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Release 1

Kirkby, A.L. and Gerner, E.J.

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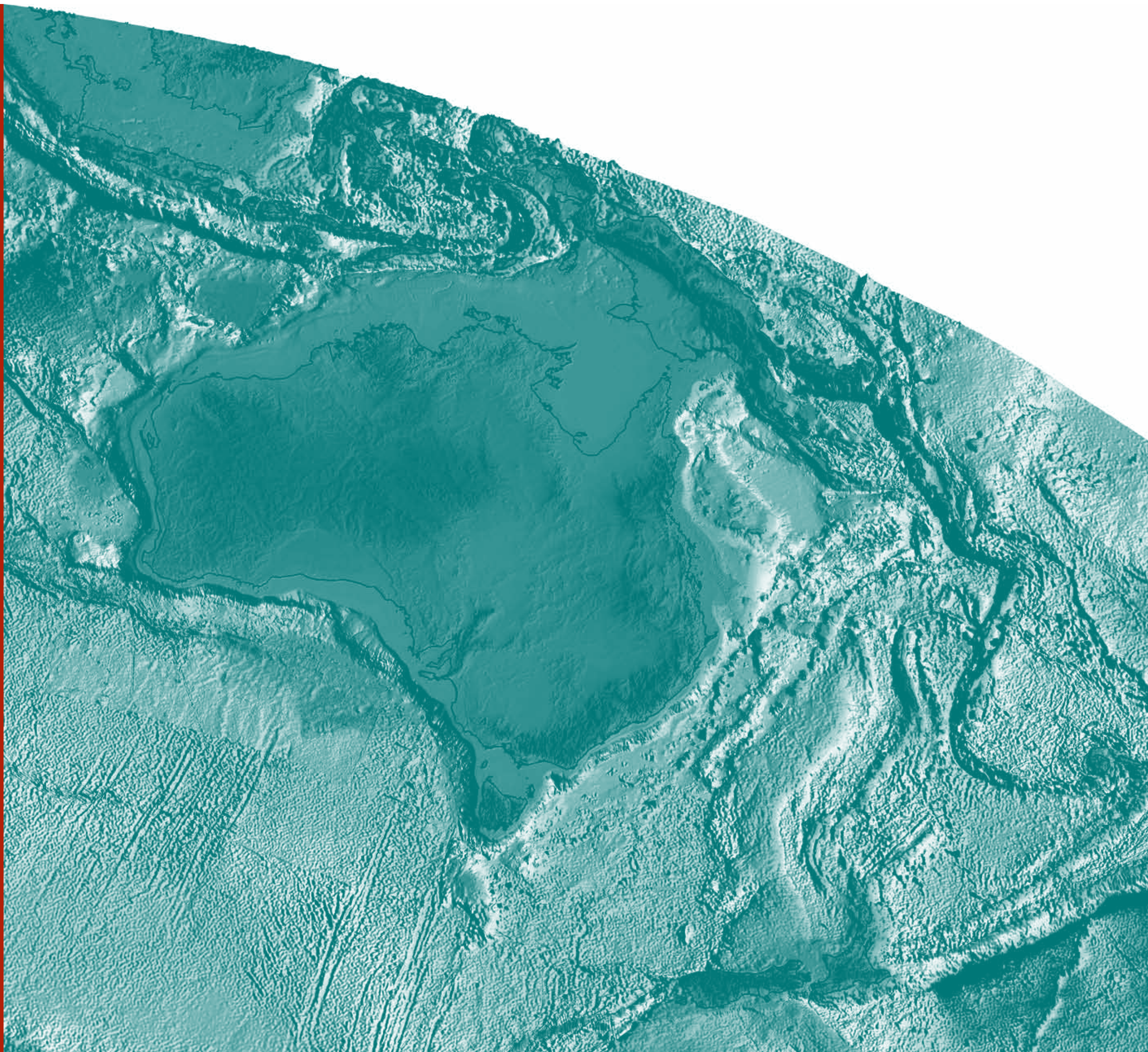

APPLYING GEOSCIENCE TO AUSTRALIA'S MOST IMPORTANT CHALLENGES

Heat Flow Interpretations for the Australian Continent: Release 1

GEOSCIENCE AUSTRALIA
RECORD 2010/41

by

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Australian Government
Geoscience Australia

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Executive Summary

Current understanding of Australia's geothermal resources is based on limited data such as temperature measurements taken in petroleum and mineral boreholes across the country. Heat flow studies are rarer, with existing publicly available compilations containing less than 150 heat flow data-points for Australia. Both temperature and heat flow data are unevenly distributed and, where no data exist, the available information has been interpolated over large areas to generate national-scale maps.

Geoscience Australia has acquired the field and laboratory equipment required to measure heat flow. It began thermal logging of boreholes across Australia in late 2008 and has since collected 155 temperature logs. In late 2009, the thermal conductivity meter became operational, allowing the project to begin thermal conductivity measurements of samples collected from logged boreholes. To help clear some of the backlog of samples collected during 2008-09, the measurement of some of these samples has been contracted out.

This record details the first set of new heat flow interpretations to be released by Geoscience Australia. The remaining temperature logs will be interpreted for heat flow and released, as thermal conductivity data for these holes become available.

Introduction

Eleven new heat flow interpretations have been made in areas of Queensland, NSW and WA. The interpretations are based on thermal gradient logs together with 3-10 thermal conductivity measurements per hole. The holes, their location, and their interpreted heat flow value are summarised in Table 1. These details, together with files containing the raw data used in the interpretation, are attached as digital appendices (1-4).

Table 1. Name, location, logged depth (measured depth and true vertical depth), mean dip, and interpreted heat flow for the 11 holes discussed in this report.

WELL NAME	REGION	LATITUDE (GDA 94)	LONGI-TUDE (GDA 94)	LOGGED DEPTH, M		MEAN DIP	HEAT FLOW, mW/M^2
				LOGGED DIST.	TRUE VERT. DEPTH		
ABJ014	Goomeri, QLD	-25.92271	152.03511	713.0	635.3	-63	76 ± 6
CNYDD004W1	Cobar, NSW	-32.11410	146.32370	835.0	715.7	-59*	93 ± 7
DD09NC0101	Cobar, NSW	-31.51298	145.85690	659.6	602.6	-66*	106 ± 5
08MGDD014	Kalgoorlie, WA	-31.00820	121.92144	368.0	350.0	-72	41.5 ± 1.5
MYACD001	Narromine, NSW	-32.36503	148.03936	237.2	205.4	-60	41-58
MYACD002	Narromine, NSW	-32.36671	148.03803	333.0	291.2	-61*	52 +4/-6
NMD134	Forrestania, WA	-32.45535	119.68383	647.2	581.7	-64	44 ± 2
SED246	Forrestania, WA	-32.72147	119.81375	951.0	926.6	-77	34 ± 3
WYACD006	West Wyalong, NSW	-33.83921	147.43004	594.4	514.8	-60	50 ± 3
WYACD007	West Wyalong, NSW	-33.81729	147.44421	363.2	314.5	-60	47 ± 5
WYACD008	West Wyalong, NSW	-33.81587	147.45050	403.0	349.0	-60	42 ± 2

*Downhole survey information available as .csv files (Appendix 2). Dip given is a mean for the hole.

Input Data

TEMPERATURE LOGS

Temperature logging of the holes was undertaken using either an Auslog A626 combined temperature/gamma probe, or an Auslog A621 temperature only probe. The probes have a temperature precision of 0.007°C and can be used at temperatures up to 70°C. The logging winch held 1800m of 4-conductor cable, sufficient to log all holes to full depth or to where the holes were blocked. Communication with the tools and data recording was through an Auslog DLS5 digital logging system connected to a laptop computer. Data was continuously recorded downwards into the hole at a speed of approximately 5m per minute; a logging interval of 20cm was used. All holes were logged as long as possible after drilling, within the constraints of accessibility, to ensure that the hole was as close to thermal equilibrium as possible. However, in some cases it is unlikely that the hole was at equilibrium when logged. Where this is the case, a note has been made in the results. Once collected, the temperature logs were converted from measured depth (logged distance along drillhole) to true vertical depth using survey information, and smoothed using a 3 point running mean. The raw temperature logs (as .las files) can be found in Appendix 3.

THERMAL CONDUCTIVITY MEASUREMENTS

Core specimens were collected from each hole in order to perform thermal conductivity measurements. Approximately 15cm long core samples were collected at intervals of 50-100m down each hole. Where available, lithology logs were used to select representative samples. In addition, where possible the temperature and gamma logs were inspected prior to core sampling to ensure samples were collected in areas where there was little fluctuation in the logs.

The samples were measured by Hot Dry Rocks Pty Ltd during 2010 using a divided bar apparatus. Up to three samples were prepared from each specimen to investigate variation in thermal conductivity over short distance scales, and to determine mean conductivity and uncertainty. Each sample was ground flat and polished, then evacuated under a >95% vacuum for at least 3 hours. Samples were then submerged in water prior to returning to atmospheric pressure. Samples were left in water at atmospheric pressure for a minimum of twelve hours, and all samples were left in water until just prior to conductivity measurement.

