FUSE- A new infrastructure to help derisk site selection for future Underground Hydrogen Storage and White Hydrogen exploration

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An increase in the production of clean hydrogen, particularly green hydrogen generated from water electrolysis using only renewable energy, alongside the growing interest in exploring natural (or white) hydrogen deposits (e.g. Hand 2023, Fig. 1), are key elements of Europe's energy transition strategy. These approaches offer large-scale, flexible, and low-carbon solutions towards a Net Zero economy.

In the context of developing a green hydrogen-based economy, Underground Hydrogen Storage (UHS) plays a fundamental role, as UHS can balance the intermittency of renewable sources.

Achieving the objectives of the EU Hydrogen Strategy requires a step change in subsurface investigation capabilities, combining high-resolution imaging, laboratory experimentation, and predictive modelling. Integrated research infrastructures are therefore essential to reduce uncertainty and de-risk site selection and operation for hydrogen-related subsurface activities.

FUSE (Open Infrastructure on Future Underground Hydrogen Storage) is a newly established research infrastructure initiative, launched in April 2025 through a collaboration between OGS, the University of Trieste, and the University of Udine, and funded by Regione Autonoma Friuli Venezia Giulia.

FUSE is designed as an open and distributed platform that brings together advanced geophysical monitoring technologies, dedicated laboratory facilities, and multi-scale numerical modelling tools. Its capabilities include borehole and surface geophysics, seismic and electrical methods, fibre-optic and orbital-vibrator monitoring, airborne and drone-based magnetic and gravity surveys, as well as petrophysical and fluid-dynamics laboratories tailored to hydrogen–rock–fluid processes, both in Italy and elsewhere. The combination of these methodologies and approaches will create an

integrated infrastructure for the identification, characterization, and subsequent monitoring of suitable UHS sites, some of which have already been identified in Italy by Barison et al., 2023.

Furthermore, FUSE will acquire new geophysical tools (Fig. 2) to contribute to the study of white hydrogen deposits, which represent a new research frontier. Although these deposits, present in various parts of the world, are still little known compared to conventional hydrocarbon deposits, they are potentially of great importance for the development of the Hydrogen Economy. They could provide both a natural resource to help meet the growing demand for hydrogen and a useful analogue to improve understanding of subsurface processes, a necessary condition for making UHS more efficient, safe, and sustainable.

Here we outline the scientific and technological framework of FUSE and discuss its relevance for UHS and white hydrogen exploration, including links with ongoing initiatives such as the North Adriatic Hydrogen Valley (https://www.nahv.eu/). We illustrate how the infrastructure supports improved characterisation of subsurface heterogeneity, assessment of structural and geohazard controls, and more robust simulations of hydrogen behaviour in geological formations.

By strengthening national and transnational capabilities, FUSE will act as a catalyst for safer, more efficient UHS deployment and for advancing the frontier of white hydrogen exploration within the broader context of the energy transition.

