

*Panax Geothermal Limited*

ABN 89 122 203 196

Annual Report

Licence Year 2008

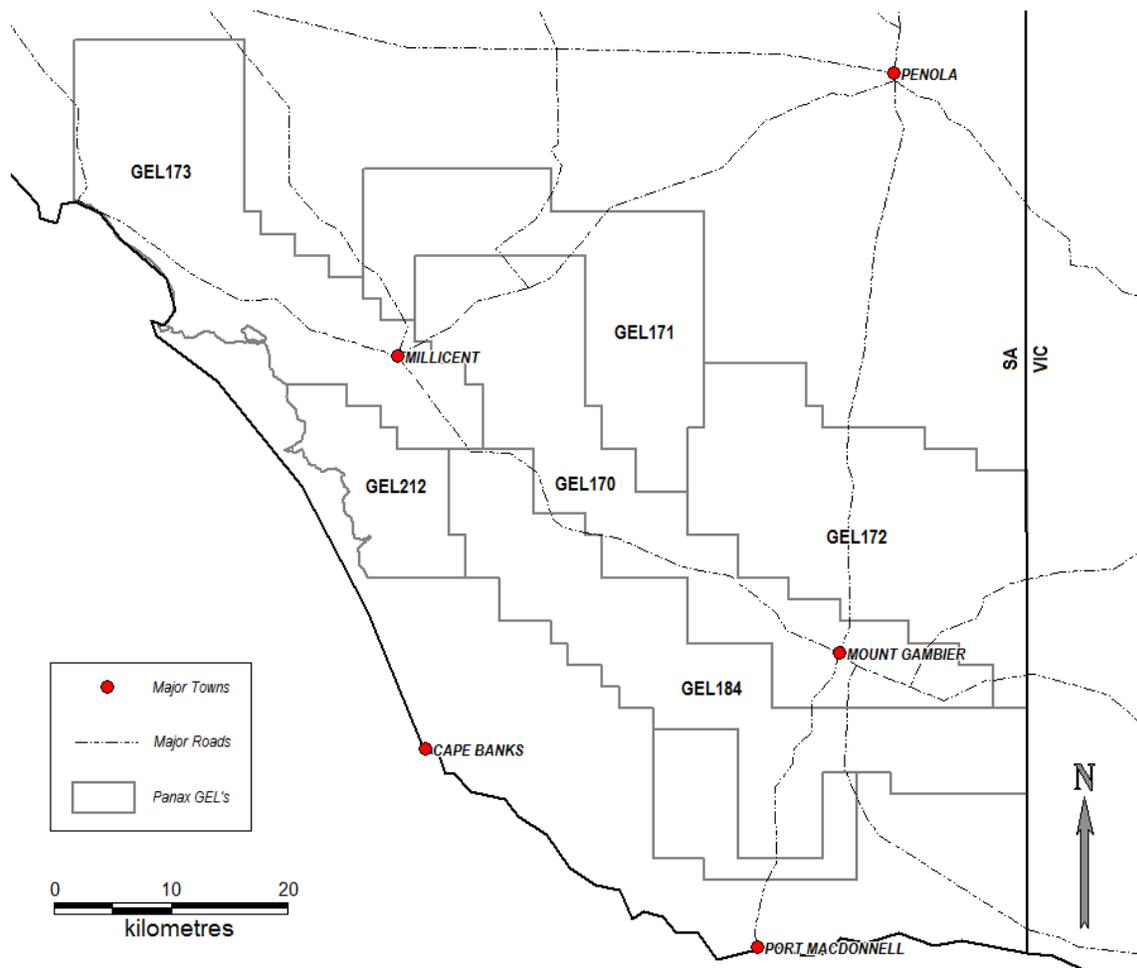
*23 November 2007 – 22 November 2008*

*Geothermal Explorations License's  
170, 171, 172, 173, 184 & 212*

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## 1 Introduction

Geothermal Exploration Licence's (GEL's) 170, 171, 172, 173, 184 and 212 were acquired by Panax Geothermal Ltd ("Panax") on 16 October 2007 when it acquired 100% of the issued capital of Scopenergy Pty Ltd. The licences are located in the onshore Otway Basin of South Australia (see Figure 1). This report details the work conducted during Licence Year 4 (being the period from 23 November 2007 to 22 November 2008 inclusive) in accordance with Regulation 33 of the Petroleum Act 2000.



