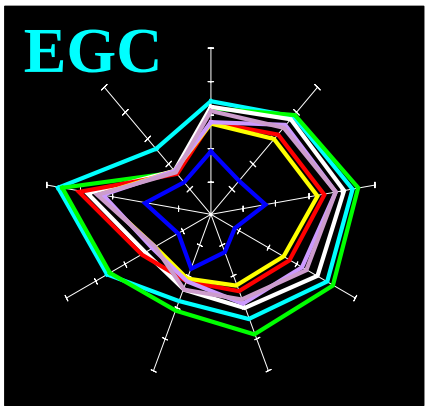

GEOCHEMICAL EVALUATION
OF

MEGASCOLIDES-1

Onshore Gippsland Basin

Victoria

Prepared for Karoon Gas Australia Ltd. by:

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EXECUTIVE SUMMARY

Megascolides-1 was drilled by Karoon Gas Australia Ltd. in the onshore portion of the Gippsland Basin in 2004. A geochemical programme was undertaken to characterize a hydrocarbon show observed at 1889m in conventional core recovered from the well. In addition, vitrinite reflectance measurements were performed on four cuttings samples and three samples of conventional core from between 240-1920m.

The VR-based maturity-depth profile is offset at the unconformity at the base of the *C. hughesii* interval, suggesting that significant erosion occurred on this surface during the Early Cretaceous (Barremian).

In addition, the hydrocarbon-generative window is unusually shallow (entrance at 400m), indicating that the Megascolides-1 sequence has been uplifted by as much as 2.5 km, and, therefore, that the generative window is presently inactive. Estimating the timing and amount of uplift is critical, since this will determine the risk of non-preservation of any hydrocarbons accumulated in the area.

The 1889m core extract contains a suite of n-alkanes characteristic of the presence of higher-plant-derived waxes, and of source rocks deposited in a sub-oxic sedimentary environment. In addition, these data suggest that the source organic matter is mainly land-plant-derived, but that a component of aquatically (algal-) derived organic matter may also be present. This is to some extent supported by the branched-cyclic biomarker data.

The extract appears to be moderately (rather than advanced) mature, equivalent to approx. 0.83% VR, consistent with the maturity of the host sediments. It is therefore unlikely that the 1889m extract has migrated over any significant vertical depth interval, and more likely that is indigenous to its host sediment, or locally migrated.

1. INTRODUCTION

Please note that all drilling and sample depths quoted in this report are mRT.

Megascolides-1 was drilled by Karoon Gas Australia Ltd. in the onshore portion of the Gippsland Basin in 2004.

A geochemical programme was undertaken to characterise a hydrocarbon show observed at 1889m in conventional core recovered from the well, and to determine the maturity-depth relationship in the drilled section. The Megascolides-1 geochemical programme is summarised in Table 1.

Geotechnical Services, Perth, solvent-extracted the 1889m core sample and separated it into its constituent bulk fractions by liquid chromatography (LC). Saturate-fraction GC-MS, branched/cyclics GC-MS and aromatics GC-MS analysis were then performed on the resulting fractions.

Vitrinite reflectance measurements were performed on four cuttings samples and three samples of conventional core from between 240-1920m.

Written and graphic interpretations of the results of the above analyses are the subject of this report. The analytical data on which these interpretations are based are included in Volume 1 ("Basic Data") of the Megascolides-1 WCR.

TABLE 1

MEGASCOLIDES-1
Geochemical Programme

SOURCE ROCK CHARACTERISATION

Sample Type	Depth mMDRT	Screening Pyrolysis	Alkene Removal	TOC	Rock-Eval	VR
Core	1889m					Yes

FLUIDS CHARACTERISATION

Sample Type	Depth mMDRT	Solvent Extraction	Whole-Extract GCMS	LC	Saturate-Fraction GCMS	Branched-Cyclics GCMS	Aromatics GCMS
Core	1889m	Yes		Yes	Yes	Yes	Yes

2. SOURCE ROCK CHARACTERISATION

2.1 Vitrinite Reflectance and Organic Petrographic Data

Vitrinite reflectance measurements were performed on four cuttings samples and three samples of conventional core from between 240-1920m in Megascolides-1. These resulting data are plotted against depth in Figure 1.

The VR data suggest that the maturity-depth profile is offset at the unconformity at the base of the *C. hughesii* interval, the higher value of 1.15% VR from the core sample at 1920m being obtained from the F. wonthaggiensis interval below the unconformity. This suggests that significant erosion occurred on this surface during the Early Cretaceous (Barremian).