All samples were measured for thermal conductivity at a temperature of 30±2°C. Samples were oriented so that thermal conductivity was measured in the direction of the long axis of the core. The results are presented in spreadsheet form in Appendix 4.

Heat Flow Calculation Method

Heat flow interpretations were made using the following method:

- A depth interval interpreted to represent conductive heat flow was selected from the temperature log, avoiding the near surface parts of the log likely to be seasonal effects, and also any sections with indication of being influenced by significant advective flow. The top of the selected interval was taken to be the surface for the purposes of 1D heat flow modelling.

- Thermal conductivity values and depth information were inspected to determine which values correspond to the conductive section of the temperature log.

- The conductive section of the hole was divided into sub-sections to coincide with the thermal conductivity values. Boundaries between sub-sections were determined based on significant changes in the gamma or lithology logs (where available), otherwise they were taken to be the mid-point between thermal conductivity measurements. Since in most cases, thermal conductivity measurements were taken at 50-100m intervals down the hole, it was necessary to assume that each measurement was representative of a section of the temperature log of approximately this length.

- Thermal conductivity values and depths defining the extent of each sub-section were entered into a 1D conductive heat flow modelling spreadsheet. Modelling was started at the top of the conductive section, using the measured temperature at that point. Starting from this point, the spreadsheet used the measured thermal conductivities and the sub-section boundaries assigned above, together with a constant heat flow value for the hole, to predict temperature at the base of each successive thermal conductivity sub-section.

- The predicted temperatures were then plotted together with the temperature log, and the heat flow value adjusted until the modelled temperature predictions matched the logged temperature data.

- Errors on the heat flow measurement were determined by shifting the boundaries between thermal conductivity measurements, first to emphasise the higher conductivities and therefore requiring a lower heat flow to match the data, and then to emphasise the lower thermal conductivities, requiring a higher heat flow to fit the data. The reported errors are the difference between these upper and lower bounds, and the median fit.

Results

ABJ014

ABJ014 is located in southeast Queensland approximately 30km north of Goomeri. It was drilled by Activex Limited, and logged by Geoscience Australia (GA) using the combined temperature/gamma probe to a depth of 712.5m (measured depth) approximately a month after drilling. Therefore it is uncertain whether the hole had reached equilibrium prior to temperature logging. No lithological logs from this hole were provided to GA.

Visual inspection of the temperature gradient profile shows that above 175 true depth (196m measured depth), the gradient is disturbed. Therefore our heat flow interpretation is based only on data below this point.

Boundaries between thermal conductivity measurements were picked using the gamma log where there were distinguishable variations in the signal. In other cases, the boundary was assumed to be half way between measurement points. In the case of sample ACTVX/6, the thermal conductivity value was significantly lower than all other measured values for this hole. Because there was no obvious change in gradient accompanying this point, and because it coincides with a small gamma spike of limited extent, the simplest explanation is that this sample is not representative of the dominant lithology in the hole. Therefore this thermal conductivity measurement has been given a limited extent. Table 2 shows the picked boundaries and the rationale behind each selection.

Table 2. Sub-section boundaries for ABJ014 and the reason for the selection of each boundary.

SAMPLE NAME	SECTION TOP, M (TRUE DEPTH)	SECTION BOTTOM, M (TRUE DEPTH)	THERMAL CONDUCTIVITY	ERROR	RATIONALE (BOTTOM BOUNDARY)
ACTVX/2	175.0	225.0	2.76	0.02	Mid point between measurements
ACTVX/3	225.0	311.0	3.53	0.03	Change in gamma log
ACTVX/4	311.0	375.0	2.79	0.02	Change in gamma log
ACTVX/5	375.0	518.0	2.74	0.10	Change in gamma log
ACTVX/6	518.0	523.0	1.54	0.15	Change in gamma log
ACTVX/7	523.0	616.0	2.74	0.16	Bottom of conductive section

Taking the above boundaries (and modifying them to determine error bounds) the conductive heat flow for ABJ014 is interpreted to be **76±6 mW/m^2**. The model is plotted along with the measured data in Figure 1.

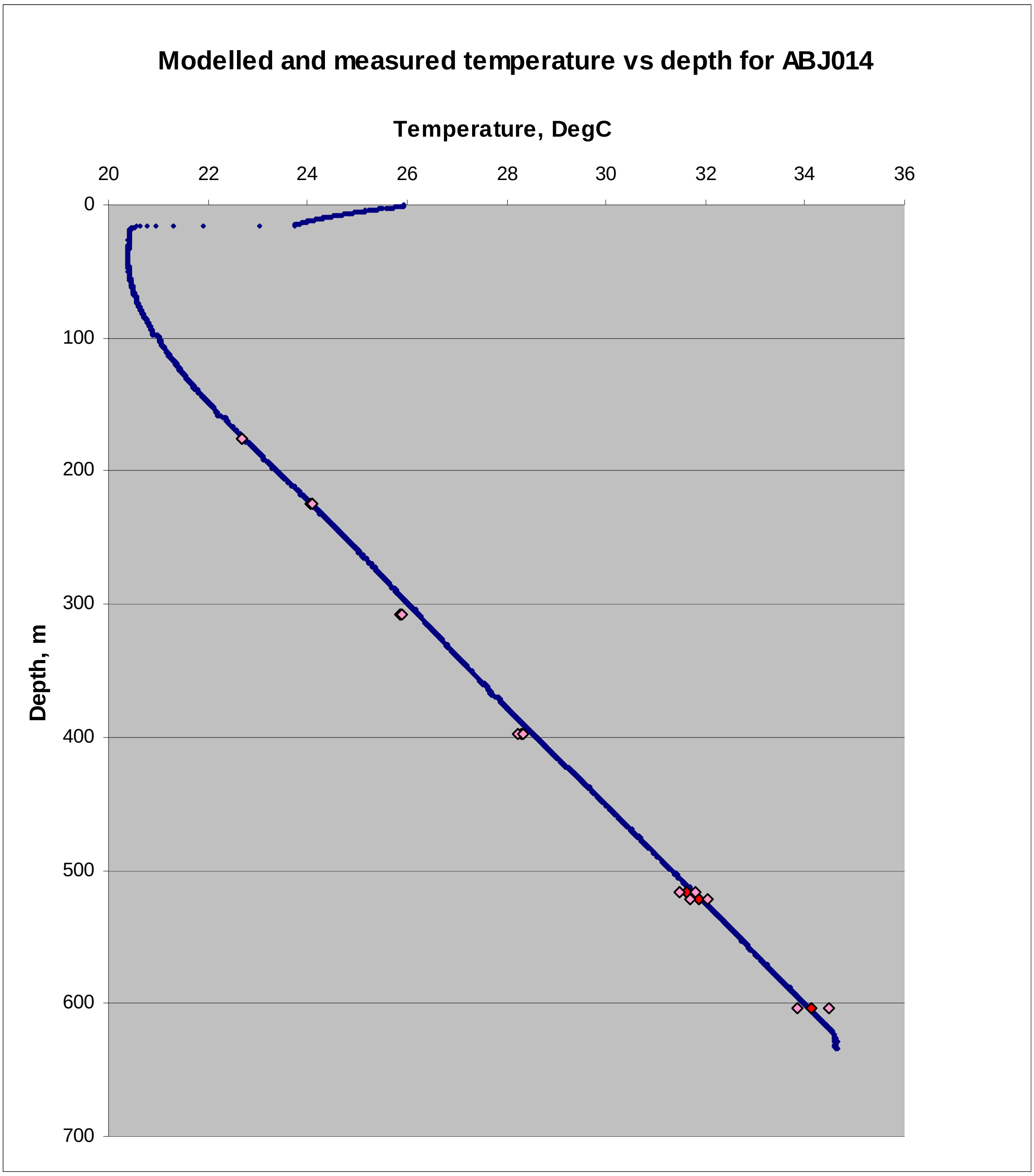

***Figure 1**. Modelled and measured temperature vs. true depth for ABJ014. Blue line shows measured data, red and pink dots show predicted temperature at the base of each thermal conductivity section (pink dots indicate error bounds in predicted temperature).*

CNYDD004W1

CNYDD004W1 is located in central NSW, approximately 90km SE of Cobar. It was drilled by YTC Resources, and logged by GA using the temperature only probe to a total depth of 835.2m (measured depth). It is not certain whether this hole had reached thermal equilibrium when it was logged. No lithological logs were provided to GA.

Visual inspection of the temperature gradient profile shows that above 200m true depth (218m measured depth), the gradient is disturbed. Therefore our heat flow interpretation is based only on data below this point.

Because there were no data to constrain the location of boundaries between thermal conductivity measurement points, the boundaries were taken to be the mid point between each measurement point (Table 3).