**Figure 1.** Location of Panax GEL's in the western Otway Basin of South Australia.

The Limestone Coast Project is a unique geothermal project designed to test the viability of delivering significant amounts of clean, grid connected, base load power, by flowing fluids (brines) from a sedimentary basin through conventional, off the shelf binary, geothermal power plants. The project area, the on-shore Otway Basin, has a number of geological and geographical properties that make it particularly prospective as a sedimentary-hosted geothermal resource:

- Known porous and permeable sediments of the Crayfish Group, particularly the Pretty Hill Formation, which are proven petroleum reservoirs and have

significant potential as geothermal reservoirs. These sediments are known to retain their porosity and permeability to depths of at least 3,500m in the Penola Trough. A large amount of geoscientific data is available to assess the viability of these reservoirs in the Otway Basin.

- Regionally elevated heat flow (average ~75 mW/m<sup>2</sup>) with the potential for areas of locally elevated high heat flows (> 75 mW/m<sup>2</sup>) as measured in a number of deep petroleum wells in the license areas. Temperatures in excess of 140 °C are known in the Katnook wells in the nearby Penola Trough.
- A thick insulating layer of low thermal conductivity sediments, in particular the thick, shale-rich, Eumeralla Formation, which acts to elevate thermal gradients in the area.
- Close access to high voltage powerlines (132 kV and 275 kV) with close access to both local electricity demand in the southeast and demand from major cities of Melbourne and Adelaide

Panax is well on the way to completing Stage 2 of the Limestone Coast Project plan – Proof of Concept - and plans to drill a production well (Salamander 1) in 2009.

## 2 Permit Summary

For the duration of the licence year, licensees for the Geothermal Exploration License's (GEL's 170, 171, 172, 173, 184 and 212) were:

- *Scopenergy Pty Ltd* 100% interest

*(Scopenergy Pty Ltd is 100% owned by Panax Geothermal Ltd)*

The current work commitments (including all variations) associated with GEL's 170, 171, 172, 173, 184 and 212 can be seen in Table 1.

Table 1 Current work commitments by licence year

Licence Year	Licence dates	Minimum Work Program
Year 1	23 November 2004 – 22 November 2005	<ul style="list-style-type: none"> <li>• <i>Review of open file geological and geophysical data</i></li> </ul>
Year 2	23 November 2005 – 22 November 2006	<ul style="list-style-type: none"> <li>• <i>3D modelling of geological and heat resources, including detailed 3D lithology; and</i></li> <li>• <i>Conceptual development planning, engineering and commercial scoping study; and</i></li> <li>• <i>Measure detailed geothermal gradients in any accessible water wells.</i></li> </ul>
Year 3	23 November 2006 – 22 November 2007	<ul style="list-style-type: none"> <li>• <i>Geological &amp; Geophysical Review</i></li> </ul>
Year 4	23 November 2007 – 22 November 2008	<ul style="list-style-type: none"> <li>• <i>Re-interpretation of 1200 line km of 2D seismic data</i></li> </ul>

		<ul style="list-style-type: none"> <li>• A review of SEEBASE 3D geological model</li> <li>• 159 station MT Survey across Rivoli, St Clair, Tantanoola &amp; Rendelsham Troughs</li> <li>• Drill narrow diameter holes to an aggregate depth of at least 1,800m and measure geothermal gradients</li> </ul>
Year 5	23 November 2008 – 22 November 2009	<ul style="list-style-type: none"> <li>• Drill a deep appraisal well and conduct production testing</li> </ul>

Licence Year Four concluded on 22 November 2008. The following table displays the minimum work program (after all variations) and the actual work completed up until the end of the current licence period.

Table 2 Final work program and work completed (as of end of current reporting period) by licence year

