

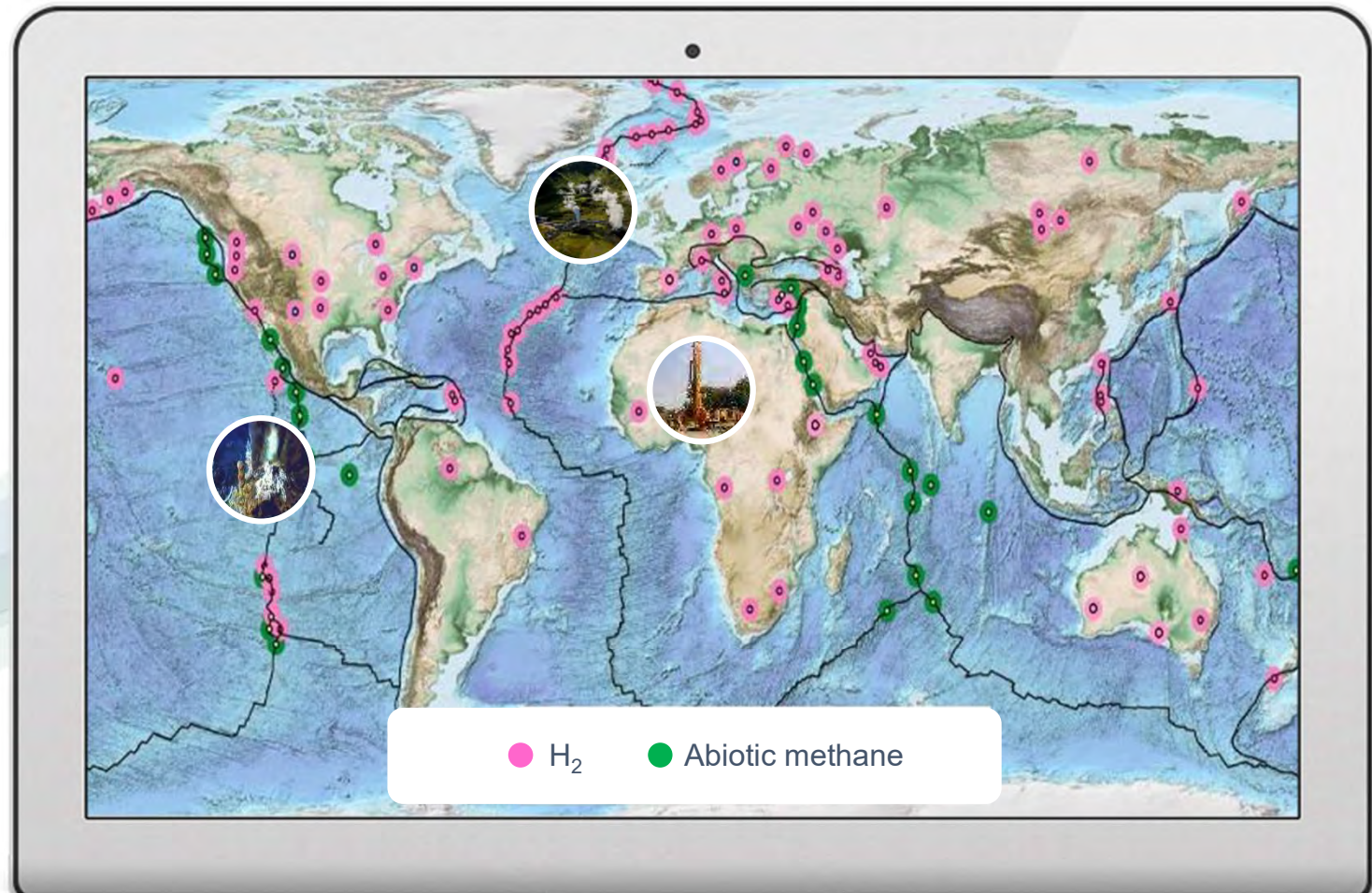
Potential, exploration,
production, innovation

Natural hydrogen exploration in Australia

Ema Frery
CSIRO Energy

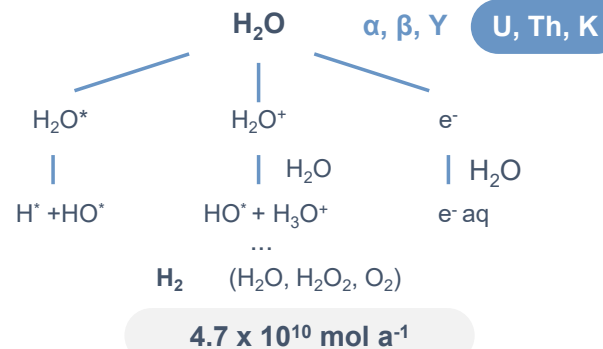


Where to find Natural Hydrogen?

