

ENERGY MINING

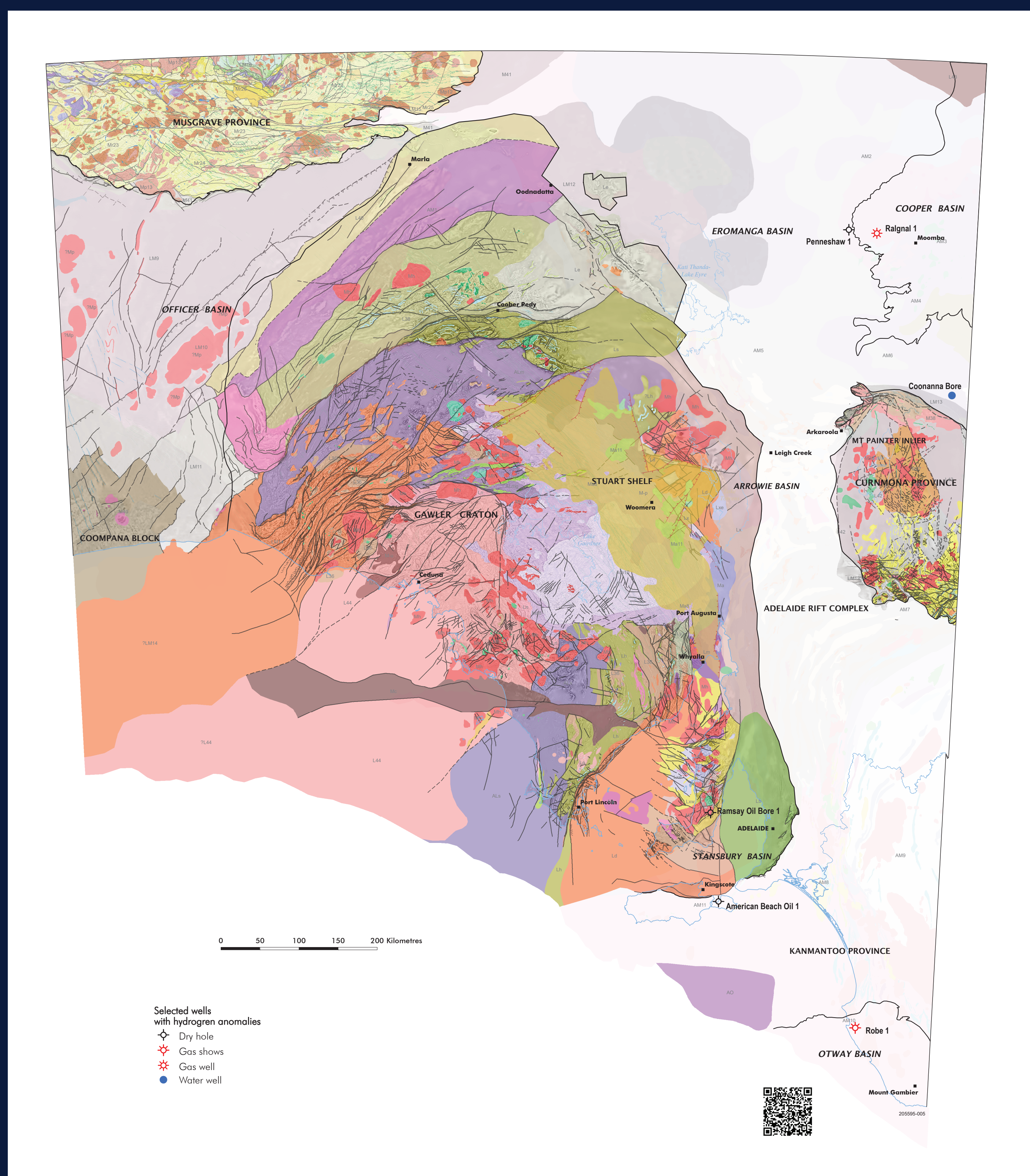
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NATURAL HYDROGEN EXPLORATION

