

# Natural hydrogen exploration in South Australia - update

## 2023 Roundtable for Energy Resources in SA

**Elinor Alexander**  
**Department for Energy & Mining**



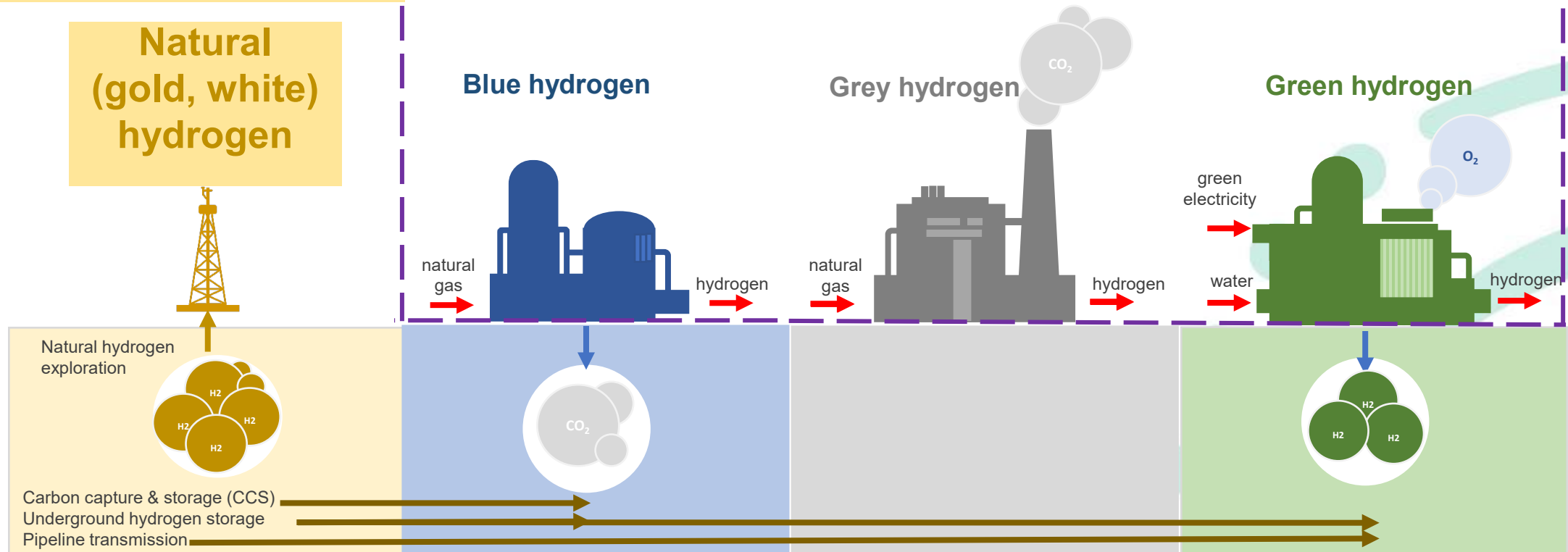
# South Australia's hydrogen legislative framework

## *Petroleum & Geothermal Energy Act 2000* (*Energy Resources Act 2023*)

- single window into government for natural hydrogen.
- includes underground storage and pipeline transport for all 'colours' of hydrogen

## *Hydrogen and Renewable Energy Act 2023*

- Single window into government for all manufactured/generated hydrogen.




# It's on every continent' | Bill Gates-backed start-up drilling for natural hydrogen in the US

Secretive Koloma backed with \$91m from investors, including Breakthrough Energy

20 July 2023 11:54 GMT    UPDATED: 20 July 2023 12:15 GMT

By Rachel Parkes

A secretive company backed with funding from billionaire investor Bill Gates is mining for natural hydrogen in the US Midwest — and plans to apply for subsidies under the Inflation Reduction Act's (IRA) production tax credit.



## Forget Oil. New Wildcatters Are Drilling For Limitless 'Geologic' Hydrogen

TRANSPORTATION • DAILY COVER

Article in Preview - November 2022

0/01 20.3380/044641136225220109

CITATIONS

0

READS

34


1 author:

### Hydrogeninsight

Production Transport Industrial Power Innovation Policy Analysis

#### INNOVATION

See all articles



There fairy circles in Namibia may indicate a hydrogen deposit. Photo: Hoberman Collection/Universal Images Group via Getty Images

## ANALYSIS | Will natural hydrogen extracted from the ground be the next global gold rush?

The existence of naturally occurring H<sub>2</sub> has been known about, but not well understood, for centuries — but this could be about to change, writes Rystad Energy Hydrogen Research

VIEW NEWS: 7607 18.11.2021    UPDATE: 11 December 2022 10:02 GMT


Hydrogen Energy Research

### THE FIFTH STATE

RENEWABLES • DAILY COVER

Holdings    Business & Politics    Climate & Environment    Opinion    Library    What's On    The Financial

## So there's a hydrogen gold rush in South Australia – here's what we know so far



## Australian companies explore hydrogen in underground caves

By KARLA DODD    12/05/2022

Share    Tweet    Add

### upstream

Latest News    Exclusive    Regions    Field Development    LNG    Energy Transition    e-paper

Brent spot \$96.97    +0.32%	Brent futures (1 mo) \$96.92    +0.46%	WTI spot \$90.93    +0.37%	WTI futures (1 mo) \$90.83    +0.52%	UK Nat Gas (1 mo) \$44.87    +3.52%
---------------------------------	---	-------------------------------	---	--

## HYDROGEN

See all articles



## Will natural hydrogen be Australia's next gold rush?


Potential fuel source is drawing interest — and significant investment — Down Under

28 July 2022 7:44 GMT    UPDATED: 1 August 2022 20:55 GMT

By Amanda Battersby    in Brisbane

Australia could be set for its next gold rush, which could prove as exciting as back in February 1851 when a prospector discovered shimmering flecks in a waterhole near Bathurst, New South Wales, sparking interest from domestic and international miners and investors.

Today, exploration Down Under has a novel 21st century focus with players targeting



## Gas outlook


HOME    ABOUT    ANALYSIS    OPINION

### Companies • Hydrogen

17.08.2022    by Tim Daliss

## Gold hydrogen takes to the stage in Australia, but it could remain

Gold hydrogen is garnering attention in Australia as a potential competitor to blue and even green hydrogen, but critics say that gold hydrogen comes with considerable methane emissions and is volumetrically significant.



## AMS


energy today

AMS is an absolute pressure instrument, which is ideal for liquid, steam or gas media. In rugged conditions, accuracy, low maintenance and cost are important. DP BV-Cone is especially useful in tight-fit installations.

### Hydrogen detected at Ramsay

VIVIEN TOPALOVIC    4 days ago

High when SANT




Australia, Drilling and exploration, Featured, Hydrogen, News, South Australia

Gold Hydrogen has detected hydrogen through its drilling activities at the Ramsay Well 1 in South Australia (SA).

### Companies    Energy    Renewables

## Limitless 'white' hydrogen could soon shatter all energy assumptions

Ambrose Evans-Pritchard



Home    Companies    Markets    Street Talk    Politics    Policy    World    Property    Technology    Opinion    Wealth    Work

### Exclusive

## South Australia's new 'gold' rush is hydrogen




Acres covering almost a third of South Australia has been snatched up by entrepreneurial explorers in search of "gold" hydrogen deposits that they believe could easily undercut the cost of manufacturing the clean fuel.

