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Surface study of a shallow geothermal site for Abhé Geothermal Village Project (Djibouti)

Géraud Y. [4], Aden M.A. [1], Amman J. [2], Chibati N. [4], Cardoso C. [5], Diraison, M. [4], Favier A. [4], Hassan, M. [1], Hautot S. [3], Marty B. [5], Moussa K. A. [1], Pik R. [5], Piolat L. [5], Tarits P. [2], Varet J. [6], Walter B. [4]

1. ODDEG
2. UBO, LGO
3. IMAGIR
4. UL, GeoRessources
5. UL, CRPG
6. Géo2D

Geothermal Village at the Lake Abhé geothermal site

- The Geothermal Village project in the LEAP-RE program
- The lake Abhé geothermal site
- Geological context and new datasets:
  - Structural data
  - Petrophysical data
  - Thermal mapping
  - Geochemical data
  - Magnetotelluric data
  - Electrical resistivity and induced polarized tomography
  - Targets

Geothermal Village project

Consortium:

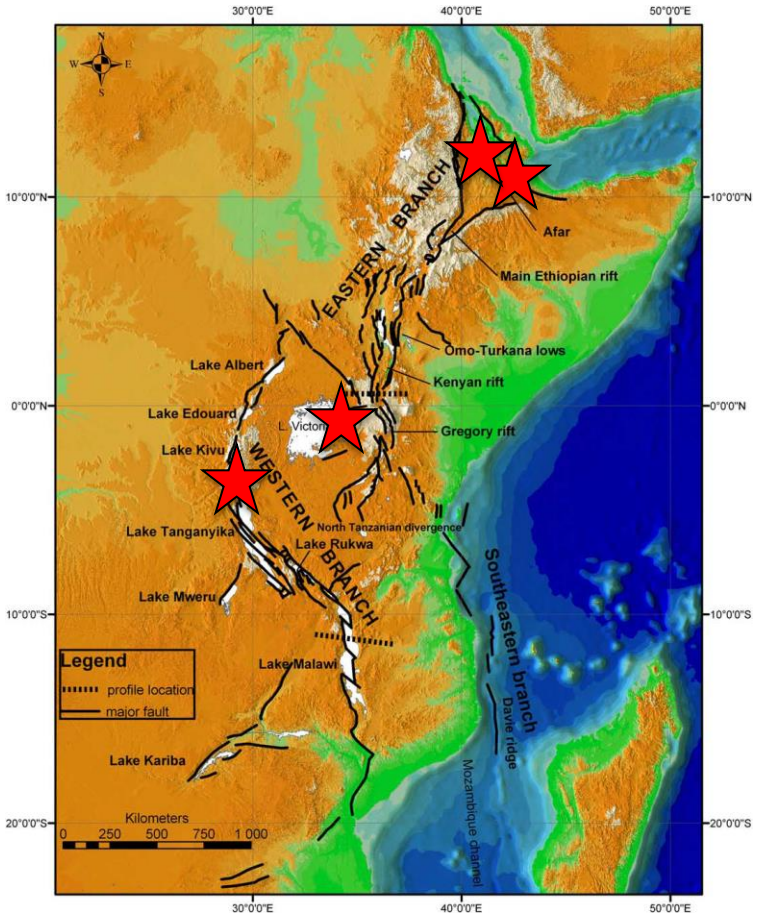
Composed of 7 EU & 5 AU organizations

The **objective** is to introduce geothermal-based stand-alone electric and thermal energy systems to off-grid African communities

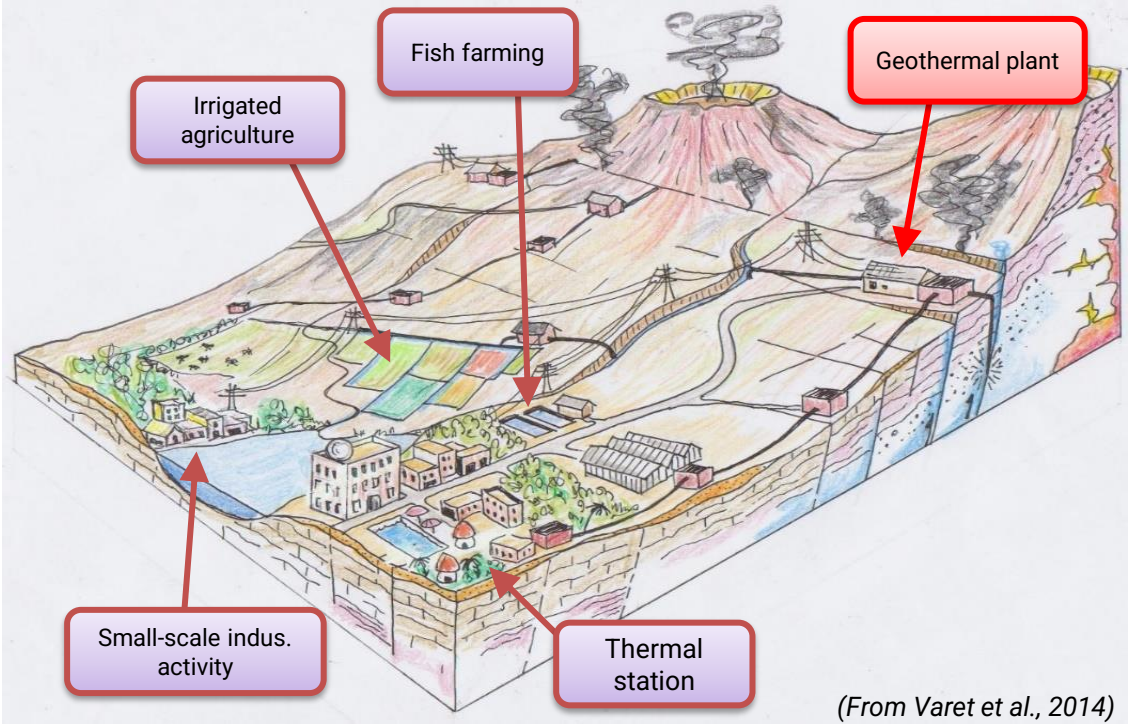
- Providing **template case-studies** on adapting GV concept to different socio-eco contexts
- Proposing **implementation strategies**
- Demonstrating **feasibility** to public and private investment organizations

Geothermal Village project

→ **4 targeted sites with different characteristics** (geology, socio-eco.)