<b>Licence Year</b>	<b>Minimum Work Program</b>	<b>Actual Work</b>
Year 1	<i>Panax did not operate the GEL's during this licence year</i>	<ul style="list-style-type: none"> <li>• Review of open file geological and geophysical data</li> </ul>
Year 2	<i>Panax did not operate the GEL's during this licence year</i>	<ul style="list-style-type: none"> <li>• 3D modelling of geological and heat resources, including detailed 3D lithology; and</li> <li>• Conceptual development planning, engineering and commercial scoping study; and</li> <li>• Measure detailed geothermal gradients in any accessible water wells.</li> </ul>
Year 3	<ul style="list-style-type: none"> <li>• Geological &amp; Geophysical Review</li> </ul>	<ul style="list-style-type: none"> <li>• Geological &amp; Geophysical Review</li> </ul>
Year 4	<ul style="list-style-type: none"> <li>• Re-interpretation of 1200 line km of 2D seismic data</li> <li>• A review of SEEBASE 3D geological model</li> <li>• 159 station MT Survey across Rivoli, St Clair, Tantanoola &amp; Rendelsham Troughs</li> <li>• Drill narrow diameter holes to an aggregate depth of at least 1,800m and measure geothermal gradients</li> </ul>	<ul style="list-style-type: none"> <li>• Re-interpretation of 1200 line km of 2D seismic data</li> <li>• A review of SEEBASE 3D geological model</li> <li>• 159 station MT Survey across Rivoli, St Clair, Tantanoola &amp; Rendelsham Troughs</li> <li>• Acoustic impedance analysis on selected seismic lines</li> <li>• Seismic sequence stratigraphy interpretation</li> </ul>
Year 5	<ul style="list-style-type: none"> <li>• Drill a deep appraisal well and conduct production testing</li> </ul>	Not yet commenced

### **3 Regulated Activities**

#### ***Drilling and Related Activities***

No regulated activities undertaken in the licence reporting period

#### ***Seismic Data Acquisition***

No regulated activities undertaken in the licence reporting period

#### ***Seismic Data Processing and Reprocessing***

No regulated activities undertaken in the licence reporting period

#### ***Geochemical, Gravity, Magnetic and other surveys***

Panax contracted Quantec Geoscience to undertake a Magnetotelluric (MT) Survey (the Limestone Coast MT Survey 2008) in a number of areas within GEL's 170, 171 and 173 (Figure 2). Magnetotellurics (MT) is a non-invasive, electromagnetic, geophysics technique that is considered to be the 'work horse' for delineating conventional geothermal reservoirs. MT measures naturally occurring electric (telluric) currents that are induced in the earth by natural variations in the earth's magnetic field. These electric currents are influenced by rock properties including rock type, porosity and permeability and temperature. Surveying involves measuring variations in the earth's magnetic and electric fields via use of ground magnetometers and induction coils respectively. These instruments are placed in the ground and left for long recording periods (typically 24 hours). Inversion of the MT data provides a model of the electrical conductivity distribution beneath MT stations and allows for geological interpretation.

The primary aim of the Limestone Coast MT Survey 2008 was to delineate sandier (and hence more porous and permeable) sections of the Crayfish Group (i.e. the Pretty Hill Formation). The secondary aim was to allow geological mapping of units such as the Eumeralla Formation, particularly in areas that are devoid of seismic data (i.e. the Tantanoola Trough). Discussion here is limited to relevant information concerning the regulatory requirements of the survey (e.g. the planning, acquisition and post-survey).

Survey acquisition commenced on the 8 August 2008. 152 MT stations were recorded over 40 production days resulting in an average of approximately 3.8 stations per production day.

No reportable incidents occurred during the survey and no landholder complaints were received. Some problems were experienced with cattle disturbing MT stations which resulted in a number of repeated readings required to be completed.

#### ***Processing, inversion and Interpretation***

Processing, inversion, and interpretation is under-way and will be the subject of a separate report to be issued.

### ***Post-survey activities***

Photos were taken before and after the installation of MT stations at all locations. These were submitted to PIRSA on completion of the survey as a means of assessing compliance with the SEO.

Landholder release forms were sent out after completion of the survey to ensure that landholders were satisfied that restoration of the MT station sites had been satisfactorily completed.

### ***Production and Processing***

No regulated activities undertaken in the licence reporting period

### ***Pipeline/Flowline Construction and Operation***

No regulated activities undertaken in the licence reporting period

### ***Preliminary Survey Activities***

No regulated activities undertaken in the licence reporting period

## **4 Non-regulated Activities**

### ***Interpretation of seismic data in the Rivoli and Rendelsham Troughs***

Hot Dry Rocks Pty Ltd (HDRPL) was commissioned to undertake interpretation of 50 seismic lines in the Rivoli and Rendelsham Troughs. This greatly expanded on the use of existing open-file 2D seismic by the previous operators, Scopenergy.

