Hot Rock Limited

A Review of Current Geothermal Development Activities in the Otway Sedimentary Basin, Victoria, Australia

Peter Barnett and Kerry Burns

SMU Conference, Dallas

17-18 June, 20088

Australia’

Strong drivers for geothermal development in Australia

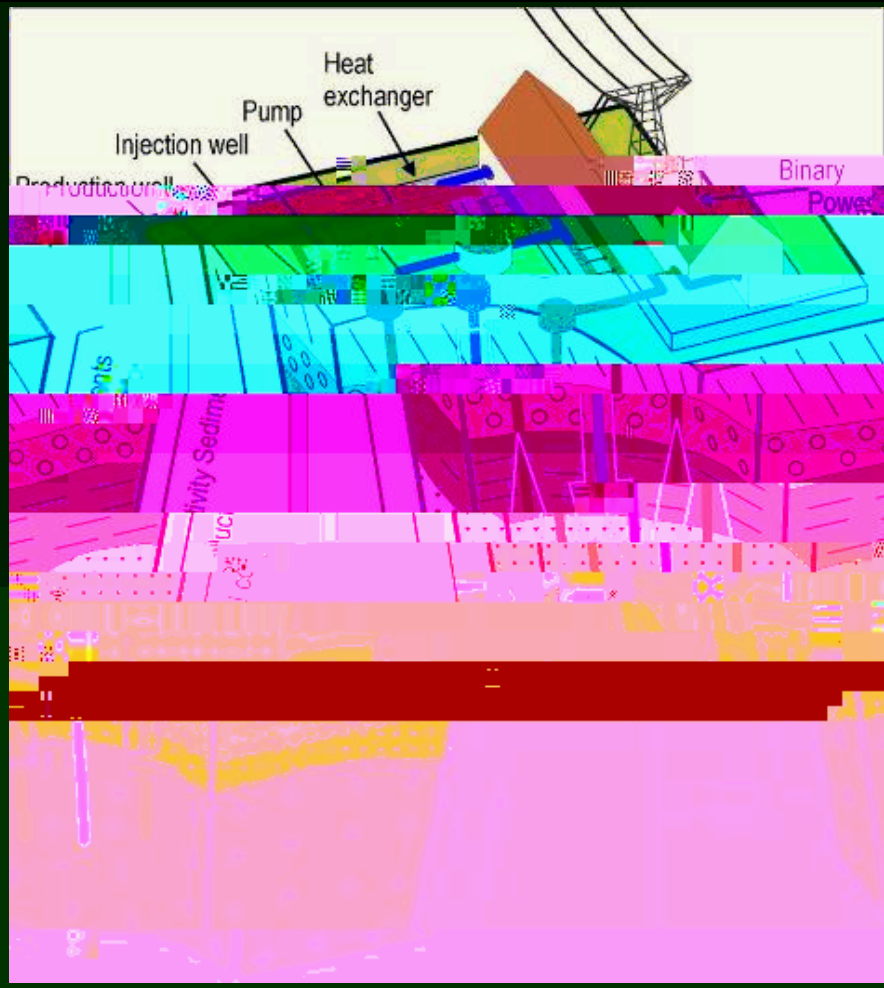
- **Vast sources of deep heat**
  - In granites
  - In wet and dry sedimentary rocks above the granites
- **Pioneering "EGS" work by Geodynamics**
  - Cooper Basin
  - the 'right' tectonic environment
- **Recent strong Government support for renewables**
  - Reduction of large carbon footprint
    - Wind
    - Geothermal
    - Solar
    -

Rapidly growing private sector involvement in geothermal

Geothermal Stocks	ASX	Price	Shares (m)	Options (m)	Mkt Cap ($m)	Area	Model
Geodynamics	GDY	$1.55	211.6	4.0	334	SA/NSW	HDR
Eden Energy	EDE	$0.34	166.8	86.5	86	Focus on hydrogen	HDR
Petratherm	PTR	$0.85	57.9	13.1	60	SA/Spain	HDR/HWR
Geothermal Resources	GHT	$0.66	33.0	1.8	23	SA	HDR
Torrens Energy	TEY	$0.40	50.1	28.2	31	SA	HDR

Types of Australian Geothermal Resources

- High temperature granites >200°C
  - Naturally impermeable / require fracturing
  - "HDR" / "HFR" / "EGS"
- Moderate temperature sedimentary, 100–200°C
  - Naturally permeable
    - "HWR", "SG"
  - Naturally impermeable
    - thermal insulators above granites
      - "HEWI" (Petratherm) "EGS"



