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Core Sampling Report
Well: MD4

McArthur Basin
Northern Territory, Australia

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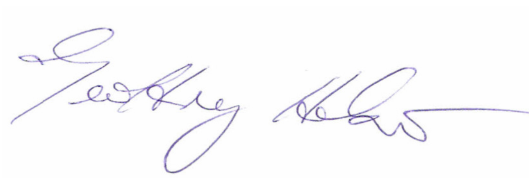

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Introduction

In accord with the Northern Territory petroleum exploration reporting and data submission guidelines Imperial Oil & Gas Pty Ltd ('Imperial') hereby submits this Core Sampling Report for samples acquired from the core MD4 stored at the Darwin Core Library. This report provides a brief discussion of the data obtained from the analysis.

This historical bore hole MD4 was sampled as part of an exploration program undertaken by Imperial to evaluate the Velkerri Formation within the Exploration Permit (EP) 187. This historical bore hole was drilled in proximity to a desired location for investigation by Imperial. While originally drilled as a mineral exploration hole the bore penetrated the carbonaceous black organic shales of the Velkerri Formation predicted by Imperial to have potential as a hydrocarbon generating source rock. These shales are a significant target of petroleum exploration within EP187 within the central portion of the McArthur Basin and within tenements in the Beetaloo Sub Basin.

This historical well MD4 was drilled as a stratigraphic drill hole in 1993 by BHP Minerals exploring for Cu-Pb-Zn within the Proterozoic geology of the McArthur Basin of the Northern Territory. The drill hole MD4 intersected the Proterozoic Velkerri Formation of the Roper Group. The drill hole was reported to have intersected bituminous mudstone and shale between 305.25m and 312.53m .

Detail on this historical exploration program is available online from the NTGS library and is contained in the report MD004_CR19940042_1994_ GA. The hole was collared at 532559mE 8126878mN and spudded on the 25/08/93. Total depth of the hole was reached at 348.20m measured drill depth on the 10/09/93.

According to the original report the pre-collar was hammer percussion drilled to a depth of 114m. There was no sample return from 78 to 114m. The percussion chips were presumed by the exploration team at the time to have been retained in cavities in limestone. Cream red brown unconsolidated claystone of cretaceous age was intersected from the top of the hole to 64m. Below this the drilling encountered limey chips through to 78m when sample return was lost. This area was reported to be the top of Cambrian top Springs Limestone. The limestone was encountered through to 127.4m.

Roper group Velkerri Formation was encountered at 127.4m and persisted through to total depth of the hole. The formation was represented in the upper section as a red white laminated siltstone with mudstone interbeds with calcite-pyrite veining and was intersected through to 142.14m. Below this to 305.25m the geology was purple-green-grey micaceous mudstone becoming more laminated and carbonaceous with depth and some calcite veining with trace pyrite.

The original lithology log for the hole records bituminous mudstone was intersected from 305.25m to 312.53m and contained weak mineralization of pyrite, chalcopyrite, galena and sphalerite as fracture coatings. Below this was a laminated micaceous and glauconitic siltstone to fine sandstone with mud cracks, cross bedding and soft sediment slumping. The hole terminated at 348.2m MD.

On re-examination of the core by Imperial in May 2015 thirteen samples (Table 1, pg. 7) of micaceous and carbonaceous mudstone and carbonaceous siltstones were taken of formations between 184.65m and 333.70m for source rock analysis. These samples were sent to the Sprigg Laboratories Mawson Centre at the University of Adelaide for analysis [Not all samples were analysed]. Results of the TOC analysis presented in table 3 (pg 13) show a range of organic content from 0.16wt % to 6.16wt% with an average TOC across a 104.4m (342.5ft) interval of intersect of 2.4wt%. Re-logging of the core provided the same geology description of the core as the original.

Sampling Summary and General Data

Sampler:	Geoff Hokin
On behalf of:	Imperial Oil & Gas Pty Ltd
Address:	Level 7, 151 Macquarie Street, Sydney, NSW 2000
Main office number:	+61 2 9251 1846
Current permit:	EP187
Field:	Carpentaria Downs
Prospect/Location name:	Mangala/OT Downs
1:250K Map Sheet Name:	Bauhinia Downs
1:100K Map Sheet Name:	Bloodwood Creek
Well name:	MD4
Well location:	0532 559mE 812 6878mN. (GDA94 Zone 53K)
Ref. Report Number WCR:	CR19940042_1994_GA
Coredat ID:	84
Tenement at the time:	EL 7450
Drilled by:	BHP Minerals Pty Ltd
Spud date:	25-08-1993
TD date:	10-09-1993
Duration:	17 days
TD:	348.20 m
Inclination:	- 90
Azimuth:	N/a
Core Location:	Darwin
Sampling allowed	Yes
Cutting available:	No
Hylogged:	No

Geochemical Analysis

Thirteen MD4 core samples were taken from the core and of these eleven samples were selected for source rock analysis and geochemical characterisation. A range of analyses were conducted on these samples. Sample preparation and analyses were conducted by the Sprigg Research Laboratories at the University of Adelaide. The sample preparation and analytical methods utilized by the lab are outlined below. This information is supplied by Dr Tony Hall of the Sprigg Research Laboratory at the University of Adelaide.

Sample preparation

The study used cored cutting samples collected from the MD4 core held at the Darwin NTGS library. This core was recovered from the well drilled in the Bauhinia/Carpentaria Downs region within the central McArthur Basin in the Upper McArthur River catchment area of the Northern Territory.

Samples (Table 1) were taken of the prospective carbonaceous micaceous mudstones, siltstones and shales recovered within the core and identified as samples 351323 to 351333. While all samples were lithologically logged not all samples were sent for analysis. The samples sent for analysis were chosen to investigate the Velkerri Formation. All samples were selected to be representative of the differing zones of interest exhibited through the core sections. Prior to analysis all samples selected for further investigation were cleaned, dried for ≥ 24 hrs at 40^0 C and ground using a tungsten carbide ring mill to <120um. Samples were washed, dried and cut into appropriate sections for SEM stub mounting preparation.

Analytical Methodology (TOC, SRA,GC-MS)

Total carbon (TC) content for each sample was measured in a Perkin Elmer 2400 Series II CHNS analyzer. Inorganic carbon (IC) content was determined using the pressure-calcimeter acidification method of Sherrod et al. (Sherrod et al., 2002). TOC content was calculated by difference (TOC=TC-IC).

Total petroleum hydrocarbon analyses (TPH) were conducted using a Source Rock Analyser (SRA TPH) Workstation, (Weatherford Laboratories Instruments Division), this is equivalent to the 'Rock-eval' analytical instrumentation. The sample is purged in Helium prior to being raised into a desorption furnace at 300^{o}C for 3 minutes which releases the free hydrocarbon, or S1, fraction. The sample is then pyrolysed by heating at a 25^{o}C/minute ramp to 600^{o}C to generate the potential hydrocarbon, or S2, fraction. Detection of released hydrocarbons is conducted by flame ionization detection(FID) and quantification is conducted by calibration against a certified reference material of known S1& S2 response.

Thermal maturity and hydrocarbon potential (S1 & S2) of each sample was determined by pyrolysis using a Weatherford Instruments Source Rock Analyser. Thermal maturity was estimated using the method of Jarvie et al. (2005), which relates measured Tmax to calculated vitrinite reflectance using the following relationship: calculated %Ro =0.0180×Tmax −7.16. Based on the TPH data collected by SRA a sub-suite of samples were identified for further characterization of the organic matter (OM) fractions by mass spectrometry. Both the S1 & S2 fractions of each sample were evolved by thermal and pyrolytic extraction respectively.

Thermal extraction gas chromatography mass spectrometry(GC-MS) screening was conducted using micro scale sealed vessels (MSSV) to characterize OM present within the samples. Between 5 & 10mg of sample was transferred to the MSSV reaction vessel and extracted at 300^{o}C for 1 hour. GC-MS was run with a temperature program of 50^{o}C held for 1 min ramped at 8^{o}C/Min to 300^{o}C and held for 17 mins. Analysis was undertaken using a Quantum MSSV injector fitted to a Hewlett Packard 6890/5973 GC-MS system and was analysed under standard extraction parameters,(see Hall et al.(1999) and Hall et al.(2011).

Mineralogy was determined by XRD analysis conducted qualitatively using a Bruker D8 ADVANCE Powder X-ray Diffractometer with a Cu-radiation source. Data was processed using Bruker

DIFFRAC.EVA software and Crystallography Open Database reference patterns for identifying mineral phases. Major component quantification was conducted by XRF with quantification reported following ignition. Trace & REE quantification was conducted by whole rock digestion and ICPMS elemental detection using an Agilent 7500cs with ORS for Solution ICP Analysis.

Inorganic sediment analyses

Mineralogy was determined from randomly orientated bulk powder samples, using X-ray diffraction (XRD; Bruker D8 Advance XRD with Cu source). Samples were scanned between 3.5^0 - $50^0 2\Theta$ using a 0.02 step size and 1s dwell time. Mineral phases were identified in the Diffrac.Eva software package using reference patterns from the Open Crystallography Database. Clay mineralogy was determined on orientated preparations of the <5µm fraction and prepared as per Moore and Reynolds (1997).

Results

Bore hole MD4 Total organic carbon (TOC) analysis results (Table 3) and the (figure 1) geochemical log organic richness indicate that samples 351326 through to 351332 all have good to very good levels of organic matter. The TOC levels of these samples range from 1.76% through to a maximum in the samples of 6.16% with an average of 3.65%. These optimum samples lie over an interval of 7.2 m (approx. 24 ft). Samples 351323, 351324, 351325 and 351333 all have TOC less than the minimum cut off point of 0.5wt% predicted to be suitable for reasonable hydrocarbon generation. These samples report TOC of 0.16% to 0.29% and contain hydrocarbon indices (HI) indicative of petroleum generation. The eleven samples analysed represent an interval of 104.4m (342.5 ft) with an average TOC of 2.40%.

The figure 2 Kerogen quality plot of TOC to remaining hydrocarbon production potential indicates that the kerogen is type III gas prone. This is consistent with the results obtained from earlier research of samples obtained from the Velkerri in other areas of the basin and consistent with the work of Crick, I. H., Boreham, C. J., Cook, A.C., & Powell. T.G. 1988. The predicted age of the formation suggests that the organic material source would be lamalginite (Adelaide Research & Innovation Pty Ltd. 2013.; Holman A.I., Grice K., Jaraula C.M.B., Schimmelmann A. (2014); Korth j. 1987; Page, R.W. and Sweet, I.P. 1998.).

The analysis of the major elements presented in Table 5 when compared to the average shale (AS) values of Wedepohl (1971, 1991a, 1991b) and Condie (1993) and to the post Archean Australian shale standard (PAAS) averages indicates a significant number of differences in the MD4 shale composition. When the MD4 results are compared in conjunction with the results of analysis obtained from the core hole 82/1 against the shale overages of Wedepohl and the PAAS (Table 7) it can be observed that the calcium oxide levels of these samples is one tenth that of the standard averages while the sodium oxide values are one tenth to one half that of the standards.

While silica contents of the MD4 shales are generally in line with the AS and the PAAS they are somewhat higher overall. Significantly the XRF analysis also suggests a high clay content while the titanium oxide contents are in line with the AS they are three quarters of the values expressed in the PAAS.