### ENB energy news bulletin

Hydrogen    ENB Magazine    Audio and Video

## One third of South Australia pegged for native hydrogen exploration

AUSTRALIA'S government is pushing hard to get the cost of hydrogen down to A\$2 per kilo by 2030 but some little known frontiersmen in South Australia believe they can cut that by 75%.



## Future Of Energy > Hydrogen

07 December 2021

Comments    Share    Helen Clark

Out in the dry of the state, there could be a best estimate prospective resource of 1.3 billion kilos of hydrogen (1.3 million tonnes), based on a basement interval of 86 metres and is currently being appraised by a new company which suggests if converted to electricity could power one million homes for 40 years.

Natural, or native, hydrogen is the latest buzzword picking up steam in the Australian energy industry, though as yet commercial concentrations are yet to be found. However, since February, the state government has awarded 18 petroleum licenses for six companies looking

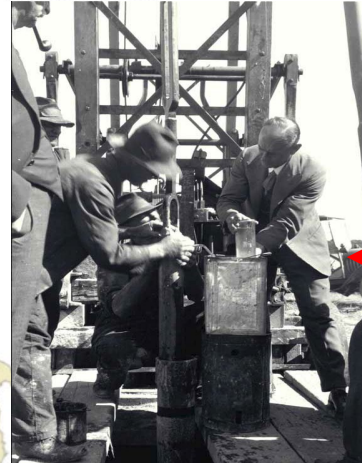
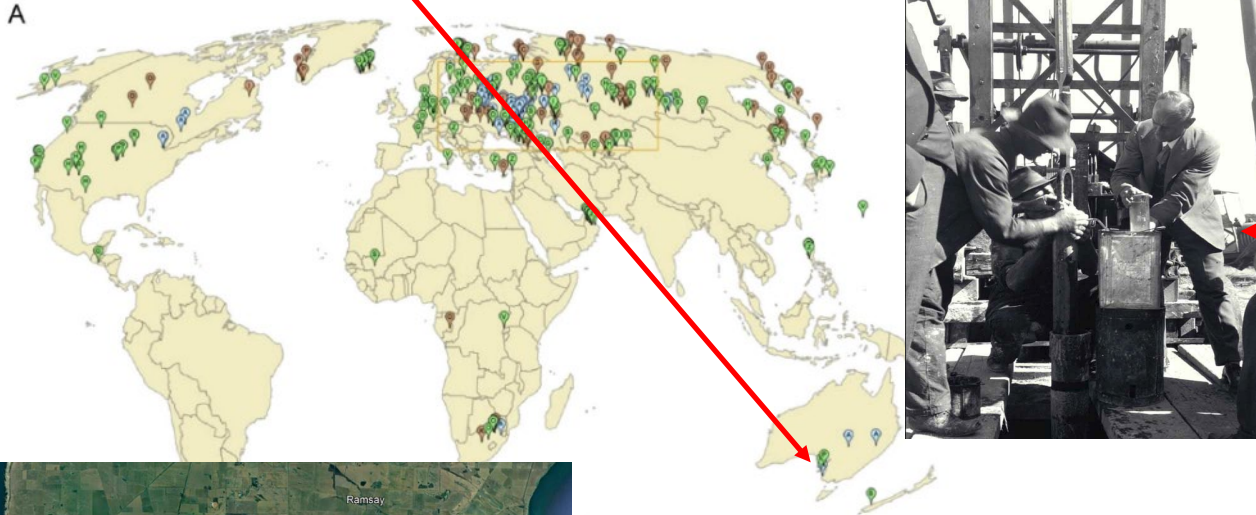


# 3 reasons why South Australia is now on the global map:

1. Zgonnik (2020) First drew attention to natural hydrogen indications in Australia in his review of global occurrences.

V. Zgonnik

Earth-Science Reviews 203 (2020) 103140



1. Zgonnik found online SARIG records revealing significant hydrogen contents from Government analyses of gas samples taken from three historic drillholes:

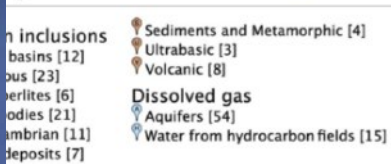
**1915 – Robe 1 (25.4% hydrogen)**

**1921 – American Beach Oil 1 (64.4-80% hydrogen)**

**1931 – Ramsay Oil Bore 1 (51.3-84% hydrogen)**

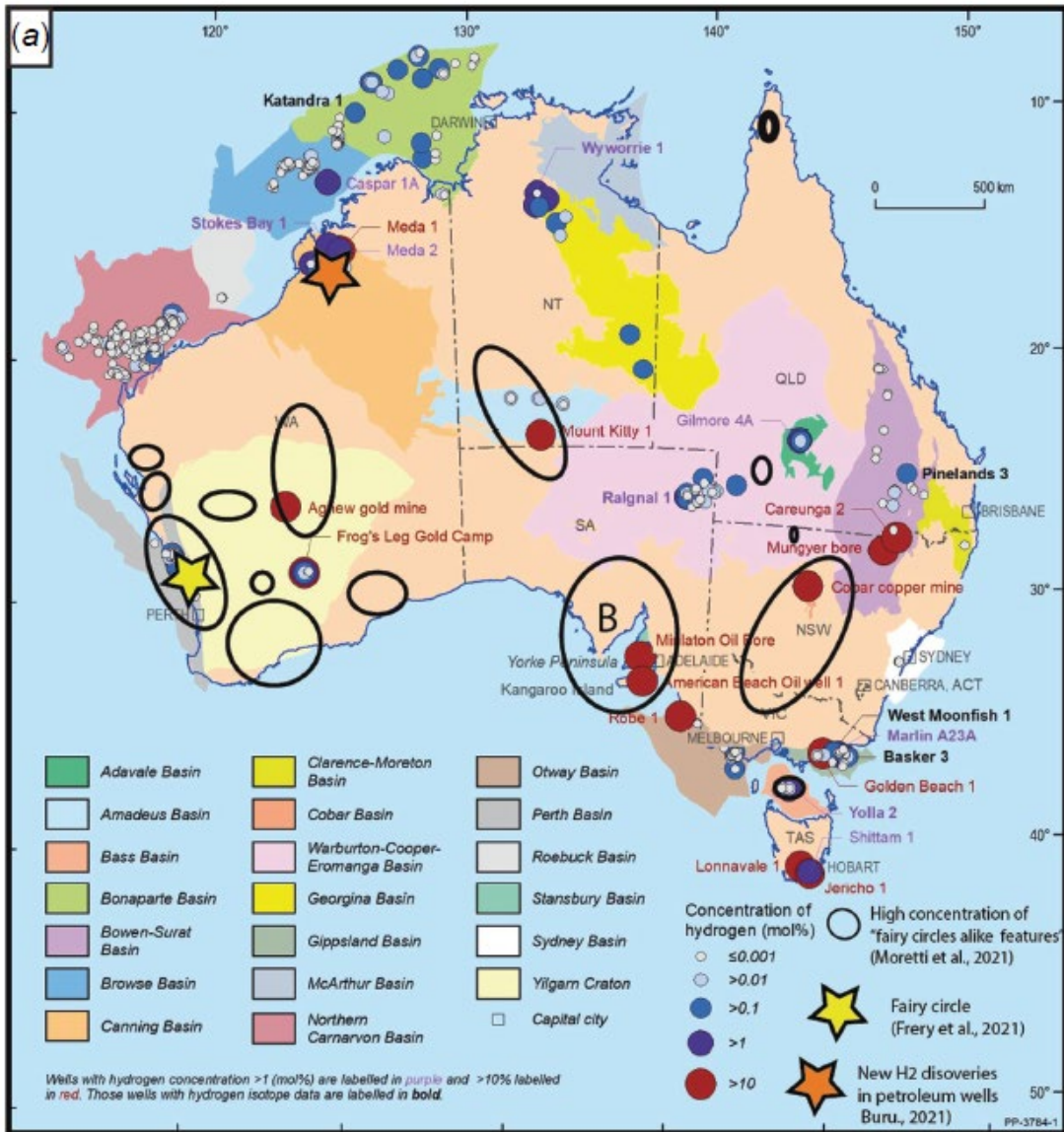
2. Moretti et al., 2021 postulated that salt lakes on Yorke Peninsula and Kangaroo Island were natural hydrogen seeps, formerly known as 'fairy circles'.

