ANALYSES AND MODELLING OF RESERVOIR PRESSURE CHANGES TO INTERPRET THE ROTOKAWA GEOTHERMAL FIELD RESPONSE TO NGA AWA PURUA POWER STATION OPERATION

Jaime Quinao, Lutfhie Sirad-Azwar, Jonathon Clearwater, Viola Hoepfinger, Morgane Le Brun, and Candice Bardsley

Mighty River Power Ltd.
283 Vaughan Rd
Rotorua, 3010, New Zealand
e-mail: jaime.quinao@mightyriver.co.nz

ABSTRACT
The Rotokawa Geothermal Field has recently increased its fluid extraction by about 400% to provide steam supply to the new 140 MW Nga Awa Purua (NAP) power station. This paper analyzes the reservoir pressure response to the increased take as observed in the continuous downhole pressure monitoring wells and reservoir pressure data from downhole pressure and temperature (PT) logs. The data sets analyzed cover the period from the start-up of NAP in 2010 to the start of a reservoir pressure pseudo-steady state in 2012.

Reservoir pressure data showed a strong correlation with the increased production, showing initial high pressure decline followed by a transition to a stable pressure decline rate. Periodic pressure data from downhole PT logs of active wells showed differences in absolute pressure drawdown over the small production area, suggesting heterogeneous permeability and/or strong pressure controls across the field.

The difference in pressure drawdown between groups of wells has been interpreted as semi-permeable compartment behaviour. Simple models were used to match the reservoir and compartment pressure responses using Saphir© well test software. The relationship between compartment behaviour and the overall reservoir pressure forecast was also investigated.

INTRODUCTION
Reservoir pressure has been regularly monitored in the Rotokawa geothermal field since the beginning of commercial operations in 1997. This was mainly done through downhole pressure surveys taken while the wells are shut-in. Pressure was measured in most wells including wells that were drilled later as new or replacement production and injection wells.

To capture the reservoir response with the addition of the new NAP power station, continuous reservoir pressure monitoring equipment were installed in deep monitoring wells within the production area. The monitoring equipment has sensors that run on 1/8-inch tubes and positioned at or near the main permeable zone of the monitoring well. For greater coverage, additional monitoring equipment was installed to measure reservoir pressure changes in the injection area as well as periodic shut-in pressure data measured from all the active and idle wells all over the Rotokawa geothermal field.

This paper describes the observations and results of the analyses done on the reservoir pressure data response to production two (2) years since the NAP start-up.

THE ROTOKAWA GEOTHERMAL FIELD PRIOR TO NGA AWA PURUA START-UP
The Rotokawa geothermal field is located in the Taupo Volcanic Zone of New Zealand, 14km northeast of Taupo. To its southwest is the Wairakei-Tauhara geothermal field and to its north is the Ngatamariki geothermal field (see Figure 1).

Between 1965 and 1986, the New Zealand government drilled seven investigation wells (RK1-RK6, and RK8) in the area to assess the geothermal resource. From 1997 to 2010, the installed capacity in Rotokawa gradually increased from 24 MW to 34 MW through the combined-cycle Rotokawa Geothermal Power Station. The combined-cycle power plant operation is further described by Legmann (1999) and Legmann and Sullivan (2003).

The Rotokawa station required about 645 t/hr of reservoir fluid to generate electricity at maximum capacity.
Between 1997 and 2005, nine more wells were drilled (RK9, RK11-18). Generation was supported by four production wells (RK5, RK9, RK13 and RK14). Brine injection was to shallow wells RK1, RK11, and RK12 until 2005. In 2005, the shallow injection was transferred to deeper wells RK16 and RK18 after it was concluded that shallow injection was unsustainable in the long term (Hunt and Bowyer, 2007). With this new brine injection location, a tracer test was conducted in 2006 to verify potential injection fluid returns. The tracer test results identified a connection from RK18 to RK17 and RK13, suggesting a preferred flow direction with a SW-NE orientation. Because of this chemical connection, injection was transferred to the next available deep injection well (RK20) drilled in the new southern injection area for both Rotokawa and NAP power stations.

Prior to the NAP start-up, the reservoir pressure decline has been estimated at 9-10 bars from the natural-state pressure level (Azwar, 2011).

