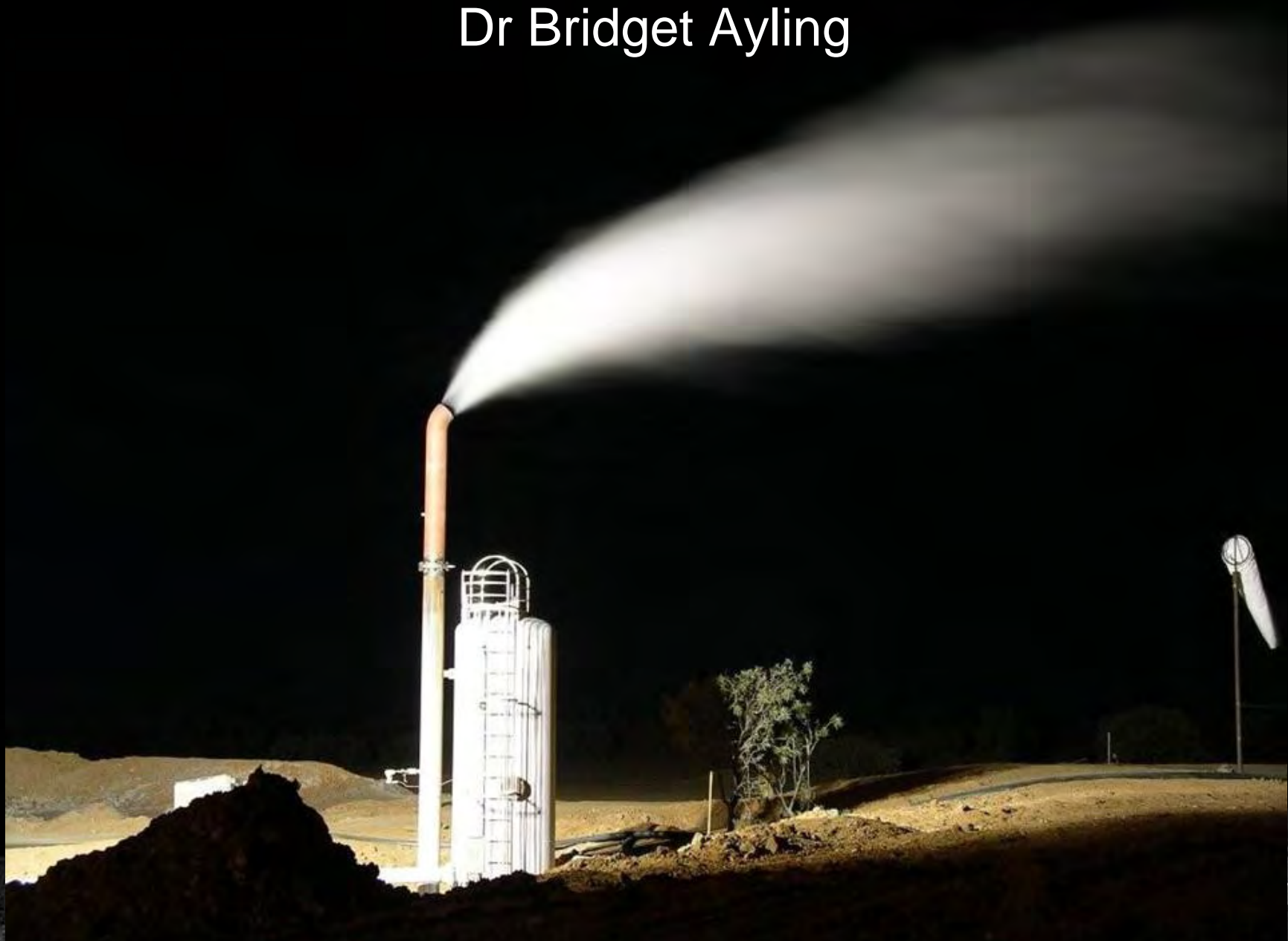


Geothermal energy in Australia: Current status and future potential

Dr Bridget Ayling

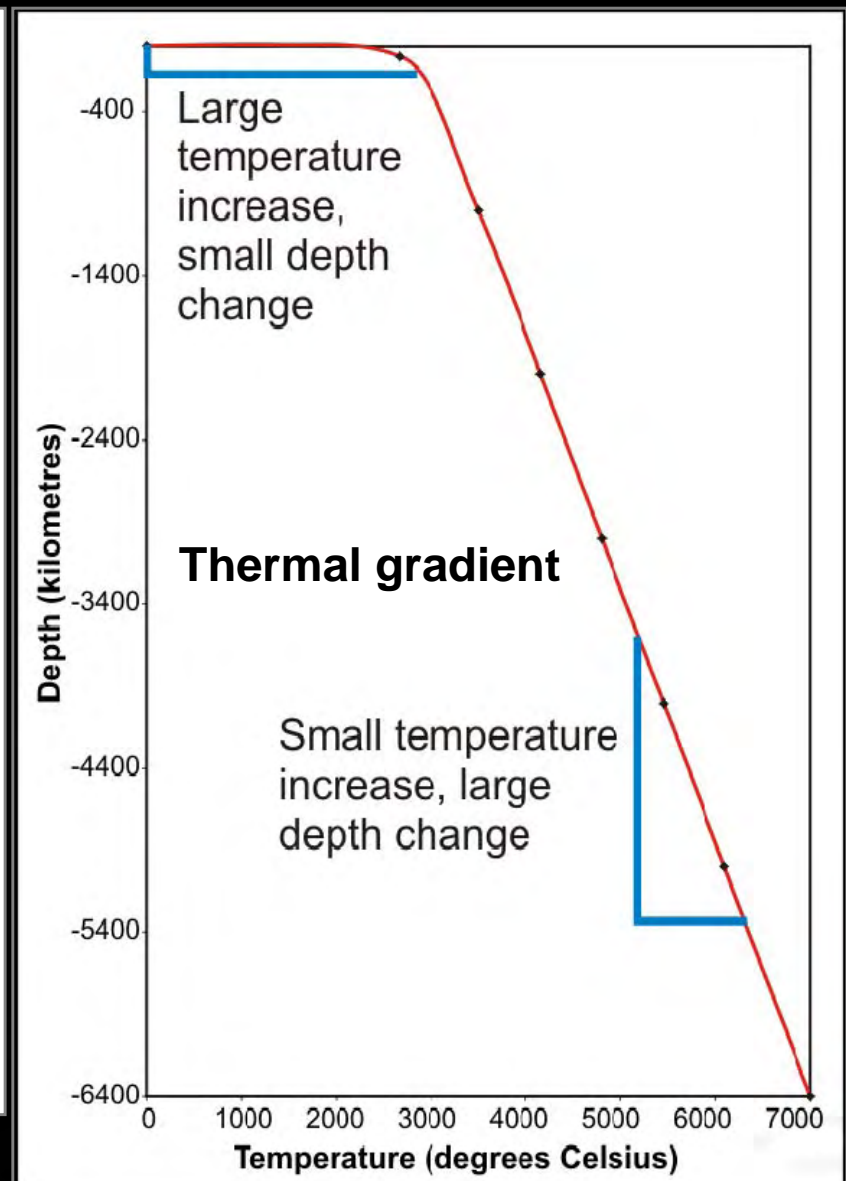
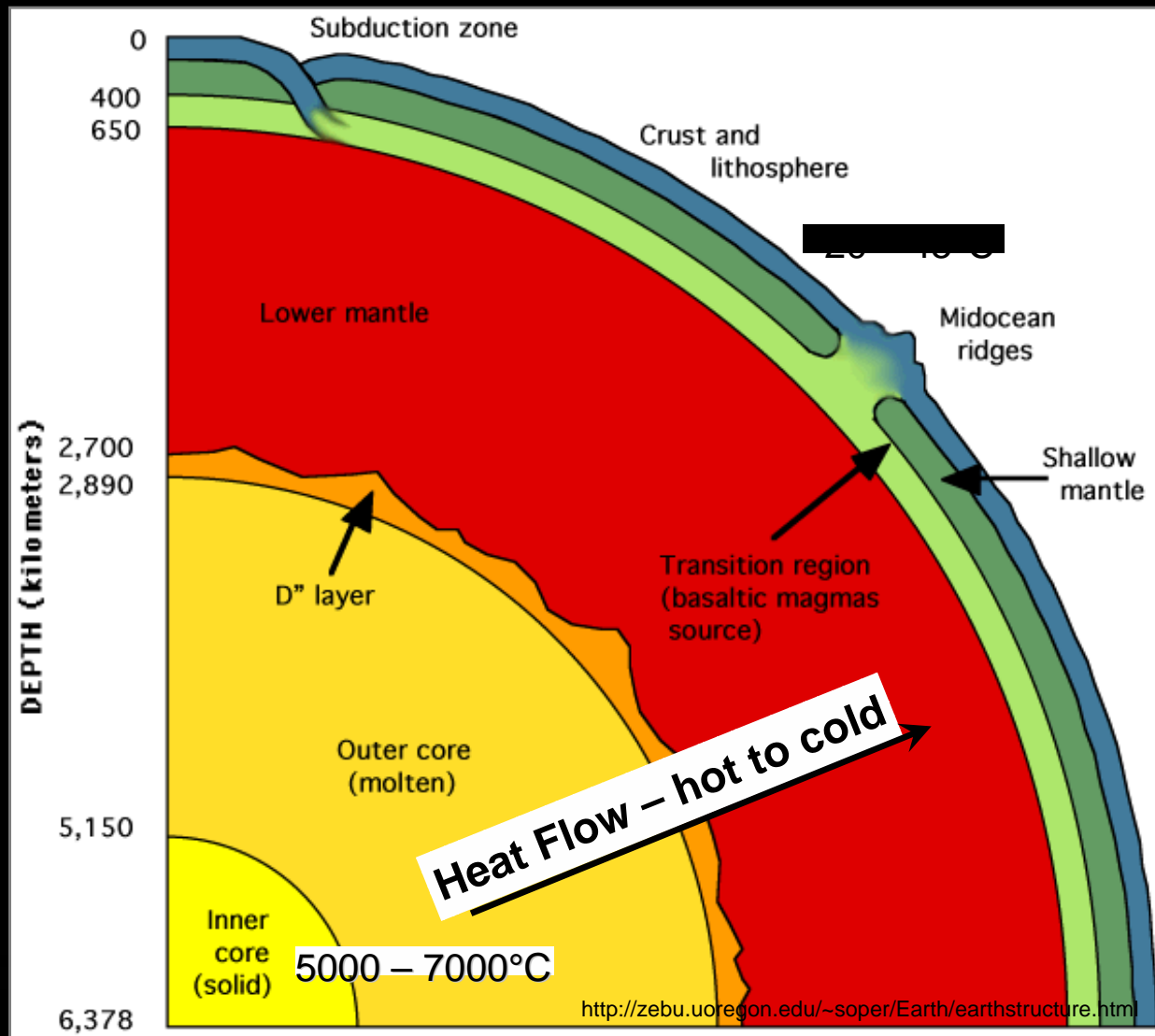


