

SOURCE ROCK DISTRIBUTION and QUALITY

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Chapter 8

INTRODUCTION

One key attribute, namely the association of Proterozoic and Cambrian source rocks and evaporites, is shared between the Officer Basin, Persian Gulf and southwest Siberian Platform. In these regions, halite and anhydrite are associated at two main stratigraphic levels with argillaceous dolomite (the chief source rock) and sandstone. These were originally interbedded sabkha-lagoonal deposits but they have been extensively altered by halokinesis. Mobile salt occurs in the early Neoproterozoic (~800 Ma) Alinya Formation of the Officer Basin, Bitter Springs Formation of the Amadeus Basin, and Hormuz Series of the Persian Gulf region where salt diapirs have become major oil traps (Edgell, 1991).

The evaporite association also occurs in younger strata of late Proterozoic and early Cambrian age (~650–518 Ma) in southwestern Siberia (Kuznetsov *et al.*, 1992), Oman and the Manya–Tallaringa Trough region of the eastern Officer Basin. The salt has remained largely immobile in the Officer Basin and Siberia.

Despite major oil and gas production from Siberia and the Persian Gulf, and numerous *in situ* oil bleeds (e.g. Byilkaoora 1), the Proterozoic–Cambrian hydrocarbon potential of the Officer Basin has been perceived as low, a perception shared with rocks of similar age in the Amadeus Basin (e.g. Summons and Powell, 1991). Current interpretations emphasise that Mereenie and Palm Valley oil and gas migrated from source facies of the Ordovician Horn Valley Siltstone, whereas oil generated in the Proterozoic or Cambrian migrated prior to trap development (e.g. Jackson *et al.*, 1984). This assumption, based mainly on the stratigraphic range of the cyanobacterium *Gloeocapsomorpha prisca*, is weakened by several factors. These include the dry gas composition at Palm Valley, the presence of gas but not oil at West Walker 1 (Jackson *et al.*, 1984), wet gas in the Bitter Springs Formation at Magee 1 (Wakelin-King, 1994), and the discovery of *G. prisca* in the Early Cambrian Ouldburra Formation in the Officer Basin (Kamali, 1995a; Michaelsen *et al.*, 1995). On the basis of this and other evidence, the Amadeus Basin oil and gas may have been generated from formations as old as the Bitter Springs Formation, a play that was actively explored by Pacific Oil and Gas Pty Ltd and resulted in the Magee 1 discovery (Wakelin-King, 1994).

A lack of knowledge of pre-Ordovician source rocks should not be a deterrent to exploration in the Officer Basin. As McKirdy (1993) pointed out, the eastern Officer Basin is remarkably well endowed with oil shows in Neoproterozoic

and Cambrian rocks, the oils representing four genetically distinct families. Potential source rocks appear to be organically lean on average but this is largely due to the pyrolysis technique being not well suited to treatment of the carbonate-dominated lithologies. Most samples comprise vertical portions of core, even though the organic-rich material is horizontally laminated. Pyrolysis is carried out on powdered rock samples which thus comprise perhaps 90% matrix and must be considered minimal because samples are pre-digested in ~30% HCl, which is harsh treatment. The Total Organic Carbon (TOC) content of Officer Basin samples is usually quite low (<0.5%) but, where organic-rich layers are specifically sampled, the TOC may be >4.5% (McKirdy *et al.*, 1983).

Figure 8.1 provides a stratigraphic summary of both the source potential of the Officer Basin and oil shows.

FORMATION DESCRIPTION

Alinya Formation

Source richness

Six samples of the Alinya Formation analysed from Giles 1, and nine from Manya 5, revealed that the source richness is very poor to poor (average TOC = 0.24, range 0.02–0.62). However, samples are from thin black shale beds at the base of upward-shallowing evaporite cycles (Zang and McKirdy, 1994) in Giles 1 and redbeds in Manya 5, and may not be representative of the more basinal parts of the unit. Given the very limited sampling from only two wells, it is premature to dismiss the unit as too organically lean for hydrocarbon generation. Available Rock-Eval data for the Alinya are summarised in Table 8.1.

Kerogen type and source potential

Hydrogen Index (HI) values are commonly low (0–106), indicating gas-prone Type IV to III kerogen (Fig. 8.2). The samples in Manya 5 have near zero genetic potential; these are overmature and contain intertinite or sub-graphitic kerogen (McKirdy *in Weste*, 1984). Samples from Giles 1 indicate poor genetic potential up to 0.91 kg hydrocarbon per tonne of source rock, but an almost identical molecular biomarker assemblage to the Alinya Formation is found in the correlative Gillen Member of the Bitter Springs Formation (Amadeus Basin; McKirdy *in Zang and McKirdy*, 1993), which also contains an oil-prone black, pyritic shale (in Bluebush 1, Mount Charlotte 1; Jackson *et al.*, 1984). Thus, oil-prone kerogens may be found in the Alinya Formation. Confirmation of this potential is provided by oil