According to the profile in Figure 1, the entrance to the oil-generative window lies at approximately 400m (while the entrance to the wet-gas window lies at approximately 2300m). These generative windows are therefore unusually shallow, indicating that the Megascolides-1 sequence has been uplifted by as much as 2.5 km, and, therefore, that the generative windows are presently inactive. Estimating when this uplift took place (and therefore when any generation, expulsion and migration of hydrocarbons terminated) is critical, since this will determine the probability of preservation (or, conversely, the risk of non-preservation) of any hydrocarbons accumulated in the area, particularly more mobile wet-gas/condensates.

Most of the samples analysed contain coal and related lithologies (such as coaly shale). While the coal material appears to be dominated by humic, Type III (vitrinitic) gas-prone material, some Type II, exinitic, oil-prone macerals (such as sporinite, cutinite and resinite) appear to be present, and occasionally abundant, in the samples between 240-1104m. These macerals become less conspicuous at 1535m and below, possibly because of advancing thermal maturity.

3. FLUID CHARACTERISATION

3.1 Solvent-Extraction/Saturate-Fraction GC-MS Analysis

A sample of conventional core from 1889m in Megascolides-1 was solvent-extracted in order to characterise observed traces of hydrocarbons. The resulting extract yield was 359 ppm. The extract was then separated into its bulk fractions by liquid chromatography (LC), and its saturate-fraction analysed by GC-MS.

The resulting chromatogram (Figure 2) shows that this liquid consists of a series of n-alkanes peaking within the nC_{17}-nC_{21} range. The liquid is depleted in light-end compounds due to the solvent-extraction process. The higher molecular weight range (above nC_{21}) displays an odd-over-even preference (Figures 2 and 3) characteristic of the presence of higher-plant-derived waxes, consistent with the dominance of higher-plant-derived organic material in the Megascolides-1 drilled section. This O/E preference is relatively subdued (CPI values = 1.07-1.08), indicating that the extract is moderately mature (see the later discussion of the aromatics GC-MS and VR data).

The Pr/Ph ratio from the extract is 2.94, indicating that its source organic matter was deposited in a sub-oxic sedimentary environment. The relative values of Pr/nC_{17} and Ph/nC_{18} (Figure 4) place the 1889m extract within the higher-plant-derived field, though close to the transition with aquatically derived organic matter. This (together with the Pr/Ph ratio) suggests that the extract was generated from source rocks containing land-plant-derived organic matter, but that a component of aquatically derived organic matter may be present. In the absence of truly marine environments in the Early Cretaceous section of the onshore Gippsland Basin, this may indicate a partly algal, lacustrine influence for the Megascolides-1 1889m extract. Note, however, that the even-over-odd preference often associated with algal-derived hydrocarbons is not evident in the 1889m extract, due to the apparent dominance of land-plant-derived source material.

3.2 Branched/Cyclics GC-MS Analysis

The branched-cyclic compounds were isolated from the saturate fractions of the Megascolides-1 condensate, then analysed by branched-cyclics GC-MS. The resulting m/z 191 chromatograms in respect of the tri- and tetra-cyclic compounds are shown in Figure 5.

As the upper trace in Figure 5 shows, very few branched-cyclic biomarker compounds (C_{19} and C_{20} tricyclics only) are identified or reported from the Megascolides-1 1889m core-extract. However, the lower trace infers the presence of a number of additional tri-, tetra- and penta-cyclic compounds, albeit in low concentrations. (The C_{19} and C_{20} tricyclics peaks are also re-assigned, being possibly mis-labelled in the original upper trace.) Assuming these inferences are correct, the dominance of the C_{19} and C_{20} tricyclics over the C_{23} tricyclic is a further indication of the land-plant input to the source of the extract. The very low abundances of all other branched-cyclic compounds largely preclude any other meaningful interpretations of the data, or valid comparisons of the Megascolides-1 extract with other Gippsland liquids.

3.3 Aromatics GC-MS Analysis

The Megascolides-1 condensate was analysed by aromatics GC-MS. The major application of aromatic GC-MS data is in the estimation of the thermal maturity of hydrocarbons, chiefly using the methylphenanthrene index (MPI) calibrated to the vitrinite reflectance scale. The equivalent vitrinite reflectance, or Rc(a), calculated from MPI value obtained from the Megascolides-1 1889m core-extract is 0.83%, suggesting an early oil-window maturity for the source rocks from which the extract was expelled.