Talk overview

1. Introduction: what is geothermal energy?
2. Where is it in Australia?
3. Electricity generation Vs direct use
4. Geoscience Australia's geothermal project
5. Australian Government initiatives
6. Australia's geothermal industry
7. Geothermal in the future: how many MW?

What is geothermal energy?

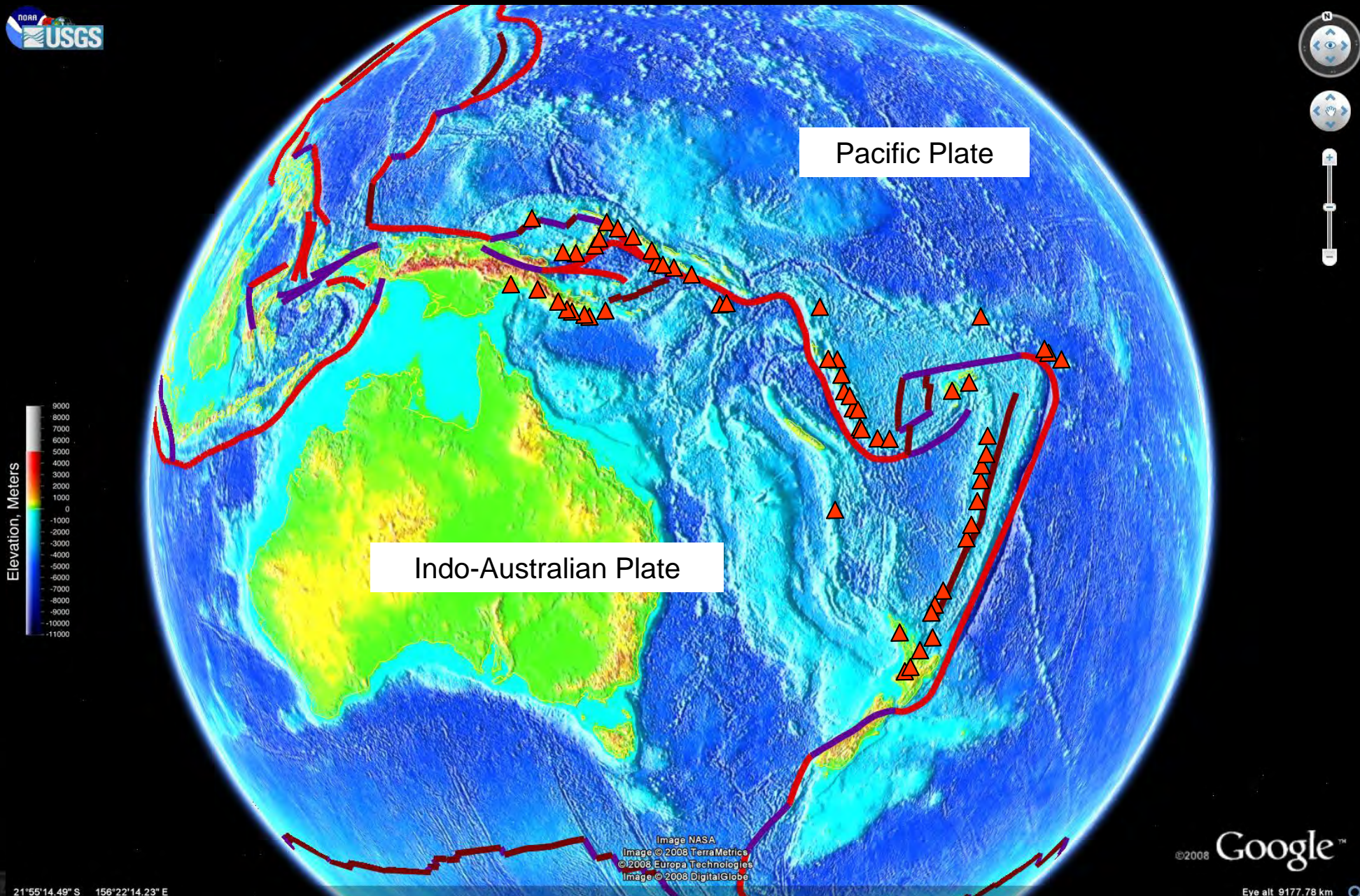
Geo = Earth, thermal = heat; the Earth's heat



Main contributors of heat to the surface of the Earth are magmas and decay of radioactive elements (uranium, thorium and potassium)



