Natural hydrogen exploration in South Australia

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Department for Energy & Mining

SOUTH AUSTRALIA

Government of South Australia

Department for Energy and Mining

Why South Australia?

Zgonnik (2020) First drew attention to natural hydrogen indications in Australia

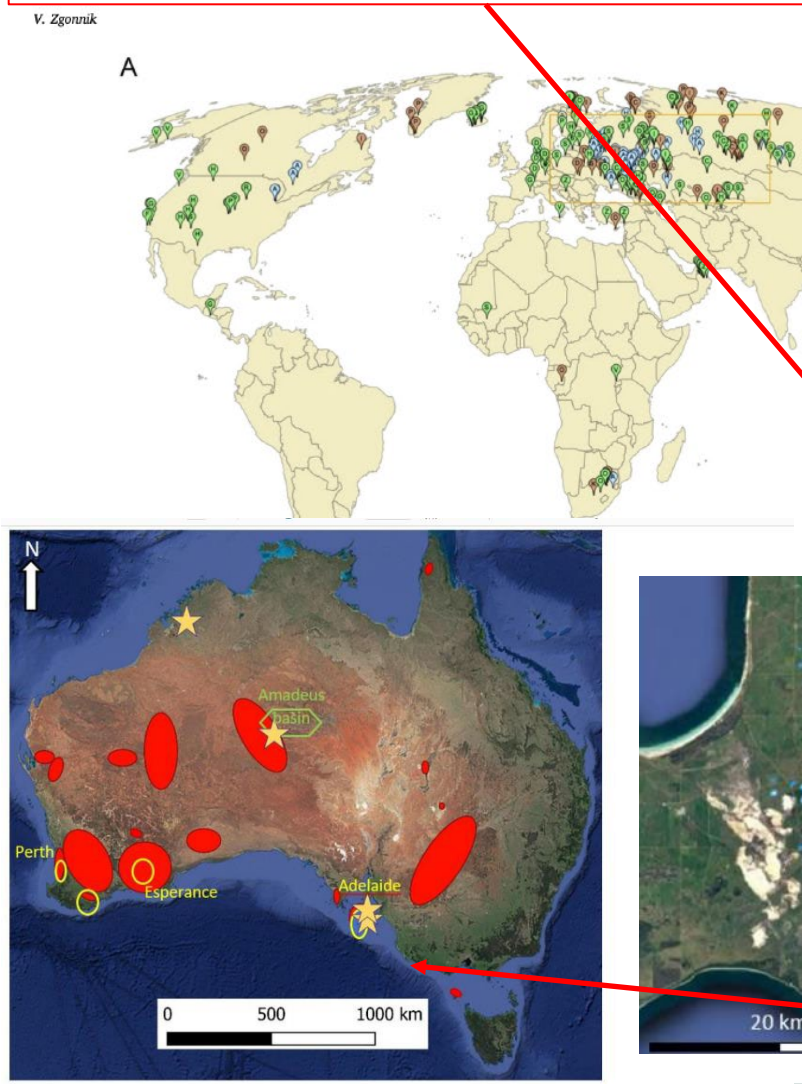


Figure 5. Location of the areas with many circular depressions in Australia (red areas). The yellow stars are the location of the wells that found H_2, the yellow circles highlight the areas where depressions that look like fairy circles can be observed and where statistic has been done in this study.

1. DEM's online records revealed significant hydrogen contents from Government analyses of gas samples taken from three historic drillholes (Zgonnik 2020):

   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. Salt lakes on Yorke Peninsula and Kangaroo Island were postulated to be 'fairy circles' caused by hydrogen seeps (e.g. Moretti et al., 2021).

3. Natural hydrogen exploration become possible in in SA in February 2021 when changes to the *Petroleum and Geothermal Energy Regulations 2013* added hydrogen as a 'regulated substance' – joining petroleum, CO_2, H_2S, He, N and substances produced with petroleum.

Moretti et al. (March 2021) drew attention to potential 'fairy circles'

Potential natural hydrogen sources

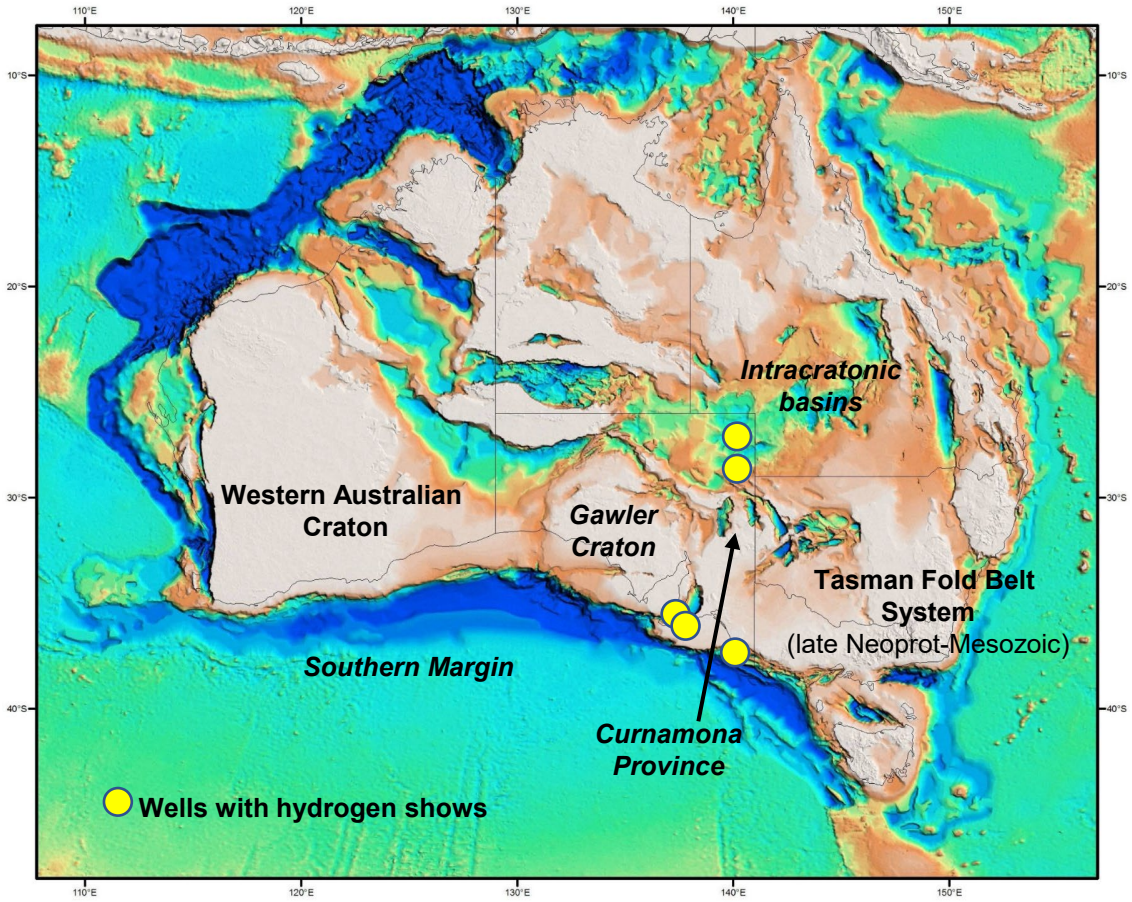


Image - OZSEEBASE 2021 (Geognostics)
https://www.geognostics.com/oz-seebase-2021

- ☑ **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 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 exposed 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).

