

Paralana EGS Project - Findings from the Fracture Stimulation

Reid P.W., Messeiller, M and Llanos, E.M., *Australian Geothermal Energy Conference* , November 2011



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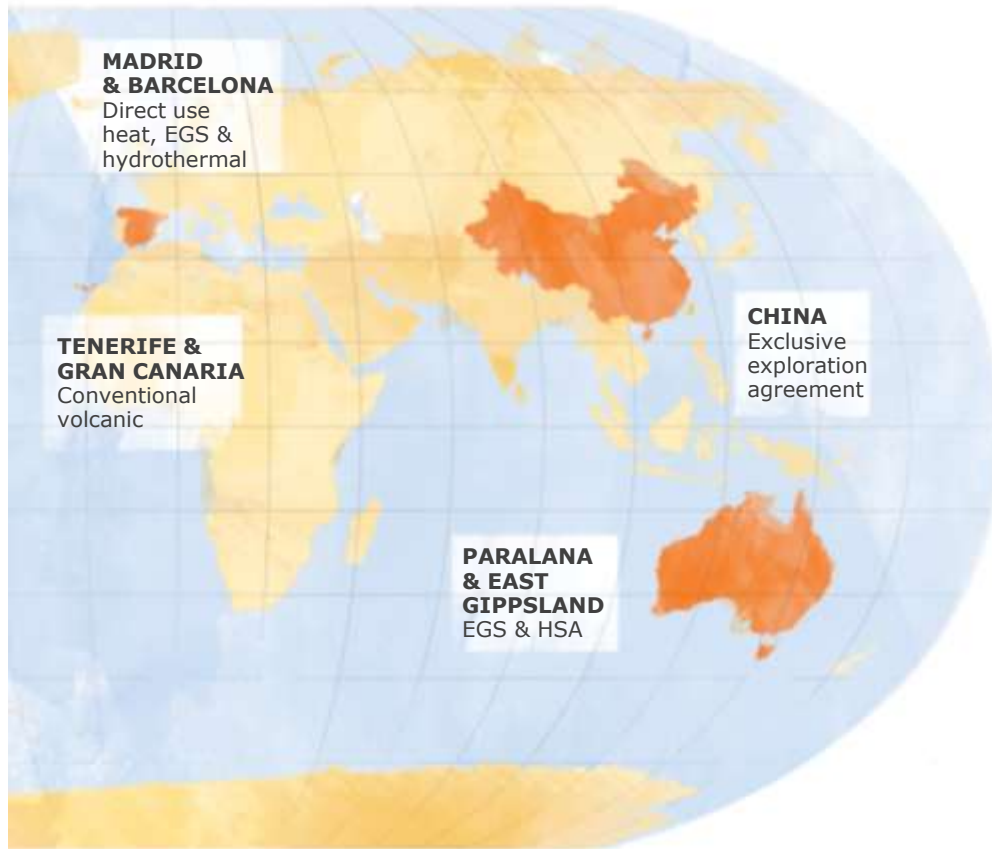
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Petratherm overview

