H-NAT 2022 by Xcorp

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OFFICE NATIONAL DES HYDROCARBURES ET DES MINES

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NATURAL — HYDROGEN

NATURAL HYDROGEN EXPLORATION IN THE SOUTH OF MOROCCO

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National Office of Hydrocarbons and Mines

A

State organization with legal personality, financial autonomy and Governmental control

B

Established on 2005 by the merger of :

- BRPM (1928)
- & ONAREP (1981)

C

ONHYM is in charge of research and development of Mines and Hydrocarbons potential of Morocco

D

ONHYM lunched the renewable energy projects:

- 2012 – geothermal
- **2017 – Natural H_2**

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History of natural H_2 research in Morocco (1/2)

2017

In November 2017, HYNAT presented to ONHYM the potential for cooperation on this new renewable natural resource.

ONHYM has carried out a preliminary assessment on Moroccan potentialities in natural Hydrogen

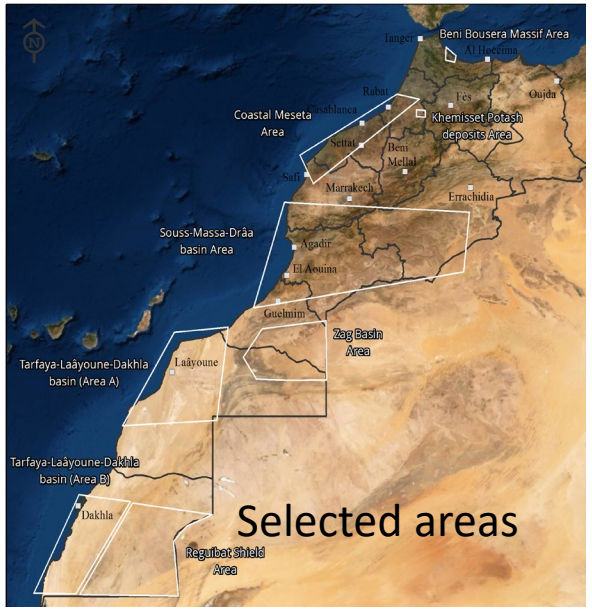
2019

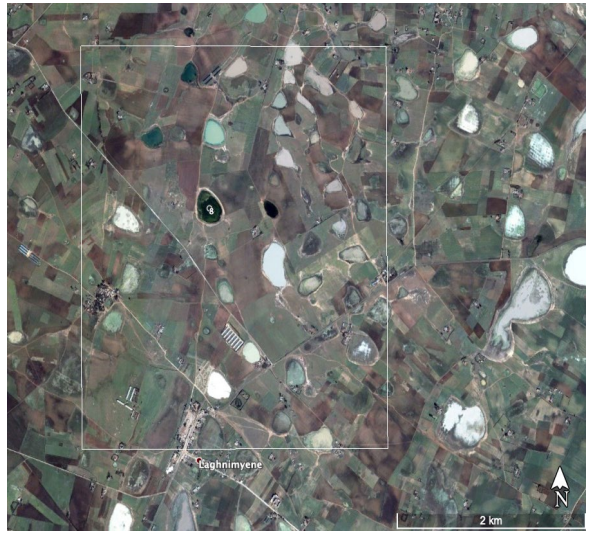
ONHYM has launched a support and international expertise in the research of natural hydrogen in Morocco

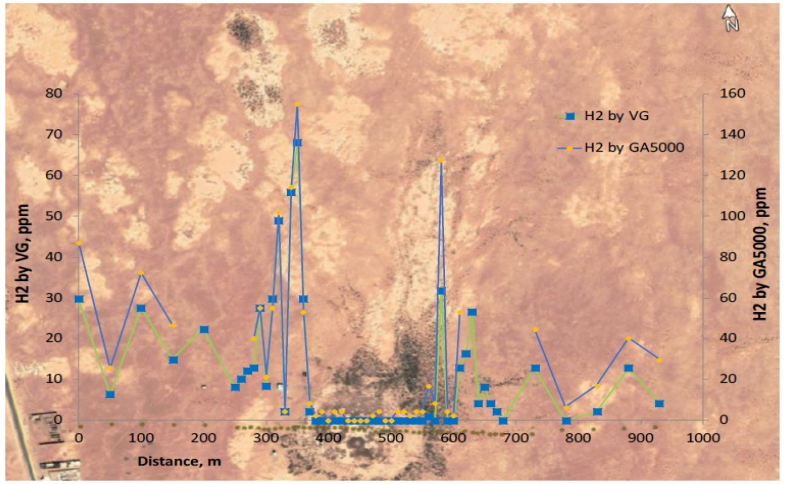
1. ONHYM and the Ministry of Energy Transition and Sustainable Development signed an agreement granting ONHYM, the exclusive right to research for natural H_2 in the potential areas in Morocco.
2. ONHYM discusses partnerships for the development of natural H2 in Morocco

2017 — 2019

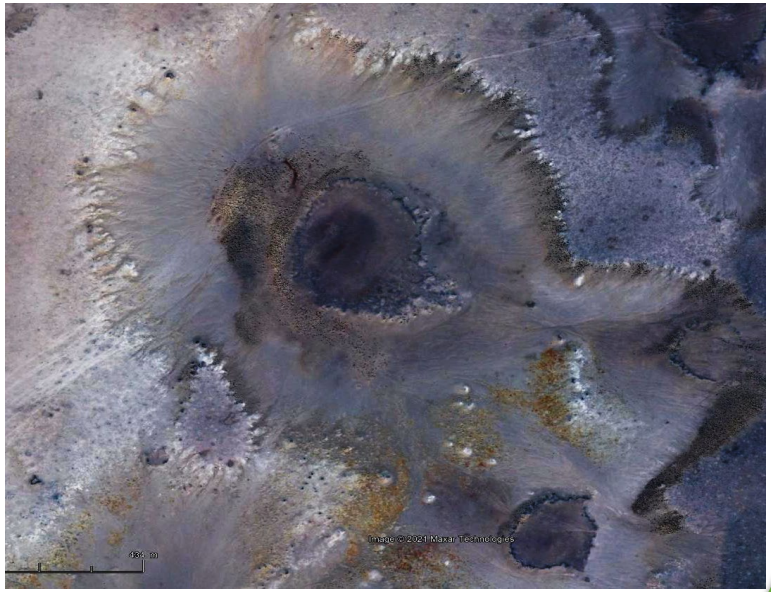
ONHYM continues to develop in partnership all targets highlighted