Table 1: Overview of MD4 sample lithology

Sample number	depth [mMD]	Lithology
351323	229.3	Mudstone, grey white, carbonaceous and micaceous, pyritic, white carbonate fracture fill/vein.
351324	244.9	Mudstone, grey green, dolomitic with minor siltstone and sandstone laminae and carbonaceous laminations. Minor carbonaceous veining.
351325	288.8	Mudstone micaceous, grey green, with minor glassy mudstone laminae veins. Moderate carbonaceous laminations, crumbles on drying, minor carbonate veining with minor interbedded dolomitic siltstone.
351326	304.7	Mudstone micaceous, with mudstone glassy laminae, light green, with moderate carbonaceous laminations.
351327	305.4	Mudstone glossy, black, laminated, friable, pyritic with chalcopyrite, galena and sphalerite. Bituminous paint style mineralisation, crumbles on drying.
351328	306.7	Mudstone glossy, black, laminated, friable, pyritic with chalcopyrite, galena and sphalerite. Bituminous; paint style mineralisation, crumbles on drying.
351329	307.7	Mudstone glossy, black, laminated, friable, pyritic with chalcopyrite, galena and sphalerite. Bituminous; paint style mineralisation, crumbles on drying.
351330	308.5	Mudstone glossy, black, laminated, friable, pyritic with chalcopyrite, galena and sphalerite. Bituminous; paint style mineralisation, crumbles on drying.
351331	311.1	Mudstone glossy, black, laminated, friable, pyritic with chalcopyrite, galena and sphalerite. Bituminous; paint style mineralisation, crumbles on drying.
351332	311.9	Mudstone glossy, black, laminated, friable, pyritic with chalcopyrite, galena and sphalerite. Bituminous; paint style mineralisation, crumbles on drying.
351333	333.7	Mudstone carbonaceous with interbeds of mudstone, grey white, pyritic. Laminated and wispy mudstone with veins (?) or carb dolomite bed.

Note: Sample depths reported have not been corrected for loggers depth.

Table 2: Lithology Log of MD4

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McARTHUR BASIN PROJECT – DRILL HOLE HEADER SHEET

Sheet 1 of 5

HOLE NUMBER: MD4
Oz Recon Record No.:
Logged By: I. BROWN
Drill Target: Subdued magnetics on western side of Mongala Fault.

PROJECT

PROJECT: McArthur Basin
PROSPECT: Mongala
Tenement: EL 7450 Job No.: LPI

Location: 1:250 000 Sheet Name: Bauhinia Downs
1:100 000 Sheet Name: OT Downs

Grid Name:
Grid Type (AMG, GEO, Local): AMG
HOLE NUMBER: MD4

Collar Coordinates:-
AMG Easting: 532559 Local Grid Easting: —
AMG Northing: 8126 878 Local Grid Northing: —
AMG Zone: 53 Azimuth: — RL: Inclination: -90

Hole Type (RCH, DDH, RAB, PDH): PDH / DDH
Hole Depth: 348.20m Depth to Water: ≈ 90m
Depth to Basement: 127.40m Depth of Oxidation:

Cover Description (standard codes): CRE / UCm
Basement Description (standard codes): UPR
Stratigraphic Unit: Velkerri Formation
Tectonic Unit: McArthur Basin

DRILLING INFORMATION

CONTRACTOR: Gaden Drilling
RIG TYPE: Universal 1000 WARMAN
Date Commenced: 25-8-93 Date Completed: 10-9-93

HOLE TYPE

Method/Size	From	To	Comments
5½" Hammer (Pre-collar)	0	114m	No sample return 78-114m
NQ Core	114	348.2	
HQ reamer	114	175	

WEDGE POSITION

Depth from Collar	Azimuth	Inclination

MATERIAL LEFT IN HOLE

Casing	From	To	Comments

SURVEY DATA

Depth	Azimuth	Dip

METHOD

Depth	Azimuth	Dip

GEOPHYSICAL LOGGING

Type	Contractor	From	To	Comments

COMMENTS:

ANALYSIS

Sampled Inter. From	Sampled Inter. To	Sample No's From	Sample No's To	Sample Type	Laboratory Batch No.	Elements	Method
114	344	EH3473	3518	Fillet	AC10485		5m
344	348.2	EH3519		Fillet	AC10485		4.2m

COMMENTS:

SUMMARY LOG

From	To	Formation	Lithology	Comments
0	64	Kl - Cretaceous	Claystone	Moderately ferruginous
64	127.4	Et - Top Springs Limestone	Limestone /	Brecciated and dolomitised
127.4	348.2	P - Velkerri Fm		
127.4	142.14	Velkerri Fm	Laminated siltstone	Red & white; minor mudstone; minor carbonate + pyrite veins
142.14	305.25	Velkerri Fm	Micaceous mudstone	Purple-green-grey; increasing carbonaceous content with depth; minor siltstone; minor carbonate ± pyrite veins
305.25	312.53	Velkerri Fm	Bituminous mudstone	Laminated; trace pyrite, chalcopyrite, sphalerite and galena
312.53	348.20	Velkerri Fm	Laminated mudstone + siltstone + sandstone	Micaceous; interbedded; light grey; upward fining; mudcracks; slumping; cross bedding; glauconitic; trace dolomitic siltstone; rare carbonate and pyrite veins.

INTERSECTIONS

From	To	Cu	Pb	Zn	Au	Ag

GENERAL COMMENTS:

HOLE No. MD4

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McARTHUR BASIN PROJECT – DIAMOND DRILL HOLE LOG SHEET

Sheet 2 of 5

DATE 26-8-93 LOGGED BY M. Rennison / I. Brown HOLE DEPTH 348.20 m JOB No. LP1 **HOLE No.** MD4

DRILLED INTERVAL FROM	TO	CORE LOSS (cm)	FORMATION	ROCK TYPE MAJOR	q	ROCK TYPE MINOR	q	OXIDATION	COLOUR LIGHT	COLOUR HUE	STRUCTURE S1	ANGLE TO LCA	TEXTURE T1	TEXTURE T2	ALGAE A1	ALGAE A2	EVAPORITE TEXTURE 1	EVAPORITE TEXTURE 2	EVAPORITE TEXTURE 3	SULPHIDE MINERALISATION PYRITE m %	CHALCOPYRITE m %	GALENA m %	SPHALERITE m %	m %	m %	COMMENTS:
0.00	6.00			LATR	SA			7	4	RV																
6.00	22.00			CYST	SI			7	4	RV																
22.00	30.00			CYST	BD			5	5	GV			V–													Weakly consolidated
30.00	36.00			CYST	V–			5	4	GV			V–													Green-red-brown ; weakly consolidated
36.00	42.00			CYST	PI	CHER		5	5	V			V–													? old weathering surface ; moderately consolidated
42.00	46.00			CYST	V–			5	8	G			V–													Weakly consolidated
46.00	50.00			CYST	FE			5	7	G			V–													Minor Fe staining ; weakly consolidated
50.00	56.00			CYST	V–			5	5	E			V–													Weakly consolidated
56.00	58.00			CYST	MI			5	5	E			V–													Weakly consolidated
58.00	64.00			CYST	SI			5	5	VE			V–													Slight green tinges; very weakly consolidated; slightly damp
64.00	66.00			LIST		CHER			8	E			ID													Driller reported cavity.
66.00	78.00			CLAY		LIST		5	5	VE			V–													+ chert ; fragments only.
78.00	114.00			LOST																						No sample return.
114.00	116.15		El+	LIST	SI	LIST	BX	3	8	V																
116.15	117.45		El+	LIST	MS	LIST	BX	0	6	E																Co-dominant massive grey limestone and brecciated limestone
117.45	120.30		El+	LIST	BX			0	7	EV			BX													Good recovery – complete sticks of core. Dolomitized
120.30	127.40		El+	LIST	BX			0	4	EG			BX													Very broken. No solid sticks. Dolomitized
127.40	129.75		P	SIST	LM	MDST		3	B	RW	BD	7.0	FR	FI												Very broken. Minor shearing on upper contact
129.75	130.20			SIST	S–	MDST		3	B	RE			LM													Minor shear zone
130.20	131.45			SIST	LM			3	B	RW																
131.45	131.65			SIST	FR			3	B	RW	FZ									VT						Fracturing + microfaulting
131.65	134.60			SIST	LM	MDST	M–	3	B	RW	BD	6.5	FR							LT						
134.60	136.14			SIST	LM	TUFF	SX	3	B	WI	BD	6.5	FR													? Possibly tuff – white porcelainous; conformable to bedding ;
																										5 ?tuff bands within interval ; to 8cm
136.14	137.00			SIST	LM	MDST	SX	3	B	RW	V–		FR							LT						Very minor carbonate veining
137.00	140.10			SIST	LB	MDST	LM	3	B	IR	V–		FR							FT						Leisegang banding ; minor fractures ; minor carbonate veining
140.10	140.38			DOAS	FE	DOLM	IB	3	B	RW	BD	7.0	BN							LG						Minor dewatering structures in dolarenite.
140.38	141.93			SIST	LB	MDST	M–	3	B	WI	V–	1.0	LM													Leisegang banding ; minor carbonate veining
141.93	142.14			DOAS	FE	DOLM	IB	3	B	RW	CL	3.0	BN													No pyrite
142.14	143.85			SIST	LM	MDST	M–	3	B	IG	V–		LB							FT						Carbonate veining and laminations ; minor leisegang banding
143.85	144.05			SIST		DOLM		3	B	GI	S–		BN							MG						Minor shear zone ; plus minor mudstone
144.05	145.65			SIST	IB	MDST	FI	3	P	IG																Pale green mudstone could be tuffaceous
145.65	152.20			MDST	SI			3	5	PG	V–		FI													Very minor Fe-carbonate veining
152.20	159.10			MDST	SI			3	5	PG	V–	0.5	FI							FT						Minor Fe-carbonate veining ; fissile in part ; competent in part
159.10	159.30			SIST	FR	MDST		3	5	PG	S–															Crush-shear zone (minor)