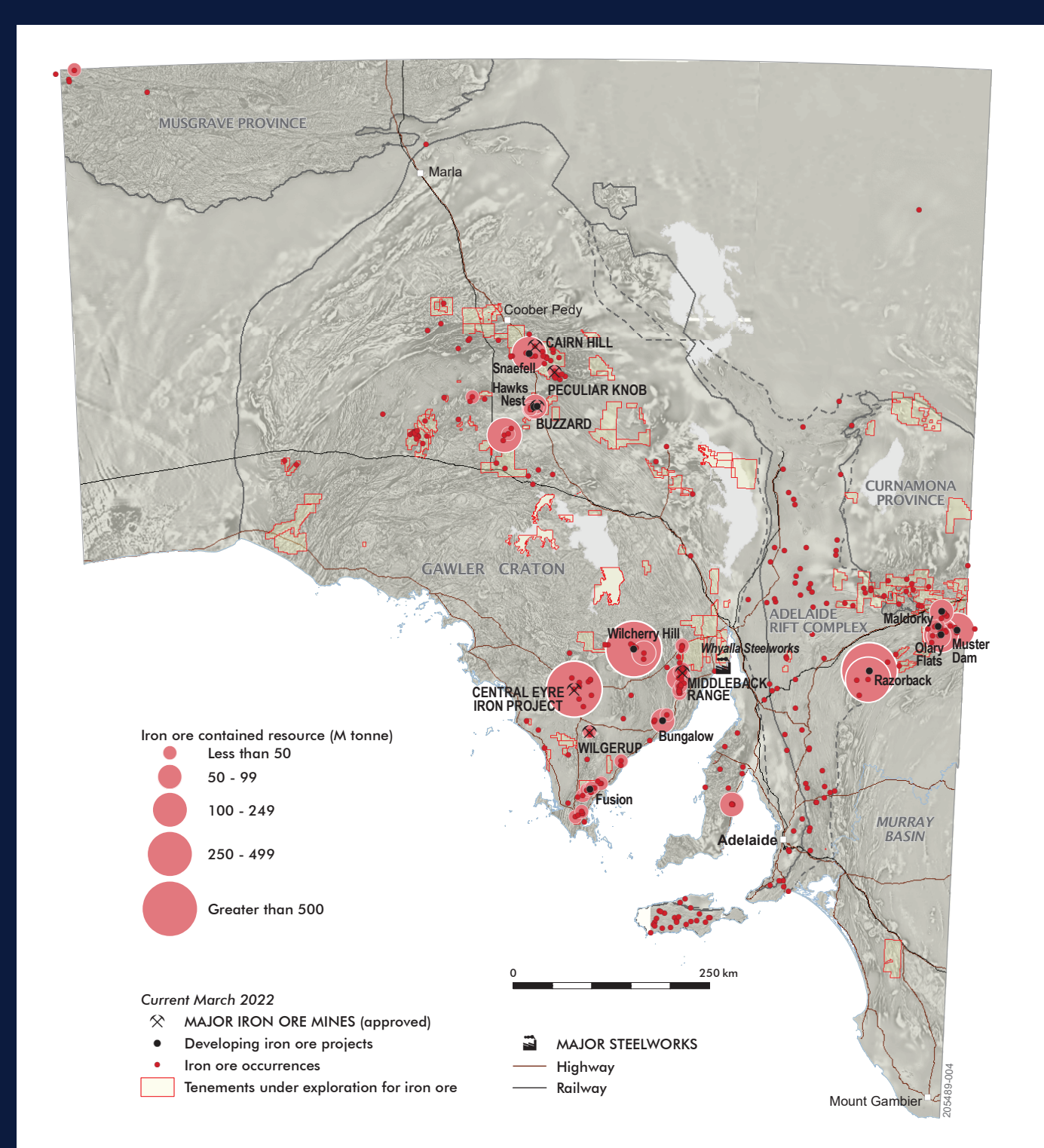
Geology

The discovery of natural hydrogen gas seeps and fluxes in a number of drillholes, including dedicated hydrogen production from the Bourakebougou field in Mali (Prinzhofer et al, 2018), has focussed attention on subsurface native hydrogen accumulations. Recent studies (e.g. Moretti et al, 2021; Zgonnik, 2020; Boreham et al, 2021) suggest that native hydrogen exists in a free gas state in a diversity of continental geological environments. Geological conditions favourable for native hydrogen exploration can include:

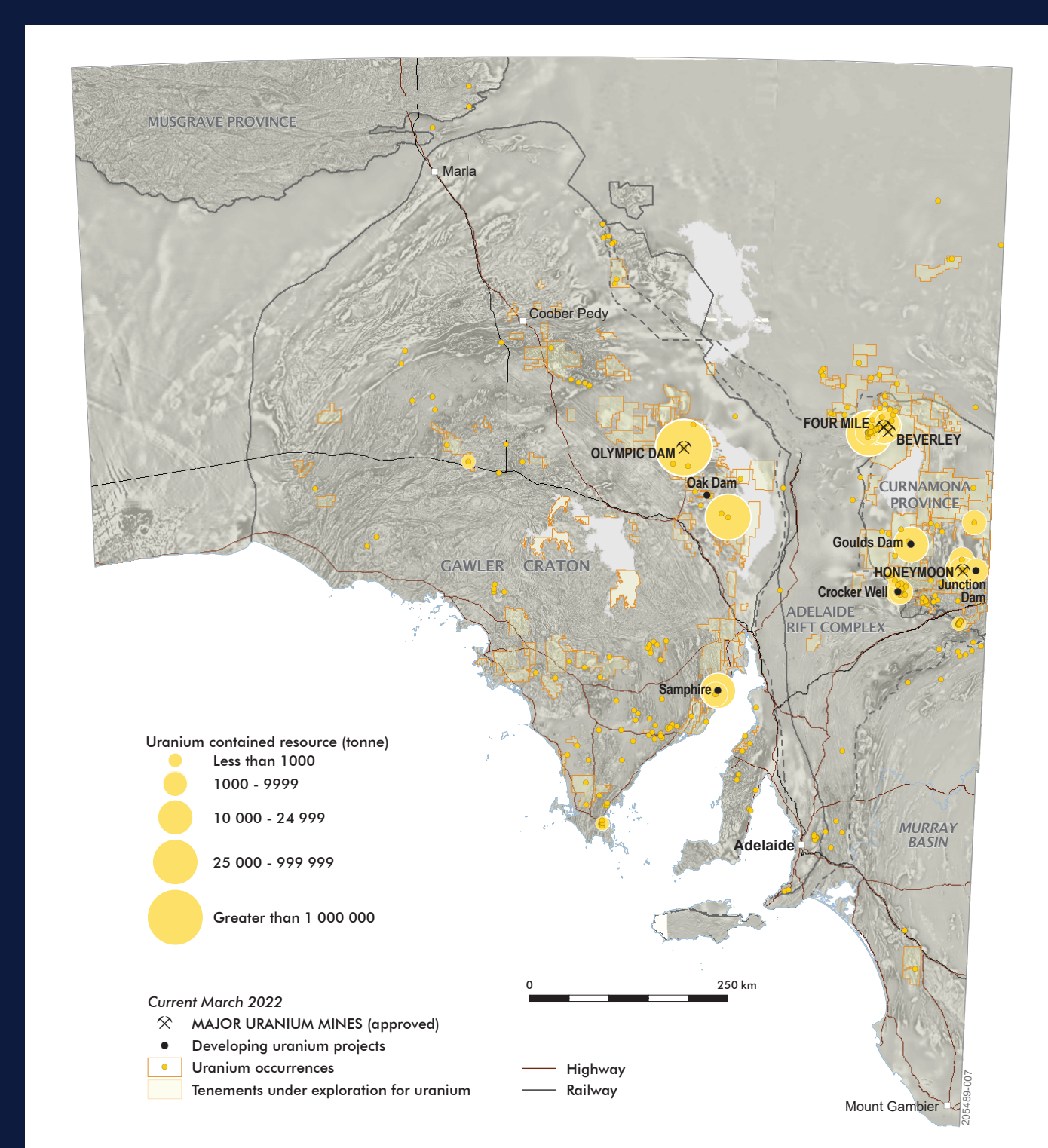
- Source rocks associated with basement complexes which contain Fe2+ and/or uranium rich rocks (see maps below). These have potential for generating hydrogen via radiolytic and oxidation processes (e.g., Archaean greenstone and Precambrian basement terranes).
- Fractured and seismically active source areas - deep-seated faults can both channel migrating hydrogen from deep sources to surface and introduce water downward for further chemical reaction with exposed Fe2+ rich rocks.
- Sedimentary overburden may enable entrapment of migrating hydrogen particularly if aquifer systems and /or seals like evaporites are present. Evaporites (carnallite, sylvite) may also constitute a hydrogen source.
- Surficial hydrogen seeps. Seeps can be blind or coincident with visible sub-circular topographic depressions on the metre to kilometre scale ('fairy circles'), often associated with perturbed vegetation cover.