3. Natural hydrogen exploration became possible in SA in February 2021 when changes to the *Petroleum and Geothermal Energy Regulations 2013* added hydrogen as a 'regulated substance' – joining petroleum, CO<sub>2</sub>, H<sub>2</sub>S, He, N and substances produced with petroleum.



2. Moretti et al. (March 2021) drew attention to potential 'fairy circles' on southern Yorke Peninsula

# Australian natural hydrogen occurrences



Natural hydrogen has been discovered in petroleum wells as well as seeping from faults (Frery et al 2022) and shallow drillholes in WA.

CSIRO Energy researchers are developing exploration techniques and equipment suitable for Australian conditions (Frery et al., 2022).

Both Gold Hydrogen and H2EX recently reported hydrogen indications from CSIRO soil gas sampling programs in their SA licences.

Gold Hydrogen report hydrogen indications in Ramsay 1  
Most Australian natural gases contain trace-low levels of natural hydrogen (Boreham et al., 2021).

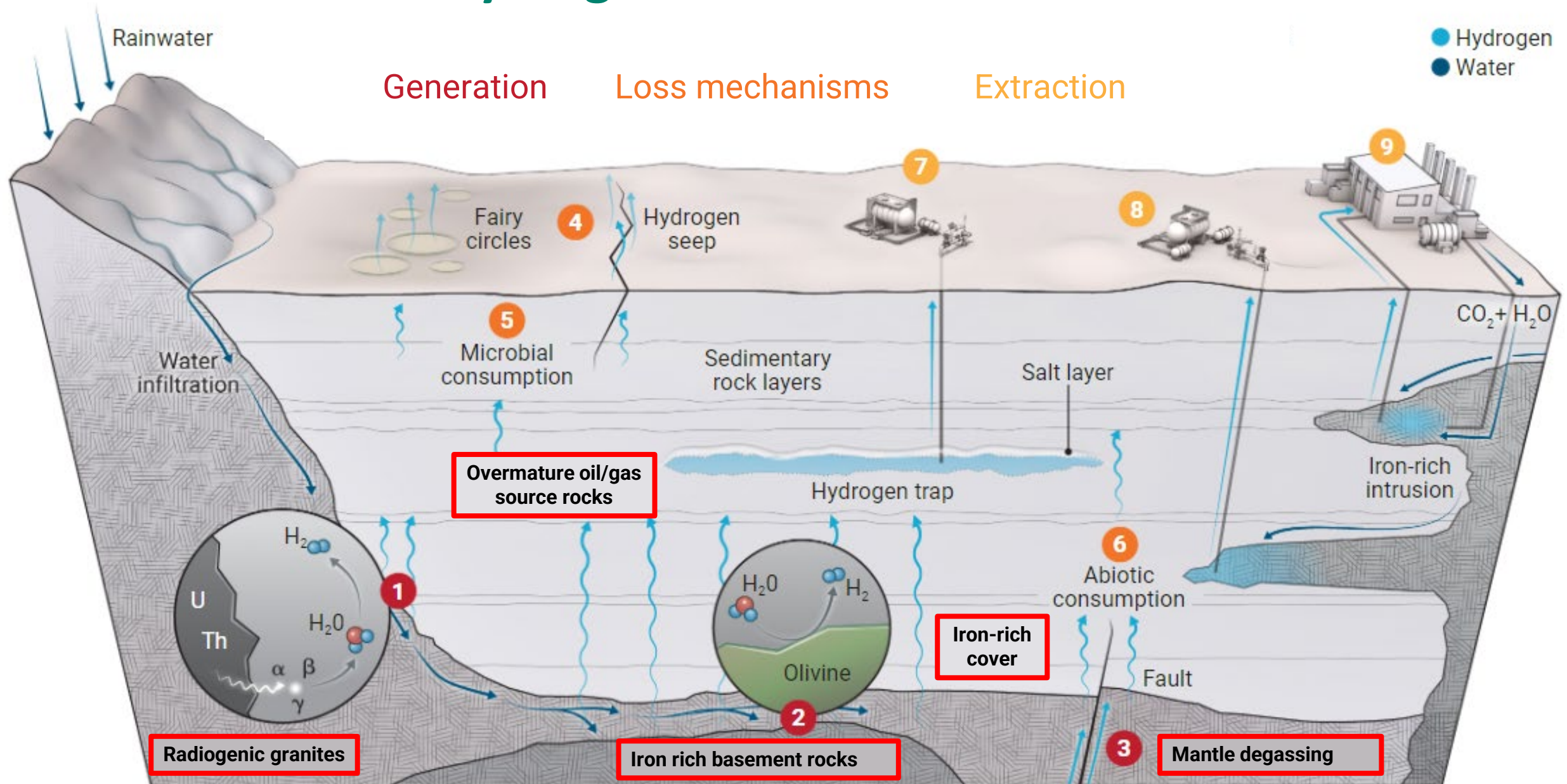
Since the mid-1960s petroleum drilling rigs can only detect natural hydrogen with a specialised hydrogen detection unit.

Mineral explorers typically don't measure gas contents.