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McARTHUR BASIN PROJECT – DIAMOND DRILL HOLE LOG SHEET

Sheet 3 of 5

DATE 7/9/93 LOGGED BY I. BROWN HOLE DEPTH 348.20 m JOB No. LP1 HOLE No. MD4

DRILLED INTERVAL FROM	TO	CORE LOSS (cm)	FORMATION	ROCK TYPE MAJOR	q	ROCK TYPE MINOR	q	OXIDATION	COLOUR LIGHT	COLOUR HUE	STRUCTURE S1	ANGLE TO LCA	TEXTURE T1	TEXTURE T2	ALGAE A1	ALGAE A2	EVAPORITE TEXTURE 1	2	3	PYRITE m %	CHALCOPYRITE m %	GALENA m %	SPHALERITE m %	m %	m %	COMMENTS:
159.30	160.80			MDST	SI			3	5	PG	V-	10	FI													Minor Fe-carbonate red veins / fracture coating
160.80	161.20			MDST				3	5	PG			VN													Moderate veining (as above)
161.20	171.50			MDST	SI			3	5	PG	V+	10	FI													Very minor veining (as above)
171.50	172.00			EBB	V-	MUDD	V-																			Rubble zone. Caused rods to become stuck. Reamed down past this zone. Limestone fragments from above
172.00	175.00			MDST	MI	SIST		3	5	PG			FI	FR												No veining/fracture coating to mention
175.00	175.80			PEBB	V-	MUDD	V-																			Rounded mudstone pebbles in red mud. Drilling problems as before
175.80	178.85			MDST	MI	SIST		3	5	PG	V-		FI	FR												Very minor carbonate veins
178.85	179.15			MDST				3	6	G	V-	10	VN							VG						Carbonate-pyrite veining (moderate)
179.15	184.70			MDST	MI	SIST		3	5	PG	V-		FI	FR												Very minor carbonate veining
184.70	185.05			MDST	BX	DOLM		3	5	RG	V-		S-							FT						Micaceous; muddy shear-crush material; carbonate veining; waxy fracture surfaces.
185.05	187.75			MDST	MI			3	5	RG	V-		FR							FT						Carbonate/pyrite veins – fracture coating.
187.75	188.10			DOLM	FE			3	4	R	V-									FG						Hematitic ; ? sideritic
188.10	197.60			MDST	MI			3	5	LG	V-		FR													Very minor carbonate veining
197.60	209.20			MDST	MI			3	5	RG	V-		FR							FT						Very minor carbonate/pyrite veining ; crumbles upon drying; major fractures at 35° + 75° to LCA
209.20	209.50			MDST	FR			3	7	G	V-	40														Minor to moderate veining – carbonate + hematite
209.50	216.40			MDST	MI			3	5	RG	V-		FR													Very minor carbonate veining; highly fractured upon drying; some crumbling ; weakly micaceous
216.40	216.50			DOLM	FE			3	5	R	V-		FR							FG						Waxy fractures ; hematitic
216.50	221.18			MDST	MI			3	5	RG	V-									FT						Minor carbonate ± pyrite veining
221.18	221.44			DOLM	FE			3	5	R	V-		FR													? siderite ; hematitic
221.44	225.25			MDST	MI			0	7	GE	V-		FR							FT						Slightly silty; minor carbonate + pyrite fracture coatings crumbles upon drying
225.25	225.36			SIST	DO	MDST		3	5	RG	BD	60	V-							VT						Minor carbonate-pyrite veins; mudstone crumbles; siltstone competent
225.36	229.20			MDST	MI			0	7	GE	BD	60	V-							FT						Crumbles upon drying ; weakly micaceous ; trace carbonate veining; rare carbonaceous laminations
229.20	229.30			MDST	MI	CARB	V-	0	7	EW										VG						White carbonate fracture fill/vein ; random orientation
229.30	235.73			MDST	MI	T		0	7	GG	BD	60	LM							FT						Slightly silty; minor carbonaceous laminations; minor carbonate – pyrite fracture fill.
235.73	235.89			MDST	MI	CARB	V-	0	7	EW										VG						Herringbone vein pattern ; ? barite

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McARTHUR BASIN PROJECT – DIAMOND DRILL HOLE LOG SHEET

Sheet 4 of 5

DATE 20/9/93 LOGGED BY I. BROWN HOLE DEPTH 348·20 m JOB No. LP1 **HOLE No.** MD4

DRILLED INTERVAL FROM	DRILLED INTERVAL TO	CORE LOSS (cm)	FORMATION	ROCK TYPE MAJOR	q	ROCK TYPE MINOR	q	OXIDATION	COLOUR LIGHT	COLOUR HUE	STRUCTURE S1	ANGLE TO LCA	TEXTURE T1	TEXTURE T2	ALGAE A1	ALGAE A2	EVAPORITE TEXTURE 1	EVAPORITE TEXTURE 2	EVAPORITE TEXTURE 3	SULPHIDE MINERALISATION PYRITE m %	CHALCOPYRITE m %	GALENA m %	SPHALERITE m %	m %	m %	COMMENTS
235·89	241·22			MDST	MI	SIST	M+	0	7	EG	BD	65	LM													Minor laminations of dolomitic siltstone; minor carbonate veining; rare carbonaceous laminations
241·22	241·29			CARB	V-	MDST	M+	0	7	WG	V-		WS													? Barite; some lenticular crystal growth
241·29	245·60			MDST	MI	SIST	DO	0	7	EG	BD	65	LM	SS												Siltstone and carbonaceous laminations; very minor carbonate veining
245·60	245·86			CARB	V-	MDST	MI	0	7	WG	V-		WS							VT						random/herringbone veining; ? barite
245·86	260·97			MDST	MI	SIST	DO	0	7	EG	BD	60	LM	SS												Very minor carbonate veining; crumbles upon drying
260·97	261·08			MDST	MI			0	6	EW	S-	20	FR	V-						VG						Minor/weak shear; carbonate – pyrite veining
261·08	287·10			MDST	MI	SIST	DO	0	7	EG	BD	60	LM	SS												Very minor carbonate veining/fracture fill; crumbles upon drying; 2cm carbonate vein at 281·4m; trace carbonaceous laminations
287·10	291·30			MDST	MI	MDST	CS	0	5	EW	BD	70	LM	V-												Moderate – carbonaceous laminations to 3mm; crumbles upon drying; minor carbonate veining (especially at upper contact); minor interbedded dolomitic siltstone.
291·30	295·65			MDST	MI			0	7	GE	V-	70								VT						Rare carbonaceous laminations; generally massive; carbonate ± pyrite veining to 5mm (2/m).
295·65	298·22			MDST	MI	MDST	CS	0	6	GN	BD	70	LM													Moderate carbonaceous laminations; trace carbonate veining
298·22	298·64			MDST	MI			0	7	GW	V-															Carbonate ± pyrite veining – herringbone pattern; no carbonaceous laminations
298·64	303·10			MDST	MI	MDST	CS	0	6	GN	BD	70	LM							VT						Moderate carbonaceous laminations; 4cm carbonate ± pyrite vein at 300·84m
303·10	303·37			MUDD	S-	MDST	MI	0	6	G																Mudstone fragments in mud ? drilling induced or shear.
303·37	305·25			MDST	MI	MDST	CS	0	5	GN	BD	70	LM													Moderate carbonaceous laminations; trace carbonate veining
305·25	312·53			MDST	CS			0		N	BD	70	LM	FR						EG	EG	EG	ET			Bituminous; "paint" style mineralisation; crumbles upon drying
312·53	315·97			SIST	MI	MDST		0	5	GE	BD	80	XB	LM												Glauconitic siltstone; waxy fractures; mudstone crumbles; minor carbonate veining; minor fine-grained sandstone
315·97	316·80			SNST	MI			0	5	UE	BD	30	BS	LM												Slump bedding; fine-grained sandstone; black mineral ?
316·80	318·30			SNST	MI	MDST	IB	0	B	UE	BD	60	XB	BN						VT						Fine-grained sandstone; minor pyrite + carbonate veining
318·30	318·48			MDST	LM	SIST	MI	0	B	E	UF		MC													Carbonate in mudcracks
																										NOTE: More micaceous and glauconitic below the bituminous mudstone. Beginning of obvious fining-up sequence and some cyclicity.
318·48	319·00			SNST	MI	MDST	M+	0	B	VE	BD	60														Fine-grained sandstone;
319·00	319·67			MDST	MI	SIST	MZ	0	6	UG	BD	60	LM	XB												Plus fine-grained sandstone; mudstone crumbles

BHP Minerals Limited

McARTHUR BASIN PROJECT – DIAMOND DRILL HOLE LOG SHEET

Sheet 5 of 5

DATE 23/9/93 LOGGED BY I. BROWN HOLE DEPTH 348.20 m JOB No. LP1 HOLE No. MD4

DRILLED INTERVAL FROM	TO	CORE LOSS (cm)	FORMATION	ROCK TYPE MAJOR	q	ROCK TYPE MINOR	q	OXIDATION	COLOUR LIGHT	COLOUR HUE	STRUCTURE S1	ANGLE TO LCA	TEXTURE T1	TEXTURE T2	ALGAE A1	ALGAE A2	EVAPORITE TEXTURE 1	2	3	SULPHIDE MINERALISATION PYRITE m %	CHALCOPYRITE m %	GALENA m %	SPHALERITE m %	m %	m %	COMMENTS:
319.67	319.90			SNST	MI			O	B	E	BD	60	XB	V–												Fine-grained; Carbonate veinlet at 30° LCA;
319.90	320.68			SIST	MI	MDST	MI	O	B	EV	VF		XB	SR												Variable bedding; scour mark; very minor carbonate veining
320.68	320.79			SNST	MI			O	B	E	BD	75	V–	LM												Minor fracture/vein at 10° LCA;
320.79	321.76			MDST	MI	SIST	IB	O	B	E	BD	70	XB	LM												Minor mudcracks – now carbonate filled; cyclic; cross
																										bedded siltstone
321.76	325.60			SIST	MI	MDST	IB	O	B	E	BD	65	XB	RM												Single ripple mark; very minor carbonate veining; minor mudcracks
325.60	327.17			MDST	MI	SIST	IB	O	B	E	BD	70	LM	SR												Minor carbonate laminations; crumbles upon drying
327.17	328.30			SIST	DO	MDST	IB	O	B	E	BD	65	WS	XB												Minor carbonate veining; micaceous; cyclic
328.30	329.27			MDST	MI	SIST	IB	O	B	E	BD	70	SR	MC												Cross-bedded siltstone; crumbly mudstone
329.27	329.47			SIST	MI			O	5	E	BD	70														
329.47	330.38			MDST	MI			O	5	E			MS													Crumbly mudstone
330.38	333.19			MDST	MI	SIST	IB	O	B	E	BD	65	LM	MC												Cyclic; minor scour marks
333.19	333.56			SIST	MI			O	6	E	BD	70														Fine siltstone
333.56	333.70			CARB	V–	MDST	WS	O	5	EW			IB							BG						Laminated and wispy mudstone; ?vein OR carb/dolm bed.
333.70	334.01			MDST	SI			O	6	E			MS													Crumbly
334.01	334.22			MDST	MI	SIST	IB	O	B	E	BD	70	LM	MC												
334.22	334.89			MDST	MI			O	5	E			MS													Crumbly
334.89	336.20			MDST	MI	SIST	C+	O	B	E	BD	70	MC													Cyclic
336.20	336.84			MDST	MI			O	5	E			MS	WS												Wispy in part.
336.84	338.00			MDST	MI	SIST	IB	O	B	E	BD	70	XB													Cross-bedded siltstone
338.00	338.50			SIST	GN	MDST	MI	O	B	E	BD	70	MC	IB												Laminated; cross-bedded
338.50	342.90			MDST	MI	SIST	IB	O	6	E	BD	70	LM													Some laminated; some massive
342.90	343.01			CARB	V–	MDST	WS	O	7	EW			WS							VG						possible slumping; ?vein OR carb/dolm bed.
343.01	348.02			MDST	LM	SIST	GN	O	6	E	BD	70														Micaceous; mudstone crumbly; some massive; some laminated

Table 3: Results of TOC/SRA analysis

Sample ID	Top Depth (mMD)	SRA TOC	S1	S2	Tmax (°C)	Calc[1]. % Ro
351323	229.30	0.25	0.16	0.11	313	
351324	244.90	0.29	0.03	0.05	444	0.83
351325	288.80	0.16	0.09	0.08	304	
351326	304.70	1.76	0.29	2.88	454	1.01
351327	305.40	1.85	0.24	2.86	451	0.96
351328	306.70	2.62	0.33	4.92	445	0.84
351329	307.70	4.45	0.52	8.83	450	0.95
351330	308.50	3.96	0.45	7.04	445	0.85
351331	311.10	4.72	0.35	9.08	445	0.85
351332	311.90	6.16	0.47	6.64	441	0.78
351333	333.70	0.18	0.05	0.08	449	0.93

[1] % R_o is calculated using the formulae $\%R_o = 0.0180 \times Tmax - 7.16$ (Jarvie et al 2005).

Table 4: Calculation of petroleum potential using hydrocarbon index (HI) and production index (PI) from source rock analysis results presented in Table 3 for core samples from well MD4.