Archaean to Mesoproterozoic Solid Geology of South Australia with TVD of Reduced to Pole Total Magnetic Intensity indicating the nature and distribution of major lithostratigraphic suites, and locations of major faults systems, within South Australian basement provinces. The distribution of Neoproterozoic to Cambrian basins, and the location of individual historical boreholes with measured anomalous hydrogen fluxes, are also displayed.



Distribution of known Iron ore occurrences and resources.



Distribution of known Uranium occurrences and resources.

Prospectivity

Why the interest in SA?

Based on recently published papers, significant potential exists for natural hydrogen plays in South Australia and this has generated over 30 applications for PELs targeting natural hydrogen. The interplay between the favourable geological conditions of source, structure and sedimentary overburden and various South Australian geological terranes is summarised in the Tables.

SA has a number of Archaean-Proterozoic Basement provinces and Neoproterozoic to Cambrian basins which host substantial Fe-rich ultramafic, mafic, and bimodal volcanic and intrusive suites, komatiites, ironstones, iron ore and uranium resources. These provinces are structurally complex, hosting major crustal scale fault systems with many of the non-cratonic areas still seismically active.

The maps above show solid geology with basement provinces and uranium and iron ore mines and occurrences.

Direct evidence suggests some younger sedimentary basins in South Australia may also be prospective for native hydrogen. Anomalous levels of native hydrogen gas have been measured in several boreholes in South Australia including 50 - 80% in gas samples from Ramsay Oil Bore 1, American Beach Oil 1 and Robe 1 located in the Stansbury and Otway Basins respectively. In addition salt lakes on Yorke Peninsula and Kangaroo Island are postulated by international researchers to be "fairy circles" caused by surficial seepage of hydrogen gas fluxes (e.g. Moretti et al, 2021).

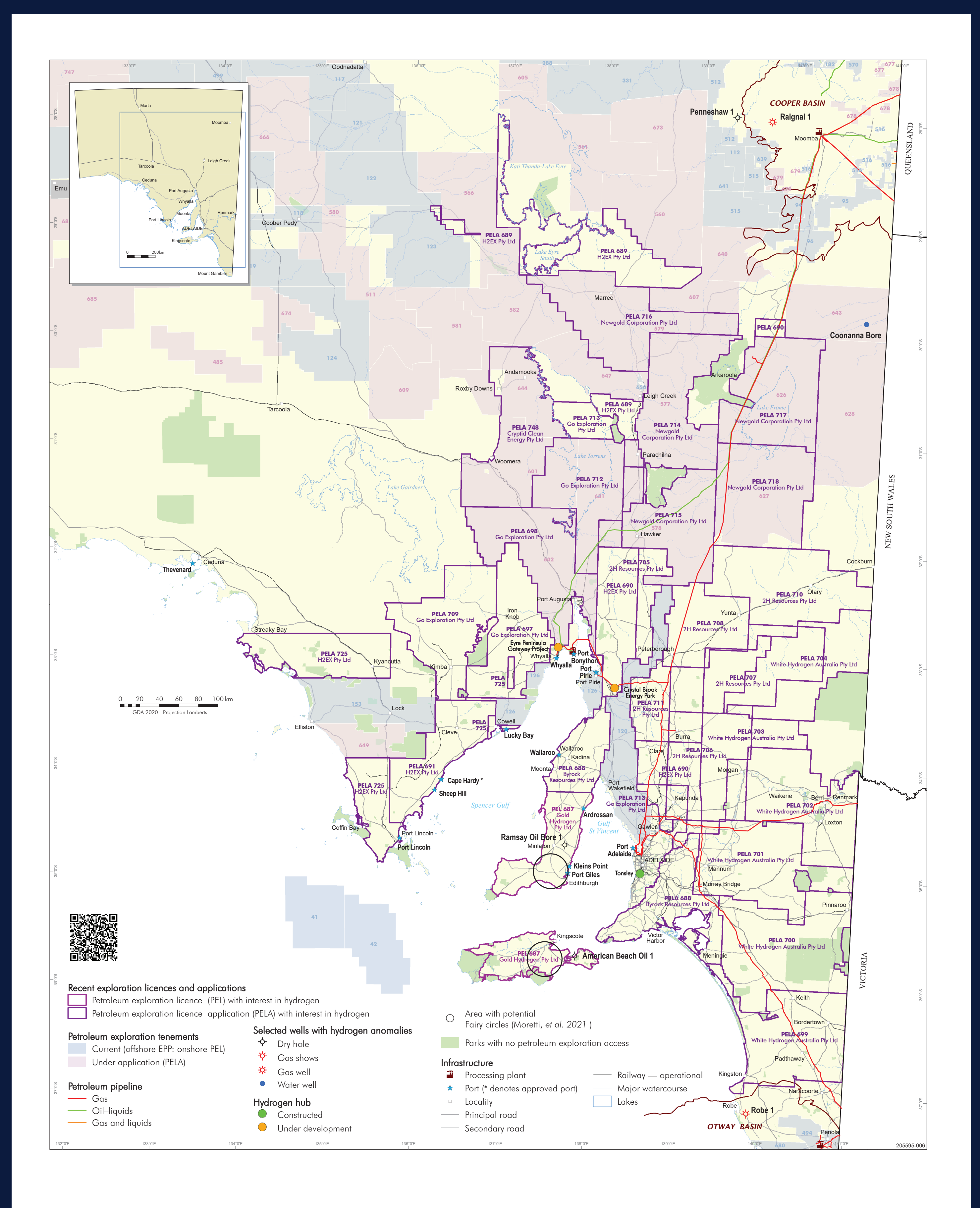
For more information on exploring for **NATURAL HYDROGEN**: www.petroleum.sa.gov.au/geology-and-prospectivity/hydrogen