Oceania: tectonic setting



©2008 Google™

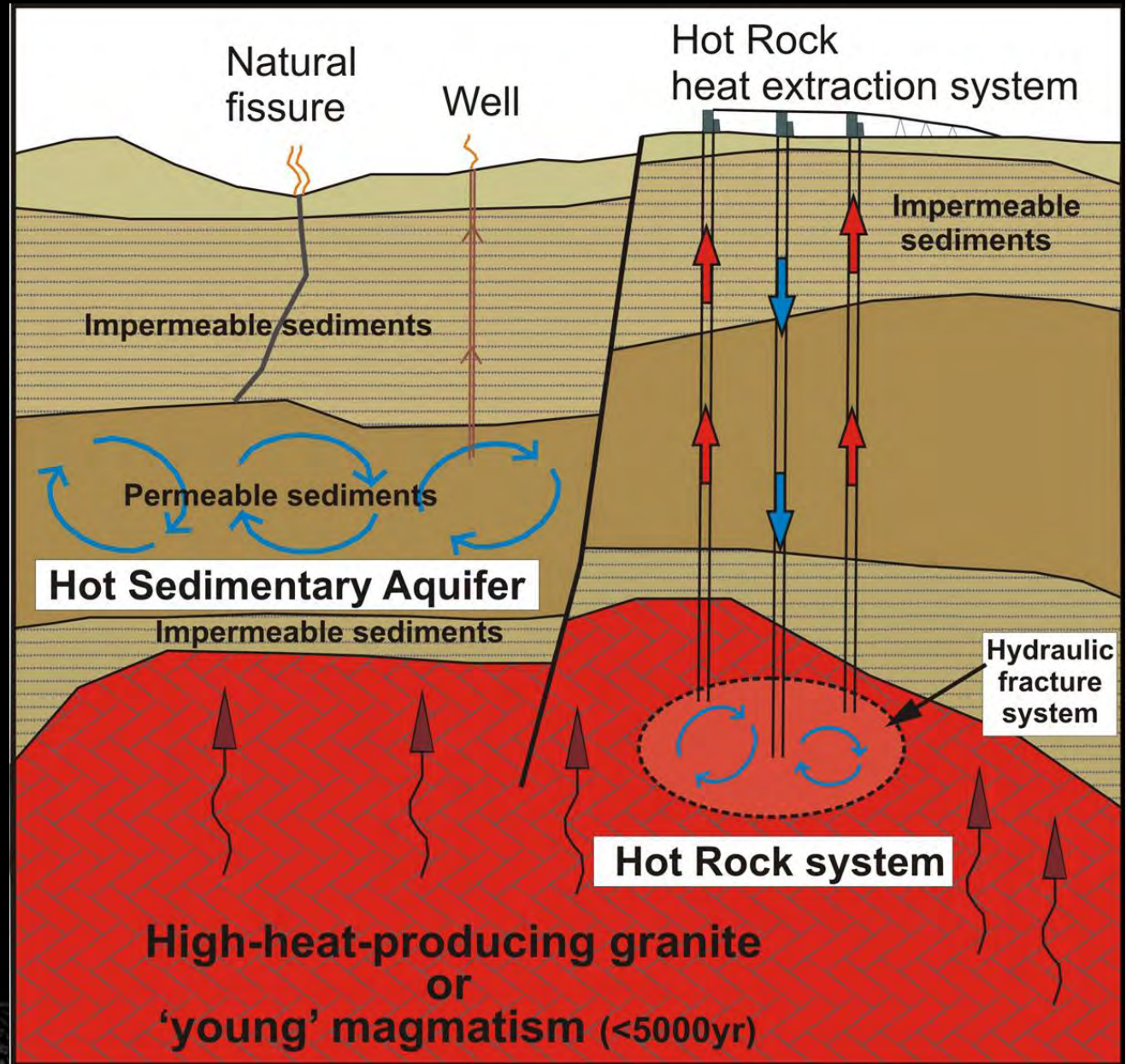
Eye alt 9177.78 km

GEOSCIENCE AUSTRALIA

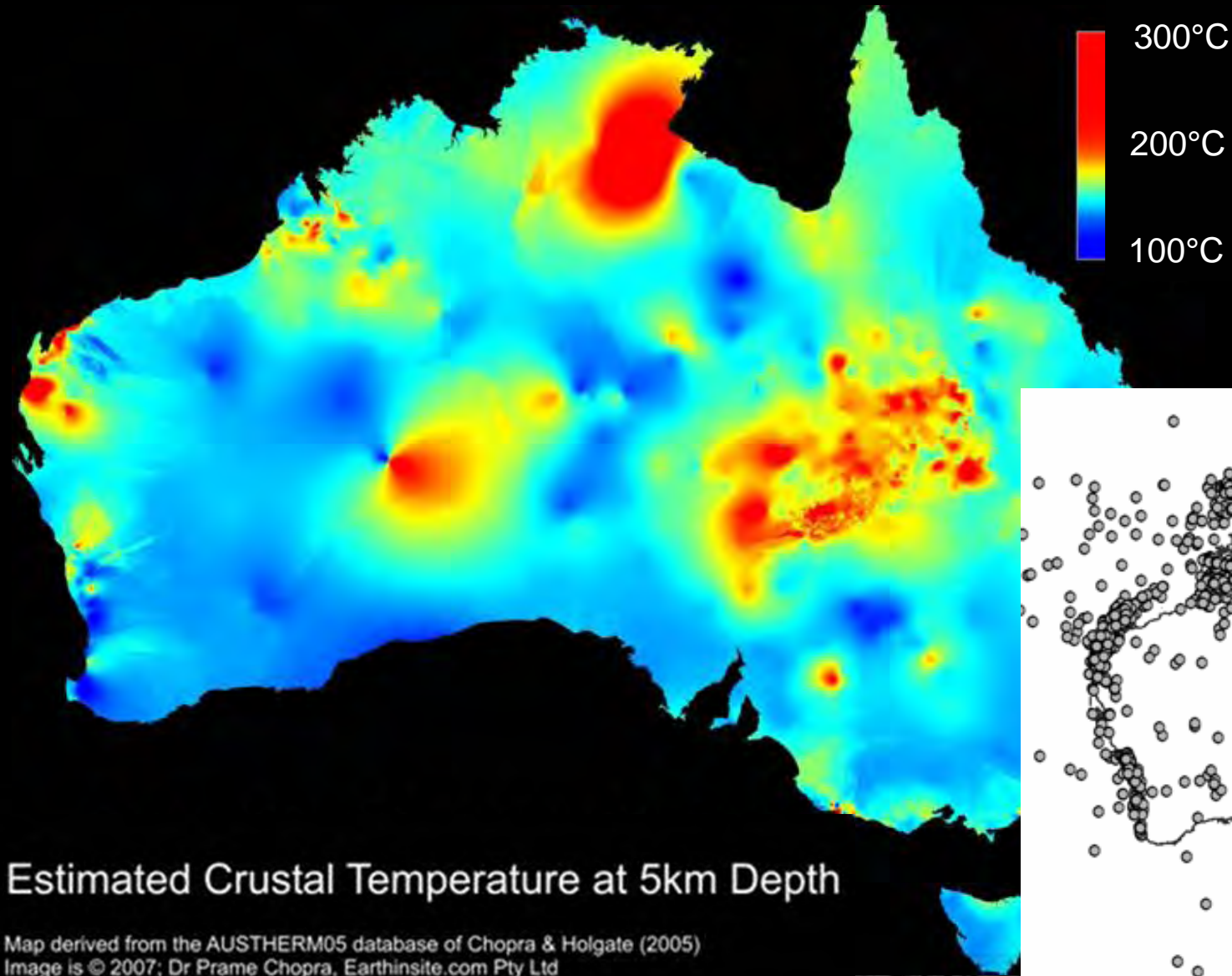
Geothermal systems in Australia

Hot Rock + Hot Sedimentary Aquifer

- High-heat-producing basement enriched in U, Th & K, and overlain by thermally-insulating sediments
- 'Blind' geothermal resources
- Exploration requires borehole temperature measurements, and/or heat-flow data