HRL focus is on "Sedimentary Geothermal"

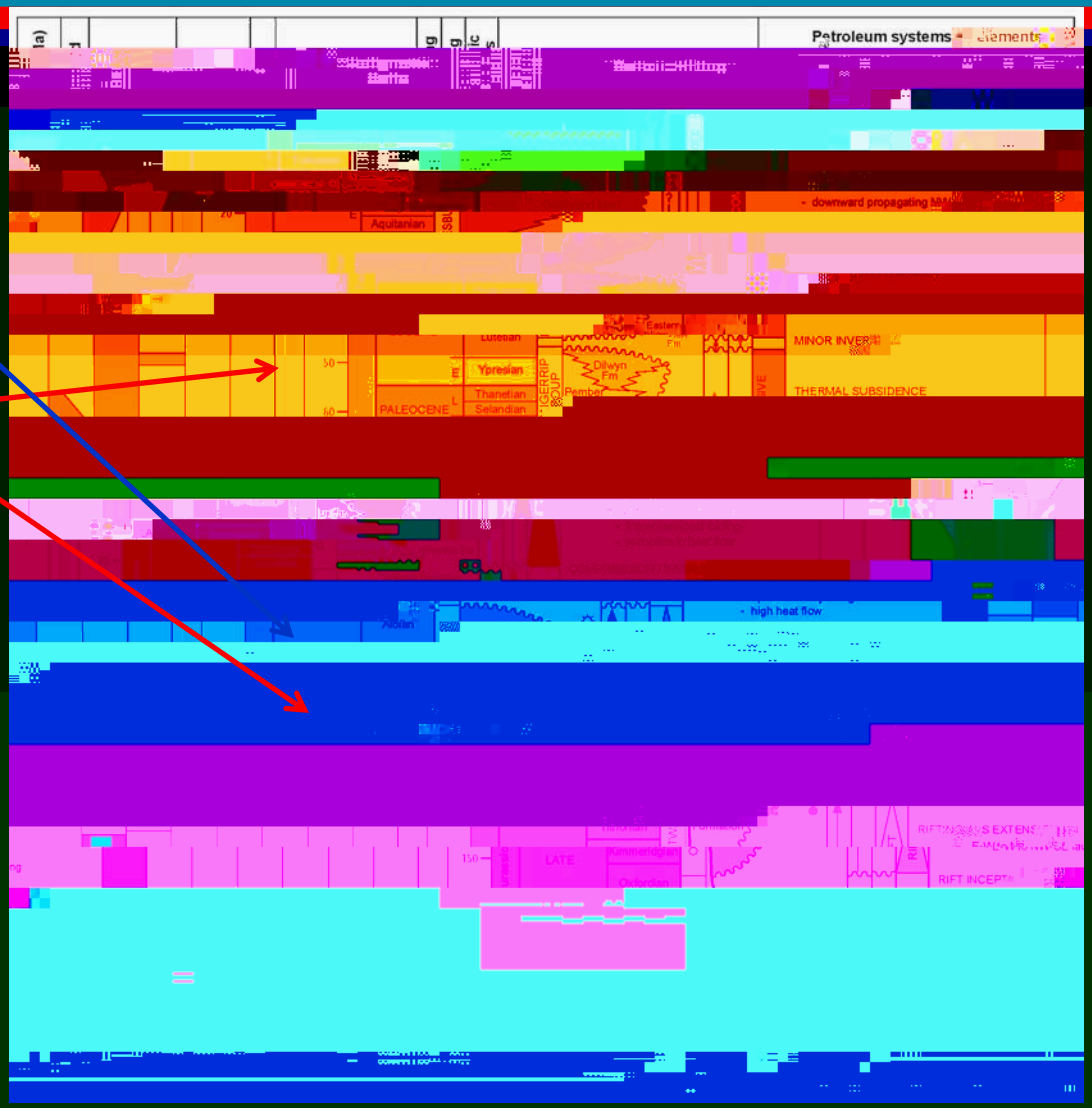
- Naturally permeable systems
  - Don't require hydro fracturing
- Naturally wet
  - Don't require injection of water / circulation loop
- Lower development costs due to
  - Shallower production drilling targets
  - Higher well flow rates
- Lower operating costs
  - Reduced parasitic pump costs
- Lower Risk
  - Proven production and power plant technology
  - 100 year history of geothermal electricity generation
    - r.e/MCID 33 >>BDC /CS1 cs 0.604 1 0.396 scn-0.04 0.04 Td0083>TjE