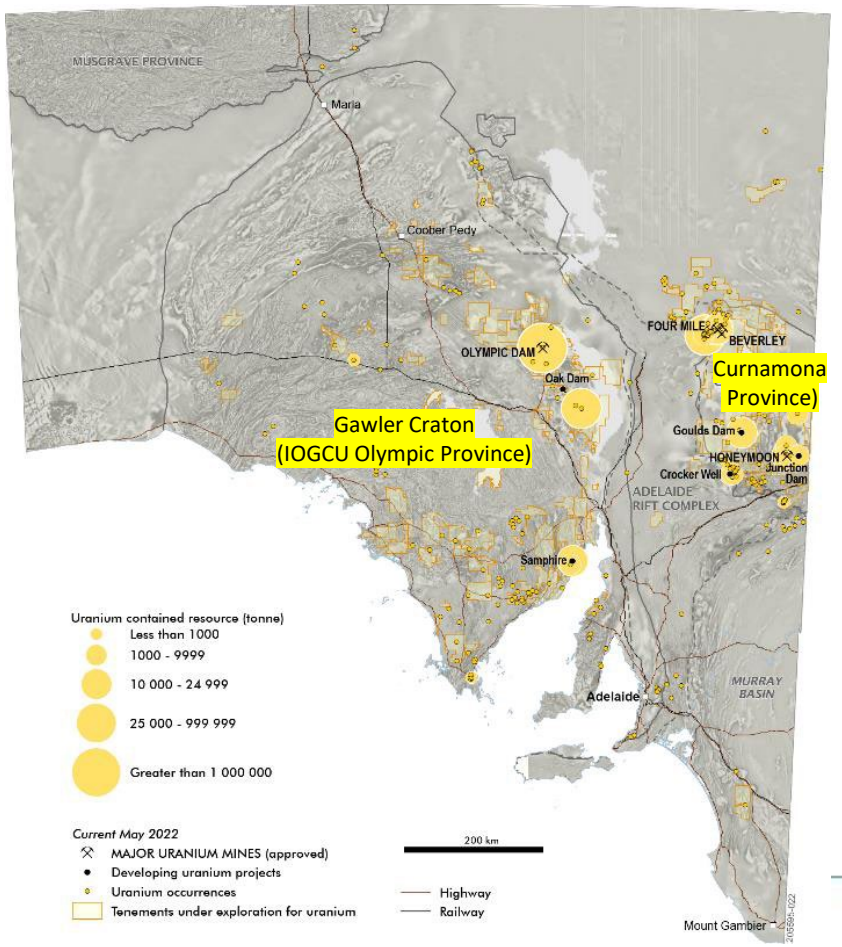
Surficial hydrogen seeps? Seeps can be blind or coincident with visible sub-circular topographic depressions on the metre to kilometre scale **('fairy circles').**

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

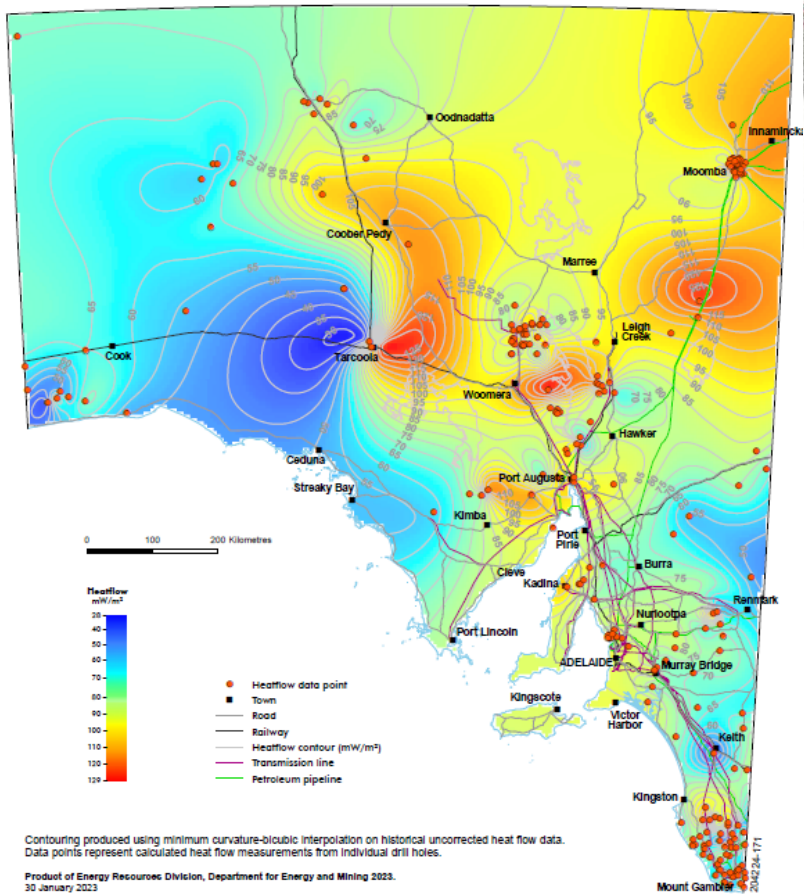
Uranium and iron occurrences and mines in SA

