Induced micro-seismic event records compared with geology and structure: Cooper Basin

INTREPID GEOPHYSICS

Description of the project

The concept of an EGS geothermal prospect is based on fracture network permeability enhanced by hydraulic stimulation. Characterisation of fracture/fault mechanisms and geometries are therefore an important part of prospect development. In this study, building a prospect-scale 3D geology and structure model of the Cooper Basin geothermal field has assisted prospect exploration and evaluation, but even greater advantage come from the ability to integrate (ir the same workspace) information from induced seismic events records such as location, magnitude, timing, focal mechanism, and shear plane orientation.

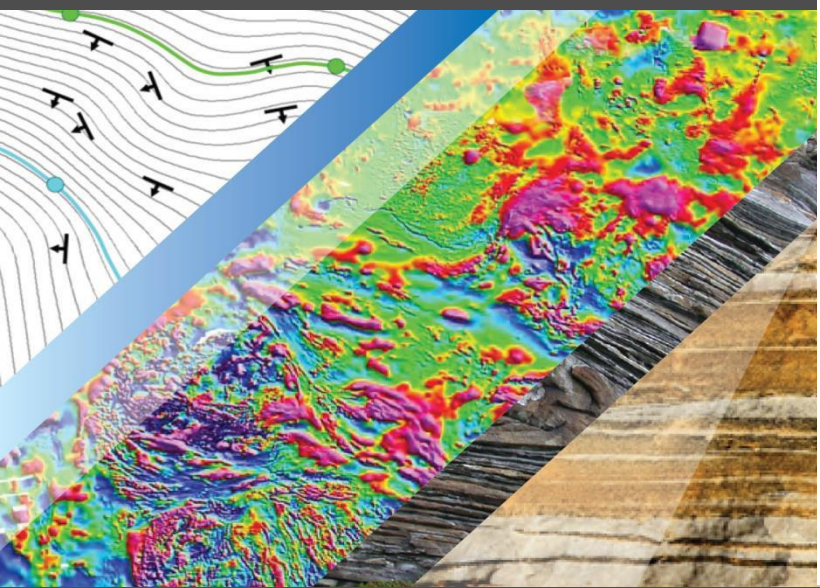
Software used

GeoModeller 2012 is a software tool for 3D geological modelling: for building complex, steady state, 3D geology models and performing forward and inverse geophysical modelling directly from solid 3D geology.

Author

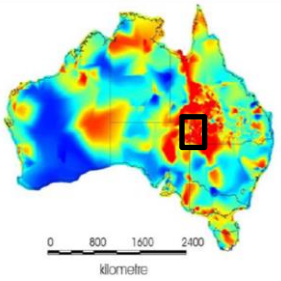
C.Bonet, H.Gibson Intrepid Geophysics 28 Feb 2011

Suite 110, 3 Male Street
Brighton, VIC 3186, Australia
Tel: +613 9593 1077
Fax: +613 9592 4142
Email: info@intrepid-geophysics.com
www.intrepid-geophysics.com



Case History

The Cooper Basin geothermal field is located near the commoı borders of Queensland and South Australia. Since geothermal exploration began ir 2002, 4 wells have been drilled into the underlying granite with final depths around 4300 metres.

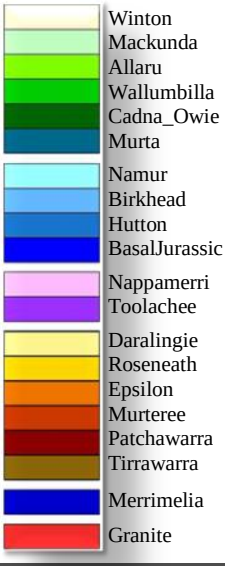


The Habanero-1 borehole was hydraulically stimulated in 2003 and in 2005.
The database underpinning this project comes from the mid-September **2005** hydraulic re-stimulation. Over a period of 13 days of stimulation, 22,500m^3 of water was injected into 4421 m and approximately 16,000 detectable seismic events were recorded. From this total, were determined absolute hypocentre locations for **8886** events.

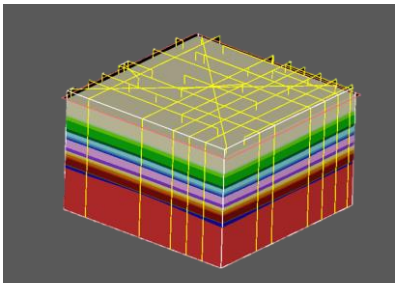
Wells names	Latitude	Longitude	Depths(m)	Dip	Date
Habanero 1	27°48'57.0''	140°45'15.9''	4420.82	90°	14/10/03
Habanero 2	27°49'9.7''	140°45'4.9''	4357.73	90°	31/03/05
Habanero 3	27°48'43.3''	140°45'28.9''	4221.48	90°	05/02/08
McLeod 1	27°48'53.2''	140°45'31.3''	3806.34	-	08/10/83

Geological model

- Extensions of the model : 10 x 10 x 6.5 km
- Stratigraphic successions of the Cooper and overlying Eromanga Basin.
- Sub-horizontal sedimentary layers.
- Top of the granitic bedrock lies between 3500-4200m.