Onshore extent of Otway Basin

Onshore outcrops of Otway Basin sedimentary rocks

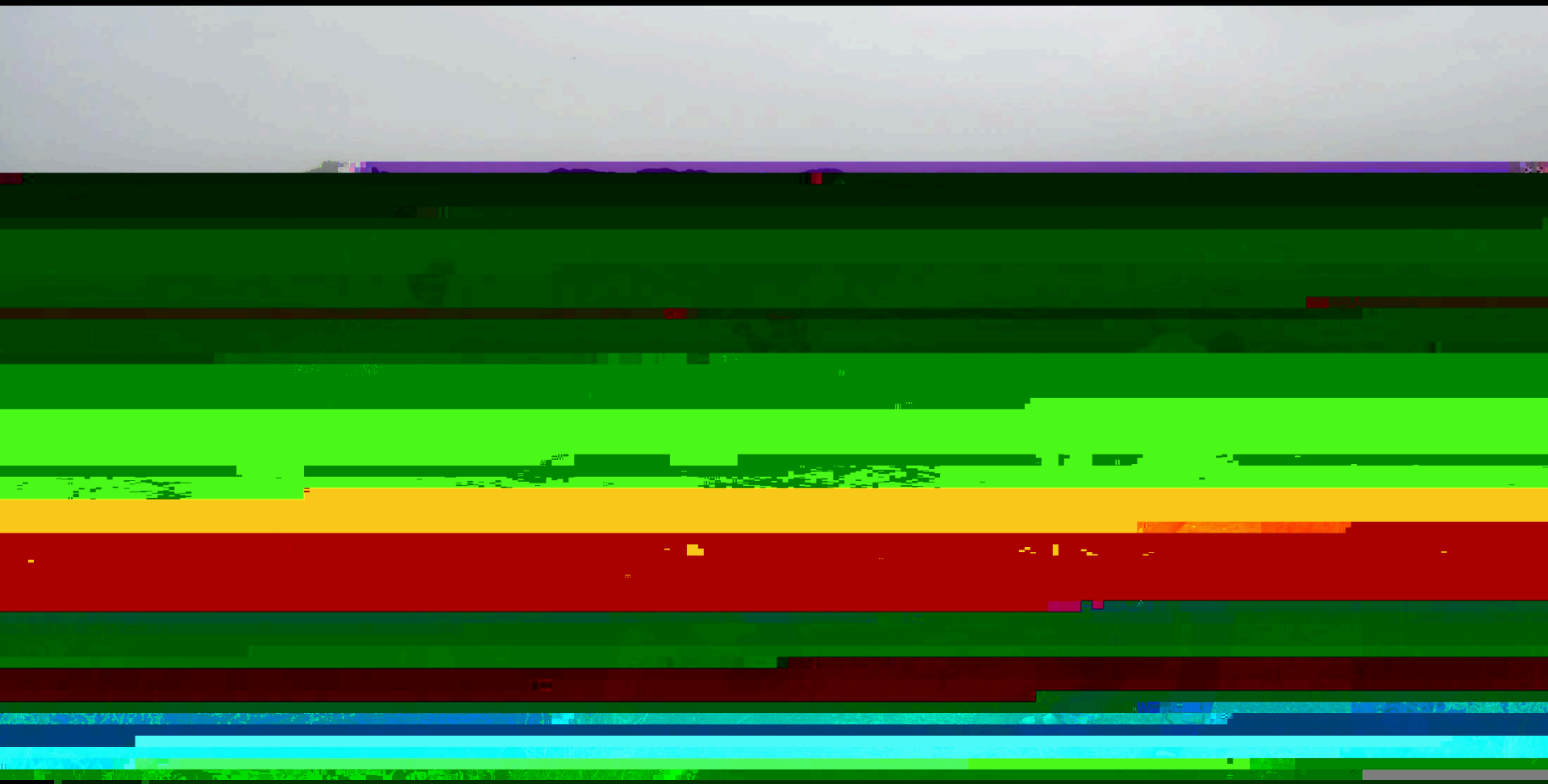
Otway Basin - Stratigraphy

- Thick sequences of:
  - Low permeability msts and zsts (thermal insulation)
  - high porosity / permeability clean ssts
- Crustal thinning as a result of rifting
  - Elevated heat flow
  - Voluminous recent basaltic volcanism