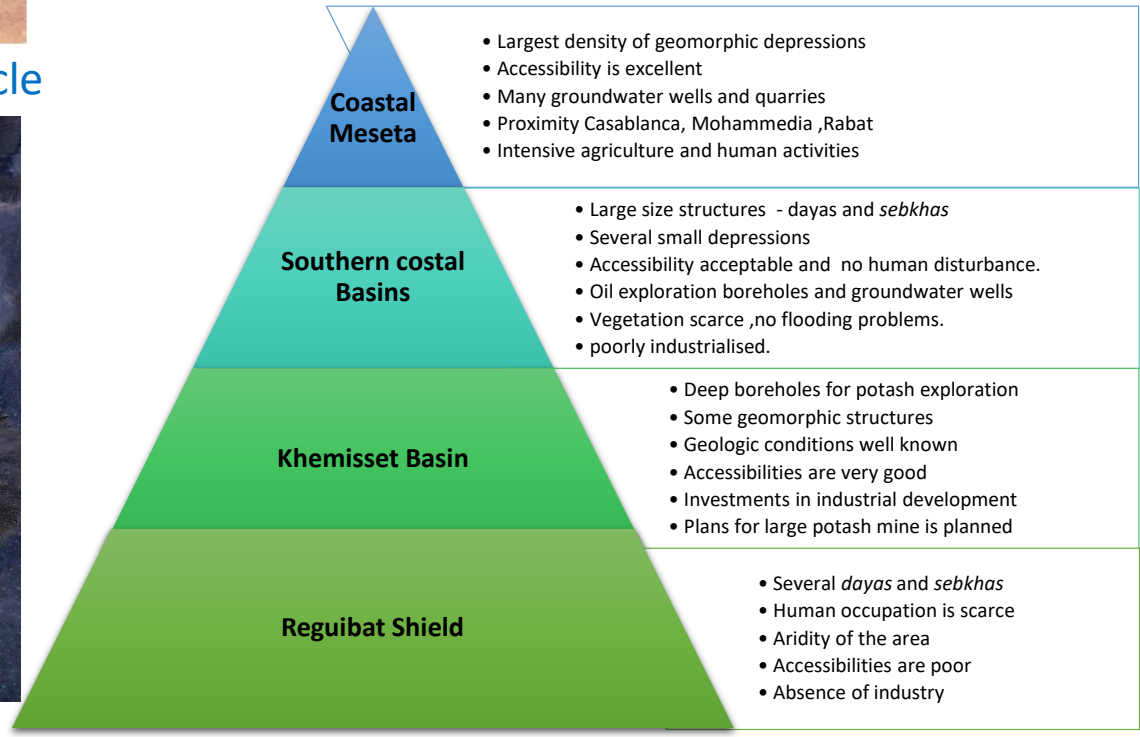




H_2 anomalies at the border of fairy circle



ONHYM puts natural hydrogen as a new lever at the heart of Morocco's the energy transition strategy and also to contribute to the energetic MIX



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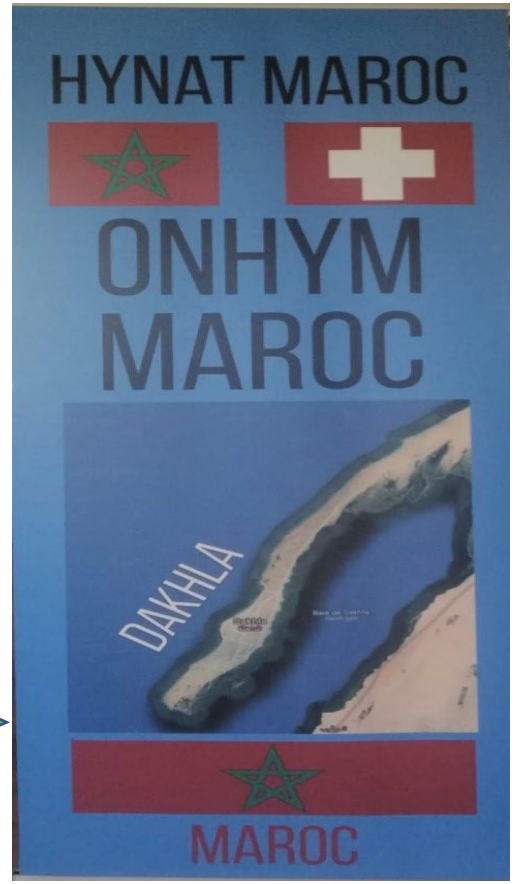
History of natural H_2 research in Morocco (2/2)

2021

ONHYM and HYNAT have signed a memorandum of understanding (MOU) for the development of natural H_2 potentialities in the Southern Provinces of Morocco

2021 — **2022**



DNA

Created in 2006, AAQIUS is a Swiss innovation company focused on the hydrogen and automotive sectors with more than 100 million new vehicles in the world

AMBITION

Since 2015, HYNAT SA (CH), specialized in the research, exploration, production of natural, renewable hydrogen on a human scale, have become a reference player.

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ACTION

HYNAT SA is currently researching and exploring in Morocco in partnership with ONHYM and in 6 other countries in Africa in cooperation with governments

EXPERTISE

With an experienced team led by Prof. Dr. Alain Prinzhofer, CTO of HYNAT SA, we offer more than 20 years of experience in Africa and on all other continents.