Temperature at depth in Australia



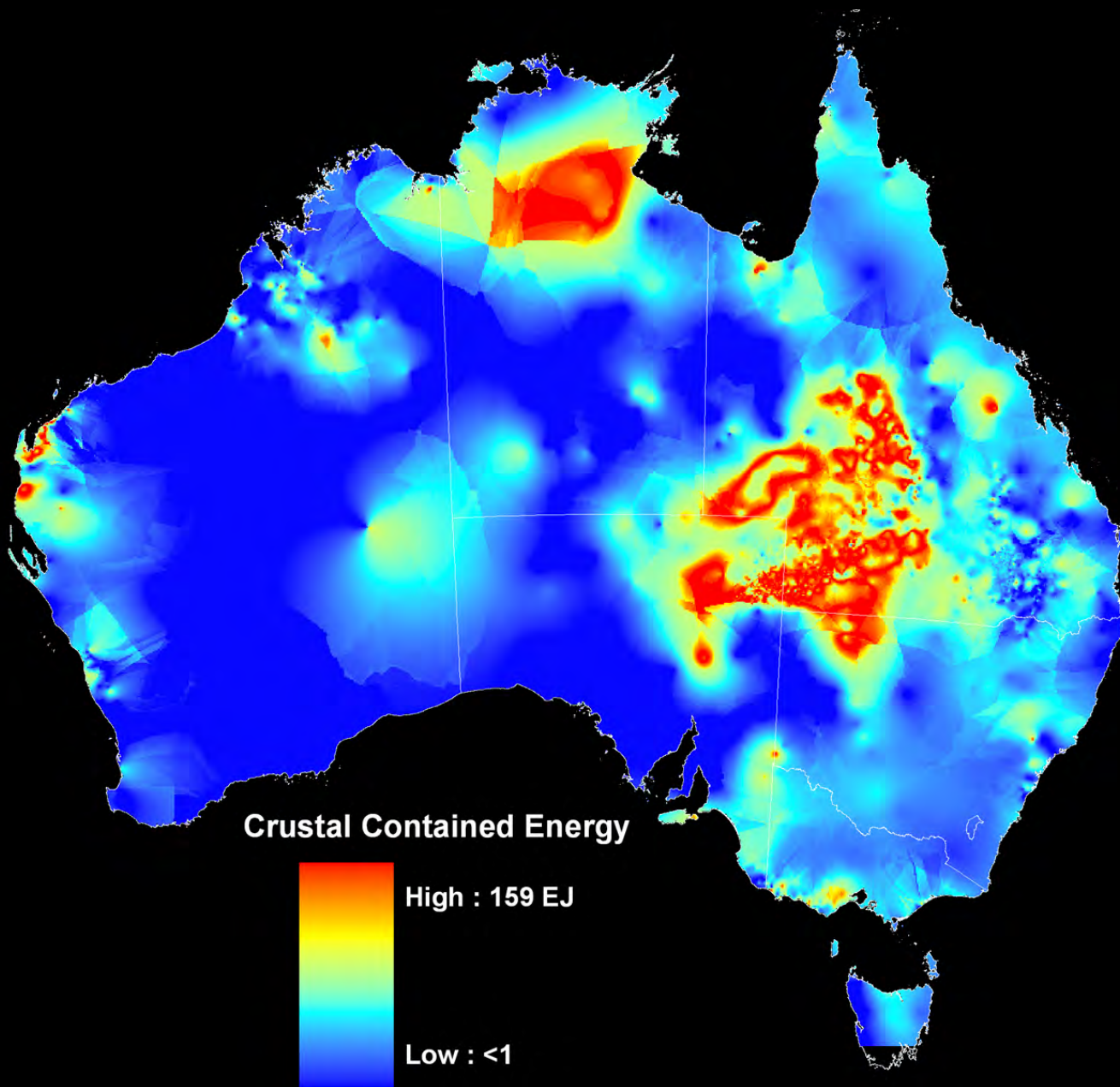
An enormous resource potential

In 2007 Geoscience Australia estimated that the “high-grade” Geothermal Energy contained in the Australian Crust at depths less than 5km was of the order of

1.9×10^{25} Joules

Just 1% of this value is equal to 25,000 times Australia’s total energy consumption in the FY 2004-2005

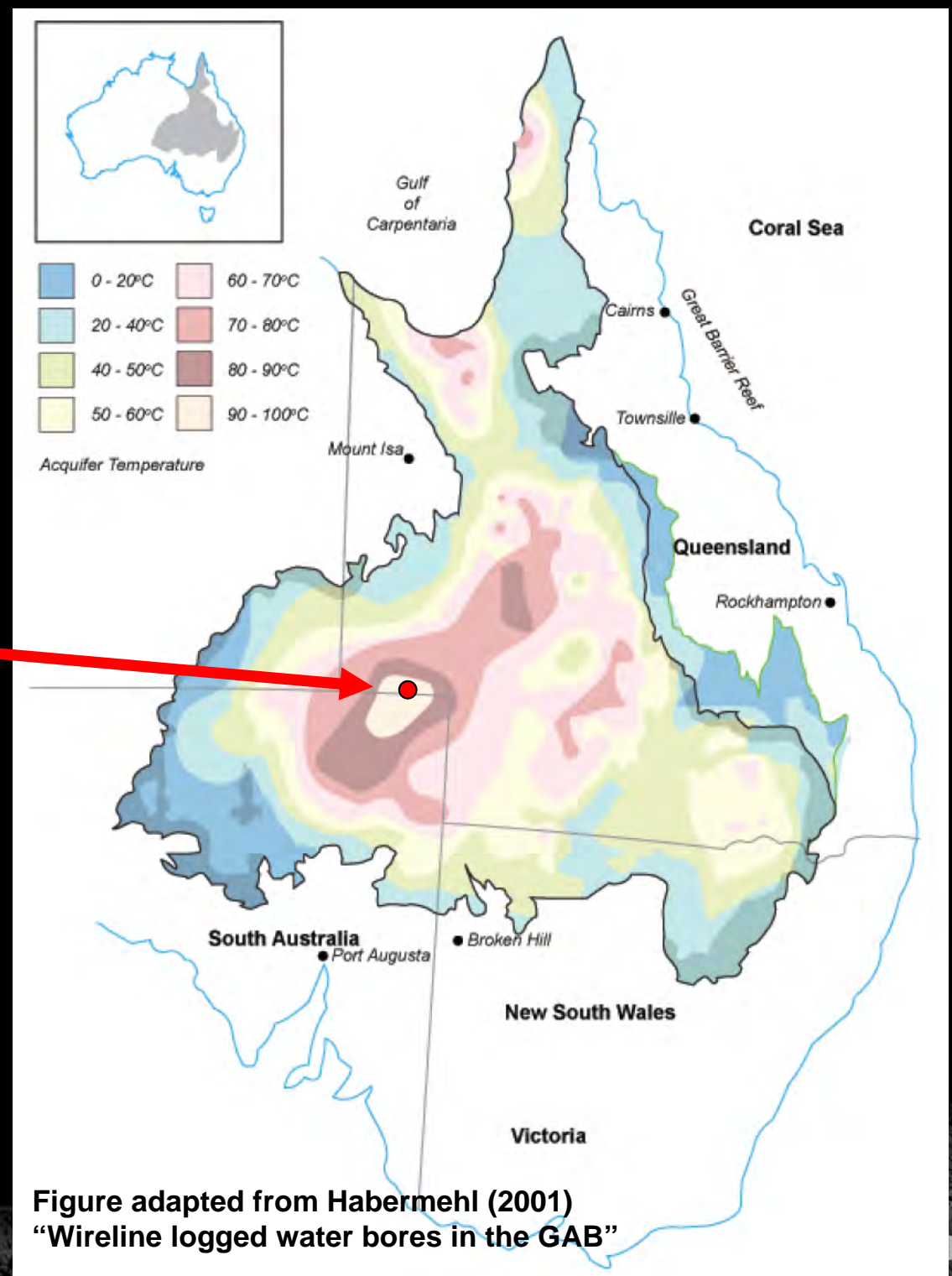
[Value is calculated on a 5 x 5 km grid for areas of crust above 5 km and 150°C. It does not take into account renewability or heat contained at depth]