Regulation and licensing

The scope of the Petroleum and Geothermal Energy Act 2000 will be expanded to cover exploration, generation and pipeline transmission of hydrogen and renamed the Energy Resources Act.

- In February 2021 the definition of a 'regulated substance' under the Petroleum & Geothermal Energy Act 2000 (PAGEA2000) was expanded to include hydrogen. Companies can apply to explore for natural hydrogen via a Petroleum Exploration Licence (PEL).
- 30 'over the counter' applications have been lodged for PELs targeting natural hydrogen since February 2021. The first PEL was granted in July 2021 to Gold Hydrogen Pty Ltd. Their 5 year work program includes soil sampling, AEM-PTP, aeromagnetics and gravity surveying, seismic reprocessing and new acquisition, plus drilling one deep well.
- Production of hydrogen from processing natural gas or underground gasification of coal in combination with CCS (blue hydrogen) is permissible through a Petroleum Production Licence and Gas Storage Licence.
- Additional proposed amendments to PAGEA2000 aim to provide hydrogen generators the same leading practice regulatory and one-window to government regime currently provided for the petroleum sector:
 - Hydrogen Generation Licences (HGL) will cover generation currently not under PAGEA2000 – e.g. green hydrogen from electrolysis of water.
 - Hydrogen or hydrogen compounds will be covered by transmission pipeline licences for transport.
 - Gas Storage Licences will enable the withdrawal of stored regulated substances such as hydrogen.

This report explains SA's current and proposed **HYDROGEN LICENSING REGIME**:



Hydrogen prospectivity summary

Hydrogen play elements	Province				
	Coompana	Musgrave	Gawler	Curnamona & Mt Painter inlier	Kanmantoo
Gabbros, mafics, ultramafic intrusives					
Fe-rich granitoids/intrusives					
Uranium rich rocks			IOCGU		
Iron formations					
Ferruginous duricrusts					
Structural complexity/active faults					
Hydrogen shows					American Beach Oil bore 1

Hydrogen play elements	Basin				
	Adelaide Fold Belt/Stuart Shelf/Arrowie Basin	Officer Basin	Stansbury Basin	Eromanga Basin	Otway Basin
Mafic intrusives/extrusives					
Iron stones					
Salt/anhidrite			?		
Deep Faults					
Hydrogen shows			Ramsay Oil syndicate Bore 1	Coonana 1, Ralignal 1	Robe 1

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