The interpretation was integrated with available well data and the following formation tops could be interpreted on all lines:

- Top Sherbrook Group
- Top Otway Group
- Top Crayfish Group
- Top Intra-Crayfish marker
- Top Basement

The main outcome from the work was the delineation of areas where the depth to the top of the Crayfish Group and top Intra-Crayfish marker, thought to be the top Pretty Hill Formation, were within the 3.2 - 4.2 km depth. Most of the Rivoli Trough and north-western parts of the Rendelsham Trough were identified as having Intra-Crayfish in this depth range.

Other outcomes of the work included:

- The Crayfish Group and deeper horizons cannot be interpreted south of the Tartwaup Hingeline due to the development of a thick succession of Late Cretaceous sediments. Hence the depth to the Crayfish Group in these areas is largely unconstrained but is thought to be deeper than 4.2 km.

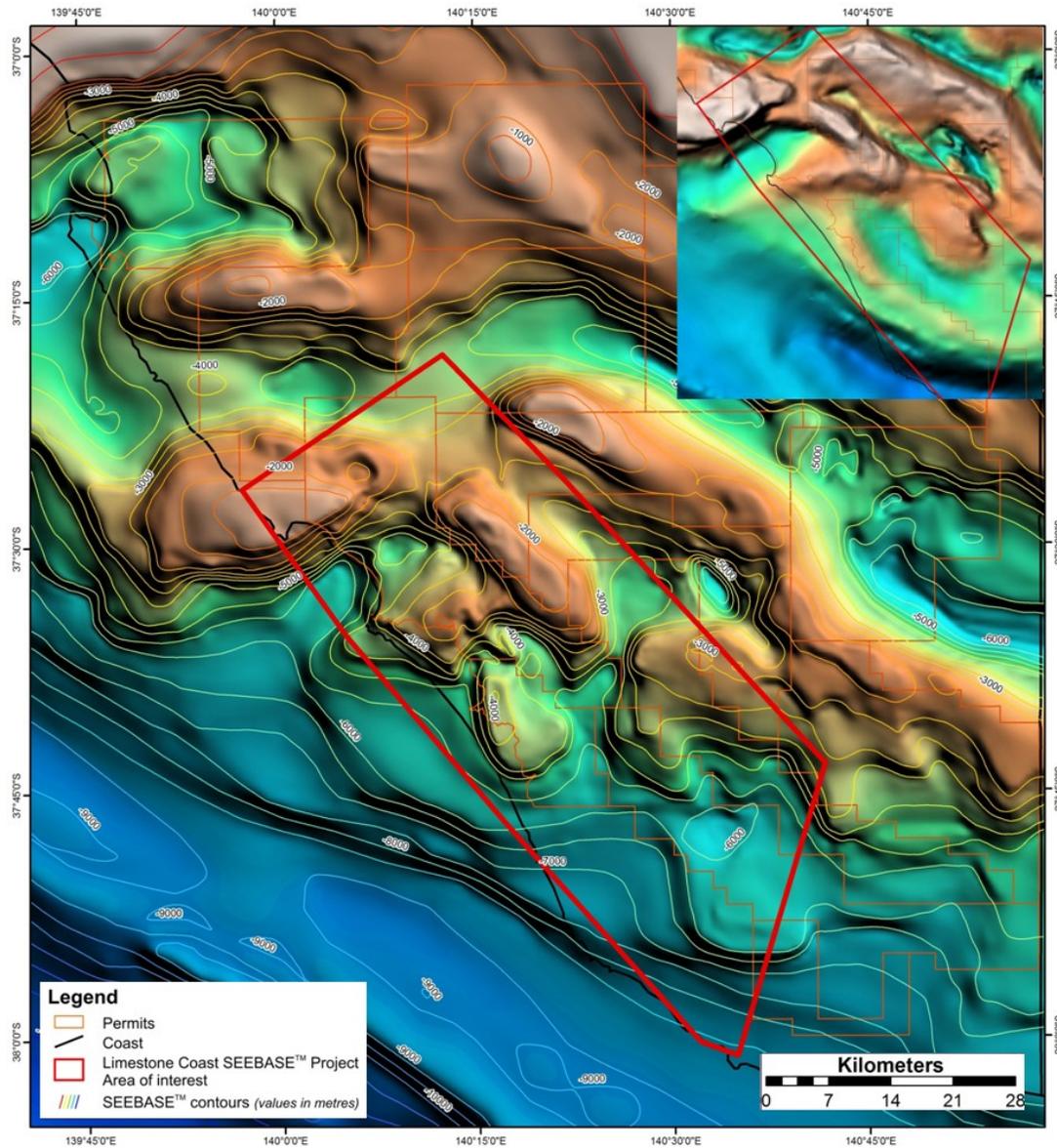
- The Rivoli Trough is structurally complex and characterized by changes in fault polarity and the development of splay faults and overlaps.
- The nature and distribution of the Intra-Crayfish marker is uncertain (but may represent the top of the Pretty Hill Formation). It is possible that the marker lies within the Lower F. wonthaggiensis palynological zone, which is known to be more sand-prone in other areas of the Otway Basin.

