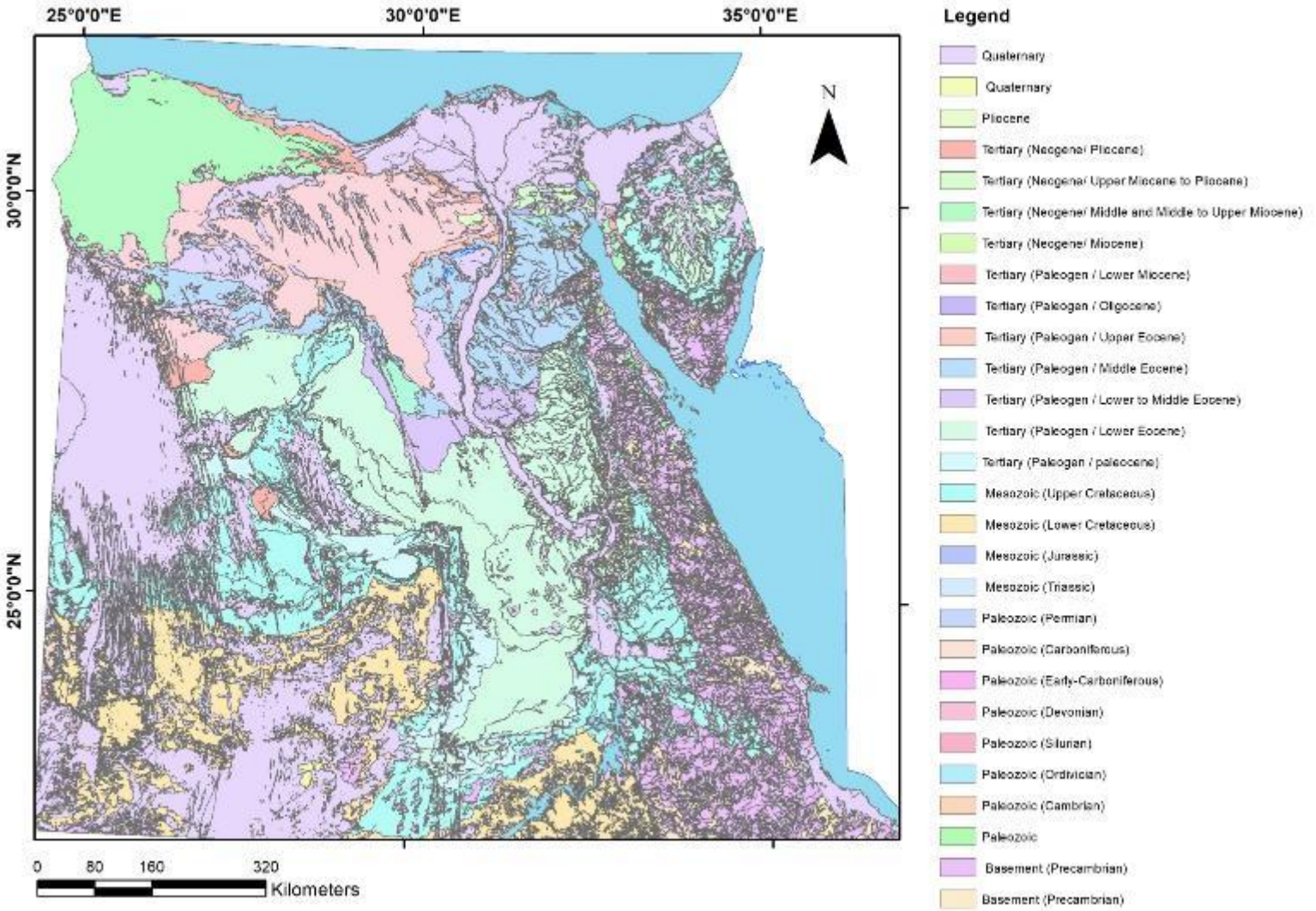
- ***Hot springs in oases located in the western desert such as: Kharga, Baharyia, Farafrah, and Dakhla oases.***
- ***Hot springs around Gulf of Suez, Ain El Sukhna and Helwan Sulfur springs.***
- ***Some locations in Sinai.***
- ***Surface temperature is in range from 30 ℃ to 45 ℃***

Potential Geothermal Sources-2

- ***Most important one is Hammam Faraun which can produce water of temperature to 76 ℃ at the surface.***
- ***In Hammam Faraun-Sudr area the estimated formation temperature reaches 128℃ at a depth of 1.720m, which is considered high as compared with other comparable depth (Lashin, 2015).***
- ***Lashin (2013) pointed out that Hammam Faraun area attains the highest recorded subsurface formation temperature 94.86 ℃ and heat flow (121.67 mW/m2)***

