

# Natural Hydrogen Projects

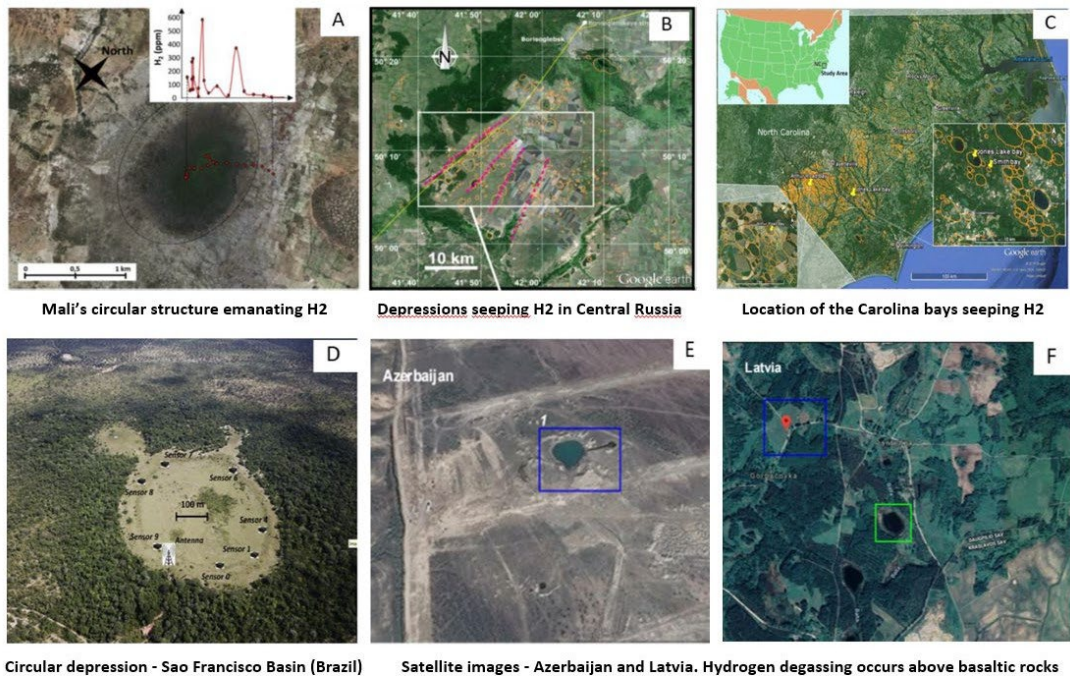
**Xcalibur Smart Mapping**

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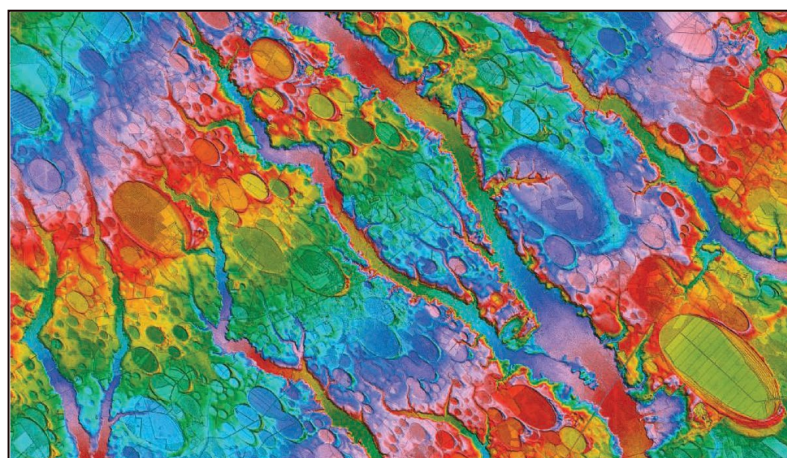
## Natural Hydrogen Exploration

Hundreds of shallows, circular depressions have been identified from satellite images in Azerbaijan, Australia, Brazil, Mali, Namibia, Russia, and US. Soil gas studies in North Carolina (US) detected significant concentrations of molecular hydrogen around the morphological depressions, suggesting fluids flow pathways for hydrogen moving from depth to surface (Zigonnik et al., 2015). These hydrogen emitting structures are known as fairy circles.