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

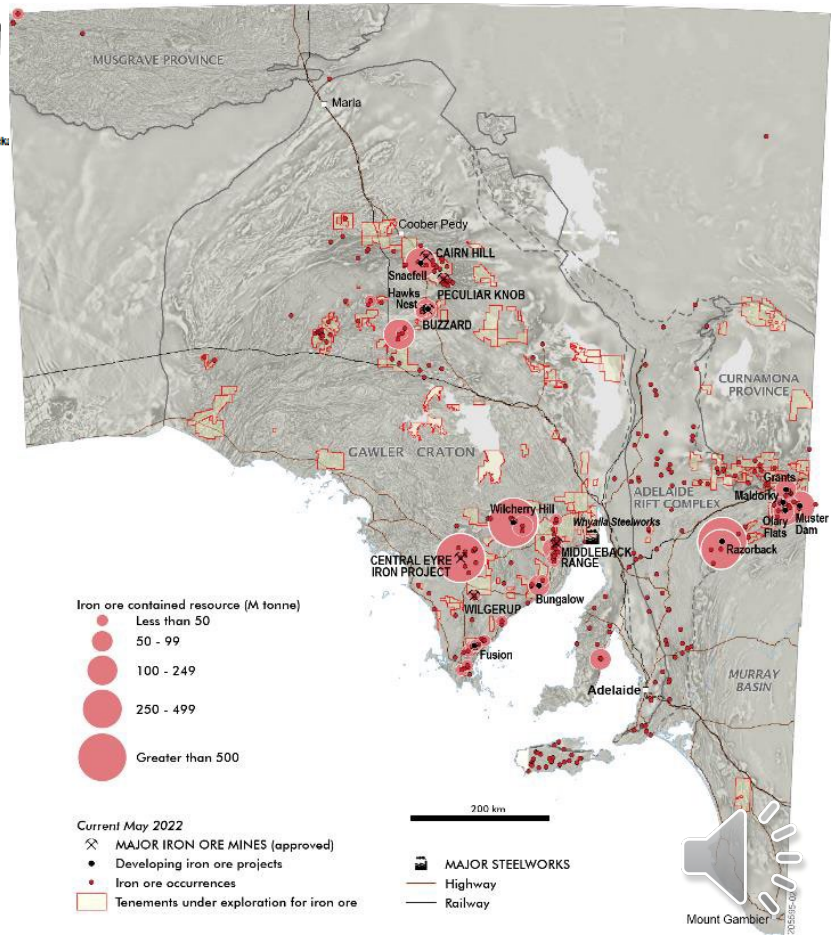
Uranium occurrences and mines



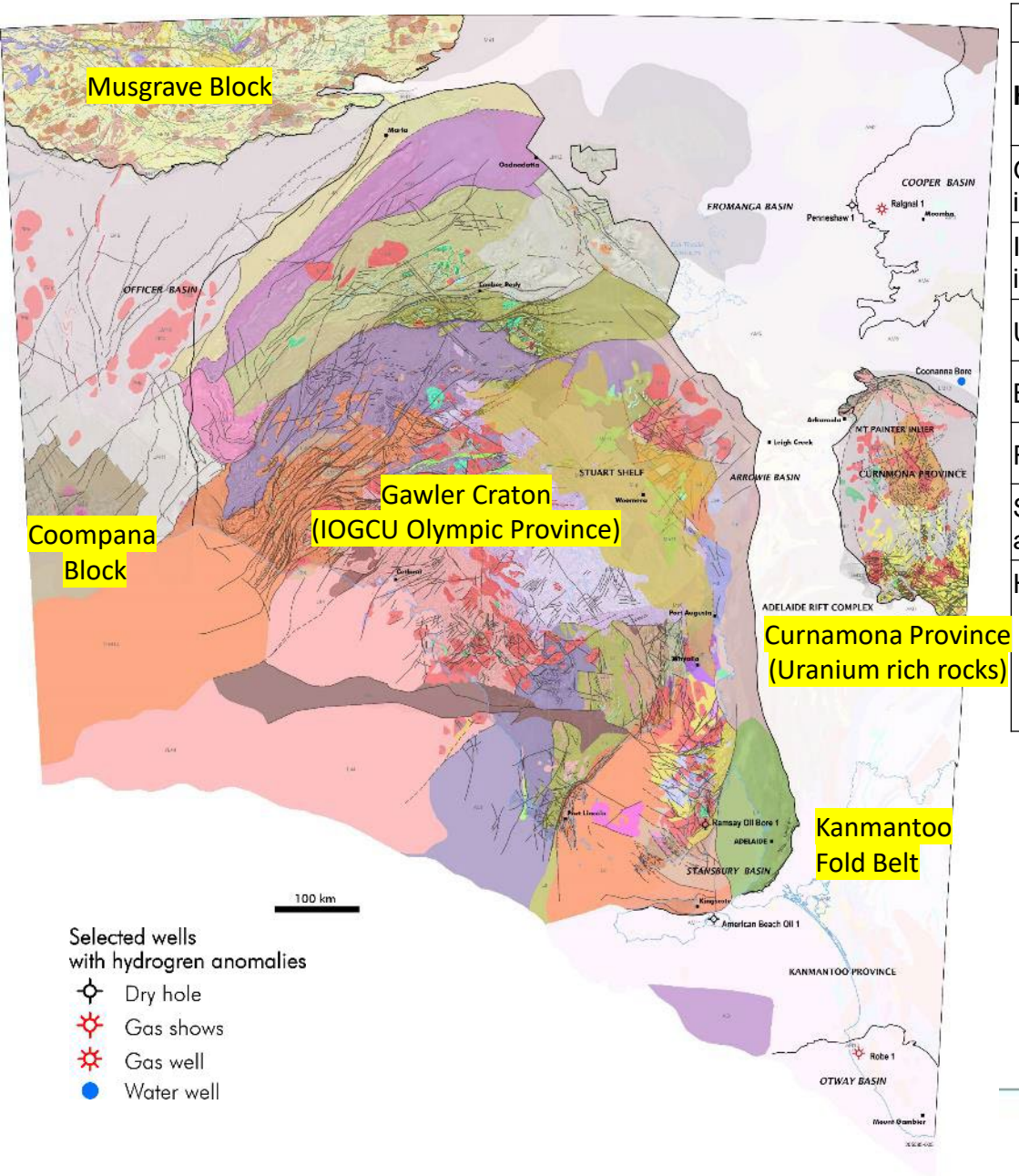
Surface heat flow



Iron ore occurrences and mines



Prospectivity – screening basement provinces

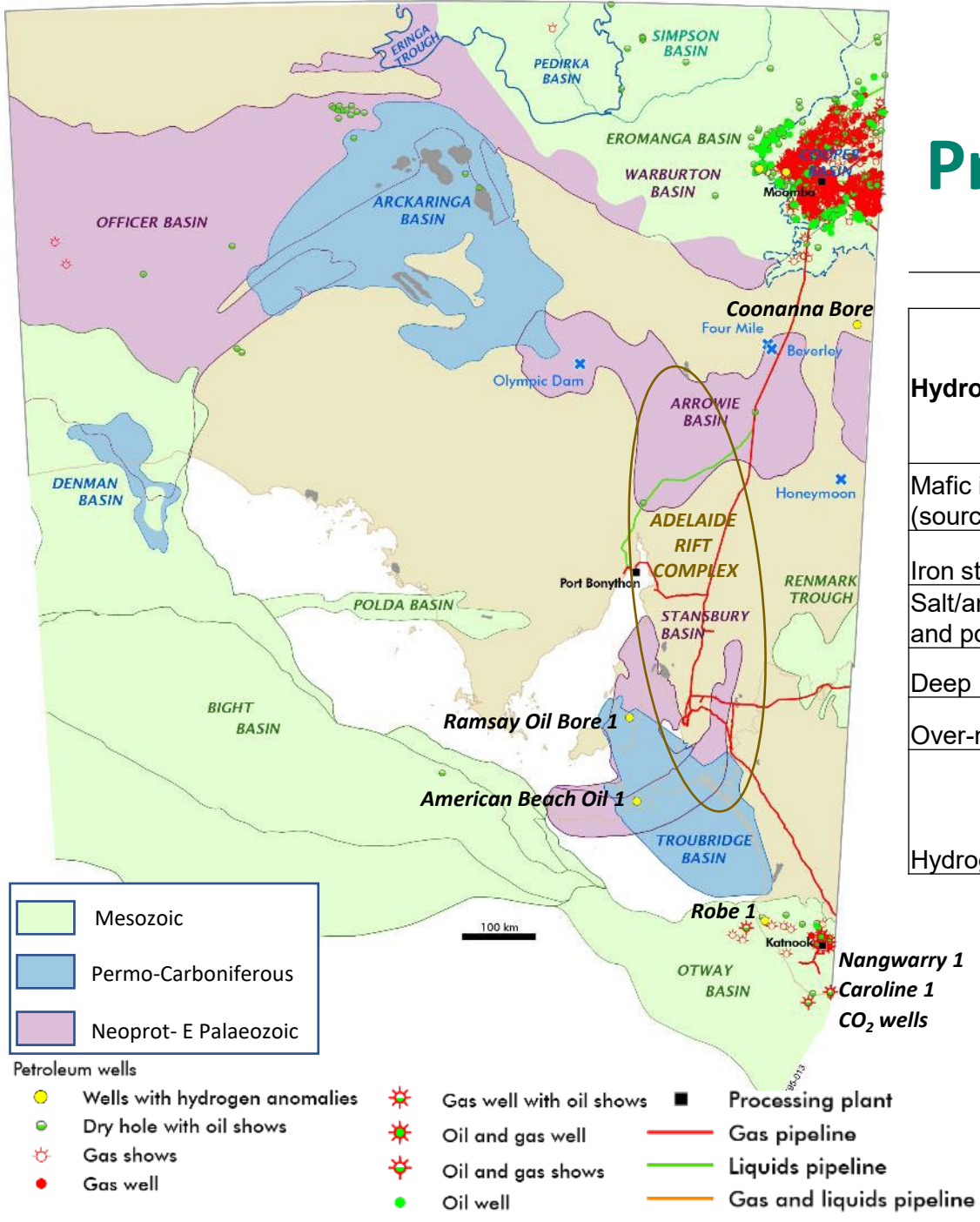


	Province				
Hydrogen play elements	**Coompana**	**Musgrave**	**Gawler**	**Curnamona & Mt Painter inlier**	**Kanmantoo Fold Belt**
Gabbros, mafics, ultramafic intrusives					
Iron-rich granitoid/ intrusives					
Uranium-rich rocks			IOCGU*		
Banded iron formations					
Ferruginous duricrusts					