Otway Basin – recent volcanism

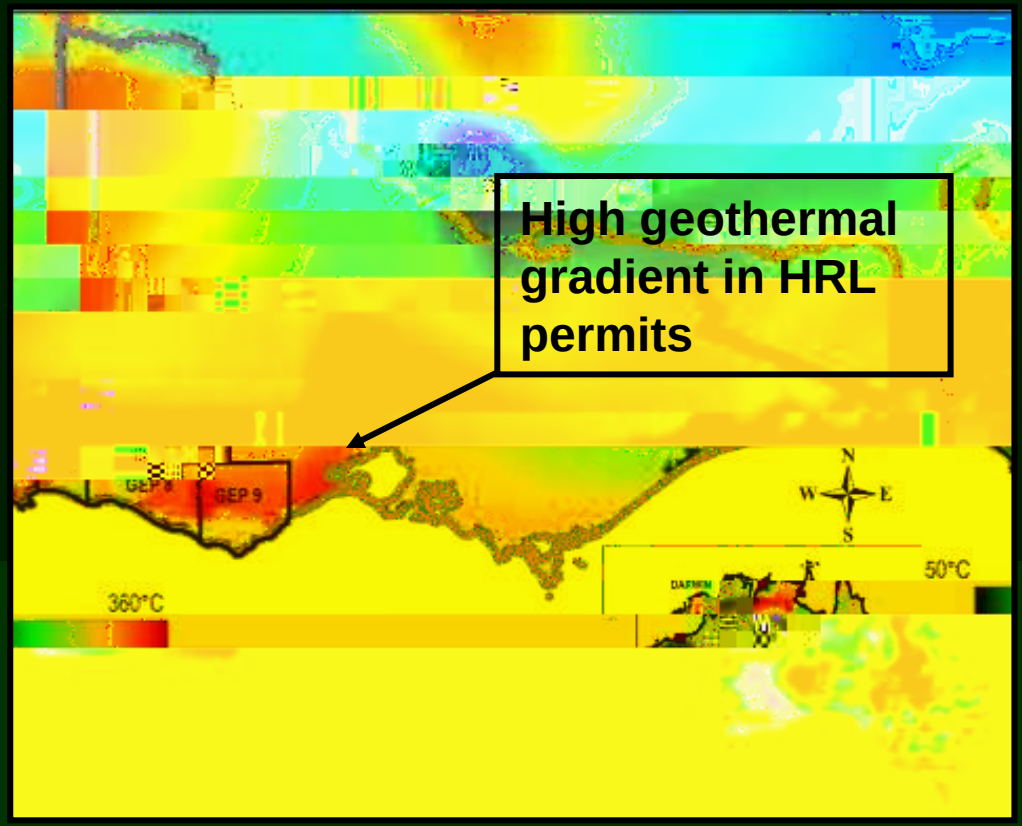
Otway Basin – recent volcanism



Close proximity to markets &

HRL Otway Basin Geothermal Permits

- **4 permits cover large area of prospective Otway Basin (+18,000sqkm)**
- **Anomalous geothermal gradients**
  - Elevated heat flow up through basement
  - Structurally controlled upflows of hot fluids from depth to shallow levels
  - Some association possible with young volcanic