In 2021, ONHYM and HYNAT signed contract in order to develop the natural H_2 potential in the southern Provinces of Morocco

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Field exploration

- Compilation and processing of existing geoscientific data
- Preliminary targeting for the study areas
- Field works
- Laboratory works
- Processing and interpretation of results

Geophysical works

- Geophysical prospection works
- Data compilation and processing
- Interpretation of results
- Identification of zones to drill

Drilling and testing

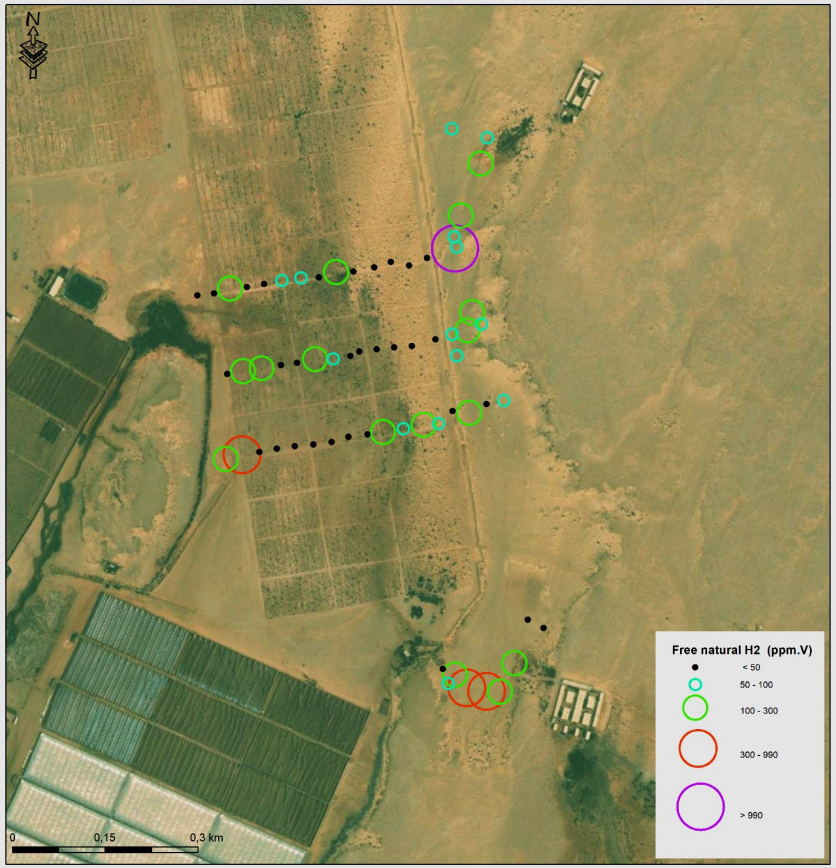
- First drilling campaign and production tests
- Monitoring works
- Compilation, processing and interpretation of results
- Elaboration of the action plan for the industrial project