Sample ID	HI	S1/TOC*100	PI
351323	44	64	0.59
351324	17	10	0.38
351325	52	58	0.53
351326	163	16	0.09
351327	154	13	0.08
351328	188	13	0.06
351329	198	12	0.06
351330	178	11	0.06
351331	192	7	0.04
351332	108	8	0.07
351333	43	27	0.38

Table 5: XRF analysis results

(wt.%)	MD4		82/1
Sample	351326	351331	351348
SiO_2	70.15	68.40	66.38
TiO_2	0.696	0.668	0.725
Al_2O_3	18.02	17.41	19.65
Fe_2O_3	4.488	5.541	4.747
MnO	0.0185	0.0189	0.0148
MgO	1.808	1.736	1.636
CaO	0.336	0.188	0.377
Na_2O	0.640	0.719	0.151
K_2O	3.380	3.812	4.337
P_2O_5	0.111	0.055	0.294
SO_3	0.016	0.144	0.077
Cl	<10	<10	<10
LOI (XRF wt%)	0.33	1.30	1.62
Total	99.67	98.70	98.38
Fe_2O_3/k_20	1.33	1.45	1.09
SiO_2/Al_2O_3	3.89	3.93	3.38
CaO/K_2O	0.10	0.05	0.09

Table 6: XRD Mineralogy results

Sample	**351 326**	**351 331**
	Wt. %	**Wt. %**
Quartz	40.4	37.2
Plagioclase (Albite, Var. Cleavelandite)	5.7	6.4
Pyrite		0.5
Total Non-Clays	**46.1**	**44.1**
Kaolinite (Ordered)	3.8	
Smectite (Na-Kinney Montmorillonite)	2.6	2.1
Illite (1md)	47.6	53.8
Total Clays	**54.0**	**55.9**
Total	100.0	100.0

Table 7: Concentration of major elements (as wt%) of the samples sourced from the MD4 core hole showing comparison of the shale averages of the Velkerri Formation samples to the Average Shale composition determined by Wedepohl (1971, 1991) (sourced from Ross et al 2009) and the PAAS*. Velkerri Fm. averages drawn from correlation of samples obtained from MD4 historical core.

	MD4		**82/1**	**Velkerri**	**Wedepohl (1971, 1991)**	**PAAS***
Depth (m)	**304.7**	**311.10**				
Sample	**351326**	**351331**	**351348**	***n= 3***	**Avg Shale**	**Avg Shale**
SiO_2	70.15	68.4	66.38	68.31	58.9	62.8
TiO_2	0.696	0.668	0.725	0.696	0.78	1
Al_2O_3	18.02	17.41	19.65	18.36	16.7	18.9
Fe_2O_3	4.488	5.541	4.747	4.925	2.8	7.22
FeO						
MnO	0.0185	0.0189	0.0148	0.017		0.11
MgO	1.808	1.736	1.636	1.727	2.6	2.2
CaO	0.336	0.188	0.377	0.300	2.2	1.3
Na_2O	0.64	0.719	0.151	0.503	1.6	1.2
K_2O	3.38	3.812	4.337	3.843	3.6	3.7
P_2O_5	0.111	0.055	0.294	0.153	0.16	0.16
LOI	0.33	1.3	1.62	1.08		6
Total	99.67	98.7	98.38		89.34	104.59
TOC	1.76	4.72			0.2	0.2
Fe_2O_3T					3.64	3.64
Fe_2O_3T/k_20					1.01	1.01
Fe_2O_3T/AL_2O_3					0.22	0.22
SiO_2/Al_2O_3	3.89	3.93	3.38	3.73	3.53	3.53
CaO/K_2O	0.1	0.05	0.09	0.08	0.61	0.61
K_20/Al_2O_3	0.19	0.22	0.22	0.21	0.22	0.22
MgO/Al_2O_3	0.10	0.10	0.08	0.09	0.16	0.16
TiO2/Al2O3	0.04	0.04	0.04	0.04	0.05	0.05
SO_3	0.016	0.144	0.077	0.08		
Cl	<10	<10	<10			

* PAAS = Post Archean Australian Shale standard

Table 8: ICP Element Analyses Results

Well	MD4		82/1
Depth (m)	304.7	311.1	
Sample (ug/g)	351326	351331	351348
Li	51.3	30.3	40.2
Be	2.4	2.2	1.6
B	64.3	48.2	50
Sc	N.D.	N.D.	N.D.
Ti	N.D.	N.D.	N.D.
V	58.70	58.80	124.20
Cr	50.30	29.00	38.10
Co	9.00	9.10	8.80
Ni	30.60	21.50	17.70
Cu	59.2	23.80	73.30
Zn	80.70	149.90	568.80
Ga	20.60	13.50	14.50
ge	80.50	68.7	54.40
As	6.50	6.4	3.80
Rb	149.40	118	101.70
Sr	68.30	48	93.80
Zr	N.D.	N.D.	N.D.
Nb	N.D.	N.D.	N.D.
Ag	N.D.	N.D.	N.D.
Mo	N.D.	N.D.	N.D.
Cd	N.D.	N.D.	N.D.
Sb	1629.4	1342.9	668.2
Te	1598.2	552.8	383
Cs	11.2	7.7	8.8
Ba	296.1	206.9	212.1
Hf	3306.9	2194.7	1944.1
Ta	614.9	452.6	543
W	2103.4	3277.9	7601.8
Tl	0.2	0.3	0.3
Pb	21.6	33	17.7
bi	1.1	0.7	0.5
Th	14.1	10.6	12.2
U	2.6	3.1	2.8

Table 9: Rare earth elements analysis

Well	MD4		82/1
Depth (m)	304.7	311.1	
Sample (ug/g)	351326	351331	351348
La	33.94	24.76	30.65
Ce	71.16	56.06	68.62
Pr	8.56	6.83	7.78
Nd	31.34	25.64	27.63
Sm	6.44	5.76	5.83
Eu	1.10	1.07	1.09
Gd	5.66	5.27	5.76
Tb	0.90	0.82	0.87
Dy	5.19	5.05	4.79
Ho	1.07	1.08	0.94
Y	27.11	25.94	23.14
Er	3.17	3.31	2.75
Tm	0.48	0.50	0.40
Yb	3.41	3.27	2.64
Lu	0.53	0.51	0.40