Structural complexity/deep active faults					
Hydrogen shows			Ramsay Oil Bore. Fairy circles on Yorke Peninsula?		American Beach Oil Bore 1 Fairy circles 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. Fairy circles?	Coonana 1, Ralgnal 1 etc.	Robe 1 (mantle derived CO_2 in Caroline 1 and Nangwarry 1)

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

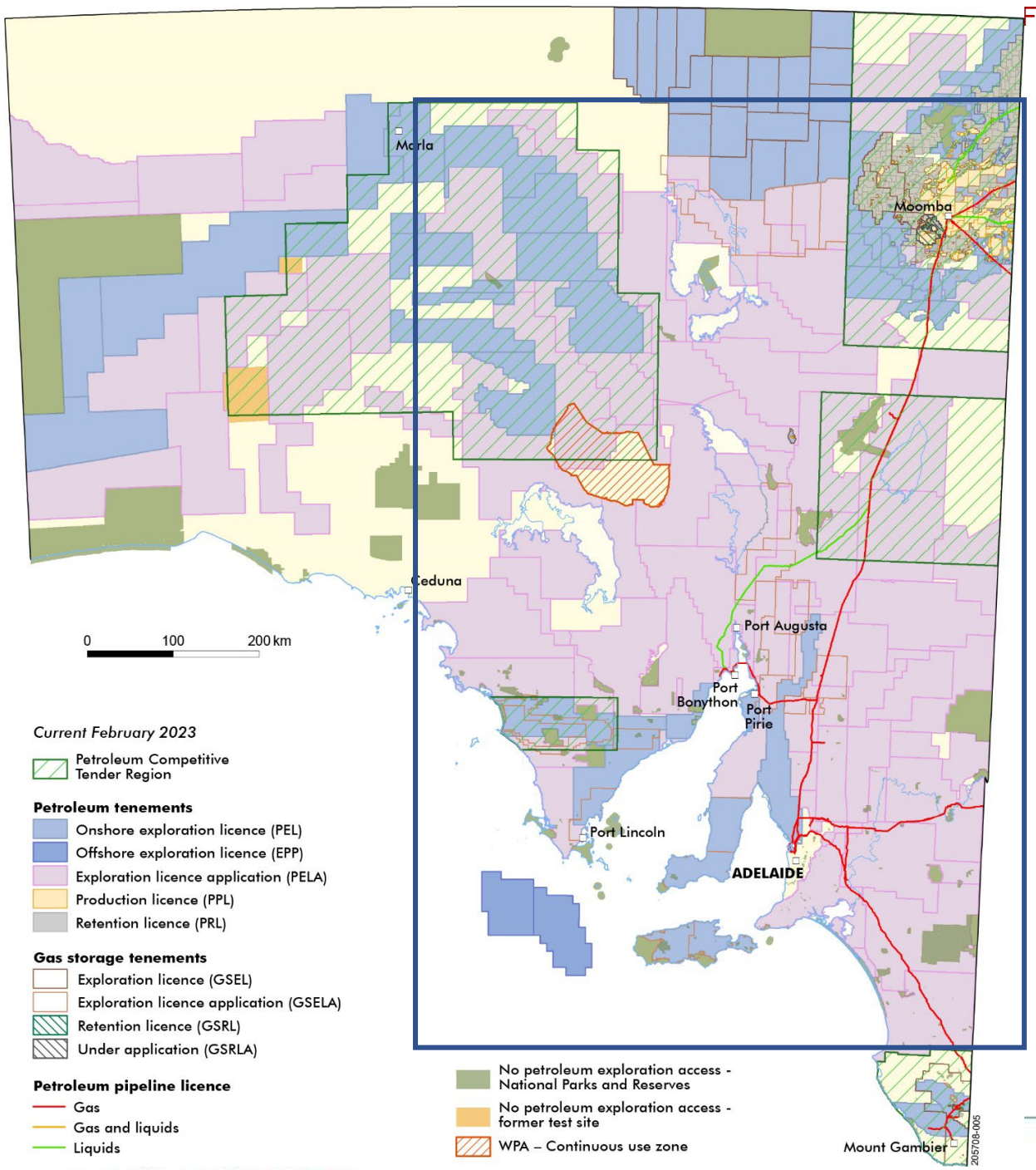
Licensing

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

Three 5 year terms, 1/3 relinquishment at end of each term.

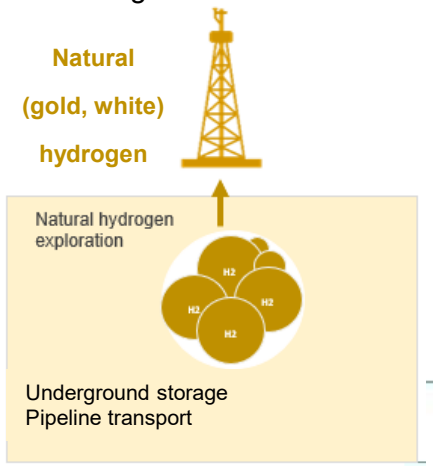
Discoveries are held by Petroleum Production Licences.