Table 3. Sub-section boundaries for CNYDD004W1 and the reason for the selection of each boundary.

SAMPLE NAME	SECTION TOP, M (TRUE DEPTH)	SECTION BOTTOM, M (TRUE DEPTH)	THERMAL CONDUCTIVITY	ERROR	RATIONALE (BOTTOM BOUNDARY)
YTC/8	200.0	248.8	4.70	0.12	Mid point between measurements
YTC/9	248.8	322.4	4.76	0.17	Mid point between measurements
YTC/10	322.4	386.2	5.18	0.21	Mid point between measurements
YTC/11	386.2	454.7	4.49	0.12	Mid point between measurements
YTC/12	454.7	567.5	4.85	0.13	Mid point between measurements
YTC/13	567.5	671.6	5.09	0.14	Mid point between measurements
YTC/14	671.6	710.0	4.41	0.11	Bottom of conductive section

Taking these boundaries (and modifying them to determine error bounds) the conductive heat flow for CNYDD004W1 is interpreted to be **93±7 mW/m^2**. The model is plotted along with the measured data in Figure 2.

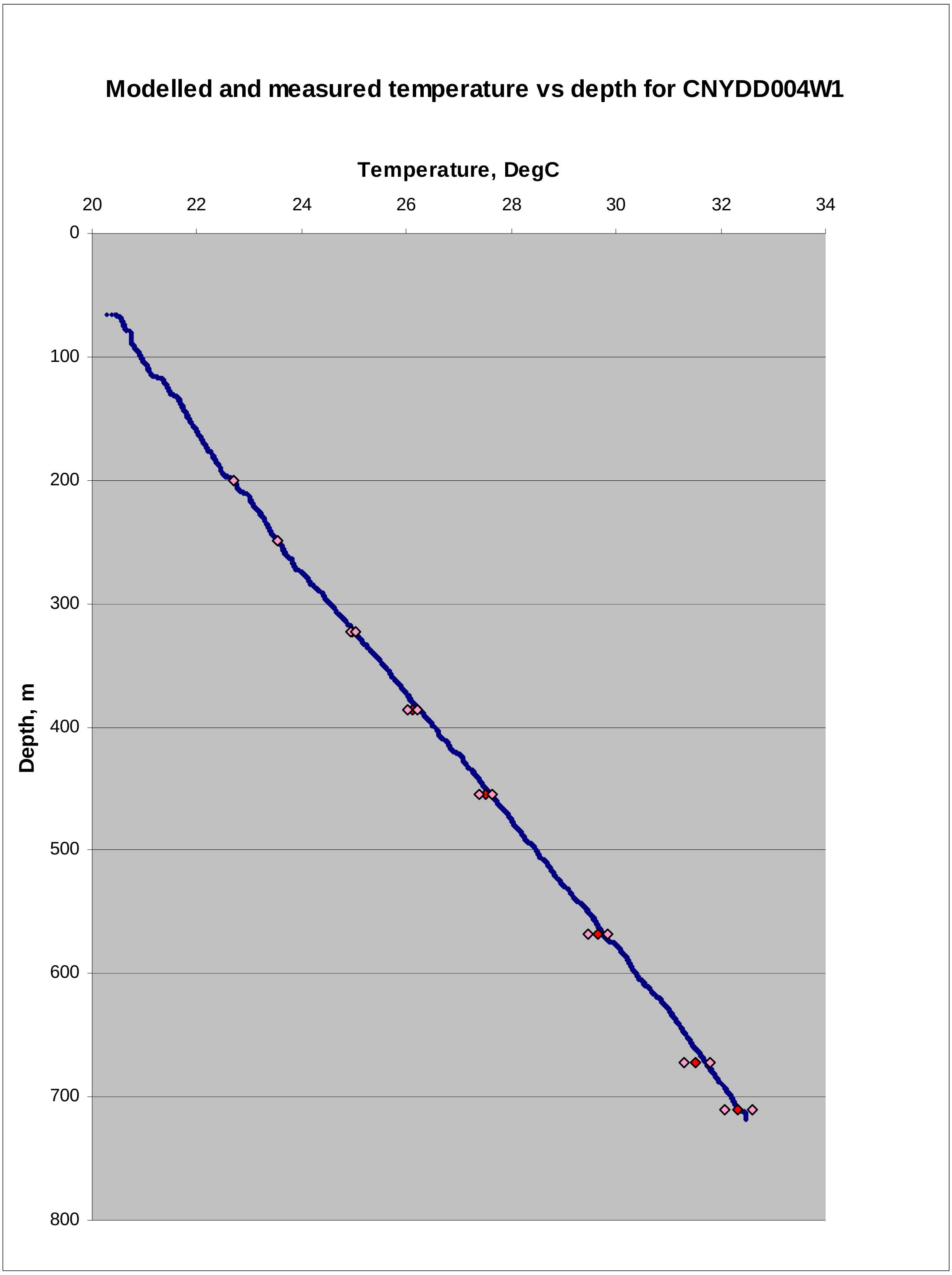

Figure 2. *Modelled and measured temperature vs. true depth for CNYDD004W1. Blue line shows measured data, red and pink dots show predicted temperature at the base of each thermal conductivity section (pink dots indicate error bounds in predicted temperature).*

DD09NC0101

DD09NC0101 is located in central NSW, approximately 2km SE of Cobar. It was drilled by Peak Gold, and logged by GA using the temperature only probe to a total depth of 659m (measured depth). Lithological logs were provided to GA.

Visual inspection of the temperature gradient profile shows that above 215m true depth (221m measured depth), the gradient is disturbed. Therefore our heat flow interpretation is based only on data below this point.

Because only sections of the temperature log below 215m were used, only two thermal conductivity measurements were available for this hole. The lithology log was inspected but it was found that there were no major lithological breaks between the two thermal conductivity measurements. Therefore, the boundary between the measurements was taken to be the mid-point between the samples. A change in lithology occurs at approximately 560m measured depth, and this was taken as the bottom of the profile for the purposes of the interpretation. The sub-section boundaries selected for 1D heat flow modelling are listed in Table 4. Taking these boundaries (and modifying them to determine error bounds) the conductive heat flow for DD09NC0101 is interpreted to be **106±5 mW/m^2**. The model is plotted along with the measured data in Figure 3.

Table 4. Sub-section boundaries for DD09NC0101 and the reason for the selection of each boundary.

SAMPLE NAME	SECTION TOP, M (TRUE DEPTH)	SECTION BOTTOM, M (TRUE DEPTH)	THERMAL CONDUCTIVITY	ERROR	RATIONALE (BOTTOM BOUNDARY)
Peak0101/4	215.0	427.9	5.32	0.13	Mid point between measurements
Peak0101/5	427.9	560.0	5.01	0.11	Bottom of conductive section

Figure 3. *Modelled and measured temperature vs. true depth for DD09NC0101. Blue line shows measured data, red and pink dots show predicted temperature at the base of each thermal conductivity section (pink dots indicate error bounds in predicted temperature).*

08MGDD014

08MGDD014 is located in WA, approximately 50km southeast of Kalgoorlie. It was drilled by Silverlake Resources, and logged by GA using the combined temperature/gamma probe to a depth of 367.8m (measured depth). No lithological logs were provided to GA.
Visual inspection of the temperature gradient profile shows that above 100m true depth (105m measured depth), the gradient is disturbed. Therefore our heat flow interpretation is based only on data below this point.

Boundaries between thermal conductivity measurements were picked using the gamma log where there were distinguishable variations in the signal. In other cases, the boundary was assumed to be half way between measurement points. Table 5 shows the picked boundaries and the rationale behind each selection.

Table 5. Sub-section boundaries for 08MGDD014 and the reason for the selection of each boundary.

SAMPLE NAME	SECTION TOP (M, TRUE DEPTH)	SECTION BOTTOM (M, TRUE DEPTH)	THERMAL CONDUCTIVITY	ERROR	RATIONALE (BOTTOM BOUNDARY)
SILVER/1	100.0	153.5	4.19	0.06	Mid point between measurements
SILVER/2	153.5	221.0	3.96	0.02	Change in gamma log
SILVER/3	221.0	268.9	4.03	0.08	Mid point between measurements
SILVER/4	268.9	311.5	4.06	0.05	Change in gamma log
SILVER/5	311.5	327.9	3.63	0.17	Change in gamma log
SILVER/6	327.9	340	3.54	0.21	Bottom of conductive section

Taking the above boundaries (and modifying them to determine error bounds) the conductive heat flow for 08MGDD014 is interpreted to be **41.5±1.5 mW/m^2**. The model is plotted along with the measured data in Figure 4.