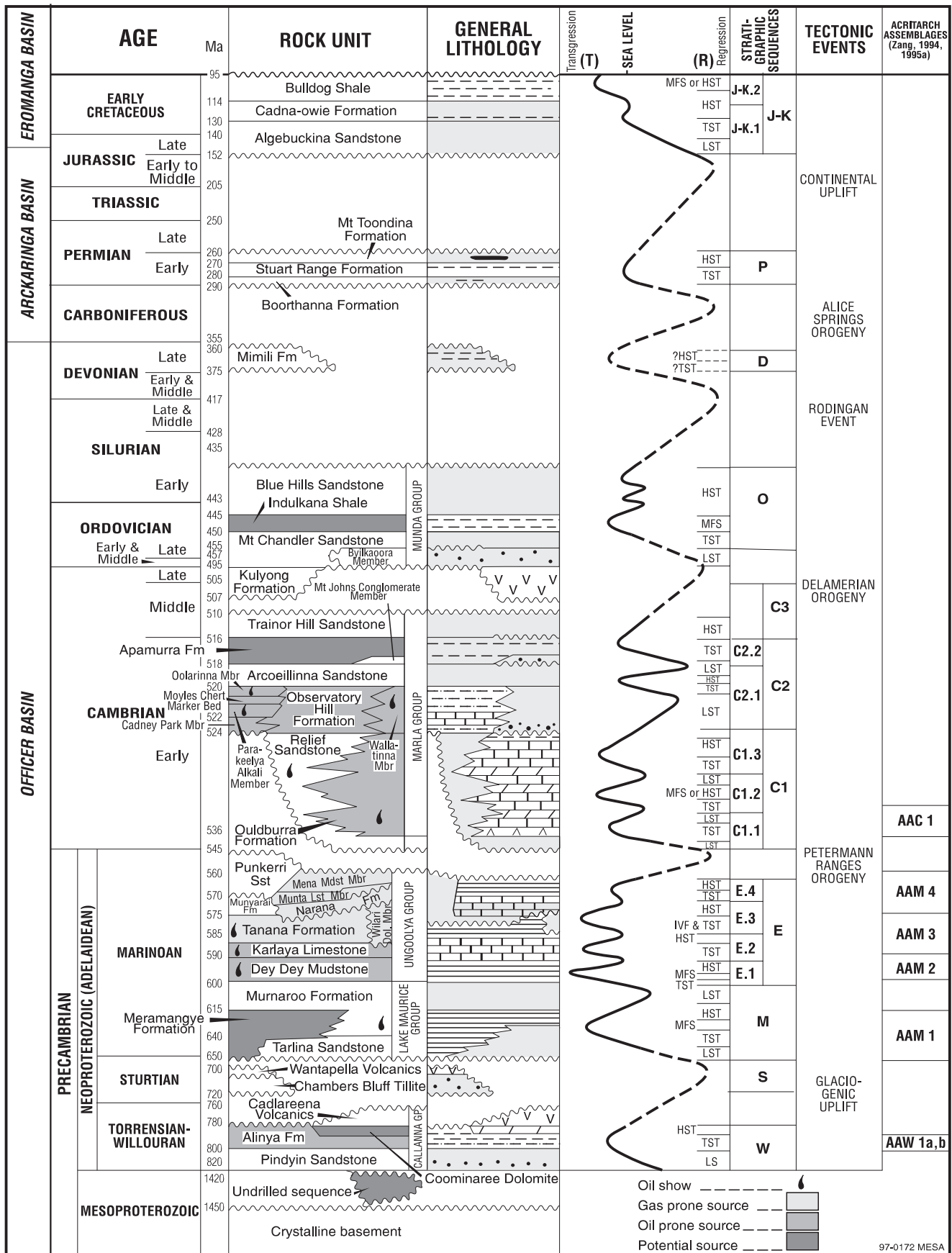


Fig. 8.1 Summary stratigraphic column of the Officer Basin, showing potential and proven source units, and oil shows.

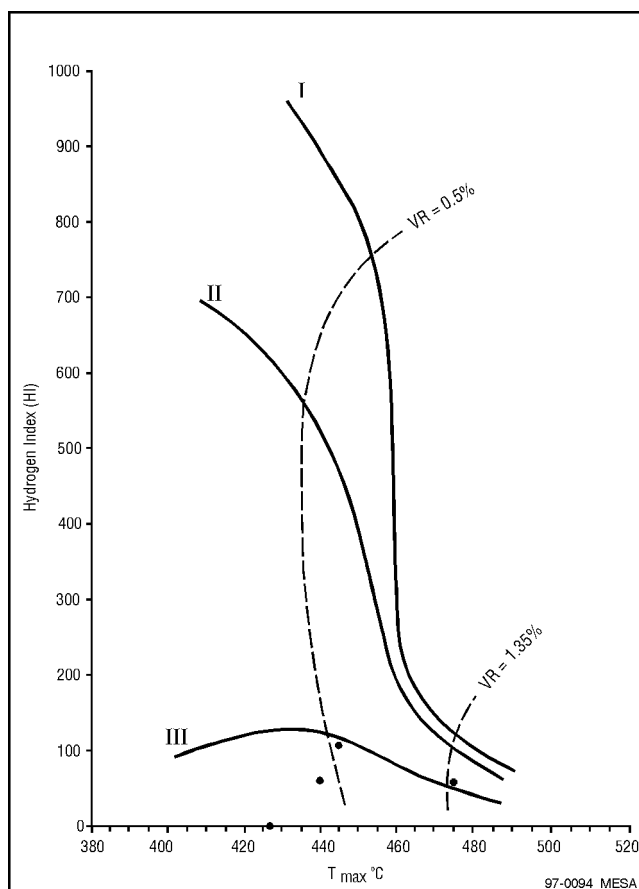


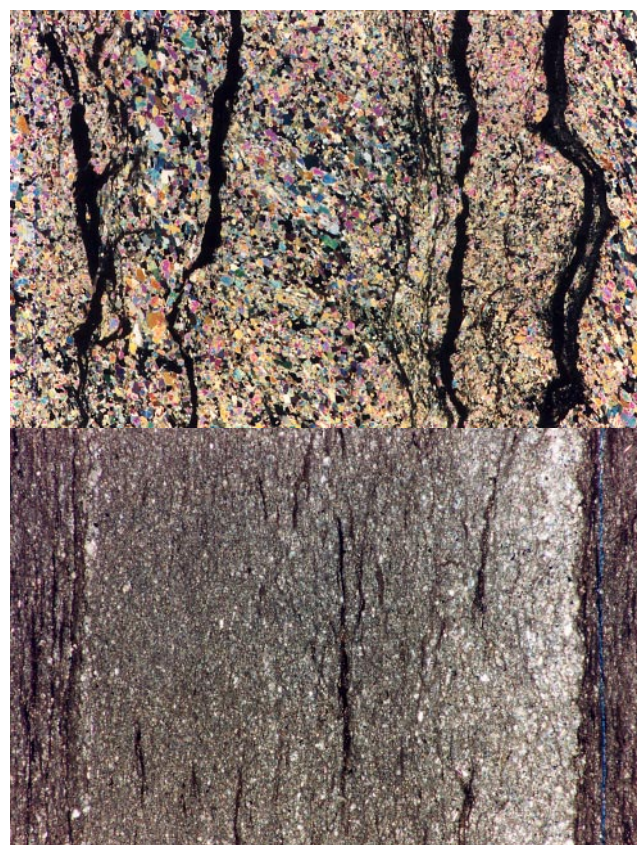
Fig. 8.2 HI versus T_{max} plot, Alinya Formation.

shows recorded from the Relief Sandstone in Observatory Hill 1, and from the Murnaroo Formation in Lake Maurice East and West wells. The source for this oil has been unequivocally determined as Alinya Formation based on biomarker distributions (McKirdy, 1993).