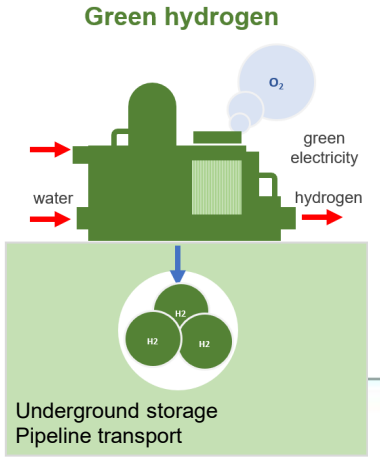
- To apply for a PEL:
  - Pay the fee of $5,174 (~£2,726).
  - 5 year work program – with at least 1 well.
  - Evidence of technical & financial capacity.
- Competitive tender regions - vacant acreage is only available via DEM releases which are based on work program bidding (5 year exploration program).



Petroleum & Geothermal Energy Act 2000

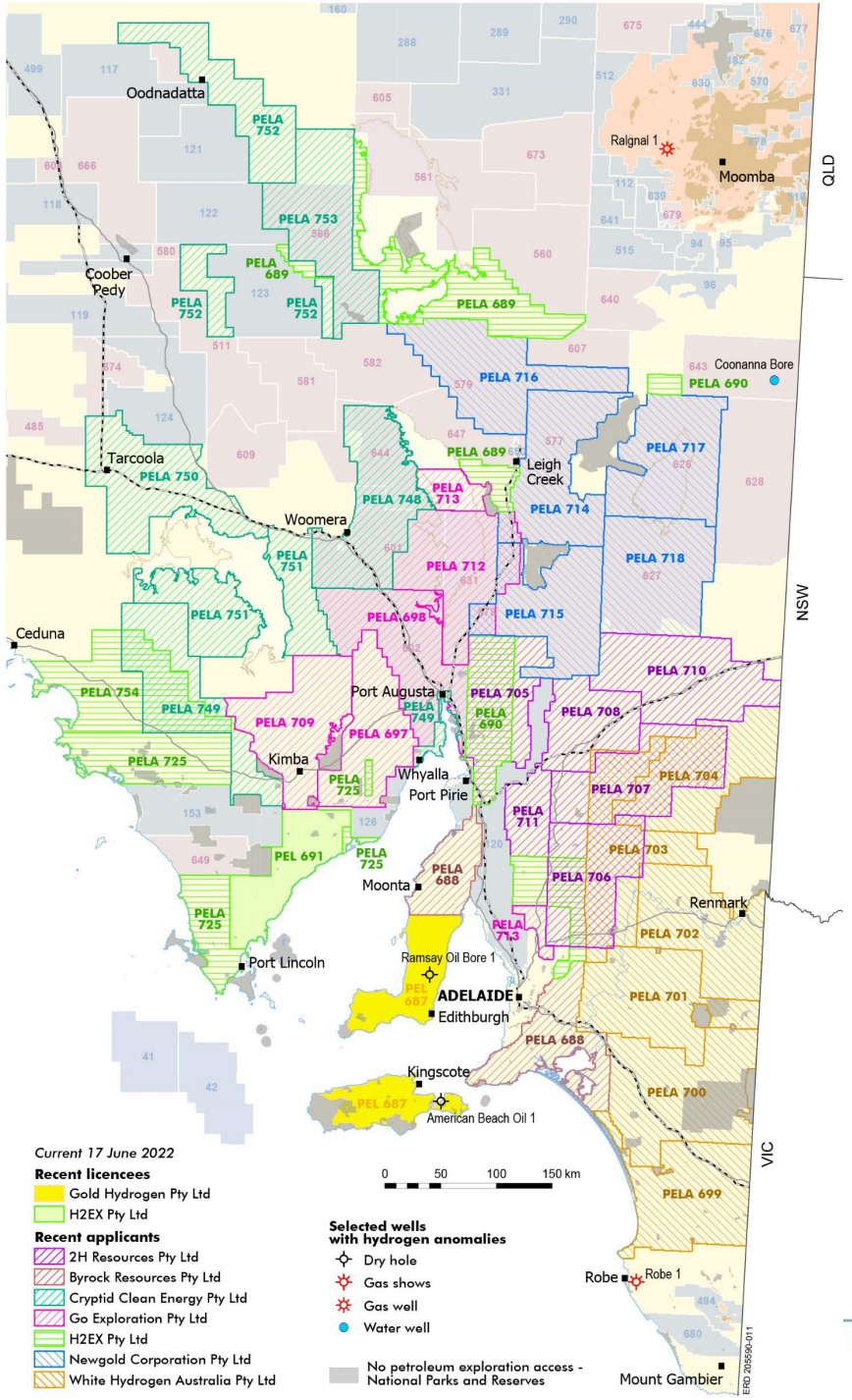
- single window into government for petroleum and natural hydrogen E&P.
- includes underground storage and pipeline transport for all 'colours' of hydrogen.
- Bill is being tabled in Parliament this year.