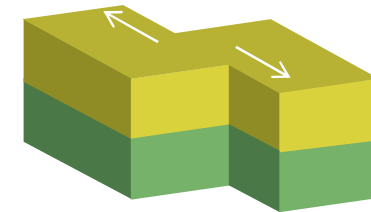


H² natural sources (just few from Klein et al., 2020)

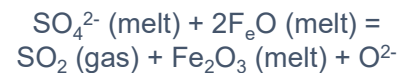
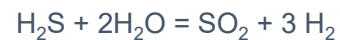
RADIOLYSIS



MECHANORADICALS

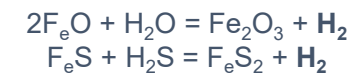
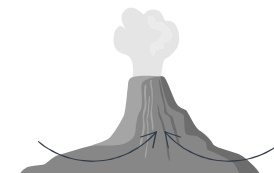


VOLCANIC DEGASSING



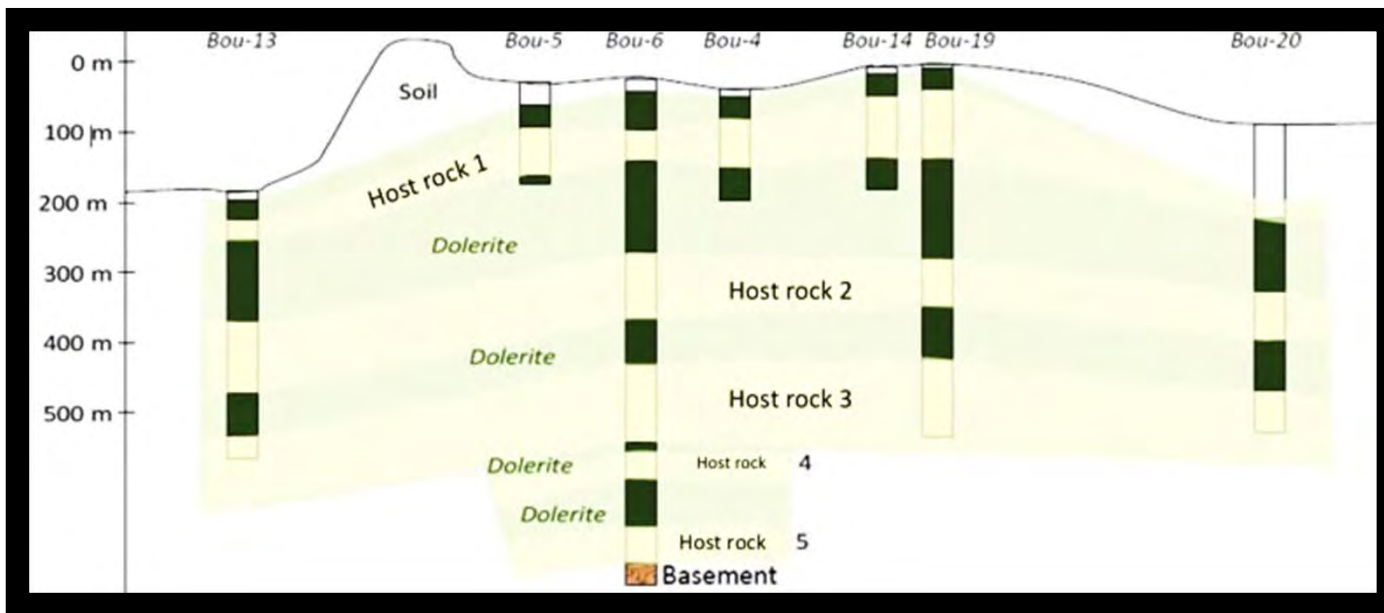
4.96 x 10⁹ mol a⁻¹

HYDROTHERMAL ALTERATION



10¹² mol a⁻¹

Mali: first production of pure natural H₂ Where will be the next one ?



Hydroma NI 51-101 report, 2020



About 640 kg of H₂ are escaping per day of this structure in Brazil (Moretti et al. 2021)

Some examples of what is happening worldwide

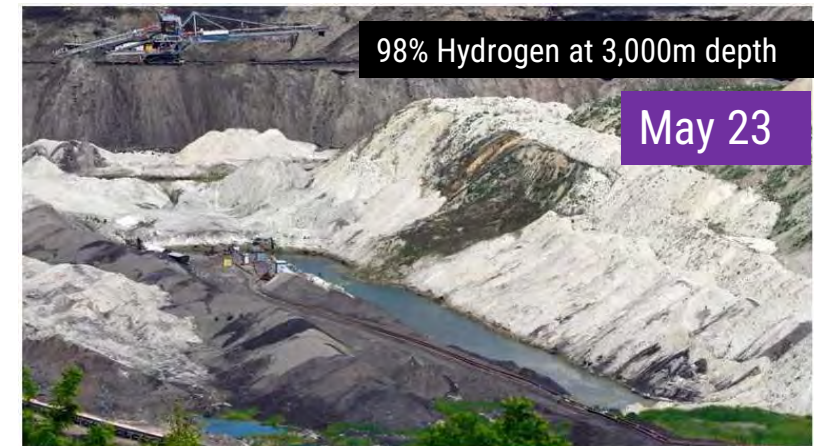
- Mali: 20 new wells, certification of the reserves by Chapman (Canada)
- Germany/France: 45-8 looking for both H_e and H₂
- France: New discovery in the Lorraine mining basin
- Helios and Ascent drilled in Spain in 2021- legislation restrictions
- Us: Bill Gates invested \$22 million in natural hydrogen
- Australia: Gold hydrogen Ramsey prospect, confirmed by well testing in March 2024 (helium and hydrogen)



March 23

Natural hydrogen found? | State-owned oil company analysing five sites across South Korea

Korea National Oil Corporation says it has been searching for naturally occurring H₂ since last year, and is now investigating possible discoveries