Origin and organic petrology

McKirdy (in Zang and McKirdy, 1994) has identified a diverse assemblage of molecular biomarkers from the Giles 1 evaporitic facies association, which indicates derivation from precursor eucaryotic algae and eubacteria.

The tidal flat facies of the Alinya Formation in Giles 1 contains abundant mats of the cyanobacterium *Eoentophysalis gilesis* (Zang, 1995a), which may form stratiform stromatolites 1–8 mm thick. The thinly bedded to laminated tidal flat evaporite association is very similar to that described from Shark Bay by Ferguson and Skyring (1995, fig. 5d), despite the 800 million year age difference



Photomicrograph of algal mats in the Alinya Formation in Giles 1: **Top:** intertidal anhydrite; cross-polars, width of view is 5.7 mm. (Photo 44405) **Bottom:** subtidal shale; plane polarised light, width of view is 2.2 mm. (Photo 44406)

between the two occurrences. Such cyanobacterial mats are capable of transforming into oil-prone kerogens under anoxic conditions.

Coominaree Dolomite

The Coominaree Dolomite is restricted to the eastern part of the basin, and has been intersected only in Manya 5. It is more widespread in the Peake and Denison Ranges, 200 km to the southeast. Contrary to Gravestock and Sansome (1994), no samples have been analysed for source rock quality, but the presence of stromatolites in the unit may indicate a minor source potential. However, the oxygenated environment may have resulted in the organic matter being consumed by aerobic bacteria.

Meramangye Formation

Only two samples (Marla 9) from the marine Meramangye Formation have been analysed for TOC, and

Table 8.1 Rock-Eval source rock data, Alinya Formation.

Well	Depth (m KB)	TOC (%)	Genetic potential (kg/t)	Oxygen Index	Hydrogen Index	T_{max} (°C)
Giles 1	1243.0	0.62	0.91	29	106	445
	1256.0	0.40	0.26	8	58	475
	1265.5	0.62	0.47	0	60	439
Manya 5	1266.4	0.26	0.00	158	0	427
	1283.9	0.28	0.01	64	0	323
	1300.6	0.26	0.01	50	50	218
	1314.2	0.46	0.01	61	0	271

indicate a very poor source with TOC ranging from 0.07 to 0.09%. No Rock-Eval analyses have been performed

Dey Dey Mudstone

Source richness

Fifty-one samples of the Dey Dey Mudstone analysed from Giles 1, Karlaya 1, Munta 1, Munyarai 1, and Ungoolya 1 indicate source richness ranging from very poor to poor (average TOC = 0.11%, range 0.03–0.81%). The source potential improves towards the top of the formation, where the depositional environment changes from fluvial to

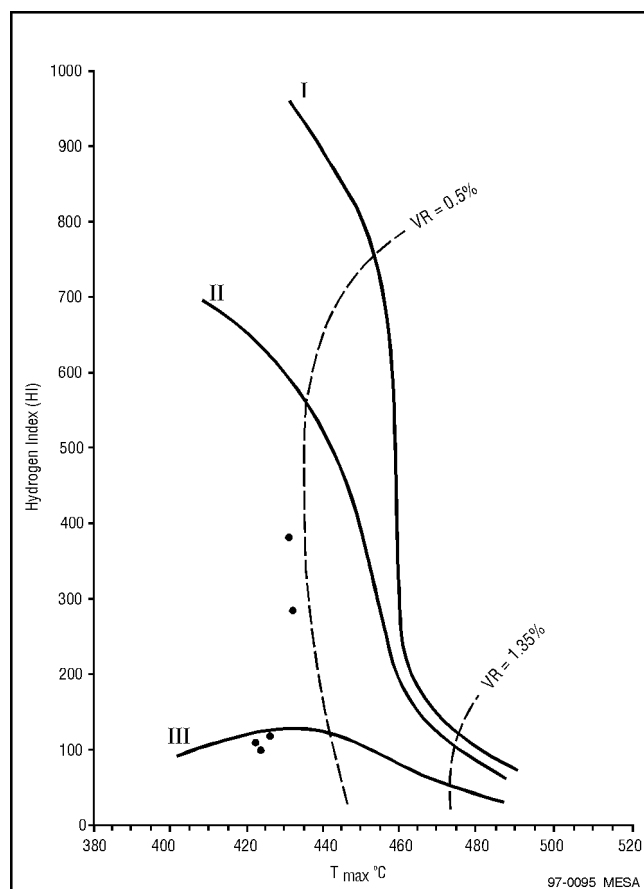


Fig. 8.3 HI versus T_{max} plot, Dey Dey Mudstone.

Table 8.2 Rock-Eval source rock data, Dey Dey Mudstone.

Well	Depth (m KB)	TOC (%)	Genetic potential (kg/t)	Oxygen Index	Hydrogen Index	T_{max} (°C)
Karlaya 1	2093.7	0.81	2.92	34	285	432
	2094.9	0.40	2.10	50	382	431
	2096.2	0.21	0.32	119	109	422
	2099.2	0.23	0.30	126	100	424
	2101.0	0.31	0.48	61	119	426

Table 8.3 Rock-Eval source rock data, Karlaya Limestone.

Well	Depth (m KB)	TOC (%)	Genetic potential (kg/t)	Oxygen Index	Hydrogen Index	T_{max} (°C)
Murnaroo 1	182.3	0.40	0.22			417
	182.4	0.72	1.54	98	194	426
	185.4	0.60	1.18	116	173	424

marine. Rock-Eval data for the Dey Dey Mudstone are summarised in Table 8.2.

Kerogen type and source potential

HI values are moderate (100–382), indicating oil-prone Type II kerogen (Fig. 8.3), with poor to fair genetic potential up to 2.92 kg hydrocarbon per tonne of source rock. The oil potential of the upper Dey Dey Mudstone is confirmed by the presence of oil shows in thin sandstone beds in Karlaya 1 and Marla 9. This is discussed further in Chapter 9.

Origin and organic petrology

The potential source beds are thin but contain oil-prone lamalginite which was probably derived from acritarchs and cyanobacterial mats (McKirdy, 1993). Sterane distributions suggest a green algal source (see Tanana Formation).