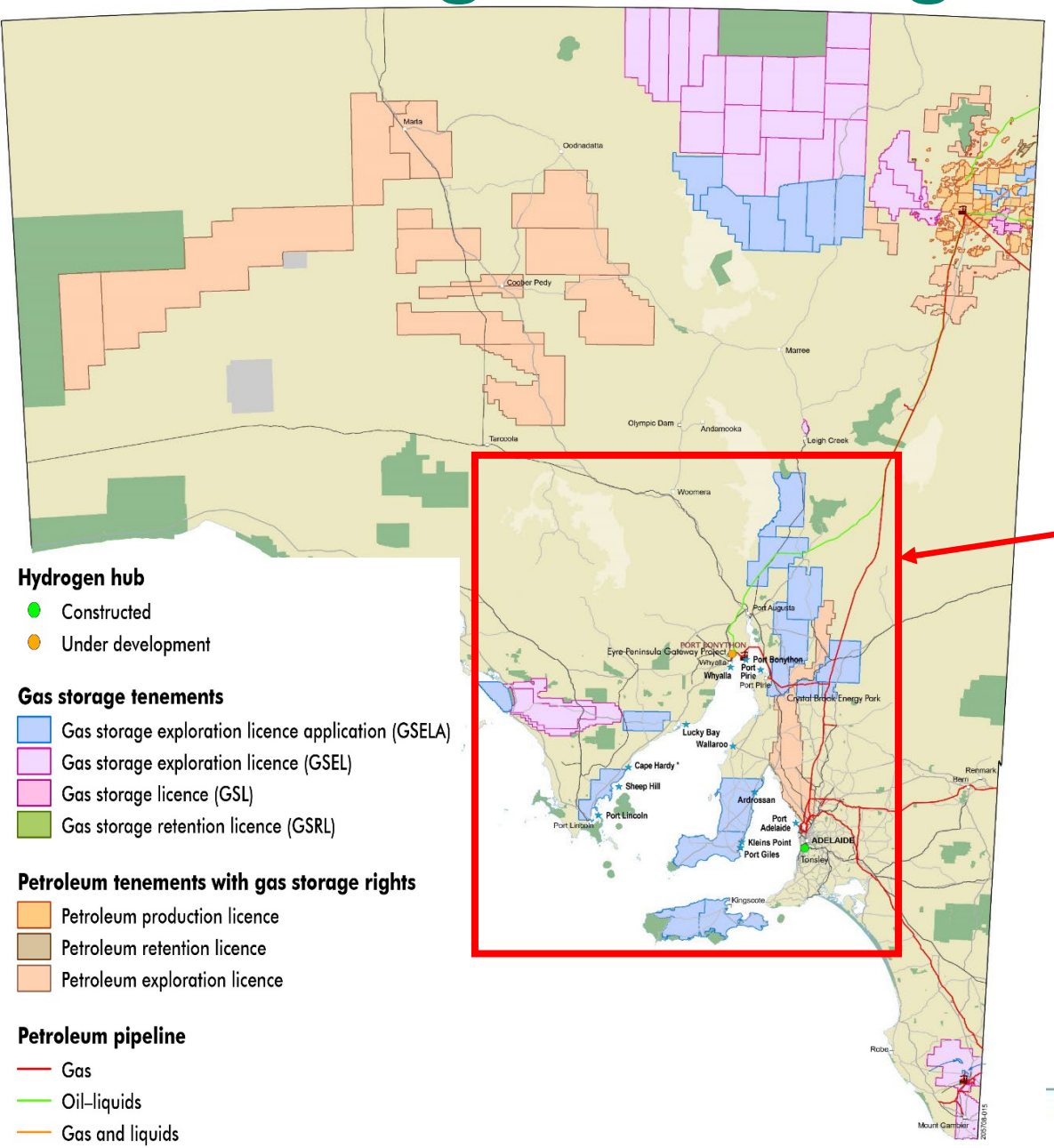
Hydrogen exploration status

- 40 ‘over the counter’ applications have been lodged for PELs targeting natural hydrogen by 7 companies 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 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.
- Grant McMurtie (2H Resources) spoke yesterday about their plans.



Yorke Peninsula salt lake, Sundown Rd.

Gas Storage Licencing



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

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

Some hydrogen explorers have applied for GSELs to acquire the right to explore for hydrogen storage for their projects.

Pipeline Licence (PL)

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

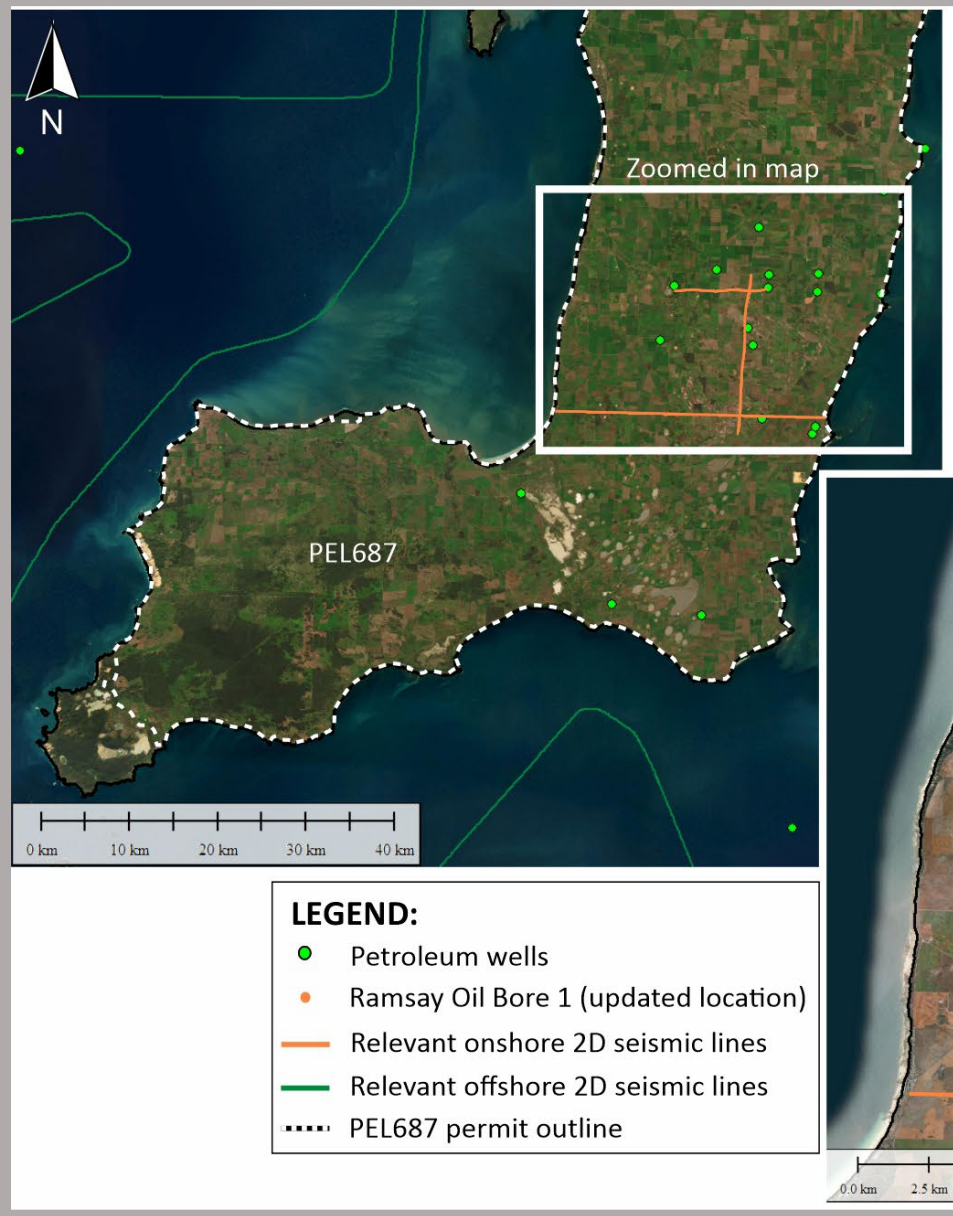
Gold Hydrogen's Ramsay Project location

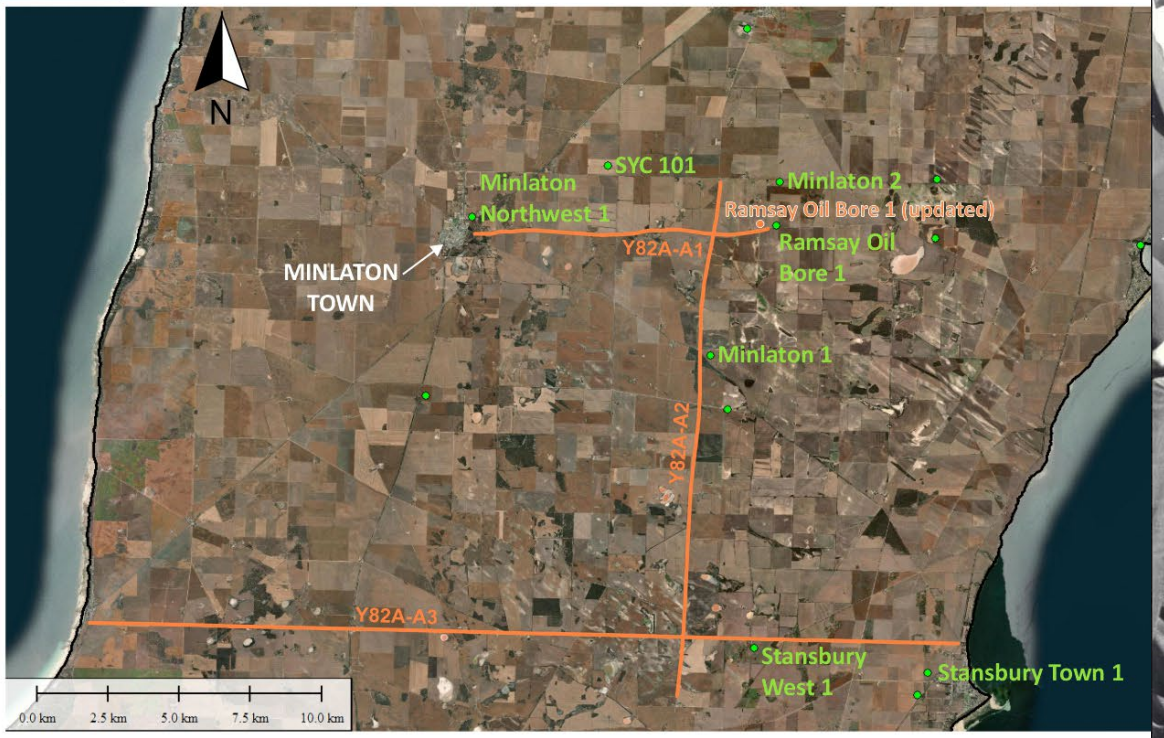
Gold Hydrogen is planning to drill a dedicated hydrogen exploration well on the Yorke Peninsula in October 2023.