(From Chorowicz, 2005)



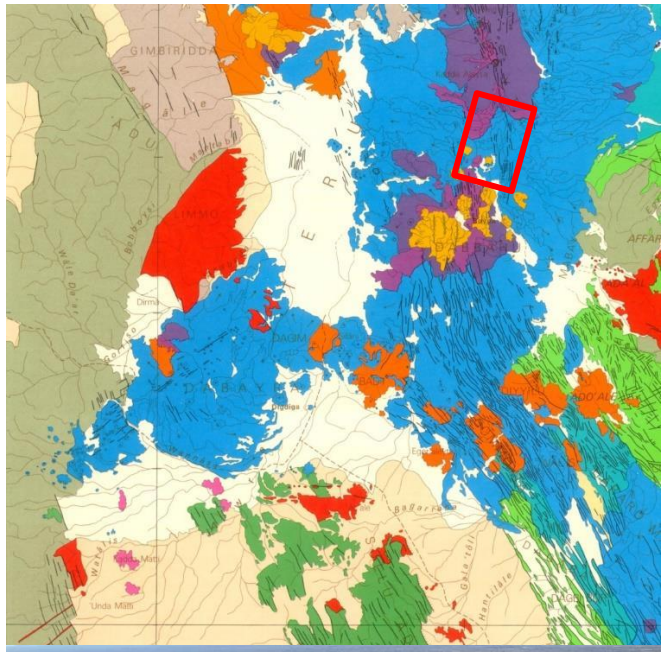
(From Varet et al., 2014)

Outcome :

- **New data, adapted solutions**
- **Feasibility studies, Implementation strategies**

Sites selected : (1) Era Boru, Afar Regional State, Ethiopia

Geographic Coordinates 12°40’N – 40°20’ E; *Altitude* : 700m



Surface thermal manifestations are numerous (steam vents) and well known by the Afar pastors, as they are engineered to condensate the steam and produce water that is used for both livestock’s and human consumption

- digging holes in the fumarole site,
- use the clay (red kaolin-iron hydroxides mixtures) produced by the hydrothermal decomposition of the volcanic rock to create an impermeable basin for condensate water collection,
- close the system with a chimney made of blocks of lava covered by branches (acacias trees) that will allow to condensate the steam (as in condensation towers of thermal plants).
- Example of such devices, are quite common all over Afar particularly at Era Boru where 150 families live from this resource

The project – delayed due to Tigray war - will allow to identify shallow drilling targets and answer the needs of the communities on site (energy and water production)

Sites selected : (3) Bugarama, southern Rwanda

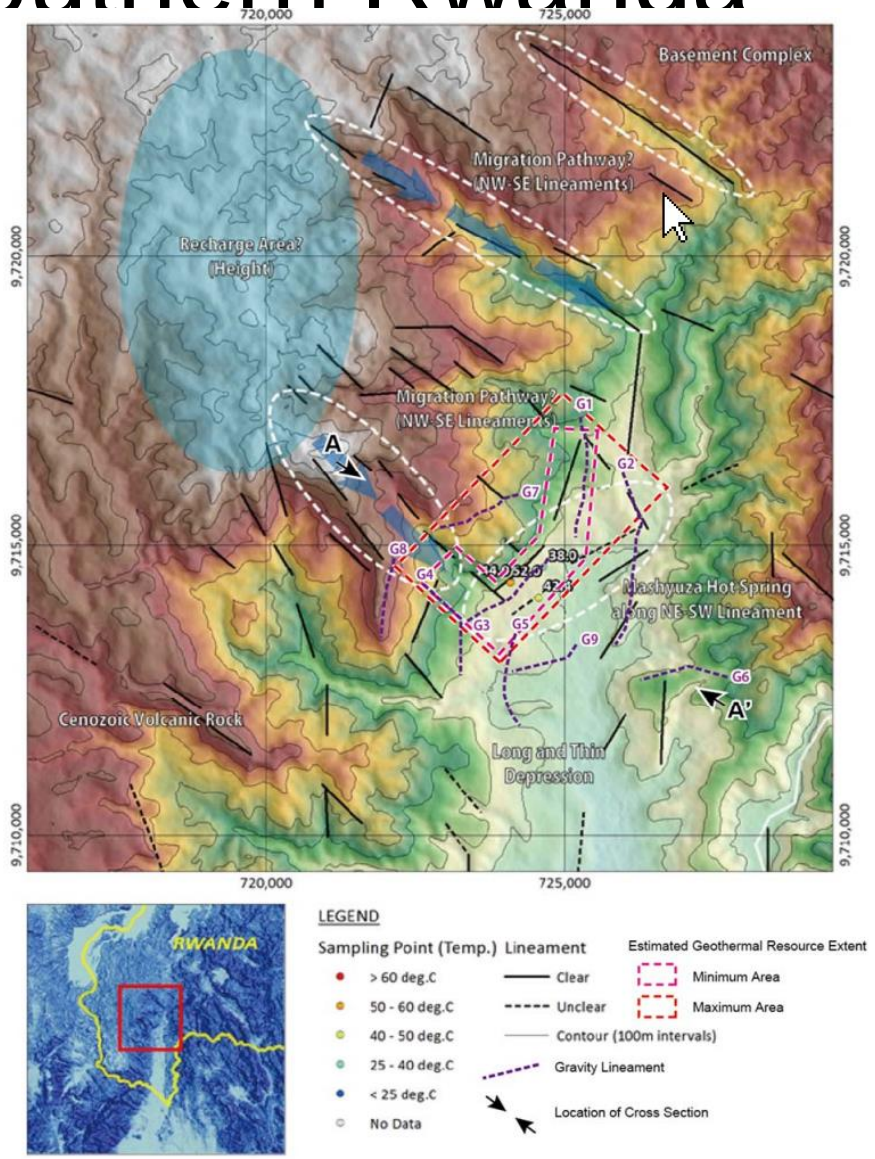
Coordinates: 2°42’ S ; 25°01 E *Altitude*: 956m

Access (distance & time): 288km from Kigali, 6 hours drive

Bugarama, is rather rich in thermal manifestations. At least 3 sites are gifted with hot springs, with characteristics not suitable for electricity production. One of them will be selected in the frame of GV project in February 2022;

Given the local economy based on agriculture, Direct Uses (DU) applications will be studied in the area (crop drying and fish farming in particular),

Further exploration works to be engaged with EDCL late 2022, implying both earth science and social science teams, followed by technology assesments.



Geothermal Village

Sites selected : (4) Homa Hills, E. Lake Victoria, Kenya

Geographic Coordinates: 0°20’20 N ; 34°31’ E ; *Altitude* : 1131-1180 m

Previous investigations confirmed:

- Low to intermediate temperature geothermal system in the prospect.
- Heat source associated with magmatic intrusive.
- Estimated reservoir geothermometry from 160ºC to 235ºC.
- A resource to be utilized both for electricity generation (using ORC) and direct uses (fish drying, thermalism).

Field works (geoscience and social sciences) to be engaged march 2022

- structural geology, geochemistry geophysics to establish a 3D picture of the hydrothermal system plumbing at 1 Km3 scale.
- Anthropological study & analysis of the local socio-economic demand (present and future) being quantified.

Sites selected : (2) Djibouti, Lac Abhé

Georgaphic Coordinates: 11°09’16 N; 41°53’00 E *Altitude* : 245-313 m

Geosciences :

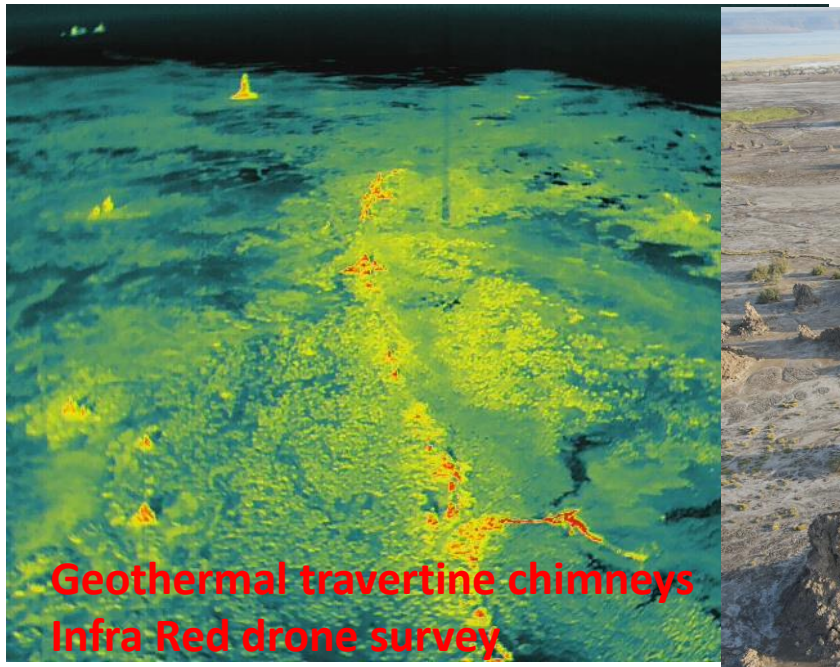
Successful geosciences field work in the Lac Abhé area (Oct. – Nov. 2021)