Geology and geoscience

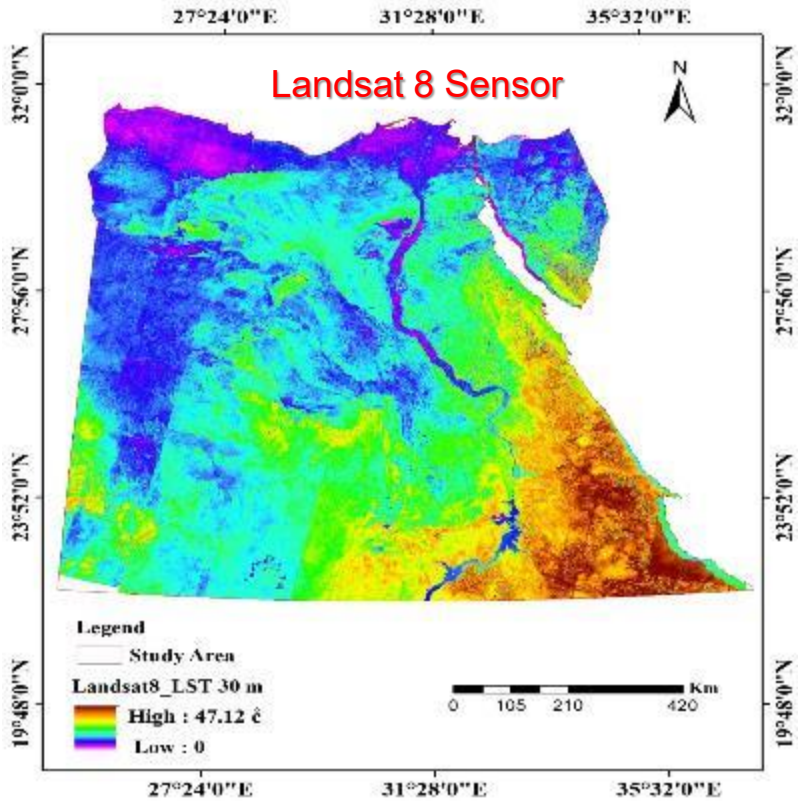


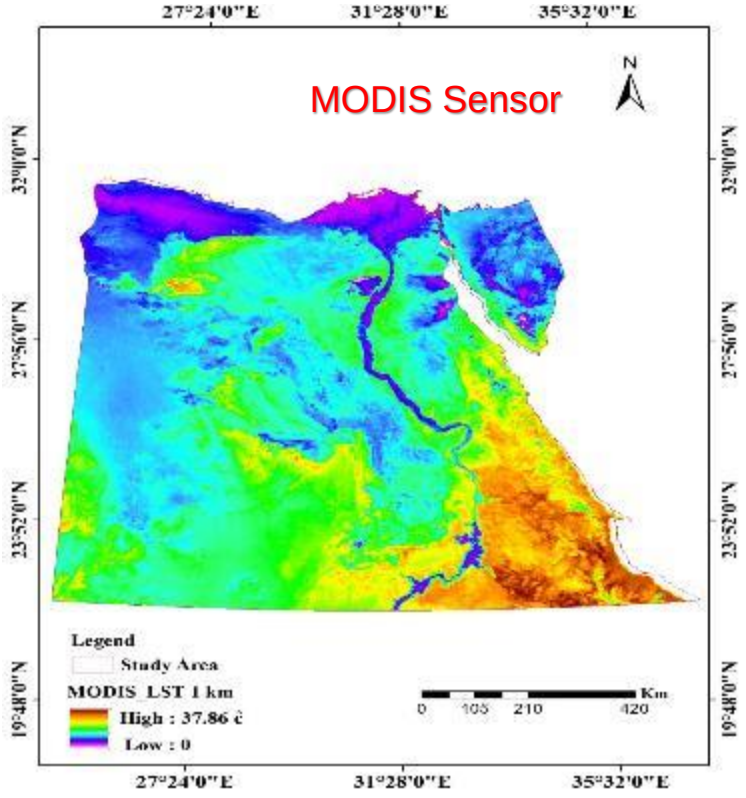


Other EO - Sources

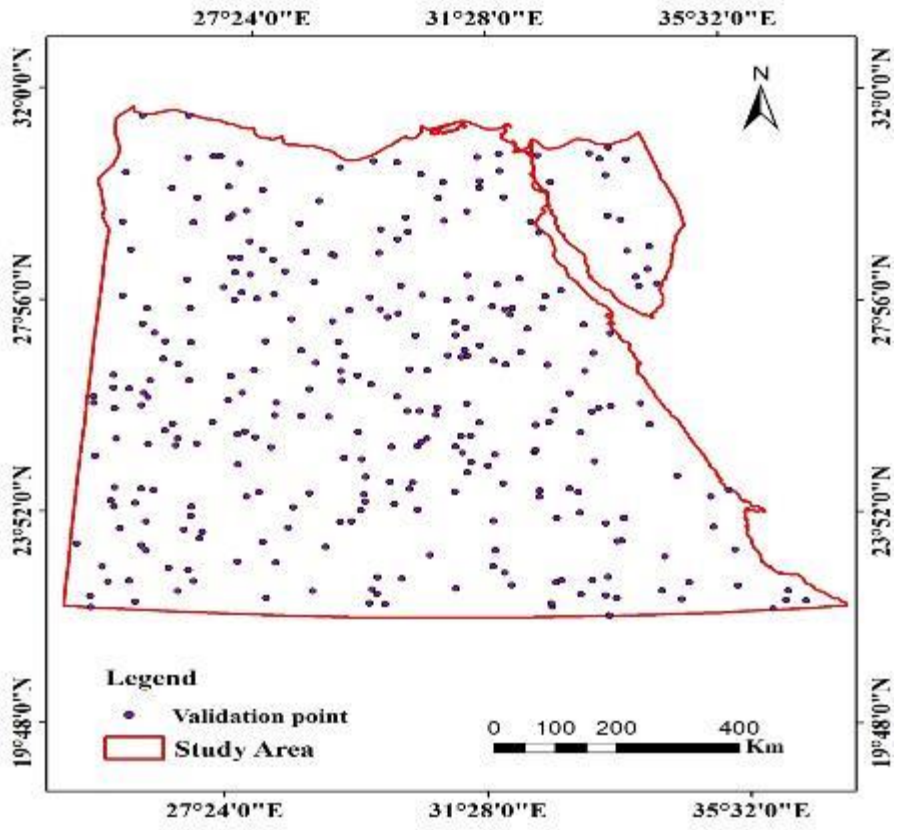
Land surface Temperature

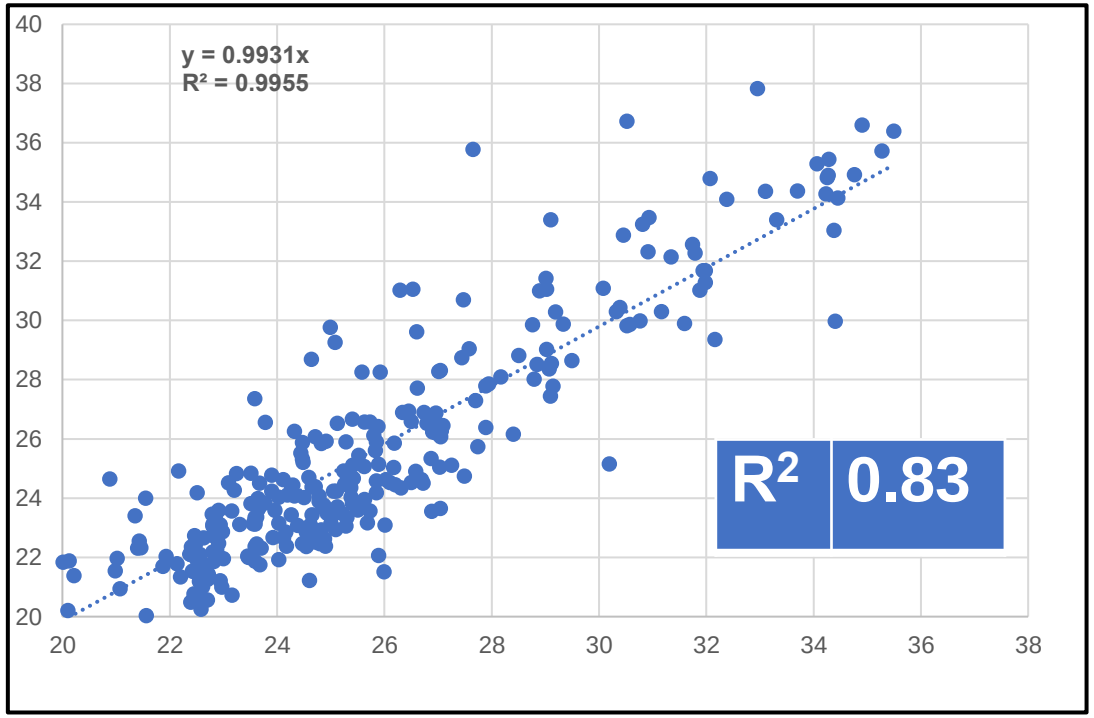
LST is a good indicator of the thermal information and surface heat fluxes.