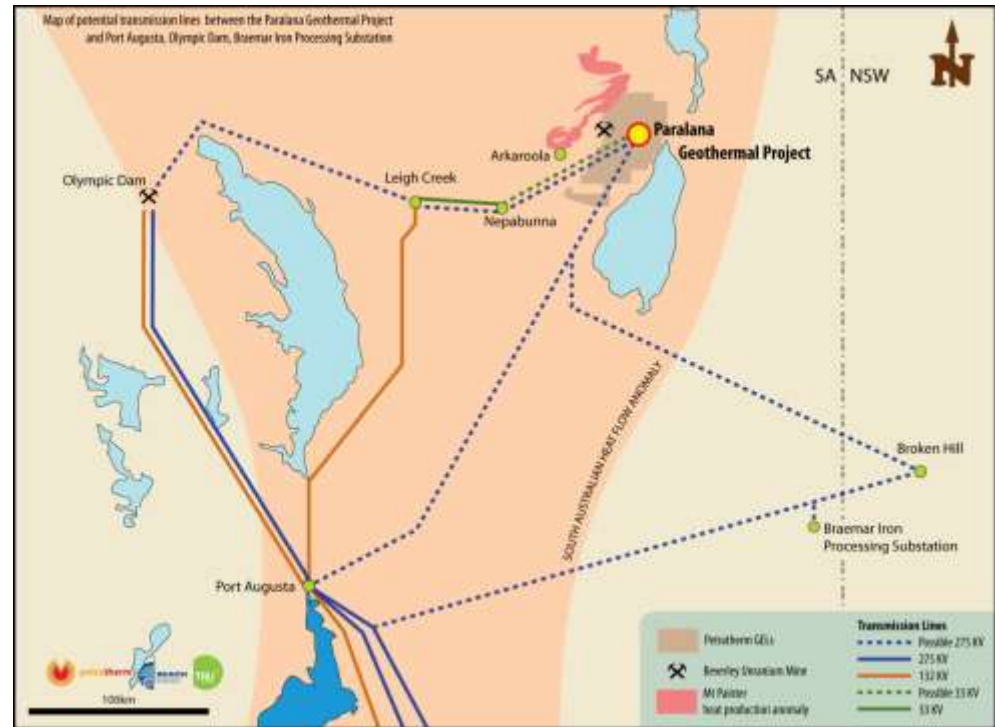


Our company

- ❑ Projects spanning Australia, Spain and China
- ❑ Projects across the spectrum of geothermal technology
- ❑ Flagship project – Paralana in SA's northern Flinders Ranges

Paralana Project – commercial / market overview

- ❑ Small off grid market (5-30MWe)
- ❑ Potential large on grid development (260 MWe+)
- ❑ Expenditure well leveraged for proof of concept, then potentially fully funded to initial commercial demonstration scale 30MWe plant
- ❑ Funding and expertise from JV:
Beach Energy (up to 36% for \$30m)
TRUenergy (up to 30% for \$57m)
- ❑ Federal Government grants support:
\$7 million geothermal drilling fund
\$62.8 million REDP grant



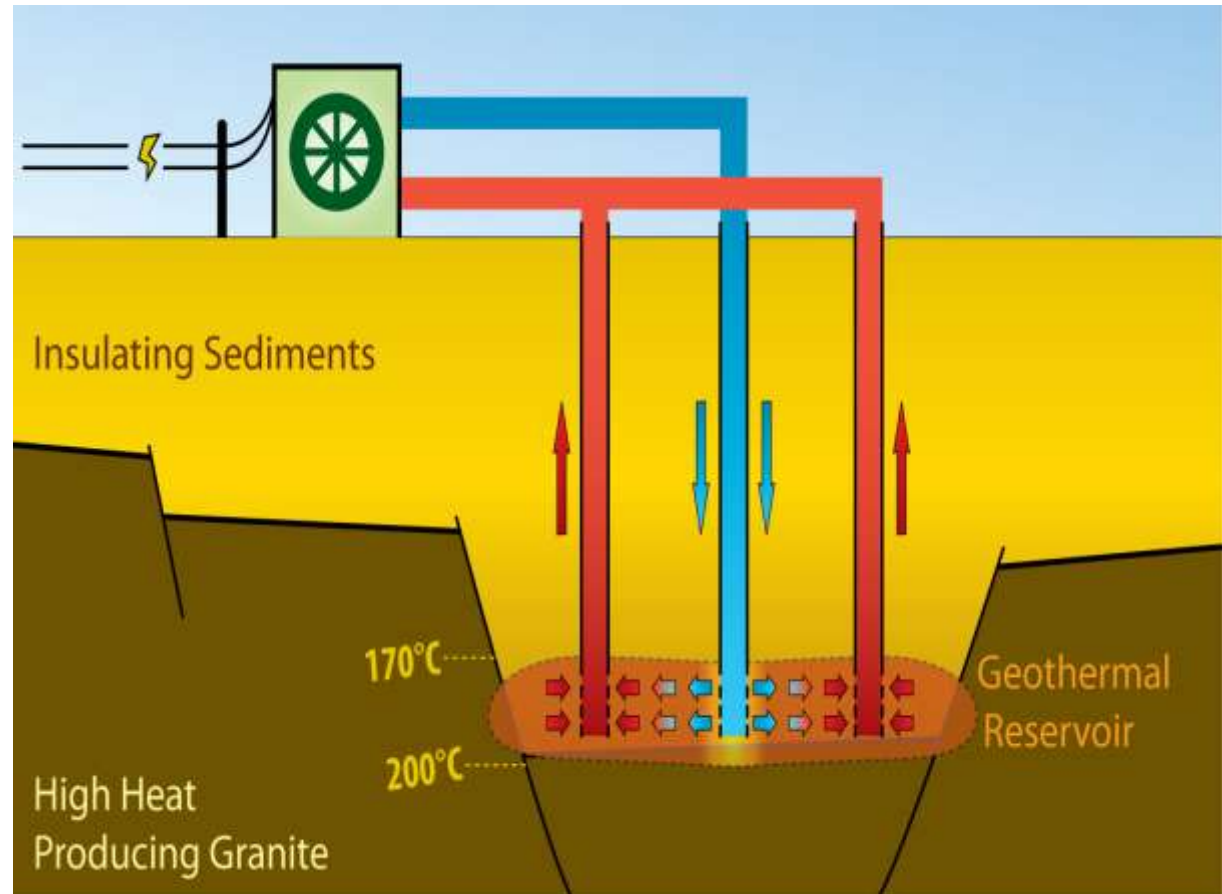
Paralana Project – Regional Picture



Development Model – Heat Exchanger within Insulator

Targeting Fracture Permeability in

- > Mesoproterozoic metasediments - bedding / joint surfaces
- > Fracture Permeability at Basin / Basement Interface (FABBI)