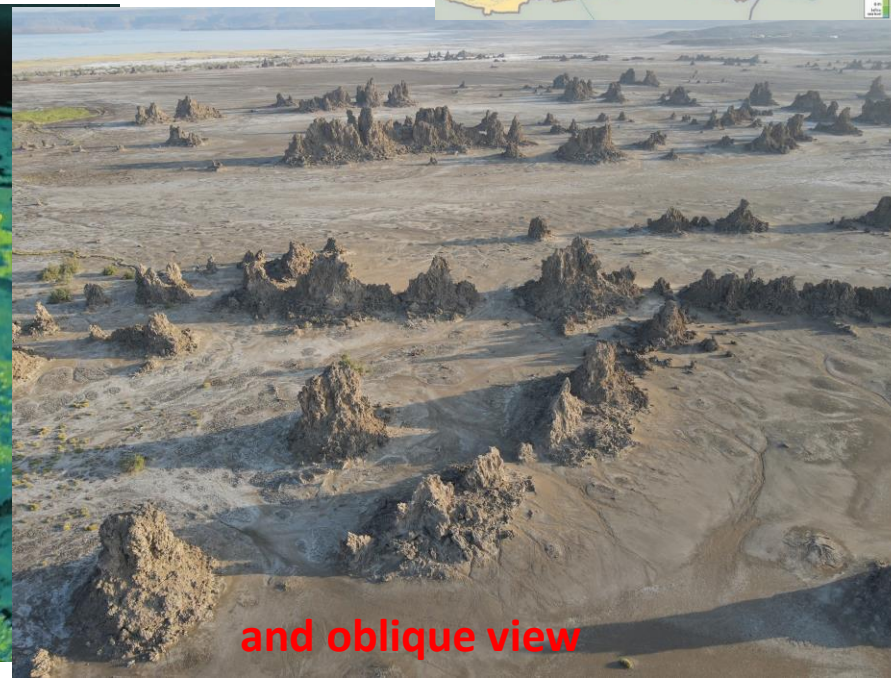
- *Gelogy*
- *Geochemistry*
- *Geophysics*
- *Characterization of the potential drilling site and of the geothermal reservoir*
- Starting of data processing with all the involved partners

Social sciences : Preliminary survey

- 70 families near the site;
- a school just built and started operating
- More families will join the village that the geothermal resource will power,
- also providing water

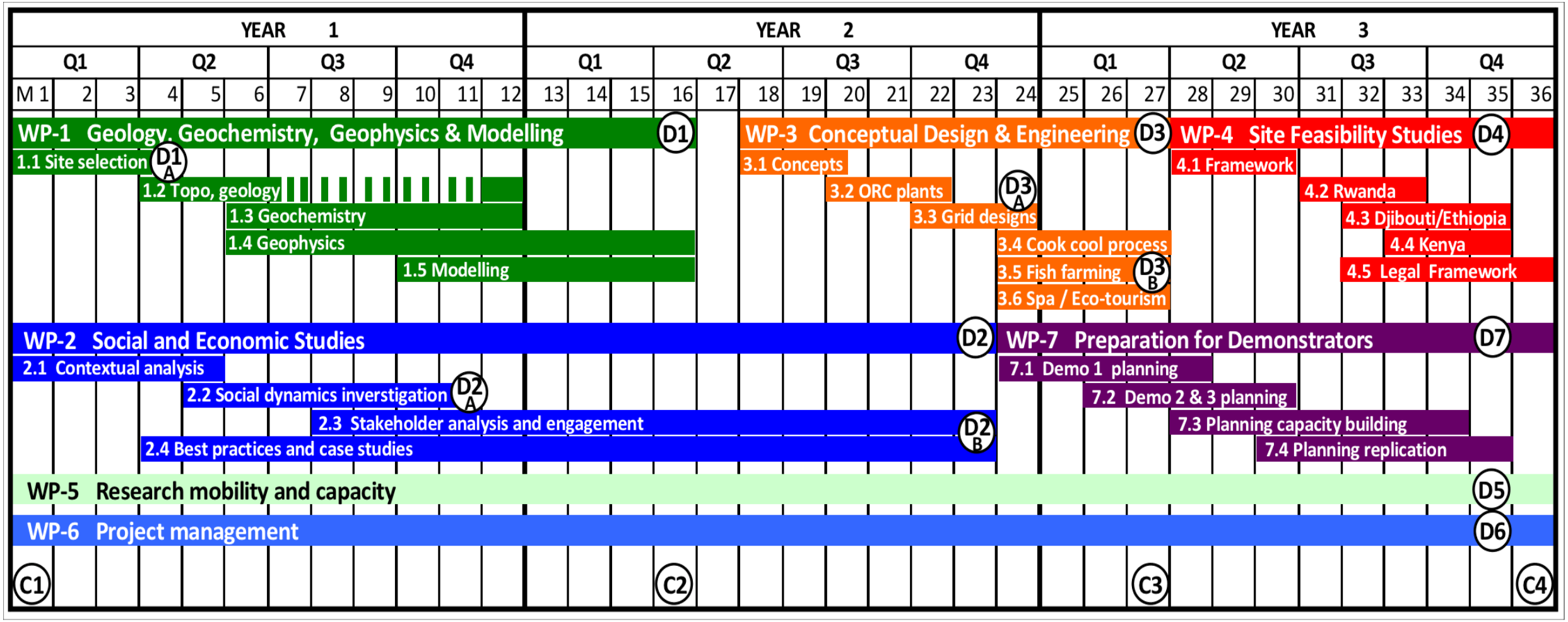
The detailed social study will be engaged in the coming months