98% Hydrogen at 3,000m depth

May 23

FDE makes natural hydrogen discovery in the Lorraine mining basin

May 18, 2023 By JOHN MAX

June 22

HYDROGEN ECONOMY

Helios Aragon Records High Levels of Gold Hydrogen and Helium in Spain

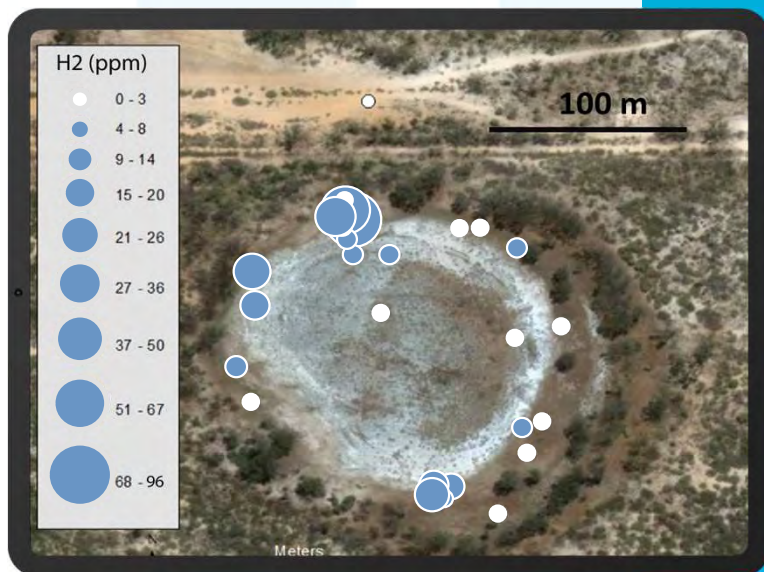


Nov 23



Natural hydrogen seeps CSIRO research project

Geological sources, Pathways & Geochemistry



First H2 seeps measured in Australia

(Frery et al., 2021 International journal of Hydrogen)



>400 ppm
Frery et al,
2022 APPEA



Monitoring phase
Mainson et al, 2022

New sampling protocols and datasets: Aimar et al, 2023, Langhi & Strand 2023



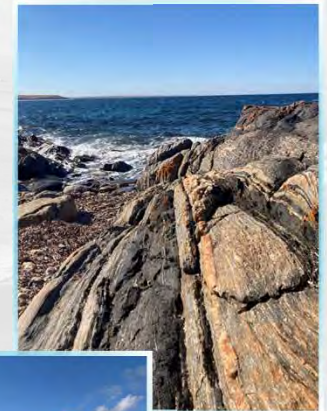
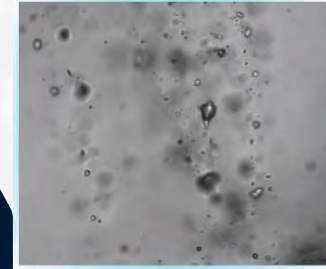
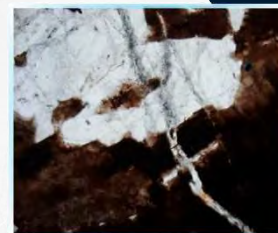
H2-NAT systems exploration with a focus on seeps