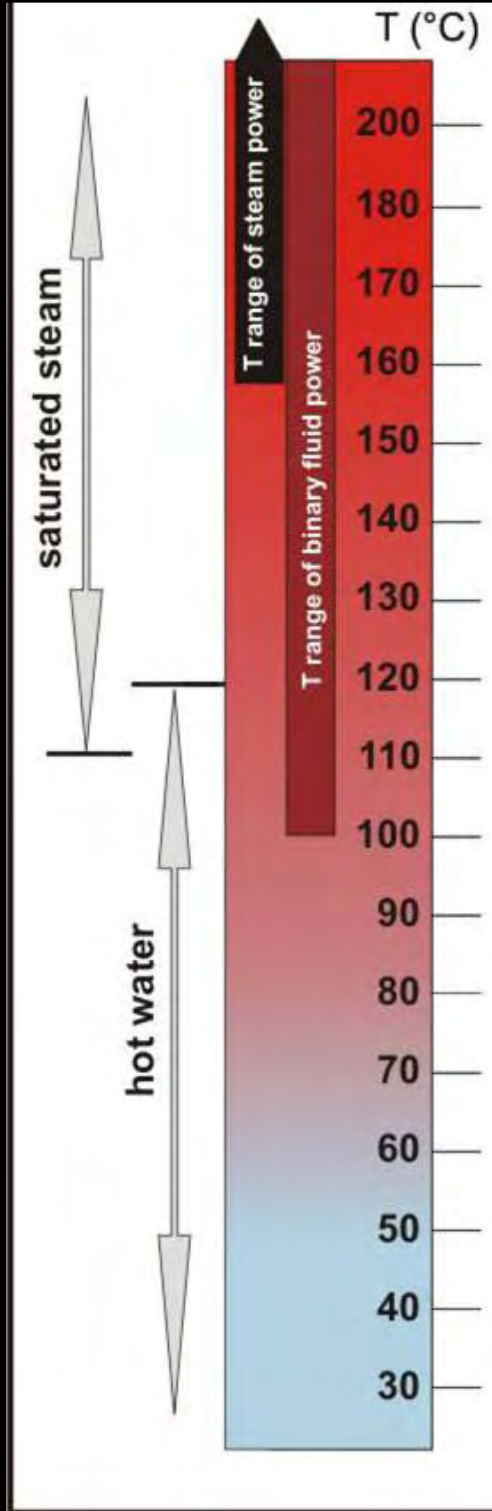
Great Artesian Basin

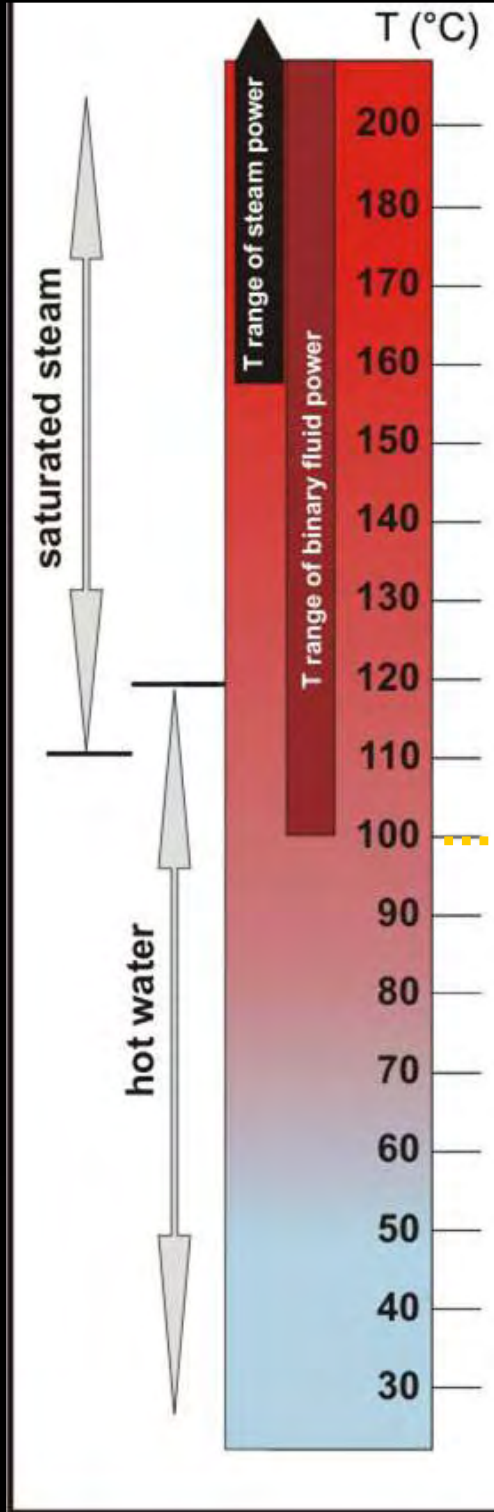
(Hot Sedimentary Aquifer)

- Water temperatures up to 100°C
- Birdsville geothermal power plant uses this water → 80kW



Geothermal resource temperature





Electricity generation

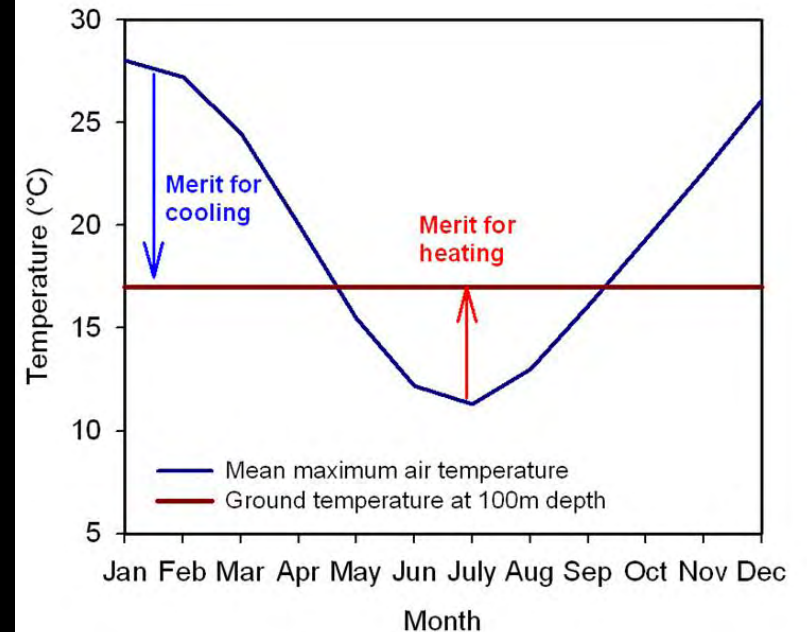
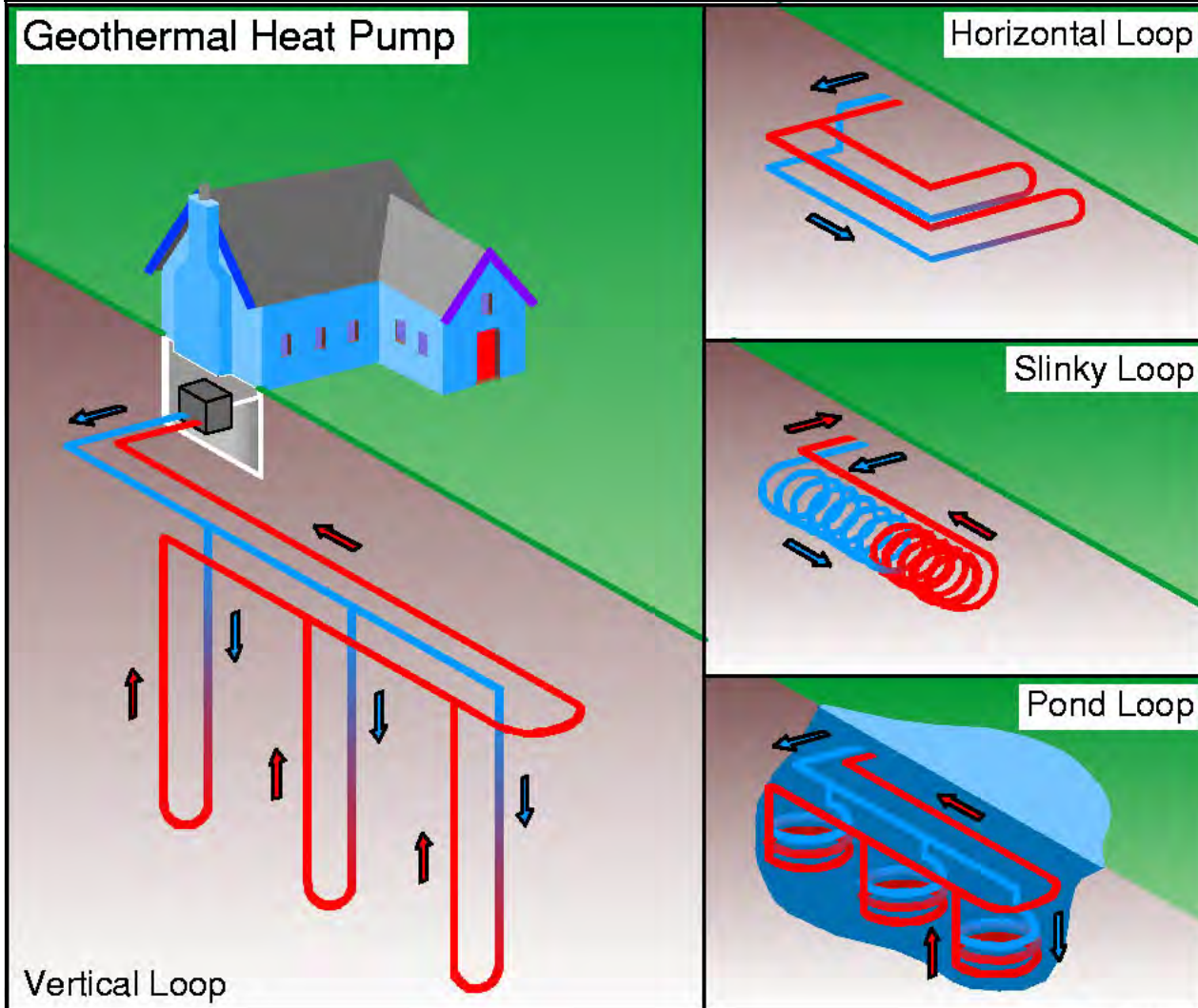
Direct use