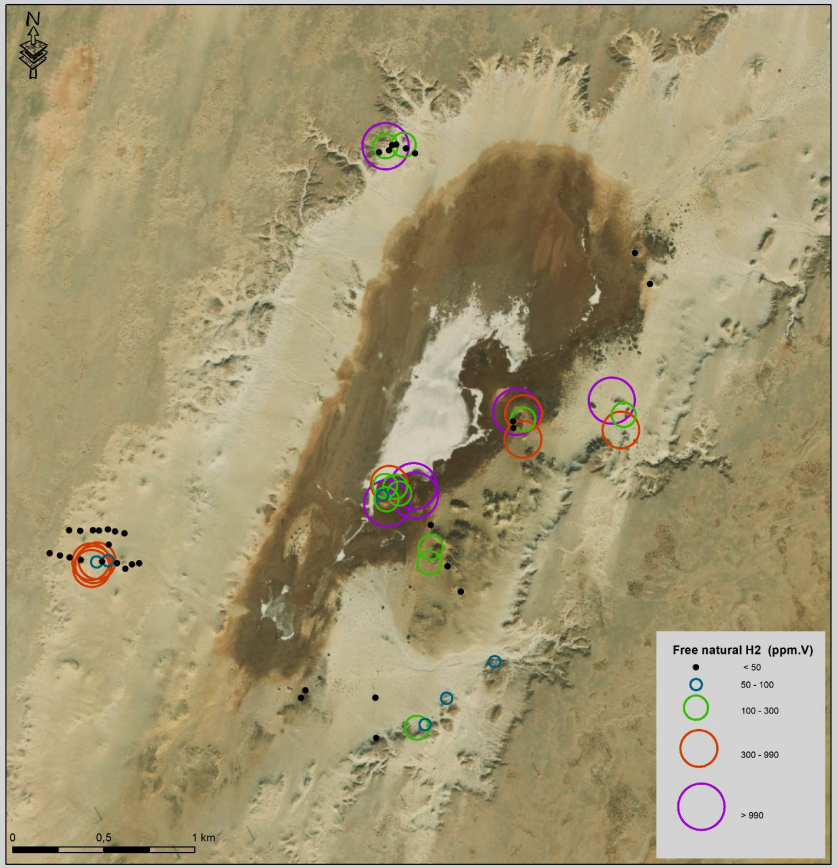
TODAY

2021 2022 2023

Geophysical preliminary results

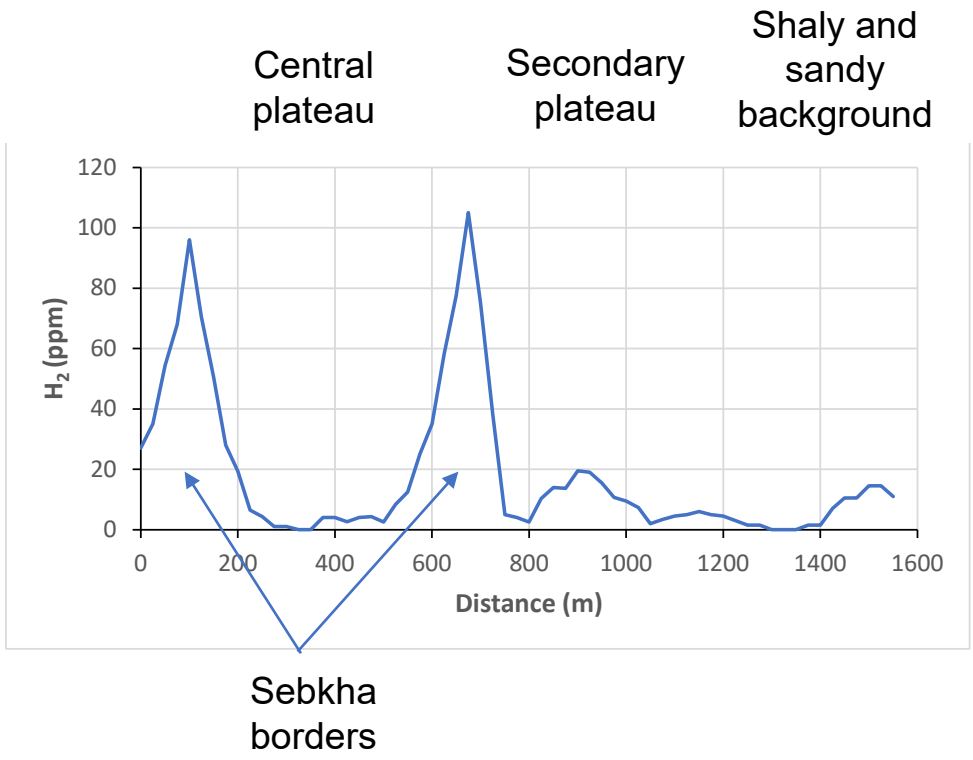
- Majority of inventoried structures show natural Hydrogen seepage.
- The flow rate of the free gas is sometimes very important exceeding 0.1%.V (saturation value of GA5000)

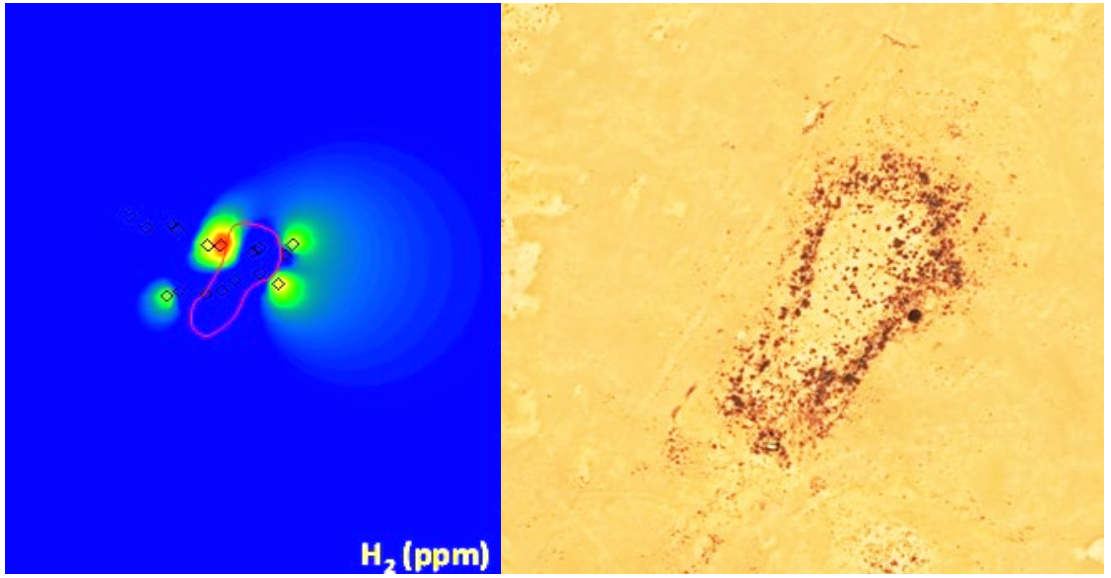


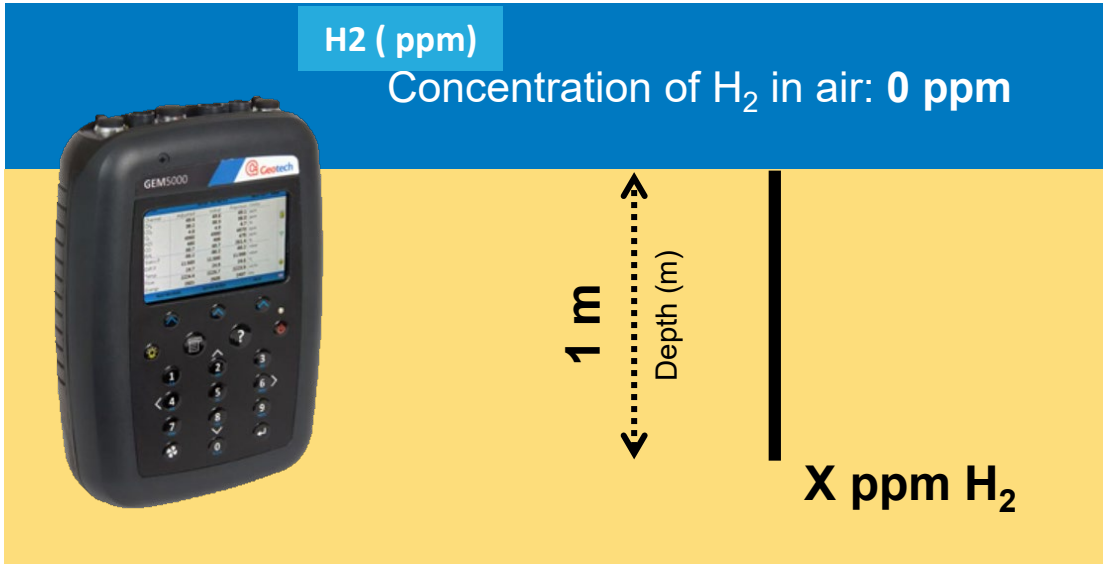


H_2 analysis

H_2 measurements at 1m depth in soils show anomalies at the periphery of fairy circles, and at the border of sebkhas