**NGA AWA PURUA (NAP) PROJECT AND START-UP**

In 2007, resource consents were obtained to further develop Rotokawa. The NAP Geothermal Project was started in May 2008 and was online by April 2010. Details of the project are discussed by McLoughlin et al. (2010).

The new 140 MW NAP development required the drilling of an additional 12 wells (RK19-RK30). Since then, two make-up production wells (RK32 and RK33) have been drilled. The wells are shown in Figure 2. As of 2012, there are a total of 12 active production wells (red), five deep injection wells (blue at SE), three shallow aquifer injection wells (blue at centre), three deep pressure monitoring wells (RK18L2, RK8, and newly-installed RK22). The baseline pre-NAP pressure contour relative to these new wells is shown in Figure 3.

![Figure 1: Location map showing the Rotokawa geothermal field with other nearby geothermal systems. Insert shows the location of the Taupo Volcanic Zone, New Zealand.](image1)

![Figure 2: Location of wells in the Rotokawa Geothermal Field. Insert shows the location of the field in central North Island, New Zealand.](image2)

NAP commissioning increased the Rotokawa geothermal field fluid extraction by about 400% to provide for the new power plant’s fuel requirement. The NAP power station is further described by Horie and Muto (2010). Rotokawa reservoir now supplies a combined installed capacity of 174 MW requiring about 2,570 t/hr total mass flow rate.
Continuous reservoir pressure monitoring: production area

The reservoir pressure response observed in RK18L2 correlated well with the increased production rate while RK8 showed no significant response. This was not entirely unexpected since the RK18 area has shown a good tracer connection with the production area when it was tested in 2006. Although the pressure monitor is in RK18L2 instead of the original RK18 hole, the general reservoir area remains the same. RK18L2 is also relatively closer to the production area than the original RK18 (Figure 2). This provides RK18L2 with good pressure signal for the whole production area and the pressure data was used to represent reservoir pressure decline rate for the whole field in the absence of other effective continuous pressure monitors. In addition, the continuous pressure data was also useful in correlating reservoir pressure responses with changes to operations and power plant shut-downs.

The pressure decline against natural state reservoir pressure is plotted with the overall field production in Figure 4. In 2010, the total field production rate increased from 645 t/hr to around 2,530 t/hr. The reservoir pressure declined by about 10-12 bars in the first year of NAP operation. The initial high-decline period was confirmed by high production decline in the western producing wells (RK17, etc.) and a noticeable increase in field enthalpy from 1480 kJ/kg to around 1560 kJ/kg.

The pressure response has since moderated to around 1.5-2.0 b/yr from mid-2011 to 2012. The reservoir decline stabilized around 16-18 months after NAP commissioning. The total pressure drop observed due to NAP is currently at 15 bars and the field enthalpy has since stabilized. The field enthalpy contour as of 2012 is shown in Figure 5.

The pressure stability has been interpreted as either due to a pseudo-steady state established by the reservoir material balance or an increase in system compressibility due to reservoir thermodynamic changes i.e. two-phase zone development in the production area based on well enthalpy changes.

One factor complicating RK18L2’s pressure response is the strong pressure connection observed between the monitor well and a number of nearby wells. This pressure connection is observed as an increase in pressure decline rate that dominates the RK18L2 response, masking the reservoir pressure decline with a local transient effect. This highlights the need for a closer review of the pressure response relationship with production monitoring to identify local transient effects from general reservoir behavior. This is an ongoing study being done by Hoepfinger (2012).

Figure 3: Reservoir pressure drawdown before NAP start-up (2010) showing the estimated 9-10 bars general pressure drawdown with a localized drop of 30 bars around RK14. Pressure is estimated at -1250 mRL.

Figure 4: Reservoir pressure drawdown from natural state pressure in monitor well RK18L2 showing the pressure behavior before and after NAP start-up.
Figure 5: Field enthalpy contour showing the discharge enthalpy of most of the production wells within the 1550 kJ/kg envelope. The lighter areas have higher enthalpy while the darker areas have lower enthalpy. Enthalpy contour shows that thermodynamic changes could be occurring in the reservoir causing a stabilizing effect on reservoir pressure. Data used are updated as of December 2012.

Continuous reservoir pressure monitoring: injection area

Continuous pressure monitoring equipment was also installed in RK22 to monitor the pressure response of the injection area to the south east of the production wells. The general pressure trend has been stable showing immediate pressure response to changes in injection well operations: pressure build-up during injection start-ups and pressure fall-off during injection shouts. The RK22 pressure monitor with the total injection flow rate is shown in Figure 6.