*Natural hydrogen seeps satellite expression*

Source: Frery et al (2021).



*Satellite image of natural hydrogen seeps in North Carolina (US).*

Source: <https://www.science.org/doi/10.1126/science.adh1477>

Although the hydrogen seeps can be observed in satellite images and analyzed by soil-gas and water sampling, the assessment of the resources requires multi-physics exploration before the drilling campaigns.

A combination of methodologies and technologies from Oil & Gas, mining and geothermal industries are being used in natural hydrogen exploration.

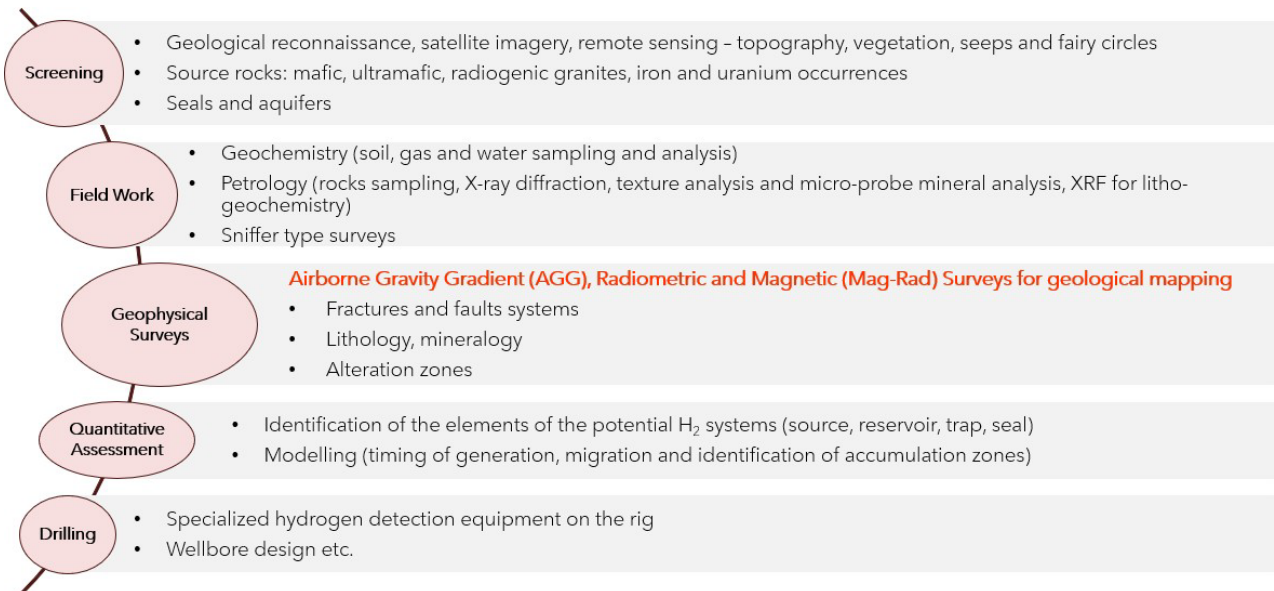
Seismic data image the subsurface in sedimentary basins, but other geophysical methods become essential to characterize the basement and to perform the near-surface interpretation. The following geophysical methods are fundamental to determining the geological elements of the hydrogen system:

**Radiometrics:** mapping cratons basement enriched in radiogenic elements. Measurements of Potassium (K), Uranium (U) and Thorium (Th) at the surface of the ground with their natural radioactivity.

**Gravity/Gravity Gradiometry:** gravity and gravity gradient anomalies guide the delineation of aquifers and fault zones where native hydrogen is trapped or could be migrating.