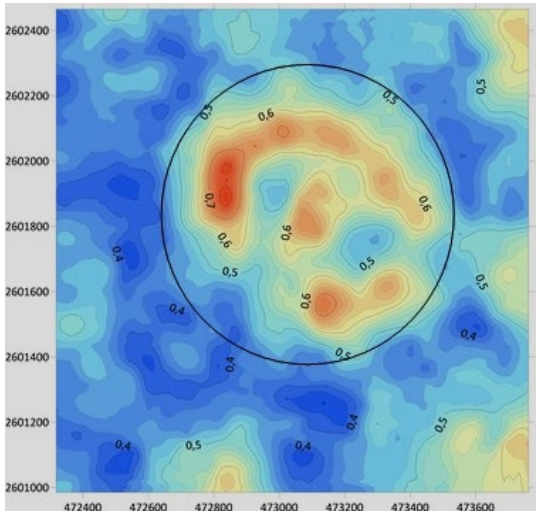




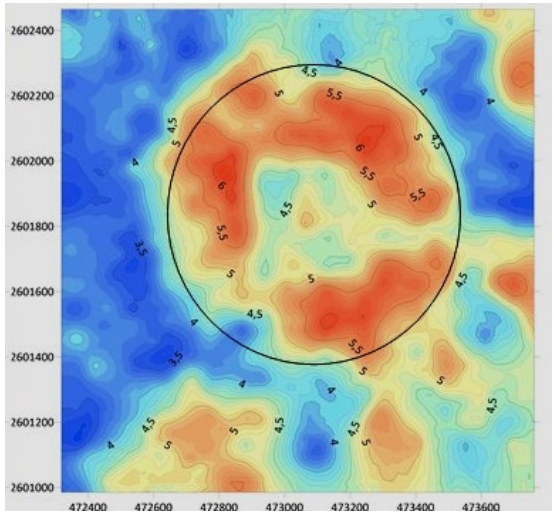


Contribution of gamma spectrometry

Concentration maps in potassium and thorium

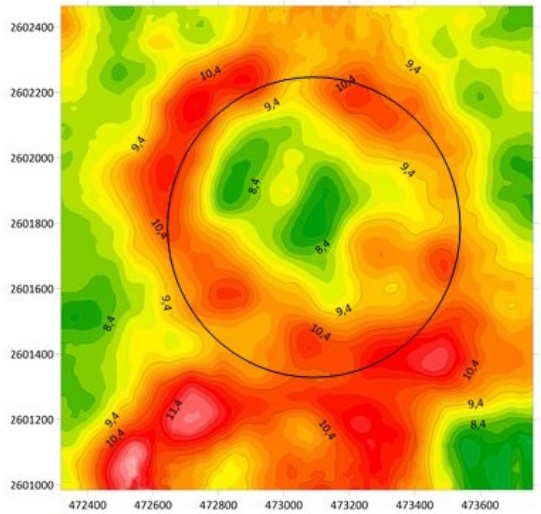


K max/min = 4,2



Th max/min = 3,7

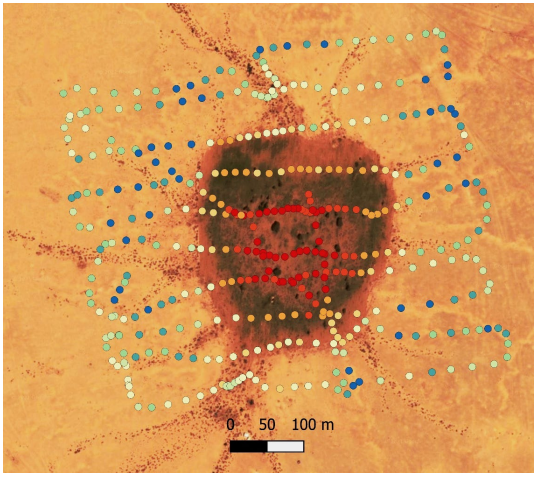
Ratios Th/k

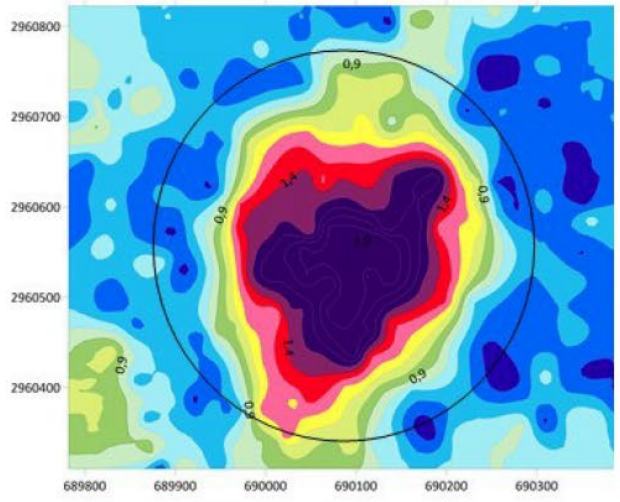


Th/k max/min = 4, 2

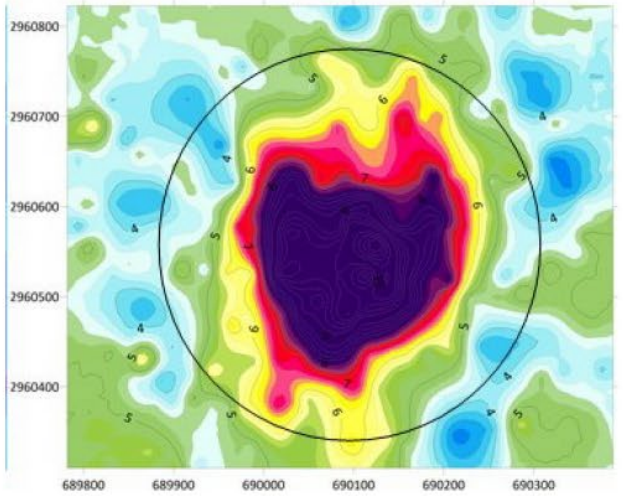
As in many other areas in the Word, anomalies observed with gamma spectrometry present a spectacular **proxy for the activity of hydrogen systems**