**It's likely that natural hydrogen occurrences have been missed by Australian and global explorers.**



# Sources of natural hydrogen



# Potential natural hydrogen sources

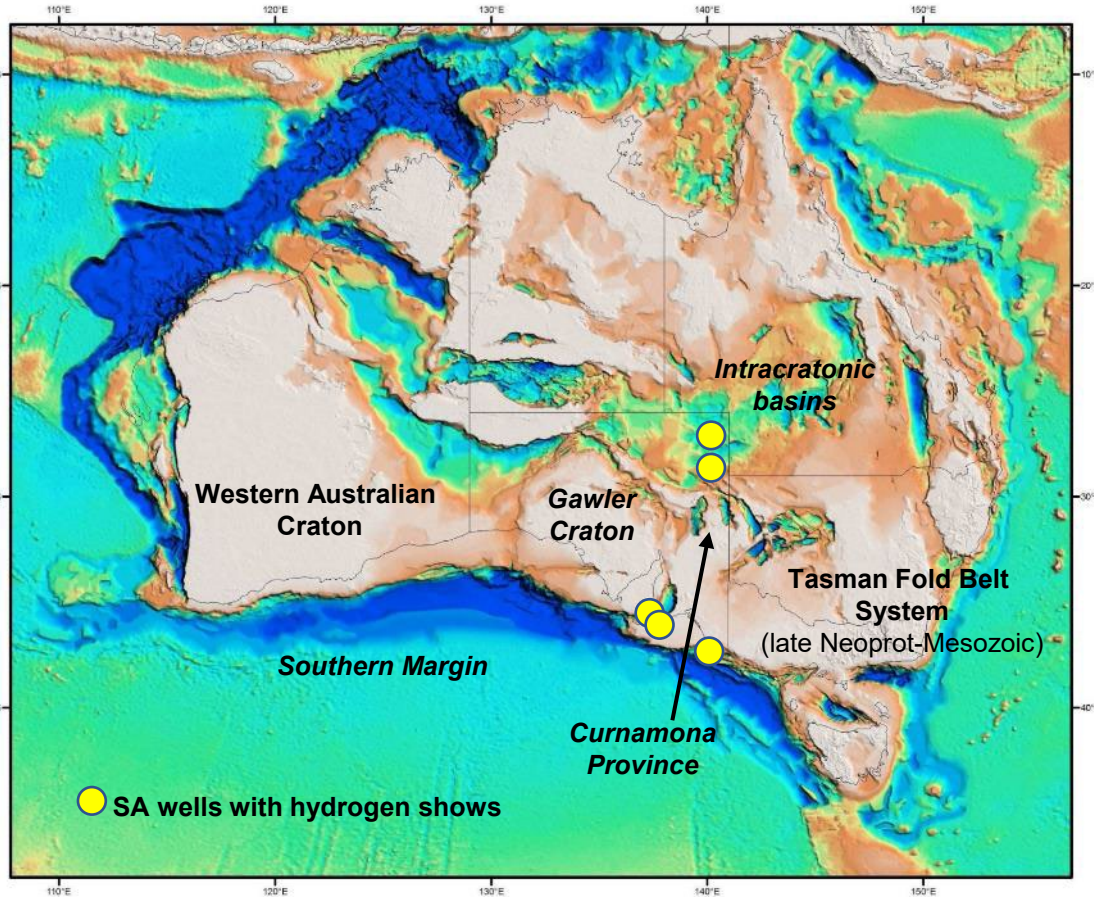


Image is OZSEEBASE 2021 – depth to basement (Geognostics)

<https://www.geognostics.com/oz-seebase-2021>

- ✓ **Hydrogen indications in drillholes.**
- ✓ **Ancient basement complexes which contain iron and/or uranium rich rocks** e.g. Archaean greenstone and Precambrian basement terranes, 'hot' granites' - may generate hydrogen via:
  - radiolytic processes (radioactive decay breaks bonds in water) &
  - oxidation of  $\text{Fe}^{2+}$ -rich minerals (serpentinization).
- ✓ **fractured and seismically active source areas** - deep-seated faults can both channel migrating hydrogen up from deep sources to surface and introduce water downward for further chemical reaction with iron-rich rocks.
- ✓ Sedimentary cover may reservoir and trap migrating hydrogen particularly if **aquifer systems and /or seal rocks like salt** are present (see Bradshaw et al. 2023).
- ✓ Thermogenic **decomposition of organic matter** (e.g. over-mature source rocks).

Surficial hydrogen seeps? Seeps can be blind or coincident with visible sub-circular topographic depressions on the metre to kilometre scale (**'fairy circles'**).

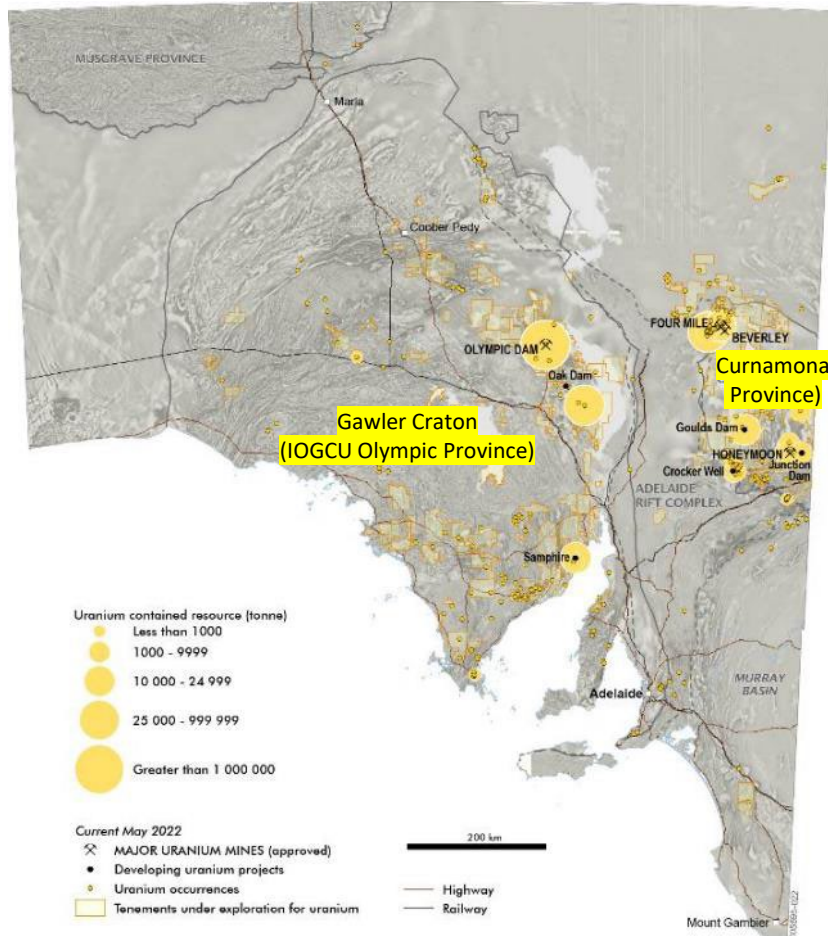
With input from Dr Betina Bendall 2022 <https://www.energymining.sa.gov.au/industry/geological-survey/ mesa-journal/previous-feature-articles/current-perspectives-on-natural-hydrogen-a-synopsis>



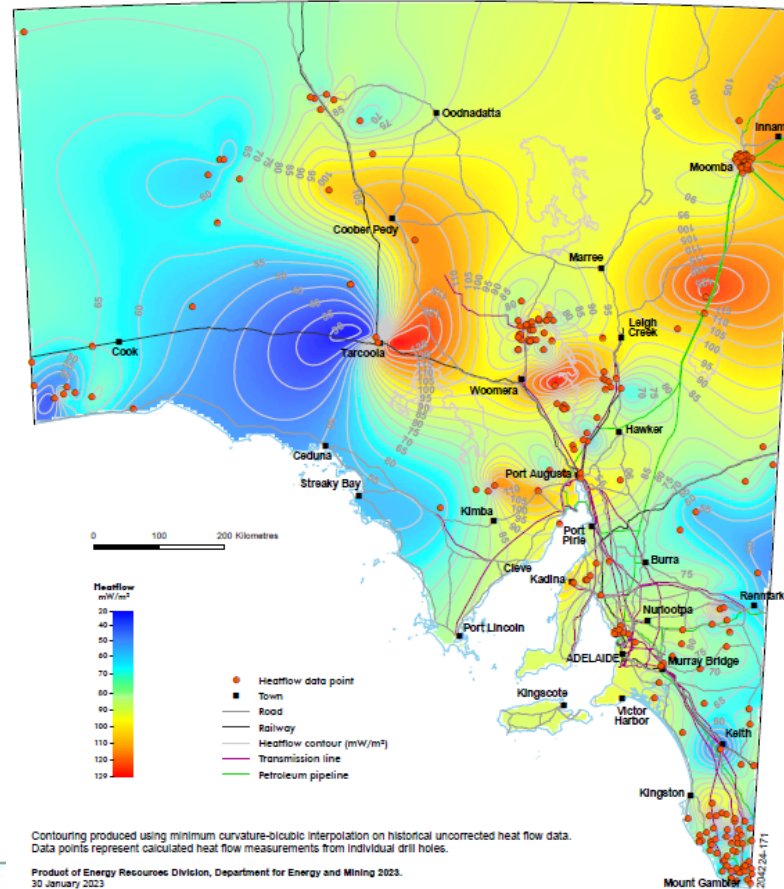
# Uranium and iron occurrences and mines in SA