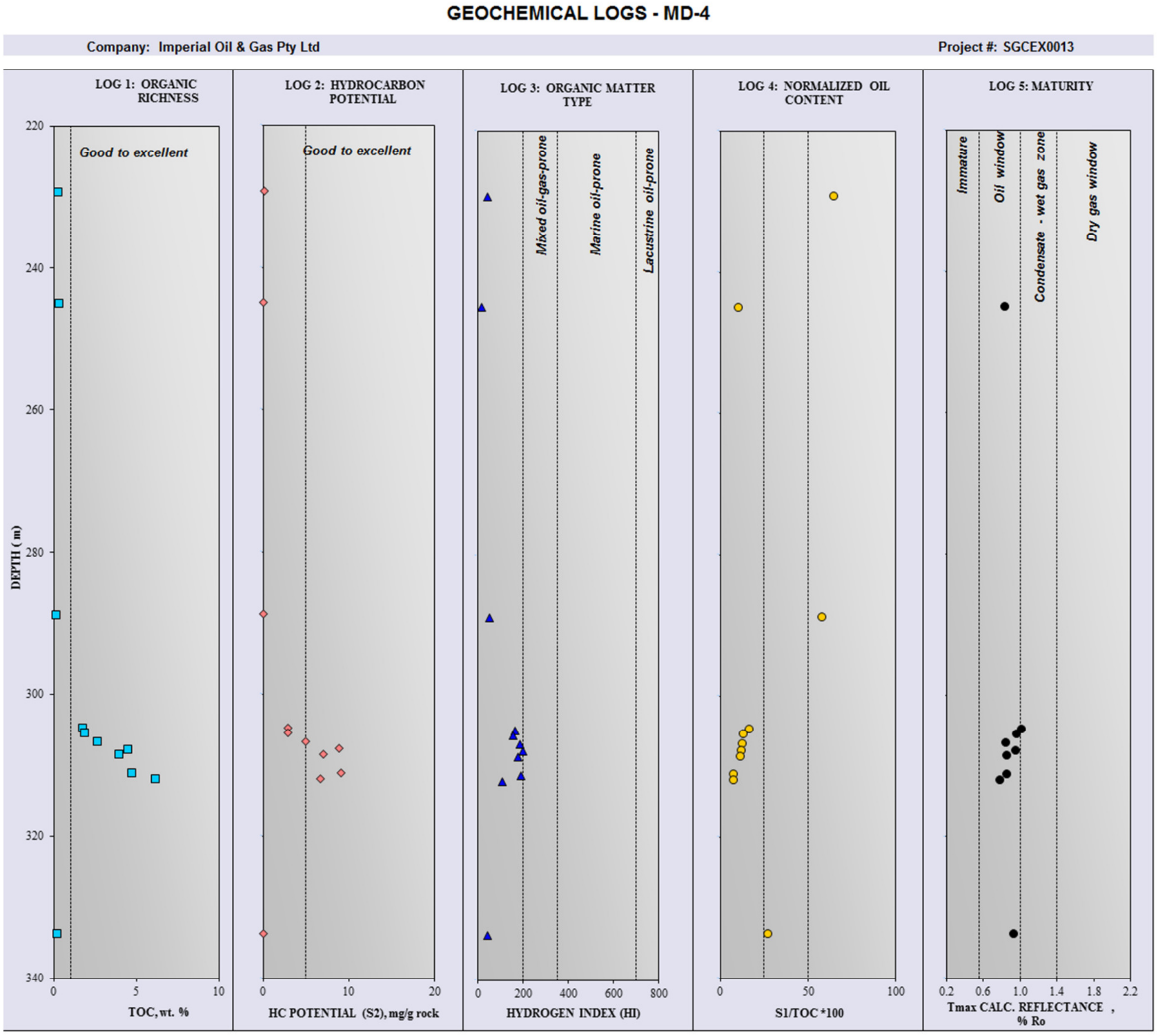


Figure 1: Geochemical log

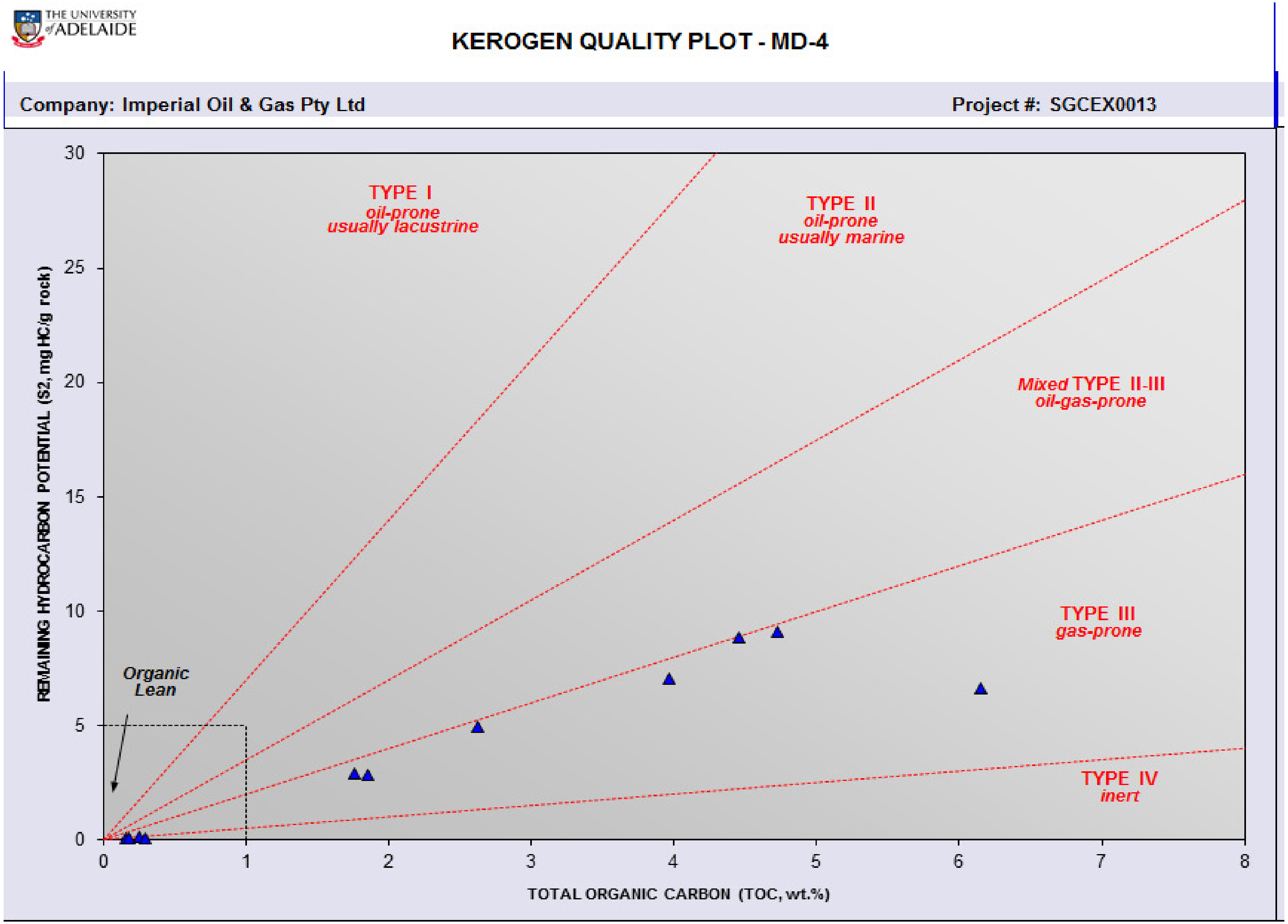


Figure 2: Kerogen quality plot

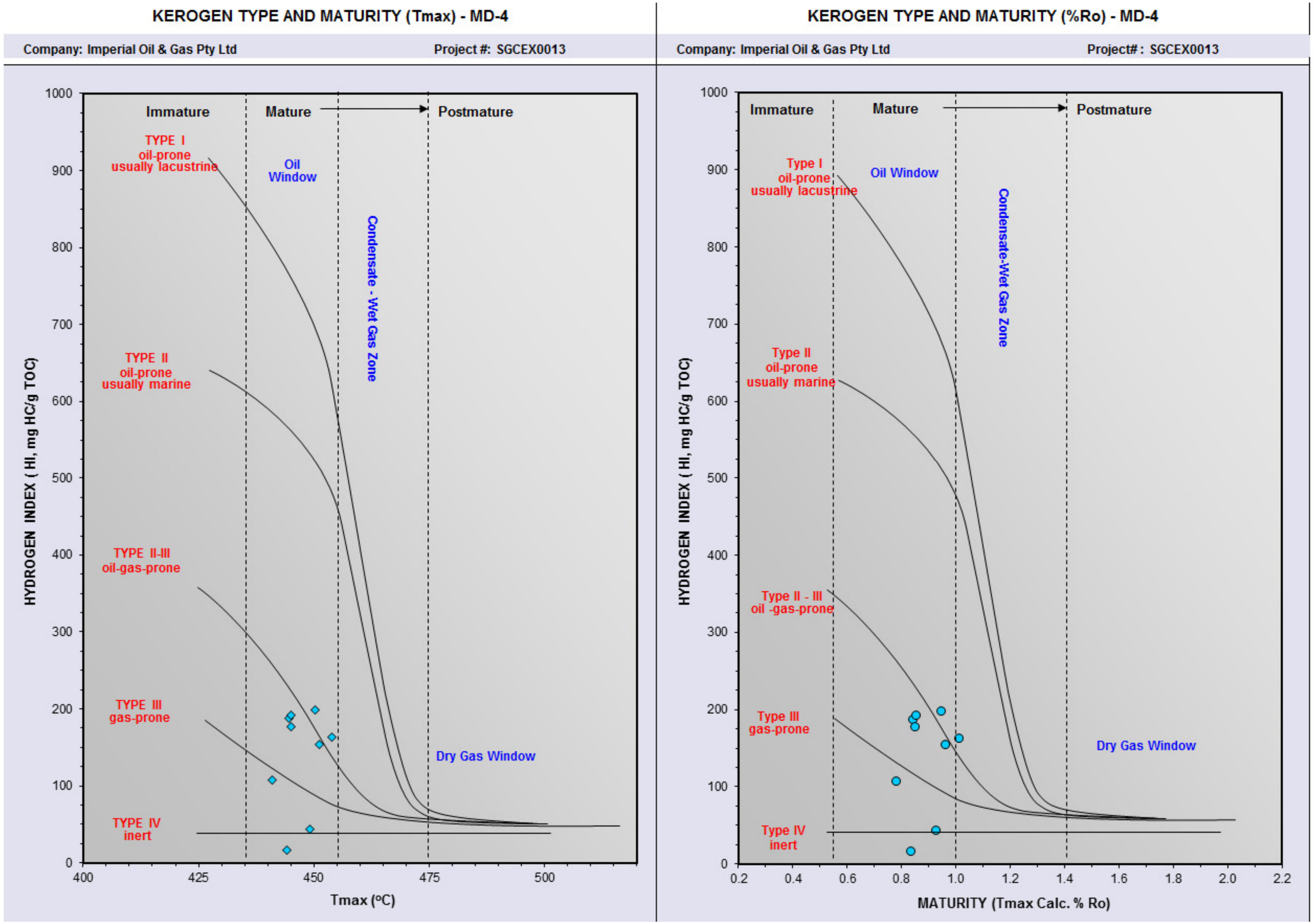


Figure 3: Kerogen type and maturity

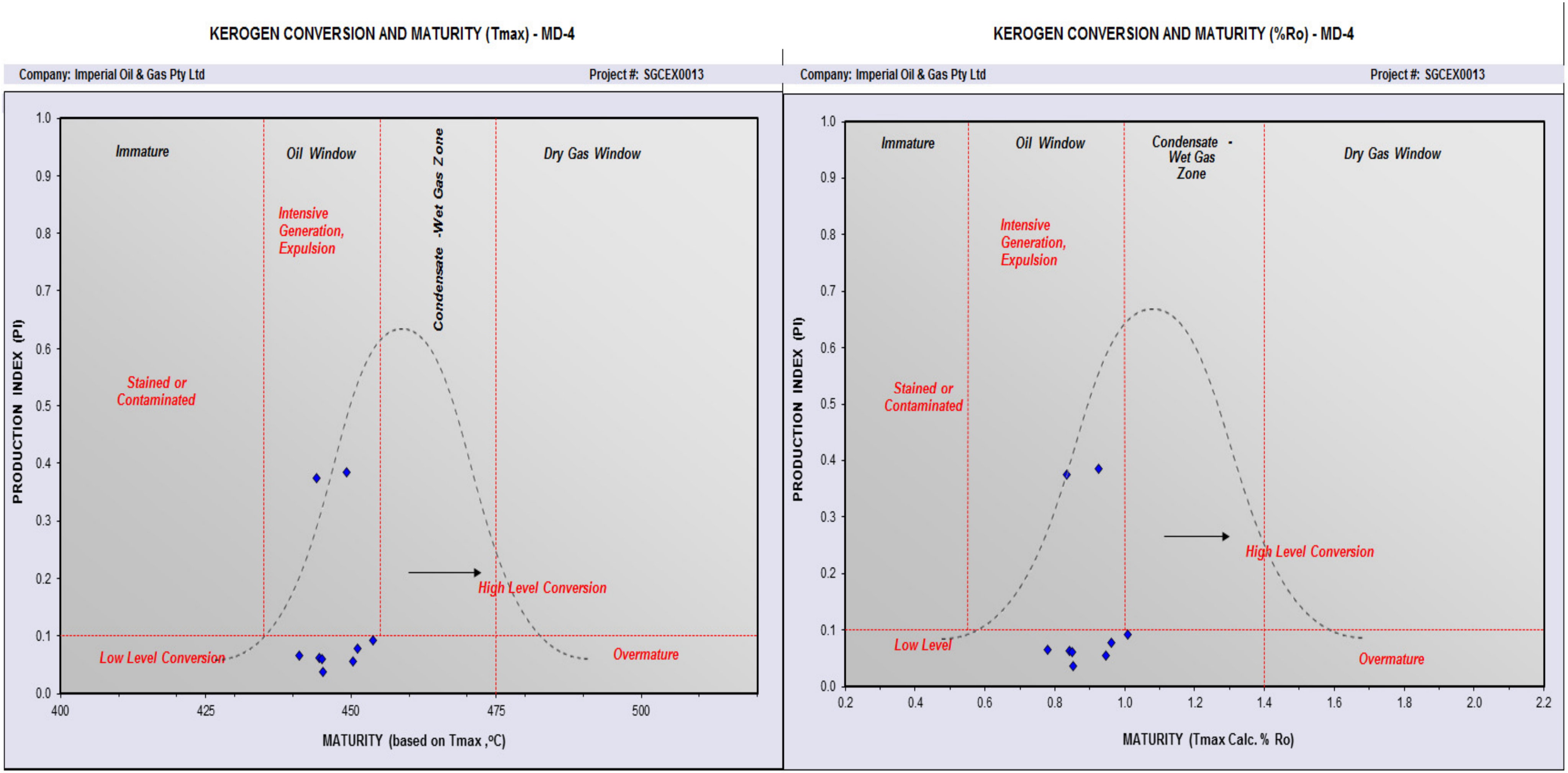
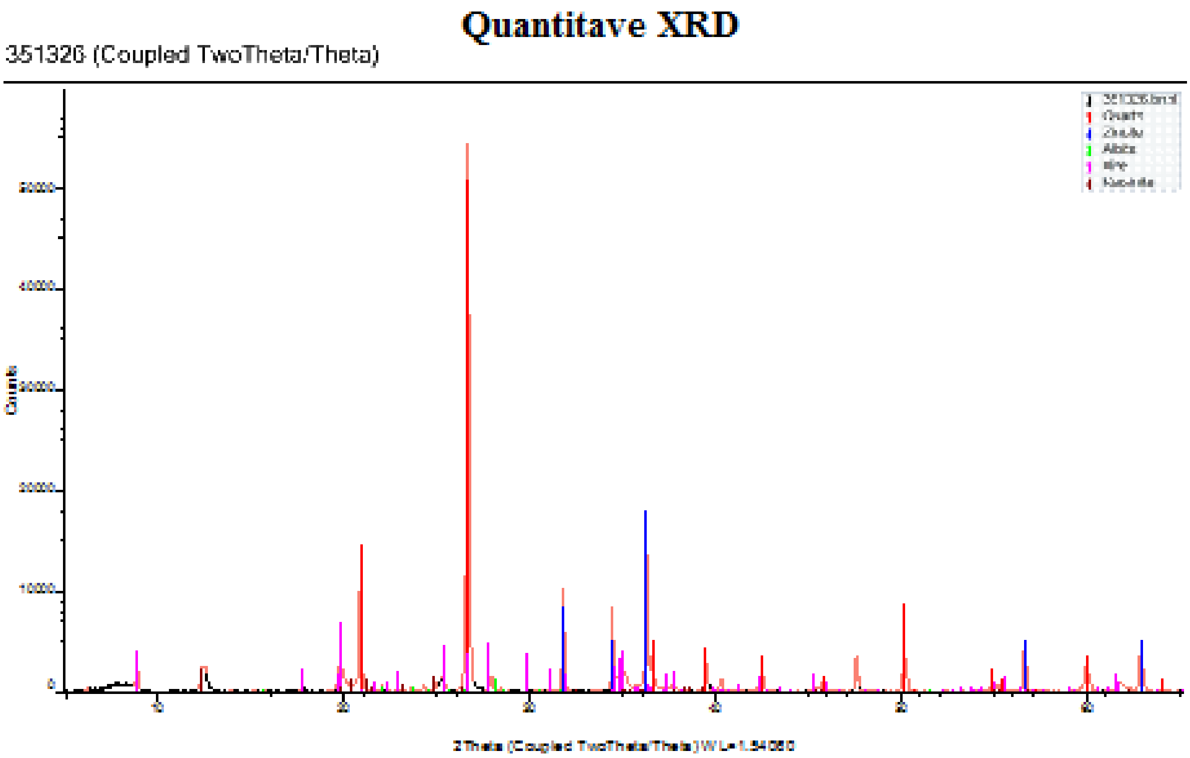