Geophysical preliminary results

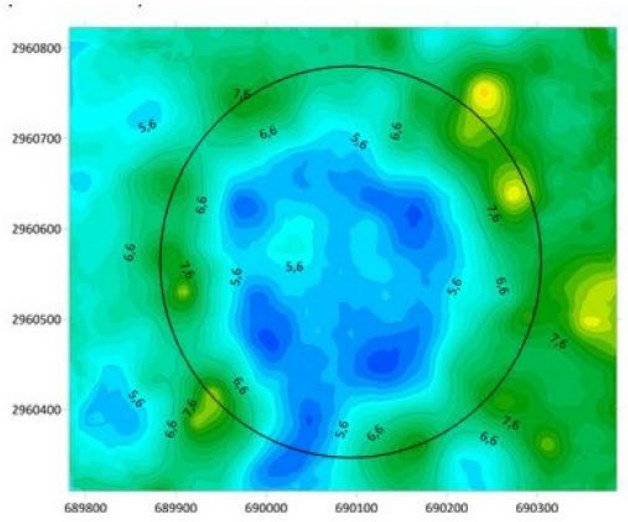




K max/min = 5,3



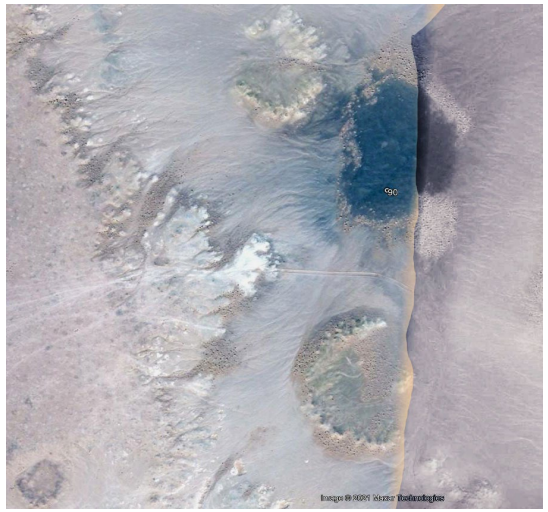
Th max/min = 4,1

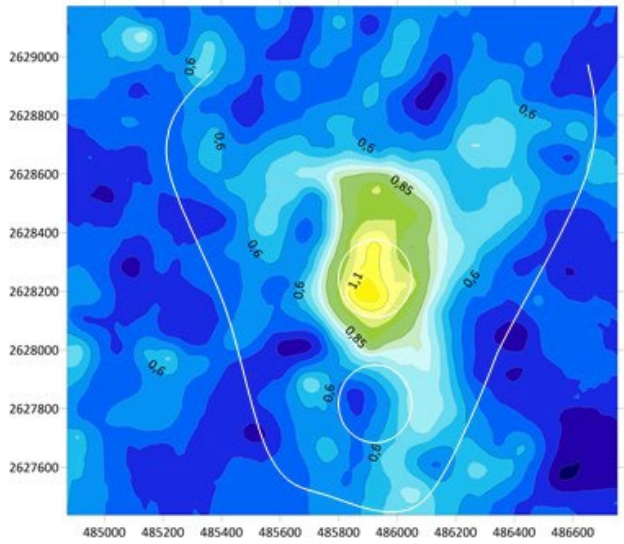


Th/k max/min = 4, 0

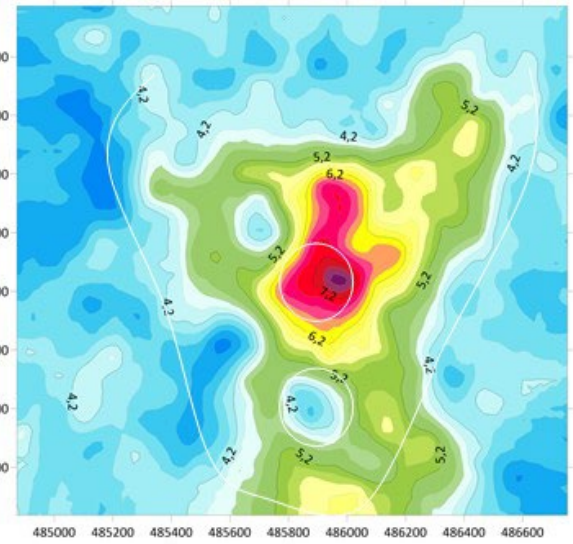
Another example of Th and K gamma spectrometry anomalies associated with a fairy circle