**Magnetics:** Hydrothermal alteration of ultramafic rocks leads to a deep mineralogical transformation corresponding to the serpentinization process. During this process, Fe<sup>2+</sup> initially contained in olivines and/or pyroxenes, can oxidize to Fe<sup>3+</sup> by incorporating newly formed phases such as serpentine and magnetite. A combination of these metals in large quantities will produce magnetic anomalies.

**Electromagnetics:** Resistivity data are useful to identify high-porosity karst systems which are favorable for a massive storage volume of aquifers, which maybe temporary hydrogen reservoirs.



*Natural hydrogen exploration workflow*

*Compiled from Alexander, E., 2022; Ellis, G.S., 2022; Levy et al., 2023; Schneider et al., 2022.*

## Xcalibur’s unique and innovative technology solutions can fast-track your Natural Hydrogen Exploration.

**Xcalibur Smart Mapping** is a global leader in airborne exploration for natural hydrogen. Leveraging our extensive experience and unique technologies, we have supported explorers such as **Koloma**, **Hytierra**, and **Gold Hydrogen** in their exploration programs.

Hydrogen exploration combines the fields of hydrocarbon and mineral exploration. Xcalibur brings decades of expertise in data acquisition, interpretation, and modelling in both areas.

### Natural Hydrogen Generation and Accumulation

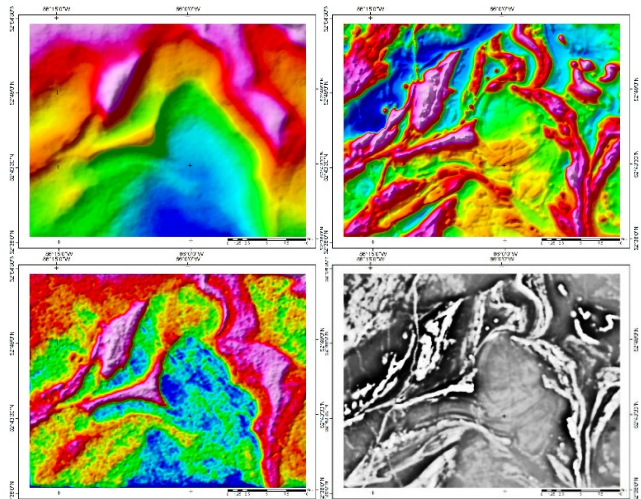
Natural hydrogen is formed in the subsurface via multiple processes. The best understood processes are Serpentinization and Radiolysis.

Serpentinization is an alteration process of mafic/ultramafic lithologies resulting from interaction with water at specific pressures and temperatures.

Ultramafic rocks are generally high density and can be mapped to great depth with FALCON® AGG with high resolution gravity.

FALCON® AGG and magnetic data will also image radiogenic granites that generate hydrogen and helium through radiolysis.

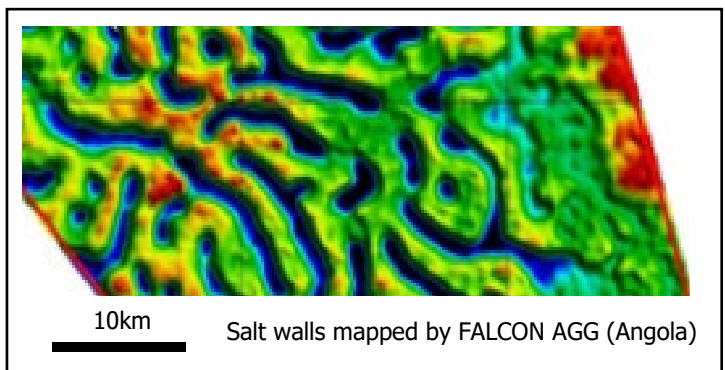
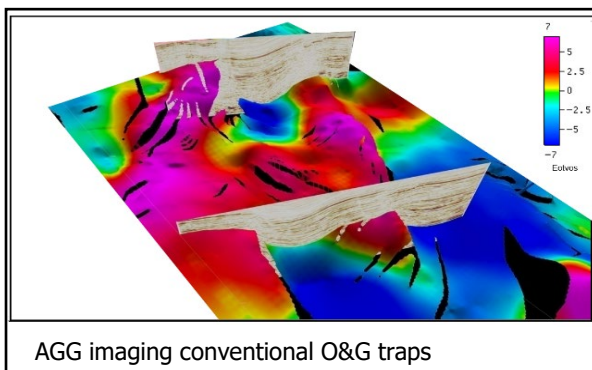
FALCON® AGG and magnetic data will map the faults and fractures that act as conduits for both processes, allowing water influx and subsequent hydrogen generation and migration.