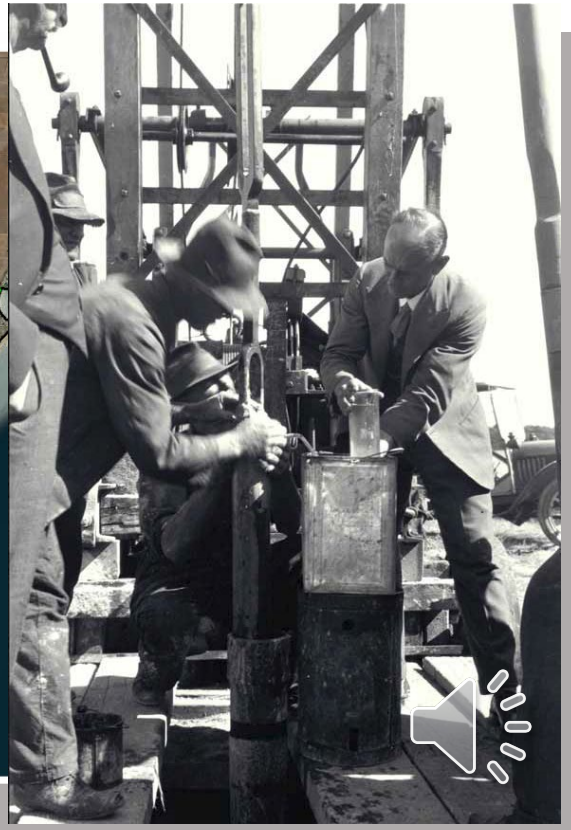
First well will twin the historical Ramsay Oil Bore 1.

Airborne gravity-magnetic survey flown in March-April 2023.

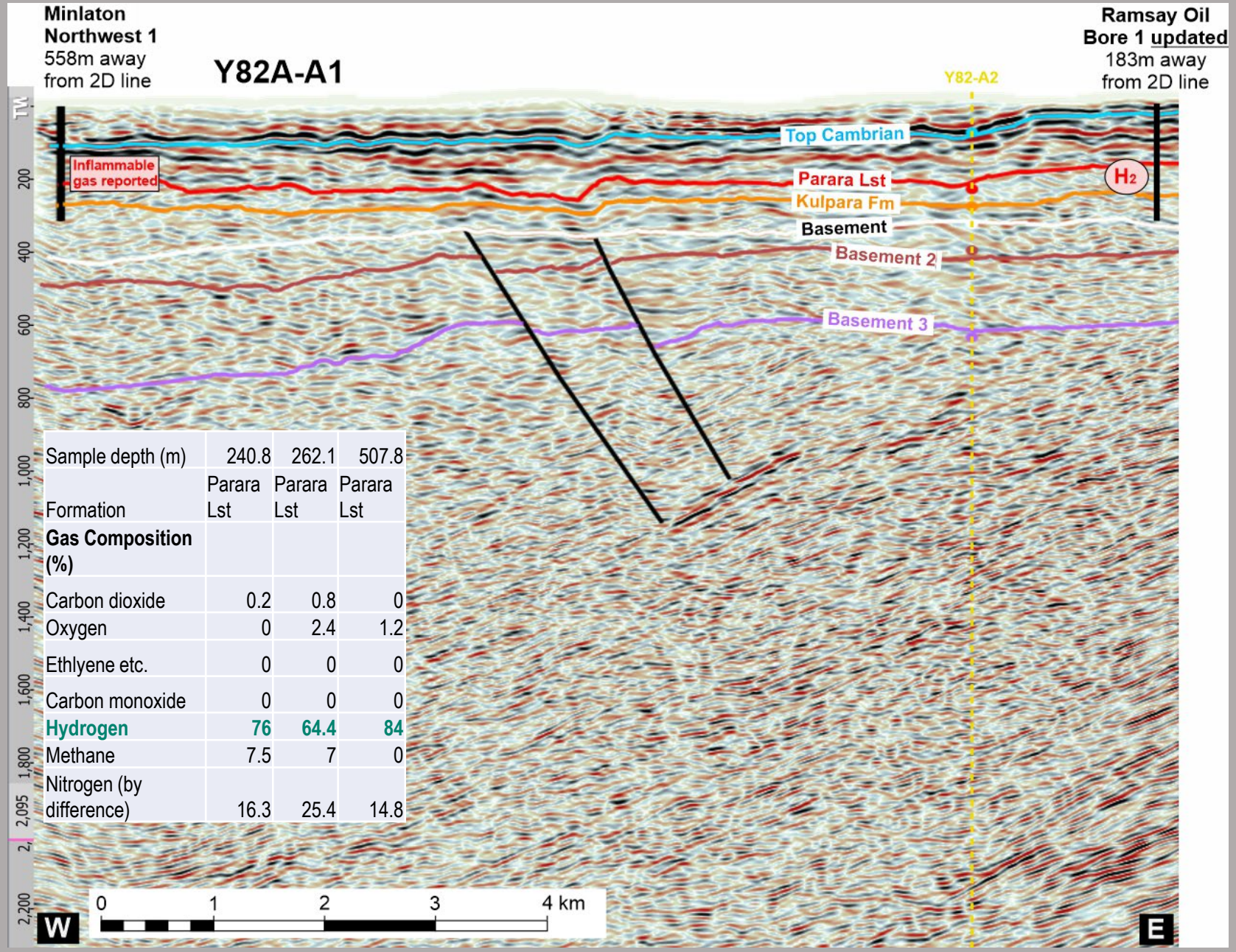
Non-invasive soil gas surveys carried out by Gold Hydrogen and CSIRO in April 2023.







https://www.goldhydrogen.com.au/ramsay-project/ *Slide provided by Gold Hydrogen*