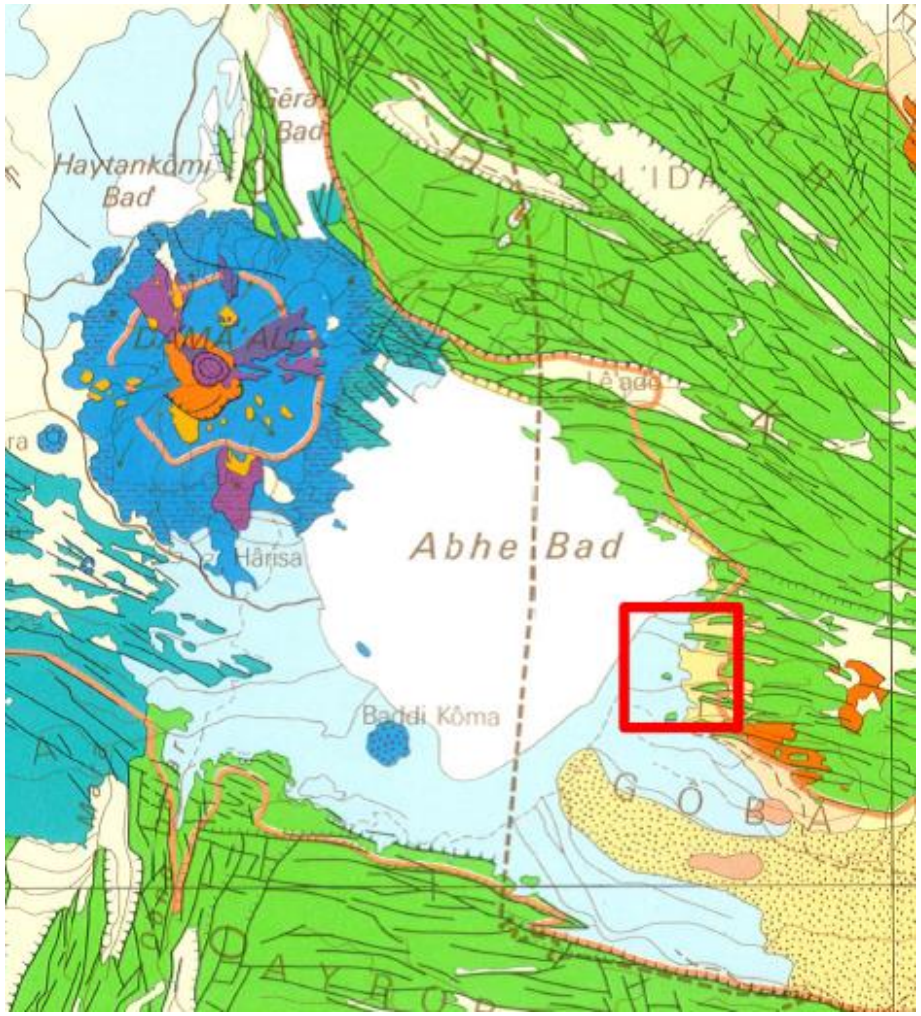


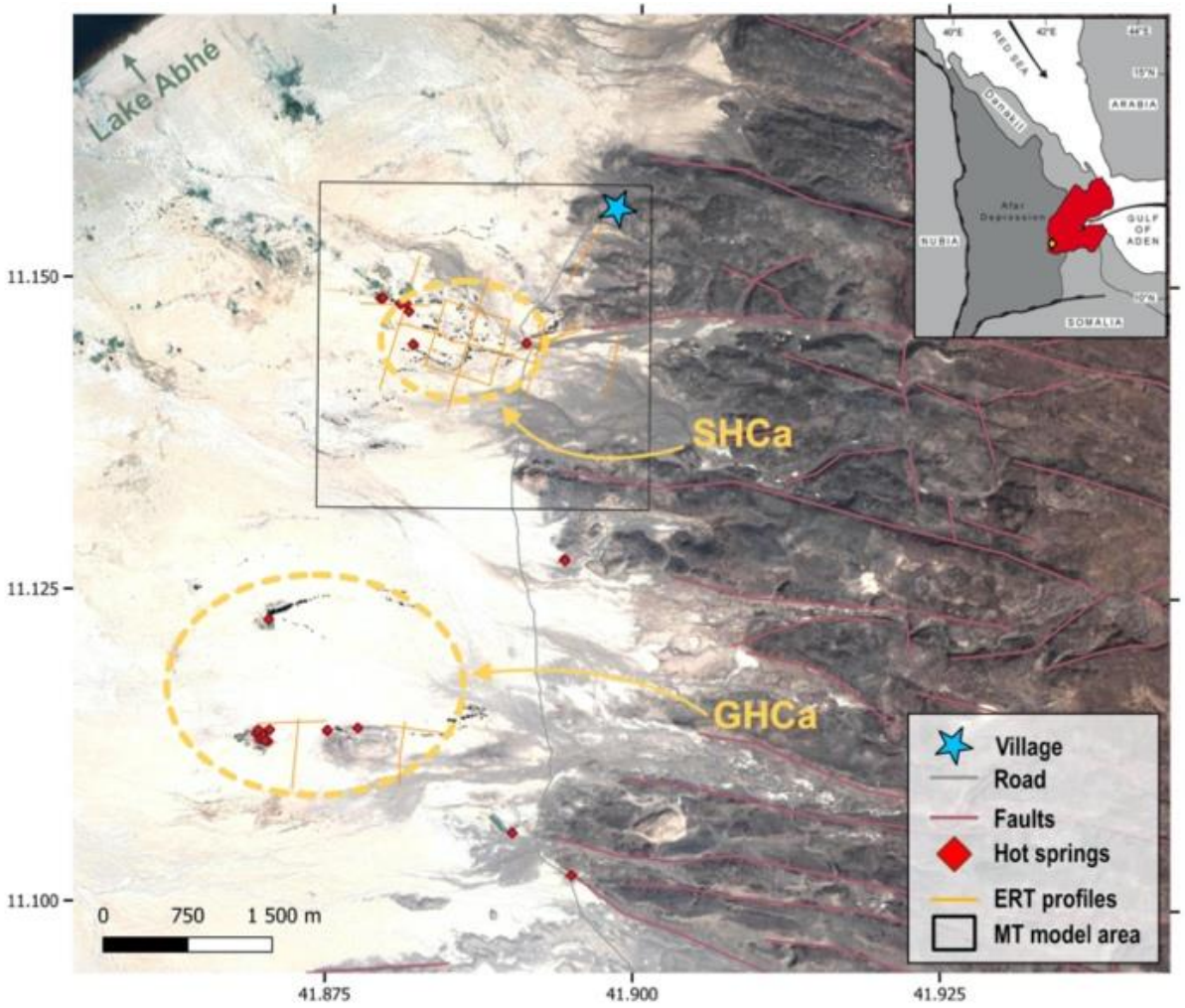
Geothermal Village

5. Time frame & work packages

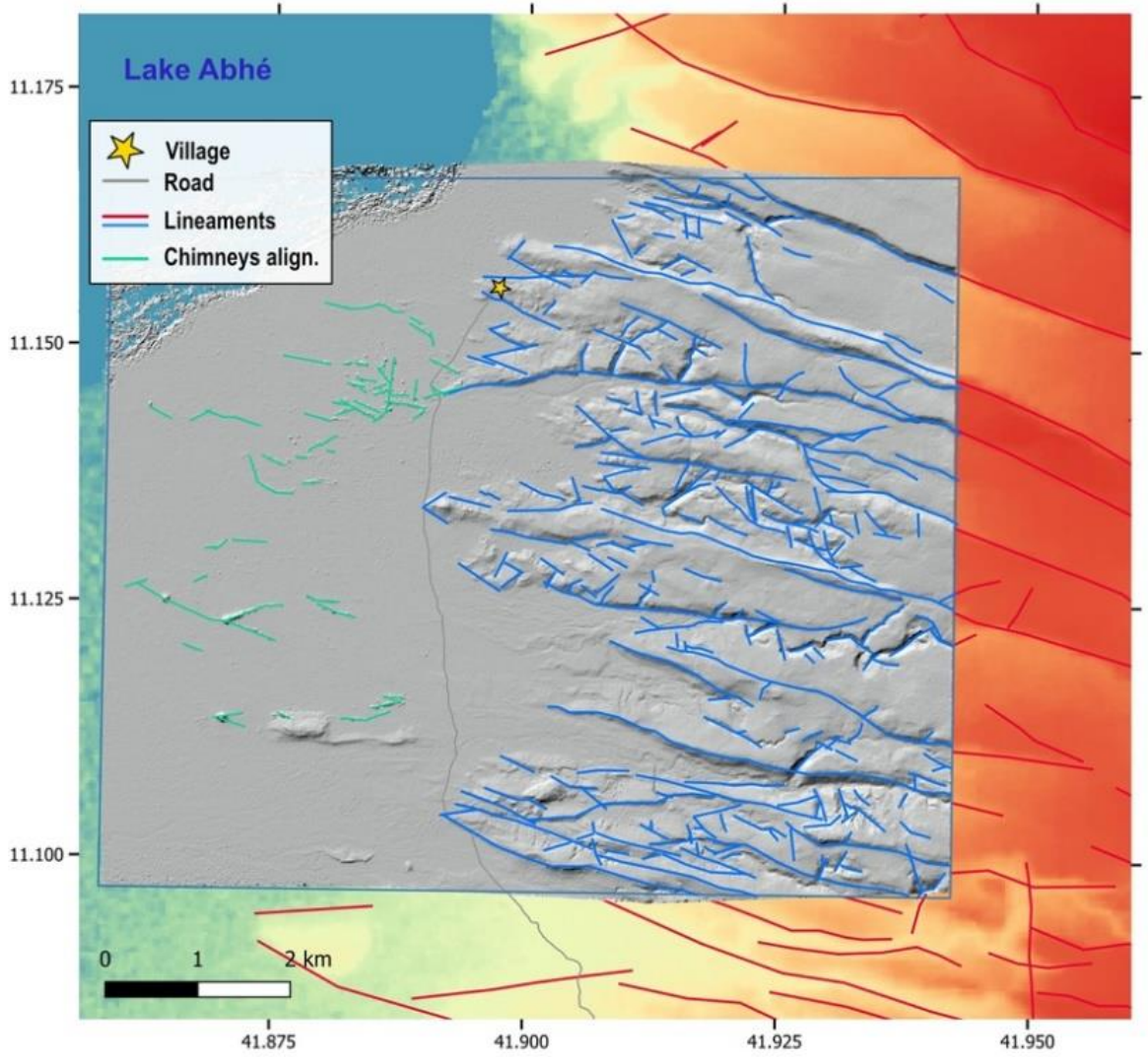


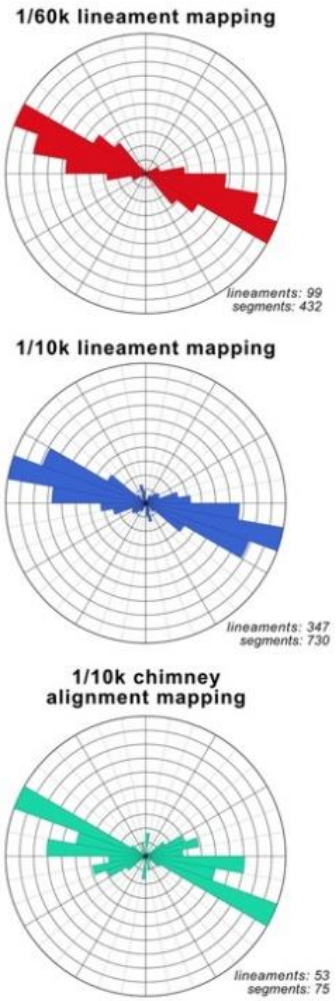
Geothermal Village at the Lake Abhé geothermal site : Geological context and study area





Geothermal Village at the Lake Abhé geothermal site : Structural Data