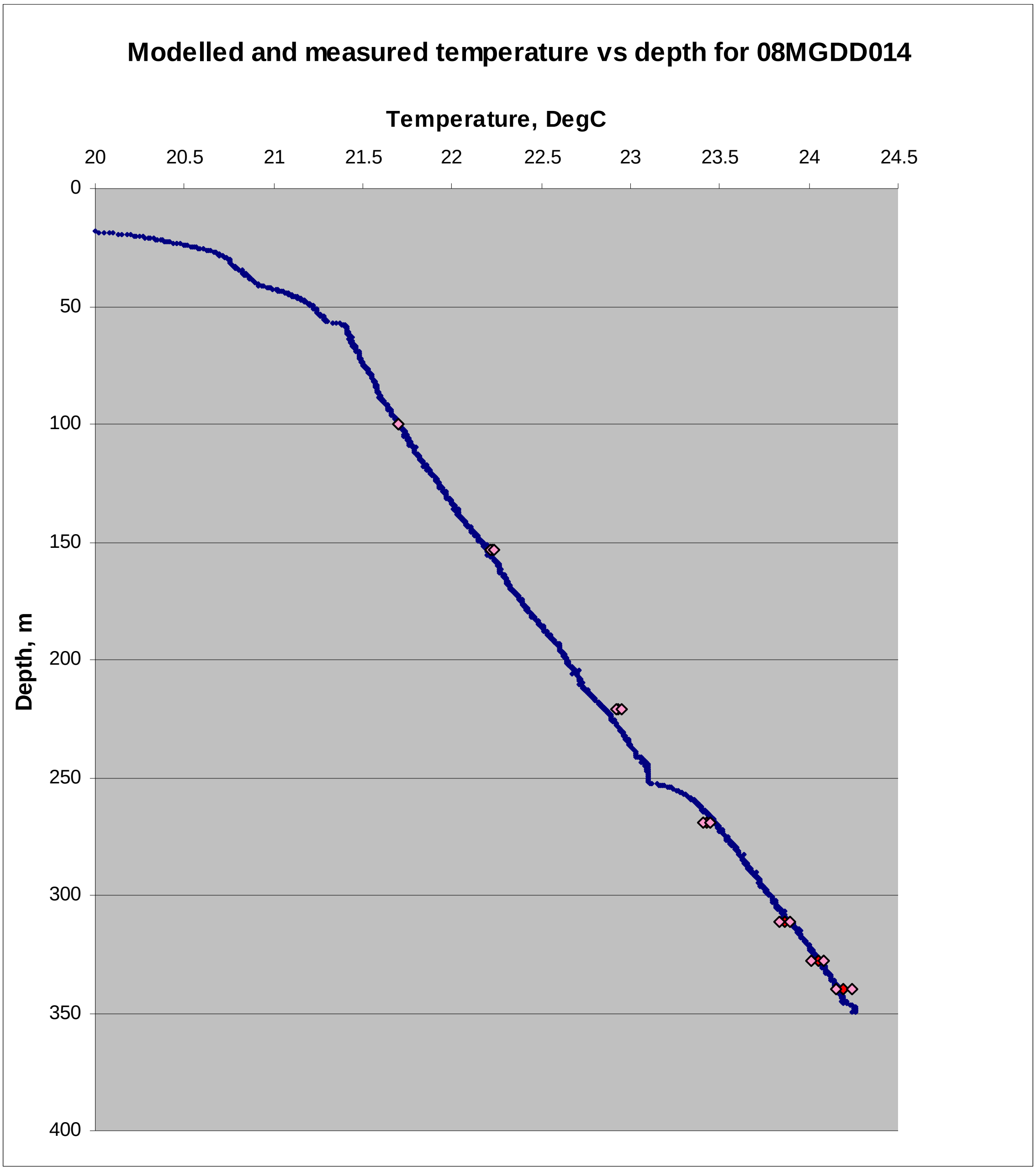

Figure 4. *Modelled and measured temperature vs. true depth for 08MGDD014. Blue line shows measured data, red and pink dots show predicted temperature at the base of each thermal conductivity section (pink dots indicate error bounds in predicted temperature).*

MYACD001

MYACD001 is located in central NSW, approximately 25km SW of Narromine. It was drilled by Gold Fields Limited, and logged by GA using the temperature only probe to a total depth of 237m (measured depth). It is not certain whether this hole had reached thermal equilibrium when it was logged. No lithological logs were provided to GA.

Visual inspection of the temperature gradient profile shows that above 120m true depth (139m measured depth), the gradient is disturbed. Therefore our heat flow interpretation is based only on data below this point.

In the absence of lithology or gamma logs, the boundaries between thermal conductivity measurements were taken to be the midpoints between each measurement (Table 6).

Table 6. Sub-section boundaries for MYACD001 and the reason for the selection of each boundary.

SAMPLE NAME	SECTION TOP (M, TRUE DEPTH)	SECTION BOTTOM (M, TRUE DEPTH)	THERMAL CONDUCTIVITY	ERROR	RATIONALE (BOTTOM BOUNDARY)
GOLD001/1	120.0	141.0	3.03	0.23	Mid point between measurements
GOLD001/2	141.0	175.9	3.59	0.02	Mid point between measurements
GOLD001/3	175.9	197.0	2.66	0.28	Bottom of conductive section

The resulting temperature profile does not fit the measured data well. Possible explanations for this include;

- the profile is not purely conductive; and/or
- the thermal conductivity samples are not representative of the formations in the well. This would explain marked changes in gradient at 157m, 160m, 176m and 187m true depth.

In conclusion it is not certain whether a conductive profile explains these data. However it is estimated that the heat flow at this location is between **41-58 mW/m^2**. The model is plotted along with the measured data in Figure 5.

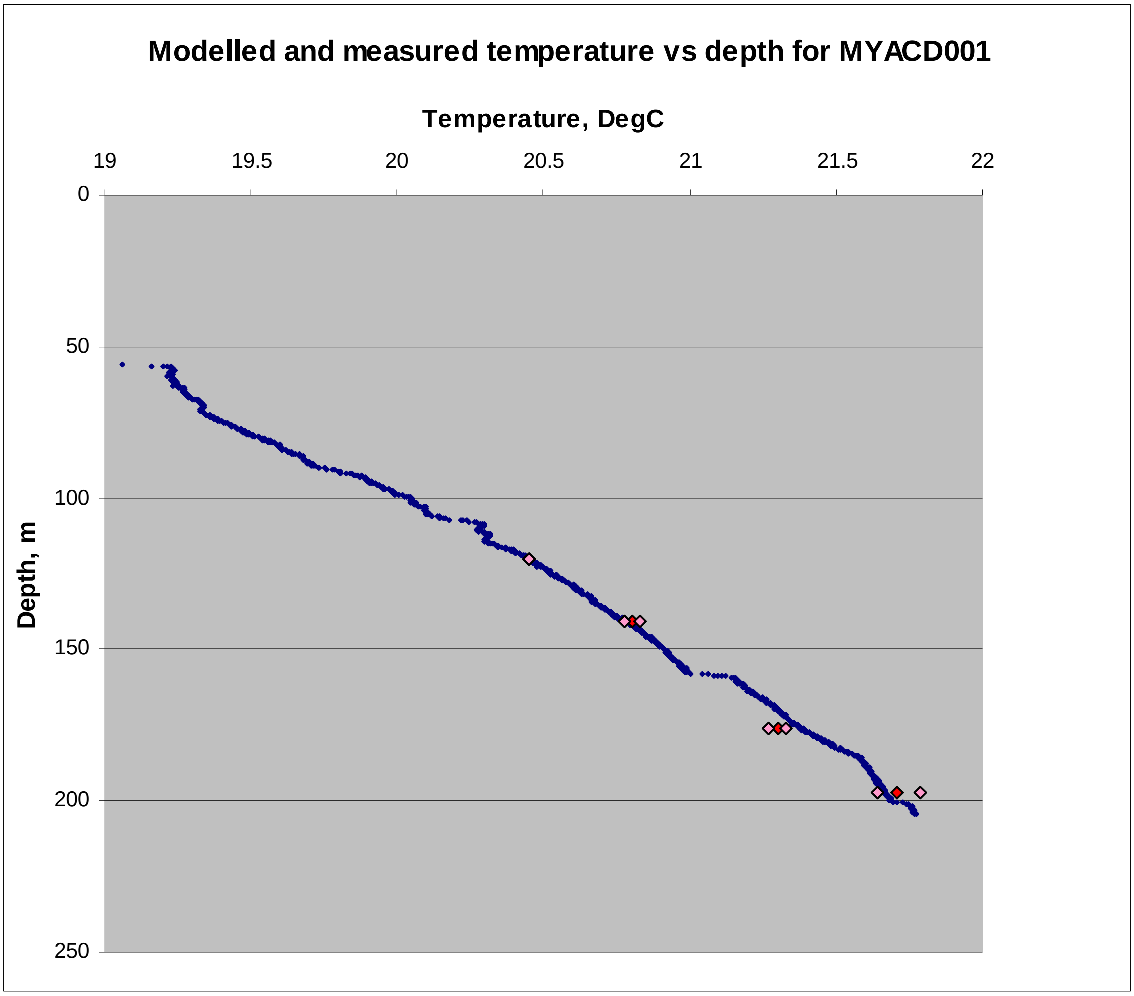

Figure 5. *Modelled and measured temperature vs. true depth for MYACD001. Blue line shows measured data, red and pink dots show predicted temperature at the base of each thermal conductivity section (pink dots indicate error bounds in predicted temperature).*

MYACD002

MYACD002 is located in central NSW, approximately 25km SW of Narromine (about 225m SW of MYACD001). It was drilled by Gold Fields Limited, and logged by GA using the temperature only probe to a total depth of 332.6m (measured depth). It is not certain whether this hole had reached thermal equilibrium when it was logged. No lithological logs were provided to GA.