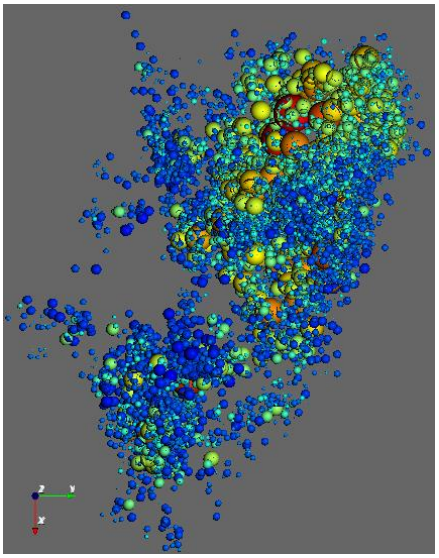


The GeoModeller 3D model of the Habanero site was built using the : Contact point from seismic line imported and Geology Data from 3 Geothermal boreholes Habanero 1 ,2 and 3 and a petroleum borehole called McLoed



Habanero Micro-seismic plot

In March 2010 Geodynamics provided the Database of the stimulation 2005 of the Habanero site. GeoModeller software was implemented to support Micro-seismic data and being able to plot the seismic cloud within 3D geology Model.



Localisation of micro-seismic events : **3200m** x **1800m** horizontally (long-axis oriented NNE) and within **600 m** vertically.

The seismicity is aligned along a single,**reactivated sub-horizontal fracture** system.

Plot microseismic events by properties: Example **Magnitude, XYZ Error Location, Time, Strike, Dip, Rake**

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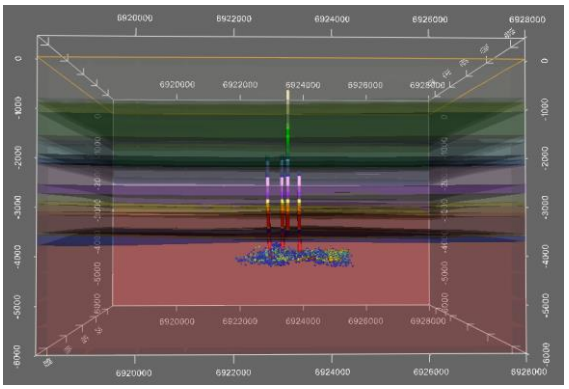
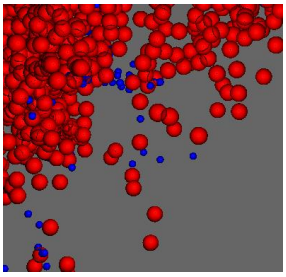
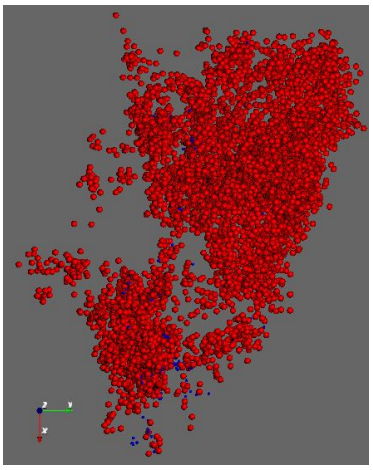


Fractures orientations

Two distinct populations of fracture orientations:

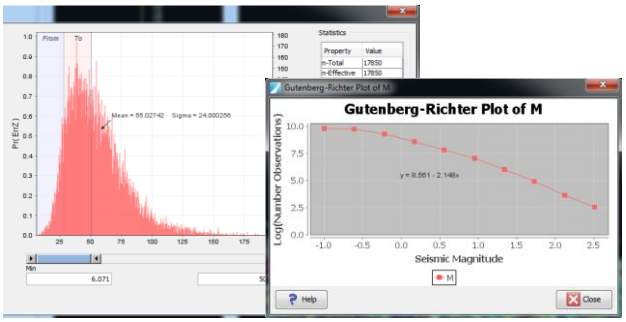
- **-96%** = N247°,9° (pale blue discs)
- **3%** = N164°,20° (red discs).
- **1%** are not defined.





Seismic cloud Interpretation

- Histogram
- Multi-filtering
- Gutenberg-Richter diagram
- Focal mechanisms Cartesian display
- Flow rate diagram



Temporal evolution

Visualization of the microseismic with a Time Cursor : 3 phases of Stimulation in Habanero between 2003 and 2005.

08/04/2005 t-17.926 | 12/09/2005 t-22.202 | 19/09/2005 t-23.471 | 11/11/2005 t-15.254