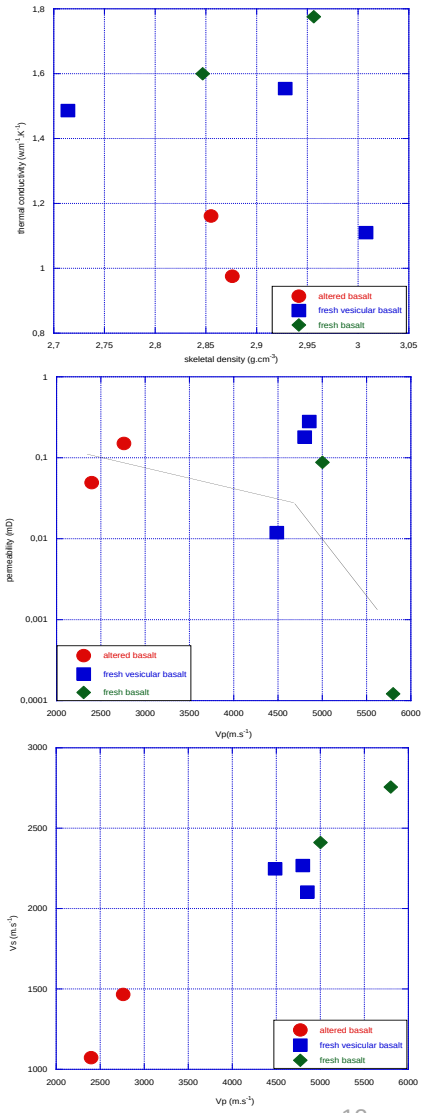


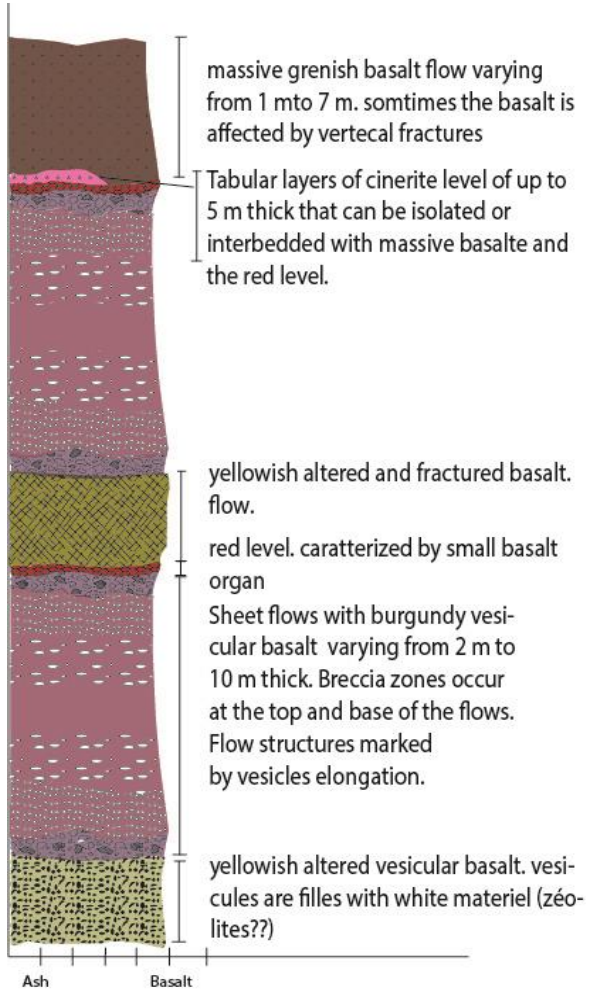


The main structural direction is N100-N110
(described with satellite images and on the field)

A few structures in N-S direction is also described that can have an important effect connecting the N100 structures

Geothermal Village at the Lake Abhé geothermal site : Petrophysics Data





More than **100 samples** !