The data show good pressure connection between monitor well RK22 and injection wells RK20 and RK24 based on the pressure transients when injection rates are reduced or stopped. The historical pressure trend in 2012 suggests that to maintain an almost constant pressure trend, the expected pressure build-up in an assumed closed injection area dissipates or leaks off. The injection fluid is being injected into an area that appears to be connected to a lower pressure reservoir, potentially the main production area or a reservoir connected to a pressure sink.

If the injection area and the production area have very good hydrological connection, the injection area pressure is expected to decline with the general reservoir pressure decline rate due to the negative net voidage in the reservoir. Based on RK22, the injection area has zero pressure change from the initial-state reservoir pressure. This is in contrast to the pressure drawdown observed in the production area. Even if the injection area is connected to the production area, as a means of dissipating pressure to avoid pressure build-up, it has a permeability low enough to maintain a net zero reservoir pressure change as observed in RK22.

Figure 6: RK22 reservoir pressure monitoring in the injection area showing the pressure transients associated with injection rate changes. The pressure trend does not appear to be building up suggesting that the pressure increase related to injection is dissipating or leaking off into a lower-pressure reservoir area.

Periodic downhole pressure measurements

To observe the reservoir pressure response across the Rotokawa geothermal field, periodic downhole pressure measurements were taken from the wells during well shut and analyzed with the RK18L2 pressure response.

Well pressures showed variations from the RK18L2 pressure change as expected, with pressure sinks in the middle of production and lower pressure change farther from the production centers. However, significant pressure gradients were observed between wells and sections in the reservoir that are situated close to each other. These pressure differences
between sections vary from as low as 10 bars to as high as 40 bars at a normalized elevation. These variations suggest some permeability controls are preventing the pressures from equalizing since the pressure measurements were taken during stable shut-in well conditions. There are earlier observations that the Rotokawa reservoir has heterogeneous or “patchy” permeability and wells drilled in the same general location could have very different permeability values. The pressure drawdown contours as of 2012 are shown in Figure 7.

![Figure 7: Pressure drawdown based on field pressure measurements showing localized pressure sinks in the production area (lighter areas) and high pressure gradient between the injection wells (deep blue) and the production wells. Note the current location of the 10-bar pressure drawdown. Data used are updated as of December 2012.](image)

Comparing Figure 7 to the pre-NAP contour (Figure 3), the 10-bar drawdown contour (dashed line) has expanded along the NE-SW direction. The 25-30 bar drawdown contour originally centered at RK14 also expanded along the NE-SW direction with localized higher drawdown contours around RK27L2-RK32 to the SW and RK25 to the NE.

While RK27L2 and RK32 are located in the middle of large producing wells, RK25 is a relatively small well in comparison. The largest producing well in the field, RK29 (50MW) located less than 500 meters to the east of RK25, has only 2-bar pressure drawdown suggesting a 40-bar pressure gradient exists between RK25 and RK29. To the north of the RK25 is RK6, an idle well, with also a minor 2-bar pressure drawdown acting as control points for the pressure contours around RK25. Note that in Figure 3, this RK25-RK29 area had zero pressure drawdown, suggesting they were not affected by the 13-yr Rotokawa station operation with active production wells nearby (RK5, RK13, and RK14).

From Figure 3, the active Rotokawa station production wells appear to have no response to NAP except for RK13’s increased pressure drawdown. RK5 and RK14 have negligible additional pressure drawdown after two years of NAP operation maintaining the pressure gradient between RK5 and RK14. This is an unexpected response assuming a well-connected production area unless there are permeability controls or strong recharge keeping the pressures constant in both RK5 and RK14. The same inference can be extended to RK29’s lack of significant pressure drawdown.

Pressure measurements from the injection wells confirmed the RK22 pressure trend of stable pressures in the injection area. The strong pressure signal observed between RK22 and the injection wells is consistent with the production area’s NE-SW pressure-connection trend. This trend may also contribute to the pressure dissipation occurring in the injection area in addition to the pressure support across to the production area as confirmed by a recent reservoir tracer test (Winick, 2013).