Figure 4: kerogen conversion and maturity

Quantitative XRD

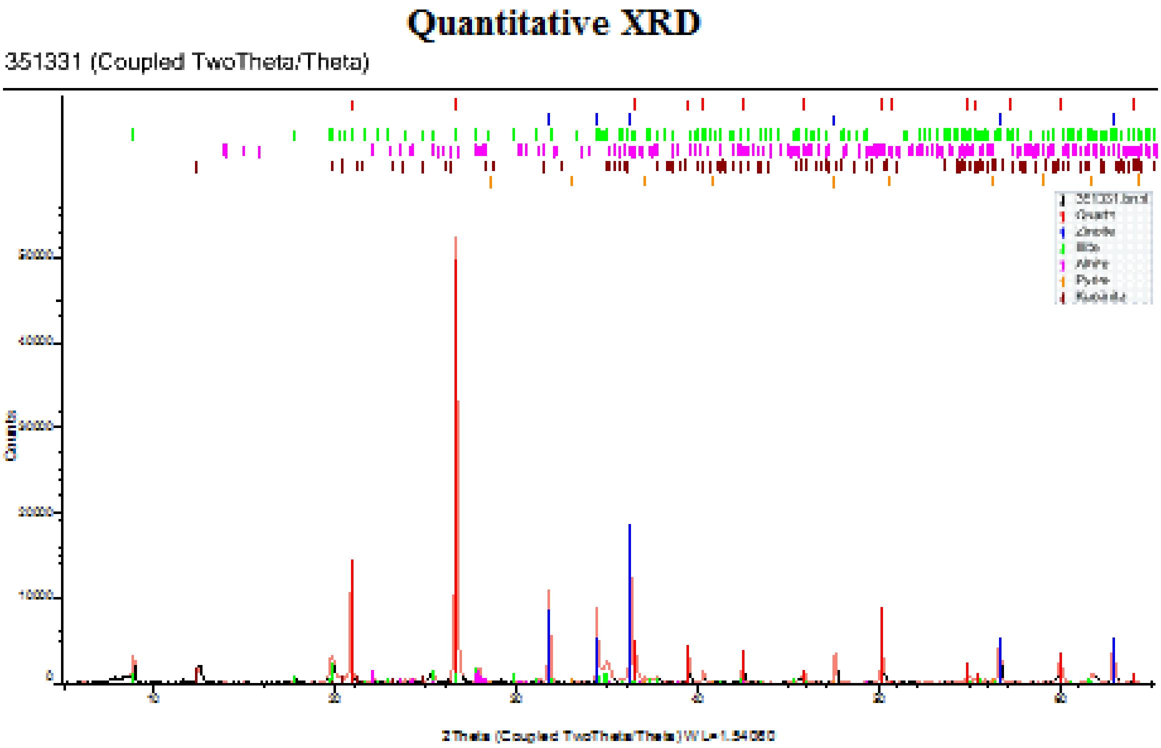
Sample 351326



Degree of fit: 0.0455

NON-CLAYS	**Weight %**
Quartz	40.4
Plagioclase (albite, var. cleavelandite)	5.7
Total non-clays	**46.0**
CLAYS	
Kaolinite (ordered)	3.8
Smectite (Na-Kinney montmorillonite)	2.6
Illite (1Md)	47.6
Total clays	**54.0**
TOTAL	100.0

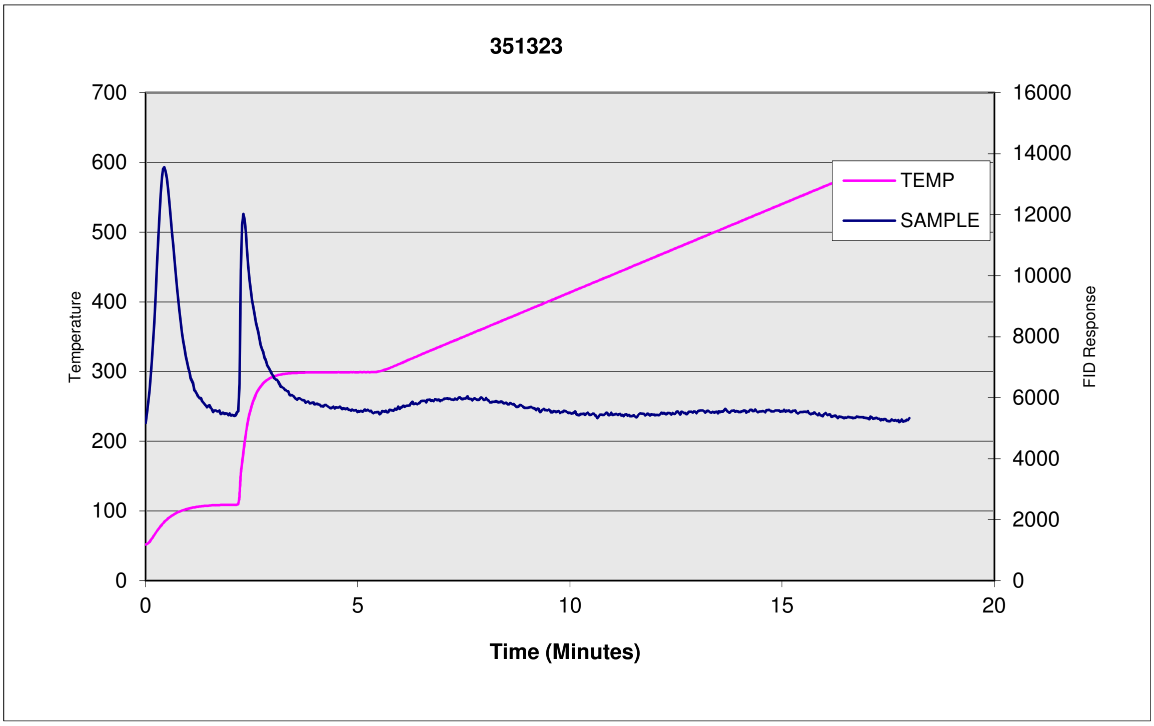
Sample 351331

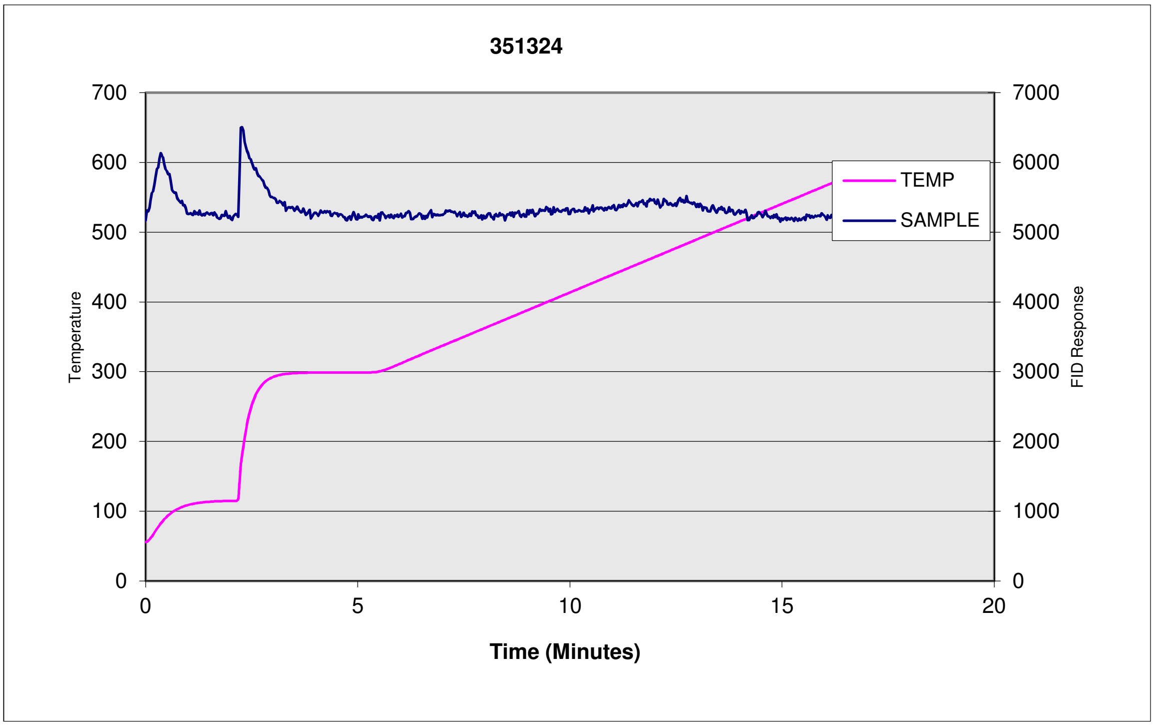


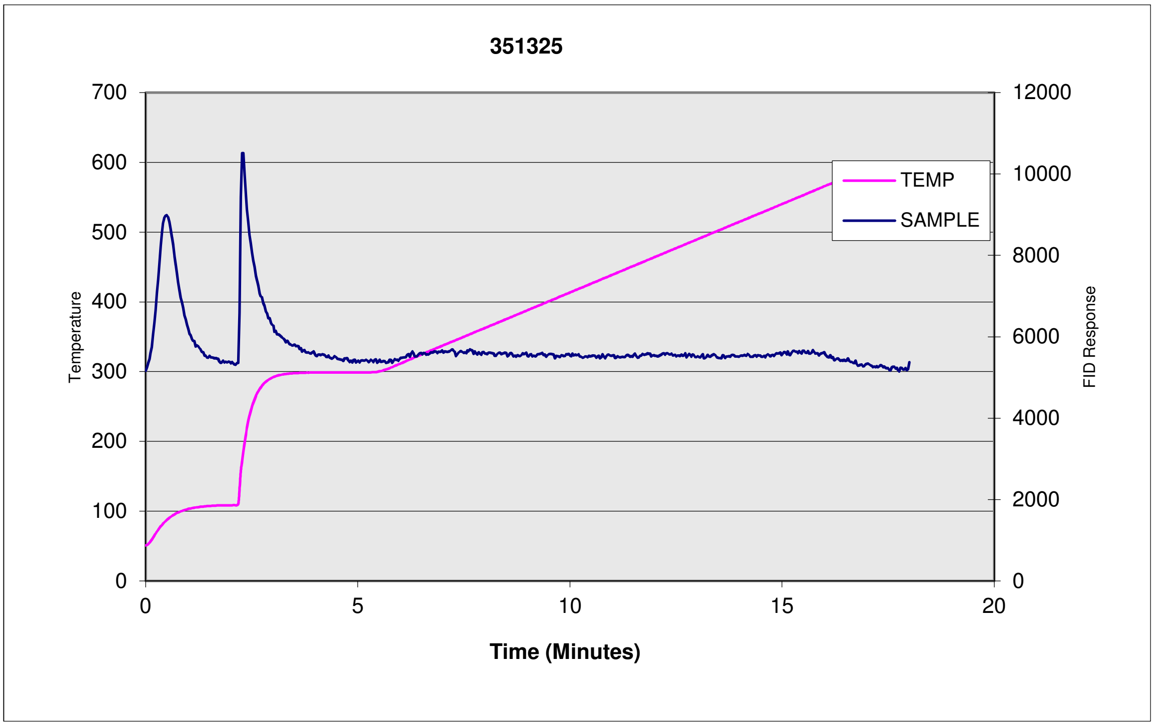
Degree of fit: 0.0465

NON-CLAYS	**Weight %**
Quartz	37.2
Plagioclase (albite, var. cleavelandite)	6.4
Pyrite	0.5
Total non-clays	**44.1**
CLAYS	
Kaolinite (ordered)	2.0
Illite (1Md)	53.8
Total clays	**55.9**
TOTAL	100.0