*Gravity (top) and vertical gravity gradient (bottom)*

*Magnetics (top) and vertical magnetic gradient (bottom)*

For hydrogen to accumulate in the subsurface, impermeable layers such as shales and salt are required to impede its escape to the surface. FALCON® AGG is ideal for mapping these formations and structures and has demonstrated this capability numerous times in conventional hydrocarbon exploration.



Xcalibur is actively involved in natural hydrogen and helium exploration programmes in several countries, using the FALCON® AGG technology in both sedimentary basins and basement provinces. Airborne gravity gradiometry and the aeromagnetic data are acquired jointly and are a fundamental part of the integrated geophysical and geological data interpretation workflow for mapping the elements of the geological system:

- ② Sedimentary basin architecture
- ② Sedimentary rocks lithologies
- ② Intra-sedimentary faults
- ② Basement faults
- ② Volcanics and intrusives
- ② Crystalline rocks lithology (granites, gabbros, mafic rocks, ultramafic rocks)
- ② Fractures (fluid migration pathway)

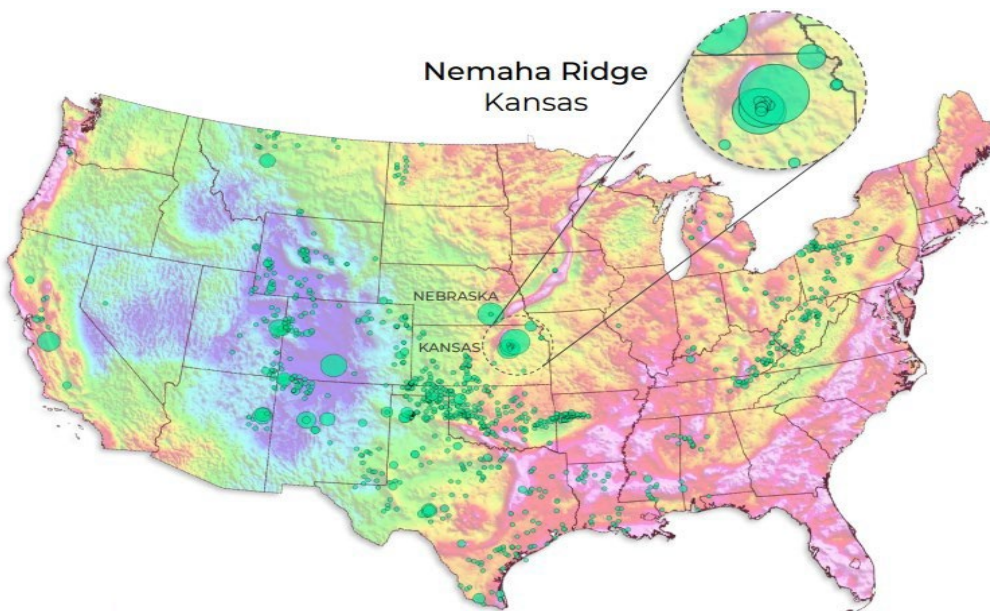
## Natural Hydrogen and Helium Exploration