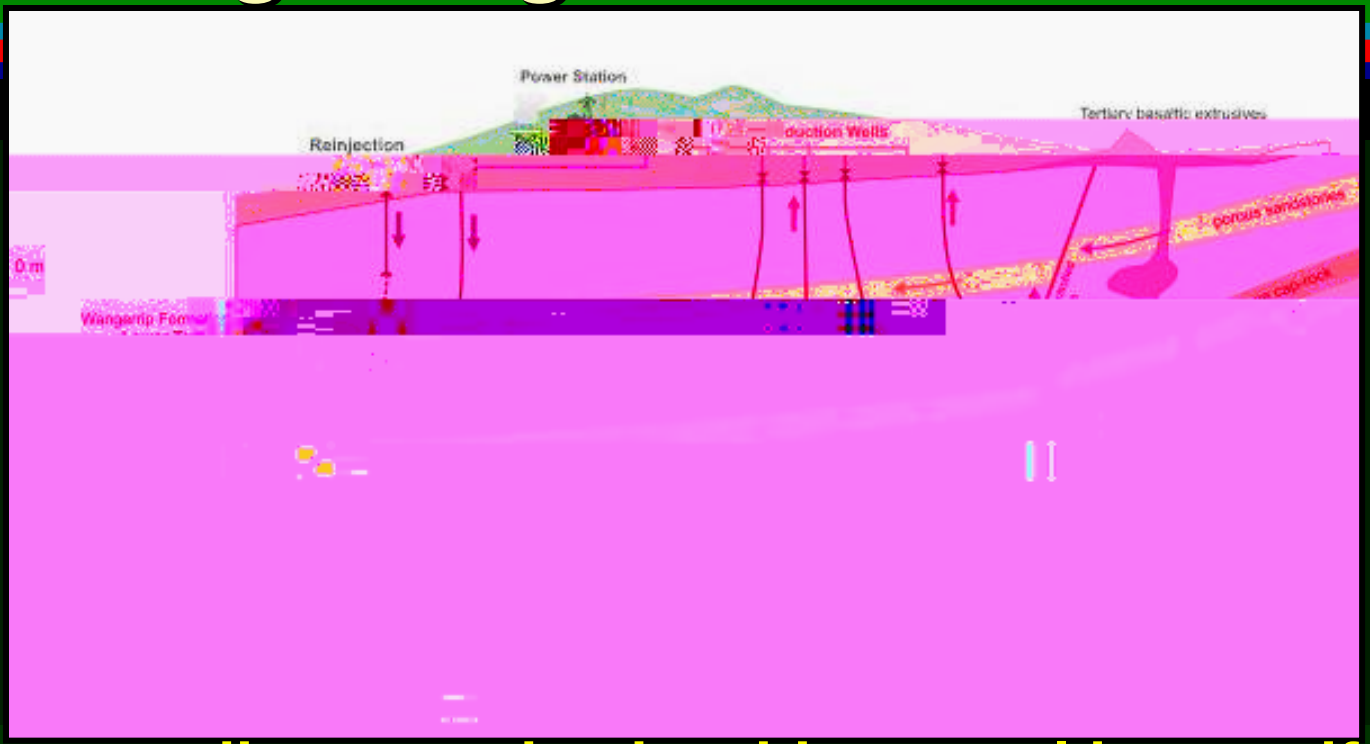
- **Very large amount of surface & sub-surface data exists and is readily accessible**

Invaluable existing exploration and well data

- Decades of active oil and gas exploration

Otway Basin wells - measured temperatures

Otway sedimentary basin hydro-geological model



- **Large sedimentary basin with several hot aquifers**
- **Geothermal reservoir contained in Early Cretaceous Crayfish Group**
  - Up to 800m thick aquifer / High porosity 20% / High perm (1000 mD)
  - Temperatures of at least 142°C + at 2,700m to 3,500m depth
- **Developable with low risk, proven HWR technology**