Radiogenic granites and iron-rich basement are potential natural hydrogen sources

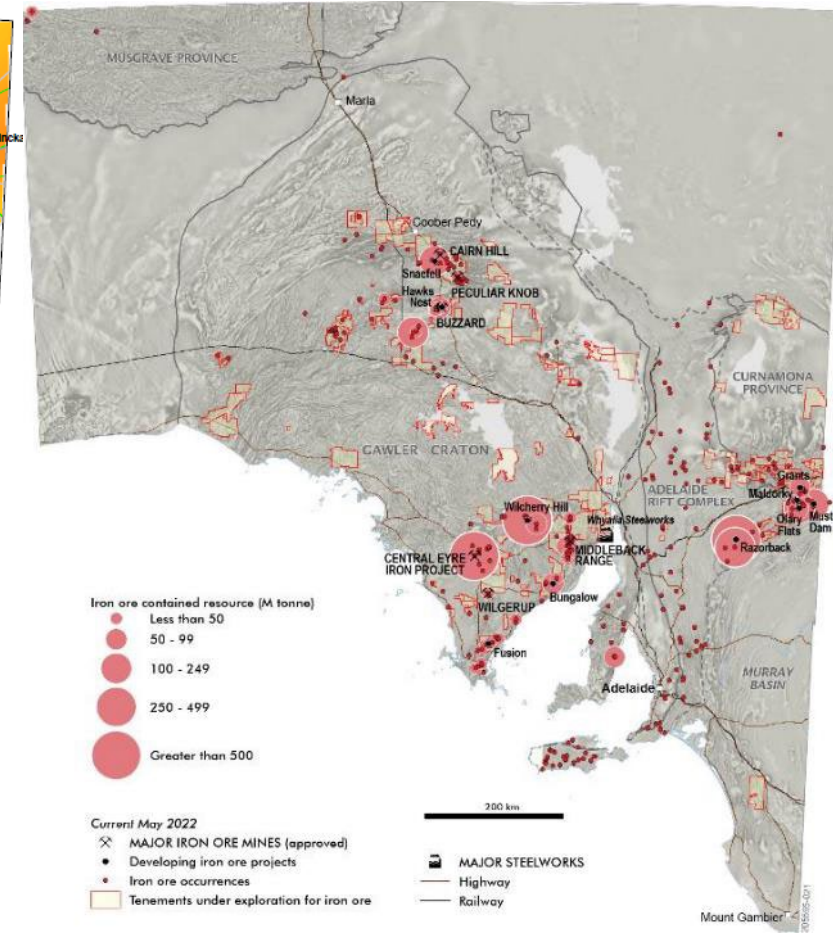
## Uranium occurrences and mines



## Surface heat flow

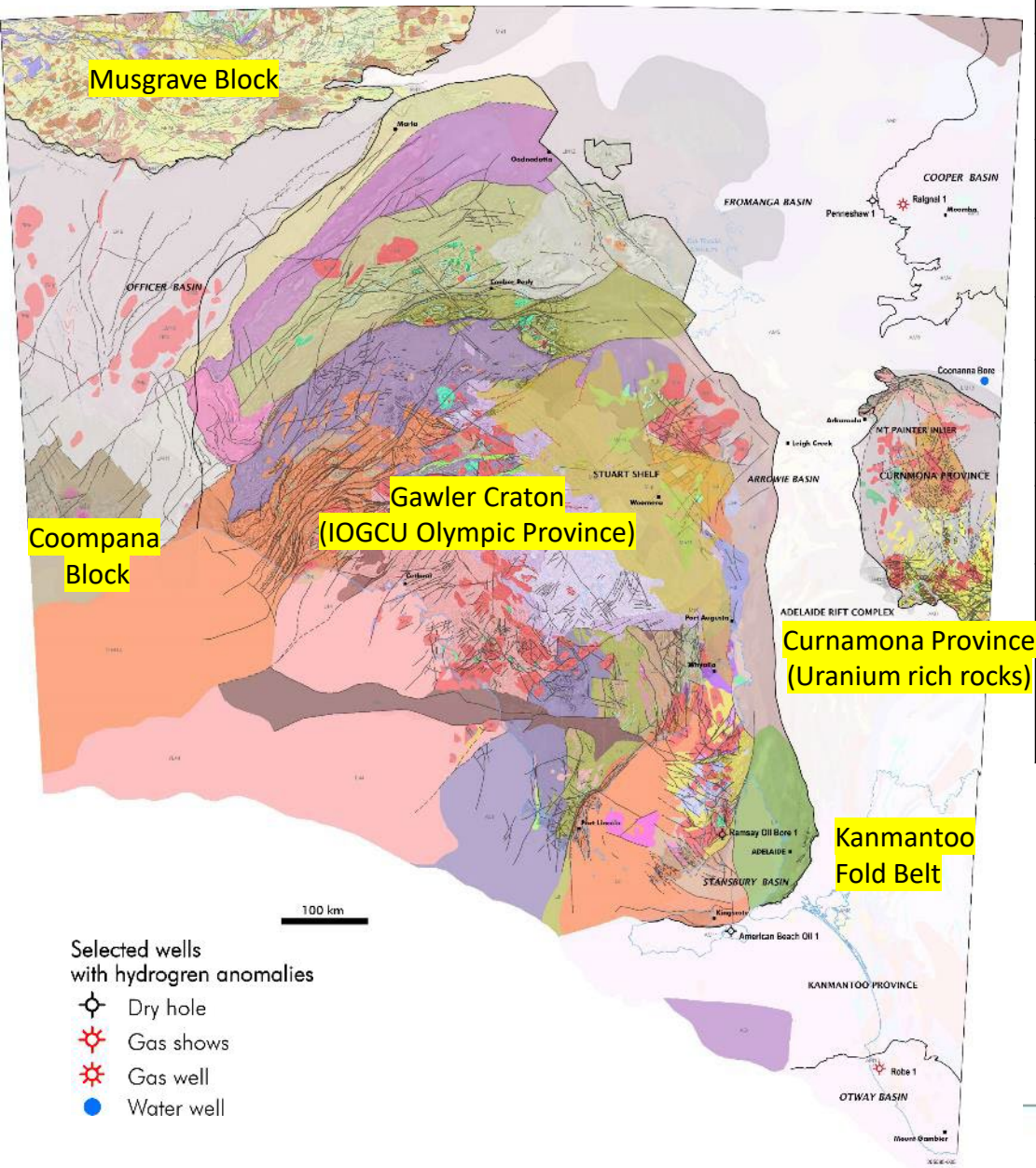


## Iron ore occurrences and mines





# Prospectivity – screening basement provinces

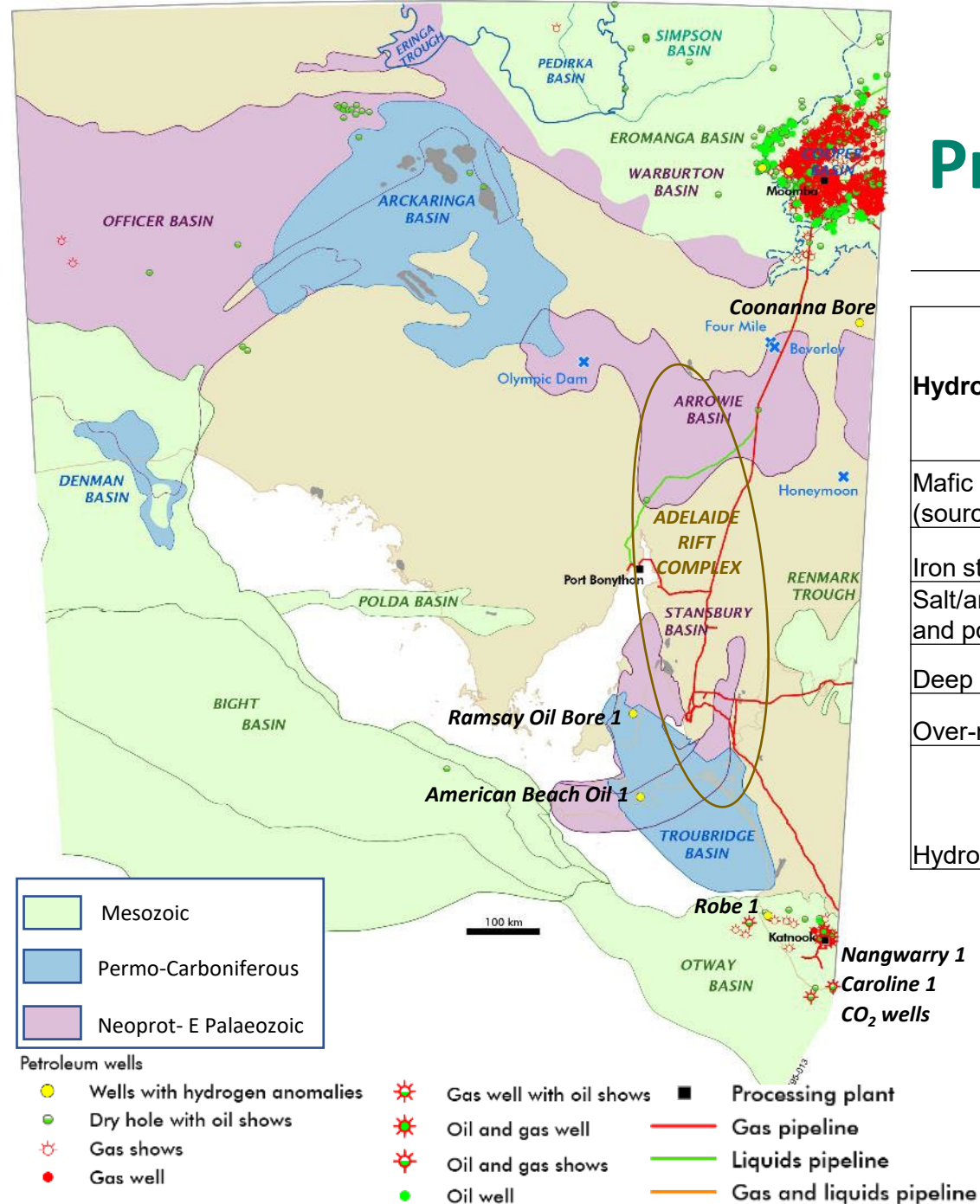


	Province				
Hydrogen play elements	Coompana	Musgrave	Gawler	Curnamona & Mt Painter inlier	Kanmantoo Fold Belt
Gabbros, mafics, ultramafic intrusives					
Iron-rich granitoid/intrusives					
Uranium-rich rocks			IOGCU*		
Banded iron formations					
Ferruginous duricrusts					
Structural complexity/deep active faults					
Hydrogen shows			Ramsay Oil Bore. Possible seeps on Yorke Peninsula?		American Beach Oil Bore 1 Seeps on KI?

\* Iron Ore Copper Gold Uranium deposits

Bendall 2022 <https://www.energymining.sa.gov.au/industry/geological-survey/mesa-journal/previous-feature-articles/current-perspectives-on-natural-hydrogen-a-synopsis>

# Prospectivity – screening basins



	Basin				
Hydrogen play elements	Neoprot Adelaide Rift Complex/ Arrowie Basin	Officer Basin	Stansbury Basin	Cooper/ Eromanga/ Warburton basins	Otway Basin
Mafic intrusives/extrusives (source and seal)					
Iron stones					
Salt/anhydrite, aquifers (seal) and potential reservoirs					
Deep Faults					
Over-mature source rocks					
Hydrogen shows			Ramsay Oil Bore 1. Possible seeps?	Coonana 1, Ralgna 1 etc.	Robe 1 (mantle derived CO <sub>2</sub> in Caroline 1 and Nangwarry 1)

Bendall 2022 <https://www.energymining.sa.gov.au/industry/geological-survey/esa-journal/previous-feature-articles/current-perspectives-on-natural-hydrogen-a-synopsis>