In Figure 6, the VR-equivalent value from the 1889m extract is compared with the VR values measured from sediment samples. As these figures show, the apparent maturity of the 1889m extract (0.83% VR) is similar to that of the cuttings samples from 1535m and 1820m (0.79% and 0.86% VR respectively).

This suggests that the 1889m extract, having a maturity commensurate with that of its host section, is indigenous or locally migrated.

4. CONCLUSIONS

Megascolides-1 was drilled by Karoon Gas Australia Ltd. in the onshore portion of the Gippsland Basin in 2004. A geochemical programme was undertaken to characterize a hydrocarbon show observed at 1889m in conventional core recovered from the well. In addition, vitrinite reflectance measurements were performed on four cuttings samples and three samples of conventional core from between 240-1920m, to determine the maturity-depth relationship in the drilled section.

The VR-based maturity-depth profile is offset at the unconformity at the base of the *C. hughesii* interval, suggesting that significant erosion occurred on this surface during the Early Cretaceous (Barremian).

In addition, the hydrocarbon-generative window is unusually shallow (entrance at 400m), indicating that the Megascolides-1 sequence has been uplifted by as much as 2.5 km, and, therefore, that the generative window is presently inactive. Estimating the timing and amount of uplift is critical, since this will determine the risk of non-preservation of any hydrocarbons accumulated in the area.

The 1889m core extract contains a full suite of n-alkanes, displaying an odd-over-even (O/E) preference that is characteristic of the presence of higher-plant-derived waxes. The alkanes ratios from the extract suggest that its source rocks were deposited in a sub-oxic sedimentary environment. In addition, these data suggest that the source organic matter is mainly land-plant-derived, but that a component of aquatically derived (perhaps algal) organic matter may also be present. This is to some extent supported by the branched-cyclic biomarker data.

This O/E preference is not marked, indicating that the extract is moderately mature. This is supported by an aromatics-based maturity estimate of 0.83% VR. This is consistent with the maturity of the host sediments. It is therefore unlikely that the 1889m extract has migrated over any significant vertical depth interval, and more likely that is indigenous to its host sediment, or locally migrated.