This seismic interpretation work was used to identify target areas for the MT survey. The work also prompted further 2D seismic interpretation including an attempt to use seismic sequence stratigraphic principles to determine the nature of the Intra-Crayfish marker (see 'Further 2D seismic interpretation' below).

### ***Revision of 3D Geological Model (SEEBASE Project)***

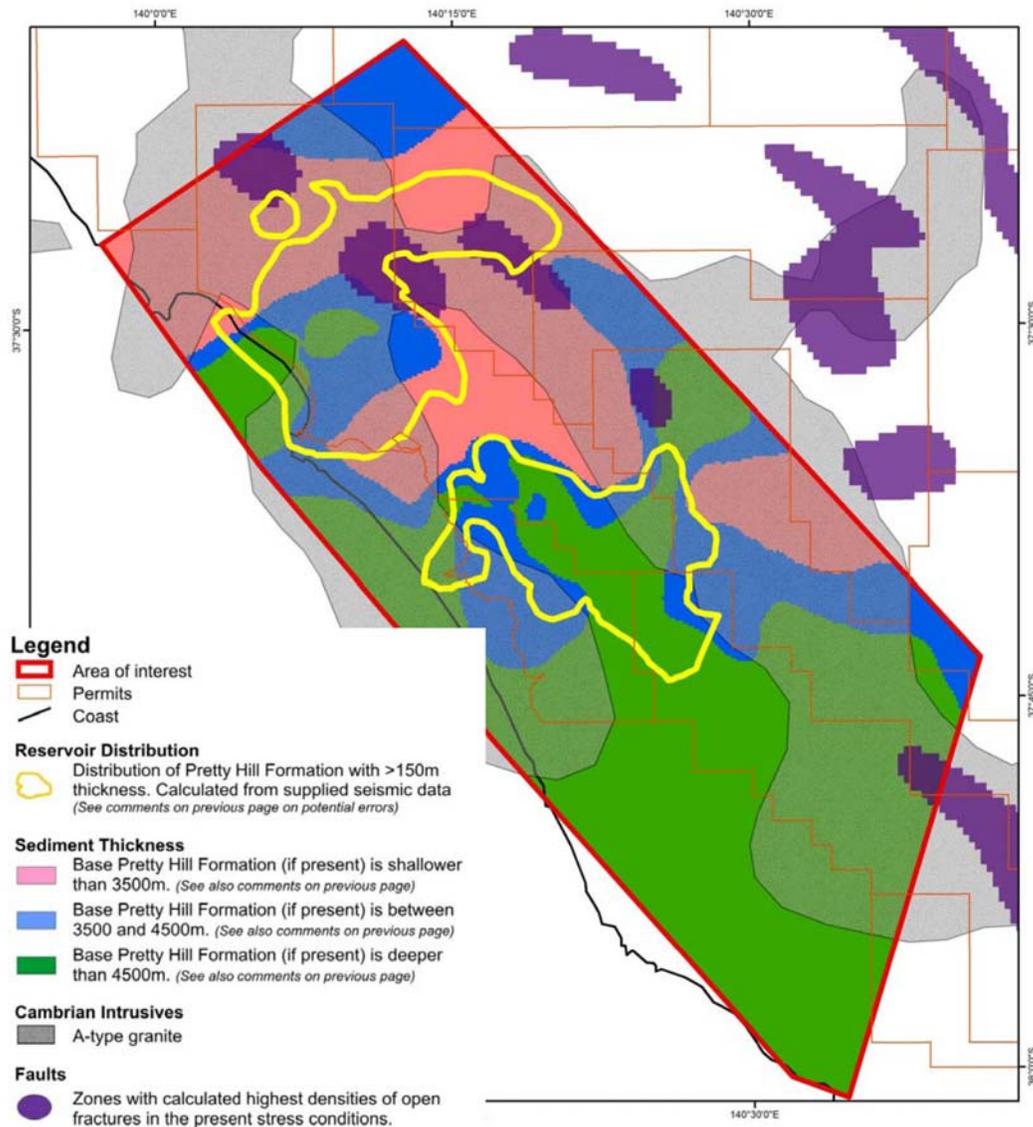
FrOGTech Pty Ltd were commissioned to undertake a revision of the Limestone Coast 3D geological model. The main outcome of the work was the production of a revised 3D geological model and included greatly improved mapping of basin architecture and structure. The new model benefits from:

- The incorporation of new constraints on formation depths provided by the interpretation of 50 seismic lines in the Rivoli and Rendelsham Troughs. Consequently, the new model provides much greater detail in these areas.
- Accounting for the confidence level of the interpretation of seismic markers for each seismic line. This accounts for differences in seismic data quality in the different areas.
- Use of a new gridding algorithm (complex spline function was used as opposed to a minimum curvature algorithm in the previous Scopenergy version).



**Figure 2.** The revised SEEBASE model showing depth to basement in the western Otago Basin. The model is constrained by seismic, gravity and magnetic datasets. The previous Scopenergy model is shown in the inset for comparison.

FrOGTech also did some work on mapping likely fracture densities based on the identification of faults in the seismic interpretation work. They also determined which fractures are likely to be open based on the current stress regime (open faults may act to enhance permeability). Figure 3 shows the location of these faults with prospective Pretty Hill Formation and interpreted buried granites (known to be high-heat producing in places from previous FrOGTech work for Scopenergy).



**Figure 3.** Distribution of prospective Pretty Hill Formation with zones of high densities of open fractures and interpreted A-type granites which may be high-heat producing.

The northern Rivoli Trough was identified by FrOGTech as being particularly prospective based on the coincidence of a thick succession of Pretty Hill Formation, optimal burial depth of the Pretty Hill, underlying, possibly high heat producing granites and a high density of fractures that may be open.

### **Acoustic Impedance Analysis**

*Gingko* was commissioned to undertake an acoustic impedance study of fifteen seismic lines in the Rivoli, Rendelsham and St Clair Troughs. It was originally thought that it may be possible to map out porosity along the seismic lines quantitatively using seismic attributes, a technique that has been used in the Penola Trough.

### ***Further 2D Seismic Interpretation***

Following the results of the previous HDRPL interpretation work, further seismic interpretation was warranted. This was mainly aimed at reducing reservoir risks by attempting to identify the nature of the Intra-Crayfish marker and to expand mapping of the Intra-Crayfish marker. An additional 14 seismic lines were incorporated into the study in the Tantanoola and St Clair Troughs. The St Clair Trough lines were included mainly to attempt to correlate stratigraphic horizons and sequences into the adjacent troughs utilising well data from St Clair 1 and Reedy Creek 1 in the St Clair Trough, both of which have significant intersections of Pretty Hill Formation.

## **5 Compliance Issues**

### ***Licence and Regulatory Compliance***

All material and significant licence, regulatory and SEO requirements have been fulfilled.

### **Regulatory Non-Compliance**

Table 2 List of regulatory non-compliances for current reporting year

<b>No.</b>	<b>Date</b>	<b>Activity</b>	<b>Details of Non-Compliance</b>	<b>Rectification of Non-Compliance</b>
Ex. 1	06/08/08	Submission of weekly production summary	First weekly update of MT survey production and incidents was not submitted on the due date.	Construct survey reporting template to ensure easy completion of weekly reports.

Compliance with Statement of Environmental Objectives

Table 3 Statement of environmental objectives for ground based geophysical operations (non-seismic) in South Australia.