Natural hydrogen systems CSIRO research project

All integrated in a prospectivity model



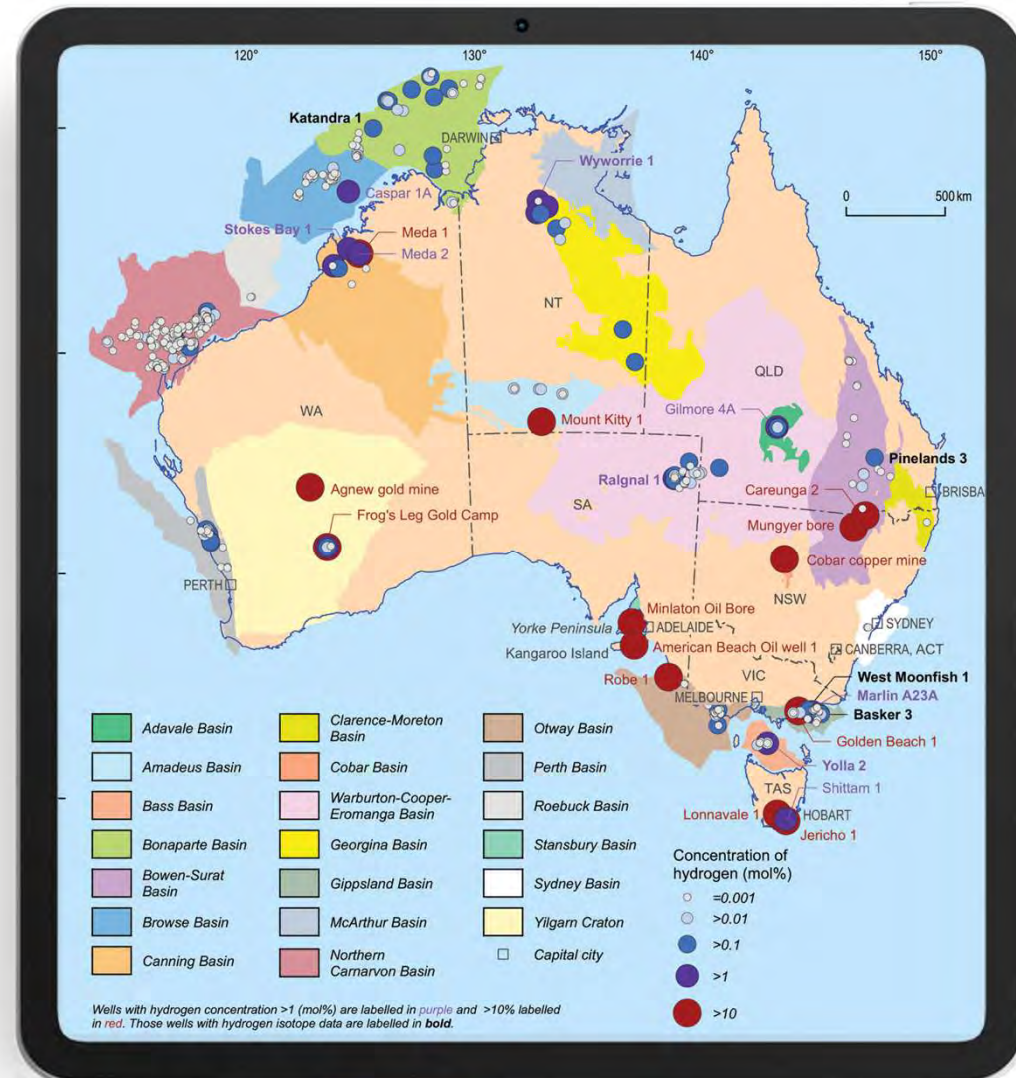
Natural Hydrogen in Australia



Historical well data



Onshore Australia's total H₂ production rate from radiolysis estimated to be between **~1.6 and ~58 MMm³ yr⁻¹** (Boreham et al. 2021)



Amadeus Basin (Central Australia)

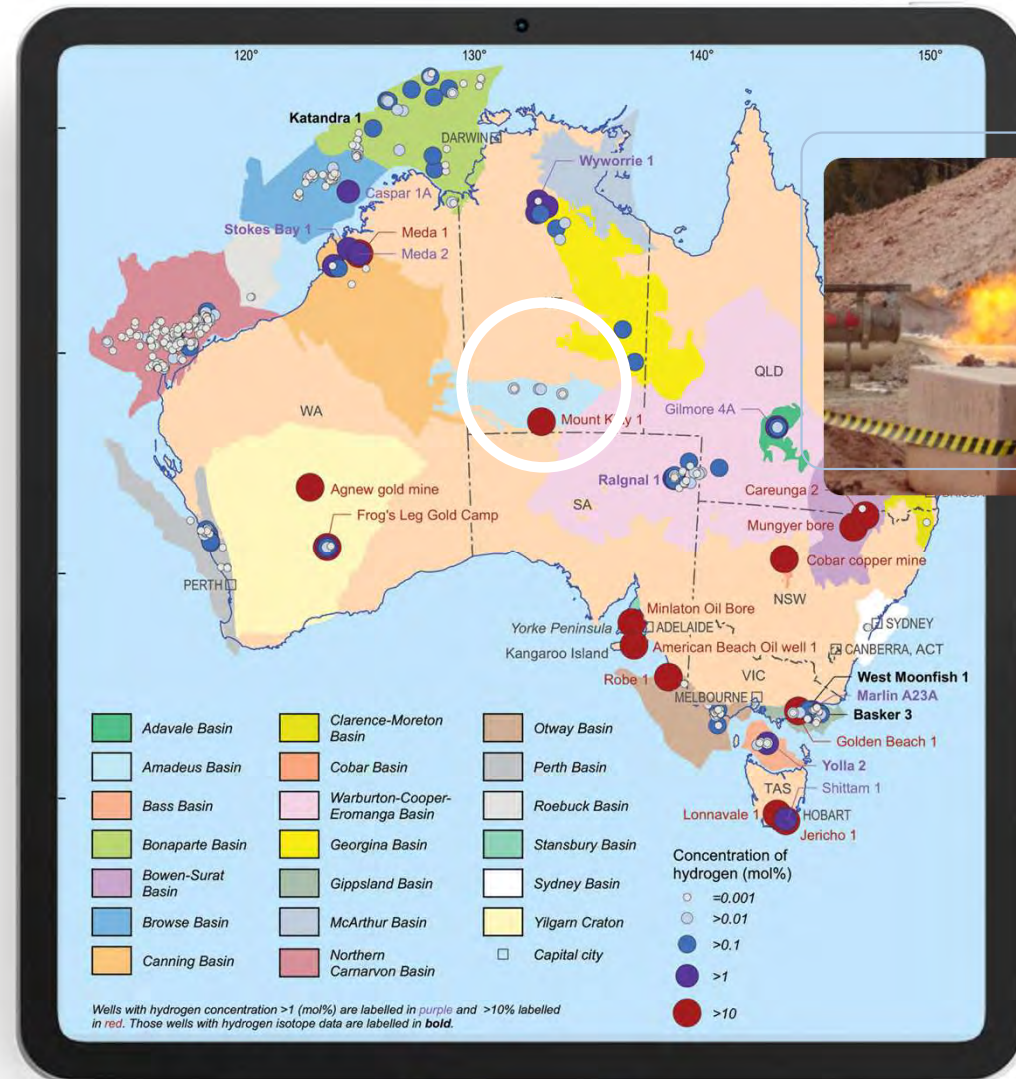
Santos



Mt Kitty 1 well drilled in 2014:
9% Helium and 11.5% Hydrogen



3 wells have confirmed the presence of Hydrogen in the Amadeus Basin sub-salt gases (>5% H₂ accumulations).



Mt Kitty 1 flow test (Mendes, 2021)

Canning Basin (Western Australia)