Petrophysical characterization in thermal conductivity, density, porosity, P- and S-wave velocity

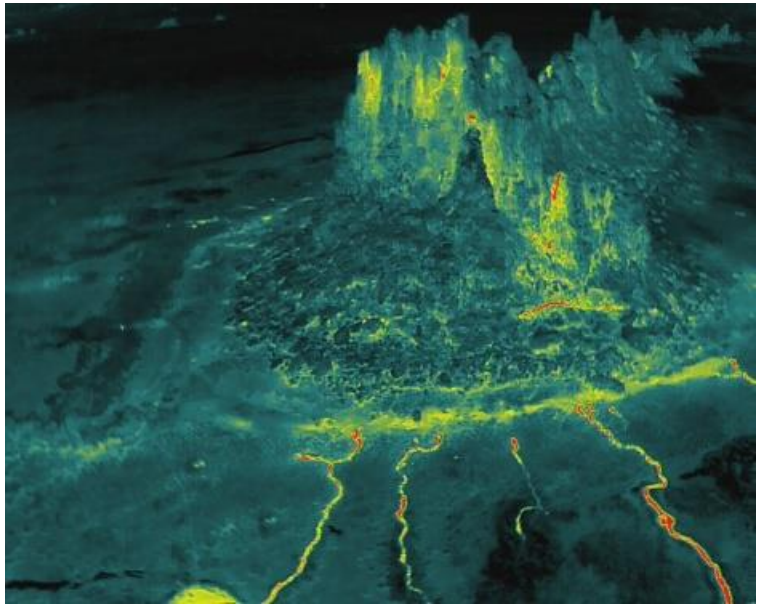
Strong effect on rock reservoir properties (i.e. poro-perm) from alteration (weathering and hydrothermal)

Permeable layers are formed by altered layers and basalts with vesicular facies

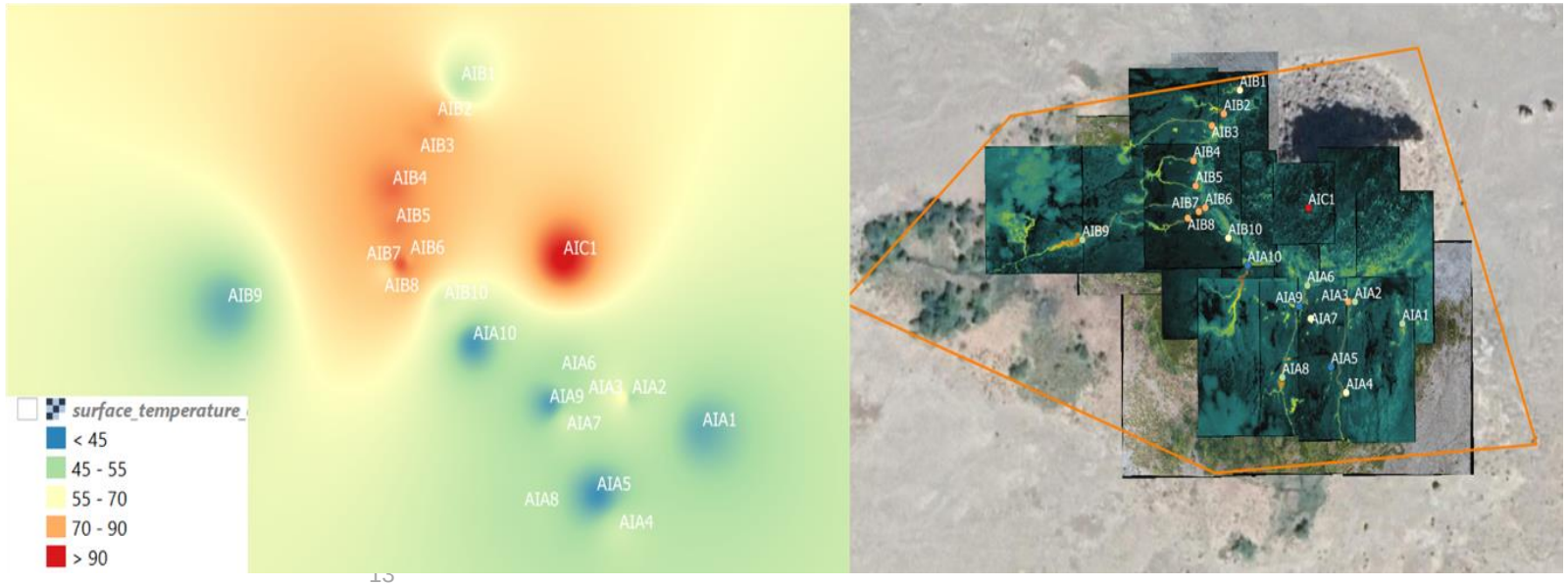
Geothermal Village at the Lake Abhé geothermal site : Thermal mapping