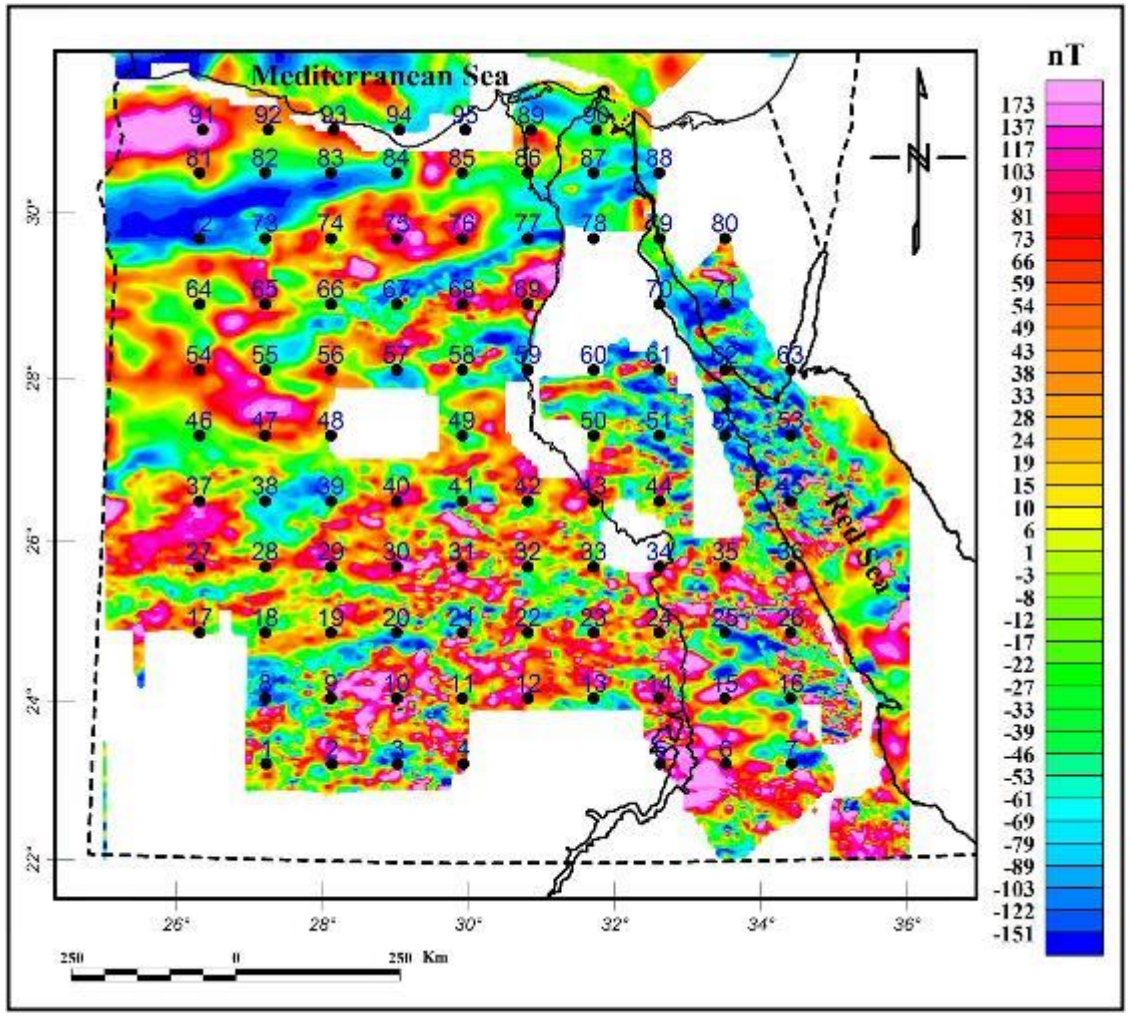


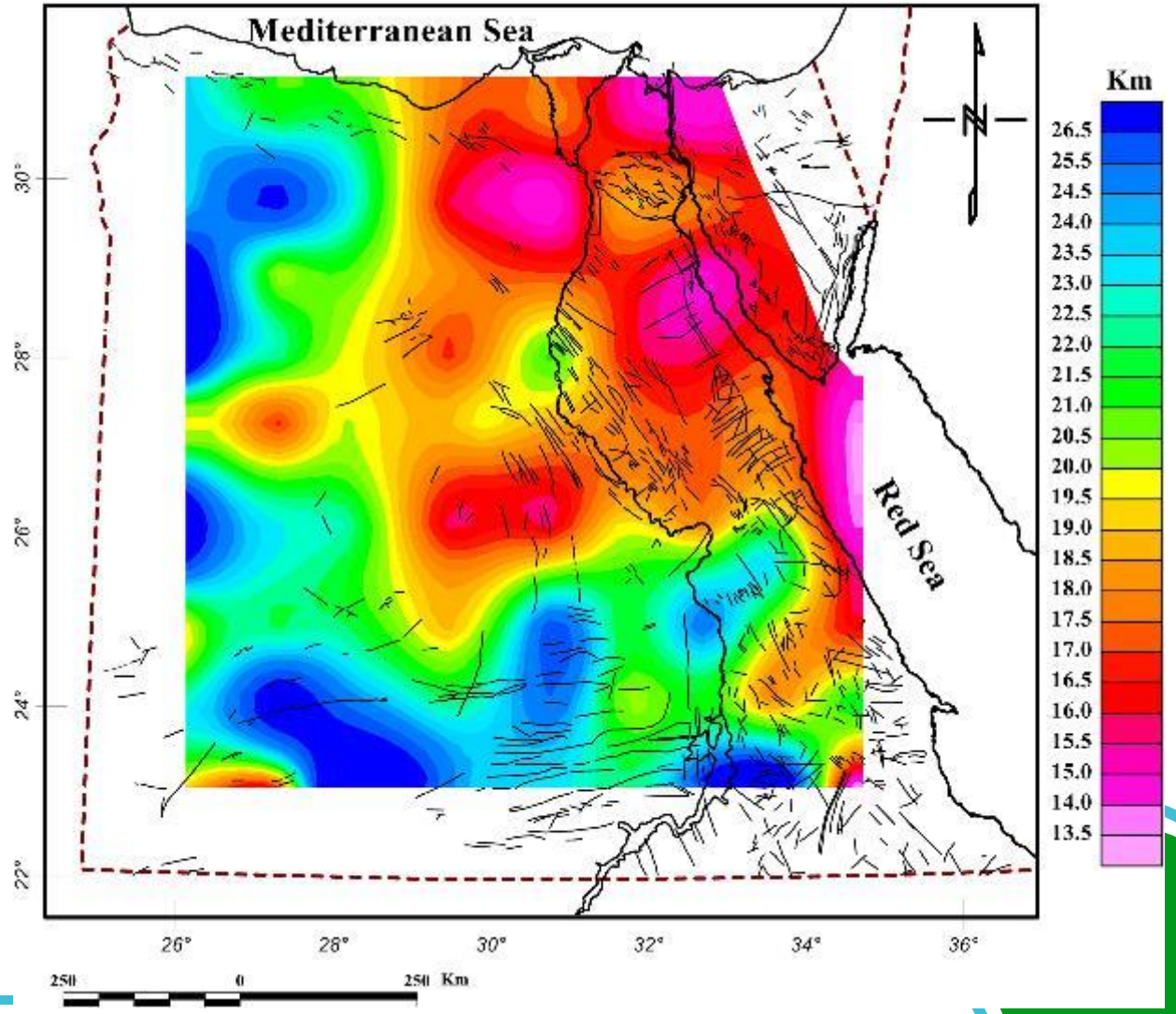
LST – MODIS VS LANDSAT 8



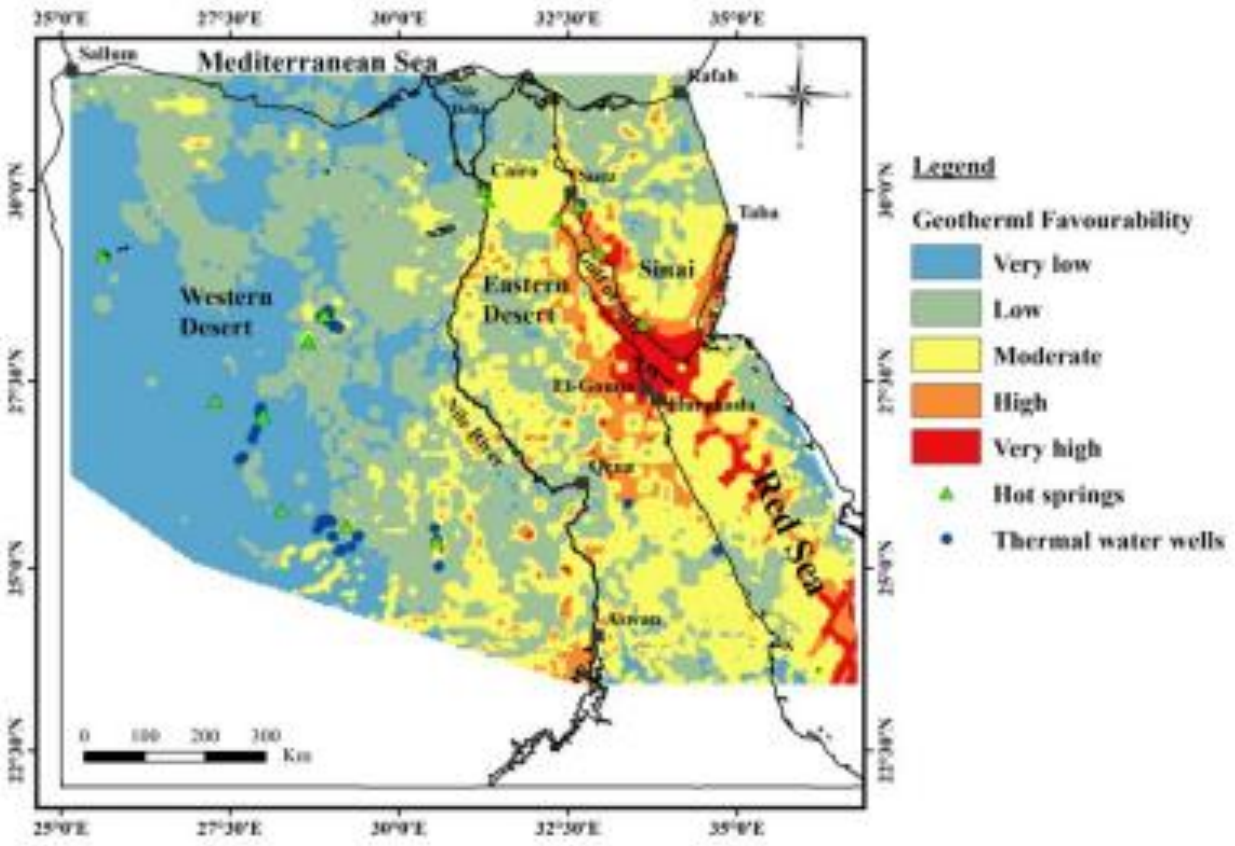


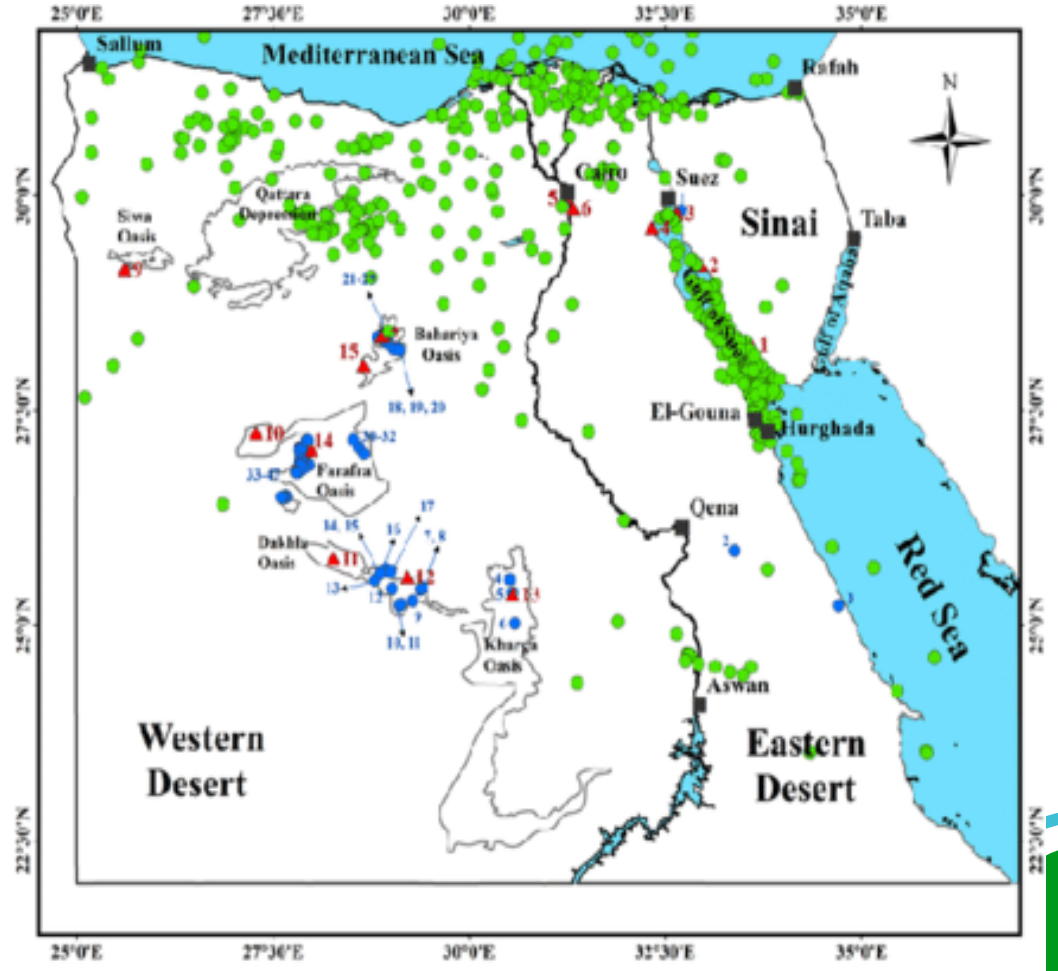
Aeromagnetic data

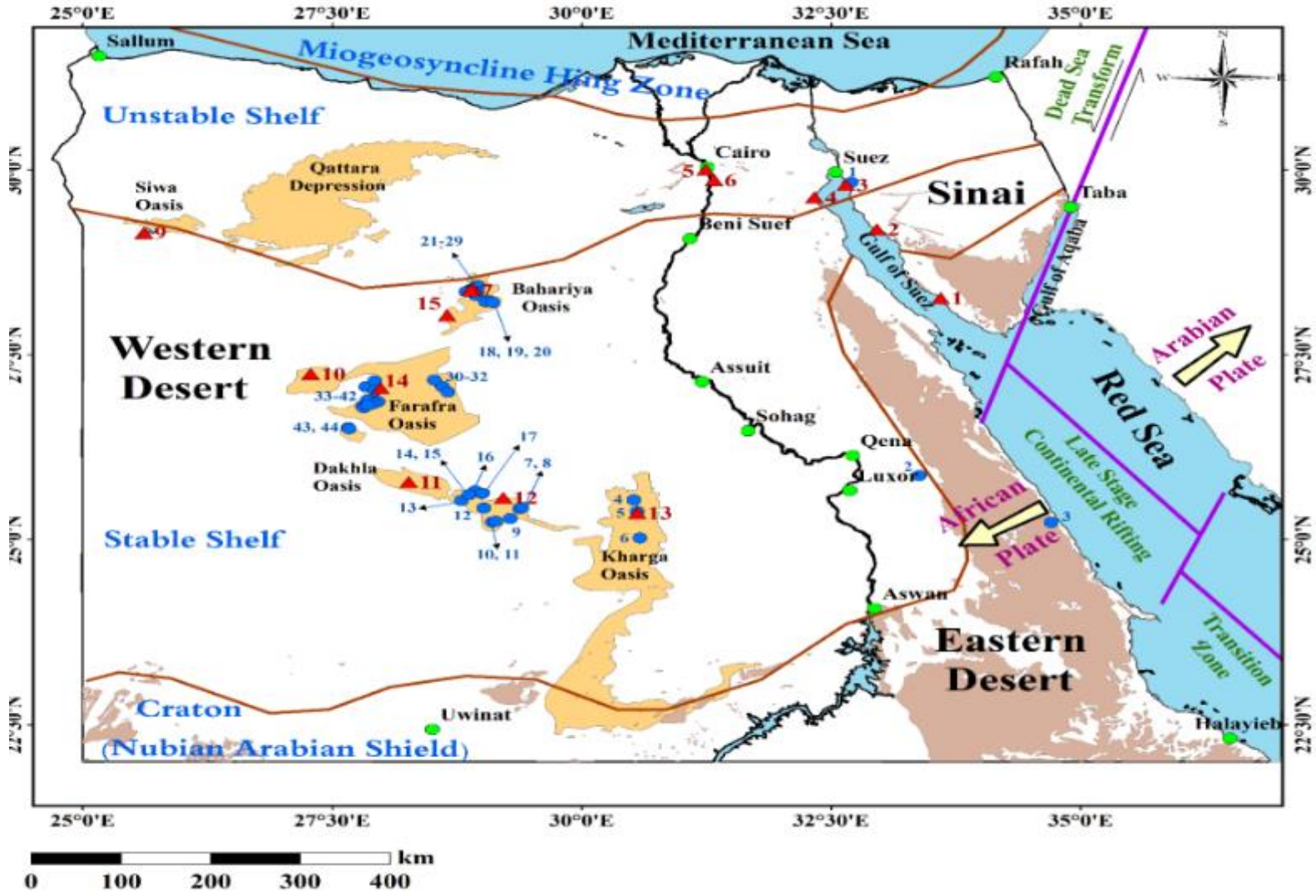


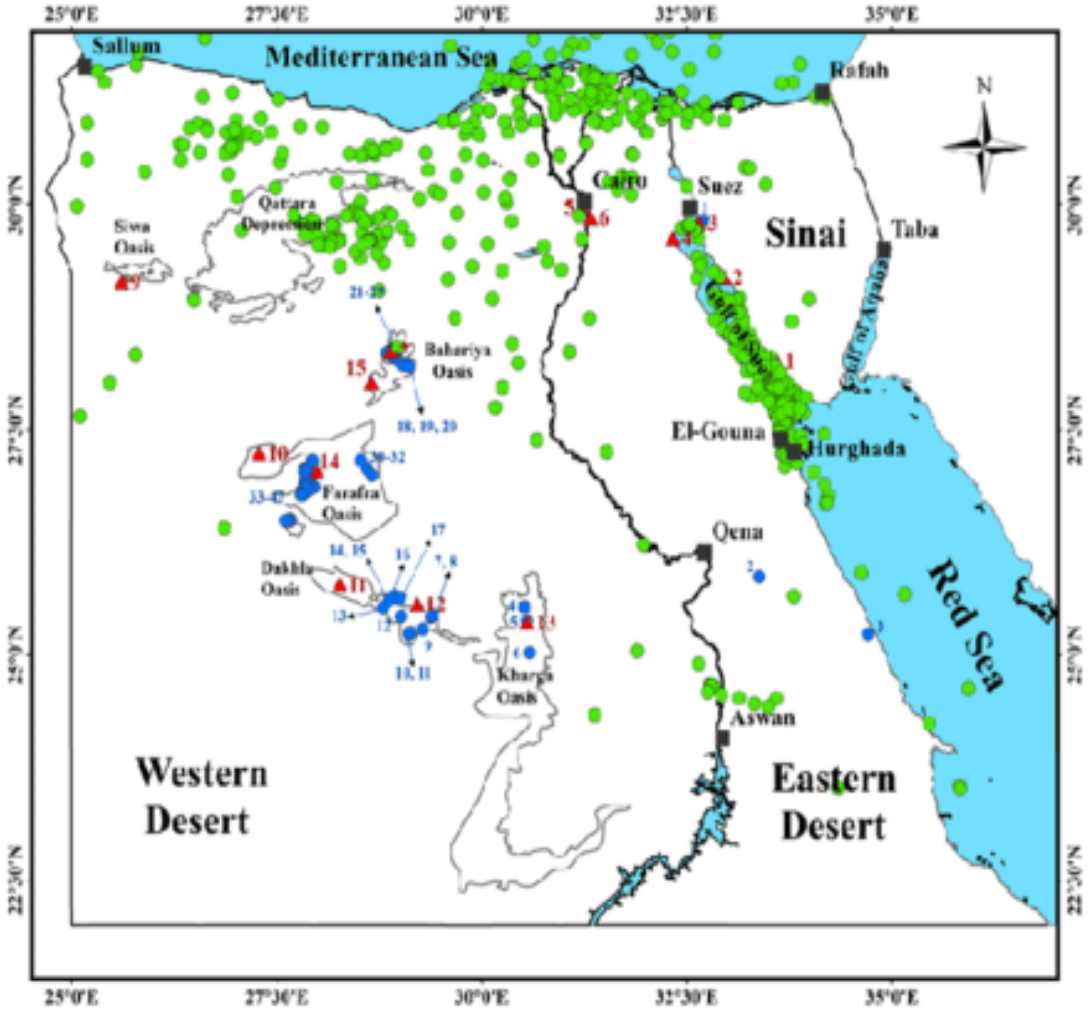