FALCON AGG Survey – Nemaha Project

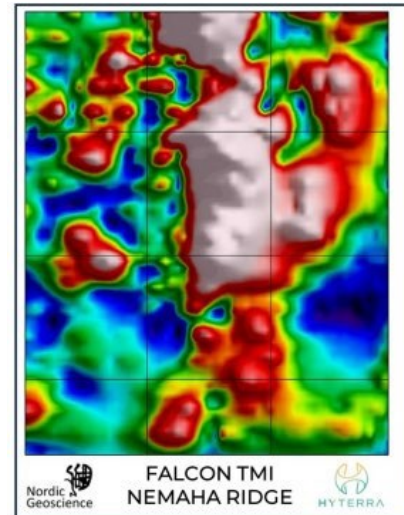
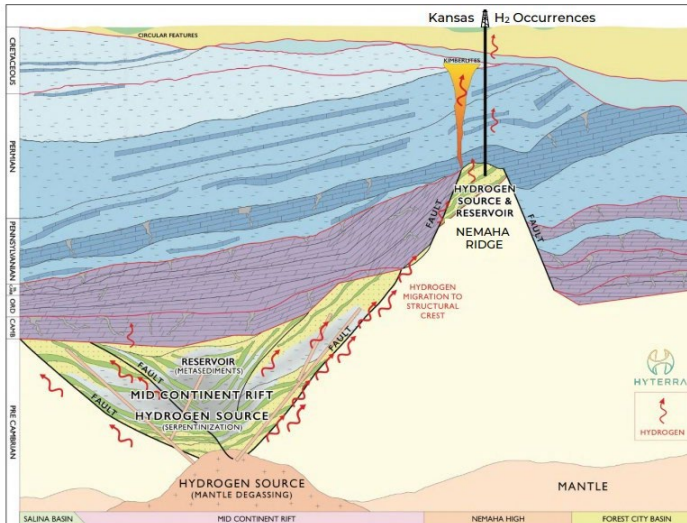


<https://static1.squarespace.com/static/61d45be50ebc296e7032ac4e/t/64740e9f8b1bfc490f48882f/1685327558573/HYT+Investor+Presentation.pdf>

Nemaha is located between Kansas City and Wichita in the center of a major industrial and manufacturing hub.



- Historical well occurrences grading up to 92% hydrogen and 3% helium.
- Drilling for hydrogen and helium starting Q3'2024.
- Significant leverage on exploration success.
- USA incentivizing investment into hydrogen.