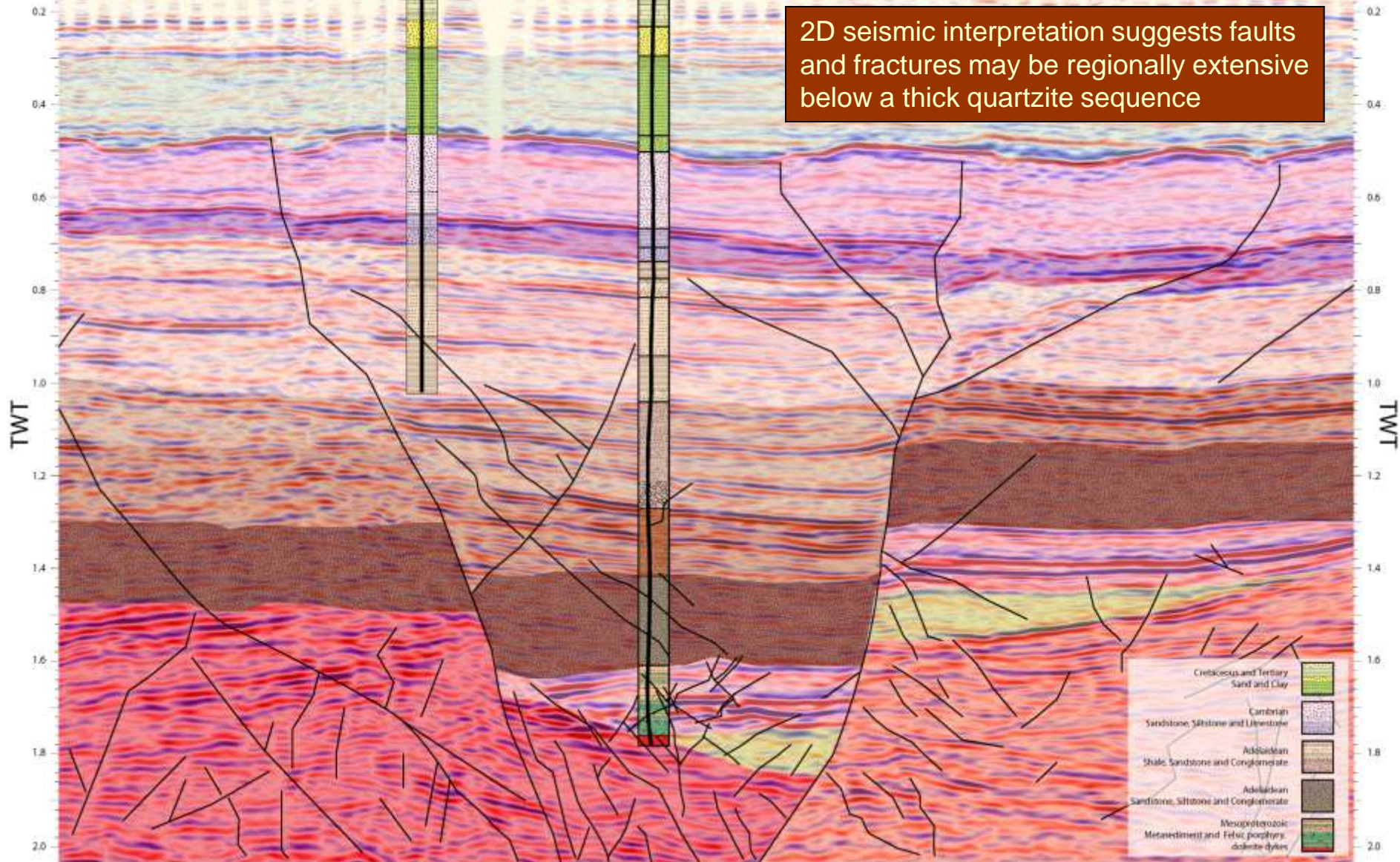
SPG84

Paralana 1B

Paralana 2

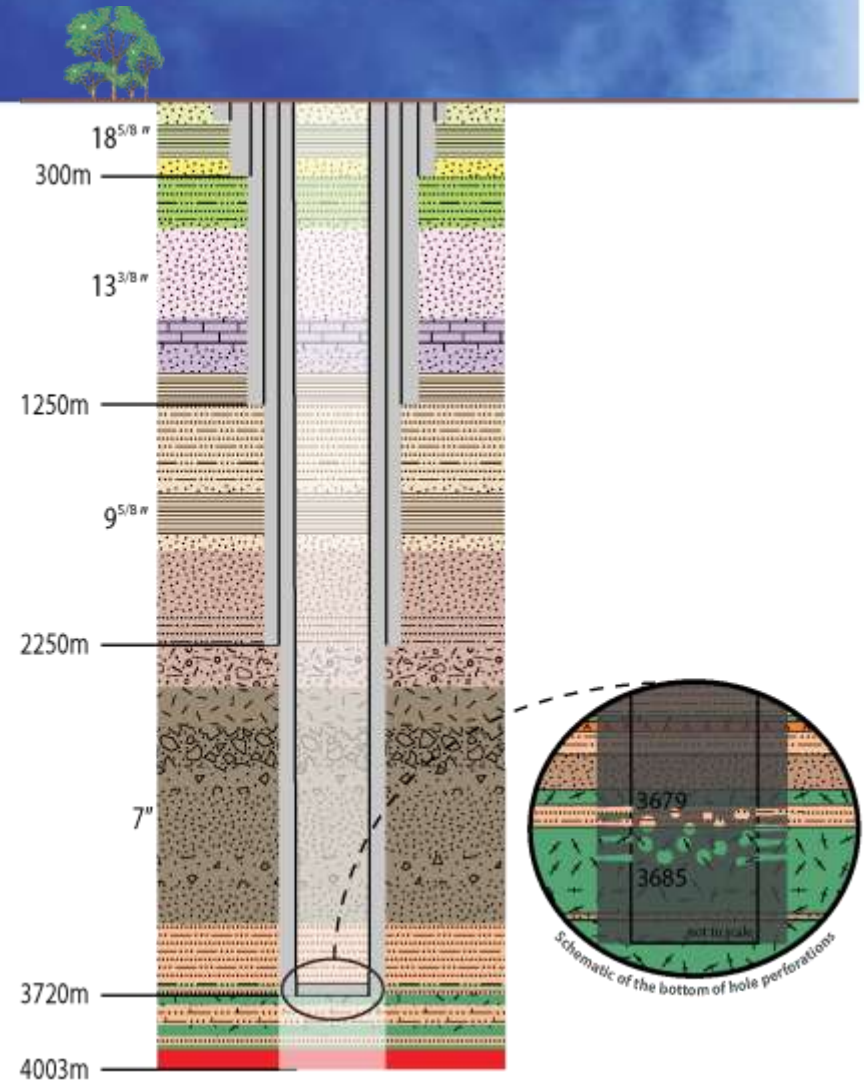
0 0.5 1 2 km

2D seismic interpretation suggests faults and fractures may be regionally extensive below a thick quartzite sequence



Paralana 2 well summary

- > Depth 4003m (G.L. A.H.D.)
- > Well cased and cemented to 3725m
- > Extrapolated bottom hole temperature ~ 190°C
- > High pressure geothermal brines intersected from 3680m
- > Zircon dating confirms 1585 ± 11 Ma Reservoir Sequence
- > Contains numerous fractures and faults
- > 6m perforated interval between 3679 and 3685m