The 2012 pressure drawdown contours confirm Azwar’s proposed concept of pressure-based reservoir compartments adopted into the conceptual model update (2011). There are ongoing investigations to characterize the pressure or permeability controls of the field ranging from a review of the geologic structural model, using micro-seismicity data gathered as a response to ongoing production, and re-analyzing all available pressure transient data to identify boundaries.

**Reservoir compartments**

Reservoir compartmentalization has been observed and characterized in different operating geothermal fields. The following examples are available for further details on the observations, characterization and compartment response to production: Nesjavellir geothermal field in Iceland (Stefansson, 1985), Awibengkok geothermal field in Indonesia (Stimac, et. al., 2008), Bulalo geothermal field in the Philippines (Strobel, 1993).

Large variations in pressure drawdown across the geothermal field consistent with repeat measurements suggest that the different sections of the reservoir
have pressure or permeability controls maintaining large pressure gradients over a small area. The proposed compartments are shown in Figure 7.

This type of compartmentalized pressure behavior was initially inferred in RK9 and RK14 while the field’s erratic permeability has been noted as early as the initial completion tests of RK1-6 and RK8 (Grant, 1985).

Structural models developed for Rotokawa (Bardsley, 2010; O’Brien et al., 2011) indicate the correlation of structural elements to the presence of high pressure gradients. This is consistent with structural permeability controls limiting rapid pressure equalization between reservoir areas. An example of this is the 25 to 35-bar pressure gradient between the main production area and the injection area, with a known fault dividing the two sectors (Bowyer, 2010).

Also, the pressure compartment around the RK17 area appears to be consistent with a fault that is believed to be the main conduit for the 2006 reservoir tracers showing good connection from RK18 through the RK17 area as far north-east as RK13.

The results of an ongoing structural model review will provide better information regarding the permeability controls in the field, especially around RK29, and improve the characterization of the reservoir compartments (Bardsley, 2012).

**MODELLING THE PRESSURE RESPONSE**

**Compartment conceptual models**

In the absence of a fully developed model for the field permeability controls, a few compartment conceptual models are proposed as basis for simplified modeling.

One of these models, model A, is a compartment box surrounded by a semi-permeable wall, dividing the inner compartment from the outer area. The semi-permeable wall acts as a flow barrier creating the pressure gradient. The inner and outer sections can be of the same permeability.

Another model, model B, is a compartment box enclosed by a volume of rock with a different permeability. The permeability difference between the inner and outer box creates the pressure gradient.
Another model, model C, is a compartment created either as a stimulation effect or as skin-damage effect from drilling. The radius of the damage is such that the well appears to be sited in a different permeability even if it is in the same formation and similar permeability as the “outer” box.

The conceptual models are shown in Figure 8.

![Figure 8: Compartment conceptual models used as basis for simplified modeling to match the observed pressure responses. The blue circle in the middle represents the observation well and the area around it is the “compartment.”](image)

The permeability controls in all these models are assumed to be constant with respect to time and no significant permeability enhancement or permeability reduction is expected over the period for modeling analyses. Note that dynamic permeability has been observed in geothermal settings and there are indications of this possibly happening in Rotokawa (Quinao, 2012).

The succeeding process models are based on conceptual model A, matching production and injection compartments.

**Process Modeling: Saphir©**

A process model using Saphir©, a well-test interpretation software, was set-up to match and interpret the continuous pressure data response to production (RK18L2) and injection (RK22). The software is limited to isothermal fluids but has the capability to include multiple wells. Modeling and interpreting reservoir pressure changes using Saphir© has been done in Tiwi’s Matalibong steam zone with a similar caution on the software isothermal limitations (Menzies, et. al., 2011).

The Saphir© modeling results are based on isothermal liquid water with compressibility about 2 to 3 degrees of magnitude lower than two-phase fluid. This compressibility difference means that the reservoir size of the Saphir© match will be larger than the reservoir size of a more compressible system. Although field data shows Rotokawa is still a generally saturated liquid reservoir, layers of two-phase and highly compressible fluid may be present.

Saphir© numerical modeling is useful for simple models of reservoirs with continuous pressure monitoring. The pressure transient responses may be used to constrain the value of the reservoir parameters through an analytical solution match and using the result of the analytical solution to match the historical pressure history of the monitoring well as affected by multiple active wells through numerical simulation.