Karlaya Limestone

Source richness

The Karlaya Limestone is widely distributed over the Murnaroo Platform and in the Munyarai Trough, and is also probably present in the Birksgate Sub-basin. Twenty-eight samples have been analysed for TOC from Karlaya 1, Munyarai 1, Murnaroo 1 and Giles 1, which indicate a poor source with an average TOC of 0.20% (range 0.02–0.72%); this is, however, significantly better than the overlying Tanana Formation. Rock-Eval analyses are summarised in Table 8.3.

Kerogen type and source potential

HI values are moderate (173–194, two samples only), indicating oil-prone Type II kerogen (Fig. 8.4), with poor genetic potential up to 1.54 kg hydrocarbon per tonne of source rock. Given that the Karlaya Limestone contains isotopically heavy shelf carbonate indicative of organic matter burial (Jenkins *et al.*, 1992; Pell *et al.*, 1993), the source potential might be expected to be better than the data would suggest. Oil shows, which may have been sourced from the underlying Dey Dey Mudstone, have been recorded from Karlaya 1.

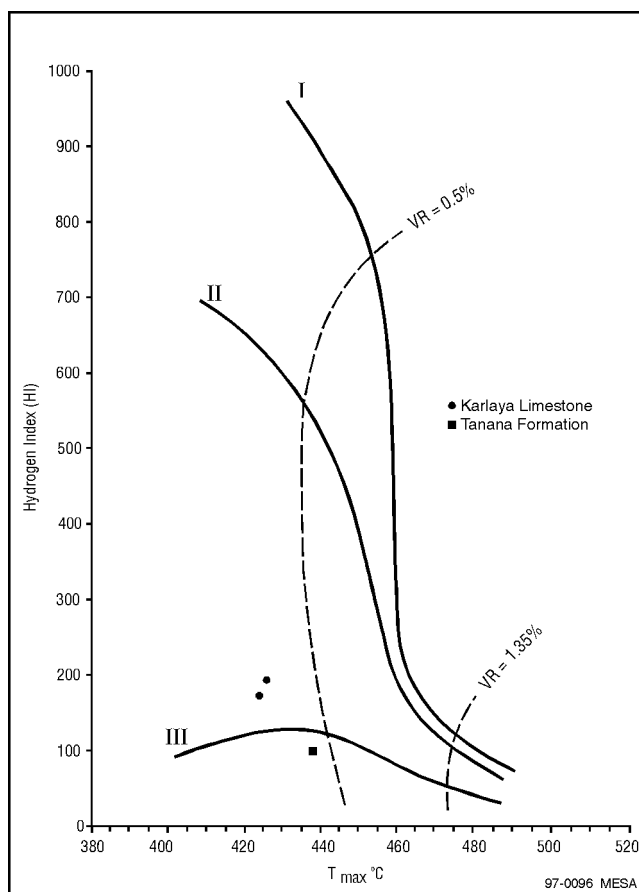


Fig. 8.4 HI versus T_{max} plot, Karlaya Limestone and Tanana Formation.

Tanana Formation

Source richness

One hundred and seven samples of the Tanana Formation, analysed from Giles 1, Karlaya 1, Lairu 1, Marla 9, Munta 1, Munyarai 1 and Ungoolya 1, indicate source richness ranging from very poor to moderate (average TOC = 0.14%, range

Table 8.4 Rock-Eval source rock data, Tanana Formation.

Well	Depth (m KB)	TOC (%)	Genetic potential (kg/t)	Oxygen Index	Hydrogen Index	T_{max} (°C)
Marla 9	218.9	0.92	0.05	11	3	
	269.3	0.53	0.67	28	100	438
Ungoolya 1	1623.1	0.20	0.16	140	75	350
	1930.6	0.20	0.12	75	60	362

Table 8.5 Rock-Eval Source rock data, Narana Formation

Well	Depth (m KB)	TOC (%)	Genetic potential (kg/t)	Oxygen Index	Hydrogen Index	T_{max} (°C)
Karlaya 1	1424.6	0.21	0.08	347	38	421
	1435.7	0.32	0.29	262	81	418
	1594.57	0.21	0.10	319	47	423
Ungoolya 1	1287.2	0.57	0.09	26	16	327
	1287.6	0.30	0.06	40	20	276
	1299.9	0.20	0.08	140	40	335
	1325.1	0.20	0.27	180	120	421
	1345.1	0.34	0.21	91	56	423
	1450.1	0.21	0.20	171	86	419
	1499.8	0.21	0.42	171	171	421
	1523.6	0.22	0.38	209	145	421
1525.0	0.21	0.33	186	129	421	

0.02–1.11%). The richest samples occur in Marla 9, although the highest value was from Lairu 1. Rock-Eval data for the Tanana Formation are summarised in Table 8.4.

Kerogen type and source potential

HI values are low (3–100), indicating gas-prone Type III kerogen (Fig. 8.4), with a poor genetic potential of up to 0.67 kg hydrocarbon per tonne of source rock. However, oil bleeds from fractures in Marla 9 suggest that oil has been generated.

Origin and organic petrology

The Marla 9 (Tanana Formation) and Karlaya 1 (Dey Dey Mudstone) oils have distinctive sterane distributions similar to those in Neoproterozoic oils and source rocks from Oman and Siberia. Primitive green algae appear to be the precursors (McKirby, 1993).

Munyarai Formation

Four samples were analysed from the Munyarai Formation in Munyarai 1, with TOC ranging from 0.08 to 0.20%. No Rock-Eval analyses were performed. The unit is predominantly fine grained and the environment is interpreted to be marine prodelta and outer shelf. This formation may have source potential but further drilling is required to obtain samples for analysis.

Narana Formation

Source richness

Fifty-one samples of the Narana Formation analysed from Byilkaoora 1, Karlaya 1, Lairu 1, Munta 1 and Ungoolya 1 indicate source richness ranging from very poor to moderate (average TOC = 0.16, range 0.04–0.57%). Rock-Eval data for the Narana Formation are summarised in Table 8.5.

Kerogen type and source potential

HI values are low to moderate (16–171), indicating gas prone Type III kerogen (Fig. 8.5), with poor genetic potential of no more than 0.42 kg hydrocarbon per tonne of source rock.