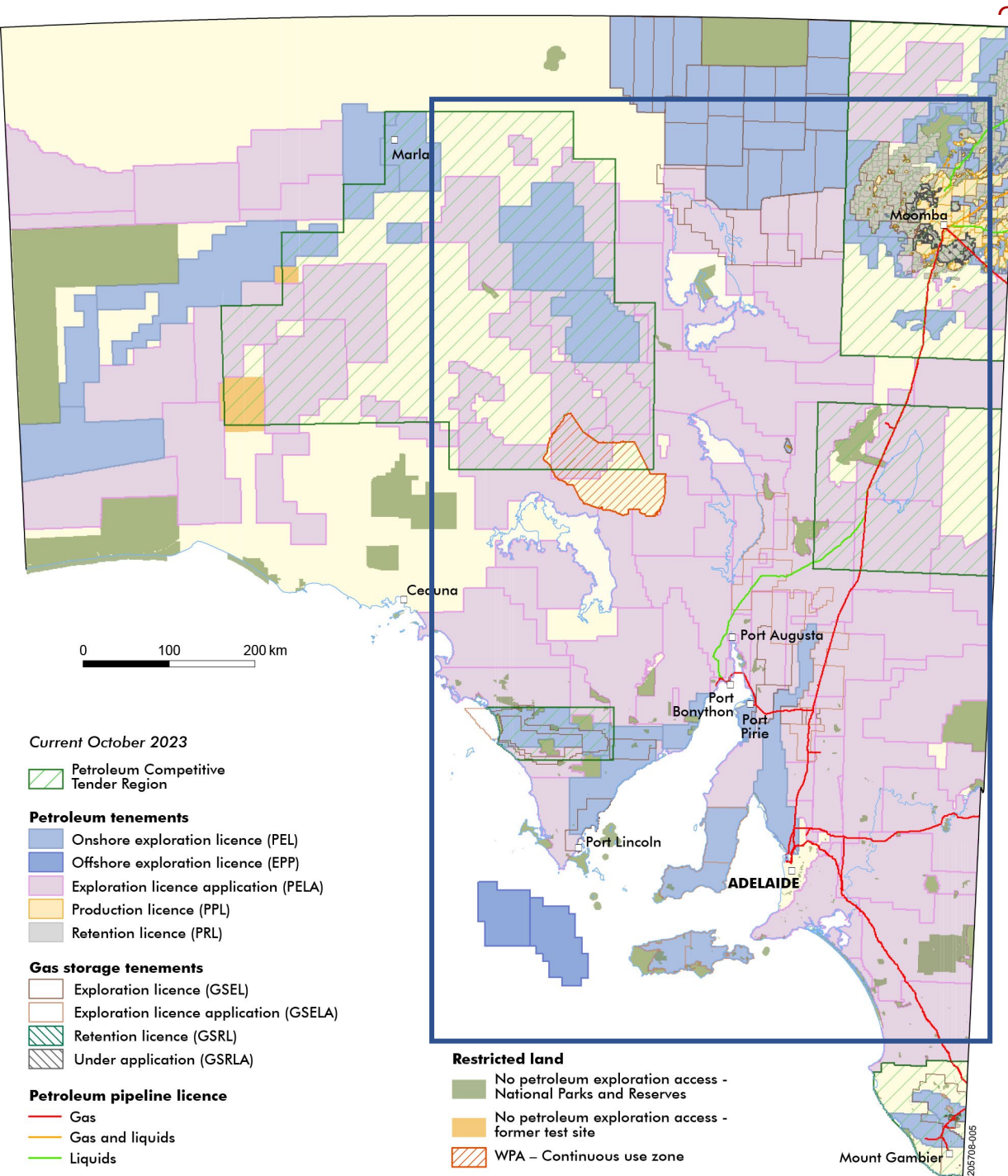


# Licensing

A Petroleum Exploration Licence (PEL) is required to explore for natural hydrogen.

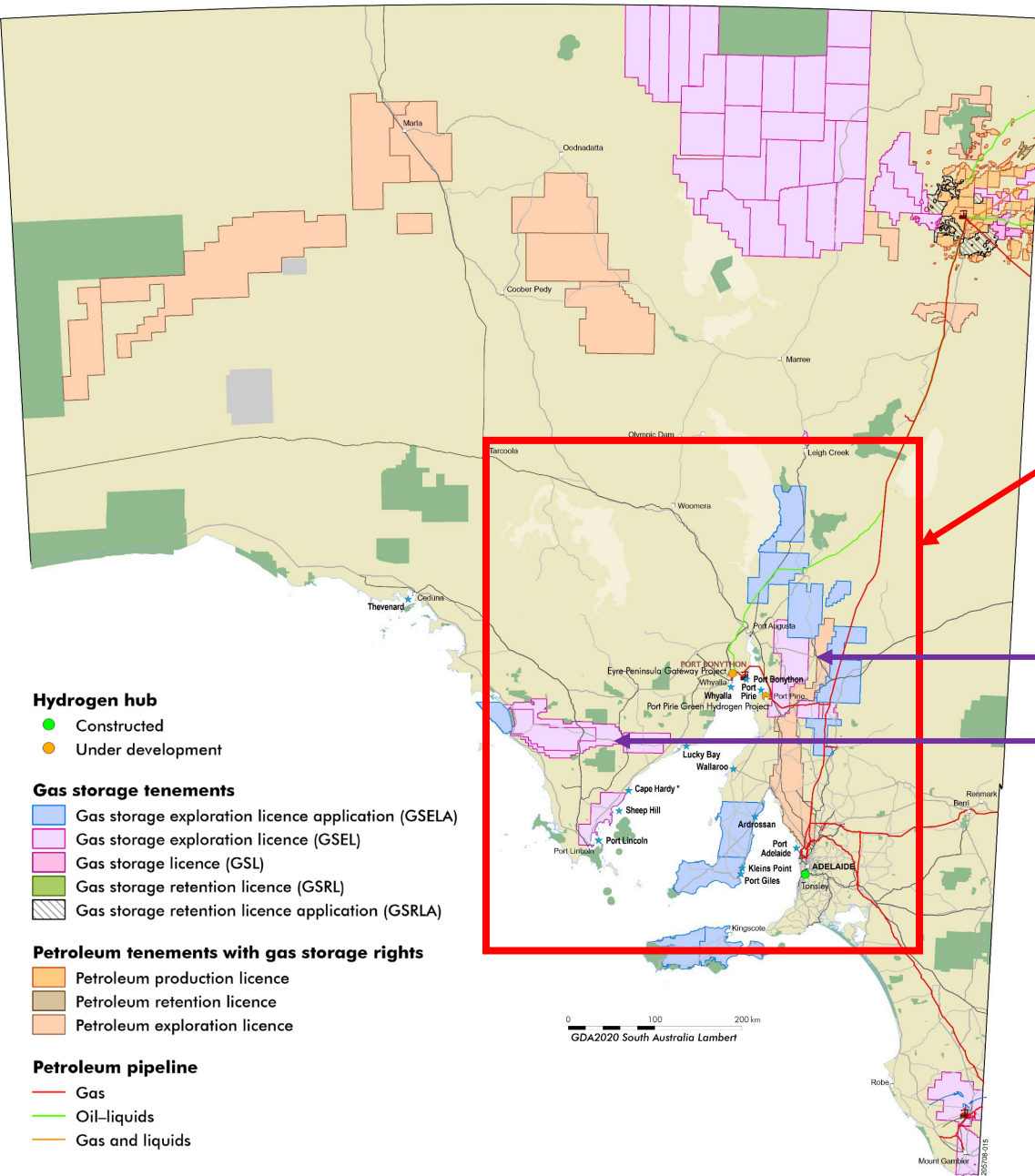
Three 5 year terms, 1/3 relinquishment at end of each term.  
Discoveries are held by Petroleum Production Licences.

- To apply for a PEL:
  - Pay the fee of \$5,174.
  - 5 year work program with at least 1 well.
  - Evidence of technical & financial capacity.
- Competitive tender regions - vacant acreage is only available via formal DEM releases based on work program bidding (5 year exploration program, evidence of financial and technical capacity).



Gold Hydrogen Ramsay 1, 17 October 2023

# Gas Storage Licencing



OFFICIAL

The following licences provide the rights to store regulated substances including hydrogen:

- **Gas Storage Exploration licences (up to 2,500km<sup>2</sup>)** - exploration and operations to establish the nature, extent and feasibility of underground storage of regulated substances.
- **Gas Storage Licences (up to 1,000km<sup>2</sup>)** - when a storage site is proven, the licensee is entitled to a Gas Storage Licence.

Some natural hydrogen explorers have applied for GSELS to explore for subsurface hydrogen storage for their projects.

There's also interest from companies focussed on developing underground storage for hydrogen:

- ECOSSAUS - GSELS 766 & 767, Adelaide Fold Belt,
- EnTX - GSEL 781, 784 and GSELA 786, Poldia Basin (*Glenn Toogood's presentation*).