Visual inspection of the temperature gradient profile shows that above 134m true depth (154m Measured depth), the gradient is disturbed. Therefore our heat flow interpretation is based only on data below this point.

Boundaries between thermal conductivity measurements were picked using the gamma log where there were distinguishable variations in the signal. In other cases, the boundary was assumed to be half way between measurement points. Table 7 shows the picked boundaries and the rationale behind each selection.

Table 7. Sub-section boundaries for MYACD002 and the reason for the selection of each boundary.

SAMPLE NAME	SECTION TOP (M, TRUE DEPTH)	SECTION BOTTOM (M, TRUE DEPTH)	THERMAL CONDUCTIVITY	ERROR	RATIONALE (BOTTOM BOUNDARY)
GOLD002/1	134	153	2.34	0.06	Change in gamma log
GOLD002/2	153	195	3.7	0.11	Change in gamma log
GOLD002/3	195	247	3.27	0.12	Mid point between measurements
GOLD002/4	247	273	2.89	0.05	Bottom of conductive section

Taking the above boundaries (and modifying them to determine error bounds) the conductive heat flow for MYACD002 is interpreted to be **52 (+4/-6) mW/m^2**. The model is plotted along with the measured data in Figure 6.

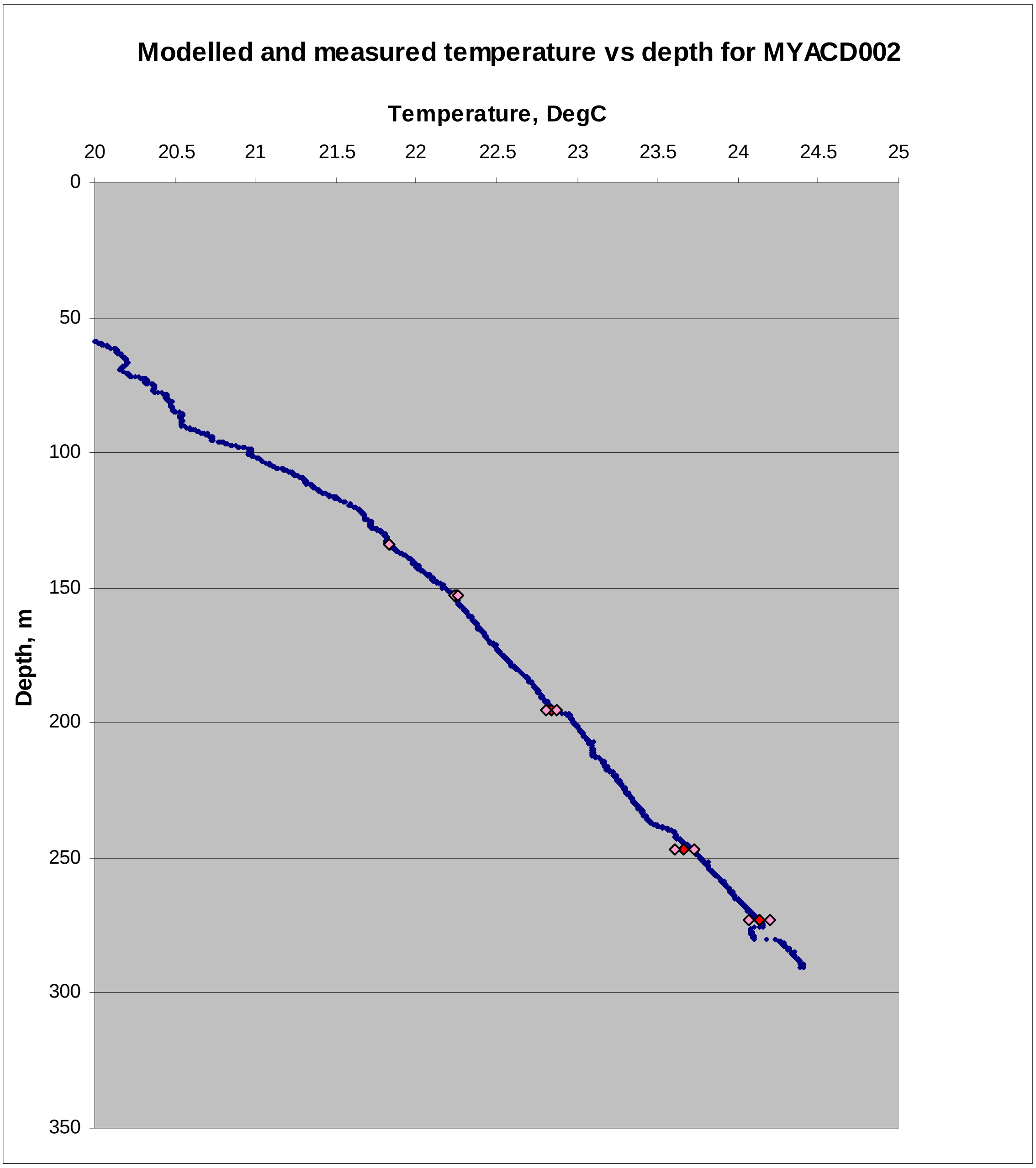

Figure 6. *Modelled and measured temperature vs. true depth for MYACD002. Blue line shows measured data, red and pink dots show predicted temperature at the base of each thermal conductivity section (pink dots indicate error bounds in predicted temperature).*

NMD134

NMD134 is located in WA, approximately 200km west of Norseman. It was drilled by Western Areas NL, and logged by GA using the combined temperature/gamma probe to a depth of 647m (Measured depth). A lithological log for this hole was provided to GA.

Visual inspection of the temperature gradient profile shows that above 305m true depth (339m Measured depth), the gradient is disturbed. Therefore our heat flow interpretation is based only on data below this point.

The lithological log defines five major lithological sections in the section of the hole below 305m. All but one of these sections have at least one thermal conductivity measurement. The exception is from 525.8 – 556.9m, from which no samples were taken. However, this section has the same lithology as that sampled at 165.8 and 275.2m depth in the hole. Therefore, a section with a thermal conductivity equal to the harmonic mean of the measurements at 165.8 and 275.2m depth was added to the conductive heat flow modelling section. Table 8 summarises the thermal conductivity of each lithological section and the rationale behind the definition of the boundaries of these sections.

Table 8. Sub-section boundaries for NMD134 and the reason for the selection of each boundary.

SAMPLE NAME	SECTION TOP (M, TRUE DEPTH)	SECTION BOTTOM (M, TRUE DEPTH)	THERMAL CONDUCTIVITY	ERROR	RATIONALE (BOTTOM BOUNDARY)
WEST/3	300	381.1	3.54	0.02	Major lithological change
WEST/4	381.1	472.6	4.2	0.02	Major lithological change
WEST/1 + WEST/2	472.6	500.4	2.86	0.18	Major lithological change
WEST/5	500.4	535.8	4.38	0.05	Mid point between measurements
WEST/6	535.8	568.9	4.28	0.08	Bottom of conductive section

Taking the above boundaries the conductive heat flow for NMD134 is interpreted to be **44±2 mW/m^2**. The model is plotted along with the measured data in Figure 7.