Identification of net geothermal energy within the hotspots






25°0'E
27°30'E
30°0'E
32°30'E
35°0'E
30°0'N
27°30'N
25°0'N
22°30'N
Sallum
Mediterranean Sea
Miogeosyncline Hing Zone
Unstable Shelf
Rafah
Dead Sea Transform
Cairo
Suez
Siwa Oasis
Qattara Depression
Sinai
Taba
Beni Suef
Gulf of Suez
Gulf of Aqaba
Bahariya Oasis
Western Desert
Arabian Plate
Red Sea
Assuit
Sohag
Qena
Luxor
Farafra Oasis
Dakhla Oasis
Late Stage Continental Rifting
African Plate
Stable Shelf
Kharga Oasis
Aswan
Eastern Desert
Transition Zone
Craton
(Nubian Arabian Shield)
Uwinat
Halayieb
km
0
100
200
300
400



Legend

Hot springs

No.	T°C	Hot spring name
1	48	Hammam Musa
2	71	Hammam Faraun
3	37	Ayun Musa
4	33	Ain Sukhna
5	40	Ain El-Sira
6	36	Ain Helwan
7	31.6	Ain El-Bishmo
8	33.7	Ain Bowitti
9	27	Ain El-Arayes
10	35	Ain Dalla
11	40	Ain El-Gabal
12	39	Ain El-Kasr (Qasr)
13	31	Ain El-Bousa
14	28	Ain El-Balad
15	28.3	Ain El-Ris