Geophysical preliminary results

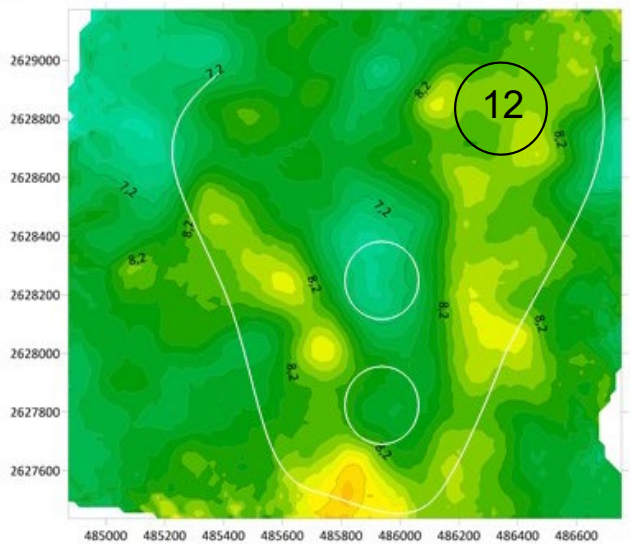




K max/min = 6,0



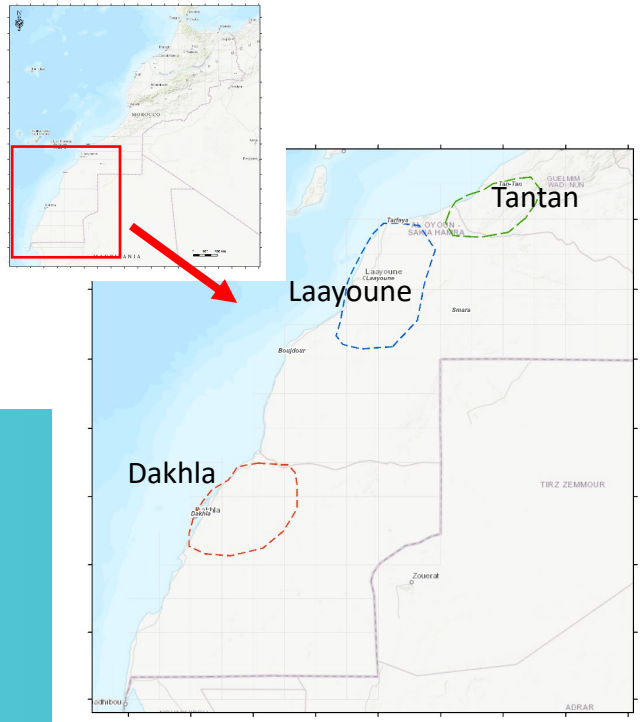
Th max/min = 4,5

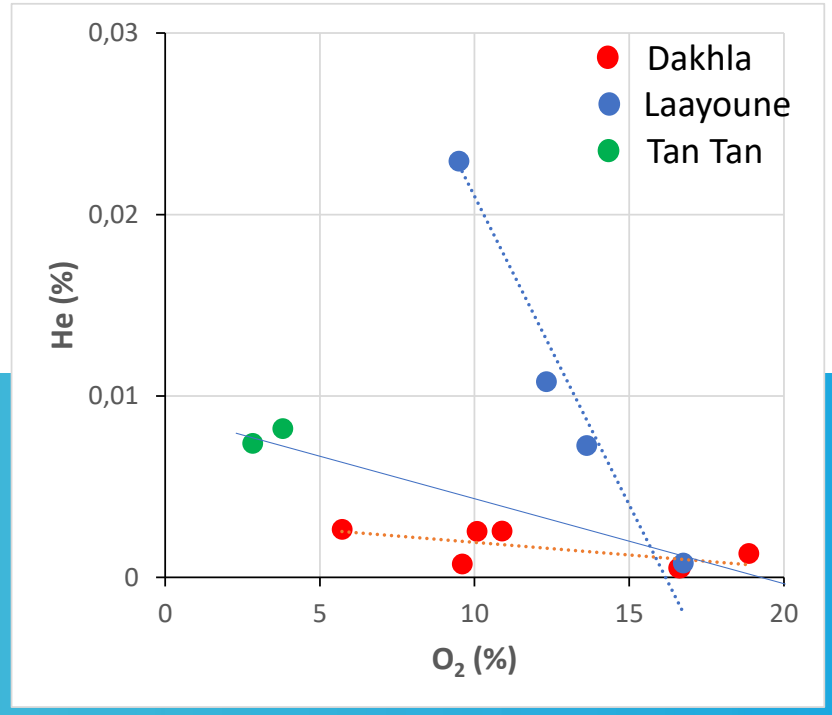


Th/k max/min = 5,3

Two fairy circles, one black (North), the other light (South) are enclosed in a macrostructure.
Positive Th anomaly only in the black structure and at the border of the macrostructure

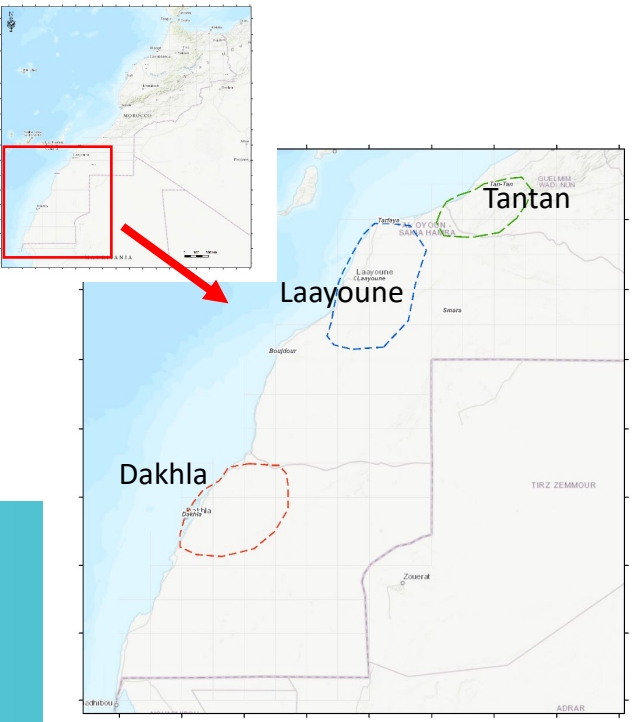
Helium and oxygen measurements
In 3 areas