Pyrolysis data



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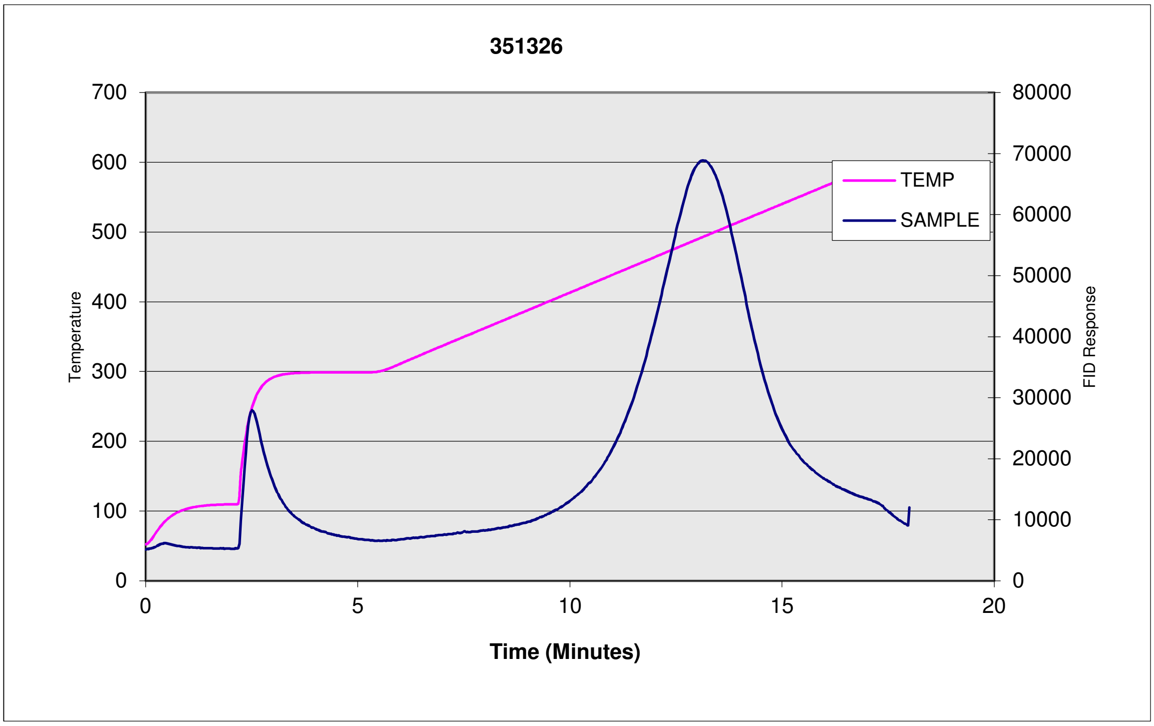
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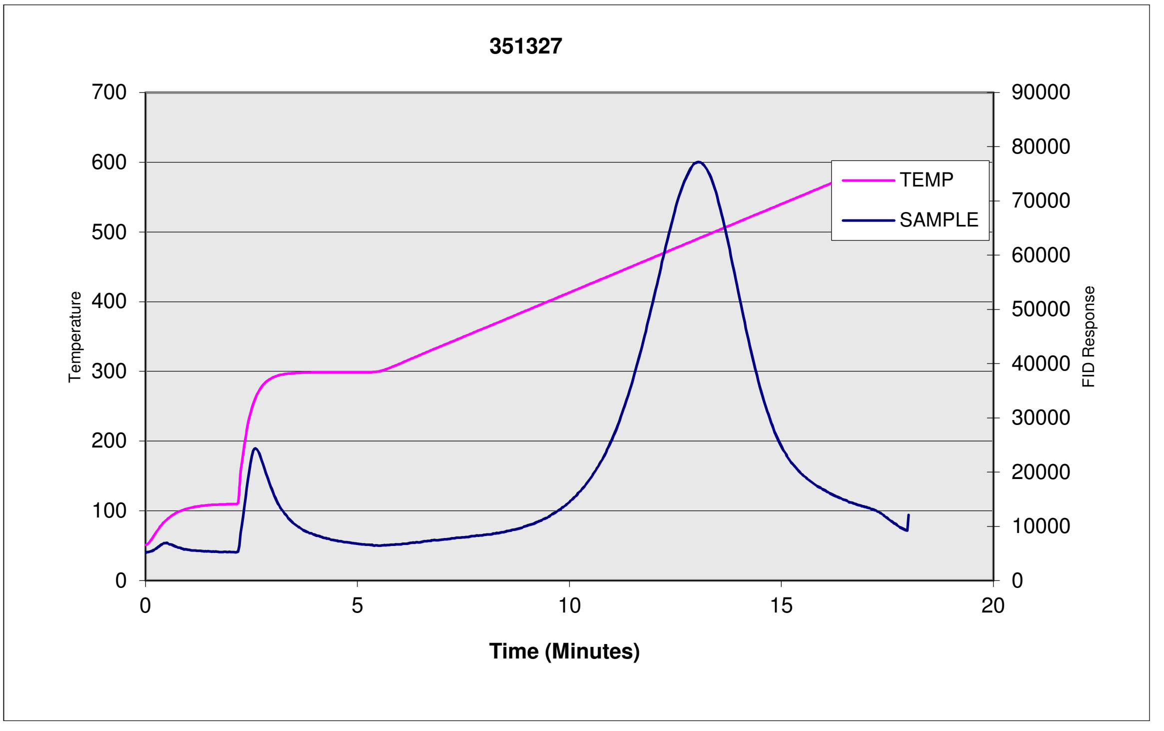

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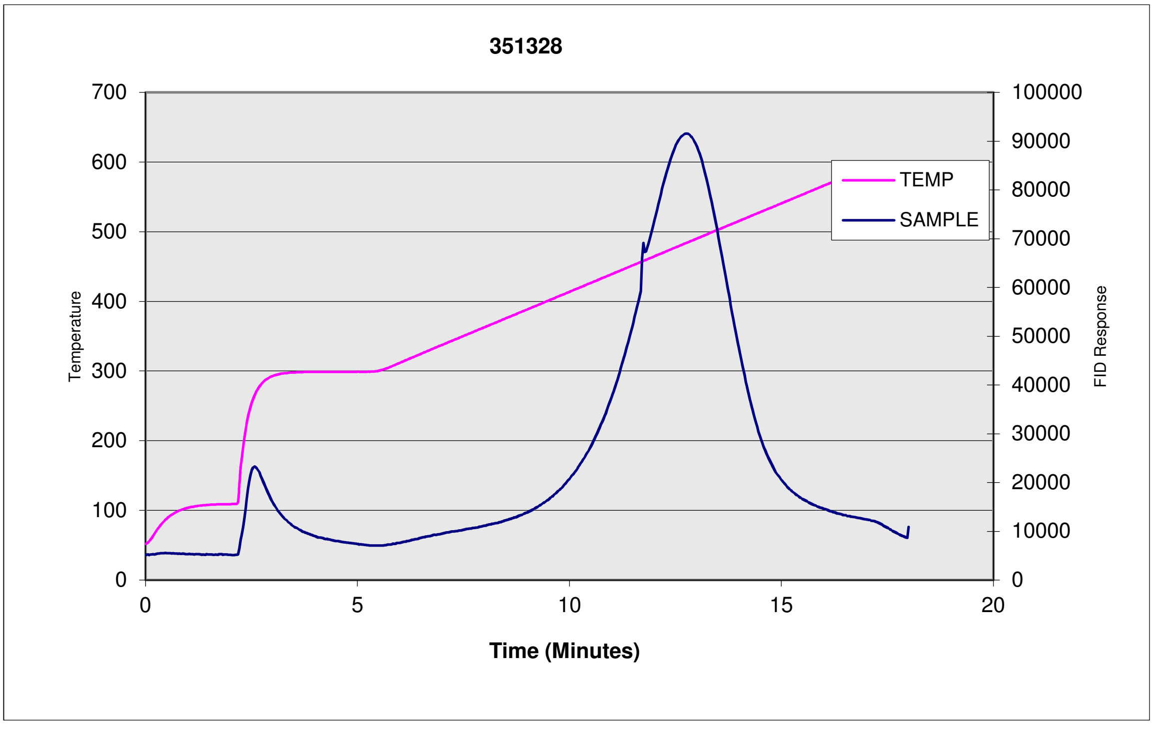