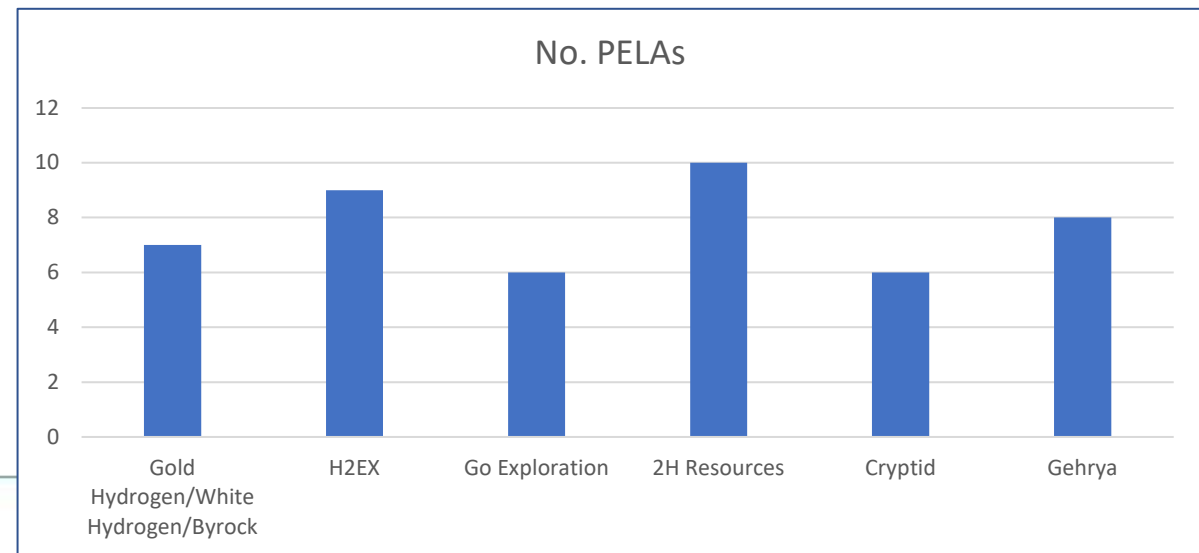
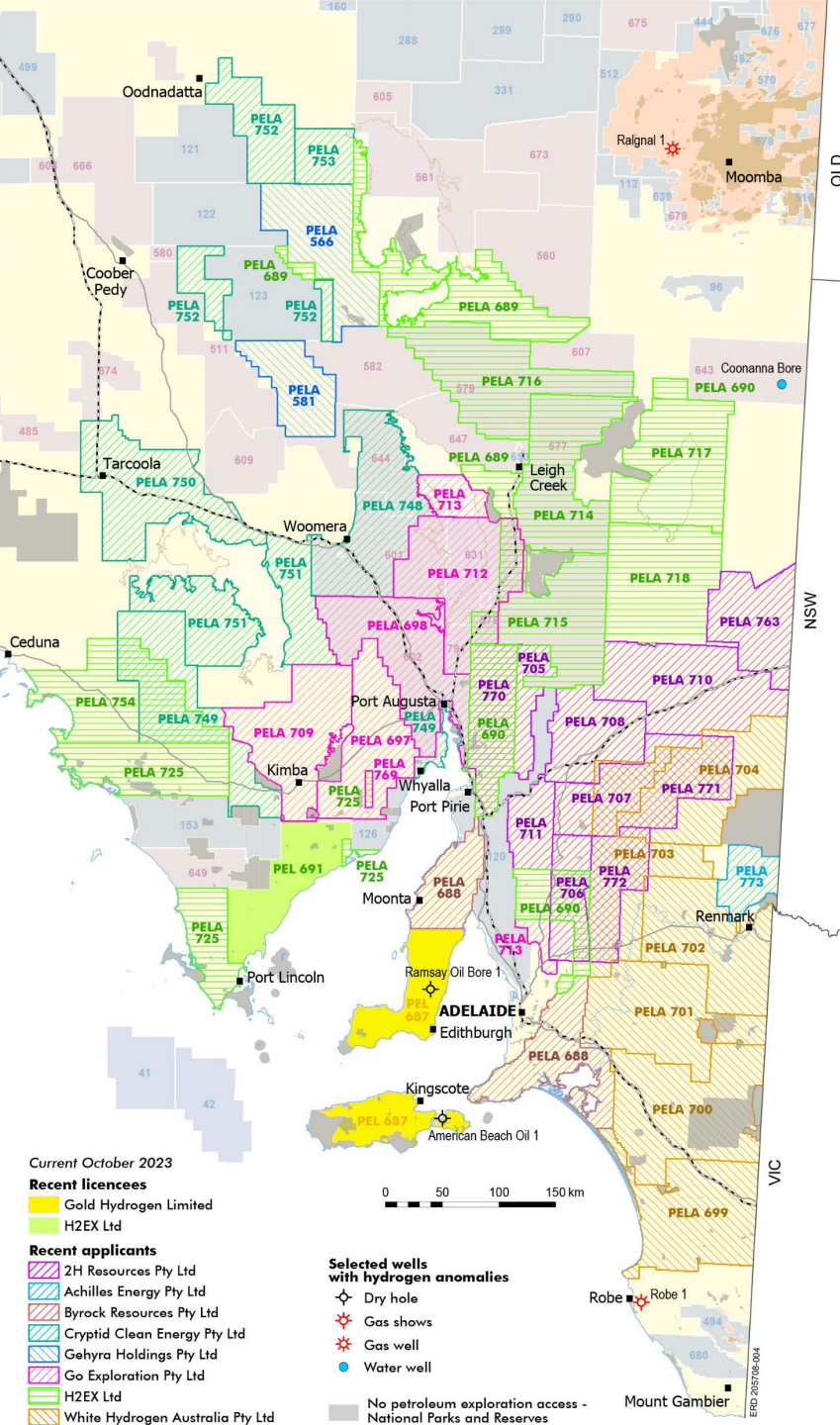
## Pipeline Licence (PL)

Pipeline licences (PLs) allow construction and operation of a transmission pipeline for carrying a regulated substance including hydrogen.



# Hydrogen exploration status

- >40 'over the counter' applications have been lodged for PELs targeting natural hydrogen since February 2021.
- Applications are assessed by DEM-ERD and if valid, licences are then offered to the applicants.
- In areas where Native Title may exist, a Native Title Agreement is required before licence grant.
- The first PEL was granted in July 2021 to Gold Hydrogen Pty Ltd shown in yellow. Second PEL was granted to H2EX in June 2022 shown in green.
- 2H Resources is the first mover in 6 PEL applications.



# Gold Hydrogen Ramsay 1 update



- Ramsay 1 spudded on 11 October 2023, close to the Ramsay Oil Syndicate Bore which was drilled in 1931 and recorded up to 84% hydrogen.
- On 19 October, Gold Hydrogen reported preliminary results - ***“Hydrogen detected at elevated levels while drilling the Parara Formation, which was confirmed by onsite mudgas samples, and offsite laboratory analysis.”***
- The well has also encountered faults and fractures which Gold Hydrogen indicate may form pathways for migrating hydrogen.
- A second well is planned in November-December 2023.



The old and the new - Ramsay 1 seen from the 1931 Ramsay Oil Bore  
(Gold Hydrogen)



# Conclusions

- While it's very early days, high level screening reveals that South Australia has prospective geology and evidence of natural hydrogen occurrences.
- Regulatory, licensing and investment frameworks are in place, enabling grant of Australia's first exploration licences targeting natural hydrogen.
- Explorers are also able to apply for licences to store hydrogen underground and licences for the transmission of hydrogen in pipelines.
- Company exploration activity in SA will test a diversity of natural hydrogen plays.
- Gold Hydrogen have announced that hydrogen indications have been recorded in Ramsay 1.
- Watch this space!

## Disclaimer

*The information contained in this presentation has been compiled by the Department for Energy and Mining (DEM) and originates from a variety of sources. Although all reasonable care has been taken in the preparation and compilation of the information, it has been provided in good faith for general information only and does not purport to be professional advice. No warranty, express or implied, is given as to the completeness, correctness, accuracy, reliability or currency of the materials.*

*DEM and the Crown in the right of the State of South Australia does not accept responsibility for and will not be held liable to any recipient of the information for any loss or damage however caused (including negligence) which may be directly or indirectly suffered as a consequence of use of these materials. DEM reserves the right to update, amend or supplement the information from time to time at its discretion.*