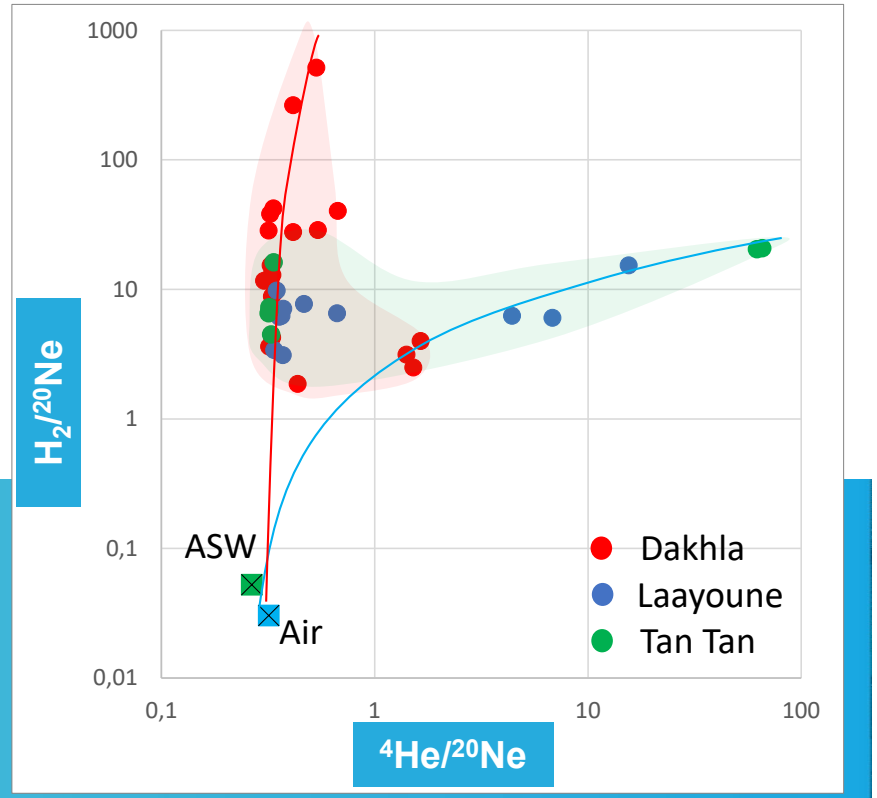




- **Measured** oxygen in sampled gases are only related to **atmospheric contribution**.
- **Extrapolation of helium concentrations to zero O_2 allow to know the concentrations at depth without air contribution.**
- It appears that the **Laayoune area presents a higher He potential than the two other ones,** associated with N_2 as the **main gas compound**

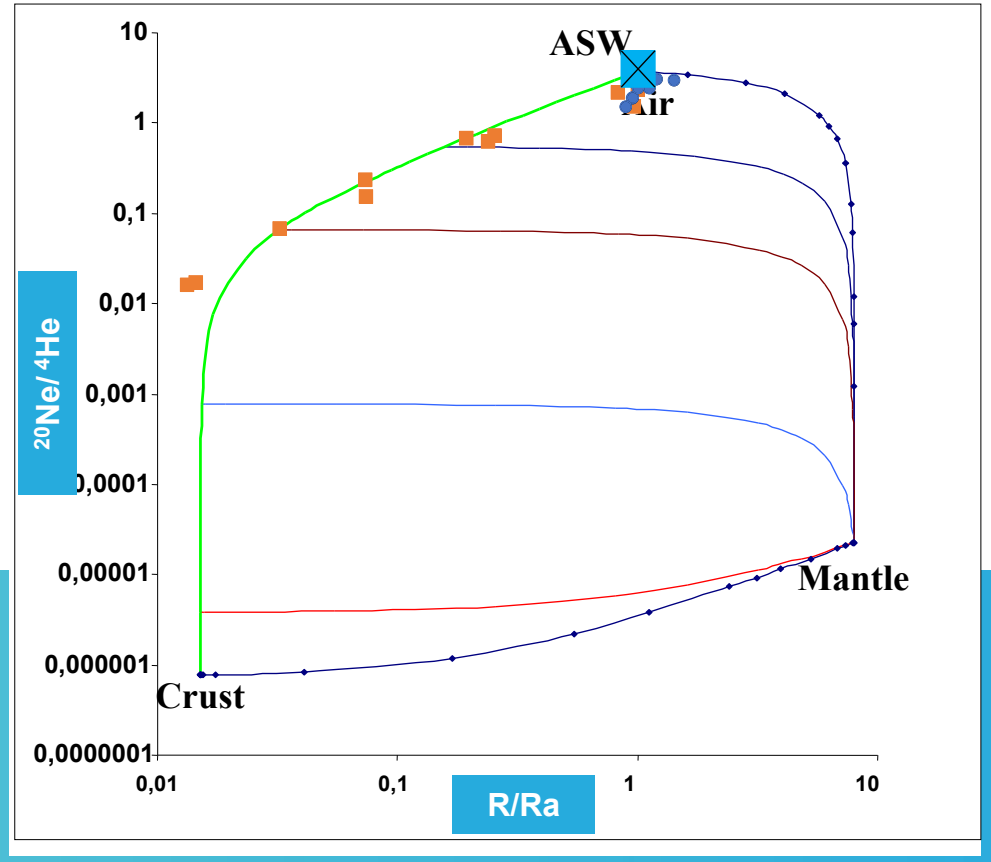
Helium and hydrogen concentrations
In 3 areas





- Hydrogen and Helium concentrations, normalized with a fossil noble gas isotope (here ^{20}Ne) show that the **Dakhla area is prefentially enriched in H_2** compared to helium
- **Tan Tan** and **Laayoune are enriched in helium and poor in H_2**

Noble gases isotopes



R/Ra:
Isotopic ratio of helium $^{3}He/^{4}He$, normalized to the atmospheric ratio of $1.4\ 10^{-6}$

- **Concentrations and isotopic ratios of noble gases** as He and Ne associated to sampled gases show clearly a **mixing between air and continental craton fluids.**
- **No influence of mantle or any volcanic fluid** is associated with these gases.

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CONCLUSIONS & PERSPECTIVES

- H_2 systems were confirmed in the southern provinces of Morocco
- Estimated H_2 potential is very important
- Some visited sites show a more important potential for helium with an evidence of H_2–He–N_2 zonation
- Gamma-ray spectrometry, tested on the ground for the first time, shows very encouraging results for the exploration of natural hydrogen
- The chemical and isotopic analyses of the gases also confirm the presence of hydrogen systems in depth
- The ONHYM – HYNAT partnership is a success in the field of natural hydrogen research in Morocco especially in the southern Provinces
- ONHYM – HYNAT will continue hand in hand for the development of the natural H_2 branch in Morocco
- The work schedule foresees the first technical drillings in 2023/2024 and SOP in 2024/2025.

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Thank you

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