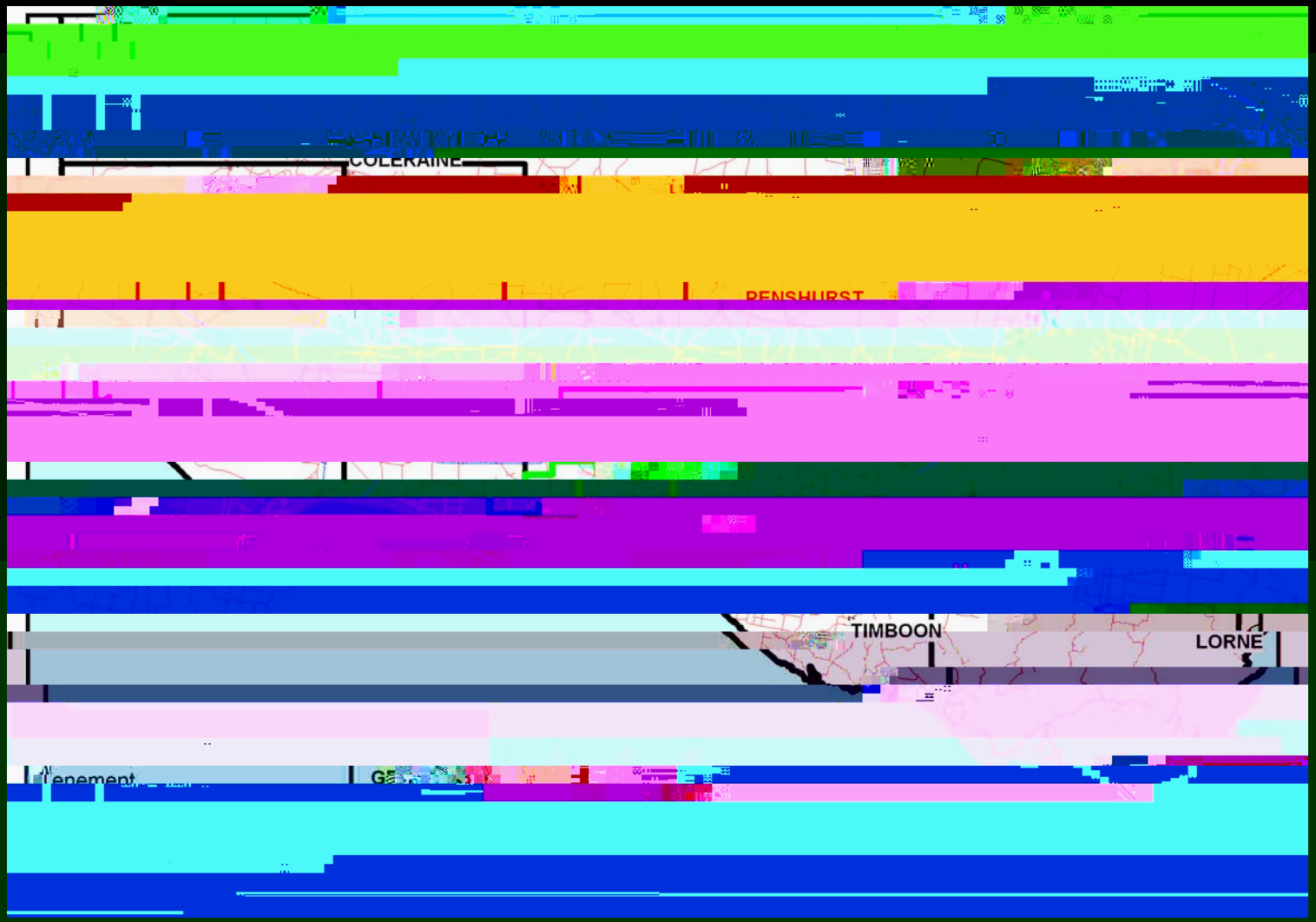
Initial assessment of geothermal resource capacity

- **Volumetric stored heat calculations for 17 geothermal "depo – centres" in 4 GEP's, based on simple conceptual exploration model with conservative assumptions yield:**
  - potential power generation targets ranging from 300 to 720 MWe per prospect, 1750MWe in total
  - 40% of Victoria's base load power
  - potential total annual gross revenues of A$ 1.1billion
- **Suggests initial pilot plant of 1MWe with series of staged subsequent commercial power developments with a capacity of 50 MWe per plant**