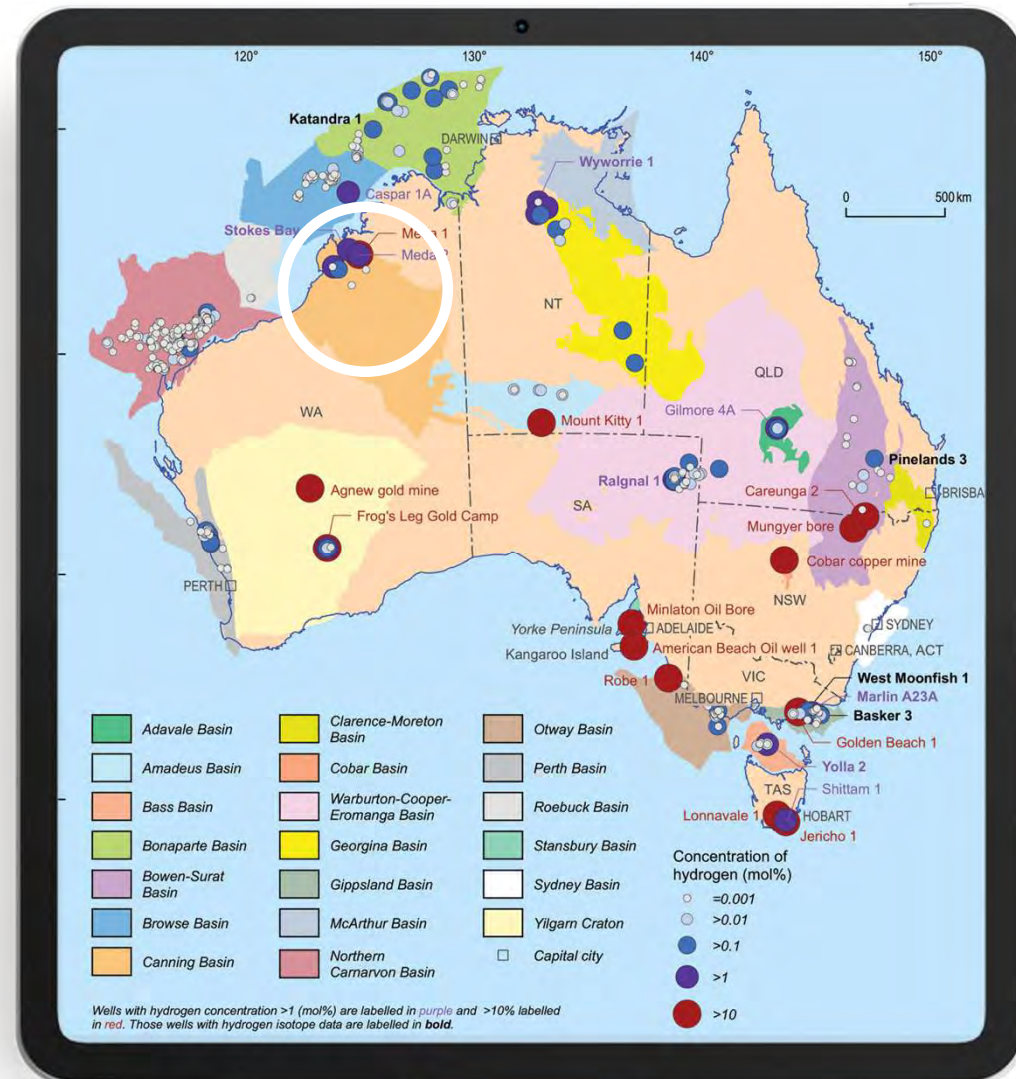


Two new wells drilled in 2021 reveal the presence of Hydrogen in different geological formations:

- **Currajong 1**: up to 6% H₂
- **Rafael 1**: up to 4.9% H₂



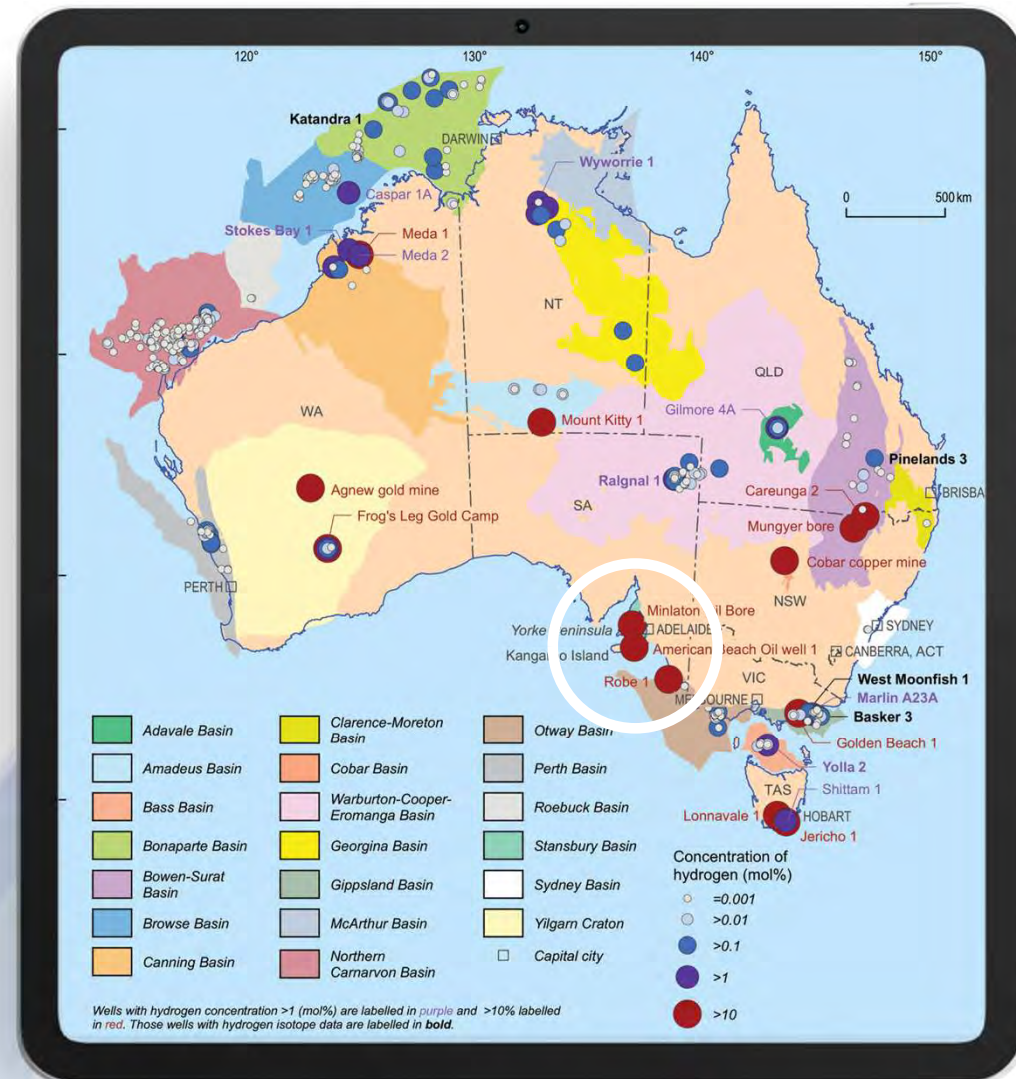
Specialised hydrogen mudgas detection unit installed on the rig.