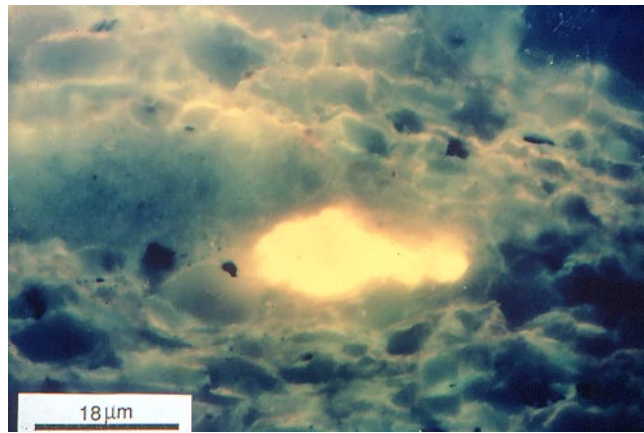
Origin and organic petrology

No organic petrology has been carried out. The Narana Formation comprises a lower canyon fill succession which is organically lean and an upper limestone–mudstone succession which contains the richest source rocks. The latter are presumed to derive from algal–cyanobacterial precursors.

Ouldburra Formation

Source richness

More than 260 TOC measurements have been made on samples from the Ouldburra Formation, including Marla 1A, 1B, 3, 6, 7 and Manya 3, 6 in the Marla Overthrust Zone and Manya Trough, and Wallira West 1, Wilkinson 1 and Karari 1, 2A in the Tallaringa Trough. The average TOC of all samples is 0.29% but may be much higher (up to a very good 4.56% in Marla 1A) in thin, organic-rich layers that are only reliably detected by close sample spacing. A profile of part of the Ouldburra Formation in Manya 6 (Fig. 8.6) shows the downhole variation in TOC (Kamali, 1995a). Between 680 and 850 m depth there are frequent high TOC ‘spikes’ against a low background, while from 1050 to 1450 m, spikes are more sporadic but the background TOC level rises to 0.3%.



Fluorescing *Gloeocapsamorpha prisca* and lamalginitite in the Ouldburra Formation at 263.35 m in Karari 1, Tallaringa Trough (from Kamali, 1995a). (Photo 44404)

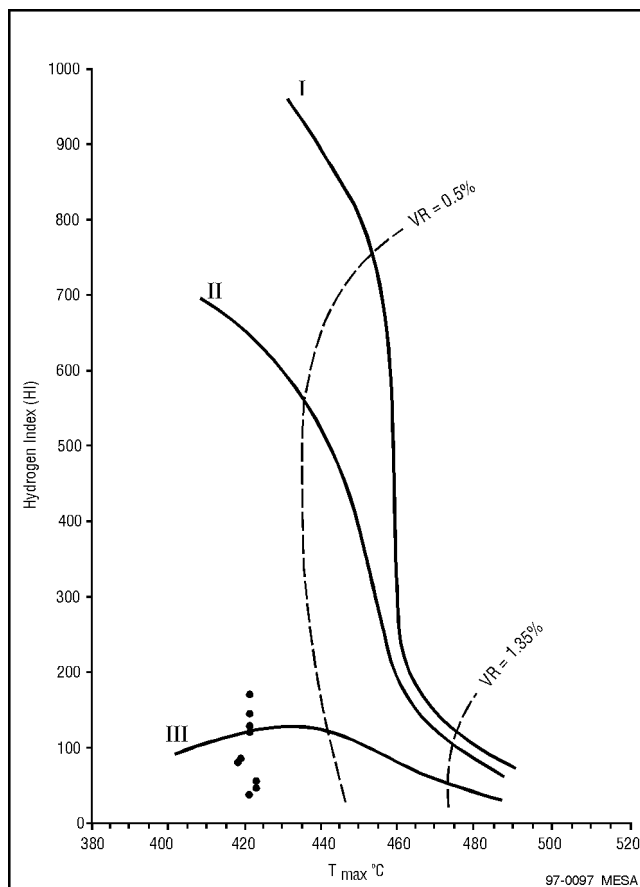


Fig. 8.5 HI versus T_{max} plot, Narana Formation.

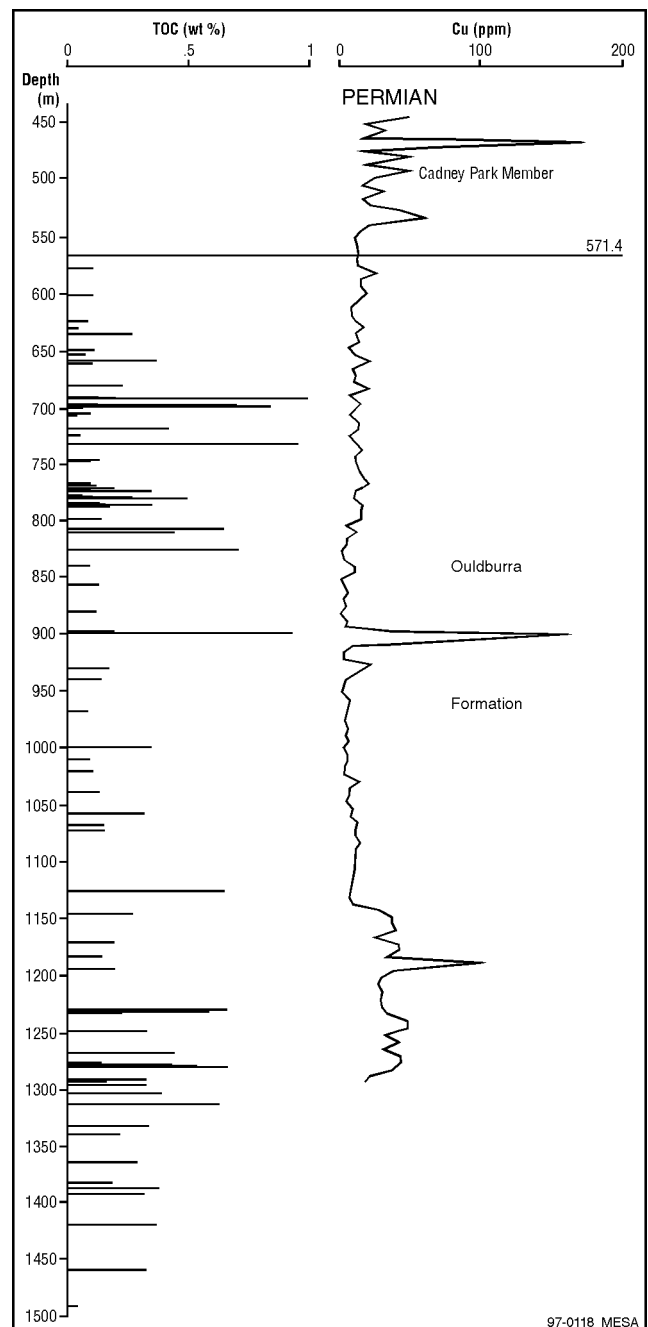


Fig. 8.6 Manya 6 TOC and copper profile (after Kamali, 1995b).