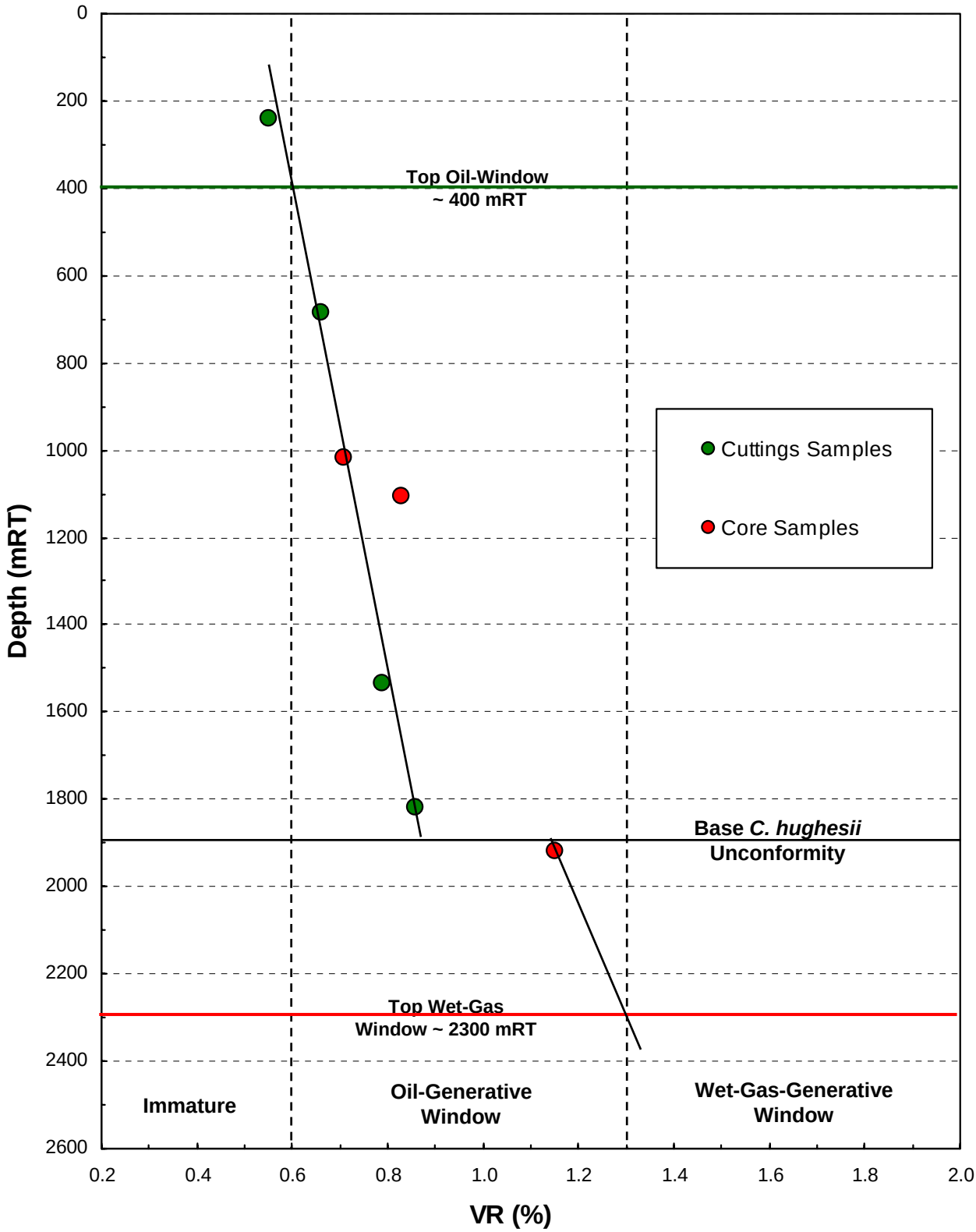
FIGURES

MEGASCOLIDES-1

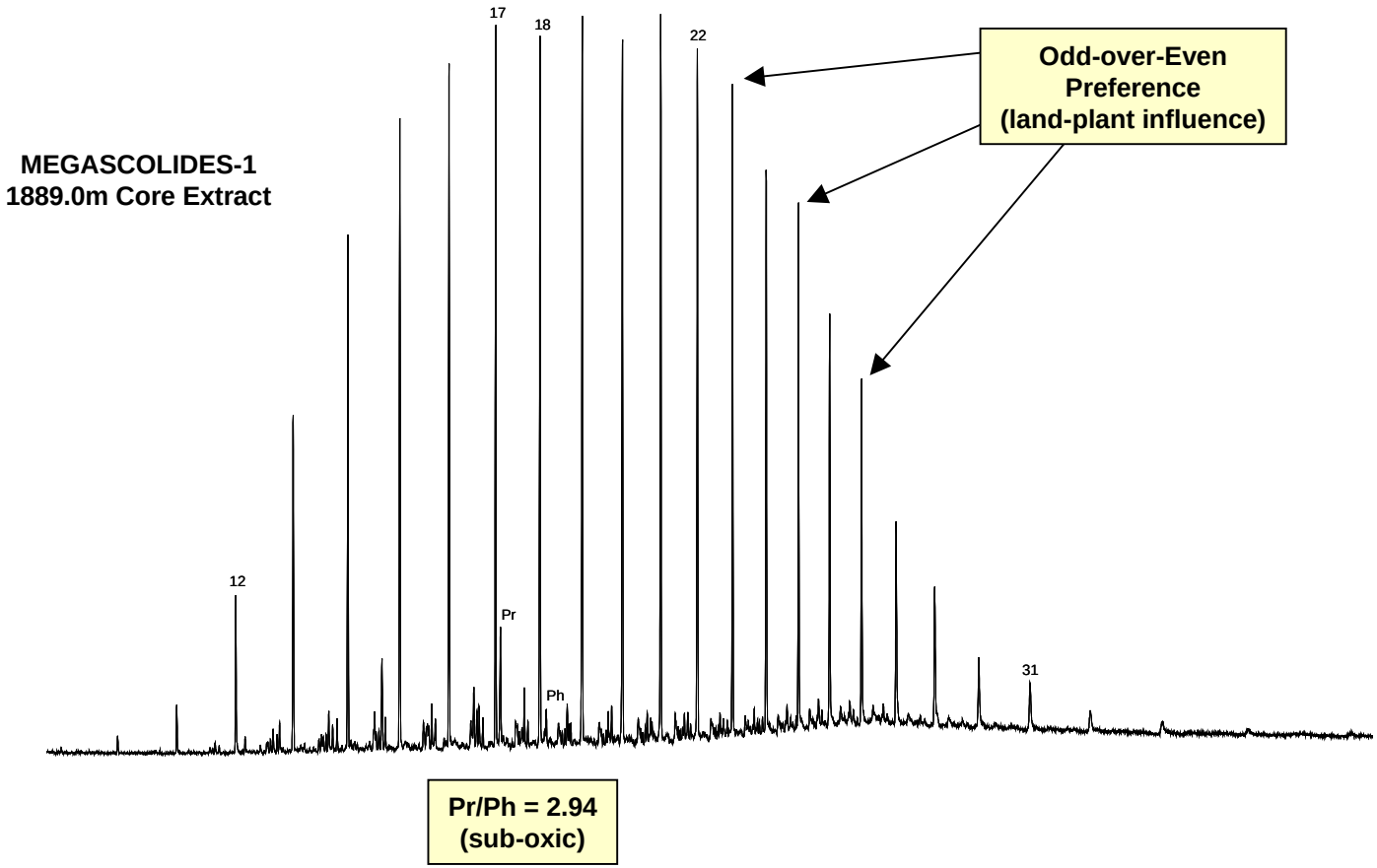
GEOCHEMICAL INTERPRETATION