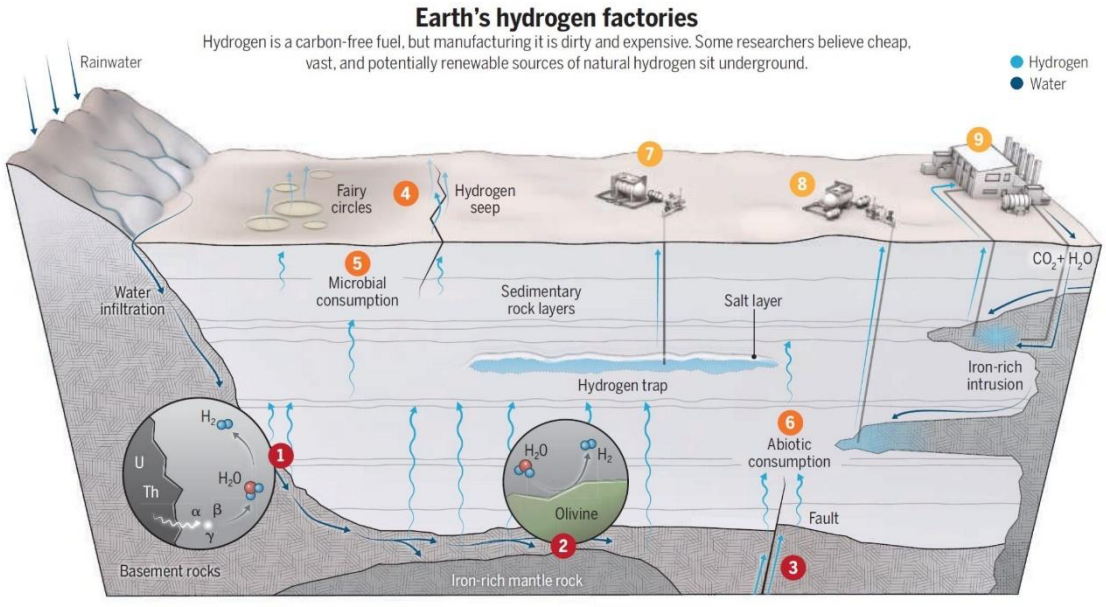

Fig. 1 – Diagram illustrating different geological contexts of formation of white hydrogen, a still little-known subsurface resource (from Hand, 2023).

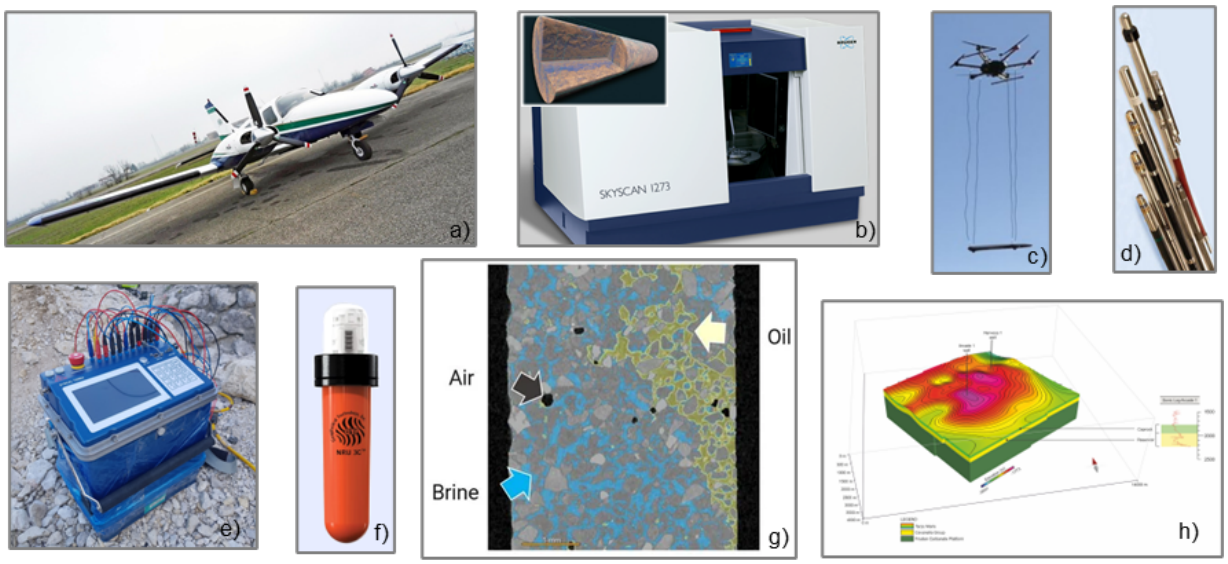

Fig. 2 – Some examples of the instrumentation and tools available within FUSE infrastructure: a) OGS airplane Piper PA-34-220 T Seneca III; b) CT scan for reservoir rock characterization; c) Aeromagnetic drone; d) Geophysical well logs; e) Resistivity & IP surveying system; f) 3C seismic nodes; g) Image acquired via a micro-CT scan at Rigaku laboratories shows the flow of three different phases (air in black, brine in blue, and oil in yellow) within a porous rock (shown in grey); h) Reservoir modelling.

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