Oil and gas wells

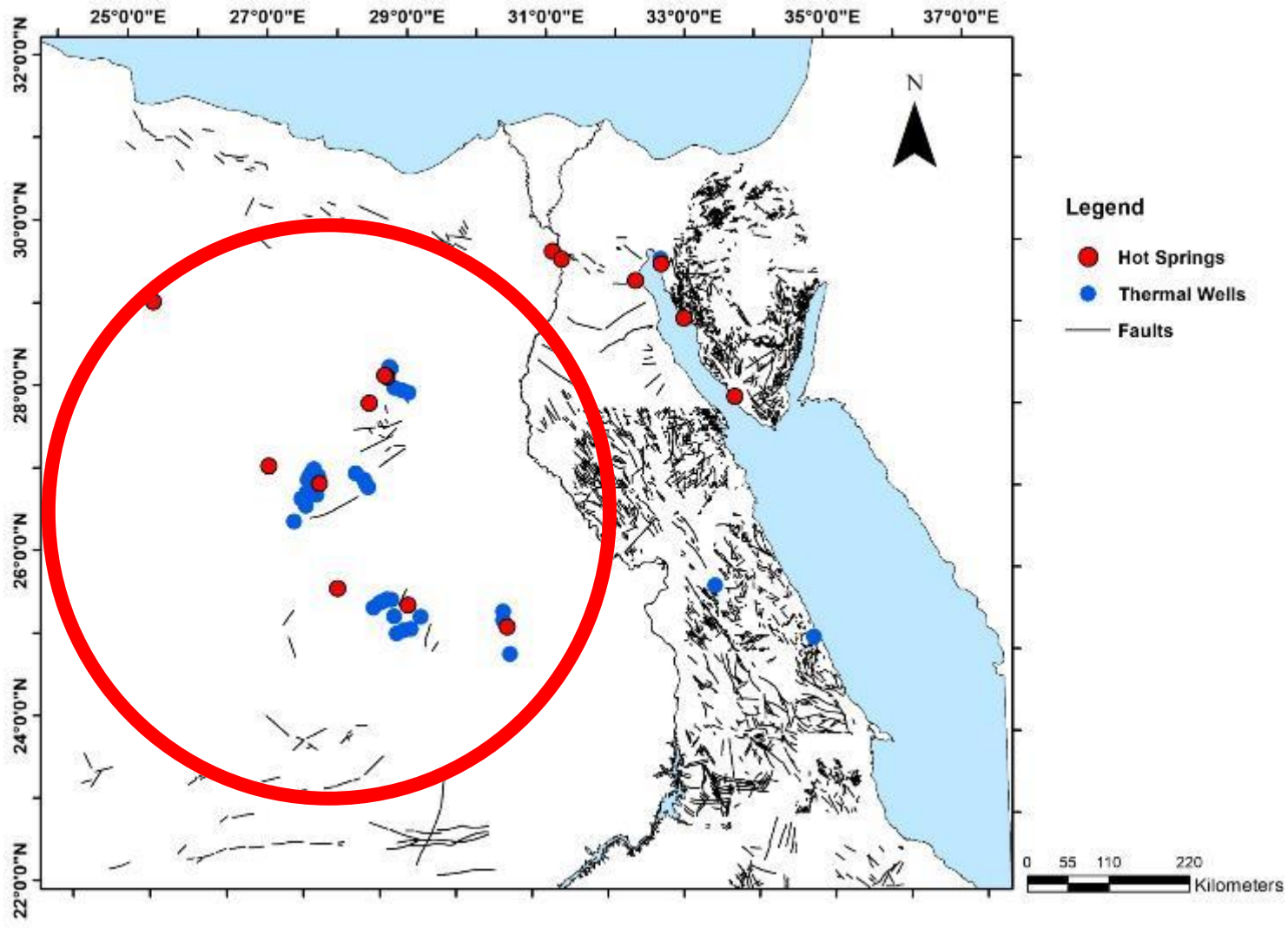
0 100 200 300 km

Thermal wells

No.	T°C	Well name
1	48.3	Ayun Musa Well
2	35	El-Laqeita
3	35.8	Umm Khariga
4	37.5	Mahariq
5	38	Kharga
6	35	Bulaq 5
7	38.9	Bir Balat No. 10
8	37.2	Bir Balat No. 10A
9	41.1	Bir Masara No.3
10	35	Bir Mut 1
11	42.2	Bir Mut 3
12	37.8	Bir Ezab Qasr 1A
13	42.8	Bir El-Mahuh
14	42.8	Bir Ezab Qasr 3
15	38.3	Bir El-Dinariya
16	39	Bir El-Omda
17	38.3	Bir El-Qasr Elbalad
18	41.1	Ain El-Wadi
19	41.1	Bir Sigam
20	42.2	Halfa
21	47	El-Gawak
22	45.5	Halfa
23	46	El-Nebiga
24	37.5	Matar
25	50	Qasaa
26	45	Hamra
27	43.5	Sigam
28	42	Givara
29	42	Agouz
30	37	QRHO
31	47	QR1
32	41	QR2
33	47.7	Bir-5
34	51.7	Bir-3
35	44	Bir-15
36	47.8	Bir-1B
37	41.9	Bir-11
38	42	N2
39	43.3	Bir-38
40	53.4	Bir-2
41	44.2	N-4
42	44.5	Bir-9
43	44.3	Bir-61
44	45.8	Bir-40
45	46.3	Bir-18
46	44.6	Bir-400
47	52	Bir-39

Geographical distribution

Mostly in rural and desert areas



Socio-economic Analysis

- All Geothermal sources in Egypt are in direct use rather than power generation applications.
- The most common forms of utilization are:
  1. District Farming
  2. fish Farming
  3. Agriculture Application
  4. Green Houses
  5. Touristic and medical use

Sinai

Siwa Oasis – western desert

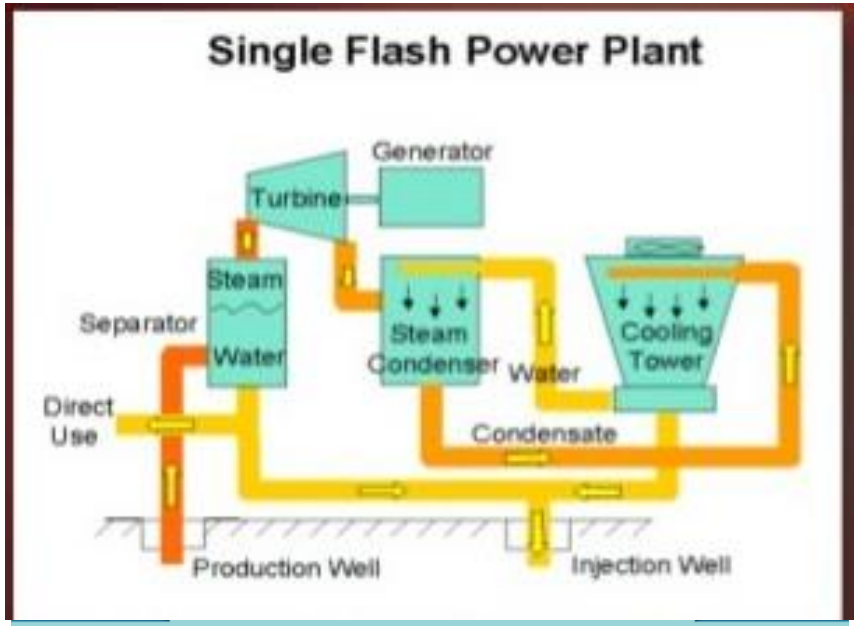
Strategic Analysis

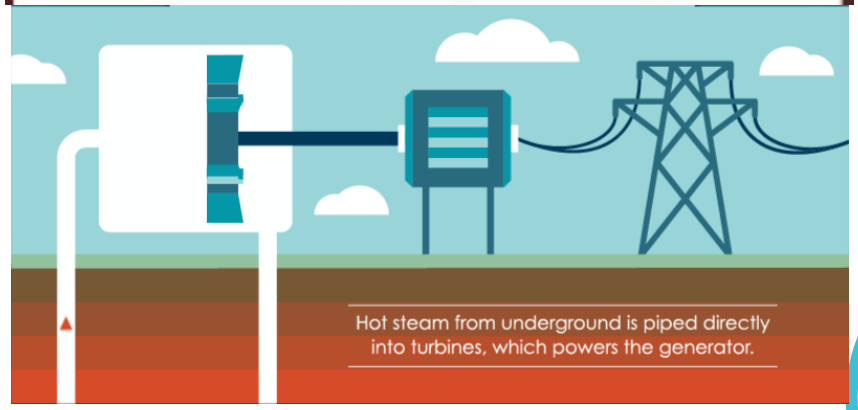
- **Unfortunately, there is no intention from the Egyptian government to invest in the geothermal resource for power generation till now.**

- **They may invests in direct use application for future.**

Way Forward - Engineering Model

- **Simple engineering model to generate electricity for rural and Pedon areas:**
  - **Liquid – dominated plants (Flash Plants)**
  - **Liquid-dominated reservoirs (LDRs) were common with temperature more than 200 C.**
  - **Pumps are generally not required, powered instead when the water turns to steam.**
  - **Steam is separated from liquid via cyclone separators, while the liquid id returned to the reservoir for reuse.**
  - **Lower temperature LDRs (120-200 C) require pumping.**