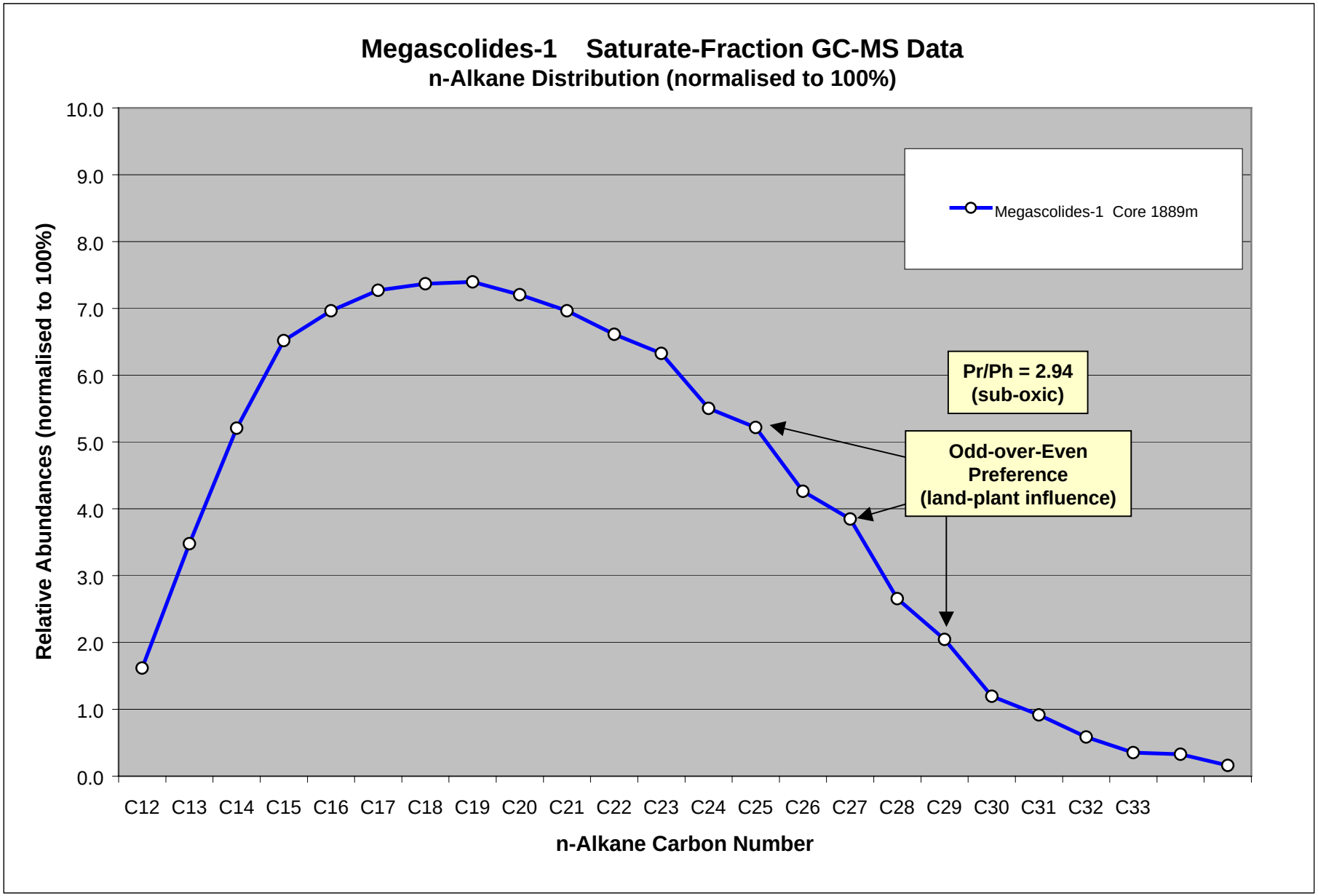
Megascolides-1

Vitrinite Reflectance versus Depth (mRT) plus Rc(a) Values