Ground source heat pumps

Existing geothermal in Australia

- Birdsville geothermal power plant ($T = 100^{\circ}\text{C}$, 80kW net electricity)
- Portland district heating system ($T = 58^{\circ}\text{C}$)
- Spas/balneology – Mornington Peninsula, VIC, Moree and Lightning Ridge, NSW ($T = 41^{\circ}\text{C}$)
- Pool heating – Challenge Stadium (Perth) ($T = 42^{\circ}\text{C}$; pool $T = 26.5^{\circ}\text{C}$)
- Ground-source heat pumps (e.g. Geoscience Australia, Hobart Aquatic Centre, Antarctic Centre)

Ground Source Heat Pumps



Seasonal temperature variations in Canberra compared to ground temperature at ~100m depth.

(Climate data courtesy of the Bureau of Meteorology

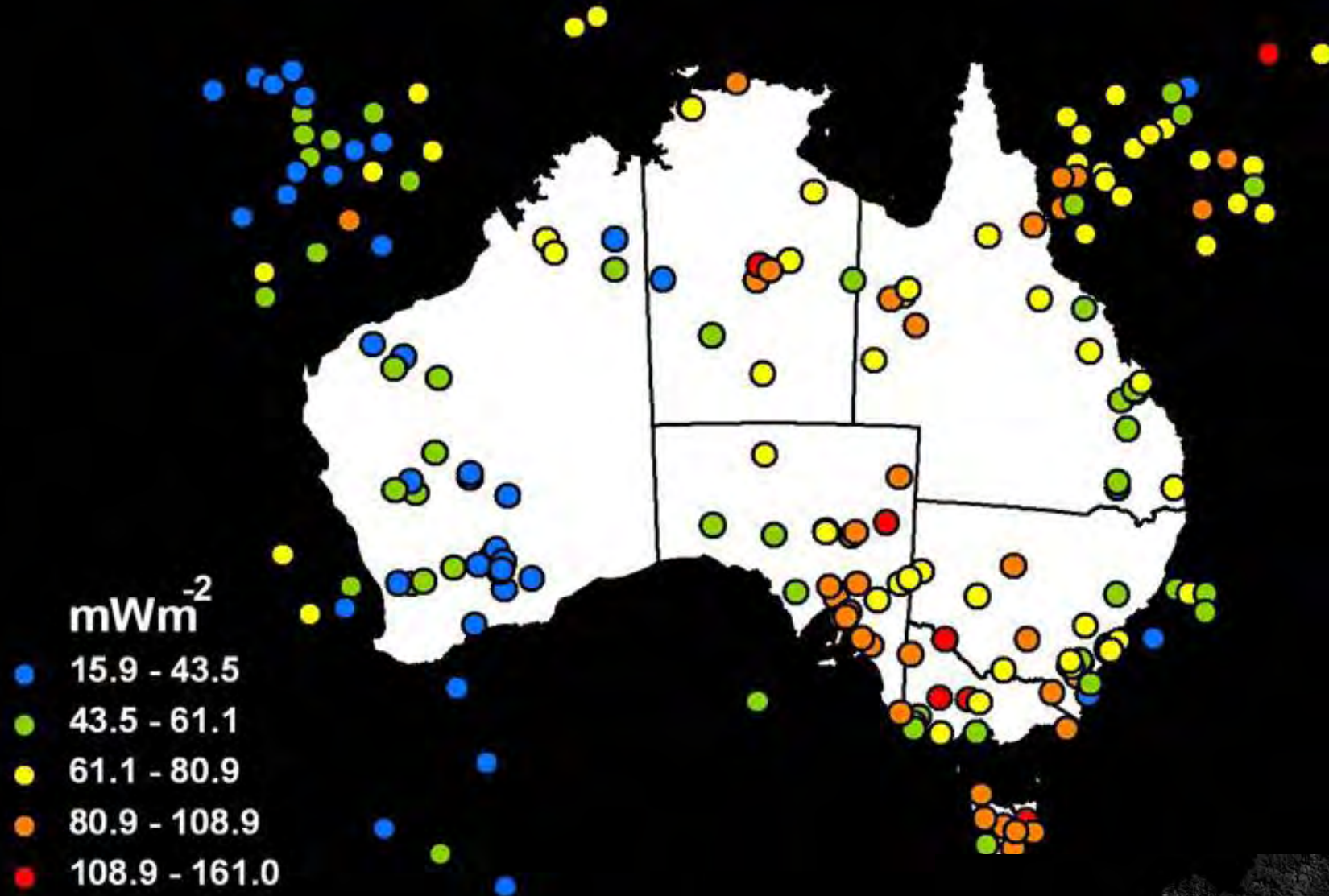
<http://www.bom.gov.au/climate/averages/>).

Geoscience Australia – savings of \$40,000 per year

Geoscience Australia: the OESP

- Provision of pre-competitive geoscience data to industry
- Onshore Energy Security Program: \$58.9 million over 5 years to better understand Australia's potential for onshore energy resources: U, Th, petroleum & **geothermal**.
- Geothermal project priorities:
 1. Map temperature across the Australian continent
 2. Collect new heat flow data
 3. 3D source-trap modelling
 4. Build a geothermal information system