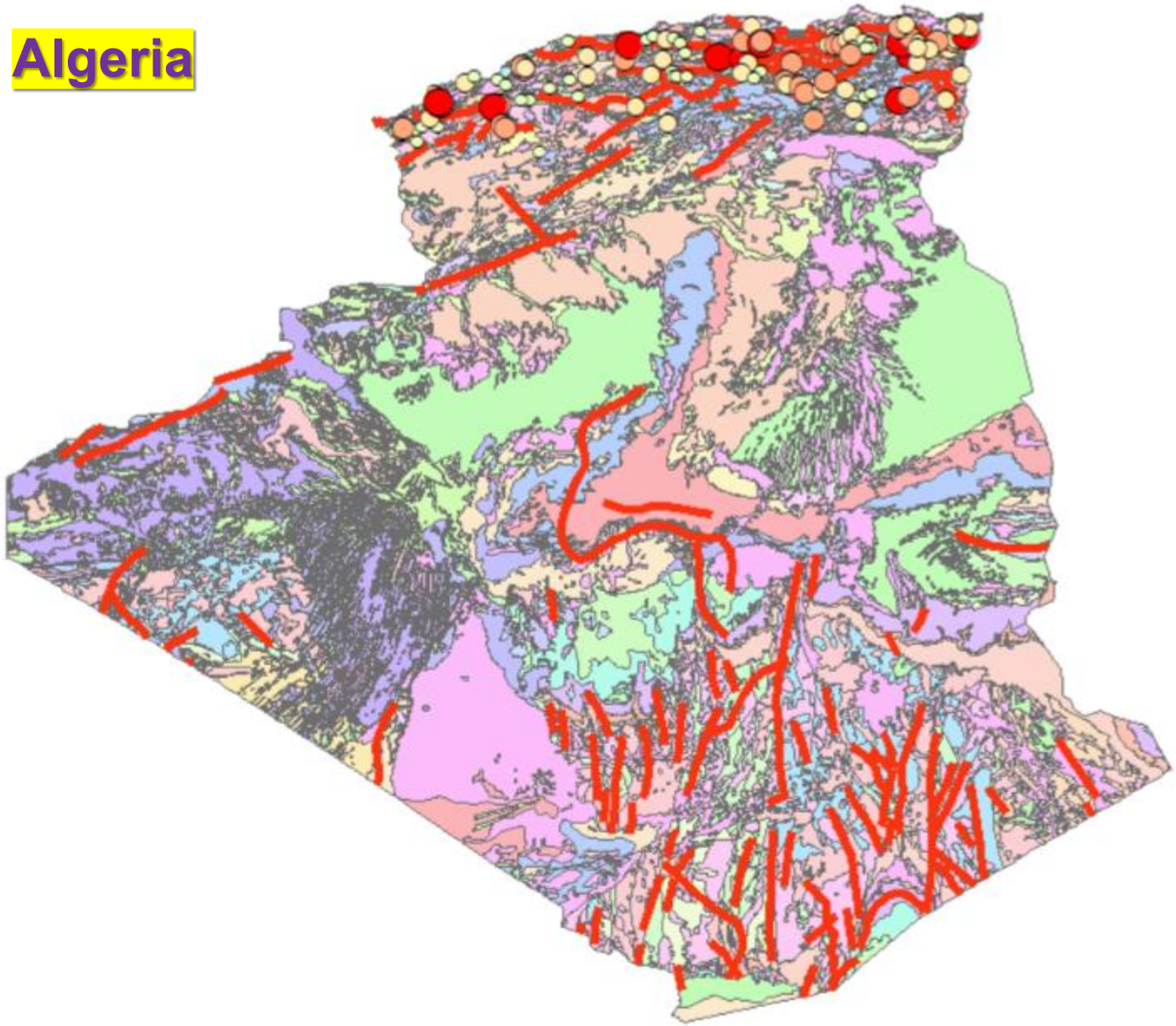




Conclusion

- Egypt is increasingly in demand for energy
- Renewable energy is the future and world wide perspective.
- Geothermal energy is a resource to invest in at low cost.
- Significant locations are very potential for power generation such as Hamam Faraun hot springs (water temp. reaches above 70 C).
- The red sea coast in the eastern desert has a very high temperature, makes it a good area for electricity generation by making a deep geothermal reservoir for direct use and industrial applications.
- Various data sources and models could guide and support the future investment in geothermal energy in Egypt.
- Further awareness to maximize the value and usage of geothermal energy in Egypt in needed.

Algeria



Tunisia

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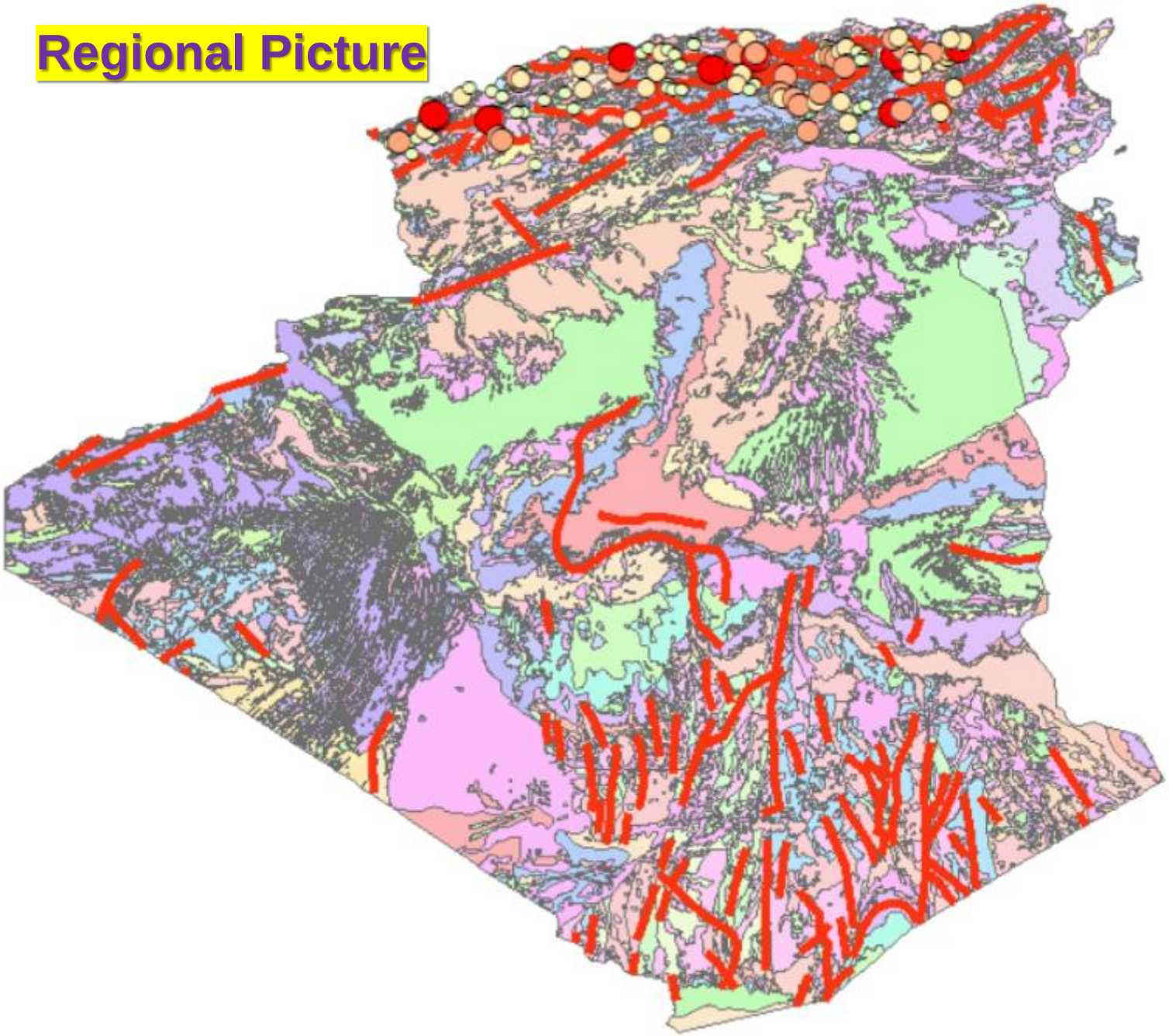
Regional Picture



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Thank You