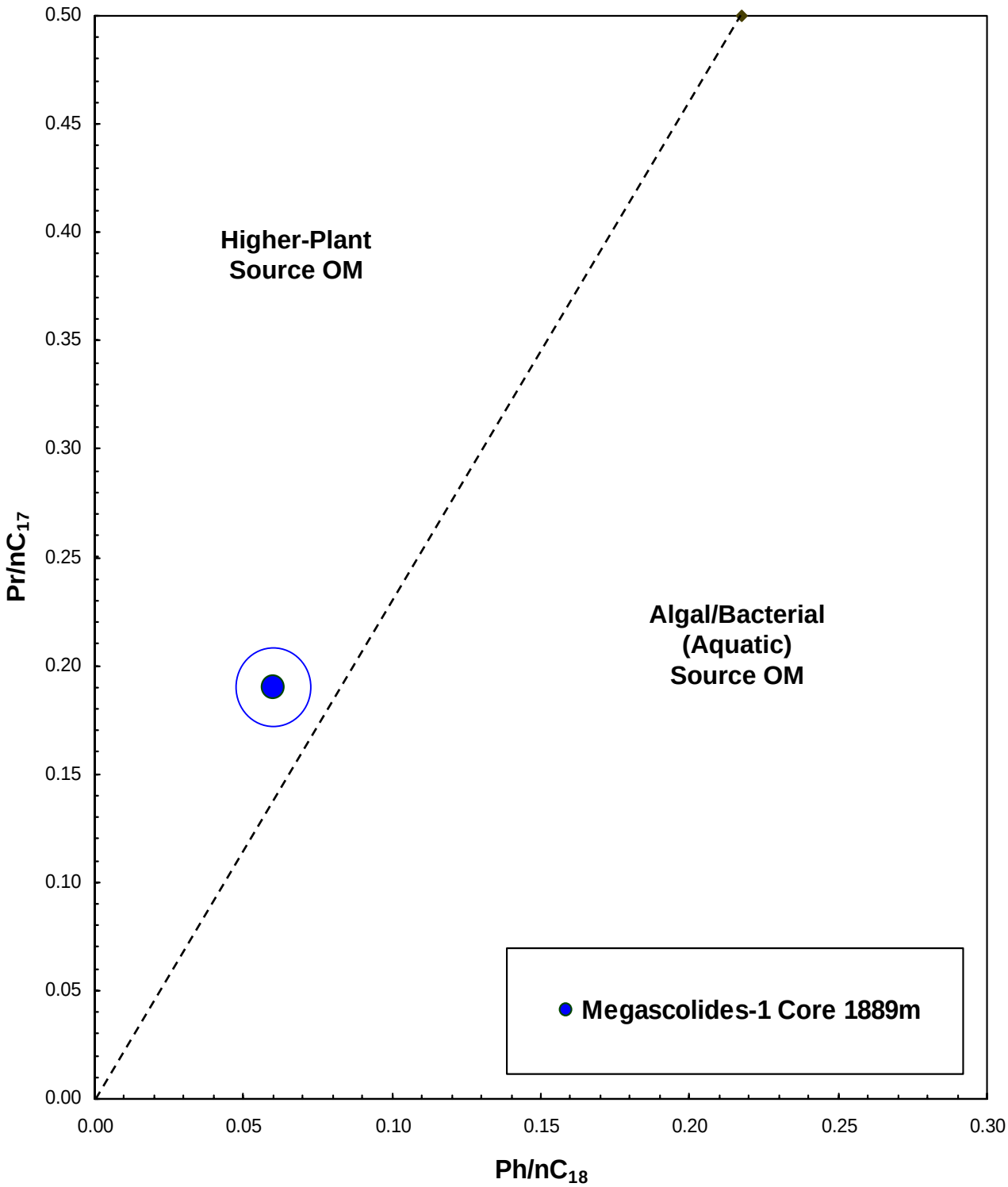
Megascolides-1 1889m Core Extract
Chromatogram from Saturate-Fraction GC-MS