Paralana 2 – Brine Intersected

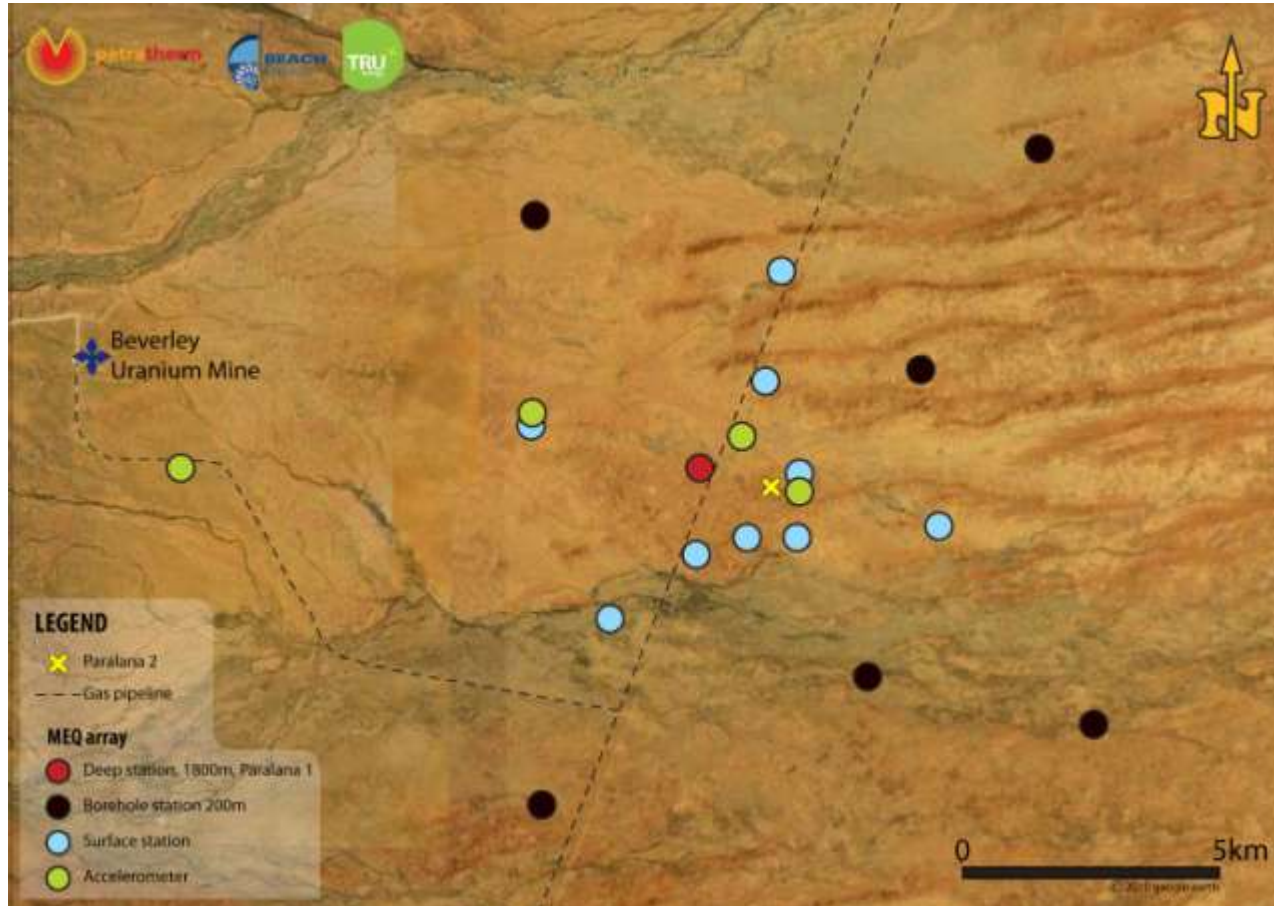
- ❑ High torque, intervals of high ROP' s, drilling breaks and increase in well bore deviation
- ❑ Inflow of over-pressured geothermal brines between 3670 - 3864 m
- ❑ Shut in pressure indicated ~ 3,300 psi, of overpressure and mud system weighted up to 13.2ppg to stop flow.
- ❑ Well bore stability problems limited wire line logging to LWD measurements to 3725 m



Numerous large Fractures/Faults Intersected!



Passive seismic array



- ✓ MEQ - Array
Managed by IESE
- ✓ 1 deep borehole sonde at 1800m in Paralana 1b
- ✓ 6 borehole sondes ~ 200m
- ✓ 10 surface seismometers
- ✓ 4 accelerometers

Injectivity test – January 2011



- > 15000 litres injected
- > Pressure \sim 8700 psi
- > Rates \sim 1.3 and 5.3 l/sec
- > WHP \sim 4000 psi
- > $>$ 140 MEQ
- > Magnitude -1 to 1 (RS)

The fracture array cloud measured by the array indicated that it extended 300m by 200m and was approximately 130m thick.