The analytical model used has homogeneous permeability with an infinite-acting reservoir boundary. The resulting reservoir parameters are then applied to a closed-boundary rectangular reservoir model optimizing the minimum area required to match the pressure transient response. These analytical results are used as inputs in the numerical model match, using the optimized rectangular area as an initial value for reservoir area.

**RK18L2 pressure match**

The continuous pressure profile from RK18L2 is observed to have a high initial pressure decline similar to a pressure fall-off transient response to production followed by a stable pressure decline rate at 2 b/yr. Field shut-downs and the corresponding well shut-ins have also shown up as pressure build-up signals. The pressure fall-off and build-up signals were both used in the analytical model and reasonable pressure matches to the historical data were obtained through numerical simulation. All the active production wells were included in the analysis.

Table 1 lists the parameters used in both the analytical and numerical model matches assuming a homogeneous permeability reservoir model. The resulting average reservoir transmissivity of 16.3 Darcy.meters is lower than expected, but is likely the average bulk reservoir transmissivity accounting for the reservoir heterogeneity.

The stable pressure decline rate at 2 b/yr requires a closed boundary reservoir to match the pseudo-steady state pressure decline rate. The resulting closed boundary reservoir size for the numerical model match is very large, representing a large area.
providing recharge into the geothermal system. Even with the large reservoir size, it was found out that it is still necessary to set a small section of the boundary to constant pressure to match the pressure decline rate. The constant pressure boundary was located in the injection area to represent injection pressure support consistent with the 2012 pressure drawdown contours.

In summary, the RK18L2 analytical and numerical Saphir© models show a low average reservoir transmissivity. The production reservoir increased compressibility and/or pulled in recharge fluid as a response to NAP production. The low transmissivity may be due to the response of pressure passing through an anisotropic reservoir. The lack of long-term pressure transient data in other wells also limit the ability to identify boundaries and to establish permeability controls through pressure transient analysis. Although the model is simple, the pressure match is satisfactory and may be used for short-term forecasts.

**RK22 pressure match**

The RK22 downhole pressure monitoring equipment, installed midway through the field response to NAP, records the reservoir pressure changes in the injection area with the changes to injection rates and general reservoir response to operations. The pressure fall-off during injection well shuts were used for pressure transient analysis while the historical pressure data were used to match the numerical model. Table 2 lists the parameters used in the analytical and numerical model matches while Figure 10 shows the simulated pressure match to the actual pressure data.

**Figure 10:** Simulation pressure match using Saphir© process model to match the RK22 pressure data in the injection area.

The average reservoir transmissivity is higher than the RK18L2 result suggesting better connection between injection wells than between production wells. The range of transmissivity from 33-46 Darcy.meters is typical of geothermal systems.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>320°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average porosity</td>
<td>7%</td>
</tr>
<tr>
<td>Water saturation</td>
<td>100%</td>
</tr>
<tr>
<td>Total compressibility</td>
<td>$1.1 \times 10^{-9} \text{ Pa}^{-1}$ ($1.1 \times 10^{-8}$)</td>
</tr>
<tr>
<td>Fluid viscosity</td>
<td>$7.98 \times 10^{-5} \text{ Pa} \cdot \text{s}$</td>
</tr>
<tr>
<td>Reservoir transmissivity</td>
<td>16.3 Darcy.meters</td>
</tr>
<tr>
<td>Reservoir size</td>
<td>357 km² (72 km²)</td>
</tr>
</tbody>
</table>

Table 1: Analytical and numerical input and results data for RK18L2. Values in parentheses represent results for increased system compressibility.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>330°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average porosity</td>
<td>1.5-2%</td>
</tr>
<tr>
<td>Water saturation</td>
<td>100%</td>
</tr>
<tr>
<td>Total compressibility</td>
<td>$1.15 \times 10^{-9} \text{ Pa}^{-1}$</td>
</tr>
<tr>
<td>Fluid viscosity</td>
<td>$7.81 \times 10^{-5} \text{ Pa} \cdot \text{s}$</td>
</tr>
<tr>
<td>Reservoir transmissivity</td>
<td>33-46 Darcy.meters</td>
</tr>
<tr>
<td>Reservoir size</td>
<td>7 km²</td>
</tr>
</tbody>
</table>

Table 2: Analytical and numerical input and results data for RK22.