Megascolides-1 Saturate-Fraction GC-MS Data
n-Alkane Distribution (normalised to 100%)
Relative Abundances (normalised to 100%)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
C12 C13 C14 C15 C16 C17 C18 C19 C20 C21 C22 C23 C24 C25 C26 C27 C28 C29 C30 C31 C32 C33
n-Alkane Carbon Number
Megascolides-1 Core 1889m
Pr/Ph = 2.94
(sub-oxic)
Odd-over-Even
Preference
(land-plant influence)

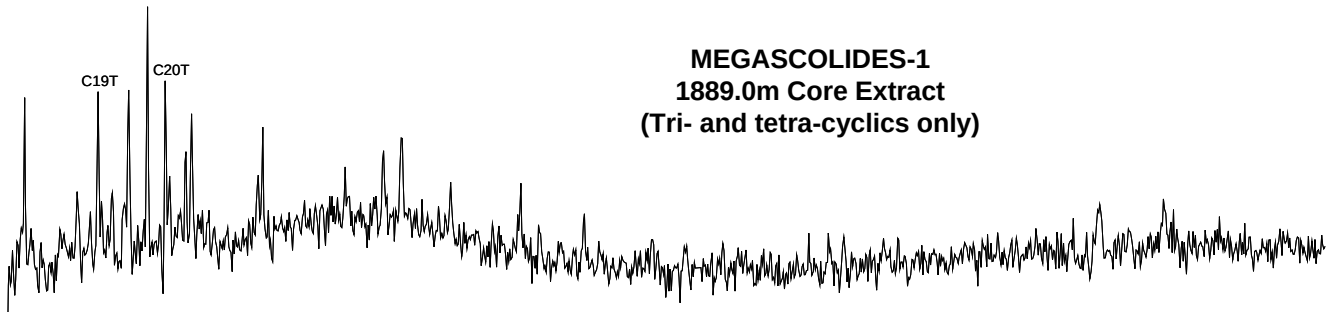
Megascolides-1

Pr/nC_{17} versus Ph/nC_{18}

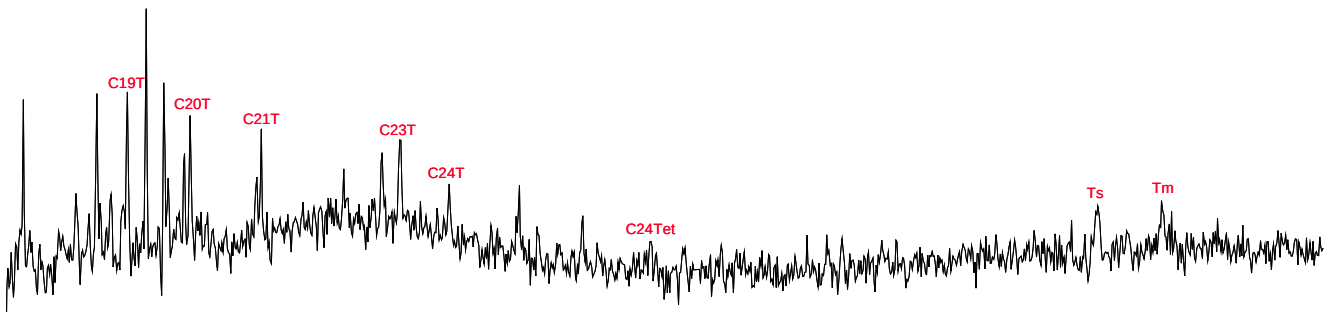


Megascolides-1 1889m Core Extract

m/z 191 Chromatogram from Branched-Cyclics GC-MS



MEGASCOLIDES-1
1889.0m Core Extract
(Tri- and tetra-cyclics only)



MEGASCOLIDES-1
1889.0m Core Extract
(Tri- and tetra-cyclics only)
with additional peaks inferred
(J.Preston)

Megascolides-1

Vitrinite Reflectance versus Depth (mRT) plus Rc(a) Values