Kamali (1995a) related the organic matter distribution in Manya 6 to five 'organic matter preservation cycles' separated by exposure surfaces. In the two lower cycles (1035–1500 m), organic matter is in laminae of algal–cyanobacterial origin interbedded with halite which indicates a hypersaline environment. Organic matter in the upper three cycles (635–1035 m) is associated with limestone or dolomite interbedded with anhydrite and thin silty layers. The high frequency of organic-rich versus organic-poor alternations is suggested by Kamali (1995a) to stem from periodic flooding events and lowstands. This cyclicity is best developed in transgressive and highstand tracts of sequence C1.2 (703–849 m; Gravestock and Hibbert, 1991), which may correlate with a global relative sea-level maximum in Early Cambrian (Botomian) time. Rock-Eval data for the Ouldburra Formation are summarised in Table 8.6.

Kerogen type and source potential

There is a problem with Rock-Eval pyrolysis data for samples from the Manya Trough. The very low HI (0–91) suggests the presence of poor quality gas prone Type III or IV kerogen and an associated mineral matrix effect in argillaceous samples, even though their *n*-alkane profiles indicate an algal source (McKirdy *et al.*, 1984). These authors also pointed out the contrast between organic-rich laminae (TOC = 4.56%) and the dolomitic host rock (TOC = 0.18%). Ill-defined S₂ peaks also result in anomalously low T_{max} values, and oxygen indices (OI) are variable.

Samples from the Ouldburra Formation in the Tallaringa Trough are in complete contrast, even though the organic matter–carbonate–evaporite association is the same. This contrast is clearly demonstrated on Figure 8.7 which shows

Table 8.6 Rock-Eval source rock data, Ouldburra Formation.

Well	Depth (m KB)	TOC (%)	Genetic potential (kg/t)	Oxygen Index	Hydrogen Index	T _{max} (°C)
Manya Trough						
Manya 3	246.7	0.37	0.02	75	2	419
	360.4	0.45	0.02	75	2	440
	418.0	0.37	0.02	64	2	221
Manya 6	657.9	0.36	0.03	139	0	249
	691.7	0.97	0.75	69	41	307
	698.0	0.68	0.57	56	38	436
	698.6	0.82	0.81	52	61	476
	732.7	0.93	0.13	41	9	359
	773.8	0.34	0.04	126	0	279
	780.0	0.48	0.10	48	6	333
	785.8	0.34	0.04	115	0	279
	807.9	0.63	0.10	11	5	317
	810.5	0.43	0.04	49	2	279
	826.2	0.69	0.09	57	6	317
	899.8	0.91	0.07	11	3	279
	999.4	0.34	0.01	27	0	279
	1057.0	0.31	0.00	39	0	279
	1127.0	0.63	0.01	24	0	279
	1229.7	0.64	0.03	30	2	241
	1231.9	0.22	0.01	49	0	266
	1247.9	0.32	0.00	44	0	241
	1267.5	0.43	0.00	86	0	266
	1277.1	0.42	0.21	214	36	466
1279.1	0.52	0.15	133	12	304	
1279.8	0.64	0.01	92	0	241	
1302.1	0.38	0.00	121	0	205	
1312.7	0.61	0.00	80	0	221	
1332.3	0.33	0.03	312	0	281	
1386.6	0.37	0.04	86	3	241	
1392.4	0.31	0.01	155	0	232	
1419.3	0.36	0.17	86	31	241	
1459.2	0.32	0.08	88	19	241	
Marla 1B	136.7	0.64	0.15	87	12	440
	138.6	0.48	0.13	137	10	432
Marla 6	416.0	1.34	1.44	30	91	422
	671.2	1.13	0.27	15	11	341
	700.2	0.47	0.08	87	0	237
Marla 7	392.8	0.53	0.43	47	60	403
Tallaringa Trough						
Karari 1	263.3	1.18	5.18	455	388	427
	275.4	0.20	1.27	150	510	435
Karari 2A	211.8	0.34	1.12	91	285	430
	285.5	0.73	3.69	652	438	427
	298.0	0.59	2.90	567	372	425
Wilkinson 1	344.4	0.72	1.91	79	243	422
	344.6	0.78	1.64	69	193	424
	462.1	0.58	1.74	63	227	431
	480.9	1.10	5.35	50	409	433

the consistently high HI of samples from the Tallaringa Trough. Kamali (1995a) ascribed this contrast in the organic matter to a lower degree of oxidation, less bacterial degradation and less compaction compared to the Manya Trough. Michaelsen *et al.* (1995) suggested that the Ouldburra Formation in the Manya Trough was deposited under 'dysoxic' conditions (pristane-phytane ratio = 1.0-2.6), compared to 'anoxic' conditions in the Tallaringa Trough (pristane-phytane ratio ≤ 1.2). It is here suggested that these differences are due to the over maturity of the Manya Trough samples (supported by burial history modelling and MPI maturity data, see Chapter 9), and that in other areas not presently sampled, suitable Ouldburra Formation facies (transgressive tracts, evaporite associations) are likely to have fair to good source potential. Genetic potential of the Tallaringa Trough samples is moderately good, with values up to 5.18 kg hydrocarbon per tonne of source rock.

Origin and organic petrology

Examination of the base-metal assays routinely carried out on Comalco cores from mineral drillholes (Brewer, 1984) showed that copper and zinc display elevated values at depths comparable with those corresponding to some of the organically rich layers. A profile for copper illustrates this effect and suggests reducing conditions in the depositional environment (Fig. 8.6). Elevated base-metal values are commonly associated with organically rich sediments including sabkhas rich in cyanobacterial mats (Demaison and Moore, 1980; Ferguson and Skyring, 1995).