Sample depth (m)	240.8	262.1	507.8
Formation	Parara Lst	Parara Lst	Parara Lst
Gas Composition (%)			
Carbon dioxide	0.2	0.8	0
Oxygen	0	2.4	1.2
Ethlyene etc.	0	0	0
Carbon monoxide	0	0	0
Hydrogen	**76**	**64.4**	**84**
Methane	7.5	7	0
Nitrogen (by difference)	16.3	25.4	14.8

Gold Hydrogen

- First well will twin the historical Ramsay Oil Bore 1 that recorded hydrogen in Early Cambrian carbonates (Parara Limestone).
- Well is planned to tag the granite basement, which is believed to be the source of the hydrogen.
- Full geological logs and samples will be taken.
- Second well planned for ~500m west of the first well and will target a larger granite section.

https://www.goldhydrogen.com.au/ramsay-project/ *Slide provided by Gold Hydrogen*

Assets

H2EX's total acreage position is approximately the size of Croatia

H2EX

H2EX Awarded an Exploration License in June 2022

- PEL 691 totals ~6,000km^2

Petroleum and Geothermal Energy Act 2000
S.115

MEMORANDUM

PETROLEUM EXPLORATION LICENCE
PEL 691

1. Petroleum Exploration Licence PEL 691 granted on 16 June 2022 is hereby entered on the public register.

Interests in the licence are:

H2EX Pty Ltd	100%

NICK PANAGOPOULOS
A/Executive Director
Energy Resources Division
Department for Energy and Mining
Delegate of the Minister for Energy and Mining

Date: 16 June 2022

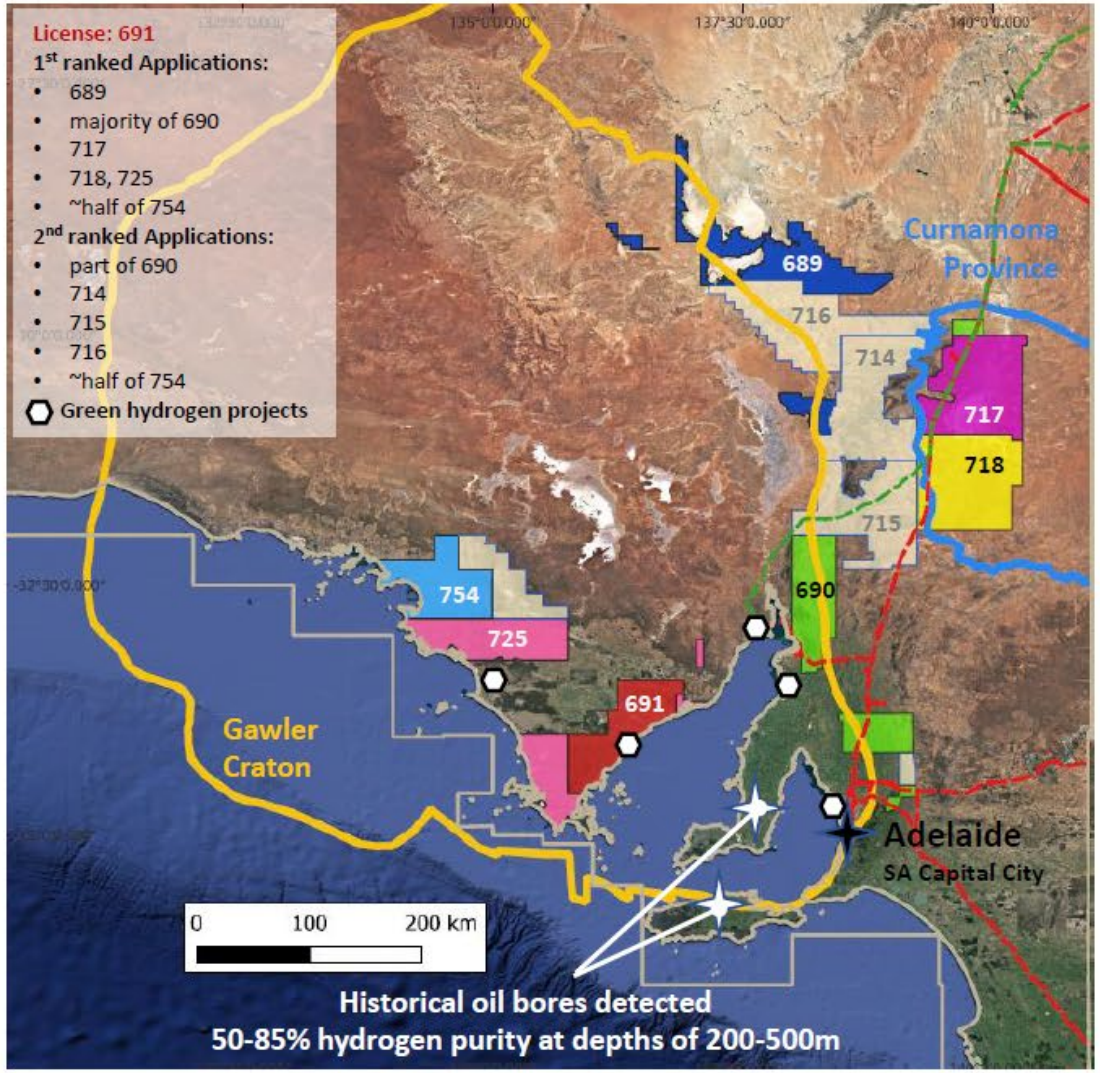
File: MER-2021/0287

- 1st ranked applications totalling ~52,000km^2; PELA 689, 690, 717, 718, 725, 754

  Right To Negotiate (RTN) Native Title negotiation process initiated for 689 & 725

- 2nd ranked applications totalling ~35,000km^2; PELA 754, 714, 715, 716

Assets Located in South Australia



https://h2ex.com.au/ *Slides provided by H2EX*

PEL 691 Exploration Activities

H2EX is collaborating with top-tier Australian research institutions to crack the code on finding natural hydrogen with intent

H2EX

Permit Year 1: 2 x CSIRO Agreements

- The Eyre Peninsula is data-rich, mining activity commenced some 100 years ago
- H2EX and CSIRO Research Agreement, desktop study completed Dec 2022
- H2EX and CSIRO Fieldwork Agreement, gas soil sampling completed May 2023. Positive detections of hydrogen and methane encountered in the field.

CSIRO team in the field on PEL 691 Apr-May 2023

Permit Year 2-3: Federal Grant Fund Approved

Accelerating The Exploration and Extraction of Renewable Natural Hydrogen

- Co-operative Research Council Project (CRC-P) Round 14 Success!
- Public announcement 30 June 2023: business.gov.au/grants-and-programs

H2EX

THE UNIVERSITY of ADELAIDE

Australian National University

BLACK & VEATCH

- The Project will unlock important first-mover benefits for Australia within an emerging sector globally, while retaining Australia's competitive advantage and highly regarded technical and engineering expertise.
- Total project cost A$2.1m (grant totals A$863k)

https://h2ex.com.au/ *Slides provided by H2EX*

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.**
- **Upcoming company exploration activity in SA will test a diversity of natural hydrogen plays.**
- **It is expected that the new *Hydrogen and Renewable Energy Act* and amendments to the *Petroleum and Geothermal Energy Act 2000* will be in place by the end of 2023.**
- **Watch this space!**