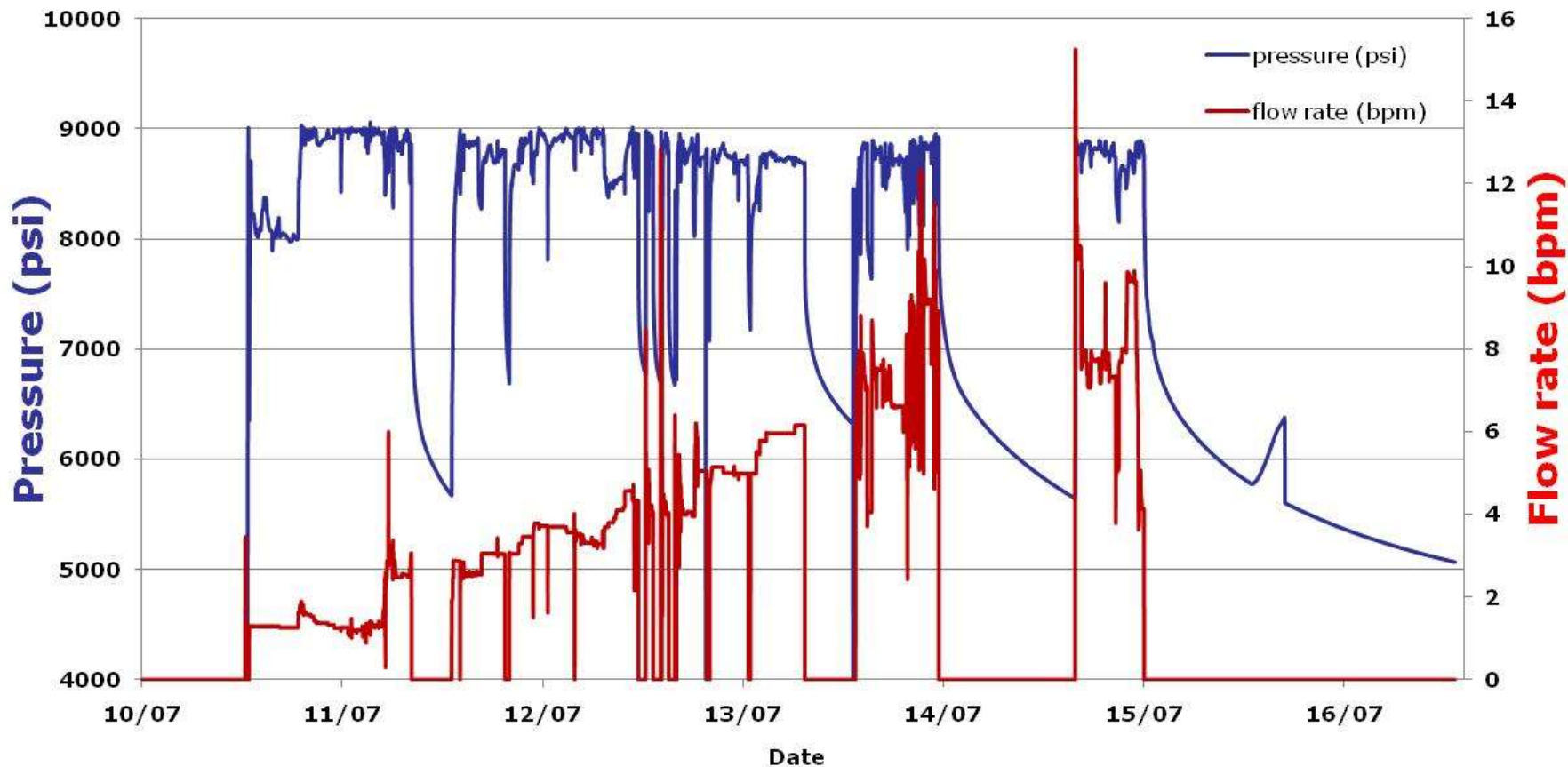
Fracture Stimulation – Key Statistics

- > 3.1 million litres injected
- > Injection rates: 3.2 - 27 l/sec
- > Equilibrium WHP prior and post operation 3940 psi.
- > Acid treatments allow higher pumping rates.
- > Sand proppant successfully placed at end of the treatment.