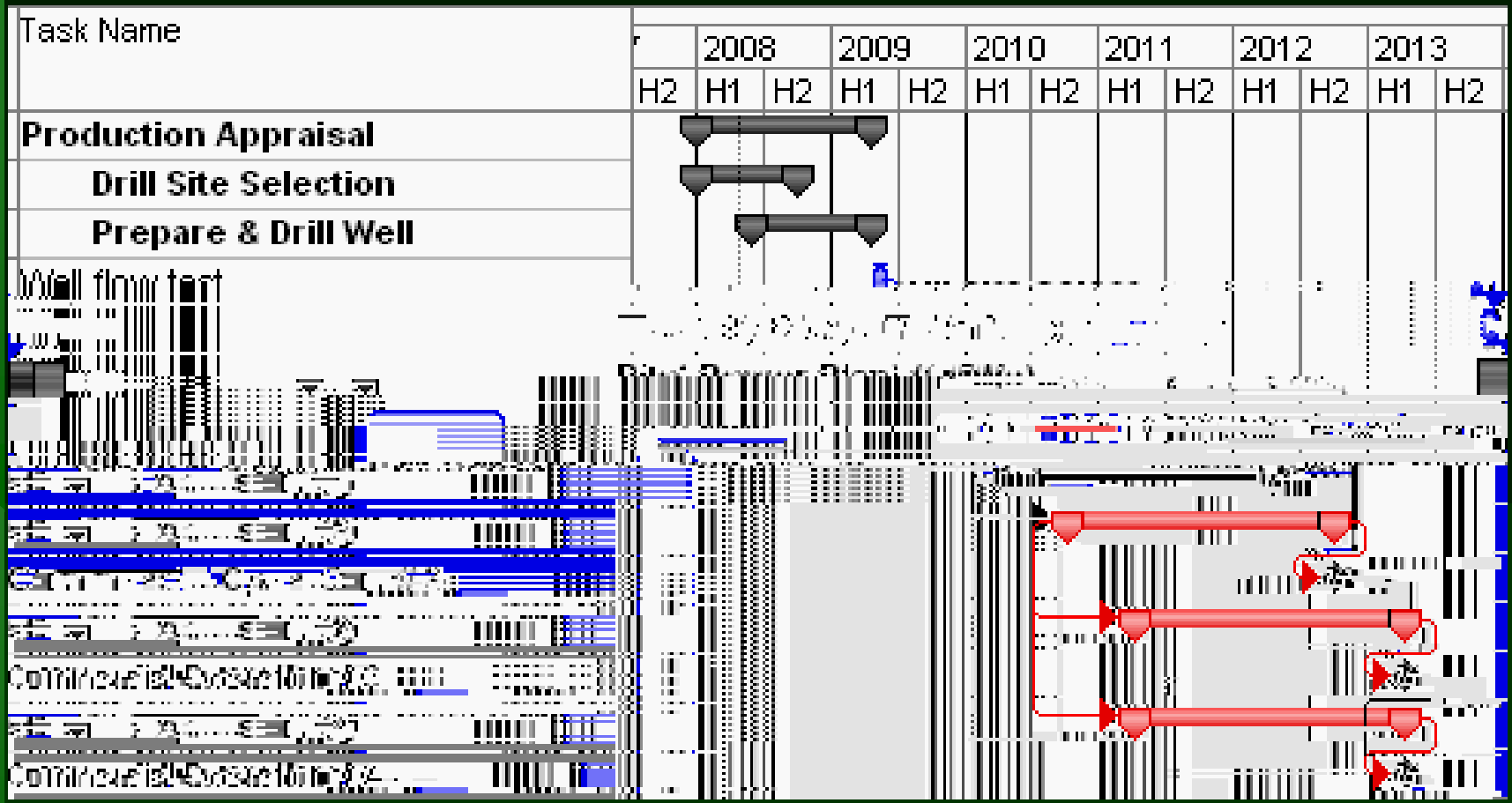
Current Status HRL Program

- O&G data from 4 GEP

Koroit Area:
Priority Development Target



Anticipated Longer Term Program at Koroit: up to 4 x 50MWe by 2013

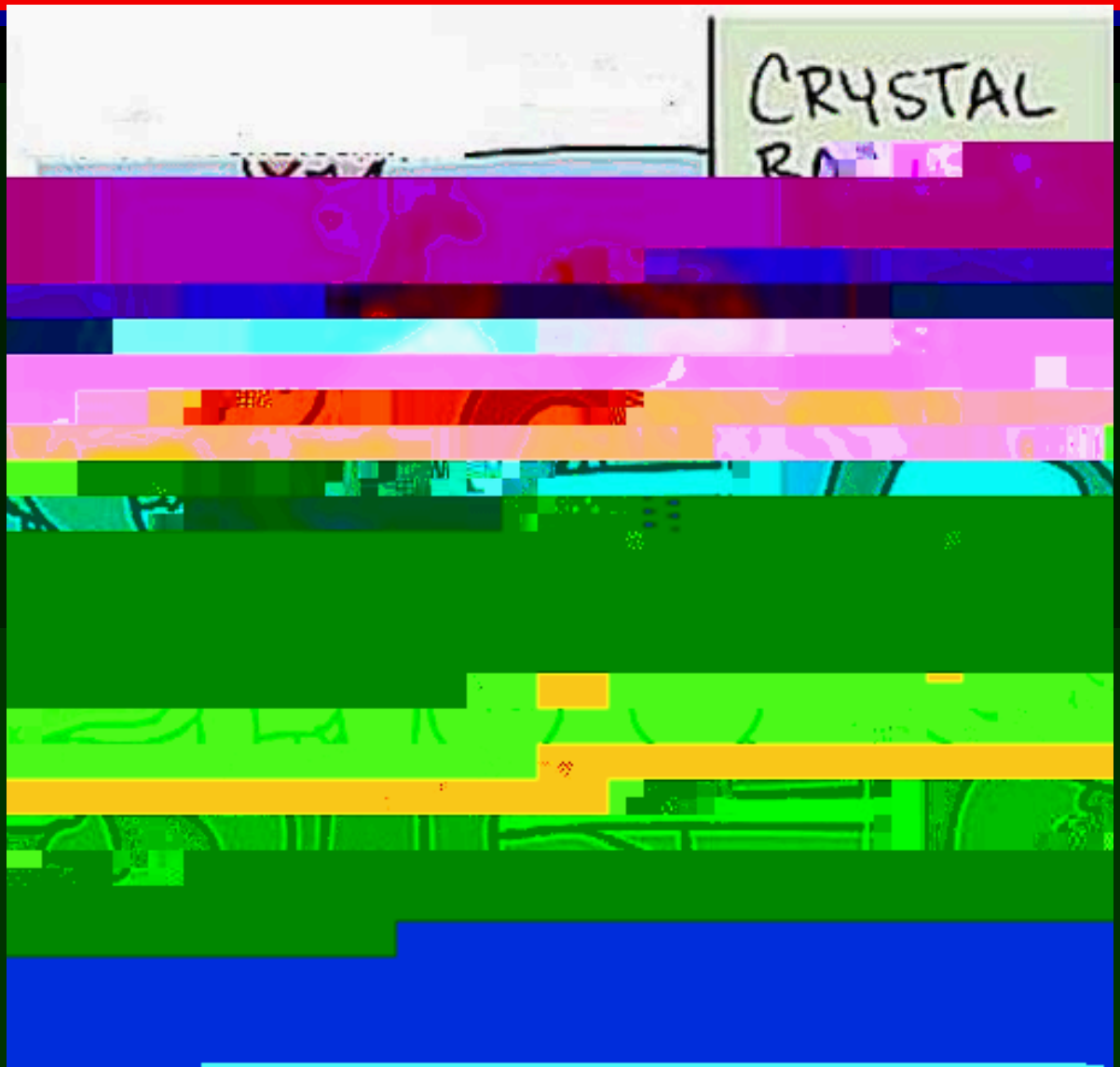


Market Considerations

- Good geothermal market in Victoria
  - For both electricity and cascaded waste heat from power plant
- Potential off-takers:
  - Utilities
    - Local LV (22kV and 66kV) and HV
  - Industrial
    - Alcoa aluminum smelter
    - Dairy Industry (Goulburn Co-op)
    - Portland City (hot water)
    - Timber chip and pulp industry (drying)

Composition of average power price in Australia - 2007 (source BBP)

Development Costs / Costs of Power ?



HRL Development Assumptions

- Production wells
  - depths 3,500m
  - 12-1/4 inch holes to 3500m with 13-3/8 inch PCsg
  - shallow down-well electric production pumps
  - 4 MWe per well production rates
    - 16 wells for 65MWe gross / 50MWe net development
- Injection wells
  - depths 1500m
  - 13 wells required for 50MWe net plant
- Power Plant
  - Organic

Key financial assumptions

Assessed Costs for HRL 65MWe (gross) development

- Capital Cost
  - $US300m
- Specific Capital Cost
  - $US 4,600 / kWe
  - (wells, power plant, transmission)
- **Power tariff**

Incentives – State Level

- Victoria Geothermal Act has no royalty
- VRET Scheme (Jan 2007)
  - State government is committed to reducing Victoria's greenhouse gas emissions to 60% by 2050
  - mandates Victoria's consumption of electricity generated from renewable sources be increased to 10% by 2016