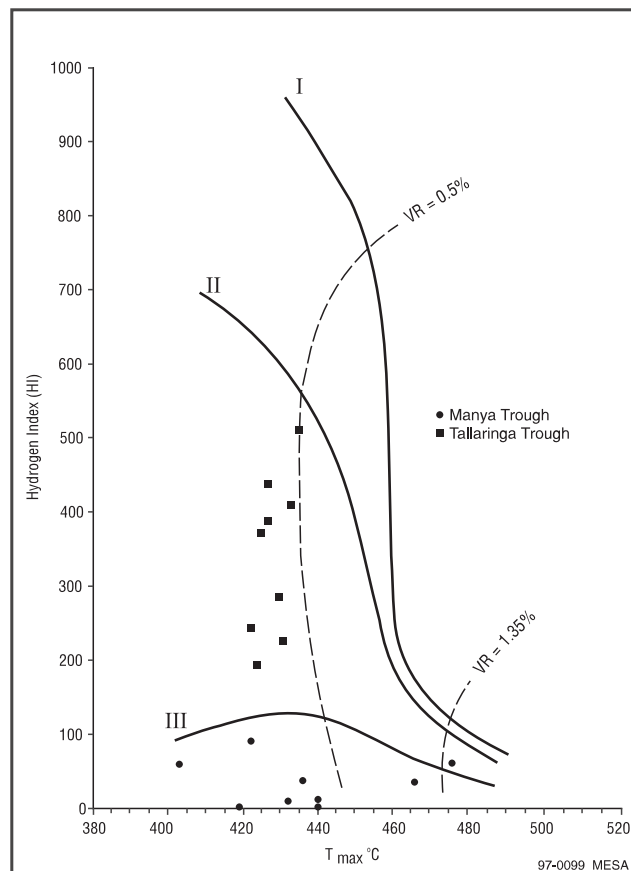


Fig. 8.7 HI versus T_{max} plot, Ouldburra Formation.

New molecular biomarkers found in the Tallaringa Trough include 24-Isopropylcholestanes, possibly from fossil sponges (McCaffrey *et al.*, 1993), and dinosterane, a dinoflagellate indicator (Michaelsen *et al.*, 1995). Of perhaps the greatest importance is the discovery of telalginite composed of the cyanophyte *G. prisca* in the Early Cambrian Ouldburra Formation (Kamali, 1995a,b; Michaelsen *et al.*, 1995). This organism had hitherto been identified only in Ordovician oil-prone source rocks (e.g. Summons and Powell, 1991).

In this context it is interesting to note the observations of Dow (*in Womer et al.*, 1987) on a whole rock extract from the Observatory Hill Formation in Ungoolya 1. Dow stated:

The whole extract gas chromatogram reveals a distinct odd carbon predominance in the C_{14} - C_{20} carbon number range ascribed ... to a particular organism *Gloeocapsamorpha prisca*. The high pristane and phytane content of the subject sample (from 1208.3 m) and the numerous extraneous peaks, however, are uncharacteristic of Ordovician oils and may be due to contamination, possibly from the drilling fluid.

As an alternative to contamination, this extract is suggested to represent oil which has migrated from the Ouldburra Formation and may have mixed with oil from a Neoproterozoic source sharing the same migration pathway. This implies that the Ouldburra Formation occurs downdip of Ungoolya 1, as indicated by Moussavi-Harami and Gravestock (1995) on their restored isopach map.

Observatory Hill Formation

Source richness

Nearly 150 samples have been analysed from the Observatory Hill Formation from Byilkaora 1, 2, 3, Emu 1, Giles 1, Karlaya 1, Munyarai 1, Murnaroo 1 and Ungoolya 1. The TOC of the Observatory Hill Formation is higher in the Marla Overthrust Zone (average 0.42%, maximum 2.29%) than on the Murnaroo Platform (average 0.20%, maximum 0.49%) where the alkaline playa facies was either not well developed or deep weathering has leached the shallow to exposed beds. There is no record of the Observatory Hill Formation in the Tallaringa Trough; strata originally ascribed to this formation in wells such as Wallira West 1, Wilkinson 1, and Karari 1 and 2A have since been assigned to the Ouldburra Formation (e.g. Stainton *et al.*, 1988).

A TOC profile of the Observatory Hill Formation in Byilkaora 1 is shown on Figure 8.8. Most of the elevated values are from the Moyles Chert Marker bed and Parakeelya Alkali Member, although values are variable due to staining by migrated oil (McKirby *et al.*, 1984). Copper assays are elevated and these also partly correspond to the organic-rich levels (data in Brewer, 1984). Rock-Eval data for the Observatory Hill Formation are summarised in Table 8.7.

Kerogen type and source potential

A plot of HI versus T_{max} (Fig. 8.9) shows that the Observatory Hill Formation has moderate to good oil source potential, and suggests Type II kerogen, but high H/C and C/N atomic ratios are consistent with an origin from Type I kerogen (McKirby and Kantsler, 1980; McKirby *et al.*, 1983).

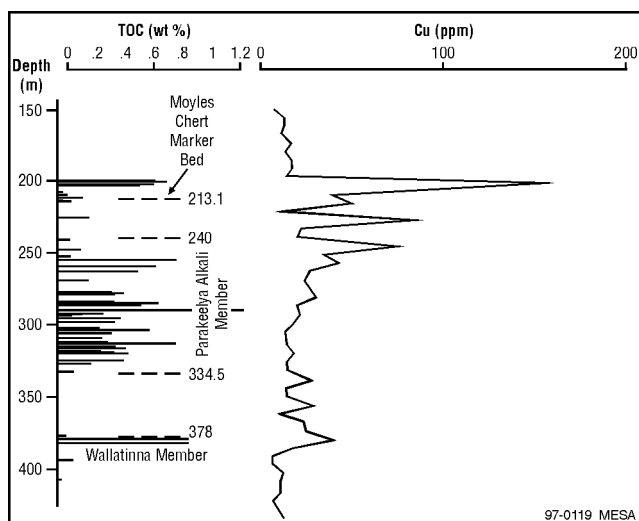


Fig. 8.8 Byilkaora 1 TOC and copper profile.