Existing heat flow measurements



New heat flow measurements

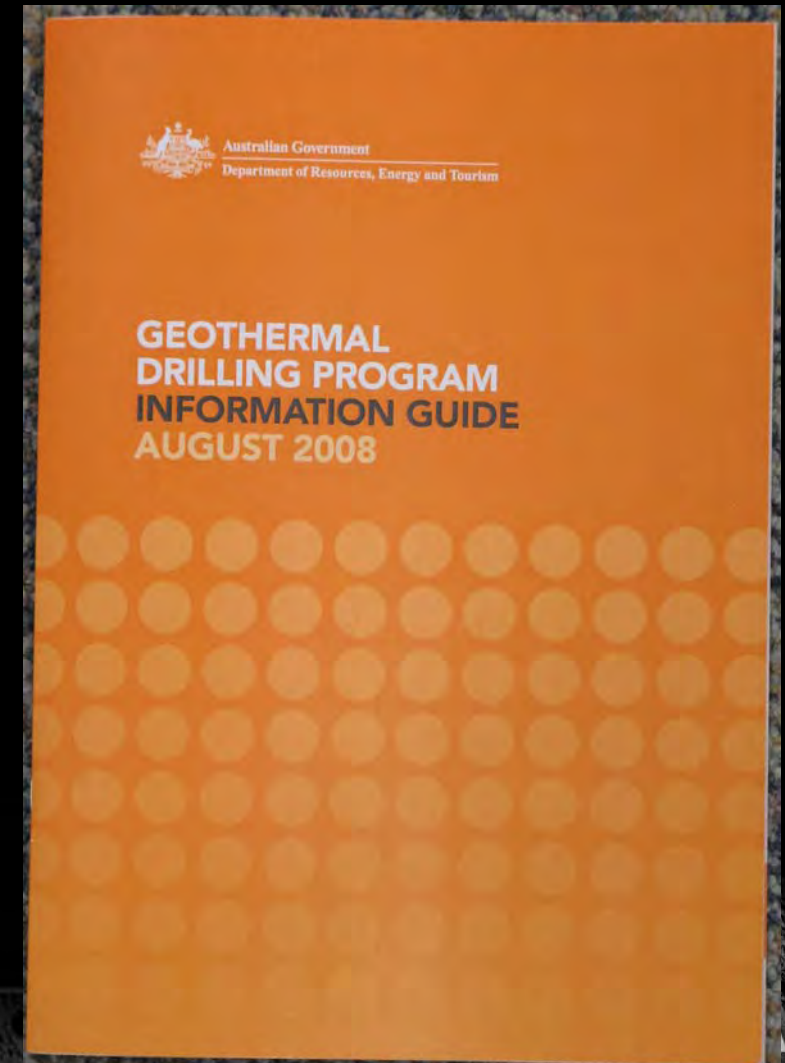


**Thermal gradient
1,800 m cable, 70°C
max temperature**

Geothermal Drilling Program

(Department of Resources, Energy & Tourism)

- AUD \$50 M program
- Proof-of-concept projects = demonstrating circulation between two wells and the surface, hydrofracturing
- AUD \$7 M maximum per project, matching funding (= ~7 projects)
- *Inferred Geothermal Resource*
- Round 1 applicants awarded early 2009 (Petratherm + Panax)
- Round 2 closed 4th August 2009



Geoscience Australia:
Onshore Energy Security Program
(Part of AUD \$58.9M)

Geothermal Industry
Development Framework;
Geothermal Technology Roadmap

Geothermal Drilling Program
(AUD \$50M)

Geothermal Industry

International Partnership
for Geothermal Technology

Renewable Energy
Grant Programs
(R&D Start, REEF, REDI)
(~AUD \$32M)

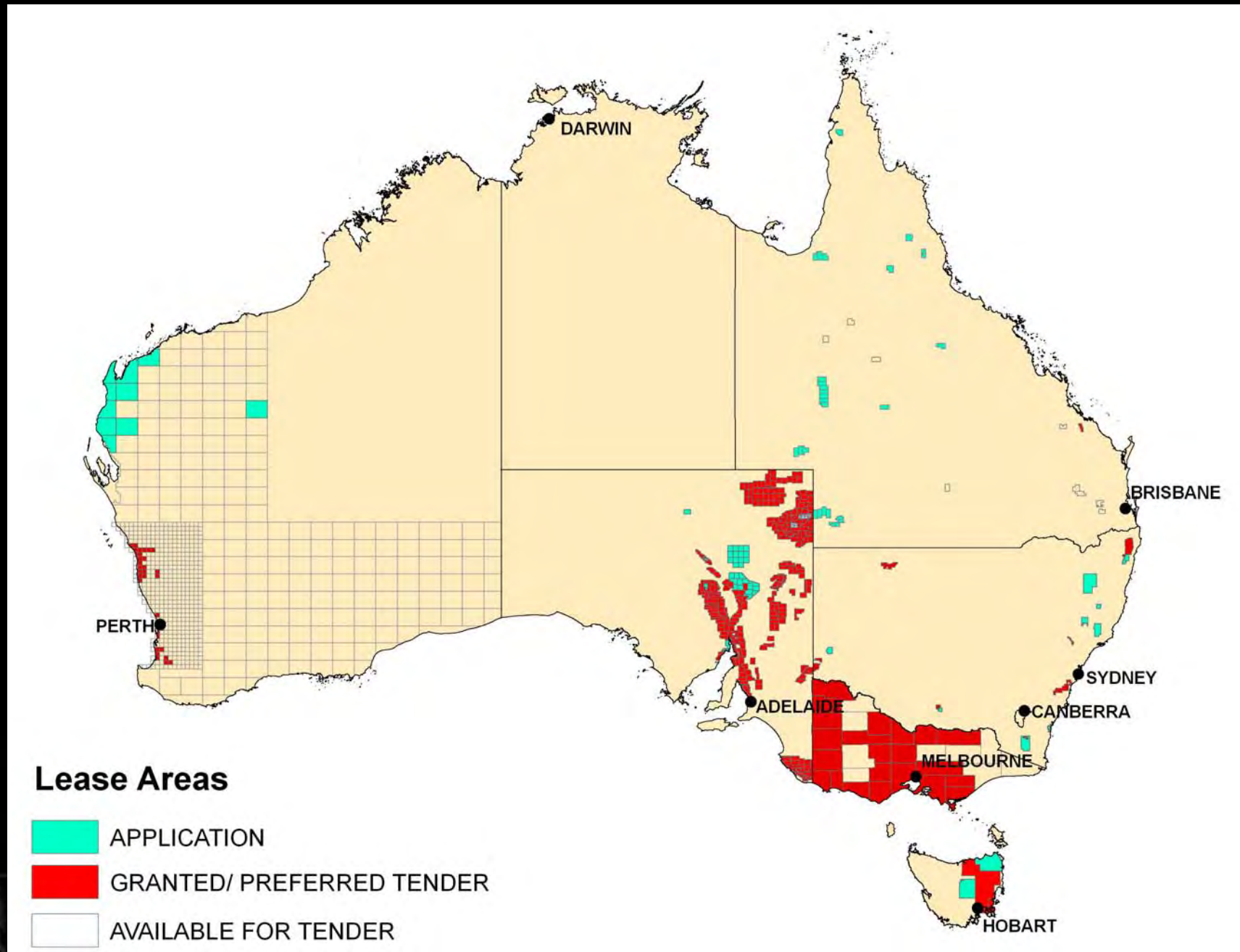
State Government funding **(~AUD \$18M)**
- WA geothermal Centre of Excellence
- Qld geothermal energy Centre of Excellence
- University of Adelaide
- PIRSA - PACE grant scheme

Renewable Energy Demonstration Program
AUD \$435M
Clean Energy Program: **AUD \$50M**

Status of Australia's geothermal industry

- 48 companies now registered, 10 on the ASX
- 385 exploration licenses/applications
- 360,000 km² acreage under exploration
- Predominantly looking at electricity generation, but interest in direct-use projects also
- No companies at proof-of-concept yet
- Most companies at exploration stage

Geothermal Exploration



Industry progress



GEODYNAMICS LIMITED
POWER FROM THE EARTH

- 1 MW by late 2009
- 50 MW by late 2011
- >5000 MW long term



Images courtesy of Geodynamics Ltd

Industry progress



- Proof of concept late 2010
- 7.5 MW pilot plant to supply Beverley Uranium mine
- Future: >500 MW (Olympic Dam?)