South Australia



The state opened the doors to **Hydrogen exploration** in February 2021...



South Australia



Exploration licenses (June 2022)



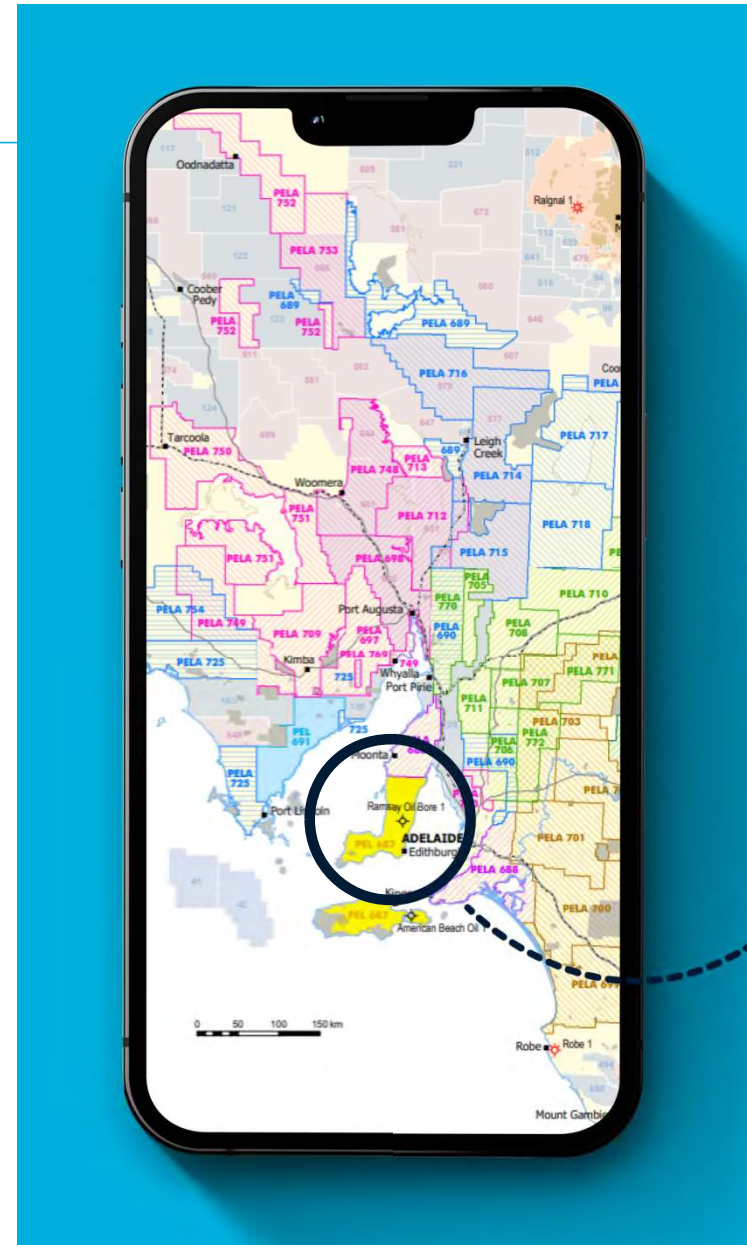
South Australia



Exploration licenses (November 2023)