Genetic potential is best in the Marla Overthrust Zone with potential yield up to 7.34 kg hydrocarbon per tonne of source rock, and the abundant oil shows (including oil

bleeding from vugs in core from Byilkaora 1) confirms the oil potential of this formation.

Origin and organic petrology

The discovery of oil bleeding from vugs and fractures in core from Byilkaora 1 first drew attention to the hydrocarbon potential of the Officer Basin. The oil was generated *in situ* from halotolerant algae and bacteria in the non-marine playa lake facies of the Parakeelya Alkali Member of the Observatory Hill Formation (McKirdy and Kantsler, 1980; Pitt *et al.*, 1980; Brewer *et al.*, 1987), an argillaceous dolomitic mudrock with pseudomorphs of the evaporites trona and shortite. Organic petrographic examination has revealed abundant lamalginites which forms 'a web of organic matter such as might be expected from an algal mat' (McKirdy and Kantsler, 1980, p.84).

The importance of cyanobacterial mats as oil-prone kerogen precursors has been discussed by Zhmur *et al.* (1994) for settings ranging from lagoonal to marine. Zhmur and colleagues from the Paleontological Institute, Russian Academy of Sciences, are currently studying cyanobacterial mats from the Officer Basin, including those from the

Table 8.7 Rock-Eval source rock data, Observatory Hill Formation.

Well	Depth (m KB)	TOC (%)	Genetic potential (kg/t)	Oxygen Index	Hydrogen Index	T _{max} (°C)
Byilkaora 1	200.7	0.76	1.79	28	211	428
	202.3	0.67	2.43	35	298	427
	204.3	0.58	1.80	50	281	420
	254.9	0.83	2.88	27	310	425
	259.4	0.68	2.51	52	301	420
	286.5	0.58	1.90	55	260	419
Byilkaora 2	660.9	0.44	0.65	77	134	434
	670.0	0.50	1.41	100	240	417
	677.4	0.53	2.16	94	362	416
	680.5	0.77	3.43	42	412	422
	688.5	0.39	1.22	64	254	415
	699.6	2.29	7.34	27	257	439
	703.3	0.20	0.37	120	160	420
	705.7	0.13	0.02	146	15	404
	711.9	0.62	1.99	46	283	416
	720.1	0.28	0.62	86	200	418
	720.3	0.39	1.30	146	303	423
	727.4	0.31	1.05	139	284	410
	728.0	0.39	1.80	110	395	415
	728.5	0.34	1.00	91	262	414
729.1	0.68	2.64	57	350	412	
729.7	0.27	0.79	156	241	415	
738.0	0.43	1.41	105	263	431	
Byilkaora 3	343.0	0.73	3.59	18	386	423
	346.2	0.61	2.66	18	364	413
	346.8	0.56	2.47	54	355	414
	348.4	0.35	1.09	123	289	416
	365.2	0.55	3.64	13	600	426
	368.7	0.50	1.98	80	370	420
	373.2	0.81	3.69	86	417	423
Giles 1	212.6	0.47	0.50	57	98	424
	213.3	0.42	0.54	40	124	426
	224.4	0.56	0.99	14	173	430
Munyarai 1	1692.9	0.12	0.02	200	0	433
Ungoolya 1	1203.6	0.43	1.51	33	333	422
	1203.8	0.50	1.48	50	276	418
	1207.5	0.26	0.74	50	262	426
	1243.8	0.21	0.07	33	29	432
	1245.6	0.27	0.14	170	44	345

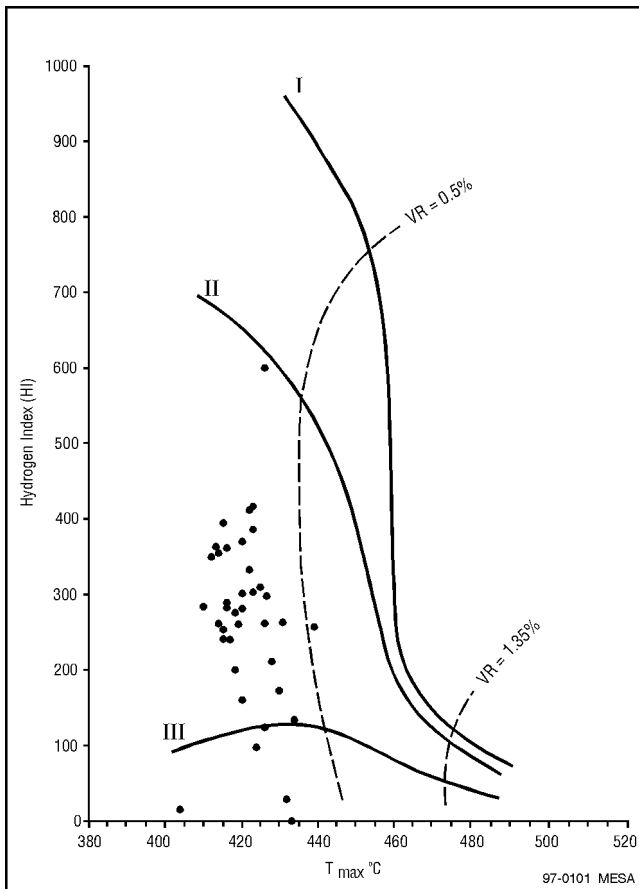


Fig. 8.9 HI versus T_{max} plot, Observatory Hill Formation.

alkaline playa facies of the Observatory Hill Formation. Results of this study will be available in 1998.

Apamurra Formation

Four samples from Byilkaora 1 were analysed for TOC, and results ranged from 0.33 to 0.64%. No Rock-Eval analyses have been performed. The unit is widespread over the eastern Officer Basin and is of shallow marine origin; it warrants further analysis to determine the source potential.

Indulkana Shale

No source rock analyses have been performed on the Ordovician Indulkana Shale because the unit has only been intersected in the subsurface in a few wells and has not been cored. The formation may have source potential as it is a probable correlative of the marine, organic-rich Horn Valley Siltstone in the Amadeus Basin. A distinctive aeromagnetic signature is associated with the Horn Valley Siltstone (Hamer, 1994) which may be caused by an oxidised pyrite-rich layer indicative of formerly reducing conditions.