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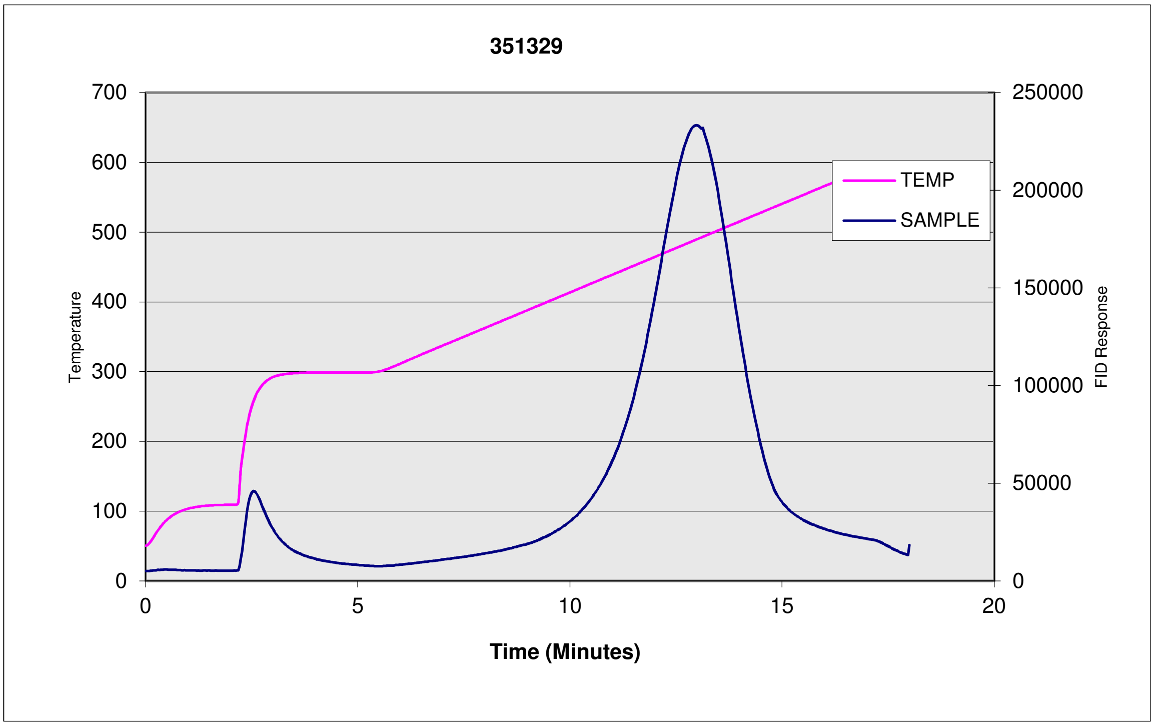
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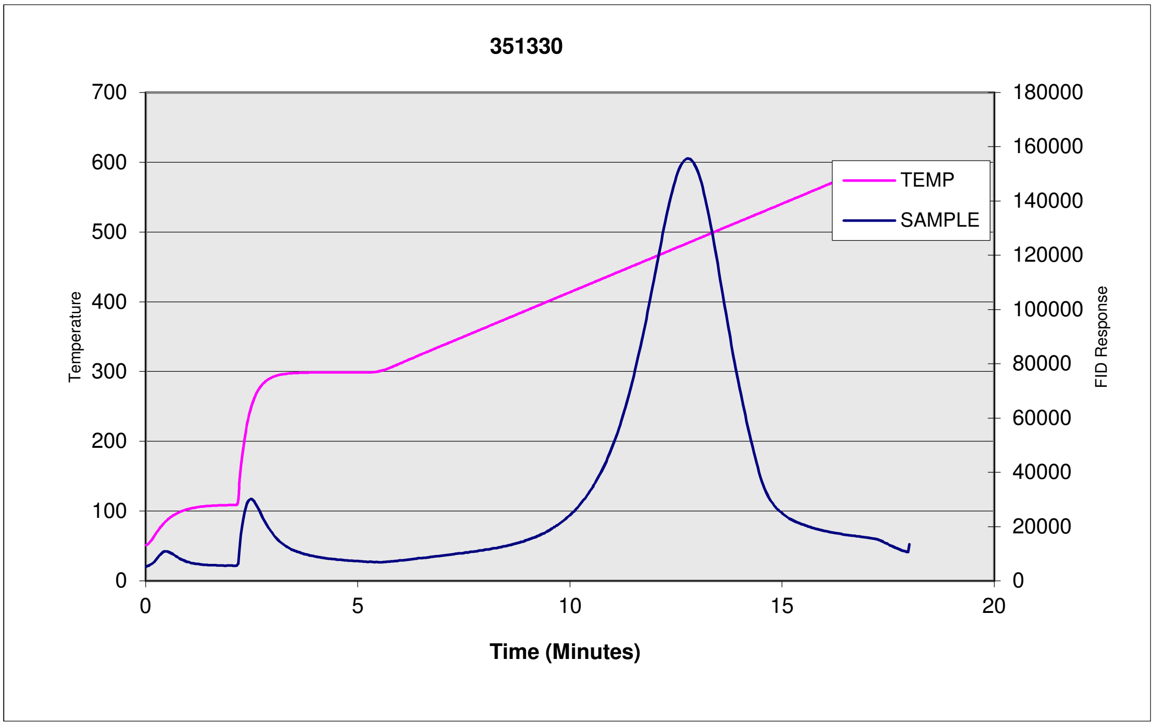
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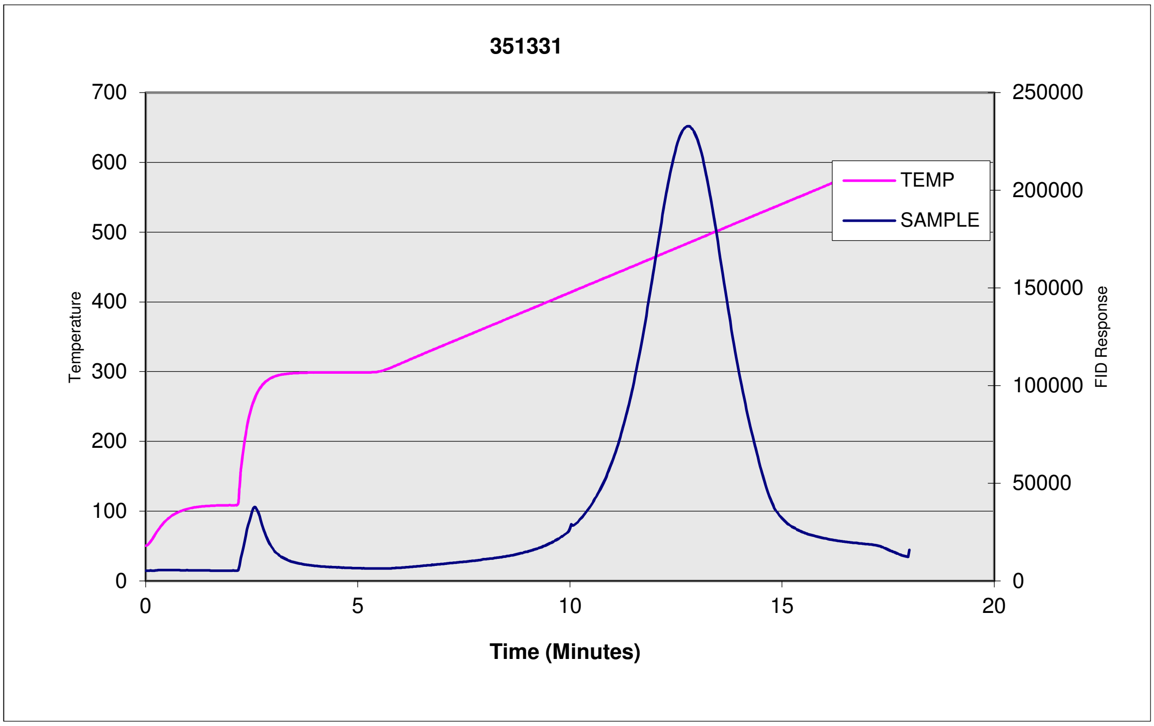
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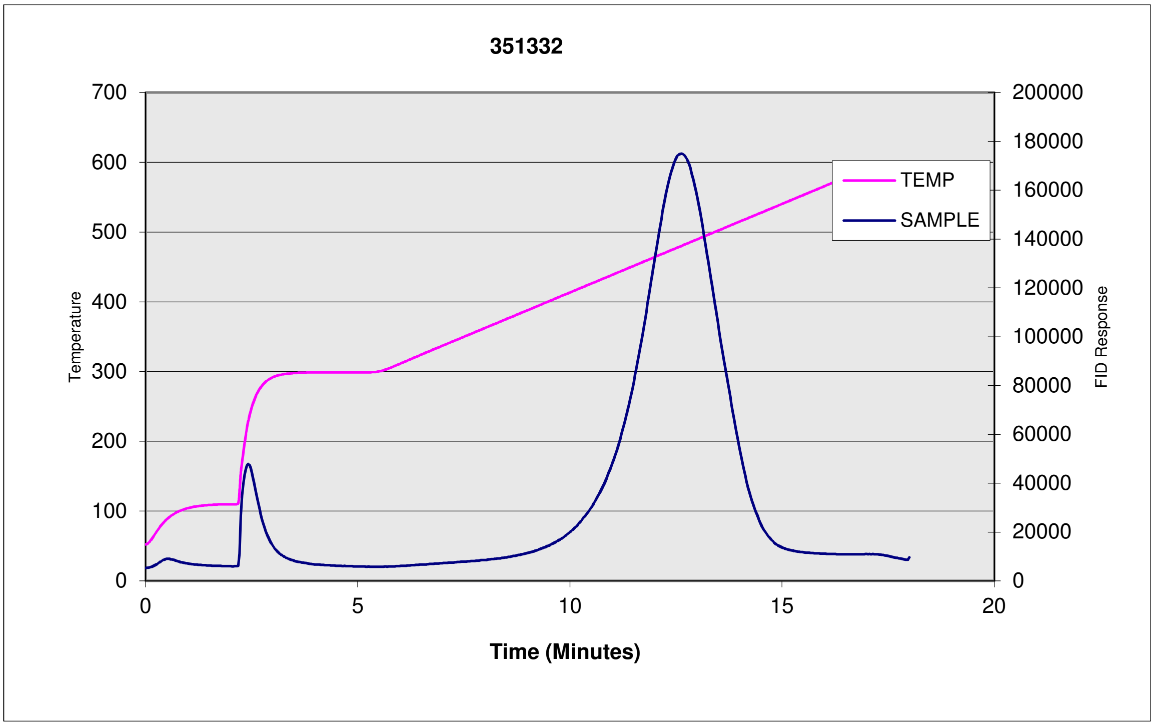
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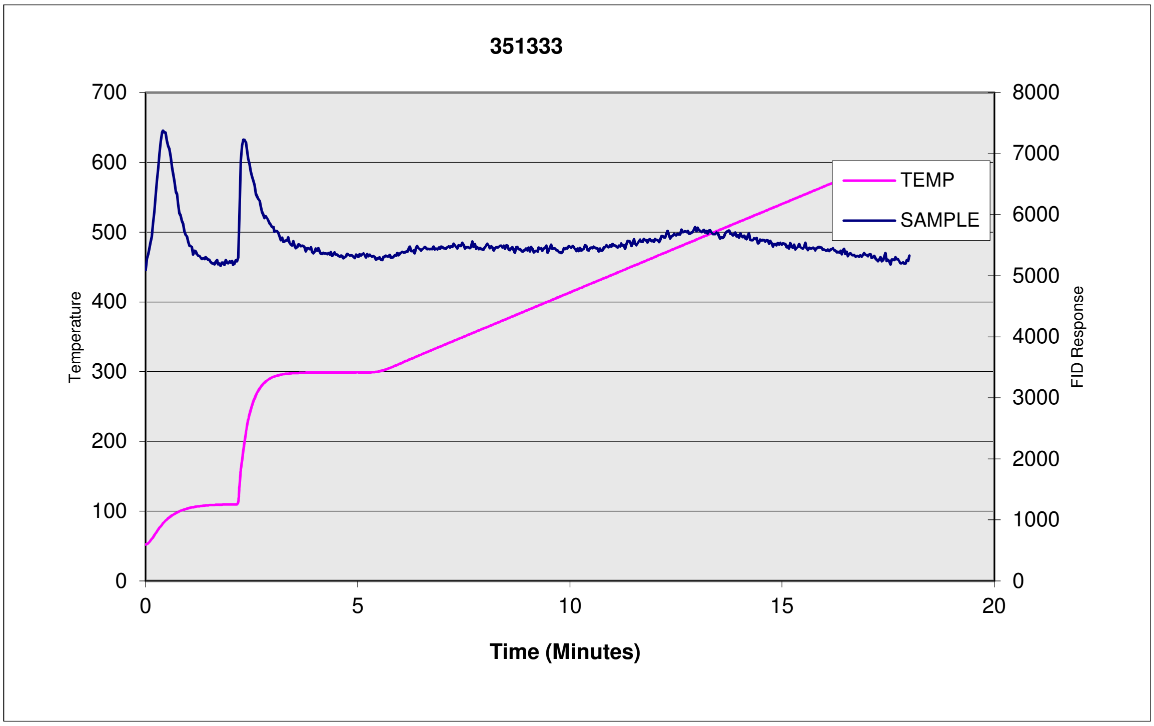
351333
Temperature
FID Response
Time (Minutes)
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SAMPLE
0
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600
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1000
2000
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4000
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