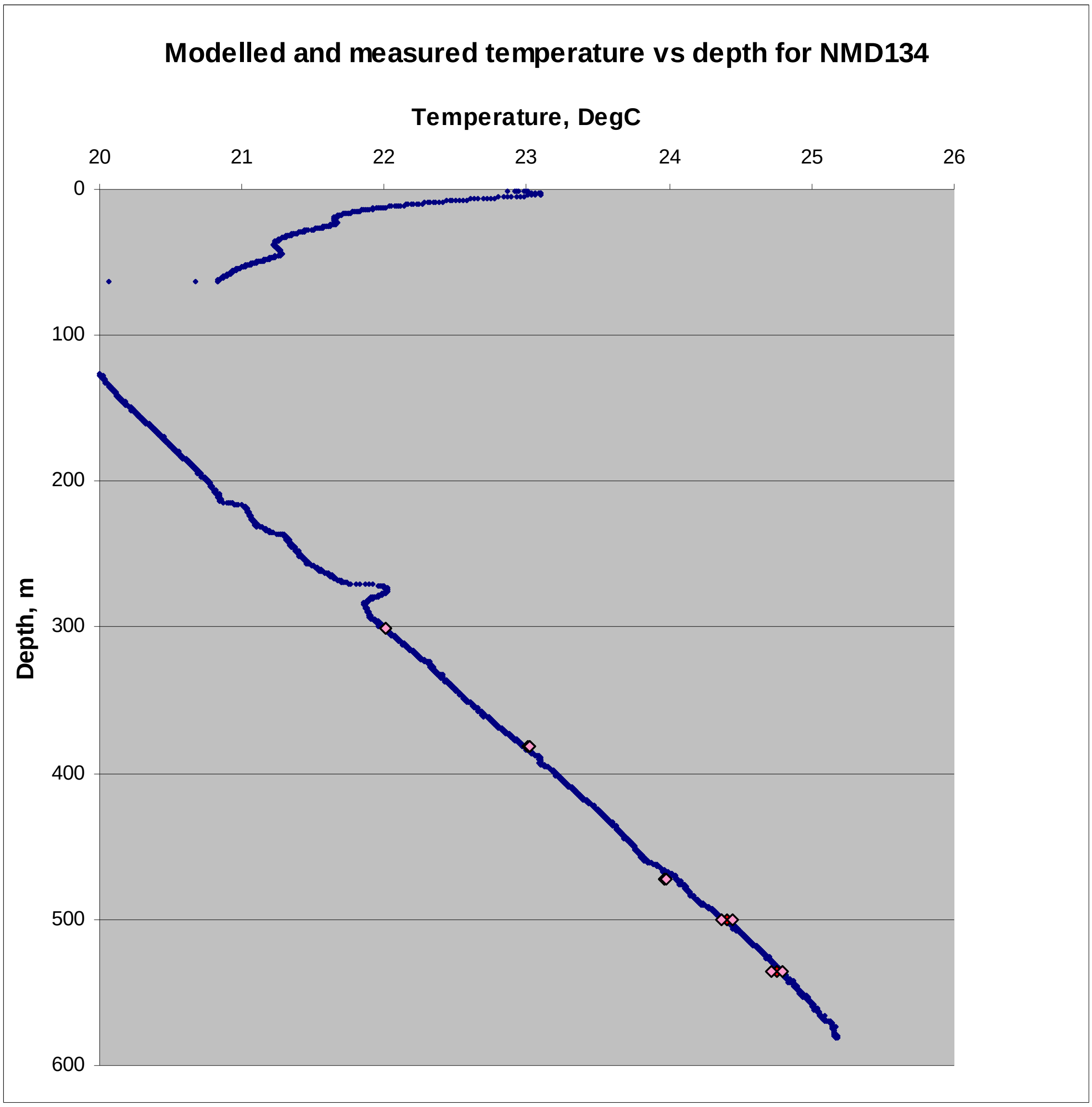

Figure 7. *Modelled and measured temperature vs. true depth for NMD134. Blue line shows measured data, red and pink dots show predicted temperature at the base of each thermal conductivity section (pink dots indicate error bounds in predicted temperature).*

SED246

SED246 is located in WA, approximately 200km WSW of Norseman (about 35km SE of NMD134). It was drilled by Western Areas NL, and logged by GA using the combined temperature/gamma probe to a depth of 950.6m (Measured depth). It is not certain whether this hole had reached thermal equilibrium when it was logged. A lithological log for this hole was provided to GA.

Visual inspection of the temperature gradient profile shows that above 200m true depth (205m Measured depth), the gradient is disturbed. Therefore our heat flow interpretation is based only on data below this point.

While a detailed lithological log was provided, this revealed no broad scale lithological changes. Therefore, boundaries between thermal conductivity measurements were picked using the gamma log where there were distinguishable variations in the signal. In other cases, the boundary was placed half way between measurement points. Table 9 shows the picked boundaries and the rationale behind each selection.

Table 9. Sub-section boundaries for SED246 and the reason for the selection of each boundary.

SAMPLE NAME	SECTION TOP (M, TRUE DEPTH)	SECTION BOTTOM (M, TRUE DEPTH)	THERMAL CONDUCTIVITY	ERROR	RATIONALE (BOTTOM BOUNDARY)
WEST/8	200.0	263.0	2.84	0.12	Mid point between measurements
WEST/9	263.0	324.0	3.30	0.13	Gamma log
WEST/10	324.0	416.0	2.79	0.14	Gamma log
WEST/11	416.0	535.2	2.76	0.05	Mid point between measurements
WEST/12	535.2	604.1	3.00	0.02	Mid point between measurements
WEST/13	604.1	663.5	2.49	0.04	Mid point between measurements
WEST/14	663.5	748.0	2.91	0.16	Mid point between measurements
WEST/15	748.0	858.8	2.85	0.01	Mid point between measurements
WEST/16	858.8	920.0	3.32	0.09	Bottom of conductive section

Taking the above boundaries (and modifying them to determine error bounds) the conductive heat flow for SED246 is interpreted to be **34±3 mW/m^2**. The model is plotted along with the measured data in Figure 8.

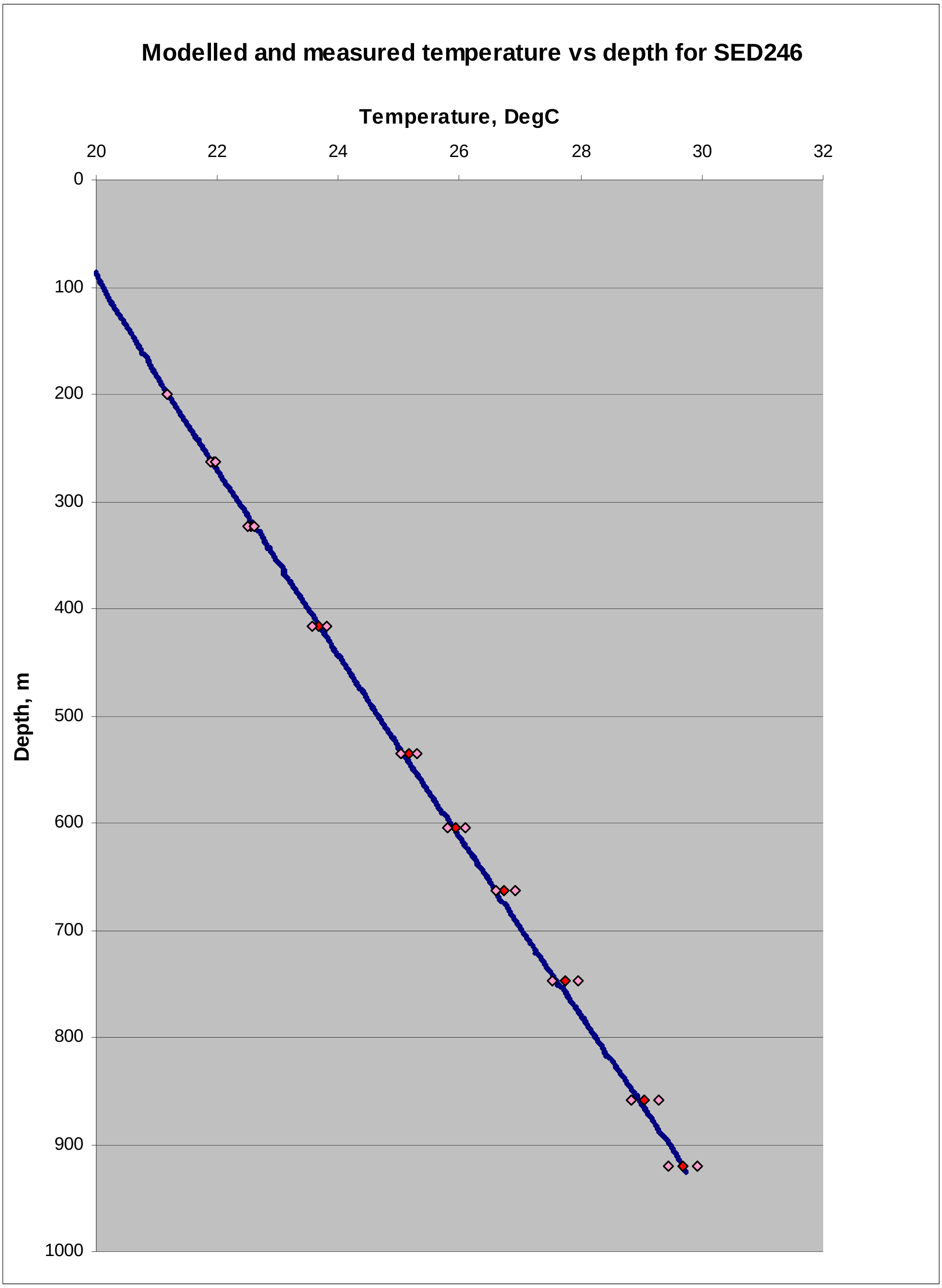

Figure 8. *Modelled and measured temperature vs. true depth for SED246. Blue line shows measured data, red and pink dots show predicted temperature at the base of each thermal conductivity section (pink dots indicate error bounds in predicted temperature).*

WYACD006

WYACD006 is located in NSW, approximately 23km ENE of West Wyalong. It was drilled by Gold Fields Limited, and logged by GA using the combined temperature/gamma probe to a depth of 594m (Measured depth). It is not certain whether this hole had reached thermal equilibrium when it was logged. No lithological logs were provided to GA for this hole.