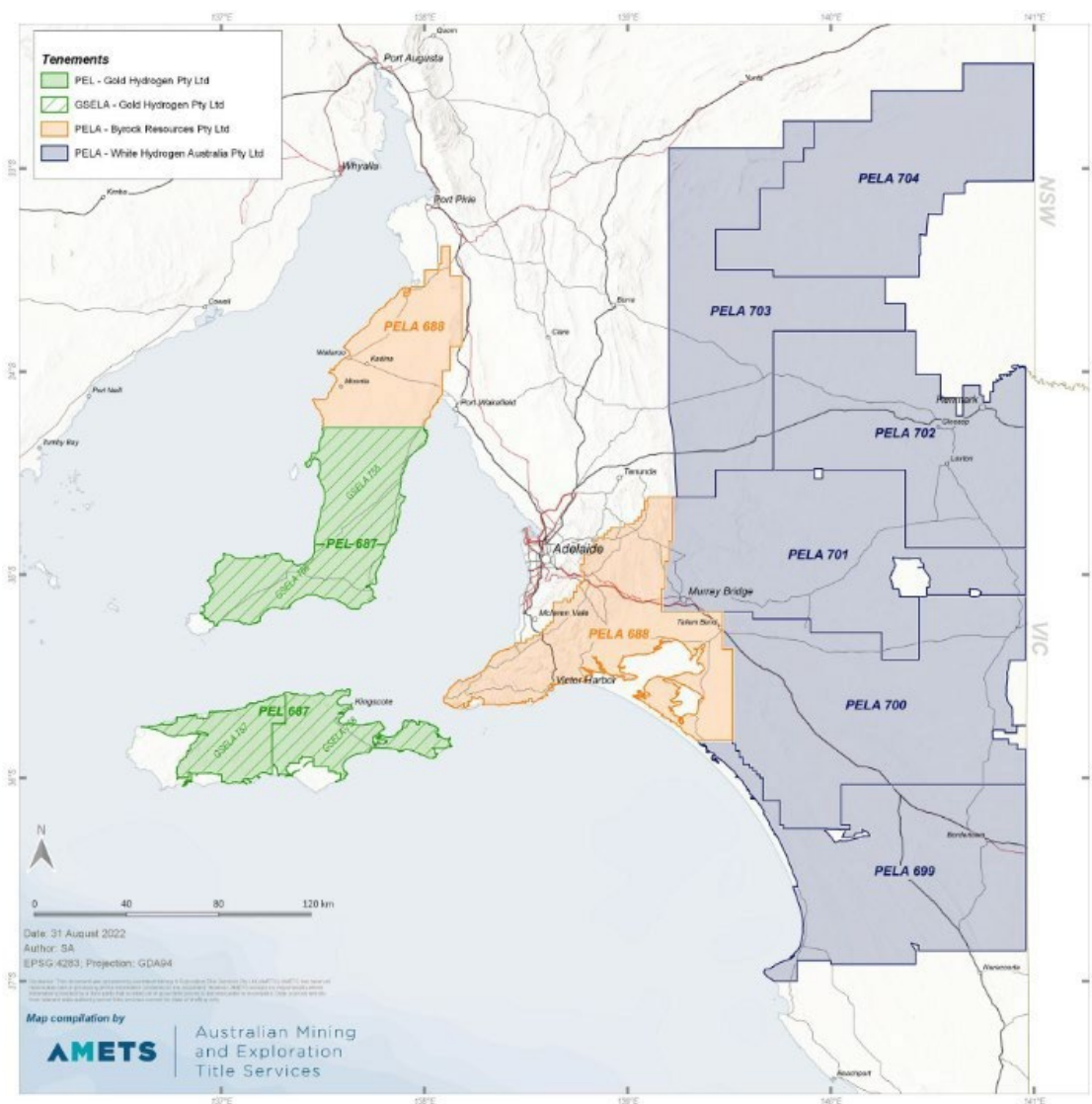


- Hydrogen is sourced from rocks within the Midcontinent Rift.
- Hydrogen migration from Midcontinent Rift via faults to adjacent crestal highs.
- Nemaha Ridge is the most prominent structural high in the region and is a focal point for migration.
- At least 10 occurrences of natural hydrogen have been recorded on this structure.
- FALCON® AGG data is imaging the subsurface geology, detecting faults, depth to basement and the composition of basement rocks, serving as a key input for an independent assessment of prospective resources and is also guiding the Company's lease acquisition strategy.

FALCON® AGG Survey – Ramsay Project

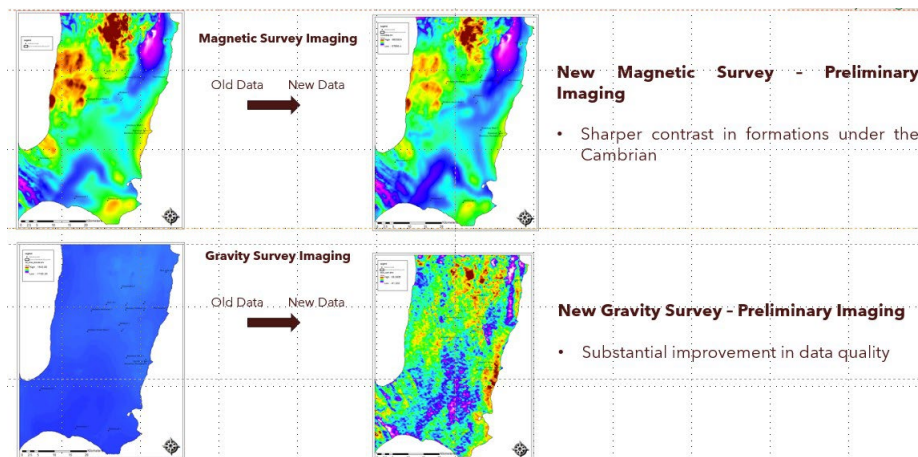


Gold Hydrogen Ltd (GHY) is an Australian company which is seeking to prove the existence of commercial quantities of natural hydrogen in its Petroleum Exploration License 687, covering portions of Yorke Peninsula and Kangaroo Island.