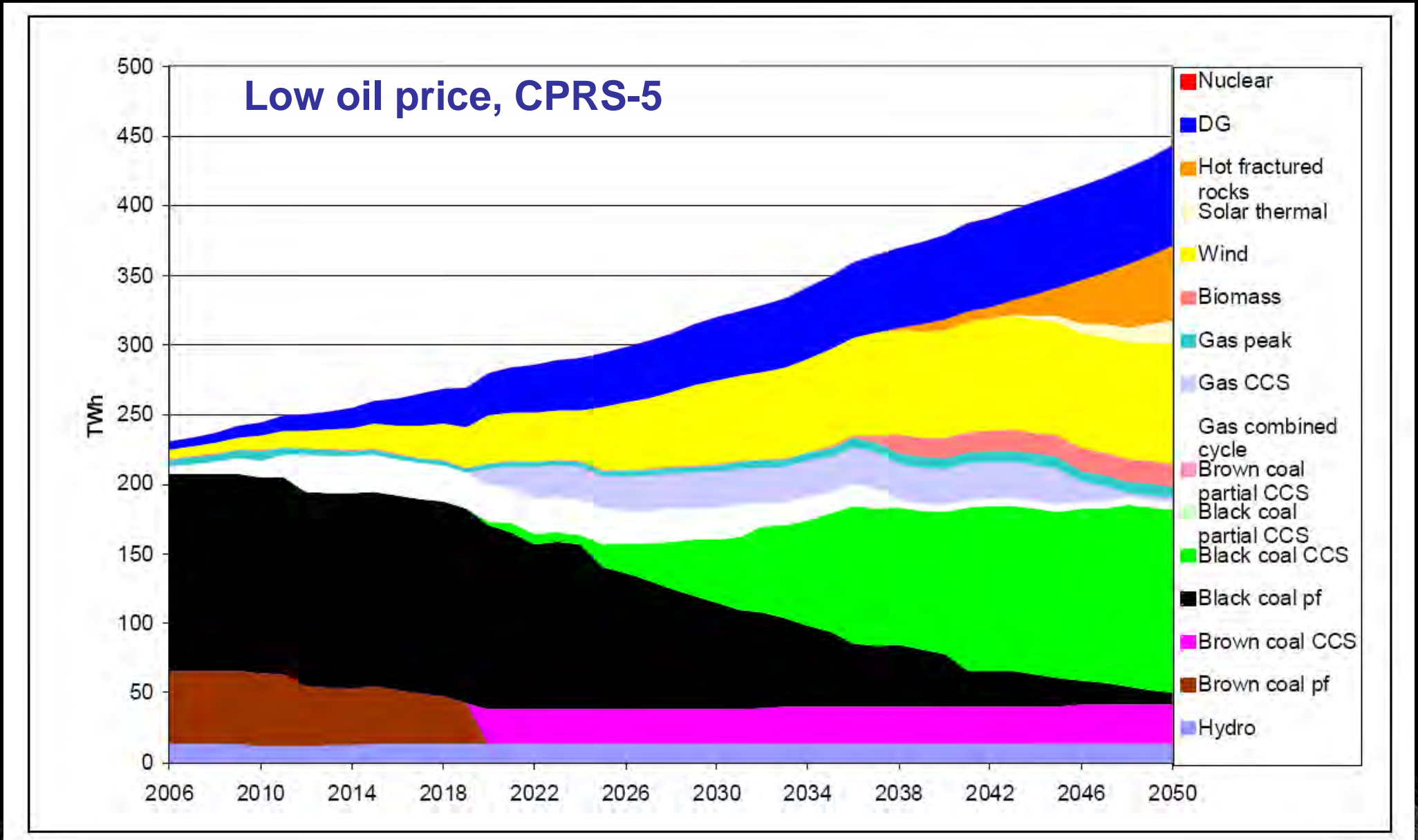
Images courtesy of Petratherm Ltd

ALIA

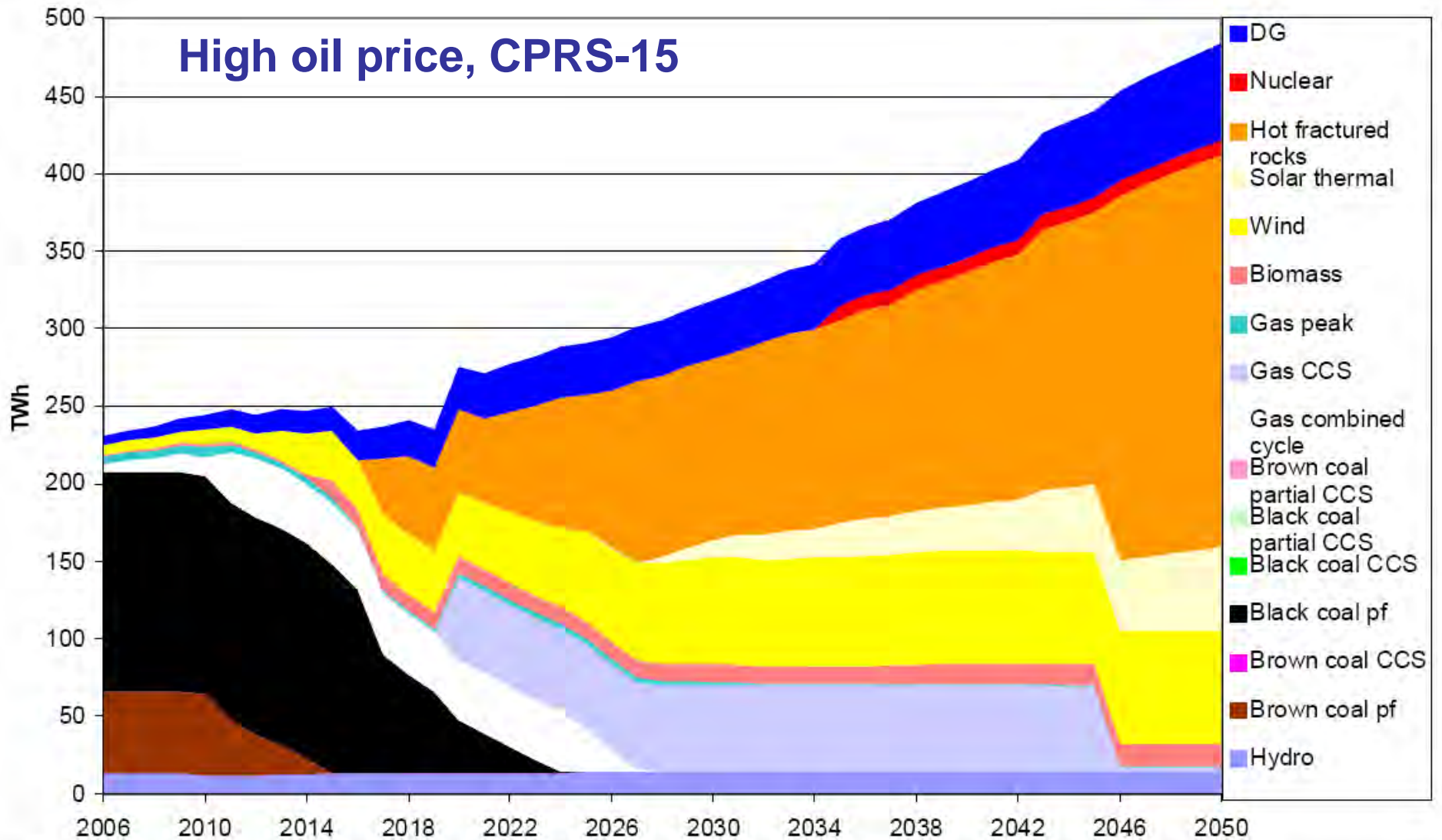
Future projections

- Renewable energy target: 20 per cent of the nation's electricity to come from renewable sources by 2020.
- MMA 2008 report “Installed capacity & generation from geothermal sources by 2020”:
 - **1000 MW** operating baseload geothermal power by 2020; Upper estimate is 2200 MW
 - Levellised generating costs estimated as **~ \$150/MWhr** for pilot plants (<10 MW), **~\$105/MWhr** for demonstration plants (10-50MW), and **\$90/MWhr** for commercial plants (~300MW)
 - Total investment to 2020 may be **~\$12 billion**

Future projections



Future projections



Source: CSIRO 2008 report "Modelling the future of transport fuels in Australia"