Photo: courtesy Advertiser, July 2011

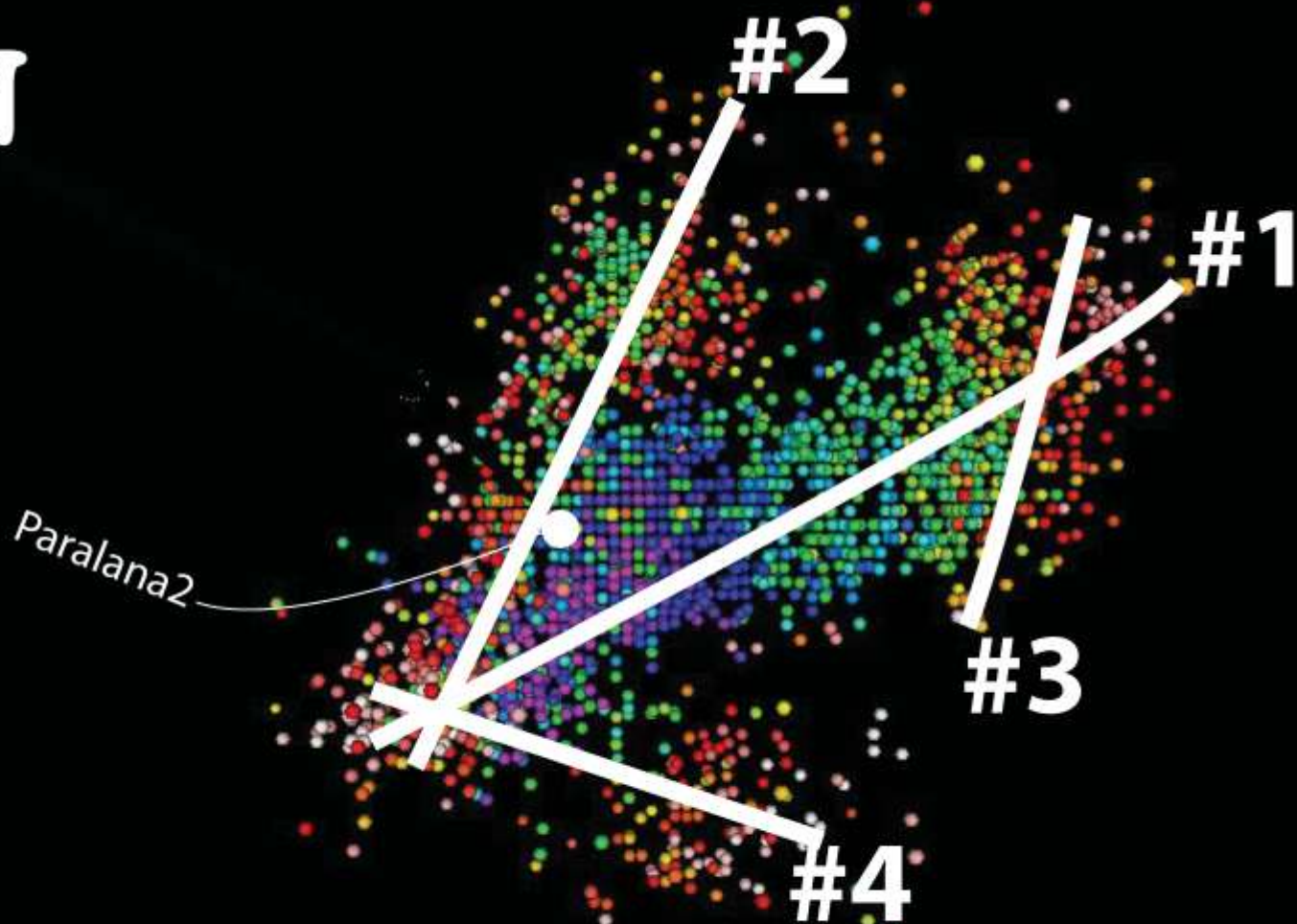
Fracture Stimulation – Pressure and flow rate



MEQ events – main fracture

- > MEQ array successfully recorded microseismicity:
 - > 11'000 events triggered and located by MIMO,
 - > 2'635 events handpicked
- > Maximum magnitude on the Richter Scale: 2.6
 - > 98% of the events were less than Mag 1.0
- > Ground motion – acceleration and velocity – always within the safe limits established in the risk management plan.
- > Good correlation between pumping rates and micro seismicity