- ☑ Ramsay Project is located at the Southern end of Olympic Dam iron-oxide-copper-gold + uranium.
- ☑ Ramsay Project is located on major lithospheric boundary, with a suggested massive-fractured basement play that would have open sets of microfractures, fractures and joints.
- ☑ Ideally the host-rocks for formation of hydrogen gas are located along major structural boundaries in an extensional geological regime where natural fractures exist.
- ☑ 2 potential reservoirs for hydrogen, MFB, the primary target; and Cambrian limestones and sandstones, the secondary targets.



- ☑ Exploration programme includes a high-resolution airborne gravity gradiometry and aeromagnetic survey over 18,203 line-kms at 500m line-spacing over the Yorke Peninsula and Kangaroo Island blocks.
- ☑ FALCON® Airborne gravity gradiometry and magnetic data are assisting GHY geoscientists in better understanding the onshore structure and basement source rocks of the Ramsey Project.
- ☑ Gold Hydrogen has drilled 2 exploration wells (2023-2024).
- ☑ Ramsay 1 & 2 exploration wells found Helium at up to 17.5% (in addition to the 86% Hydrogen identified).

**FALCON® AGG Survey – Ruwka Project**

Source: <https://www.helium-one.com/projects/rukwa-project/>



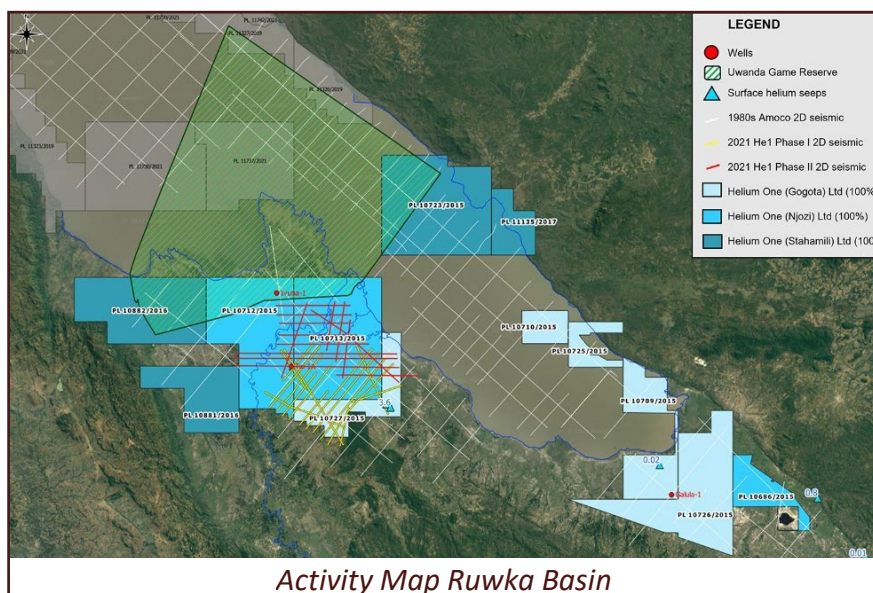
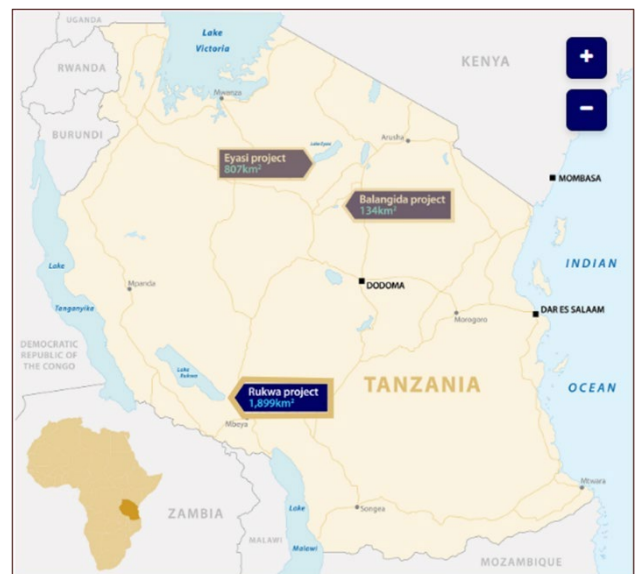
The Ruwka project is located in southwestern Tanzania within the Ruwka Rift basin which occupies the western branch of the East Africa Rift System (EARS).