<b>Objective</b>	<b>Assessment Criteria</b>	<b>Compliant/Non-Compliant (inc. Compliance statement)</b>	<b>Comments</b>
Objective 1: Minimise disturbance to other land users	<p>All reasonable landowner complaints are addressed and resolved.</p> <p>Upon completion of the geophysical survey and after any rehabilitation or reparation (if determined prior to survey), the level to which the impacts on other land users is determined by the absence of existing stakeholder complaints</p>	Compliant	
Objective 2: Minimise disturbance to native vegetation, fauna and associated wildlife habitats	<p>Vehicle access to survey traverses is to be via existing access tracks or existing seismic lines, except where they have rehabilitated. Other temporary access tracks may be utilised where such use is likely to result in less environmental impact than other options. No off-traverse driving recorded.</p> <p>No native vegetation clearance has occurred.</p> <p>Known significant species sites have been flagged and avoided.</p> <p>Waste materials do not pollute the environment and contaminate soils.</p> <p>Fuel and Chemical Storage Management</p> <p>No refuelling outside designated refuelling areas.</p> <p>No spills/leaks outside areas designated to contain them.</p> <p>Spills and leaks are immediately reported and clean up actions initiated.</p> <p>Records of spill events are maintained.</p> <p>Appropriate spill response equipment is available on site</p>	Compliant	

<p>Objective 3: Avoid disturbance to sites of cultural and heritage significance</p>	<p>Appropriately qualified and experienced personnel have scouted proposed survey area.</p> <p>These sites are flagged off and detoured around.</p> <p>Any aboriginal cultural locations found are identified, recorded and reported accordingly to DPC-AARD. Note: Where a negotiated Native Title agreement is in place, compliance with the agreement takes precedence over the above criteria. (However the Aboriginal Heritage Act 1998 is not set aside by an agreement).</p>	<p>Compliant</p>	
<p>Objective 4: Minimise the risk of introduction and/or spread of introduced species and bio-security threats</p>	<p>Weeds, feral animals or plant and animal diseases are not introduced to, or spread within South Australia</p>	<p>Compliant</p>	
<p>Objective 5: Minimise the risk of initiation and/or propagation of wildfire</p>	<p>Fire risk minimisation and situation management</p> <p>Appropriate plans in place and equipment available to identify hazards, initiate hazard mitigation and response training, fire-fighting equipment available and maintained accordingly, and fire bans adhered to</p>	<p>Compliant</p>	
<p>Objective 6: Minimise the visual impact of geophysical operations</p>	<p>Surveying, creation of wheel tracks and campsite preparation.</p> <p>Proposed survey traverses have been appropriately located to minimise visual impacts.</p> <p>Vegetation and terrain variations have been used to minimise survey traverse visibility.</p> <p>Planning procedures to minimise visibility aspects are evident and available for audit upon request</p>	<p>Compliant</p>	
<p>Objective 7: Minimise generation of dust</p>	<p>Access to properties is kept to minimum required to acquire data.</p> <p>Vehicles are driven a speeds slow enough to not generate dust</p>	<p>Compliant</p>	

<p>Objective 8: Minimise soil disturbance and contamination</p>	<p>Campsites have been appropriately located to minimise disturbance and contamination of soils.</p> <p>No refuelling outside designated refuelling/servicing areas.</p> <p>Spills and leaks are immediately reported and clean up actions undertaken.</p> <p>All appropriate spill cleanup equipment held at campsites.</p> <p>Waste materials do not pollute the environment and contaminate soils.</p> <p>Only vehicles engaged in actual data acquisition process are permitted to drive along survey traverses</p>	<p>Compliant</p>	
<p>Objective 9: Optimise waste reduction and recovery</p>	<p>Wastes with the exception of sewage and grey water wastes are segregated, burnt or transported to an Environment Protection Authority (EPA) approved waste disposal facility for recycling or burial in accordance with approved procedures.</p>	<p>Compliant</p>	

### ***Management System Audits***

This was undertaken during the period with no significant failures or deficiencies identified.

### ***Report and Data Submissions***

Relevant reports relating to the completion of the MT survey will be provided with the formal MT survey report in due course.

### ***Incidents***

There were no reportable incidents that occurred during the permit year.

### ***Threat Prevention***

There are no foreseeable threats to report in the permit year.

### ***Future Work Program***

Panax is planning to drill its first geothermal appraisal/production well in 2009. The well will test the reservoir quality and fluid content of the Pretty Hill Formation in the onshore Otway Basin.

- The Salamander 1 well is planned to drill to a Total Depth of about 4,000 metres
- Drilling is anticipated to commence in mid 2009 as the second well in a group-drilling consortium with Beach Petroleum/Petratherm and Adelaide Energy Ltd.
- Approximate duration of 50+ days
- The well will be flow and pressure tested to evaluate reservoir characteristics for future completion as the first Australian geothermal power producer to be connected to the electricity grid

## **5 Expenditure Statement**

Commercial in Confidence