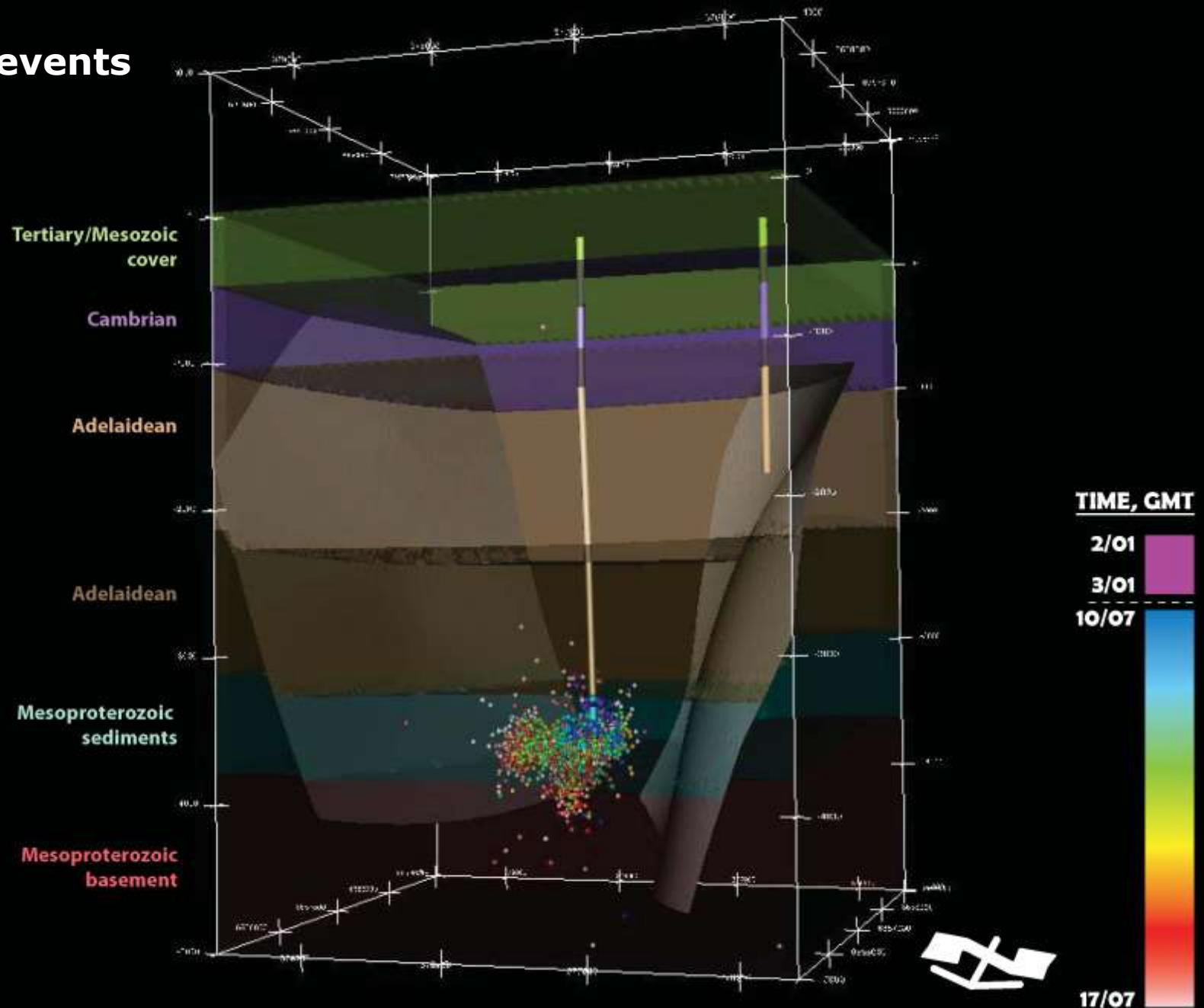
MEQ events: structures

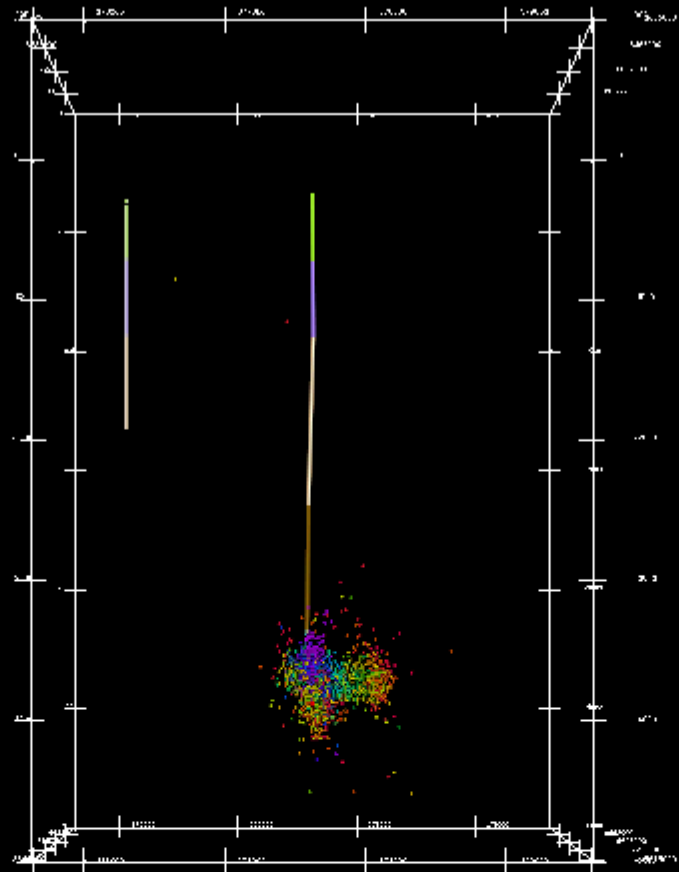


500m



MEQ events





Key milestones for the Paralana geothermal project



Paralana JV project planned milestones

- ❑ 3rd Qtr 2011: Main fracture stimulation ✓
- ❑ 3rd Qtr 2011 : Flow test ✓
- ❑ 1st half 2012: drilling of the Paralana 3 deep producer well
- ❑ Mid-2012: Circulation Test – Demonstration of Flows
- ❑ 2012: Commission first stage 3.75 MW power plant

CLEAN ENERGY FOR FUTURE GENERATIONS