Above approximately 156m true depth (180m Measured depth); the gradient appears to be affected by seasonal temperature variations. Therefore our heat flow interpretation is based only on data below this point.

There are no major breaks in the gamma log that can be used to define the boundaries between thermal conductivity measurements. Therefore, the boundary between thermal conductivity measurements was taken to be the midpoint between each sample (Table 10).

Table 10. Sub-section boundaries for WYACD006 and the reason for the selection of each boundary.

SAMPLE NAME	SECTION TOP (M, TRUE DEPTH)	SECTION BOTTOM (M, TRUE DEPTH)	THERMAL CONDUCTIVITY	ERROR	RATIONALE (BOTTOM BOUNDARY)
GOLD006/1	156.0	234.5	2.78	0.07	Mid point between measurements
GOLD006/2	234.5	266.6	2.67	0.02	Mid point between measurements
GOLD006/3	266.6	289.6	2.78	0.07	Mid point between measurements
GOLD006/4	289.6	337.8	3.03	0.09	Mid point between measurements
GOLD006/5	337.8	393.8	2.98	0.1	Mid point between measurements
GOLD006/6	393.8	445.9	2.77	0.16	Mid point between measurements
GOLD006/7	445.9	485.0	3.18	0.08	Bottom of conductive section

Taking these boundaries (and modifying them to determine error bounds), the conductive heat flow for WYACD006 is interpreted to be **50±3 mW/m^2.** The model is plotted along with the measured data in Figure 9.

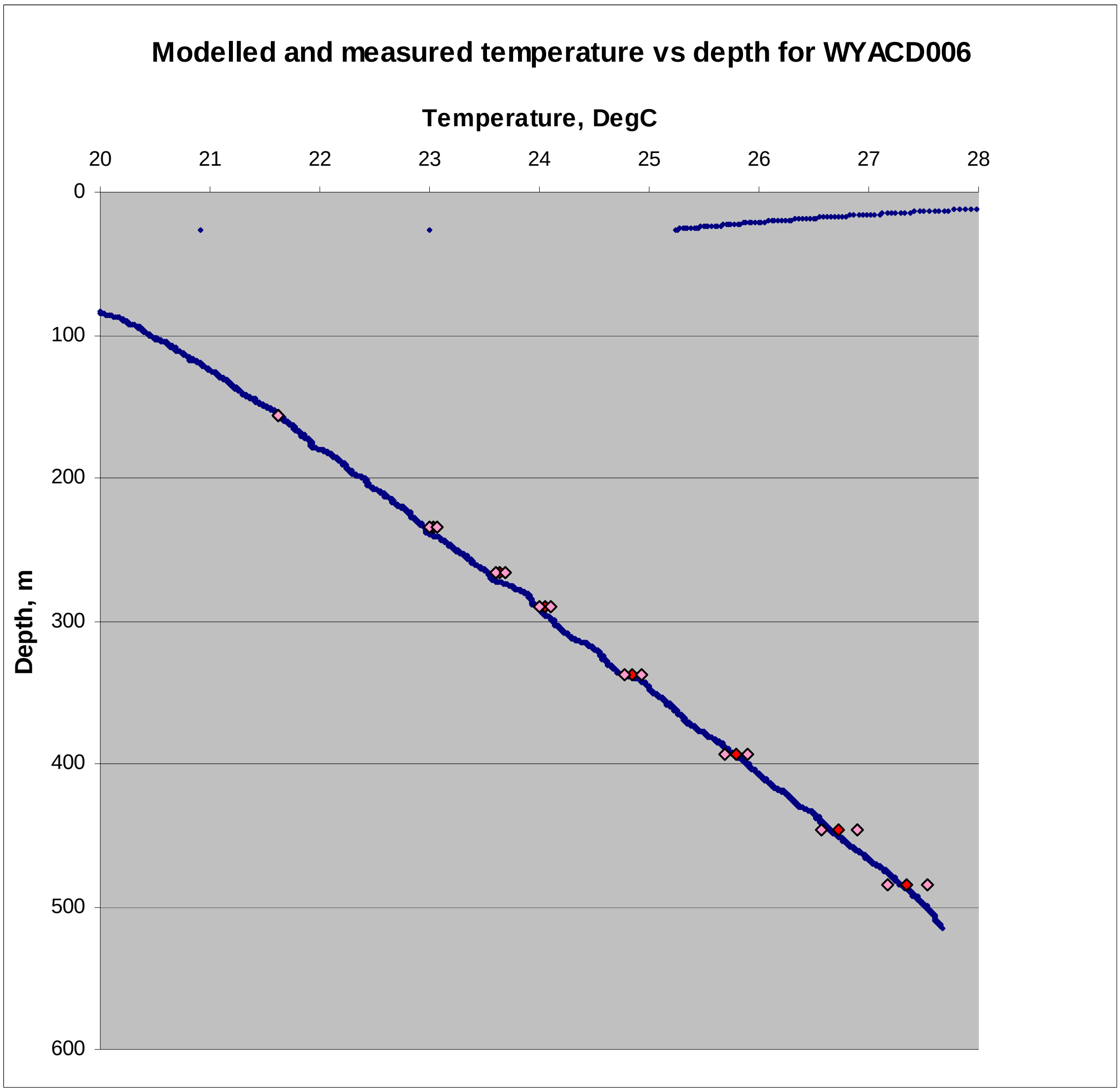

Figure 9. *Modelled and measured temperature vs. true depth for WYACD006. Blue line shows measured data, red and pink dots show predicted temperature at the base of each thermal conductivity section (pink dots indicate error bounds in predicted temperature).*

WYACD007

WYACD007 is located in NSW, approximately 25km ENE of West Wyalong (about 3km NE of WYACD006). It was drilled by Gold Fields Limited, and logged by GA using the combined temperature/gamma probe to a depth of 362.8m (Measured depth). It is not certain whether this hole had reached thermal equilibrium when it was logged. No lithological logs were provided to GA for this hole.

Above approximately 125m true depth (144m Measured depth), the gradient appears to be affected by seasonal temperature variations. Therefore our heat flow interpretation is based only on data below this point.

The gamma log was used to define boundaries between thermal conductivity measurements. The boundaries are presented in Table 11.

Table 11. Sub-section boundaries for WYACD007 and the reason for the selection of each boundary.

SAMPLE NAME	SECTION TOP (M, TRUE DEPTH)	SECTION BOTTOM (M, TRUE DEPTH)	THERMAL CONDUCTIVITY	ERROR	RATIONALE (BOTTOM BOUNDARY)
GOLD007/1	125.0	142.0	2.38	0.04	Gamma log
GOLD007/2	142.0	212.0	2.97	0.06	Gamma log
GOLD007/3	212.0	246.0	2.40	0.06	Gamma log
GOLD007/4	246.0	284.0	2.96	0.00	Gamma log

Taking these boundaries (and modifying them to determine error bounds), the conductive heat flow for WYACD007 is interpreted to be **47±5 mW/m^2.** The model is plotted along with the measured data in Figure 10.