Thermal mapping of the area with drone

- Identification of hot spots
- Modeling of the area surface temperature

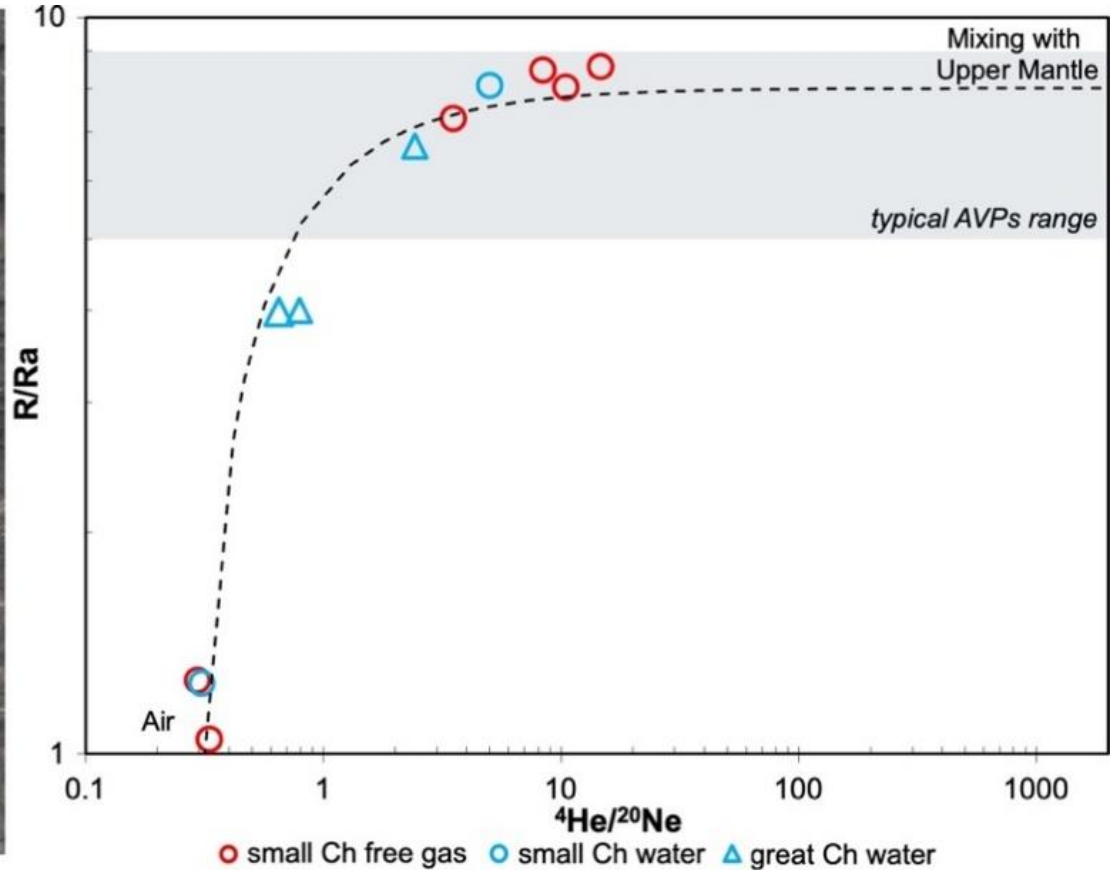


Thermal Map of the Great western chimney

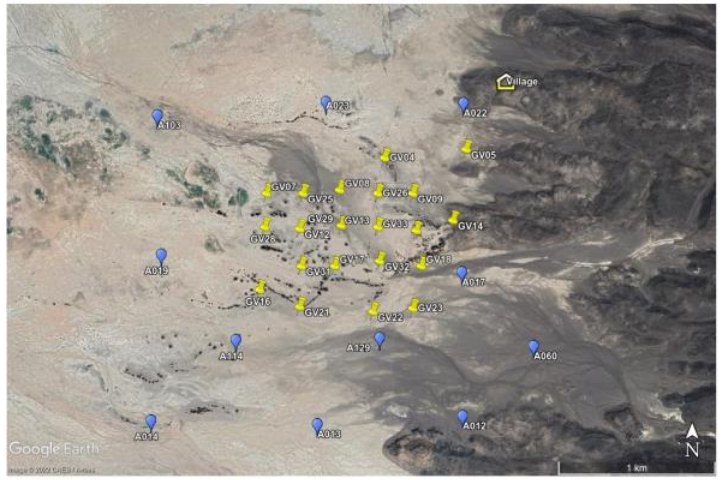


Geothermal Village at the Lake Abhé geothermal site : Geochemistry data

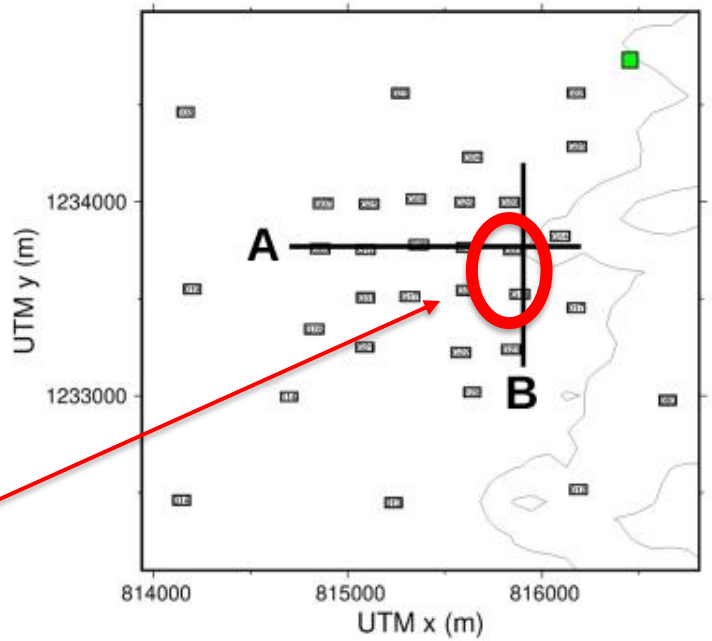
Noble gas analysis : a large mantle contribution with a mixed air (surface) contribution

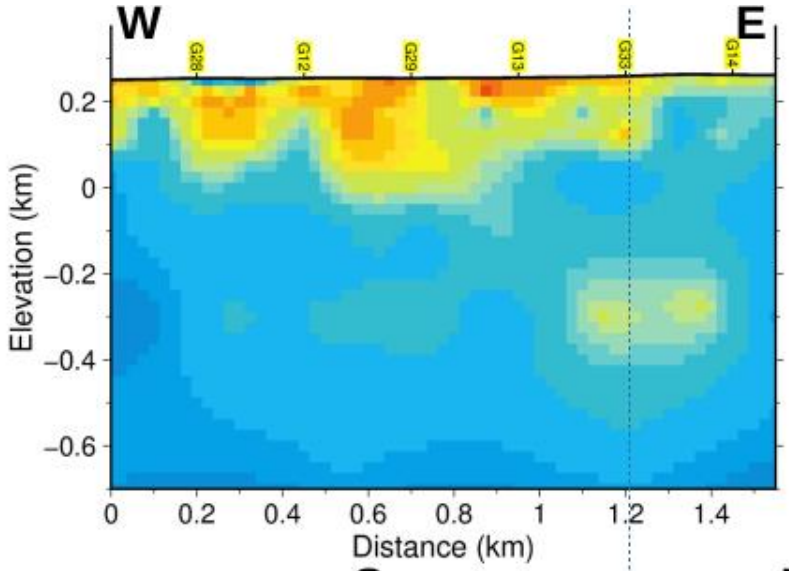


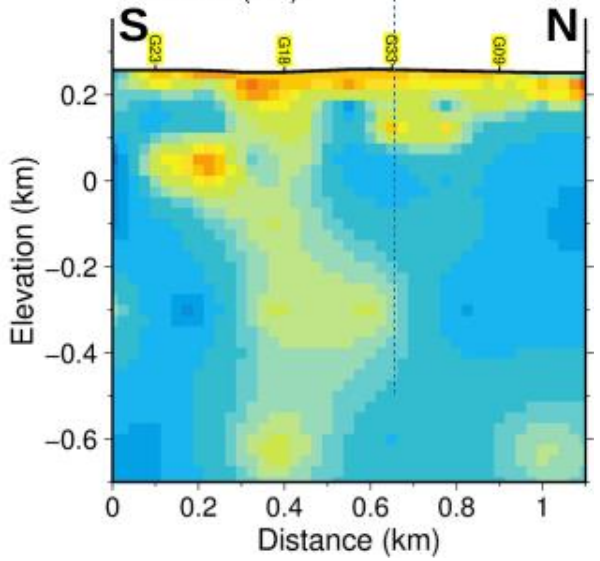
Geothermal Village at the Lake Abhé geothermal site : Magnetotelluric survey