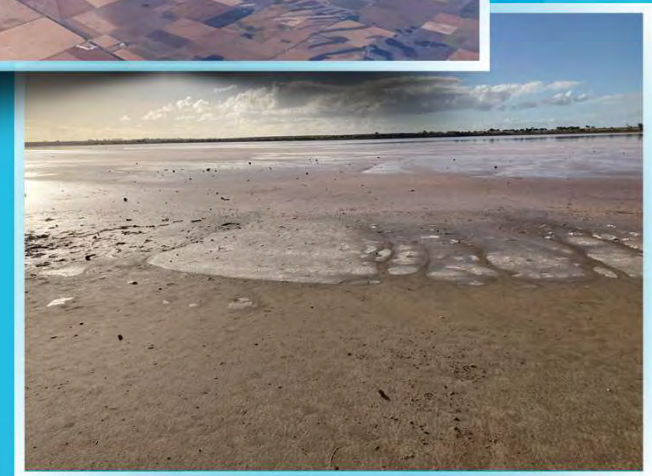
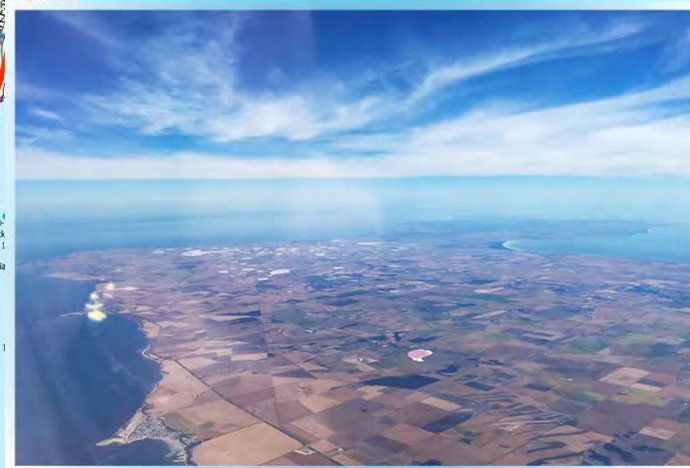
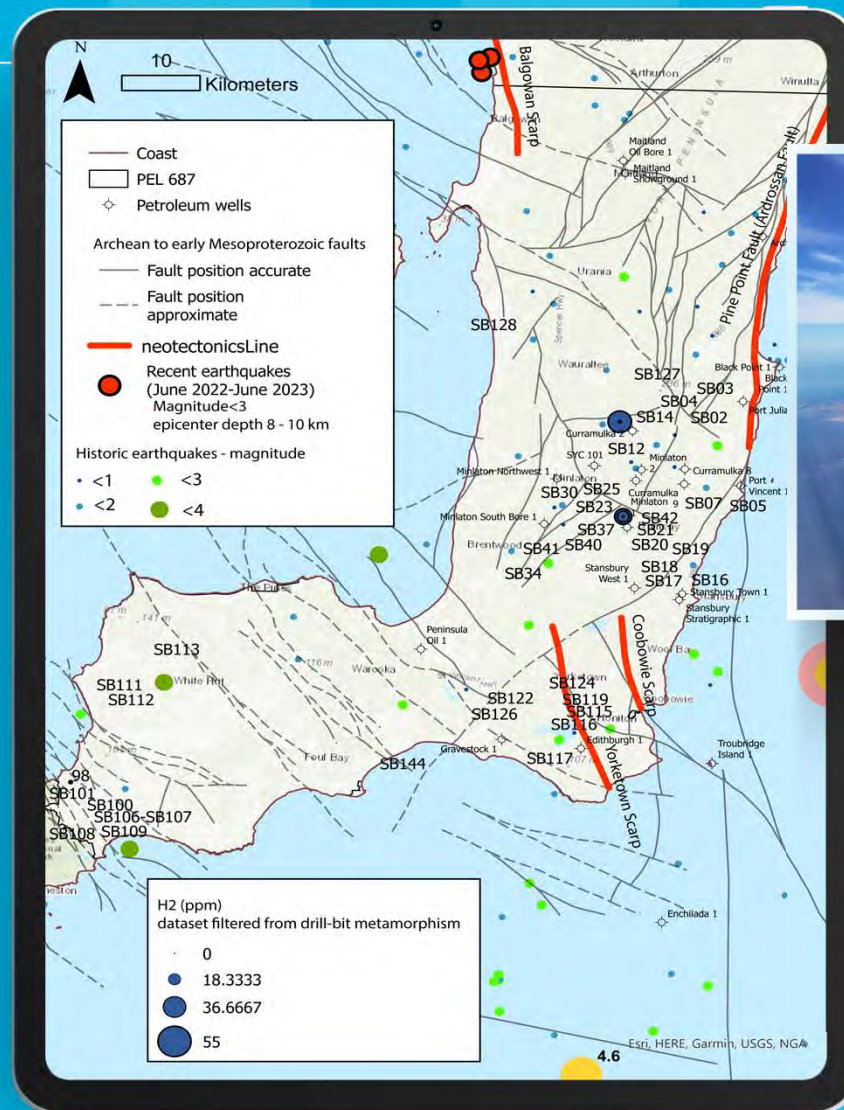
The first of these licences (PEL 687) over Kangaroo Island and southern Yorke Peninsula was granted to Gold Hydrogen Pty Ltd on 22 July 2021. Gold Hydrogen listed on the ASX on 13 January 2023 after a successful \$20 million IPO.

Government of South Australia (November 2023)