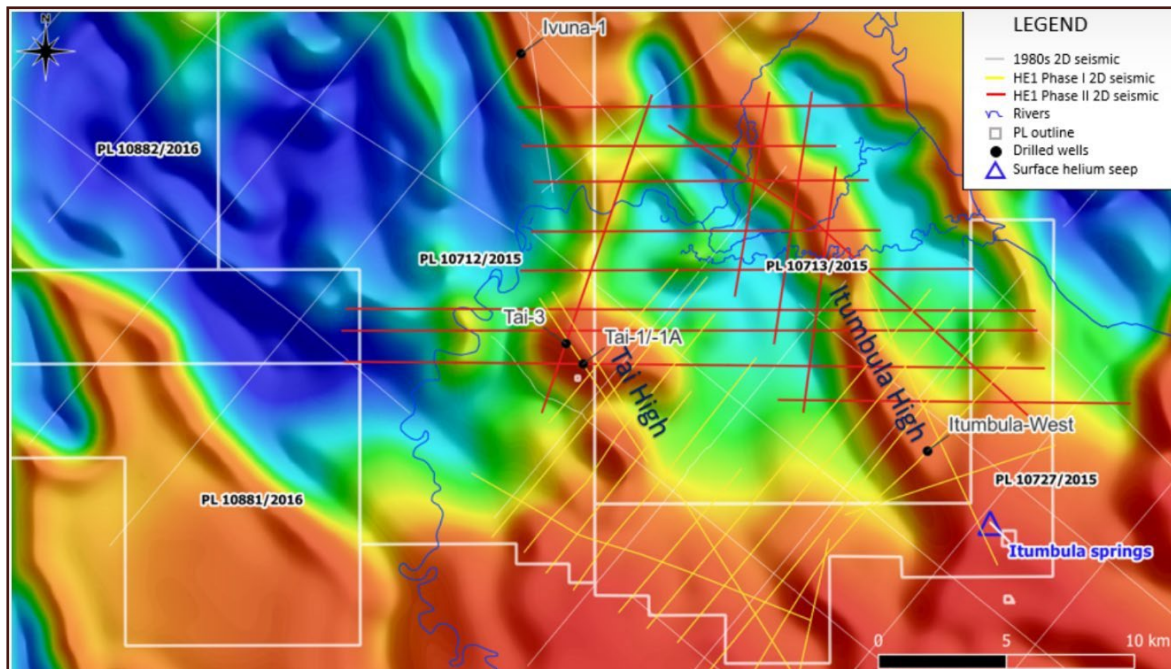
**Exploration Programme**

- Multispectral satellite spectroscopy (MSS) seep study
- **15,606 line-km of Falcon airborne gravity gradiometry data**
- ~ 400 km of 2D seismic data
- 2 wells (Tai-1/-1A and Tai-2)

This has provided proof of concept and has enabled the Company to reduce the exploration risk in the Ruwka Basin.

FALCON® AGG and Mag data supported the subsurface interpretation, mapping faults and intrusives, determining the depth to basement, providing the seismic interpreters with crucial information about the prospects before drilling.





FALCON® Gravity derived Basement map over Tai and Itumbula prospects, with 2D seismic surveys overlain.