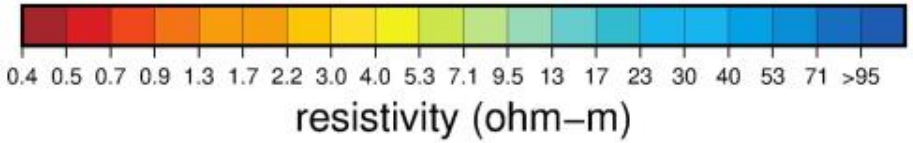


Vertical resistivity sections down to 1 km depth



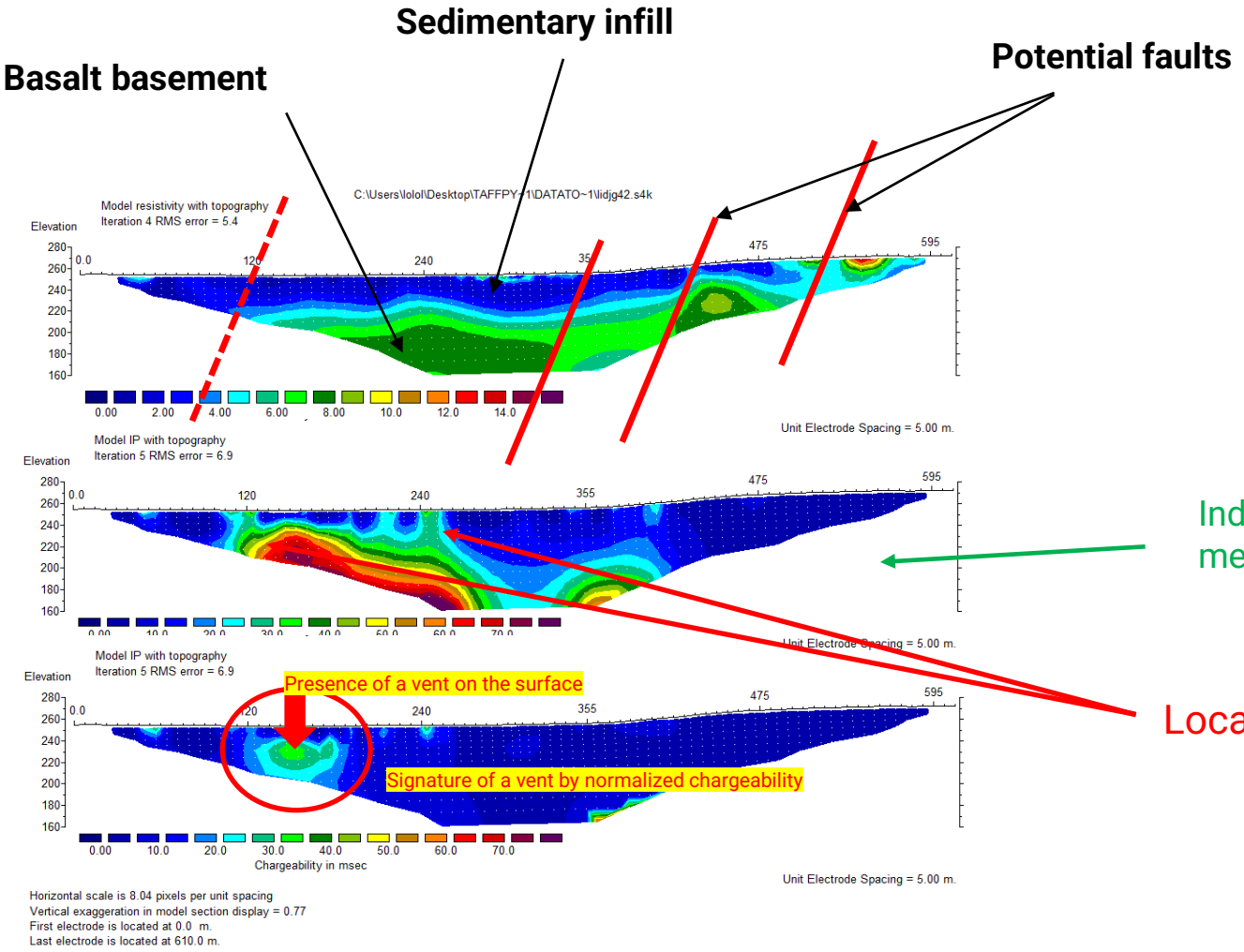






Vertical conduit identified at the intersection of A and B profiles

Geothermal Village at the Lake Abhé geothermal site : Electrical resistivity and induced polarization tomography



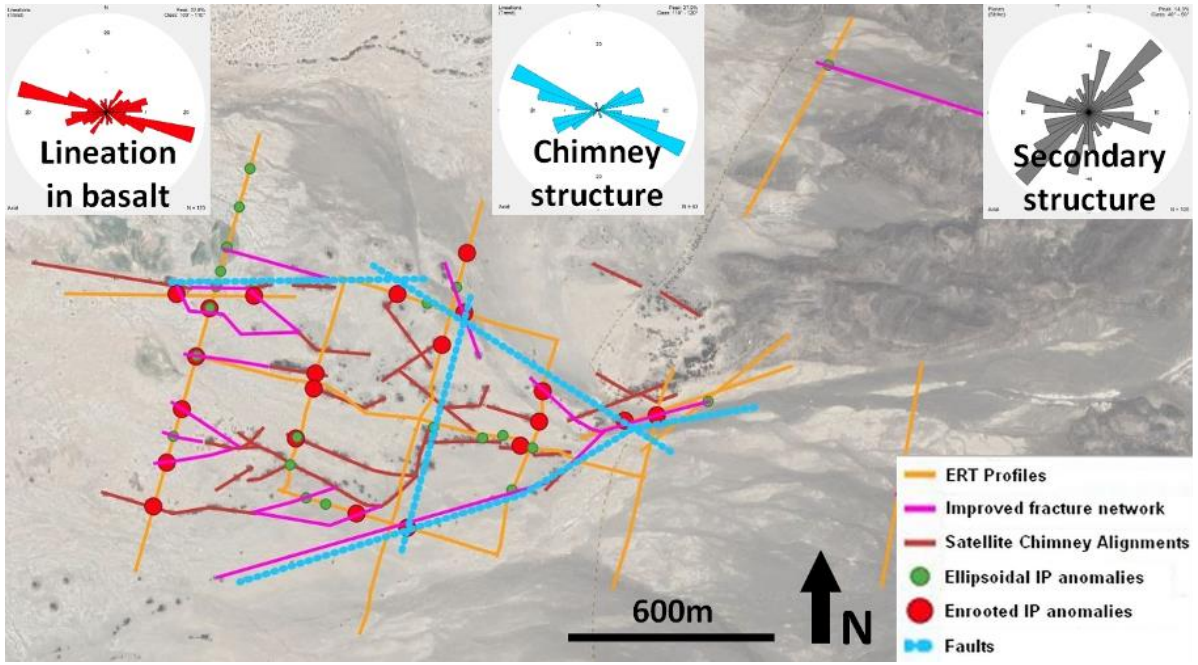
-> Description of the geothermal field features

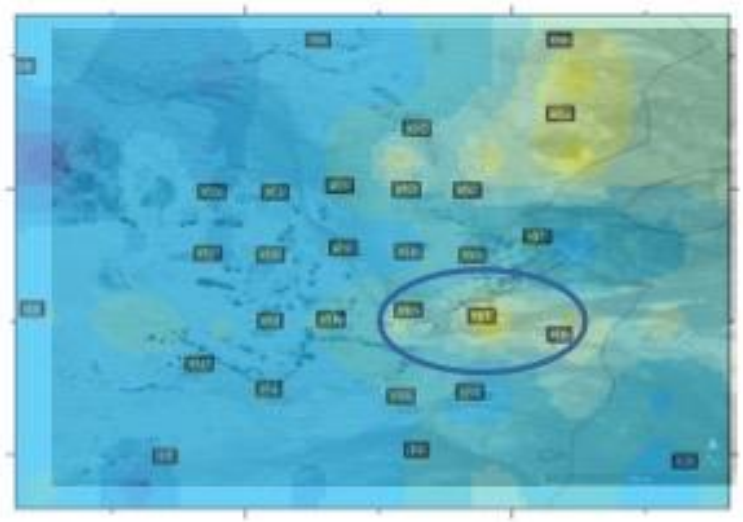
Induced polarization indicates clay and metalic mineral deposits location

Location of active hydrothermal chimneys

Geothermal Village at the Lake Abhé geothermal site : Targets

Several potential drilling targets recognized from multi-method datasets





Thank you

Jacques Varet
Géo2D
j.varet@geo2d.com
www.geo2d.com
+33 6 18 072227

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