  - objectives to encourage additional generation of electricity from renewable sources.
- Renewable energy fund of $72million (April 08)
  - ex Clinton Foundation
  - to assist large-scale sustainable demonstration energy projects, including geothermal

hotrock

Incentives - Federal Level ..1

- Mandatory Renewable Energy Target (MRET) policy to be introduced to reduce the effects of climate change caused by greenhouse gas emissions
  - Aiming for 2% of Australia's power supply from renewable sources by 2010 and 20% or 42,000 (60,000 ?) Gigawatt hours by 2020.
  - MRET expected to replace VRET

Incentives - Federal Level ..2

- Emissions trading scheme to be introduced 2010
  - Renewable Energy Certificates (RECs) to be issued to eligible parties
  - RECs are sold by the holder to other registered groups and add to the renewable power generators income.
  - fossil fuel generators will need to add the cost of emission certificates to their generating costs
  - a maximum penalty for a power generator not complying with the emission targets is $40 MWh for the power they sell
- These changes are expected to:
  - increase power prices, favouring renewables
  - cause a major shift in investment towards renewable energy sources as it becomes more competitive

Incentives - Federal Level ..3

- Federal government is also in advanced stages of planning for:
  - a $500 million Renewable Energy grant fund
  - includes a $50million drilling fund for geothermal production wells
- Objectives are to:
  - encourage early investment into renewable energy demonstration projects
  - expand the range of renewable technologies

www.hotrockltd.com