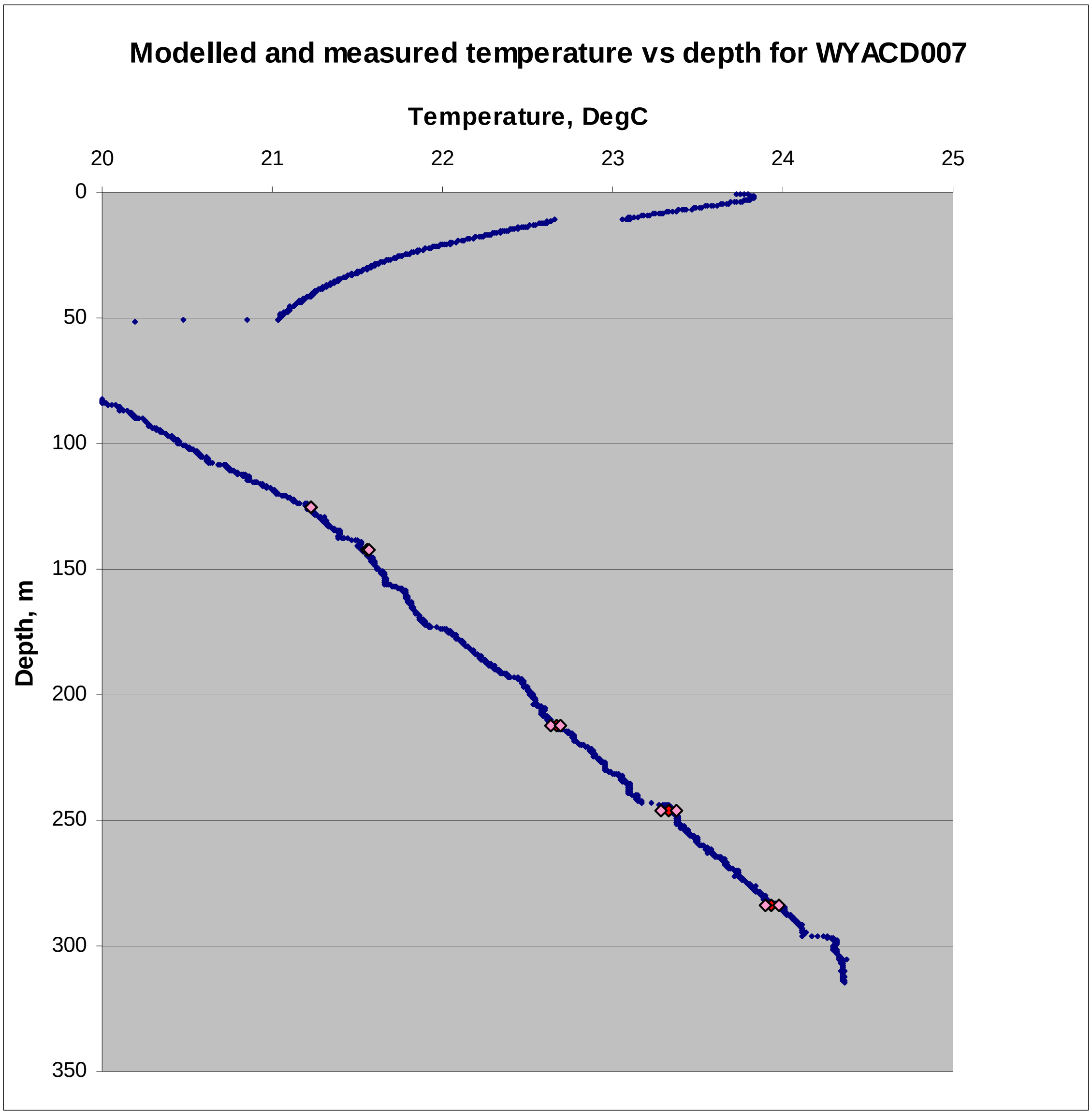

Figure 10. *Modelled and measured temperature vs. true depth for WYACD007. Blue line shows measured data, red and pink dots show predicted temperature at the base of each thermal conductivity section (pink dots indicate error bounds in predicted temperature).*

WYACD008

WYACD008 is located in NSW, approximately 25km ENE of West Wyalong (about 600m ENE of WYACD007). It was drilled by Gold Fields Limited, and logged by GA using the combined temperature/gamma probe to a depth of 402.4m (Measured depth). It is not certain whether this hole had reached thermal equilibrium when it was logged. No lithological logs were provided to GA for this hole.

Above approximately 150m true depth (173m Measured depth), the gradient appears to be affected by seasonal temperature variations. Therefore our heat flow interpretation is based only on data below this point.

There are no major breaks in the gamma log that can be used to define the boundaries between thermal conductivity measurements. Therefore, the boundary between thermal conductivity measurements was taken to be the midpoint between each sample (Table 12). Taking these boundaries (and modifying them to determine error bounds), the conductive heat flow for WYACD008 is interpreted to be **42±2 mW/m^2.** The model is plotted along with the measured data in Figure 11.

Table 11. Sub-section boundaries for WYACD008 and the reason for the selection of each boundary.

SAMPLE NAME	SECTION TOP (M, TRUE DEPTH)	SECTION BOTTOM (M, TRUE DEPTH)	THERMAL CONDUCTIVITY	ERROR	RATIONALE (BOTTOM BOUNDARY)
GOLD008/2	150.0	202.7	2.62	0.08	Mid point between measurements
GOLD008/3	202.7	241.4	2.81	0.07	Mid point between measurements
GOLD008/4	241.4	279.0	2.61	0.03	Mid point between measurements
GOLD008/5	279.0	319.2	2.52	0.01	Mid point between measurements
GOLD008/6	319.2	337.0	2.57	0.05	Bottom of conductive section

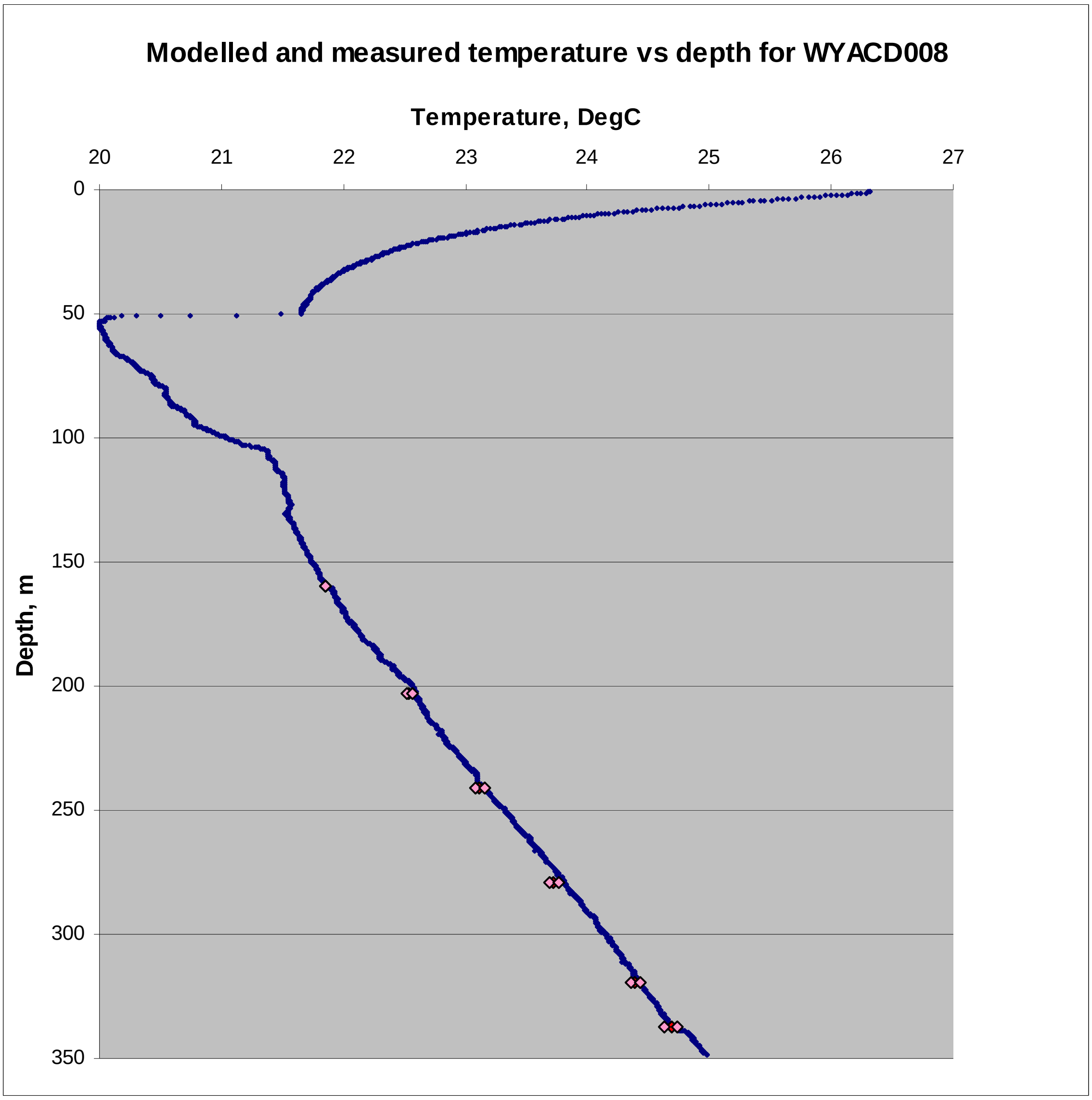

Figure 11. *Modelled and measured temperature vs. true depth for WYACD008. Blue line shows measured data, red and pink dots show predicted temperature at the base of each thermal conductivity section (pink dots indicate error bounds).*

Conclusions

The interpretations contained in this report form the first release of heat flow data from Geoscience Australia's Geothermal Energy Project. The collection of new temperature and thermal conductivity data is ongoing, and thus far temperature logging has been conducted in 155 holes over all mainland states and territories of Australia. Core samples have been collected from the majority of these holes, and the intention is that heat flow interpretations from these holes will be released as thermal conductivity data become available.

These data represent the first stage towards improving the heat flow coverage of the Australian continent. Future data releases stand to more than double the amount of available heat flow determinations and improve the spatial distribution across different geological regions. These new results will improve the understanding of the thermal structure of the Australian continent and will be a valuable input into geothermal energy prospectivity analyses.

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