**This
case
study**

Seeps

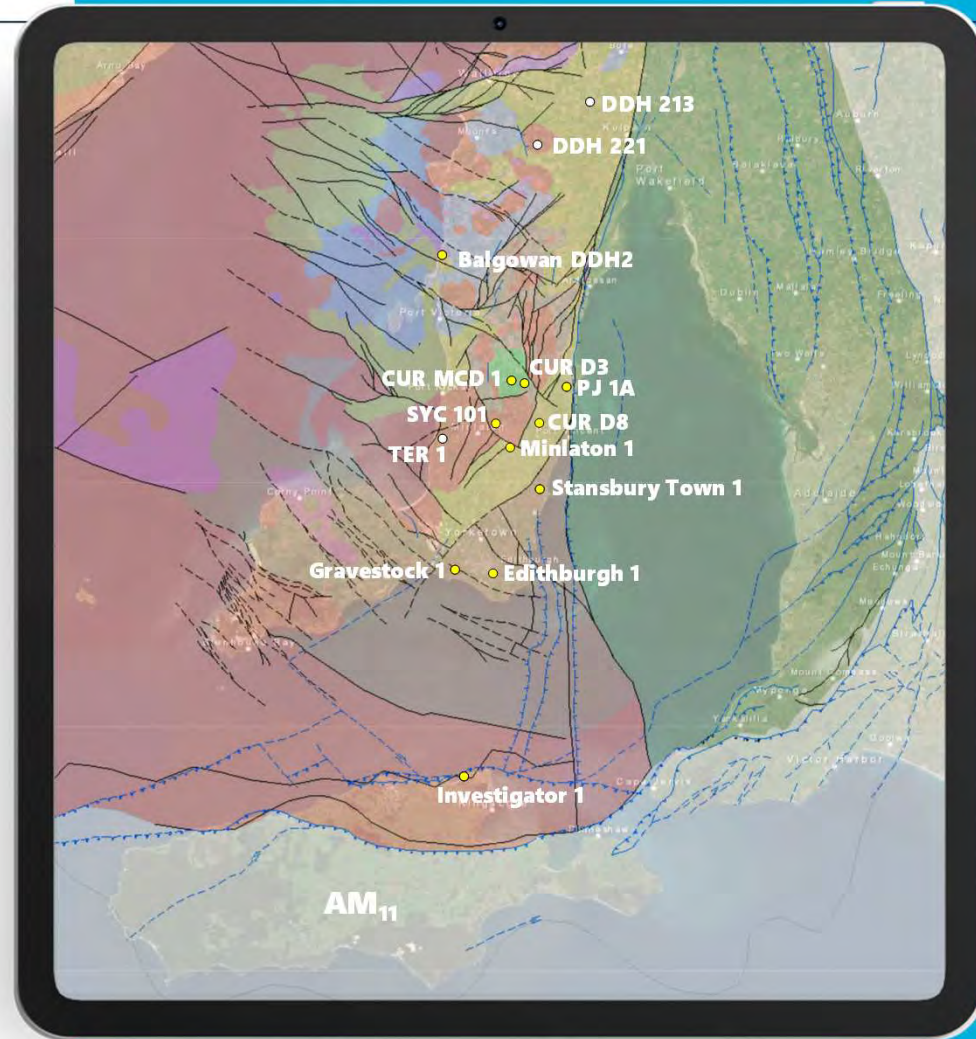
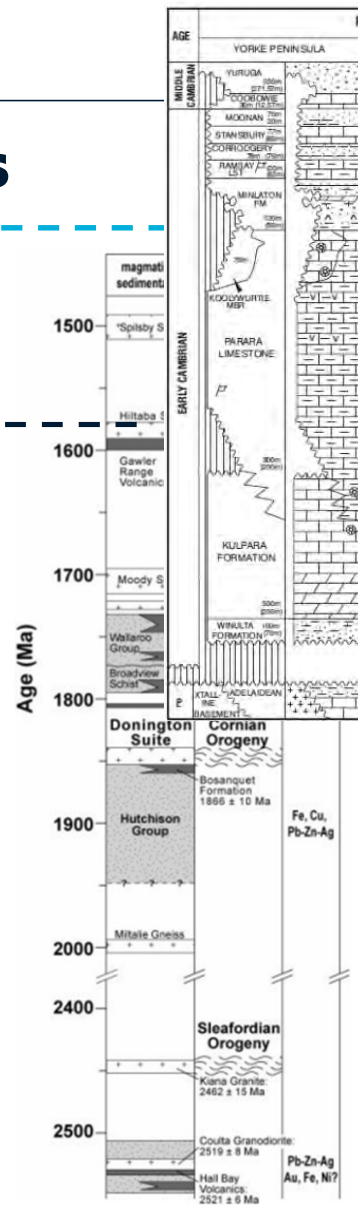


Rock samples

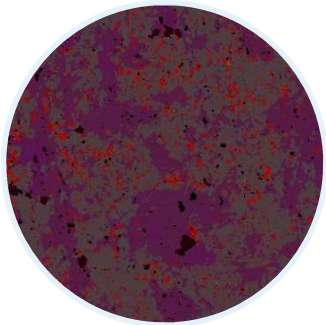
Potential caprocks

Potential reservoirs

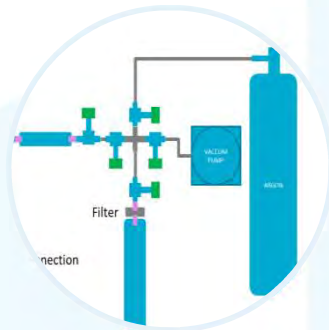
Potential sources



Experimental H₂ generation to unlock the potential sources for hydrogen generation (mineral assemblage)



**Rock characterisation,
iron characterisation**



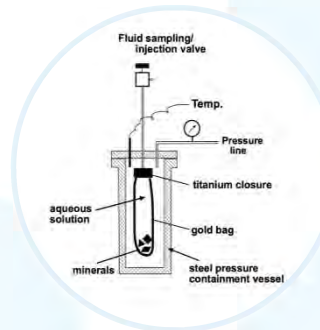
**Low pressure and
temperature vessels**

Tmax: 120°C,
Pmax: 500 PSI
(34 bars)
150 cc



**Mid pressure and
temperature vessels**

Tmax: 130°C,
Pmax: 10000 PSI
(700 bars)
150 cc



**Hydrothermal
(high) pressure and
temperature vessels**

Tmax: 400°C,
Pmax: 7250 PSI
(500 bars)
360 cc



**H₂ sensors and
vapour phase
extraction and
quantification by
Micro-GC analysis.**

Natural Hydrogen & CSIRO

Connect the research and the industry through the Hydrogen Mission. Integrate & Promote the Hydrogen E&P in the Hydrogen world.



Acting as the Australian trusted advisor in the domain of Natural Hydrogen: strong connections with the industry (small to mid-size Oil&Gas companies, new companies and consultants), new start-ups, resource funds.



Building cross-Agencies & **International collaborations.**



thank you

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emanuelle.frery@csiro.au



CSIRO FSP Hydrogen Project