The reservoir size is also sensitive to the total system compressibility input in the model. The models assume liquid compressibility. RK18L2 measures the pressure signal of a production area that has increased discharge enthalpy (Figure 5) and has a potential two-phase layer. The compressibility of two-phase fluid is about 2 to 3 magnitudes higher than that of liquid water (Brock, 1986). A model with higher total compressibility (1 magnitude higher) was run and as expected, this reduced the reservoir area down to 72 km² while maintaining and improving the pressure simulation match.

The numerical model matches to actual pressure data from RK18L2 is shown in Figure 9. Increasing the total compressibility of the system provides a closer match on the build-up pressure transients.

![Figure 9](image-url)
During the process of numerical model matching, it was found out that the RK22 pressure response requires RK20, RK23, and RK24 to be active and connected while RK21 has to be deactivated to match the pressure history.

In addition, a closed reservoir with a section of constant pressure boundary was required to get a good match. The total reservoir size was 7 km$^2$ with the constant pressure boundary located in the current production area to represent the pressure sink due to fluid extraction. The injection area does not appear to be changing thermodynamically in a way that would significantly affect system compressibility but there are still potential errors in using the initial state layer temperature (330 °C) to estimate fluid parameters when injection-related cooling might be occurring in the area.

In summary, the RK22 analytical and numerical Saphir© models show a strong connection between the injection wells. The injection compartment was also modeled to have a closed boundary with a constant pressure segment that acts as a pressure leak for the injection area.

**Analyzing the production and injection compartment connection**

A Saphir© model that uses all the production and injection wells to match the pressure profile in both RK18L2 and RK22 was done.

It was found difficult to match RK22 well pressure data without introducing permeability barriers as the simulated pressure falls off with the general reservoir decline.

RK18L2 pressure can be matched with all production and injection wells active. The match requires a closed boundary condition with a small segment set to constant pressure. This section of constant pressure boundary was required even with increased (one magnitude) compressibility suggesting that either a higher compressibility area exists in the reservoir or marginal recharge is providing additional pressure support to RK18L2.

The reservoir transmissivity, $kh$, measured from RK18L2 decreases to 11-13.6 Darcy.meters, probably because of the lower permeability dividing the production and injection areas. A composite reservoir model for Rotokawa has not been tested at this point and would be part of the recommendations.

**FORECASTING THE PRESSURE RESPONSE**

The short-term forecast for the reservoir pressure in RK18L2 was simulated using the current rates of all the production and injection wells and testing the effect of changing the production rates in nearby RK17 compartment. The results are shown in Figure 11.

![Figure 11: Simulation pressure forecast at RK18L2 using the process model that includes all production and injection wells. Short-term forecast at current rates (red) shows a pressure decline rate stable at 1 b/yr. To demonstrate the effect of nearby compartments to the RK18L2 pressure, production in RK17 area was reduced and moved to RK29 area (green dashed line).](image)

The simulated pressure under current rates show a stable decline rate at about 1 b/yr. Changing the production distribution between the different wells, for example by reducing RK17 compartment production and moving it to RK29 area, results in a transient pressure response that still stabilizes at a decline rate of 1 b/yr.

This forecast results show that the general reservoir pressure decline rate may be stable but local well activities can temporarily affect the pressure response, either as a transient pressure recovery or a transient pressure drawdown.

**CONCLUSIONS**

The Rotokawa response to increased mass production has shown that:

1. The reservoir pressure decline rate has stabilized at 2 b/yr 16-18 months after the increased take;
2. Pressure drawdown contours in 2012 suggests potential permeability controls (compartmentalization) affecting the pressure distribution in the field;
3. Simple models can be used to analyze and simulate the pressure responses observed in continuous downhole pressure monitoring;
4. Short-term forecasts of pressure behavior can be done with simple process models.
NEXT STEPS
Based on the findings of this paper, it is recommended to:
1. Analyze the models and the pressure response using a software that accounts for two-phase conditions (Petrasim©). This is to verify the pressure effects of changes to system compressibility;
2. Explore the compartment connections in detail using composite reservoirs models and/or process models.
3. Correlate the pressure drawdown contours with the updated Rotokawa structural model.

ACKNOWLEDGEMENTS
The authors would like to thank the Rotokawa Joint Venture Ltd. (Mighty River Power Ltd. and Tauhara North No.2 Trust) for allowing the publication of this paper.

REFERENCES


